Direct payments and budget subsidies versus finance and functioning of holdings and agricultural enterprises

INSTITUTE OF AGRICULTURAL
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Direct payments and budget subsidies versus finance and functioning of holdings and agricultural enterprises

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COMPETITIVENESS OF THE POLISH FOOD ECONOMY UNDER THE CONDITIONS OF GLOBALIZATION AND EUROPEAN INTEGRATION

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The work was carried out under the following theme:
Budget grounds for improvement of the competitiveness of the Polish agriculture
in the task: *Direct payments and budget subsidies versus finance and functioning of holdings and agricultural enterprises*

The main objective of this book is to present relationship between subsidies and performance of Polish farms. Authors analysed the "greening" mechanism in the system of direct payments in Poland and they used regression models for evaluation of the probable impact of its implementation on the Polish agricultural holdings.

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Foreword

The publication summarized realisation of task no. 4502 titled “Direct payments and government subsidies versus finance and running of farms and enterprises agronomic firms in 2014”.

Since the beginning, this public policy affecting agri-food sectors has been evolving from a supply management system to a holistic programme referring to producer support, agro-environmental issues and rural development.

The inclusion of Polish agriculture to the beneficiaries of the CAP instruments gave a significant boost in the direction of the acceleration of changes in the structure of farms and agricultural holdings.

Activities improving farm development are reflected in the structure of the assets of the company. Investing in newer technologies, machines or increasing the agricultural area, increased production capacity. This suggests that subsidies may be motivated to increase the production capacity of farms, as this will significantly reduce the cost of capital. This can be verified by determining conventional economic indicators.

Subsidies are an important stream of cash flowing to the farm, stabilizing its liquidity and enabling substitutability funds and increase the scale of operations. Moreover, they still had some impact on the structure of agricultural production, because subsidizing certain types of production is an incentive for the production of specific products.

The aim of the study was analysis of the relationship between subsidies and financial indicators of farms. Besides, the microeconomic modeling of the impact of proposals for the CAP for 2014-2020 were presented, in particular impact of the “greening”. The methodology has been subjected to a systematic analysis of evolution in whole implementing period of the task.

Most of models, regression and correlation analyses were established on resources of Polish FADN. Information regarding large-scale farms was taken from the Economics of Farm Holdings Department.

Construction of all chapters of the report is very similar. It consists of introduction, methodology description, presentation of the result and summary and conclusions.

1. Impact of the 2014-2020 CAP reform on the economic performance of Polish farms

1.1. Preface

Since its establishment, the Common Agricultural Policy has undergone successive reforms which were to ensure food security for the citizens of the European Union, strengthen the links between agriculture and the market and provide income support for farmers, while increasing the requirements with regard to environment protection and taking measures aimed at accelerating the development of rural areas across the EU.

One of the most important changes in the history of the CAP was the shift from product support to producer support by assigning a payment to the area of agricultural land owned by the farmer. This fundamental change in the philosophy of financial support for farmers in the EU has been made under the influence of external pressure, mainly from the WTO, and its original purpose was to eliminate distortions in international trade in agricultural commodities and food. By analogy, due to international factors, the EU started preparations to the next 2014-2020 reform. One of the primary determinants of this reform was the "greening" concept whose aim, though not expressly stated, was legitimization of financial support for agriculture due to the impact exerted by the WTO, but also in response to public expectations within the European Union.

This change was necessary due to the contemporary challenges facing the Common Agricultural Policy. They are largely conditioned by pressure from external factors. They have been defined[1] as:

- economic ones (including food security and globalization, the decline in yield growth, price volatility, pressure on production costs due to the high prices of inputs, deteriorating position of farmers in the food supply chain),
- environmental ones (with respect to resource efficiency, quality of soil and water, and threats to habitats and biodiversity),
- territorial ones (rural areas in some regions are facing demographic, economic and social changes such as depopulation or relocation of companies).

The shape of the current reform of the Common Agricultural Policy was decided upon jointly by the EU Council and the European Parliament. This was an unprecedented process in the history of the EU, as until then, the role of the European Parliament was limited to consultation.

[1] Communication from the Commission to the European Parliament, Council, European Economic and Social Committee and Committee of the Regions, COM (2010) 672, Brussels, 18.11.2010.

A public debate on the future shape of the CAP was initiated as early as in 2010, when the Commission presented the following Communication: "The CAP towards 2020: Meeting the food, natural resources and territorial challenges of the future"[2], which sets out initial assumptions and possible scenarios of the CAP reform in the new EU budgeting period. As a result of a nearly 4-year long legislative process, accompanied by debates and numerous discussions carried out between representatives of scientific, political, agricultural and pro-environmental circles, the final shape of the 2014-2020 CAP reform was set in 2014. During the legislative process, the public was informed of the subsequent proposals.

1.2. Evolution of the "greening" concept

Original proposal

The European Commission's proposal of November 2011[3] was the original document defining the shape of the future Common Agricultural Policy. The proposal assumed:

- covering with the "greening" requirement all farms with more than 3 hectares of arable area (AA), which would be required to have on their land at least three crops in rotation, with no crop covering more than 70%, or less than 5%, of the total arable area;
- maintaining the existing area of permanent grassland (PGL), with the right to a reduction of the area of no more than 5% compared to the base year;
- designating 7% of arable land for ecological focus areas (EFA).

Taking into consideration those criteria, it has been established that among all farms included in the FADN in 2009, 88% of Polish farms met the conditions for recognizing them as adapted ("green"), as they met the crop diversification criterion (Table 1). However, fully adapted farms meeting also the two main criteria (crop diversification and ecological focus area) accounted for only 14% of the FADN population.

Majority, i.e. as many as 74% of the surveyed facilities were farms with an adequately diversified crop structure, but without the required EFA. Only 12% of the farms would not meet the crop diversification requirement. It follows that the introduction of the rotation requirement would not require significant adjustments to the crop production structure (except for a relatively small proportion of farms with highly simplified crop structures). More profound production and

[2] Ibidem.
[3] European Commission, *Proposal for a regulation of the European Parliament and of the Council establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy*, October 2011.

financial effects could lead to an increase in ecological focus area up to 7% of arable land compared to that to be found on farms.

Table 1. Structure of farms represented in the FADN population in Poland in 2009 by production types and the degree of adjustment to the CAP "greening" requirements

By number of represented farms (FADN 2009)							
Specification	Cereal	Field crop	Cattle	Pig	Mixed	Other	TOTAL
"Green"	4%	13%	13%	5%	9%	48%	14%
No EFA	65%	75%	77%	75%	82%	37%	74%
No diversification	31%	12%	10%	20%	9%	15%	12%

Source: The authors' compilation based on the Multiannual Programme series 2011-2014, No. 46, Institute of Agricultural and Food Economics 2012.

Transitional stage – proposal of the European Parliament

The new Regulation of the European Parliament and the EU Council of 17 December 2013[4] mitigated considerably the previous requirements. In the new form, the CAP "greening" implied mandatory implementation of three actions consisting in:

- diversification of crops, with the exception of farms with up to 10 hectares of arable land. As regards farms with more than 10 hectares, but no more than 30 hectares of arable land a requirement to maintain at least two different crops in the crop structure, with the main crop covering no more than 75% of arable land, was introduced. On farms with over 30 hectares of arable land, at least three crops on arable land (main crop covering no more than 75% of arable land, with the two main crops covering in total no more than 95% of arable land) will be required. The ceilings shall not apply in the case of the main crop being grass or other green fodder. The term "crop" shall mean any culture of any of the different species defined in the botanical classification, as well as land left fallow. Winter and spring varieties of crops count as separate crops. For example, a farm with an area of 17 hectares of arable land, having in its crop structure 75% of spring barley and 25% of winter barley, will be recognized as a farm which meets the crop diversification requirement;

[4] Regulation (EU) No. 1307/2013 of the European Parliament and of the Council of 17 December 2013 establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy and repealing Council Regulation (EC) No. 637/2008 and Council Regulation (EC) No. 73/2009.

- maintaining at least 95% of the existing area of permanent grassland. Two ways to enforce this requirement are accepted – the first one assumes control at the level of individual farms, whereas the other assumes control at the level of the country or region. The requirement to maintain permanent grassland (PG) at the level of the farm has been limited to PGs designated by Member States and deemed to be environmentally valuable in Natura 2000 sites, including peat soils and wetlands. If the proportion of permanent grasslands in the total area of arable land in a given country or region has not decreased by more than 5% compared to the base year, it is permitted to execute control over those permanent grasslands at the level of the country or region, allowing for greater changes on individual farms;
- maintaining Ecological Focus Areas. In 2015-2017, it will be obligatory to set aside 5% of arable land, and then, depending on the decision of the European Commission, which is to be made by 31 March 2017, this percentage may be increased to 7%. Farms with up to 15 hectares of arable land will be exempt from this requirement.

Pursuant to the Regulation setting land aside for EFA may be replaced by the use of equivalent practices which are assumed, according to the definition, to yield the same or higher level of benefit for the environment and climate as obligatory practices do. Each Member State shall draw up its own list of actions that will be deemed equivalent to the "greening" practices. Equivalent practices shall include: the use of nitrogen-fixing crops (legumes), provided that they are grown without the use of mineral fertilizers and plant protection products, catch crops, land laying fallow, terraces, landscape features, buffer strips, agro-forestry area, green cover, areas with short rotation coppice with no use of mineral fertilizers and/or plant protection products and strips of plots adjacent to forest edge. Equivalent practices may also include components of the Agri-Environment-Climate Scheme, or national or regional environmental certification schemes.

It was decided that in order to convert individual equivalent practices into an area of EFA, the appropriate weighting factors taking into account the importance of the various categories of land for the environment would be applied. The proposed values of those factors were presented in July 2013 in a draft Regulation of the European Commission[5]. In the absence of consensus among the Member States on the values of the factors the decision on their determination was left to be made at the discretion of individual countries. To illustrate the general prin-

[5] Working document of the Council of the European Union No. 10991/13 *Proposal for a Regulation of the European Parliament and of the Council establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy (CAP Reform)* of 14 July 2013.

ciple, an example of a single field tree which, in accordance with the draft Regulation (ultimately rejected), was to be the equivalent of 200 m^2 of EFA can be used.

Taking into account the assumptions included in a revised version of the Regulation, the degree of adjustment by production types was re-analysed. In accordance with the re-analysis results it can be inferred that the CAP "greening" would affect to the greatest extent field crop farms and pig ones (Table 2).

Table 2. Structure of farms in the FADN population in 2011 by production types and the degree of adjustment to the CAP "greening" requirements

According to the number of represented farms (FADN 2011)						
Specification	Field crop	Cattle	Pig	Mixed	Other	TOTAL
Exempted	35%	58%	34%	59%	93%	57%
"Green"	23%	20%	18%	21%	3%	20%
No EFA	37%	20%	45%	18%	2%	21%
No diversification	1%	1%	0%	1%	1%	1%
No EFA and diversification	4%	1%	3%	1%	1%	1%

Source: S. Czekaj et al., Dopłaty bezpośrednie i dotacje budżetowe a finanse oraz funkcjonowanie gospodarstw i przedsiębiorstw rolniczych (3), Multiannual Programme, no. 82; Institute of Agricultural and Food Economics – National Research Institute, Warsaw 2013.

This is due to the fact that those production types are characterized by the lowest number of farms exempt from complying with the requirements, or those meeting all the criteria. At the same time those production types are typical of a high percentage of farms with insufficient EFA and a low degree of crop diversification.

Final shape of the reformed CAP

The final version of the Regulation[6] is based to a large extent on an earlier proposal by the European Parliament. However, the final regulations affecting the future agricultural policy were made much more specific.

From the perspective of the scenarios being considered, the introduction of a set of practices equivalent to EFA by individual Member States was of the greatest importance. This means that farmers forced to set-aside portions of their arable land will be able to at least partially restrict the area of arable land set--aside by means of using practices beneficial from an environmental standpoint. In Poland, these are "sustainable agriculture" package and the "protection of soil

[6] Regulation of the European Parliament and of the Council No. 1307/2013 of 17 December 2013 establishing rules for direct payments to farmers under support schemes within the framework of the Common Agricultural Policy and repealing Council Regulation (EC) No. 637/2008 and Council Regulation (EC) No. 73/2009.

and water" package within the agri-environment-climate measure under the RDP 2014-2020 that have been recognized as practices equivalent to crop diversification, as long as farmers concerned meet the requirements set out in the package.

A relatively extensive list of environmental practices (actions equivalent to EFA) will apply in Poland. The list will include most of the practices provided for in EU law, except for terraces, traditional stone walls and the so-called agroforestry systems. The weighting and conversion factors that will apply in Polish conditions have been provided for in national legislation. These specify the degree of replacement of EFA with individual landscape features (Table 3).

Table 3. The conversion and weighting factors applicable in Poland under the CAP 2014-2020

Specification	Conversion factor (m/tree to m^2)	Weighting factor	EFA (after the factors have been applied)
Land lying fallow	-	1	1 m^2
Landscape feature			
Hedgerows/wooded strips of land (1m)	5	2	10 m^2
Single trees (per tree)	20	1.5	30 m^2
Trees in line (1m)	5	2	10 m^2
Groups of trees/in-field trees (1 m^2)	-	1.5	1.5 m^2
Field margins (1 m)	6	1.5	9 m^2
Artificial ponds (1 m^2)	-	1.5	1.5 m^2
Ditches (1 m)	3	2	6 m^2
Other items not listed above but protected under GAEC 7, SMR 2, SMR 3 (1m^2)	-	1	1 m^2
Buffer zones (1m)	6	1.5	9 m^2
Strips of eligible hectares adjacent to the edge of the forest (1m): - on which production is pursued - on which production is not pursued	 6 6	 0.3 1.5	 1.8 m^2 9 m^2
Areas with short rotation coppice (1m^2)	-	0.3	0.3 m^2
Areas afforested under RDP (1m^2)	-	1	1 m^2
Areas with catch crops or green cover (1m^2)	-	0.3	0.3 m^2
Areas covered with nitrogen-fixing crops (1m^2)	-	0.7	0.7 m^2

Source: Agency for Restructuring and Modernization of Agriculture, 2014.

Ecological Focus Area (EFA) should, in principle, be located on the arable land of the farm, except for farmland covered with short rotation coppice and wooded areas.

Farmers whose farms are located in close proximity will be able to collectively implement the obligation to keep ecological focus areas. This solution will be restricted to those farmers whose farms are located in 80% within a maximum radius of 15 km.

The "greening" obligation will not apply to farms pursuing organic production and farmers who receive aid for small farms.

Exemptions from the requirement to use on farms selected "greening" elements have also been provided for facilities in which:

a) more than 75% of arable land is used for production of grasses or other herbaceous forage, or is fallowed, provided that the main crop on the remaining arable land is cultivated on no more than 75% of the remaining arable land (unless such remaining area is covered with grasses or other herbaceous plants, or is fallowed);
b) more than 75% of eligible agricultural area is permanent grassland, or is used for production of grasses or other herbaceous forage, or crop growing under water for a significant part of the year or during a significant proportion of the crop cycle, or a combination of these practices, provided that arable land not covered by these practices does not exceed 30 hectares;
c) more than 75% of arable land is used for production of grasses or other herbaceous forage, is fallowed or used for pursuing of a combination of these practices, provided that arable land not covered by these practices does not exceed 30 hectares;
d) more than 50% of the area declared as arable land has not been included by the farmer in his application for aid in the previous year and all arable land is used for cultivation of a different crop compared with the crop in the previous calendar year.

Taking into account the equivalents for EFA resulted in minor changes in the structure of farms in the FADN population due to the degree of adaptation to the "greening" process requirements. The percentage of non-adapted farms decreased by 4 percentage points relative to the previously existing guidelines. The final structure of the farms taking into account the level of compliance with the "greening" requirements in Poland is shown in Table 4.

Analysis of the table 4 leads to the conclusion that "greening", which was supposed to be a novelty, will apply to a relatively small group of farms which will have to make changes in their structure of field crop production. Non-compliance with the "greening" requirements is to result in a reduction in payments. Penalties in this respect in the first two years, i.e. 2015 and 2016, are expected to reach 100% of the amount of the "green" payment, in the next year − 120%, to eventually reach 125% of the amount of the "green" payment from

2018 onwards. Given that the "green" component is to be 30% of a direct payment rate, a farm that does not fulfil at least one of these three criteria will receive (in the 1st and 2nd years) aid per hectare reduced by 30% and, accordingly, by a maximum of 36% and 37.5% in the subsequent years.

Table 4. Structure of farms represented in the FADN population in 2012 by production types and the degree of adaptation to the CAP "greening" requirements

By number of represented farms (FADN 2012)						
Item	Field crop	Cattle	Pig	Mixed	Other	TOTAL
Exempted	36%	61%	36%	59%	93%	57%
"Green"	30%	20%	24%	23%	3%	23%
No EFA	30%	18%	33%	16%	2%	18%
No diversification	1%	0%	2%	1%	1%	1%
No EFA and diversification	3%	1%	5%	1%	1%	1%

Source: The authors' compilation based on FADN data.

1.3. Effects of the CAP "greening" on the organization and economic performance on agricultural holdings

The issues of "greening" under the Common Agricultural Policy have been discussed in numerous scientific works. A. Czyżewski and S. Stępień[7] believe that from the perspective of Polish agricultural holdings solutions as regards "greening" will not have a significant impact on changes in the production structure and costs. The authors support this claim with the fact that relatively high thresholds as regards farm area have been established, which, once exceeded, imply an obligation to carry out specific actions. Thus the need to isolate ecological focus area applies to 15% of Polish farms only.

The "greening" concept has been criticized by numerous authors[8] who claim that its foundations are incompatible with its objective. The authors point out that the majority of EU farmers work on farms whose areas are smaller than 10 hectares (Table 5), so they will be automatically exempt from the obligation to diversify their crops and keep ecological focus area. Therefore "greening" will not have a significant impact on the protection and improvement of the en-

[7] A. Czyżewski, S. Stępień, *Common Agricultural Policy (CAP) of the European Union after 2014 from the Polish perspective*, 9th Polish Economists Congress, Warsaw 2013.

[8] G. Pe'er, L.V. Dicks, P. Visconti, R. Arlettaz, A. Báldi, T.G. Benton, S. Collins, M. Dieterich, R.D. Gregory, F. Hartig, K. Henle, P.R. Hobson, D. Kleijn, R.K. Neumann, T. Robijns, J. Schmidt, A. Shwartz, W.J. Sutherland, A. Turbé, F. Wulf, i A.V. Scott, *EU agricultural reform fails on biodiversity*, Science 344:1090-1092, http://doi.org/10.1126/ science.1253425, 2014.

vironment, or the protection of biodiversity and natural resources, which were the original objectives of this process.

Table 5. Number of farms in the European Union with less than 10 hectares of arable land and farmland belonging to them

Region	States*	Number of farms < 10 hectares of arable land	% farms < 10 hectares of arable land	Farmland on farms exempt from the diversification and EFA requirements	% of total farmland on farms exempt from the diversification and EFA requirements
EU	EU-28	10,735,840	87.65%	83,750,890	48.31%
Western	AT, BE, DK, DE, IE, LU, NL, UK	574,350	61.40%	23,944,750	50.45%
Northern	FI, SE	44,230	32.77%	713,130	13.31%
Southern	FR, GR, IT, PT, ES	3,504,410	83.34%	35,782,640	49.98%
Central and Eastern	BG, HR, CY, CZ, EE, HU, LV, LT, MT, PL, RO, SK, SI	6,612,850	94.17%	23,310,370	46.90%

*Country codes: Belgium (BE), Bulgaria (BG), France (FR), Austria (AT), Italy (IT), Poland (PL), Czech Republic (CZ), Cyprus (CY), Portugal (PT), Denmark (DK), Latvia (LV), Romania (RO), Germany (DE), Lithuania (LT), Slovenia (SI), Estonia (EE), Luxembourg (LU), Slovakia (SK), Ireland (IE), Hungary (HU), Finland (FI), Greece (GR), Malta (MT), Sweden (SE), Spain (ES), Netherlands (NL), United Kingdom (UK), Croatia (HR).
Source: Eurostat data as cited in Pe'er G. et al., 2014.

The impact of the CAP reform on the capitalization of land in the EU has been the subject of research carried out also by Ciaian et al., 2013[9]. The authors analysed, one by one, the individual elements of the reform and their impact on the land market in the EU. According to them "greening" will result in an increase in costs incurred by farmers, which will reduce their income and thus lead to a decrease in demand for land.

The authors point out that in fact the impact of the CAP "greening" can vary greatly due to the existing diversity in the structure of production, specialization, geographical location and technology of production in agricultural holdings. Some farms will not have to adapt to the "greening" requirements all, e.g. if their production structure is diverse enough or they have land on which production is not viable. Farms, particularly those specializing in the cultivation of

[9] P. Ciaian, D. Kancs, J. Swinnen, *The Impact of the 2013 Reform of the Common Agricultural Policy on Land Capitalization in the EU*, Paper prepared for presentation at the EAAE 2014 Congress "Agri-Food and Rural Innovations for Healthier Societies", August 26 to 29, 2014, Ljubljana, Slovenia.

one crop and having no fallow land, may have to adapt their production structure to the new requirements.

Some researchers predict that "greening" will result in an increase in prices of agricultural products, which will lead to, in spite of costs incurred in order to adapt to the new requirements, an increase in the income generated by farms[10].

1.4. Effects of the CAP "greening" on Polish farms

Research methodology

In order to determine the impact of the final form of the CAP "greening" the baseline scenario and three scenarios for reformed agricultural policy have been developed. The scenarios have been supplemented with optional solutions developed under the assumption of the constant price level of 2012 or, alternatively, an increase in prices caused by restrictions related to the CAP "greening", projected on the basis of the performance within the CAPRI model. To determine the economic impact of their potential implementation non-linear optimization model was used based on the Positive Mathematical Programming (PMP). The model was applied to each identified farm type. The typology of farms and their characteristics were developed on the basis of the Polish FADN data.

The results obtained by the modelled farms were aggregated in order to determine the impact of the agricultural policy scenarios on economic results obtained in the different types of farms and FADN regions.

Farm model

The Farm-Opty optimization model of a farm upgraded a with non-linear cost function using the Positive Mathematical Programming method[11] was used to determine the potential effects of changes. The basic premise on which the model is based is the behaviour of farmers seeking to maximize profit, which is rational from the economic point of view. Thus this function assumes maximization of agricultural income, and its overall form is show in the following equation:

Provided that $Ax \leq B$

$$\underset{x_i \geq 0}{DR} = \mathbf{p}^T \left(\mathbf{x} \bullet \mathbf{y} \right) + \mathbf{s}^T \mathbf{x} + fs - fc - \mathbf{d}^{\mathbf{T}} \mathbf{x} - \mathbf{x}^{\mathbf{T}} \mathbf{Q} \mathbf{x}$$

[10] *Implementation of CAP reform in England*, Evidence Paper DEFRA, 2013; https://www.gov.uk/government/publications?keywords=&publication_filter_option=consultations&to-pics%5B%5D=all& departments.

[11] R.E. Howitt, *Positive Mathematical Programming*, American Journal of Agricultural Economics, 77(2), 1995a, pp. 329-342.

where:
DR – agricultural income (numeric value of the objective function),
p – products price vector (n x 1),
y – yield and productivity vector (n x 1),
x – non-negative vector of optimum levels of production activities (n x 1),
x•y – Hanamard's product,
s – vector of payments for production activities (n x 1),
fc – relatively fixed costs value,
fs – value of the payments for operating activities which are relatively independent of the level of production,
A – resource utilization coefficients matrix (m x n),
B – vector of available resources (m x 1),
d'x-x'Qx – non-linear element of the objective function determined in the course of model calibration[12].

This model builds on the classical linear optimization problem used in farm models[13,14]. Linear optimization models usually require a lot of data, therefore they often yield results which are different from reality, because of the tendency to over-simplify the production structure. This is due to the fact that a substantially justified number of restrictive conditions is far less than the number of the observed activities.

Significant differences between the results of linear models and observed values hinder the transfer of results to potential recipients, even if the models react properly to the stimuli assumed in the scenarios. This results in a need for their calibration by adding various restrictions. The most common ones are crop rotation constraints, specifying the maximum or minimum proportion of individual crops in the crop structure. Even leaving aside the weak theoretical or empirical justification for such restrictions, in the case of structures of models for farm aggregates (e.g. for types according to the FADN), they often over-restrict the scope of permissible solutions for simulated scenarios.

Compared to the classical linear programming models, the Positive Mathematical Programming (PMP) has several important advantages:

- the applied calibration procedure allows for easy and accurate representation of the actually observed values of modelled features[15];

[12] Ibidem.
[13] A. Wąs, *Model optymalizacyjny rolnictwa (na przykładzie gminy Kobylnica)*, Publication of the Warsaw University of Life Sciences, Warsaw 2005, pp. 1-144.
[14] W. Ziętara, *Plan roczny i koncepcja systemu kontroli jego realizacji w państwowym przedsiębiorstwie rolniczym*, Warsaw University of Life Sciences, Warsaw, 1989.
[15] P.B. Hazell, R.D. Norton, *Mathematical Programming for Economic Analysis in Agriculture*, MacMillan, New York, 1986.

- complementing the linear model with non-linear elements leads to overcoming the problems related to excessive simplification of solutions (over-specialization); solutions include a greater number of activities without having to introduce additional "artificial" limitations;
- PMP allows for avoiding sudden changes in the solutions which are disproportionate to the scale of changes in external conditions introduced in the analysed scenarios;
- modifications to the model applied at the calibration stage affect the model behaviour during simulation to a much lesser extent than calibration constraints used in linear programming models;
- non-linear (quadratic) function of the objective captures an increase in unit costs of production as a result of an increased level of pursued activities. They can result from inadequate equipment resources, insufficient organizational capacity and reduced yields due to the need to use lower-quality land[16].

For the first time the PMP approach was formalized and described in Howitt's work[17]. However, similar techniques had already been successfully applied in earlier expertise works supporting political decision-making processes[18,19,20]. In most applications of this type a new technique was introduced to the already existing linear models as a substitute for numerous calibration constraints.

The method published by Howitt immediately gained popularity as evidenced by numerous publications in which the new approach has been used[21, 22, 23].

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[16] R.E. Howitt, *A Calibration Method for Agricultural Economic Production Models*, Journal of Agricultural Economics, No. 46, 1995b, pp. 147-159.

[17] R.E. Howitt, *Positive Mathematical Programming*, American Journal of Agricultural Economics, No. 77(2), 1995a, pp. 329-342.

[18] R.E. Howitt, B.D. Gardner, *Cropping Production and Resource Interrelationships among California Crops in Response to the 1985 Food Security Act*, [in:] *Impacts of Farm Policy and Technical Change on US and Californian Agriculture*, Davis, 1986, pp. 271-290.

[19] H. Kasnakoglu, S. Bauer, *Concept and Application of an Agricultural Sector Model for Policy Analysis in Turkey*, [in:] *Agricultural Sector Modelling*, S. Bauer und W. Henrichsmeyer (red.), Vauk Verlag, Kiel, 1988.

[20] H.J. Schmitz, *Entwicklungsperspektiven der Landwirtschaft in den neuen Bundesländern - Regionaldifferenzierte Simulationsanalysen Alternativer Agrarpolitischer Scenarien*, Studien zur Wirtschafts- und Agrarpolitik, Witterschlick/Bonn, M. Wehle, 1994.

[21] F. Arfini, The Effect of CAP Reform: *A Positive Mathematical Programming Application,* Paper presented at an International Conference on 'What Future for the CAP', Padova, 1996.

[22] C. Graindorge, B. Henryde Frahan, R.E. Howitt, *Analysing the effects of Agenda 2000 Using a CES Calibrated Model of Belgian Agriculture*, [in:] T. Heckelei, H.P. Witzke, and W. Henrichsmeyer (ed.): *Agricultural Sector Modelling and Policy Information Systems*, Proceedings of the 65th EAAE Seminar, March 29-31, 2000 at Bonn University, Vauk Verlag Kiel, 2001, pp. 177-186.

Scenarios considered

A. [Base_2012] and Baseline_2020 scenarios

The scenarios assume a continuation of the current CAP. The base scenario was used only to calibrate the models designed based on FADN data from 2012, and was adopted as a baseline in the presented version of calculations. The Baseline_2020 scenario will provide a point of reference for other scenarios of the reformed CAP. The Baseline_2020 scenario assumes that the existing CAP mechanisms will remain unchanged, provided that the direct payment rate at the level which was reached in Poland in 2013 will be used in the model.

B. Green_2020 Scenario

In this option, a rate of direct payments in the amount of EUR 184 per hectare, including 30% of "green" payments – EUR 74 per hectare, is used. The option assumes the implementation of the requirements arising from the CAP "greening".

The Green_2020 scenario assumes that in connection with the inclusion of the "greening" component in the direct payment scheme and a decrease in funding of agri-environmental activities under the 2nd pillar, from EUR 2.304 billion provided for in RDP 2007-2013 to EUR 1.060 billion provided for in RDP 2014-2020, i.e. by 46%, the existing agri-environmental payments will be reduced also by 46% per average farm which will be the subject of modelling.

Farms meeting the conditions mentioned below will be entitled to the following newly introduced payments[24]:

- Payment for young farmers (up to 40 years of age) who have been running their farms for no longer than 5 years. This payment will take the form of area payment, and the rate will be 25% of the national average payment per hectare, i.e. approximately EUR 62 per hectare. The payment will be eligible for an area no bigger than 50 hectares.
- Additional payment to which all farmers owning land the area of which ranges from 3.01 to 30 hectares will be entitled. Such aid will therefore be focused on small and medium-sized farms. This will allow for more effective income support for those farms which do not enjoy benefits of large scale of farming but do have growth capacity. The rate will be around EUR 41 per hectare.

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[23] J.F.M. Helming, L. Peeters, P.J.J. Veendendaal, *Assessing the Consequences of Environmental Policy Scenarios in Flemish Agriculture*, [in:]: T. Heckelei, H.P. Witzke, W. Henrichsmeyer (ed.), *Agricultural Sector Modelling and Policy Information Systems*. Proceedings of the 65th EAAE Seminar, March 29-31, 2000 at Bonn University, Vauk Verlag Kiel, 2001, pp. 237-245.

[24] *Draft direct payment scheme in 2015-2020*, Ministry of Agriculture and Rural Development, Warsaw, August 2014.

- Payments related to production:
  - Payment for cattle to which farmers having at least 3 bovine animals aged up to 24 months will be entitled. All animals from the 1st to the 30th one will be eligible for this payment. An animal will be eligible for such a payment maximum two times in its lifetime, but only once in a given year (for example, at the age of 6-8 months and 12-24 months). The support will apply to cattle, regardless of its gender, fulfilling the requirements for the identification and registration of animals, and will amount to EUR 70 per animal.
  - Payment for cows to which farmers having at least 3 cows aged up to 24 months will be entitled, made for each cow up to the 30th one. The payment will apply to cows that meet the requirements for the identification and registration of animals, and will amount to EUR 70 per animal.
  - Payment for sheep to which farmers having at least 10 ewes aged minimum 12 months will be entitled, for all the animals on the farm in the amount of EUR 25 per animal.
  - Payment for goats to which farmers having at least 5 female goats will be entitled, made for all the animals on the farm. The payment will apply to female goats at the age of minimum 12 months, and will amount to EUR 15 per animal.
  - Payment for soft fruit – farmers who own area eligible for SAPS on which strawberries and raspberries are grown will be entitled to an additional payment in the amount of EUR 250 per hectare.
  - Payments for protein crops – paid to an area on which pulses and small-seeded legumes are grown as the main crop, if such an area is eligible for SAPS. A degressivity rate will be applied in the following ranges of area in ha:
    - 0-50 hectares – 100% of the basic rate (EUR 326 per hectare),
    - 50.01-100 hectares – 50% of the basic rate (EUR 163 per hectare),
    - 100.01-150 hectares – 25% of the basic rate (EUR 81.5 per hectare),
    - over 150 hectares – no payment.

C. No_Green_2020

The scenario implies giving up 30% of direct payments, as a result of the rejection of the proposal for "greening" under the CAP by farms non-adapted to this requirement. They would be "punished" by a reduction in direct payments by the value of the "green" payment, i.e. EUR 74 per hectare, thus receiving direct payments in the amount of EUR 110 per hectare. It was assumed that farms exempt from "greening" and fulfilling all the requirements would receive direct payments, equal to those assumed in the Green_2020 scenario. Similarly to the

Green_2020 scenario, the newly introduced payments and a reduction in payments under the agri-environmental programmes (by 46%) were accounted for.

In practice, it should be considered improbable that all farmers from non-adapted farms will give up their "greening" payments. Therefore, the solution for the No_Green_2020 scenario may only be treated as a point of reference for comparison, defining the limits for farm income changes caused by the implementation of the CAP reform.

LFA payments were assumed in all the scenarios under consideration at the level used to date.

In the scenario options designed for the models, forecasted factors applicable to changes in prices and crop yields determined via solutions developed with the use of CAPRI – the partial equilibrium model of the agricultural sector, were used alternatively to the fixed price level of 2012.

Table 6. Changes in prices and yields of basic agricultural products according to the CAPRI model applied in the "greening" scenarios under consideration [nominal prices].

Agricultural products	Baseline 2020=100	
	Yield	Price
Wheat	101.3%	103.3%
Rye and triticale	101.0%	103.4%
Barley	101.3%	103.8%
Oat	101.4%	104.1%
Corn (grains)	101.3%	103.1%
Other cereals	101.1%	103.5%
Rape	100.1%	104.3%
Legumes	100.5%	104.4%
Potatoes	100.2%	100.9%
Sugar beet	99.9%	102.3%
Beef	100.0%	101.2%
Pork	100.0%	100.7%
Poultry	100.0%	100.8%
Milk	100.0%	101.8%

Source: The authors' compilation based on the results achieved with the use of the CAPRI model[25].

[25] W. Britz, P. Witzke, *CAPRI model documentation* http://www.capri-model.org/docs/capri_documentation.pdf, 2012.

Research samples

Polish FADN resources were the main source of data for analysis. The data gathered in 2012 were used to develop a typology and prepare parameters for farm models. The data set consists of 10,909 research objects (individual farms). The entire population of farms was divided into production types according to the area of arable land, and then according to the lines of production by adopting the criteria consistent with the Community typology of agricultural holdings of 2009.

In accordance with the methodology used, standard output (SO) was used to determine the production type. The SO is defined as "the average value of output of a specified type of crop or livestock production activity over the period of 5 years, generated over one year per hectare or per animal in average production conditions in particular regions"[26].

In 2012, according to the data of the Central Statistical Office there were 1,456.5 thousand individual farms with an area of more than 1 ha of agricultural land. Population of the FADN (farms represented by the FADN sample) includes 735.5 thousand farms, which accounts for 50% of all farms in Poland. The farms covered by the FADN system produce about 90% of the total value of output in the agricultural sector, and their share in the total agricultural area in Poland amounts to 81%.

Typology of farms

The process of identifying types of farms intended for modelling took place in accordance with the following three criteria. These were:

- area of farms in hectares of agricultural land,
- production type of the farm (according to nTF 14),
- degree of adaptation to the "greening" requirements.

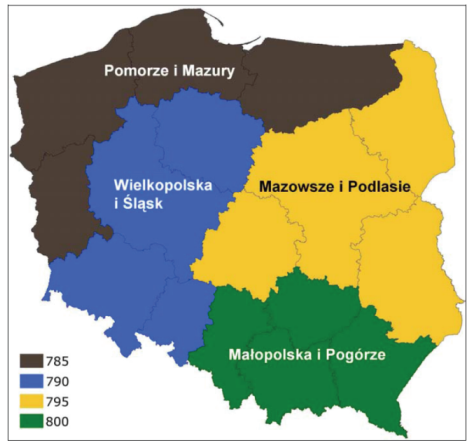
The results obtained after application of these criteria are shown both as a whole (for the entire FADN population), and taking into account the individual FADN regions (Figure 1).

Detailed assumptions for grouping farms belonging to the FADN population are presented below.

1. **Criterion 1** – classification of farms by the area of arable land:
   - Group I → farms up to 10 hectares,
   - Group II → farms above 10 hectares, but no more than 15 hectares,
   - Group III → farms above 15 hectares, but no more than 30 hectares,
   - Group IV → farms above 30 hectares of arable land.

[26] L. Goraj et al. *Analiza skutków zmian we Wspólnotowej Typologii Gospodarstw Rolnych*, Warsaw, 2010, p.11.

Figure 1. FADN regions



Pomerania and Masuria
Wielkopolska and Silesia
Mazovia and Podlasie
Małopolska and Pogórze

Source: Commission Regulation (EU) No 1291/2009 of 18 December 2009 concerning the selection of returning holdings for the purpose of determining incomes of agricultural holdings.

Such ranges were determined due to previously outlined requirements for diversification of crops and marking out EFA. The first group comprised farms exempted from the "greening" requirements. The second group included entities that have to grow at least two crops, but are not required to designate EFA. The third group includes farms which are required to meet the same requirements as the previous group in terms of diversification of crops, but they also have to designate at least 5% of arable land for EFA. The last fourth group comprises farms which are required to maintain at least three crops in the crop structure and to designate 5% of their land for EFA.

The structure of farms based on the area of arable land in the FADN population is significantly different from the structure of farms in the FADN sample. The study takes into account the number of farms represented by individual farms of the FADN sample calculated based on the SYS02 variable. The most numerous (more than half) representation in the group of farms is that of farms with up to 10 hectares of arable land, which means that they will not be covered by the "greening" requirement. The requirement to designate EFA relates to 26% of farms covered by FADN. In regional terms, most exempted farms can be found in South-Eastern Poland, i.e. the region of Małopolska and Pogórze which is characterized by a high fragmentation of agriculture.

Table 7. Structure of farms by area groups [according to the area of arable land] based on FADN data

According to the number of represented farms				
POLAND	I ≤ 10 ha	10 ha < II ≤ 15 ha	15 ha < III ≤ 30 ha	IV > 30 ha
	54%	21%	18%	8%
By FADN regions				
785	36%	20%	26%	18%
790	40%	21%	25%	13%
795	55%	24%	17%	4%
800	77%	13%	7%	3%
In the FADN sample				
POLAND	25%	16%	28%	31%

Source: The authors' compilation.

2. **Criterion 2** – classification of farms by production types (according to nTF 14):
   - Field crops (15,16, 61),
   - Cattle (45, 46),
   - Pigs (51),
   - Mixed (73, 74, 83, 84),
   - Other (including 2x, 3x, 48, 52, 53)

Details of the division are presented in Table 8.

The "MIXED" production type is the most numerous one in the FADN sample (Table 9). Farms pursuing this type of production represent 35% of the sample, but this percentage is clearly lower than the share of "mixed" production in the structure of the farms represented by FADN population (on average 62% in Poland, with a similar situation in the individual regions where this percentage ranges from 53% to 66%). Most pig farms operate in Wielkopolska, while crop farms are most numerous in Pomerania and in the north-western part of Poland.

Crop, cattle and pig farms are slightly over-represented in the FADN sample, although differences in the sample structure and in the population of the represented farms are much smaller. The structure of farm types represented by FADN shows a slight regional variation.

Table 8. Farm groups identified based on the production type in accordance with the Community typology of agricultural holdings (CTAH)

nTF14		PRODUCTION TYPE
15	Specialist cereals, oilseed and protein crops	FIELD CROPS
16	General field cropping	
61	Mixed cropping	
45	Specialist dairy	CATTLE
46	Specialist cattle-rearing and fattening	
51	Specialist pigs	PIGS
73 and 74	Mixed livestock	MIXED
83 and 84	Mixed crops and livestock	
20	Specialist horticulture	OTHER
35	Specialist vineyards	
36	Specialist fruit and citrus fruit	
37	Specialist olives	
38	Various permanent crops combined	
48	Sheep, goats and other grazing livestock	
52	Specialist poultry	
53	Various granivores combined	

Source: The authors' compilation based on "Analiza skutków…", L. Goraj et al. 2011, and FADN data.

Table 9. Structure of farms by production types based on FADN data

According to the number of represented farms					
POLAND	FIELD CROPS	CATTLE	PIGS	MIXED	OTHER
	16%	12%	3%	62%	7%
According to FADN region					
785	21%	18%	3%	53%	5%
790	20%	6%	6%	63%	5%
795	13%	16%	2%	61%	8%
800	17%	9%	1%	66%	7%
In the FADN sample					
POLAND	26%	23%	7%	35%	8%

Source: The authors' compilation.

3. **Criterion 3** - classification of farms according to the degree of adaptation to the "greening" requirements:
   - Exempted – with an area of up to 10 hectares of arable land and organic farms,
   - "Green" – meeting all the "greening" requirements,
   - No diversification – failing to meet the crop diversification requirement,
   - No EFA – having insufficient Ecological Focus Area,
   - No EFA and diversification – failing to meet both of the aforementioned requirements at the same time.

The structure of farms belonging to the FADN population, determined based on the adopted typology is shown in Table 10 (according to the degree of adaptation of Polish farms in the various FADN regions) and in Table 11 (according to production types).

Table 10. Structure of farms represented in the FADN population by regions and according to the degree of adaptation to the CAP "greening" requirements

Specification	Exempted	"Green"	No EFA	No diversification	No EFA and diversification
Poland	57%	23%	18%	1%	1%
By FADN region					
Pomerania and Masuria (785)	44%	27%	26%	1%	2%
Wielkopolska and Silesia (790)	42%	25%	29%	1%	3%
Mazovia and Podlasie (795)	58%	24%	16%	1%	1%
Małopolska and Pogórze (800)	80%	14%	6%	0%	0%

Source: The authors' compilation based on FADN data.

Non-compliance with the "greening" requirements in terms of one or two criteria applies to 20% of the farms from the population represented by FADN, with insufficient EFA being the major reason for it. It can be stated, however, that most Polish farms are diversified to the degree compliant with the European Commission's proposal. The percentage of non-adapted farms is largely diversified as far as the various regions are concerned. The greatest numbers of non-adapted farms are to be found in the Pomerania and Masuria region and in the Wielkopolska and Silesia one, 29% and 33%, respectively. The voivodeships which make up these regions are characterized by the largest average area of farms, which means that their structure comprises also the greatest number of farms to which the "greening" requirements will apply at all. In areas where

farms are relatively small, there is the largest proportion of farms exempt from the "greening" requirements. In the Małopolska and Pogórze region, the total proportion of farms which are exempted from the "greening" requirements or fully adapted to them is 87% of the population represented by FADN.

An analysis of the degree of adaptation by production types gives rise to the hypothesis that the CAP "greening" will have the greatest impact on crop farms and pig farms (Table 11). These production types are characterized by the smallest number of farms exempt from compliance with the requirements or ones that meet all the criteria. At the same time, they are characterized also by a large proportion of farms with insufficient EFA and a low level of diversification of crops.

Table 11. Structure of farms represented in the FADN population by production types and according to the degree of adaptation to the CAP "greening" requirements

Item	Field crops	Cattle	Pig	Mixed	Other	POLAND
Exempted	36%	61%	36%	59%	93%	57%
"Green"	30%	20%	24%	23%	3%	23%
No EFA	30%	18%	33%	16%	2%	18%
No diversification	1%	0%	2%	1%	1%	1%
No EFA and diversification	3%	1%	5%	1%	1%	1%

Source: The authors' compilation based on FADN data.

Farms specializing in cattle have a significantly lower proportion among farms that require adaptation to the "greening" requirements, as due to the specific nature of their activities they very often keep permanent grassland and grass on arable land. A small area of arable land and a high proportion of grassland make them exempt from the requirement to implement adjustments, or automatically assign these farms to the "green" group. A similar phenomenon can be observed in the case of mixed farms. The group of other farms covers horticultural farms that due to a significant proportion of permanent crops and their small area, below 10 hectares of arable land, are exempt from the "greening" requirements.

After dividing the research sample in accordance with the criteria described above, 66 types of model farms were identified. These types were also divided by their location in the FADN region. The following numbers of farm types were identified in the various regions:

- Region 785 – "Pomerania and Masuria" – 56 farm types,
- Region 790 – "Wielkopolska and Silesia" – 63 farm types,

- Region 795 – "Mazovia and Podlasie" – 61 farm types,
- Region 800 – "Małopolska and Pogórze" – 49 farm types.

As many as 229 farm types were ultimately designated to be modelled taking into account their geographical location, the criterion of production scale and production type, as well as their adaptation to the "greening" requirements.

Characteristics of farms of the FADN population

The population of FADN farms was divided and characterized based on the previously developed typology. The basic characteristics of the farms by production types and the area of arable land are presented in Table 12.

Table 12. Basic data characterizing types of model farms by production types and the farm area based on the FADN population

Farm type	Number of farms	Average area of agricultural land [ha]	Share of permanent grassland [%]	LU*	Stocking density LU/100 ha
According to production type					
Field crops	117,888	26.43	6	2.44	5.97
Cattle	91,857	19.01	38	18.99	99.88
Pig	21,826	22.66	4	60.67	267.71
Mixed	454,446	14.70	18	10.81	73.51
Other	49,469	8.14	14	6.25	76.73
According to farm area					
I < 10 ha of arable land	396,845	8.68	27	6.30	72.62
10 ha < II < 15 ha of arable land	151,698	15.12	19	10.57	69.93
15 ha < III < 30 ha of arable land	131,391	23.65	15	18.02	76.20
IV > 30 ha of arable land	55,552	64.74	8	37.88	58.51

* livestock unit.

Source: The authors' compilation.

Crop and pig farms have the highest average area of agricultural land, which given a small share of permanent grassland in the crop structure explains why the highest percentage of these farm types is not adapted in terms of the share of EFA.

The use of the adopted farm typology enables analysis of the distribution of the farms in the FADN population according to established criteria. Table 13 shows the characteristics of the farms in the FADN population categorized according to the criterion of adaptation to the "greening" requirements.

Table 13. Basic data characterizing the identified farm types with varied degrees of adaptation to the "greening" requirements in the FADN population

Item	Agricultural land in ha	Soil valuation index	Number of animals (LU)	Stocking density (LU/100ha of agricultural land)	Of which: cattle [%]	Of which: Pigs [%]	Proportion of farms [%]	Number of farms
Exempted	9.46	0.72	6.46	68.3	55.2	35.1	57.1	419,944
"Green"	19.31	0.76	12.86	66.6	46.7	49.7	22.5	165,704
No EFA	35.50	0.86	25.38	71.5	42.6	54.5	18.4	135,057
No diversification	18.83	0.83	10.20	54.2	25.4	59.1	0.7	5,109
No EFA and diversification	38.90	0.87	26.10	67.1	24.9	70.6	1.3	9,672
Total	16.92	0.76	11.66	68.9	47.0	47.7	100	735,486

Source: The authors' compilation.

The results shown above indicate that EFA deficiency relates to less than 145 thousand farms, with the average area of those farms being over 35 hectares of agricultural land. Farms non-adapted in terms of EFA are also characterized by stocking density which is slightly higher than the average one. This is due to a significant proportion of pig farms in this farm group.

1.5. Production yields

Crop structure

The implementation of the "greening" requirements in model farms has a noticeable impact on transformations in the crop structure and the structure of crop production (Table 14). The summary is limited to three scenarios – baseline_2020 and the "greening" scenario (green_2020 and no_green_2020). The expected increase in crop yields and profitability based on the CAPRI model has no significant effect on the production structure. Therefore the basic considerations concerning changes in the production structure relate only to the baseline option in which the prices and production yield will remain at the level of 2012.

Table 14. Changes in the crop structure in the model solutions within the "greening" scenarios (prices and crop yields at the level of 2012)

Item	Baselinr_2020		Green_2020		No_green_2020	
	Area [ha]	%	Area [ha]	%	Area [ha]	%
TOTAL						
Wheat	2.26	16.4%	2.21	16.0%	2.25	16.2%
Other cereals	7.96	57.5%	7.69	55.9%	7.90	56.9%
Cereals - total	10.23	73.9%	9.89	71.9%	10.15	73.1%
Legumes	0.39	2.8%	0.61	4.4%	0.58	4.2%
Rape	0.72	5.2%	0.69	5.0%	0.71	5.1%
Other crops	2.14	15.5%	2.04	14.8%	2.13	15.4%
EFA	0.37	2.7%	0.52	3.8%	0.31	2.2%
Total	13.84	100%	13.75	100%	13.88	100%

Source: The authors' compilation.

Transformations in the crop structure result from the restrictions on the number of crops and their maximum share in the crop structure, and the need to set aside portions of arable land to reach a level of 5% of the arable land. However, the introduction of the possibility of applying practices equivalent to EFA results in a limited impact of the CAP "greening" on the crop structure.

In the baseline option of the "greening scenario" (green_2020) the shares of all three main crops are decreased. The foregoing applies to the least extent to the most profitable crops, such as potatoes, sugar beet and wheat, as well as vegetables and fruit in the field cultivation. As regards all crops, the area designated for cultivation of cereal crops, which are the main crops in the baseline crop structure, is reduced most (by 2 percentage points).

The model points to an increased share of legumes in the green_2020 and no_green_2020 scenarios, even though lower yields and sales prices have been assumed compared to the average ones in the FADN population on farms in which such crops have not been cultivated before. This assumption seems to be well-founded, as it provides for introduction of a new form of agricultural business activity onto the farm and, based on the model solutions, a significant increase in demand. The increased legumes' share results from the introduction of an EFA equivalent which provides for recognizing 70% of the area on which legumes are cultivated as ecological focus area. For majority of farms, legumes cultivation is a more attractive alternative than leaving the land fallow.

Subsidies for the production of legumes are another factor which contributes to the increase in the area under legumes. It may be assumed that the increase in the area under legumes provided for in the no_green_2020 scenario results from the implementation of this solution.

In order to verify the requirement of crop diversification in each type of farm Shannon-Weiner's index was used, which was developed in 1948[27] and is one of the most widely used indices of biodiversity. It usually achieves values in the range of 1.5-3.5, sometimes exceeding the value of 4.5, and is calculated according to the following formula:

$$\mathbf{H} = -\sum \frac{\mathbf{n_i}}{\mathbf{N}} \mathbf{ln} \frac{\mathbf{n_i}}{\mathbf{N}}$$

where, if applied to evaluate biodiversity of crop structure:
N – total area of arable land
n_i – area of i-th crop.

This index was calculated for each farm of the FADN sample under the baseline scenario. Then the obtained values of the index were averaged for selected types of farms. As a result, for each group initial (observed) level of Shannon index was obtained.

Then in each of the farms, where it was required, necessary modifications were introduced in the structure of crops in order to adapt it to the diversification criterion. Modified index values (target level) were averaged in the same way as for the baseline situation. In optimization models for the Green_2020 scenario, for the types which do not comply with the diversification requirement, additional constraints were introduced that enforce achievement of the Shannon index value at a level not lower than the level of the target value.

Table 15. Changes in the Shannon index values in the considered agricultural policy scenarios according to the level of adjustment to the "greening" requirement

Shannon index	Prices unchanged relative to 2012	
Baseline 2020 = 100	green	no_green
Exempted	100.9	100.8
Green	100.9	100.3
No diversification	105.6	100.7
No EFA	103.6	100.3
No EFA and diversification	104.7	95.7

Source: The authors' compilation.

Adoption of the CAP requirements assumed in the GREEN 2020 scenario results in an increase in crop structure diversification. This applies in particular

[27] C.E. Shannon, *A mathematical theory of communication*. The Bell System Technical Journal, No. 27, 1948, p.379–423 and pp. 623–656.

to farms which do not meet the diversification requirement, and for which the Shannon index level increases by 5-6% compared to the baseline_2020 scenario. In the case of farms non-adapted in terms of EFA, the increase in the index value is slightly lower. Its increase is due to increased area of fallow land and area under legumes, which are EFA equivalents.

A slight increase in the Shannon index value in the no_green_2020 scenario is due to increased area under legumes resulting from the introduction of subsidies for their cultivation at the cost of decreasing the cereals share compared to the baseline_2020 scenario.

1.6. Economic results

The results presented are average values for farm types modelled. It should be noted that in the process of aggregation, the results obtained for the various types of farms were averaged. At a higher level of detail more significant differences between model types can be seen, but they may not be presented in detail due to the multiplicity of types and limitations imposed by the FADN in terms of publishing data for samples of fewer than 15 farms.

It should be also pointed out that the results presented in the tables were obtained on the basis of the FADN database and show changes in agricultural income, which may take place in case of scenarios considered for farms of the FADN population. Because of the exclusion of farms with an area of less than 10 ha, it can be assumed that small non-commercial farms outside the field of FADN observation (< EUR 4,000 of SO) will be exempt from the obligation to conform to the new requirements of the CAP. This means that the average changes in economic performance as a result of the CAP reform in the sector of Polish agricultural farms will, in fact, be somewhat lower than those presented. The precise scale of the phenomenon of changes would require determining the initial income level in small farms outside the field of FADN observation. However, given that the farms in the field of FADN observation represent 90% of the production value and 87% of the cultivated land, it can be assumed that results reported below reflect well the direction and scale of changes in the most important, from the point of view of agricultural policy, group of farms.

The results of the model solutions are presented in Table 16. The table illustrates the relative changes in agricultural income of farms divided according to geographical criterion, production type and the degree of adaptation to the CAP "greening" requirements. The table includes also the results of the green_2020 and no_green_2020 scenarios in the option providing for changes in prices and yield determined based on the CAPRI model for 2020.

Table 16. Changes in agricultural income under the each scenario according to region, production type, the degree of adaptation to the "greening" requirements and the farm size

Agricultural income	Prices and yield in 2012		Prices and yield based on the CAPRI model	
Baseline_2019 = 100	Green_2020	No_Green_2020	Green_2020	No_Green_2020
According to FADN region				
POLAND	104.6%	100.7%	110.7%	106.8%
Pomerania and Masuria (785)	102.2%	98.3%	107.2%	103.5%
Wielkopolska and Silesia (790)	103.1%	98.6%	109.6%	105.2%
Mazovia and Podlasie (795)	107.6%	103.4%	114.1%	109.9%
Małopolska and Pogórze (800)	104.1%	102.1%	109.7%	107.8%
According to farm type				
Field crops	100.6%	94.8%	107.7%	102.1%
Cattle	109.2%	106.1%	113.9%	110.9%
Pig	100.3%	97.6%	105.2%	102.6%
Mixed	106.6%	102.2%	113.3%	109.0%
Other	99.4%	100.8%	102.5%	104.0%
According to the degree of adaptation				
Exempted	107.0%	107.0%	112.9%	112.9%
Green	110.3%	110.4%	117.3%	117.4%
No EFA	95.0%	97.4%	107.4%	99.4%
No diversification	101.5%	93.3%	98.2%	100.9%
No EFA and diversification	97.8%	92.1%	103.8%	98.5%
According to farm size				
I < 10 ha of arable land	107.6%	107.6%	113.6%	113.6%
10 ha < II < 15 ha of arable land	107.5%	108.0%	113.4%	113.9%
15 ha < III < 30 ha of arable land	106.5%	98.8%	112.8%	105.3%
IV > 30 ha of arable land	100.2%	94.3%	106.2%	100.4%

Source: The authors' compilation.

The results of model solutions account for the combined impact of the two major innovations in the set of mechanisms provided for in the reformed CAP – „greening" and additional payments for small and medium-sized farms, including subsidies for livestock production.

Polish farmers will generally benefit financially from the reformed CAP to the degree reflecting the 10% increase in the national payment envelope compared to the previous financial framework.

The results of models aggregated to the level of an average Polish farm show in the baseline option of model solutions, i.e. green_2020, an increase in income caused by the implementation of the CAP reform by nearly 5% relative to the baseline_2020 scenario. Adoption of a price increase forecast in the CAPRI model more than offsets the costs incurred due to the CAP "greening", leading to an increase in the average income by approx. 10%.

Incorporating the "greening" mechanism in the system of direct payments in Poland has a small impact on agricultural income, which is due mainly to the fact that a significant proportion of agricultural farms are exempt from the „greening" requirements or satisfy them sufficiently. In the case of farms which need adjustments this results in a slight decrease in income in the option providing for retaining prices at the level of 2012. Assuming increased prices and yields calculated in the CAPRI model average values of agricultural income in the various farm groups are higher than those arising from the Baseline scenario.

Analysis of the results obtained in model solutions shows that abandoning the "green" portion of direct payment provided for in the no_green_2020 scenario is not economically viable for farmers.

Model results show some differences across the various farm groups. In geographical terms the undoubted beneficiaries of the reformed CAP are farmers from the regions of Mazovia and Podlasie, as well as those from Małopolska and Pogórze. This is due mainly to the area structure of agricultural farms in which farms with small agricultural land area prevail. Restrictions related to "greening" concern in particular farms with more than 30 hectares of arable land. At the same time, these farms are beginning to experience degressivity of the newly introduced payments (on 3-30 hectares, on 3-30 cows, on 3-30 bovine animals). Farms located in the regions of Mazovia and Podlasie (795) are large enough to benefit from additional payments and small enough to avoid at least part of adjustments arising from the "greening" requirements. While farms located in the regions of Małopolska and Pogórze (800) are largely exempt from the "greening" requirements, the small scale of their business makes them benefit less from additional payments and those related to production.

In none of the regions concerned is conforming to the "greening" requirements an attractive option. However, while in the regions of Mazovia and Podlasie (795) and Małopolska and Pogórze (800) abandoning the "green" portion of payment does not imply a decrease in the average income level, in the regions of Pomerania and Masuria (785) and Wielkopolska and Silesia (790) rejecting the "greening" requirements implies a decrease in income when compared to the scenario assuming continuation of the current CAP.

Adoption of the assumed increase in prices due to the introduction of the restrictions means an increase in income in Poland by approx. 6.6 percentage points. Benefits arising from the adoption of higher prices show slight variation across the regions. It can be seen, however, that the increase in prices has the greatest impact on income in the regions 790 and 795. This is due to relatively high individual yields in these regions.

Analysis of the impact of the reformed CAP on the various farm types leads to the conclusion that cattle and mixed farms benefit most from the new CAP. This is largely due to the high level of conforming to the "greening" requirements and the introduction of subsidies for cattle production. As far as the other farm types are concerned, the reform of the CAP has nearly no influence on income. Failure to meet the "greening" requirements is in the case of most of them disadvantageous as regards income. Rejection of the CAP "greening" is particularly disadvantageous for field crop farms and pig ones. This is due to their relatively large average area and a high share of cereals. An exception to the rule are farms referred to as other, in the case of which refusal to comply with the "greening" requirements can imply a slight increase in their income. This is due to relatively high costs arising from the obligation to replace horticultural crops or permanent ones with cereals or fallow land in order to meet the requirements. Such results may be partially due to the grouping of crops in order to reduce the number of modelled forms of agricultural activity. Failure to account for all species of vegetables and fruit grown on those farms results in somewhat stricter crop diversification requirements. The assumption of increased prices based on the CAPRI model results in increased income generated by all farm types. Implementation of such assumptions would be most beneficial for field crop farms and mixed ones, as the price increase estimated in the CAPRI model concerns mainly field crop products.

Comparison of changes in income generated by farms grouped according to the diversification criterion points to clear benefits resulting from the reformed CAP for farms exempt from the "greening" requirements and the already adapted ones. On the one hand these farms do not have to incur costs of adjustments, and on the other they benefit greatly from additional payments.

Farms which are not adapted as regards diversification incur losses caused by the introduction of the planned reforms of the CAP. It should be emphasized, however, that this applies to approx. 2% of farms represented by the FADN population. Adoption of the option with the increase in prices has a particularly beneficial effect on income generated by "green" farms and those non-adapted in terms of EFA, resulting in an increase in income by approx. 7 percentage points.

Comparison of the impact of the reforms which are being introduced to the CAP on farms grouped according to the area criterion leads to the expected conclusion that large farms will be more affected by the consequences of the reforms. Nevertheless, even in the case of farms with more than 30 hectares of arable land the results of the model point to a decrease in income below the level provided for in the baseline_2020 scenario. However, even for farms with large area of arable land, being most affected by the "greening" requirements, rejection of adjustments is not an attractive alternative in economic terms.

Differences in the amounts of agricultural income and changes in the amounts of aid received by farms depending on the scenario, result in changes in the share of direct payments in agricultural income (Table 17).

Compared to the baseline scenario, the share of subsidies in income increases in all farm types under consideration. As regards the baseline scenario, the highest share of subsidies in income occurred in the case of small farms and mixed ones. At the same time, one could observe that this share decreased with increased area of farms. This dependency remains unchanged in the scenarios for 2020. Nonetheless, an increase in the share of subsidies in income is not the same in all types of farms. As regards the green_2020 scenario, the greatest increase in the share of subsidies in income is observed in cattle farms and in mixed ones (by 4 percentage points), which is due, among others, to the introduction of additional payments for cattle production. At the opposite extreme there are pig farms and other farms, in the case of which the share of subsidies in income under the same scenario increases by 1 percentage point.

Comparison of the share of subsidies in income of farms grouped according to the area criterion shows that the greatest increase in the share of subsidies in income under the green_2020 scenario concerns farms with 10-30 hectares of arable land. This is reflected in changes which are taking place in the FADN regions. The greatest increase in the share of subsidies (by 4 percentage points) can be seen in the regions of Mazovia and Podlasie, as well as Wielkopolska and Silesia, where such farms prevail.

Table 17. Share of total payments in agricultural income in analysed farms under the assumption of prices and yield calculated on the basis of 2012 data and the results of the CAPRI model

Farm types	baseline_2012	Prices of 2012			CAPRI	
		baseline_2020	green_2020	no_green_2020	green_2020	no_green_2020
According to production type						
Field crops	44%	44%	46%	41%	43%	38%
Cattle	35%	35%	40%	38%	39%	36%
Pig	21%	21%	22%	19%	21%	18%
Mixed	51%	51%	55%	52%	52%	49%
Other	19%	20%	22%	21%	21%	20%
According to farm area						
I	52%	52%	55%	55%	52%	52%
II	48%	48%	52%	51%	49%	49%
III	43%	43%	48%	42%	45%	39%
IV	33%	33%	35%	29%	33%	27%
According to the degree of adaptation to the "greening" requirements						
Exempted	55%	55%	57%	57%	54%	54%
Green	50%	50%	54%	54%	51%	51%
No EFA	34%	33%	36%	28%	34%	27%
No diversification	18%	18%	22%	16%	21%	15%
No EFA and diversification	32%	31%	34%	25%	32%	24%
According to region						
785	37%	37%	39%	36%	37%	34%
790	38%	37%	41%	36%	38%	34%
795	51%	51%	55%	52%	52%	49%
800	39%	39%	42%	40%	40%	38%
All						
TOTAL	42%	42%	46%	42%	43%	40%

Source: The authors' compilation.

Analysis of the share of subsidies on farms grouped according to the criterion of adjustment to the "greening" requirements shows that adapted farms and those which are exempt from those requirements have the greatest share of subsidies. However, as regards farms exempt from the aforementioned requirements, the increase in subsidies provided for the green_2020 scenario is relative-

ly small. The CAP reform affects to a greater extent adapted farms for which the share of subsidies in income increases by as much as 4 percentage points.

As expected, rejection of the adjustments and abandoning the "green" portion of the payment results in a decreased share of subsidies in income. This is particularly clear in the case of farms which are non-adapted in terms of "greening", and results from a decrease in the amount of aid with income unchanged or slightly higher compared to the results of the baeline_2020 scenario.

It should be noted that rejection of adjustment to the "greening" requirements results in a decrease in the share of subsidies below the level of 2012 in field crop farms and cattle ones, as well as in the largest farms. This is reflected in the results aggregated to the level of the regions. Rejection of the "greening" concept would imply a decrease in the share of subsidies in income below the level of the baseline year in the regions of Pomerania and Masuria, as well as Wielkopolska and Silesia.

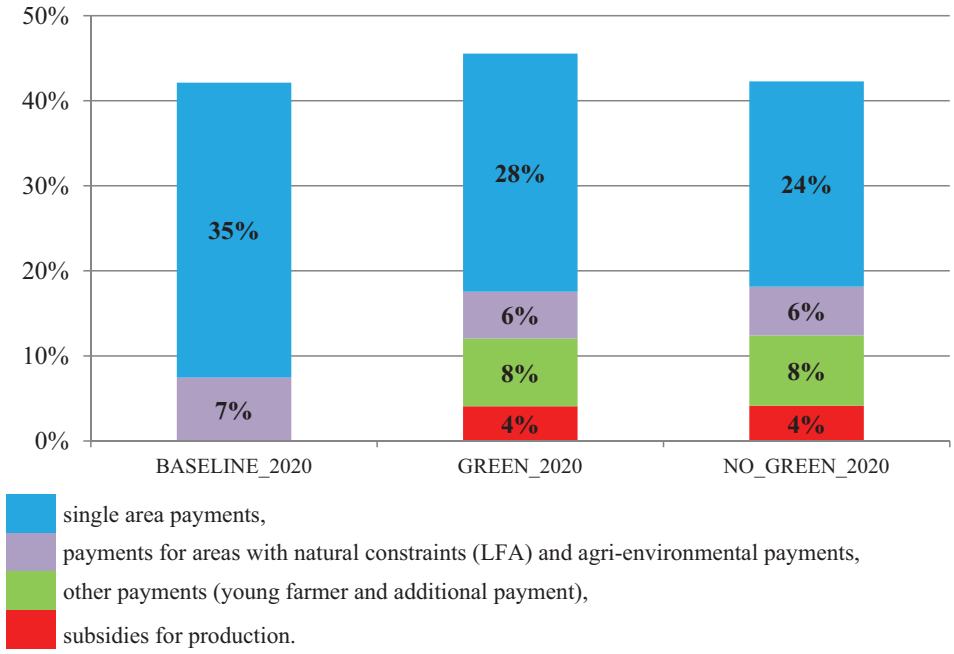
All the aforementioned dependencies are present also in the option which assumes an increase in prices of agricultural products due to "greening". However, due to increased income from sales, the share of subsidies in income is lower than in the option which assumes a fixed price level. On average, adoption of the share of subsidies in income due to the assumed increase in prices decreases by 2-3 percentage points.

The reform of direct payments and the introduction of additional payments result not only in a change in the share of subsidies in income, but also in a change in the aid structure. Changes in the average share of the various types of payments in agricultural income are shown in Figure 2.

Reduction of the amounts of SAPs in the green_2020 scenario does not result in a decrease in the average level of aid. The newly introduced subsidies for production as well as the additional payment and the payment for young farmers offset the reduction of the SAP rate. As a result, the average level of aid for farms under the green_2020 scenario is higher than that provided for in the baseline_2020 scenario.

Reduction of the share of SAPs under the no_green_2020 scenario results from the introduction of sanctions in the form of depriving non-adapted farms of the "green" component of the basic payment. Limitation of funding for agri-environmental measures and the resulting decrease in agri-environmental payments by 46% has a relatively small impact on the aid structure. This is due to a relatively low level of participation of farms in agri-environmental measures and low average amounts of payments received for implementing those measures.

Figure 2. Share of subsidies in agricultural income of farms of the FADN population depending on the scenario



Source: The authors' compilation.

It should be noted that the presented structure of payments reflects changes taking place in the average farm. Given the specific nature of the newly introduced payments, in particular their degressivity, mainly small and medium-sized farms will benefit from the new CAP, while the share of direct payments in income of larger farms (more than 30 hectares) will be lower by approx. 10 percentage points.

It needs to be emphasized that the presented results do not account for the largest, large-scale farms which are not subject to FADN observations. In the case of the aforementioned farms, the reformed CAP will have a negative impact on their financial performance, mainly due to the EFA requirement and modulation of direct payments.

1.7. Conclusions

The methodology of analyses was subject to regular evolution throughout the research carried out by the authors[28]. The need for introducing changes in the methodology was due to:

- changes in the CAP reform proposals submitted by the European Commission, including evolution of the "greening" concept;
- improving modelling tools – from simple farm optimization model to a model with a PMP component, and using the results of the CAPRI model;
- changes to farm typology related to changes in the "greening" concept;
- updating the output for models with the publication of results of the FADN accounting in subsequent years.

In the research carried out in 2014, the previous considerations were supplemented with the issues related to EFA equivalents included in the newly introduced regulations, subsidies for small farms and subsidies to particular types of production. The inclusion of leguminous crops and catch crops as EFA equivalents resulted in a further decrease in the percentage of Polish farms which require adjustments to the "greened" CAP to 20%. By far the largest group of farms classified as non-adapted ones have insufficient EFA.

Further relaxation of the requirements combined with the introduction of additional payments for farms of 30 hectares and payments to certain production types (cattle, sheep, goats, soft fruit) reduces the negative impact on income generated by the smallest farms. In the option which takes into account a possible price increase due to "greening", Polish farmers are net beneficiaries of the new policy. Even if the current level of prices is maintained, the CAP "greening" should not imply losses for the average Polish farm.

Model calculations demonstrate that the CAP "greening" will not result in significant adverse changes in the productivity of land and economic performance of farms. In the most restrictive "greening" option (calculations from

[28] S. Czekaj, E. Majewski, A. Wąs, *Koncepcja oszacowania skutków reform Wspólnej Polityki Rolnej Unii Europejskiej (WPR) w perspektywie budżetowej 2014-2020*, [in:] *Dopłaty bezpośrednie i dotacje budżetowe a finanse oraz funkcjonowanie gospodarstw i przedsiębiorstw rolniczych* (ed. J. Kulawik), Program Wieloletni 2011-2014, No. 20, IERiGŻ-PIB, Warszawa 2011; S. Czekaj, E. Majewski, A. Wąs, *Oszacowanie skutków zazielenienia Wspólnej Polityki Rolnej UE w Polsce w perspektywie 2014 roku na przykładzie zbiorowości gospodarstw FADN*, [in:] *Dopłaty bezpośrednie i dotacje budżetowe a finanse oraz funkcjonowanie gospodarstw i przedsiębiorstw rolniczych* (ed. J. Kulawik), Program Wieloletni 2011-2014, No. 46, IERiGŻ-PIB, Warszawa 2012; S. Czekaj, E. Majewski, A. Wąs, *Nowe zazielenienie Wspólnej Polityki Rolnej i jego znaczenie dla wyników ekonomicznych polskich gospodarstw*, [in:] *Dopłaty bezpośrednie i dotacje budżetowe a finanse oraz funkcjonowanie gospodarstw i przedsiębiorstw rolniczych* (ed. J. Kulawik), Program Wieloletni 2011-2014, No. 82 (3), IERiGŻ-PIB, Warszawa 2013.

2011-2013)[29] and assuming current prices of agricultural products, agricultural income would be lower on average (for the entire agricultural sector) by approx. 4%. Relaxation of the requirements by the European Commission in the final version of the reform means that "greening" does not significantly affect the amount of income, but potential benefits arising from the payments related to production, additional payments and payments for young farmers.

A more significant decrease in agricultural income can be seen, however, in certain types of farms (non-adapted ones, those characterized mainly by monoculture on good soils and those to which the EFA requirement applies). However, in certain types of farms (e.g. cattle ones, fully adapted ones) an increase in income by 2020 can even be noted due to a minor impact of the restrictions being introduced and the increasing level of aid under the newly introduced additional payments and those related to production.

In the solutions providing for changes in yields and prices based on the CAPRI model, due to the projected increase in prices despite the restrictions arising from "greening" there is also an increase in the average agricultural income. Similar conclusions have been reached also by other researchers[30] who point to an increase in farmers' income resulting from the projected increase in prices. This option, however, must be considered with a great deal of caution. Increased prices projected in the CAPRI model result from the assumption of reduced, as a result of greening, supply of agricultural products on the EU markets. It can be assumed, however, that farmers will take action to adapt their farms to the new requirements, leading to the possibly lowest reduction in the production level, while the potential price increase will serve only to cover the costs of the adjustments.

In almost all types of non-adapted farms, the introduction of changes leading to compliance with the "greening" requirements is for farmers a more favourable alternative than abandoning 30% of the direct payment rate.

In conclusion, the CAP "greening" will not have a significant impact on the volume of production and incomes in the agricultural sector in Poland. Adverse effects of the regulations which are being introduced may occur in a small number of non-adapted farms characterized by a highly simplified structure of production and lack of EFA. At the same time, it should be noted that, given a high percentage of farms exempt from the "greening" requirement, or those already adapted, the considerably mitigated "greening" concept will not contribute to the achievement of significant environmental effects.

[29] Ibidem.
[30] *Implementation of CAP reform in England*, Evidence Paper DEFRA, 2013.

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2. Regional distribution of direct payments in Poland (based on Draft direct payment scheme in Poland in 2015-2020, Ministry of Agriculture and Rural Development, August 2014)

2.1. Introduction

In the programming period 2014-2020, changes to the direct payment scheme have been proposed. The compromise reached in this regard was a result of the discussion which was expected to lead, among others, to a more profound levelling up of direct payments across EU countries. In 2007-2013, very significant differences in the level of direct aid were observed in the European Union. This was due to different models of the payment system. In the EU-15, the single payment scheme (SPS) was used. The system was based mainly on historical envelopes. These were calculated based on the base area, ceilings as regards livestock premiums and aid for certain crop groups, defined for the reference period. In Poland and in other new Member States, a simplified model of direct payments, applying primarily to arable land area (SAPS), was being implemented. Moreover, the results of the negotiations defined the gradual way of *phasing-in.*

The discussion that accompanied the process of determining the conditions of accession and direct payments after 2013 was due to very important considerations related to the impact of direct payments on the competitiveness of agriculture in Member States. As the importance of subsidies at the macroeconomic level is very high, yet it varies depending on the type and scale of production, the level of direct payments differentiates competition opportunities on the EU agri-food market. According to numerous studies in this regard (Poczta and Siemiński 2008, Sobczak 2013, Sobczyński 2008, Czekaj et al. 2011, Sadowski 2010, Ziętara and Zieliński 2012) the share of subsidies in agricultural income ranges from a few to several tens percents, and it often constitutes even the whole income, covering losses from operations. Basically, external transfers have a greater impact on large entities, and as regards the type of agricultural activity – those specializing in field production, meat cattle and grain-fed livestock farming. Their importance is, however, relatively low in the case of intensive horticultural production. Equal subsidies across the various countries would eliminate the impact of the policy on the entities' competitiveness. This could be achieved by setting the same direct payment rate per hectare of agricultural land (flat rate) in the various countries of the European Union (Chlebicka and Lewandowski-Lepak 2013). This solution was proposed also by the Polish government, arguing that preserving the Community nature of EU policy in the field of agriculture, particularly in financial terms, requires ensuring equal conditions of competition on the EU single market, which can be achieved by applying the

Single Area Payment Scheme across the EU (*Position*... 2009). The proposal was not accepted. The final form of the direct payment scheme in the financial framework for 2014-2020 includes a number of mandatory and voluntary components (Table 18), which combined with the diversification of national envelopes (in particular as regards the rate per hectare) will result in a different impact of this mechanism in the various countries and types of farms, diversifying also to a large extent their competitive position. As a result of adopted arrangements, direct support in Poland is to be composed of (*Draft direct payment scheme*... 2014, *Detailed description*... 2014):

- Single area payment – by means of maintaining the basic area payment a simplified direct payment scheme will continue to be used. This is to avoid the costs of the implementation of a payment scheme based on entitlements, and administrative costs of the implementation and management of this scheme. As much as 45.7% of the national envelope will be allocated to this payment, and the estimated aid amount is to be approx. 110 EUR/ha.
- Payment for "greening" – the idea behind this concept is that farms will take into account and balance not only their economic objectives, but also environmental and climate ones. In order to be entitled to such payment the farm will have to meet the requirements relating to care for the environment, exercised by the implementation of three basic practices: crop diversification, maintenance of permanent grassland and designating a portion of the area for environmental purposes As much as 30% of the national envelope will be allocated to this payment, and the "greening" payment amount will be approx. EUR 74/ha.
- Payment for young farmers – additional support for individuals launching agricultural business activity is supposed to enhance development in this area. Such facilitation of establishment of agricultural farms applies to people up to 40 years of age, and will be paid for a maximum of 5 years from the start of agricultural activity. 2% of the annual national envelope will be allocated to this purpose. Subsidies will be calculated based on the area of arable land, and will apply to area of up to 50 hectares. Assuming that this amount will constitute 25% of the national average payment per hectare, this means that an additional payment will be approx. EUR 62/ha.
- Additional payment – intended for the funding of additional aid for "medium-sized" farms that have real chances for growth under the EU single market conditions, but due to smaller area do not achieve the benefits of the scale of production. They have a chance to adapt their production to the changing expectations of consumers of raw agricultural materials, and

achieve sustainable competitive capacities. This is a payment for "first hectares", applicable to area in the range of 3.01 ha to 30 ha on each farm. As much as 8.3% of the national financial envelope will be allocated to this payment, and its amount per hectare of arable land in this area range is expected to be EUR 41.

- Payments related to production – the reasons for additional aid for selected lines of production include a more sustainable process of restructuring vulnerable sections of agricultural production, a reduced rate of decline in the populations of major livestock species, slowing down the trend towards simplification of the structure of crop production, thus maintaining, indirectly, the diversity of agriculture in all regions of the country and utilization to a greater extent labour and land resources. Therefore, the economic objective is to ensure the competitiveness of agriculture by supporting those sectors which will eventually play an important role in agricultural production. The environmental objective (linked to the economic one) is to preserve the structure of land use, mainly through efforts taken to continue the use of permanent grasslands for livestock production. Guided by the aforementioned premises, it was assumed that support will be provided to medium-sized herds of cattle, cows, sheep and goats, and – as regards field crop production – to protein crops, soft fruit, tomatoes, starch potatoes, hops, hemp and sugar beet. The maximum percentage allowed by EU legislation, i.e. 15% of the national envelope was allocated to this purpose.
- Transitional national support – transitional support will be provided to the tobacco sector.

A simplified scheme dedicated to small farms is a separate solution. Award of payments for farms will replace subsidies calculated based on the various types of aid. Farmers will receive payments under support to which they are entitled in accordance with the new components of subsidies (discussed above), which may not, however, amount to more than EUR 1,250 per farm. Beneficiaries choosing this solution will be exempt from controlling adherence to cross-compliance standards and requirements, as well as the requirement to apply "greening" practices.

Being familiar with the assumptions underlying the direct payment scheme and bearing in mind the course of the discussion on the shape of the new scheme, and the particular interests and arguments, in the context of contemporary challenges to agriculture, it was resolved that this study will be aimed at performing a regional analysis of direct subsidies. The first introductory analytical procedure is to show diversity across the EU countries. The second part

of the study is devoted to estimation of the effects of adopted decisions at the regional level in Poland.

Table 18. Direct payment scheme in the EU countries in 2015-2020

Cross Compliance	[**] Production-related aid	[**] Payments to areas with natural constraints	[**] Scheme for small farms
	from 10% to 15% of the envelope	up to 5% of the envelope	
	[**] Additional payment		up to 10% of the envelope
	• up to 30% of the envelope • max. 65% of average direct payments (first hectares)		
	[*] Payment for young farmers		max. EUR 1,250
	• up to 2% of the envelope • +25% of payment (max. 5 years)		
	[*] "Green" payment		Simplified payment
	• obligatory 30% • "greening" practices or equivalent ones		
	[*] Basic payment		
	• not fixed percentage • 5% degressivity above EUR 150,000		

[*] obligatory component
[**] optional component

Source: Overview…2013.

2.2. Changes in the level and differences of direct payments in the European Union countries

Based on data concerning the programming periods 2007-2013 and 2015-2020, financial envelopes for direct payments per farm and per hectare of arable land were compared. In the calculations related to this part of the study, amounts of the payments from the 1st pillar of the CAP were used, with no transfer of funds for direct payments from the 2nd pillar of the CAP. Such approach reflects the actual result of the compromise reached between the states for subsequent years, without the states' internal decisions on depleting structural funds to the benefit of direct support for agricultural income.

The amount of payments per each hectare of agricultural area is of a great importance due to, for instance, conditions for competitiveness of agriculture in different countries. Analysis of additional payments in this respect (Table 19) shows a much lower differentiation between the countries. In 2007, this ranged from less than EUR 50/ha in Romania, Bulgaria, Estonia and Latvia, to more than EUR 400/ha in the Netherlands, Greece and Belgium. From all of the so-called old EU countries (EU-15), Spain and Portugal where the only countries in which aid per hectare was lower than the average for all countries, i.e. EUR

220/ha. In the period 2007-2013, the value of direct payments in the EU-12 increased significantly. In 2007, the average payment was EUR 84/ha, while in 2013 – EUR 226/ha. This means that once phasing-in had been completed, the disparity between the groups of the old and new countries decreased, yet in the old Member States the rate was still higher by 70%.

In the next programming period, the flat rate rule was not introduced, but the solutions adopted with respect to the form of direct payments led to a further flattening of the differences in the rates of additional payments per hectare of arable land applied in the EU Member States. Compared to 2013, the amount of aid granted in 2015, calculated according to area of arable land, increased in six countries (Bulgaria, Estonia, Lithuania, Latvia, Malta and Romania). The highest decrease in aid (over 10%) concerned: the Netherlands, Belgium, Denmark, Germany, Italy, France and the UK. In all these countries, the average amount of aid per hectare of arable land in the programming period 2007-2013 was greater than the average for the EU-27. In Belgium and the Netherlands, aid was twice as high as the average for all countries, and in both of these countries direct payments in the period 2015-2020 will be lower by approx. 15%.

Direct support per farm (Table 20) results from the level of payments per hectare and the agrarian structure in a given country. The differences in rates in the period 2007-2013 were also due to different payment schemes applied in the EU-15 and in the new Member States, including, in particular, phasing-in and the regional diversity of selected field crops, as well as the breeding of groups of animals for which special payments were assigned. Due to those factors, in 2007 aid per farm in Romania and Malta did not exceed on average EUR 200, while in Denmark and the UK it was over EUR 20,000 per farm. In the first and last years of the previous period, i.e. in 2007 and 2013, only three EU-15 countries: Greece, Portugal and Italy offered payment per farm which was on average lower than the average for all Member States. Phasing-in in the new Member States did not change the distribution, and the rates in most EU-12 countries were lower than the average for the EU-27.

Changes to the direct payment scheme introduced after 2015, completion of phasing-in and structural changes in individual countries did not reduce differences in the amounts of additional payments per farm. Aid amounts range from approx. EUR 400/farm in Romania and Malta, to EUR 38,000 in the Czech Republic. Aid to be granted in 2015-2020 in countries receiving the least support per entity is on average only 11% and 14% of average aid, respectively. In the Czech Republic, payments will be 10 times higher than the average, in Denmark – approx. 6, and in Great Britain – 5.5.

Table 19. Changes in direct payments per hectare of arable land in the financial framework 2007-2013 and 2015-2020 in the various EU countries

Country	Financial framework 2007-2013						Financial framework 2014-2020					
	in 2007		in 2013		average in 2007- 2013		in 2015		in 2020		average in 2015- 2020	
	EUR/ha	UE 27 =100	EUR/ha	UE 27 =100	EUR/ha	UE 27 =100	EUR/ha	UE 28 =100	EUR/ha	UE 28 =100	EUR/ha	UE 28 =100
Austria	256	117	261	101	259	113	241	101	240	100	240	100
Belgium	437	199	453	175	449	196	395	165	372	155	381	159
Bulgaria	45	20	130	50	82	36	161	67	178	74	175	73
Croatia	-	-	-	-	-	-	99	42	198	83	154	64
Cyprus	138	63	452	175	306	134	429	179	411	171	418	174
Czech Republic	108	49	261	101	186	82	251	105	251	104	251	104
Denmark	386	176	396	153	391	171	346	145	333	138	338	141
Estonia	43	20	108	42	76	33	130	54	180	75	159	66
Finland	246	112	249	96	247	108	228	95	229	95	229	95
France	298	135	306	119	302	132	271	113	267	111	269	112
Greece	419	191	428	166	431	189	394	164	376	156	383	160
Spain	196	89	217	84	210	92	204	85	206	86	205	85
Ireland	268	122	269	104	269	118	243	102	243	101	243	101
Lithuania	56	26	139	54	98	43	152	64	189	78	173	72
Luxembourg	283	129	283	109	285	125	256	107	255	106	255	106
Latvia	34	15	82	32	58	25	109	45	169	70	144	60
Malta	143	65	446	172	332	145	448	187	410	170	425	177
Netherlands	445	203	479	186	460	202	417	174	391	163	402	167
Germany	341	155	350	136	346	151	308	129	300	125	303	126
Poland	87	40	211	82	150	66	207	86	212	88	210	87
Portugal	156	71	165	64	161	71	154	64	163	68	160	66
Romania	33	15	95	37	60	26	122	51	143	60	137	57
Slovakia	85	39	205	79	146	64	201	84	208	87	205	85
Slovenia	122	56	299	116	212	93	286	119	278	116	281	117
Sweden	246	112	251	97	249	109	227	95	228	95	228	95
Hungary	115	52	281	109	200	88	271	113	271	113	271	113
Great Britain	235	107	236	91	236	103	211	88	213	89	212	88
Italy	297	135	340	132	322	141	304	127	288	120	294	123
TOTAL	220	100	258	100	229	100	240	100	240	100	240	100

Source: The authors' own calculations based on www.eurostat.ec.europa.eu.

Table 20. Changes in direct payments per farm in the financial framework 2007-2013 and 2015-2020 in the various EU countries

Country	Financial framework 2007-2013						Financial framework 2014-2020					
	in 2007		in 2013		average in 2007- 2013		in 2015		in 2020		average in 2015- 2020	
	EUR/farm	UE 27 =100	EUR/farm	UE 27 =100	EUR/farm	UE 27 =100	EUR/farm	UE 28 =100	EUR/farm	UE 28 =100	EUR/farm	UE 28 =100
Austria	4,908	154	5,006	133	4,969	150	4,615	133	4,606	132	4,609	132
Belgium	13,848	434	14,349	382	14,229	429	12,511	360	11,792	338	12,087	346
Bulgaria	541	17	1,566	42	990	30	1,947	56	2,149	62	2,112	61
Croatia	-	-	-	-	-	-	560	16	1119	32	866	25
Cyprus	419	13	1,377	37	933	28	1,307	38	1,252	36	1,274	37
Czech Republic	16,532	518	39,777	1060	28,391	855	38,254	1100	38,181	1094	38,199	1095
Denmark	24,259	760	24,917	664	24,566	740	21,771	626	20,912	599	21,263	609
Estonia	2,060	65	5,159	137	3,627	109	6,215	179	8,637	247	7,626	219
Finland	8,824	277	8,933	238	8,876	267	8,194	236	8,214	235	8,203	235
France	16,049	503	16,520	440	16,309	491	14,636	421	14,410	413	14,500	416
Greece	3,001	94	3,066	82	3,089	93	2,820	81	2,693	77	2,745	79
Spain	4,698	147	5,209	139	5,033	152	4,893	141	4,944	142	4,922	141
Ireland	9,564	300	9,585	255	9,583	289	8,685	250	8,657	248	8,666	248
Lithuania	775	24	1,901	51	1,347	41	2,090	60	2,586	74	2,379	68
Luxembourg	16,841	528	16,856	449	16,989	512	15,274	439	15,196	435	15,224	436
Latvia	729	23	1,757	47	1,253	38	2,346	67	3,631	104	3,095	89
Malta	131	4	407	11	304	9	409	12	374	11	389	11
Netherlands	11,530	361	12,414	331	11,922	359	10,797	310	10,127	290	10,403	298
Germany	19,041	597	19,566	521	19,323	582	17,197	494	16,777	481	16,947	486
Poland	839	26	2,021	54	1,443	43	1,983	57	2,032	58	2,011	58
Portugal	1,871	59	1,987	53	1,940	58	1,853	53	1,963	56	1,917	55
Romania	115	4	328	9	207	6	422	12	493	14	474	14
Slovakia	6,597	207	15,870	423	11,348	342	15,563	447	16,124	462	15,885	455
Slovenia	790	25	1,932	51	1,372	41	1,848	53	1,799	52	1,819	52
Sweden	10,621	333	10,844	289	10,752	324	9,803	282	9,843	282	9,824	282
Hungary	937	29	2,287	61	1,626	49	2,205	63	2,200	63	2,201	63
Great Britain	21,204	664	21,349	569	21,301	642	19,036	547	19,227	551	19,142	549
Italy	2,353	74	2,701	72	2,555	77	2,407	69	2,285	65	2,335	67
TOTAL	3,191	100	3,753	100	3,319	100	3,478	100	3,491	100	3,489	100

Source: The authors' calculations based on www.eurostat.ec.europa.eu.

2.3. Estimated regional differences in direct payments in Poland in 2015-2020 Methodological notes

The design of the national direct payment scheme in the financial framework 2014-2020 provides for diverse support, aimed at the implementation of following several new major objectives: simplification of the method of applying for funding by the smallest entities, protection of agricultural environment, provision of aid for young farmers, aid for small and medium-sized farms and maintenance of some production lines which are important from the social and environmental point of view. The fundamental objective, i.e. supplementation of farmers' income remains invariably important for many years. The use of appropriate direct aid mechanisms will result in significant differences in amounts of aid depending on the specific characteristics of the beneficiary, such as: size of the farm, age of the farmer or production lines. This will also have its impact on regional distribution of the envelope for direct payments, in the case of which the main differentiating factors will be as follows: agrarian structure, scale of field crop and animal production (to the extent covered by aid for production) and the age structure of potential beneficiaries. These variations will, therefore, relate mainly to the amount of direct payments per farm and (above all) per hectare of arable land.

Estimations of regional variations in direct payments were based on the proposed national implementation of the scheme in Poland (*Draft direct payment scheme*... www.minrol.gov, www.arimr.gov) whose underlying assumptions are presented in Table 23. Total area covered by support and the area covered by support in relation to a single area payment, redistribution payment and the scheme for small farms, were calculated on the basis of unpublished data of the Agency for Restructuring and Modernization of Agriculture (ARMA), relating to the number of beneficiaries and the area under direct payments in 2012. The area and the number of animals eligible for a particular type of production-oriented aid were determined based on data from mass statistics, i.e. the Agricultural Census 2010 or the latest publications of the Central Statistical Office (Statistical Yearbook of Agriculture 2013, Land use... 2013).

The first step was identification of entities subject to a simplified form of support for small farms. In accordance with the draft, this support will involve the use of a lump sum payment of up to EUR 1,250/farm Although all entities can benefit from this form of support, it is assumed, however, that in practice only the smallest farms, for which it will be both viable and convenient as regards organization (exemption from complying with a number of standards) will do that. It was assumed for the purpose of the study that aid for small farms would be used by entities with an area of up to 3 hectares (Sadowski et

al. 2013), which were beneficiaries of aid in 2012. Calculations in this regard were based on the aforementioned unpublished data of the Agency for Restructuring and Modernization of Agriculture. In this study, it was assumed that aid for small farms will benefit entities with an area of up to 3 hectares (Sadowski et al. 2013), which were beneficiaries of aid in 2012. The significance of small entities, calculated based on the number of farms and the area occupied by them in different regions varies and depends on the agrarian structure. The scheme for small farms involves the use of flat-rate aid, which is the sum of all payments to which the farmer would be entitled if he continued to benefit from the standard scheme, subject to the provision that the aid amount may not by higher than EUR 1,250/farm. Therefore, the amount of aid was determined based on the eligible area of arable land of potential beneficiaries, multiplied by the sum of the rate of a single area payment and the rate of the "greening" payment, taking into account the participation in production-oriented aid. The calculations did not, however, account for a redistribution payment, as it is eligible for area over the third hectare.

Then area eligible for additional aid was determined. According to the national scheme this will be area from 3rd to 30th hectare. Therefore, the average area of arable land was determined for farms in the area groups from 3 to 30 hectares (in each voivodeship). Next, three first hectares (non-eligible for aid) were subtracted from this average area, and the resulting figure was multiplied by the number of entities. In the groups of farms with an area of over 30 hectares, the eligible area of 27 hectares was multiplied by the number of farms.

In the case of production-oriented aid, the eligible area and the eligible number of animals were determined for each voivodeship, including, in accordance with the scheme provisions: cattle and dairy cows[31], female sheep and goats, protein crops, starch potatoes, sugar beet, tomatoes, soft fruit, flax and hemp (Table 21). For this purpose, it was necessary in each case to indicate what portion of the area or herd belongs to farms of up to 3 ha. Nationwide data from the mass statistics were used to this end. Then, the number of cattle kept all over the country in herds of over three animals was determined. In the case of herds of over 30 animals, the number of animals eligible for payments was set at 30 (maximum aid level). The proportion of eligible animals all over the country was extrapolated to the level of voivodeships. The same method was applied with respect to female sheep and goats. In the case of the former, the number of animals in herds of over 10 animals was taken into account, while in the case of the latter, this number was 5. Aid for field crop production is not limited by the

[31] Due to the same amount of aid – EUR 70/animal, there was no need to perform separate calculations as regards cows.

size of the plantation, hence in order to set the area eligible for aid it was enough to indicate what portion of crops belongs to farms of up to 3 hectares. Only in the case of starch potatoes, it was assumed that the share of this production line in the total area under potatoes is 7% (Poczta et al. 2013).

Table 21. The number and area of farms with 1-3 ha of arable land benefiting from direct payments

Voivodeship	Area of arable land		Number of farms	
	Ha	area of arable land on beneficiaries' farms = 100	number	number of beneficiaries = 100
Dolnośląskie	33,395	3.8	18,103	32.4
Kujawsko-Pomorskie	24,522	2.4	13,363	20.5
Lubelskie	101,987	7.6	52,734	29.9
Lubuskie	11,088	2.7	6,014	30.6
Łódzkie	62,365	6.6	32,411	26.5
Małopolskie	128,426	26.4	68,527	56.8
Mazowieckie	93,944	5.1	48,086	23.4
Opolskie	15,309	3.1	8,378	30.4
Podkarpackie	121,667	23.2	65,026	56.1
Podlaskie	23,433	2.3	11,980	14.9
Pomorskie	14,778	2.1	7,912	20.8
Śląskie	41,053	12.2	22,619	48.0
Świętokrzyskie	59,348	12.4	30,603	36.1
Warmińsko-Mazurskie	14,089	1.5	7,566	17.7
Wielkopolskie	54,444	3.2	29,612	24.6
Zachodniopomorskie	12,048	1.5	6,448	23.0
Total	**811,897**	**5.8**	**429,382**	**31.8**

Source: The authors' calculations based on unpublished data of ARMA.

In accordance with the adopted direct payment rules, after 2013 aid for young farmers is to become an obligatory component of the scheme. All farmers under the age of 40 will be eligible for this payment, and they will continue to be entitled to it for a maximum period of 5 years from the commencement of agricultural business activity. Aid may be granted to any young farmer, regardless of the size of his/her farm, but the maximum area based on which an additional amount of aid will be calculated is 50 hectares eligible to a single area payment. On these grounds the number of farms run by young farmers was estimated[32], so was the area of arable land covered by aid under direct payments in

[32] The estimations have been based on: unpublished data of the Ministry of Agriculture and Rural Development and those of the Agency for Restructuring and Modernization of Agricul-

these farms in 2012. It was estimated that every year the total number of beneficiaries include approx. 90 thousand young farmers who would have at their disposal a total area of approx. 800 thousand ha. From this total area the area at the disposal of young farmers who run farms of up to 50 hectares was isolated, and the area eligible for additional aid on farms of over 50 hectares was estimated. In accordance with the calculations approx. 700 thousand hectares are eligible for aid for young farmers in Poland.

The above-mentioned numbers of farms, eligible areas and numbers of animals, determined for each voivodeship, were then multiplied by the expected rates of aid (*Draft direct payment scheme*... 2014) to determine the amount of a possible voivodeship envelope. At the same time, it was assumed that all entities that participated in the scheme in 2012 will fully benefit from aid to which they are entitled also in 2015. The thus calculated amount was very close to the allocation proposed by the Ministry of Agriculture and Rural Development. A small difference (approx. 6%) of the estimates relative to the value of the national envelope for 2015, was adjusted for each voivodeship in proportion to the amount of the difference between the envelope and the calculations.

2.4. Results

The agrarian and production structures of Polish agriculture are significantly diversified, which, given the design of the new payment scheme, will be of importance for the regional allocation of funds, because the single area payment represents only 45% of the total value of aid. This factor will also affect the volume of the system administration costs, as should be assumed that the use of lump sum payments for small farms will be the least "cost-intensive", while the use of additional payments and those related to production will be most costly. This is largely due to the significance of small farms – with an area of up to 3 hectares (Table 21), whose share in the number of farms taking advantage from direct payments ranges from about 60% in the south-eastern Polish voivodeships (Małopolskie, Podkarpackie) to about 15% in the Podlaskie voivodeship and about 20% in the Kujawsko-Pomorskie, Pomorskie and Warmińsko-Mazurskie voivodeships. The share of area which is in the possession of small farms is gradually decreasing, but the regional variation of this factor may be of environmental importance, as small farms are exempt from controls concerning adherence to cross-compliance standards and "greening" practices.

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ture, concerning the use of indirect payments in 2006-2010 and 2012, and the results of simulations presented in Czubak W., Poczta W., Sadowski A., Mrówczyńska-Kamińska A. (2013), *Sposób wdrażania płatności dla młodych rolników*. Ministry of Agriculture and Rural Development, Warszawa.

The diversity of the agrarian structure is also important as regards the amount of funds obtained under additional aid. In this case, greater concentration will be less favourable for farms. In most cases, however, the share of area eligible for this form of aid in a given region is proportional to the share of area belonging to farms larger than 3 hectares (Table 22). The only exception in this regard is the Podlaskie voivodeship, where the proportion of farms with an area of more than 3 hectares represents 7% country-wide, while the share of the area covered by additional aid is 10% of the total area eligible for additional aid.

Table 22. Estimated regional distribution of area and livestock populations eligible for aid on farms with an area of more than 3 hectares

Voivodeship	Area of arable land on farms of 3 ha eligible to aid [ha]	Area eligible to additional aid [ha]	Number of cattle animals (including cows) eligible for aid	Number of eligible ewes	Number of eligible female goats
Dolnośląskie	839,585	348,573	72,547	5,913	2,211
Kujawsko-Pomorskie	1,000,156	556,848	327,487	5,341	986
Lubelskie	1,237,866	726,736	270,339	6,438	3,096
Lubuskie	394,489	147,911	49,165	1,859	1,020
Łódzkie	885,417	547,376	322,330	7,773	1,735
Małopolskie	358,784	163,839	134,710	38,295	4,457
Mazowieckie	1,762,999	1,102,334	742,003	3,433	2,075
Opolskie	485,909	199,757	81,942	906	544
Podkarpackie	402,472	183,053	72,123	11,064	3,232
Podlaskie	994,485	677,223	655,257	10,110	1,361
Pomorskie	684,606	321,518	140,220	8,202	986
Śląskie	295,130	146,130	85,969	6,533	1,565
Świętokrzyskie	417,344	233,070	120,158	1,478	2,109
Warmińsko-Mazurskie	937,896	452,169	327,346	5,198	1,939
Wielkopolskie	1,658,221	860,551	607,928	10,730	2,313
Zachodniopomorskie	809,008	273,725	71,205	3,958	952
Total	**13,164,367**	**6,940,814**	**4,080,729**	**127,231**	**30,581**

Source: The authors' calculations.

Table 22 (cont.).

Voivodeship	Area under eligible crops (ha)					
	protein crops	starch potatoes	sugar beet	flax and hemp	strawberries	tomatoes
Dolnośląskie	7,048	1,275	17,049	73	977	7,175
Kujawsko-Pomorskie	19,666	1,200	36,815	117	956	17,758
Lubelskie	31,248	1,755	32,796	397	4,713	19,641
Lubuskie	11,546	270	1,153	235	432	3,857
Łódzkie	17,106	2,530	5,778	14	1,936	17,220
Małopolskie	7,320	1,666	1,339	6	973	14,529
Mazowieckie	31,410	3,022	9,572	154	14,713	20,987
Opolskie	3,430	492	14,064	2	136	2,332
Podkarpackie	5,480	1,695	3,742	67	396	4,843
Podlaskie	26,414	1,568	0	18	373	2,152
Pomorskie	17,850	1,321	10,173	294	983	6,816
Śląskie	4,219	561	1,740	84	205	2,422
Świętokrzyskie	12,810	1,111	4,367	15	3,055	9,776
Warmińsko-Mazurskie	36,728	861	2,741	467	644	3,139
Wielkopolskie	32,133	2,197	41,100	219	1,275	22,332
Zachodniopomorskie	42,438	762	9,377	229	741	2,601
Total	**306,846**	**22,286**	**191,806**	**2,391**	**32,508**	**157,580**

Source: The authors' calculations.

The scale of production of various field crops and livestock covered by production aid will also affect regional differences in received aid, but the significance of this factor is mitigated by the fact that only 15% of the envelope has been allocated to this purpose. Relative regional significance of the various lines of production has been determined by comparison of its share in a given region with the appropriate proportion of area of arable land owned by farms larger than 3 hectares which were eligible for direct payments (Table 22). As regards sizes of cattle herds (including cows), attention should be paid to the Podlaskie and Mazowieckie voivodeships, where the share of this population is respectively 16% and 18% of the country-wide population, while the shares in area of arable land on farms of more than 3 hectares, which were covered by the direct payment scheme, are 8% and 13%, respectively. This ratio was quite different in the Zachodniopomorskie voivodeship, which occupies 6% of the area analyzed above but has only 2% cattle herds. In the case of sheep and goats, attention should be paid to the Małopolskie voivodeship, where there are 30% of ewes and 15% of female goats, but only 3% of arable land belongs to farms of over 3 hectares. The Zachodniopomorskie voivodeship has a relatively high proportion of protein crops (14% relative to 7% of the area). As regards sugar beet,

particular attention should be paid to the Mazowieckie voivodeship, where the significance of this crop is disproportionately low (5% relative to 13% of the area) and the Wielkopolskie and Kujawsko-Pomorskie voivodeships, where it is unusually high (21% relative to 12% of the area in the Wielkopolskie voivodeship and 19% relative to 7% of the area in the Kujawsko-Pomorskie voivodeship). As regards the Mazowieckie voivodeship, it is characterized by relatively high significance of soft fruit production (45% relative to 13% of the area). In the case of tomatoes, more than average volumes of this crop production occur particularly in the Małopolskie voivodeship (9%), while in the Podlaskie voivodeship, production of this crop is of relatively least significance (1% of the crop relative to 7% of the area).

As far as the estimated 90 thousand farms run by young farmers are concerned, the total area eligible for payments (from 1 to 50 hectares) was approx. 700 thousand hectares. From among all voivodeships, the highest number of farms eligible for aid and the greatest eligible area were recorded in the following voivodeships: Mazowieckie, Lubelskie and Wielkopolskie. Farms located in the three voivodeships mentioned above will receive nearly 40% of aid for young farmers, while those located in the three voivodeships with the estimated lowest share (Lubuskie, Opolskie and Śląskie) will receive 7% of aid. Such distribution was largely due to the overall size of the voivodeship and the farm structure. As has already been mentioned, in spite of regional differences it should be noted that from among all the components of the new direct payment scheme, aid for young farmers will have a minor impact on the overall regional differences as regards aid. This is due to the fact that only 2% of the envelope has been allocated to this component.

Based on the volumes of the various components of direct aid it was possible to calculate, with the use of proposed rates (Table 23), allocation of funds in each voivodeship in Poland. This part of analysis was based on a preliminary assumption that all eligible entities would apply for all forms of direct aid to which they are entitled (Tables 24 and 25).

Table 23. National envelope for direct payments in 2015

Item	Amount arising from distribution of the envelope	
	EUR	Share [%]
SAP	1,430,050,105	44.7
"Greening"	959,765,171	30.0
Additional payments	265,535,031	8.3
Payment for young farmers	63,984,345	2.0
Production payments	479,882,586	15.0
Total	3,199,217,237	100

Source: Draft direct payment scheme…,www.minrol.gov.pl, www.arimr.gov.pl.

Regional allocation relating to direct payments indicates significant differences in the importance of each component country-wide (Table 24). Absolute values are obviously proportional to the size of the voivodeship, hence, as has been found within performed analyses, the majority of funds will be awarded to the Mazowieckie voivodeship followed by the Wielkopolskie voivodeship. As has already been mentioned, shares of individual components depend on the agrarian structure and the importance of the various lines of field crop and animal production eligible for aid. In regions where fragmented agriculture prevails (mainly the Małopolskie and Podkarpackie ones and, though to a lesser extent, the Śląskie and Świętokrzyskie ones), the share of aid for small farms will be higher than in the other regions. The opposite applies to regions with concentrated agrarian structure (the Warmińsko-Mazurskie and Zachodniopomorskie ones), where the importance of this component is relatively low – approx. 1.5%. Everywhere outside the aforementioned regions with the most dispersed structure, the single area payment and the "greening" payment have the highest share, which is related both to the fact these types of payments are applied to all types of land (except for those eligible for aid for small farms) and the fact that both types of aid constitute the vast majority in the national envelope. The importance of additional aid, applicable to from 3rd to 30th hectare, is the highest in regions with relatively significant family farming, thus mainly in the Podlaskie, Kujawsko-Pomorskie and Mazowieckie voivodeships. This is due to the fact that in regions where agriculture is dominated by small farms, there is also a significant share of lump-sum payments intended for such farms, whereas in voivodeships where large farms prevail, additional payments for 27 hectares are of little relevance. Significant differences occur as regards production-related payments. The largest share of this form of aid is observed in voivodeships which are characterized mainly by high significance of cattle breeding (including dairy cows), thus in the Podlaskie, Kujawsko-Pomorskie, Wielkopol-

skie and Warmińsko-Mazurskie ones. It should be noted that payments for young farmers are of little importance, ranging from 1.4% to 2.2%, in all the regions, which is directly related to the small share of this form of aid in the national envelope, as well as the applied estimates. The amount of aid per farm in the region, both with aid for small farms and without this form of aid, is observed to be the highest in voivodeships with concentrated agrarian structures (Zachodniopomorskie and Warmińsko-Mazurskie ones), which is a direct result of direct payments applied primarily per unit of area. As mentioned above, the single unit payment and the "greening" payment constitute majority of funds. It should be noted in this respect that payments received by a farm, thus an entity that can dispose of them in an arbitrary manner, are to a large extent a decisive factor as regards its competitive opportunities, including those related to modernization investments. The situation is different in the case of payments per hectare of arable land. A slightly greater amounts of payments per hectare of arable land are recorded in the Podlaskie, Wielkopolskie and Kujawsko-Pomorskie voivodeships. The rate of payment per hectare ranges from EUR 241 in the Podlaskie voivodeship to EUR 175 in the Śląskie and Podkarpackie voivodeships.

Table 24. Estimated regional distribution of the various components of direct payments[1]

Voivodeship	Share of the various forms of payments (Total...=100)						Total direct payments with aid for small farms [EUR]
	Aid for small farms	SAP	"Greening"	Additional aid	Aid for young farmers	Production aid	
Dolnośląskie	4.1	47.6	32.0	7.0	1.5	7.8	180,749,617
Kujawsko-Pomorskie	2.2	42.1	28.3	8.3	1.9	17.3	243,606,999
Lubelskie	7.3	41.0	27.5	8.5	2.2	13.4	309,429,800
Lubuskie	2.9	48.1	32.3	6.4	1.4	8.9	84,060,313
Łódzkie	6.3	41.2	27.7	9.0	2.2	13.7	220,315,926
Małopolskie	25.5	33.0	22.2	5.3	2.0	12.0	111,382,145
Mazowieckie	4.7	41.2	27.7	9.1	2.2	15.2	438,692,228
Opolskie	3.2	46.4	31.2	6.7	1.4	11.1	107,285,639
Podkarpackie	23.7	36.3	24.4	5.8	2.0	7.8	113,598,998
Podlaskie	2.0	39.7	26.6	9.5	1.9	20.2	256,914,610
Pomorskie	2.1	45.5	30.6	7.5	1.6	12.6	154,118,468
Śląskie	12.2	40.7	27.3	7.1	2.0	10.8	74,416,616
Świętokrzyskie	11.9	38.9	26.1	7.6	2.2	13.3	110,103,689
Warmińsko-Mazurskie	1.4	44.1	29.6	7.5	1.7	15.8	218,236,195
Wielkopolskie	3.0	42.4	28.5	7.8	1.8	16.6	400,855,622
Zachodniopomorskie	1.5	47.3	31.7	5.6	1.4	12.4	175,450,372
Total	5.6	42.2	28.3	7.8	1.9	14.2	3,199,217,237

[1] Value after adjustment resulting from the estimated regional distribution relative to the national envelope.

Source: The authors' calculations based on: Land use...2011, Statistical Yearbook of Agriculture 2013, Land use... 2013, Draft direct payment scheme... www.minrol.gov, www.arimr.gov.pl.

Table 25. Estimated regional distribution of direct payments per farm and per hectare of arable land

Voivodeship	Total payments without aid for small farms				Total payments with aid for small farms			
	per farm (EUR)	Total = 100	per hectare of arable land (EUR)	Total = 100	per farm (EUR)	Total = 100	per hectare of arable land (EUR)	Total = 100
Dolnośląskie	4,280	140	206	90	2,848	139	190	90
Kujawsko-Pomorskie	4,420	145	238	104	3,587	175	225	107
Lubelskie	2,230	73	232	101	1,630	80	222	106
Lubuskie	5,568	182	207	90	3,575	175	189	90
Łódzkie	2,160	71	233	102	1,639	80	222	106
Małopolskie	1,348	44	231	101	686	34	181	86
Mazowieckie	2,454	80	237	103	1,846	90	219	105
Opolskie	5,313	174	214	93	3,767	184	209	99
Podkarpackie	1,473	48	215	94	783	38	176	84
Podlaskie	3,553	116	253	110	2,987	146	241	115
Pomorskie	4,684	153	220	96	3,598	176	192	92
Śląskie	2,081	68	221	97	959	47	175	84
Świętokrzyskie	1,608	53	232	101	1,068	52	206	98
Warmińsko-Mazurskie	6,102	200	229	100	4,915	240	208	99
Wielkopolskie	4,186	137	234	102	3,235	158	225	107
Zachodniopomorskie	7,534	247	214	93	5,500	269	185	88
Total	3,052	100	229	100	2,047	100	210	100

Source: The authors' calculations based on: Land use...2011, Statistical Yearbook of Agriculture 2013, Land use... 2013, Draft direct payment scheme..., www.minrol.gov.pl, www.arimr.gov.pl.

2.5. Summary

The evolution of the direct payment scheme, taking place for more than two decades, i.e. since the payments were introduced, reflects the regularly changing purposes for which they were intended. In fact only the primary objective, i.e. providing public aid for agricultural income, has remained unchanged. In the first period (after MacSharry reform), this was related to the need for offsetting losses incurred due to a reduction in product support. After 2003 (following the Luxembourg reform), the use of aid was rationalized by the provision of environmental and health services, defined in the cross compliance standards, by its beneficiaries. Most new objectives which are to be achieved with the use of the direct payment scheme have been introduced under the present 2015-2020 reform, as it has been assumed that along with enhancing the environmental reasons (cross-compliance standards supplemented with "greening"), aid will be provided also to medium-sized farms (additional payment), young farmers and certain lines of field crop and animal production. The very last component is in some ways a departure from the decoupling principle, which was fundamental to the Luxembourg reform. Such a broad range of issues may raise concern about the possibility of working out efficient solutions, which in the case of the Polish implementation of the system, is particularly noticeable as regards production-related aid. Taking into account a wide range of lines of production to be covered by the 15% of the envelope intended for this purpose means that due caution should be exercised in assessing the future impact of the implementation of this component.

From the Polish point of view, the incomplete "flattening" of the relative amount of aid among the Member States seems to be half-success. However, the historical and emotional factors should be taken into account in this regard. Depriving certain groups in society (in this case, farmers from the EU-15 countries) of certain privileges which they have acquired is usually difficult from the political point of view, even if it has objective social reasons. Although the compensatory nature of direct payments has by now, if considered directly, only historical dimension, it is indirectly still present in the form of the single farm payment (which in turn results from the value of the reference period). Farms in the EU-15 countries have been benefiting from payments in appropriately high amounts for decades, hence a reduction of their amounts in favour of the new Member States is difficult to accept both for farmers and individual governments.

This analysis takes into account one more issue, namely regional differences in the national envelope. The agrarian structure determines the amounts of payments per farm, which is understandable in the case of payments whose

amounts depend on the area. Any similar support scheme, regardless of its internal structure, would produce the same result. This was also the case in previous years, when the highest single aid was awarded to farms located in regions with the most concentrated structures. The "breakdown" of the national envelope into individual components will translate also into differentiation of the amounts of payments per area of arable land, primarily on individual farms, which in turn translates into regional differentiation as regards this parameter. Despite a small amount of aid, farmers may be motivated by production-oriented payments (subject to the aforementioned reservations concerning the multiplicity of supported lines of production) and a payment for young farmers.

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3. Public support as a determinant of technical efficiency of large-scale farms

3.1. Foreword

Main objective of analysis was the relationship between subsidization of large-scale farms and their technical efficiency. The research hypothesis was: "the impact of subsidies on the technical efficiency of large-scale farms is uncertain and inconsistent". Besides, research included the identification of the factors that determine the technical efficiency of farms.

Although the subsidization of agriculture is present from the beginning of times all over the world, it must be admitted that it occurs at very different levels in different countries (e.g. in Australia, New Zealand and Chile farmers receive only 1 to 4 percent of state grants, while in Norway, Switzerland, Japan and Korea over fifty percent[33]). Subsidization interfere to some extent with the principle of rational action and reduces the incentive to improve the management efficiency in this sector.

The implementation of the policy objectives of government intervention in agriculture is carried out through the use of economic and administrative and legal instruments that limits in an indirect and a direct mechanism of free competition. They can be divided into market and non-market. You can also separate internal and external protectionism. In such intention was created the Common Agricultural Policy of the European Union in 1957. Moreover, in a similar way, officials of President H.C. Hoover (1929-1933) and most of all F.D. Roosevelt (1933-1945) introduced many state aid programs for American agriculture, which had been grown over the years.

In Polish conditions, it is necessary to have pro-effective allocation policy. This would enable the use of the means of production in areas where they will give the greatest effect. According to J. Wyzińskia-Ludian (1996) the impact of agricultural policy instruments should promote the allocation policy. On the other hand, the low intensity of the Polish agricultural sector results in less contaminated environment and "greener" food production. Polish agriculture has another advantage – family farms.

Subordination of Polish agricultural sector to the principles of the CAP (scheme 1), led many scientists to analyze the problem of affecting of CAP instruments on achievement of objectives outlined in the Treaties of Rome.

[33] Agricultural Policy Monitoring and Evaluation 2013 – OECD Countries and Emerging Economies, September 2013.

Scheme 1. Evolution in determining the priorities and objectives of the CAP

PRODUCTIVITY → COMPETITIVENESS → SUSTAINABILITY

Initial period	*Years of crisis*	*The Reform 1992*	*The Agenda 2000*	*The Reform 2003*	*The CAP Health check 2008*	*Challenges for the future 2014-2020*
Food safety **Improvement of farm productivity** **Agricultural markets stabilization** **Support of agricultural incomes**	Overproduction of food Increase of the CAP budget International disputes Structural Instruments	Limitation of food surplus Environmental protection Stabilization of agricultural incomes Stabilization of the CAP budget	Deepening of the CAP reform process Competition Rural areas development	Market orientation Consumer benefits Development of rural areas Environment Simplification of the CAP Compliance with the priorities of the WTO	Strengthening of the reform of 2003 Improvement of current instruments of the CAP Improvement in energy policy Risk management Sustainable agriculture	Targeting policy Income stabilization International disagreements (EU vs. Russia) Environment Climate change Instruments of the CAP more oriented towards sustainable rural development

Source: Overview of CAP Reform 2014-2020, Agricultural Policy Perspectives Brief, No. 5, December 2013.

The integration with the European Union changed the conditions for the functioning of Polish agriculture in terms of the possibility of financing the development of farms. This integration allowed us to improve the competitive position on the domestic and European markets. In the years 2004-2013 Poland experienced historical growth of funds for the agricultural sector and rural development, which resulted in an increase in agricultural income and improvement of living conditions in the countryside.

The implementation of the CAP instruments changed relationships between the factors of production. Investment expenditures improved the technical equipment of farmland. The better technical equipment operation also resulted from a decrease in the number of employees in this sector. However, only a small amount of those, about 8% of all farms, are holdings able to benefit from the investment activities of the CAP.

At the same time, it is clear that the direct payments and other subsidies often weakened the incentive to look for other ways to improve efficiency and productivity. L. Latruffe has written on this topic a lot of publications[34]. The world pioneers in this field were mainly L. Lachaal (1994)[35] and A.D. Hennessy (1998)[36], who analyzed the various aid programs directed to agriculture in the context of improvement of the efficiency, productivity and growth.

In the present study large-scale farms were subjected to analysis that this extra money treat as capital expenditure. Investments in new technologies, machinery or increase of the agricultural area, increased production capacity of the farm. This suggests that financial support should motivate to increase the production capacity of farms, as it will significantly reduce the cost of capital. It can be verified by determination of the technical performance indicators and classic economic indicators.

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3.2. Methodology of research

3.2.1. The essence of technical efficiency

The oldest concept of efficiency comes from the Italian economist V. Pareto (1848-1923), who was a co-founder for Lausanne school of economics. V. Pareto extended the application of mathematical methods in economics and developed the concept of general economic equilibrium. From a general, equilibrium involving the concept of optimality (Pareto optimality) means a situation where it is not possible the reallocation of resources, the growing prosperity of any unit without simultaneous reduction of the welfare of another entity. In the next section it is showed, among other things, the method of Data Envelopment Analysis, which uses the V. Pareto approach to explain envelope data estimation procedures.

Efficiency is one of the terms most frequently used to characterize the functioning of the organization. It can be considered that effective organization is the one that achieves its objectives. Analysis of technical efficiency as derivative financial support, reasonably expended in development of large-scale farms, is justified. Farm's development is reflected in the structure of assets. When we invest in new technologies, machines or increase the agricultural area, we enlarge the production capacity of farm. Organizations that use performance measurement system, better operate in a competitive economic environment.

Technical efficiency (productive efficiency) is used to indicate the possibility of increased production using the same amount of expenditures (maximizing outcomes for given inputs) or reduce expenditures while maintaining the same level of effects (a reduction in the effects on the data). And allocative efficiency (or price) can determine the optimum proportions of their expenditures at specific prices and production technology. These measures were originally oriented expenditures (cutting unnecessary expenditures). Their product can, in turn, determine the economic efficiency. Overall economic efficiency (economic efficiency – EE) can be written as the relation of segments (relation 0R to 0P). Get a similar result by multiplying the technical performance indicators (TE) and allocative (AE):

$$TE * AE = \frac{0Q}{0P} * \frac{0R}{0Q} = \frac{0R}{0P} = EE.$$

M.J. Farrell (1957) developed alternative concept of best practice frontier, also referred to as the efficiency frontier or production, which was the technological frontier of achievable production capacity for the company. It should be clear that the entity model, in terms of the results of each of the aforementioned

performance, in practice does not exist and you should evaluate the effectiveness of the isoquant on specific empirical data.

Therefore in literature is recommended to use one of two solutions:

- parametric – eg. the Cobb-Douglas production function,
- non-parametric – Farrell linear isoquant.

On the other hand, in the case of the efficiency scale, understood as rational achieving benefits from the large volume of production and lower unit costs of production, the problem is to choose one of the two options – variable (VRS) or fixed (CRS)[37] effects of the scale. In the case of non-parametric methods for the selection of the first solution it is related to the revaluation of performance indicators, the choice of the second one – with their underestimation.

3.2.2. Methods of technical efficiency estimation

On the basis of the work and analysis M.J. Farrell (1957) searched other methods of evaluation of the technical, allocative and economic efficiency. As a result, we have many useful techniques for determining the efficiency curves. These techniques can be classified in various ways. The division into parametric and non-parametric method is based on the criterion of having definition of the form of analytical functions (production, costs etc.). There are two approaches of measuring the effectiveness of the methods:

a) non-parametric (*Data Envelopment Analysis* – DEA, *Free Disposal Hull* – FDH),
b) parametric (*Stochastic Frontier Analysis* – SFA, *Distribution Free Approach* – DFA, *Thick Frontier Approach* – TFA).

An example of a non-parametric method is a mathematical programming model by which the efficiency curve is determined and the companies are ranked. The parametric approach is further distinguished by deterministic and stochastic models. Deterministic models (deterministic functions limit) can be estimated using mathematical programming, econometric tools and stochastic only with use of econometric techniques as well.

[37] VRS – variable return to scale; CRS – constant returns to scale.

3.3. The measurement of technical efficiency

3.3.1. Stochastic Frontier Analysis

Stochastic Frontier Analysis is the most widely used method of evaluating efficiency among parametric methods. The starting point is the choice of the production function, which is followed by determining the relationship between inputs and outputs. Normally, this is a logarithmic form or its modification.

A.N. Berger and L.J. Mester (1997)[38] compared the results of translogarithmic function and Fourier function. They found that the latter was not a good solution. The main drawback of parametric methods lies in their deterministic nature. On the other hand, selection of an appropriate one as a function of the parametric approach causes more problems.

In summary, the SFA method is used to verify the accuracy of selection in terms of the structure of production consumed in the course of the investment, and to identify the factors that cause the technical inefficiency of the surveyed enterprises. In addition to the columns of the inputs and the effects, the analytical form of the production function should be also specified here. It often creates difficulties for researchers. This method allows the random identification (stochastic) to estimate the technical inefficiency. SFA has two important advantages. Firstly, in contrast to other parametric and nonparametric methods, it enables the secretion of a random error. Secondly, like other methods of parametric statistical significance tests, it enables the model parameters on the basis of which is carried out evaluation of the effectiveness of the surveyed companies.

3.3.2. Data Envelopment Analysis

Data Envelopment Analysis is a non-parametric, deterministic method, assuming the lack of provisions for the random component and the lack of specification of the function, describing the relationship between inputs and effects[39]. The creators based their method on the concept of productivity, formulated by G. Debreu (1951) and M.J. Farrell (1957)[40]. They applied the approach of the predecessors while modifying some assumptions (regarding the case of the use of many resources and achieving a variety of effects). The intention of its authors, is to establish a tool to measure the efficiency

[38] A.N. Berger, L.J. Mester, *Inside the black box: what explains differences in the efficiencies of financial institutions*, „Journal of Banking and Finance", Elsevier, vol. 21(7), July 1997.
[39] www.deazone.com, www.rutcor.rutgers.edu/pub/rrr/reports2002/1_2002.pdf.
[40] A. Kucharski, *Metoda DEA w ocenie efektywności gospodarczej*, wyd. 2, Wydawnictwo KBO, Łódź 2014.

of organizations whose activities are not characterized by the generation of prof-profit. The literature on the non-parametric method for the years 1978-2001 included more than 3.2 thousand publications in peer-reviewed journals. This approach makes it possible to estimate the productivity and technical efficiency (type X). Objective functions can be written as:

- maximization of the effects at the data inputs – a measure of technical efficiency proposed by M.J. Farrell,
- minimization of the effects at the data inputs – Shepard distance function.

In both cases the DEA is examined using linear programming. The most effective technically units are the points along the curve in the efficiency coordinate system, while inefficient – below this curve. Efficiency is measured in relation to other objects (a measure of relative) of the study group of companies (the best, the most homogeneous).

In its original version, DEA models relate to solid economies of scale (CRS models), but this assumption allows the repeal of disaggregation efficiency for pure technical efficiency and scale efficiency. Hence, the model with the assumption of variable economies of scale (VRS) adjusts the envelope in a less rigorous way and therefore more units can be considered effective.

The DEA algorithm provides information on the level of effectiveness of the company (farm), efficiency of the individual effort and the creation of performance and value, or the amount of lost effort or performance (depending on whether the model was oriented inputs, or effects). The solution obtained with its use can be interpreted as a local approximation of the production function (empirical production function).

To summarize the considerations set out in this section, it should be emphasized that the key element of both methods (parametric and non-parametric) is the right choice of costs and benefits. Here, you should always keep in mind the purpose of the enterprise and the main object of its activities. Revenues from operating activities are usually adopted for effect, while employment (or other ways of expressing labor input) capital or operating expenses are usually vectors of inputs. Another issue that needs clarification applies to entities that are characterized by extreme values on the inputs (outliers). DEA method, and in particular VRS model is very sensitive to these values. Hence, you can find in the literature a recommendation on the appropriateness of the exclusion of outliers. However, this exclusion alters the course of the boundary data and thus an average rating of effectiveness in the sample.

SFA method adopted due to *a priori* analytical form of the production function gave more stable and independent extreme values. The concomitant

uses both methods to objectify the final results of the study. Moreover, the as-assumption is assumed that in a situation where we have more than one column of the effects of non-parametric approach is used (DEA and FDH) and, in the case of one effect – the method of parametric SFA. Comprehensive comparison of the most important properties of both methods is presented in Comparison 1.

Comparison 1. Parametric and non-parametric methods

Attributes / characteristics	Parametric method	Non-parametric method
The need to define the functional relationship	yes	no
The ability to verify the statistical significance of the results	yes	a limited extent
Consideration of the random error	yes	no
Range of the evaluation of technical efficiency indicators	(0;1)	(0;1)
Number of the most efficient DMU's	usually one	many
Number of inputs	many	many
Number of effects	one	many
Possibility of calculating the scale effects	no	yes
Possibility of forecasting on the next periods	yes	no

Source: own study based on: D. Sikora, A. Kulczycki, Efektywność oddziału banku detalicznego, Wydawnictwo CeDeWu, Warszawa 2008.

According to D. Sikora and A. Kulczycki (2008)[41] to measure the efficiency more often were used the approaches based on regression. Thus, by traditional methods parametric approaches should be considered. Hence the solutions obtained using the DEA are more suited to each surveyed farm. In addition, the parametric methods are not capable of identifying the sources of inefficiency and non-parametric methods provide such information in detail (wasted within each of the inputs and effects possible to obtain). However, an important advantage of methods based on regression (parametric) is ability to forecast the results in future periods, which is enabled by the function of production or cost function. In addition, the parametric model can be extrapolated to observations that were not originally included in the sample. Furthermore, the most important advantage of the parametric methods is the ability to verification the results of the statistical significance tests. Finally, it should be also added that the parametric method corresponds with revenue-cost approach. The main focus of the non-parametric methods, is, on the

[41] D. Sikora, A. Kulczycki, *Efektywność oddziału banku detalicznego*, Wydawnictwo CeDeWu, Warszawa 2008.

technical aspect of the production (the proportions of effort and waste), and not on the economic aspect of optimization.

3.4. Review of the literature

A review of the international literature shows that research of the technical efficiency of farms have been taken already in the 1950s. The impetus for this was the article of 1957 by M.J. Farrell who also started the analysis of technical and cost efficiency and productivity. In empirical research were used stochastic limits models (Stochastic Frontier Models and Stochastic Frontier Analysis) or deterministic envelope method (Data Envelopment Analysis). One of the first applications of SFM for the analysis of the efficiency of farms is presented in the article of G.E. Battese and G.S. Corra (1977)[42].

M. Gorton and S. Davidova (2004)[43] analyzed the effectiveness of farms in the Central and Eastern Europe. Technical feasibility of farms in Poland conducted D.K. Munroe (2001). They used the parametric method (SFA) and the Cobb-Douglas production function. An important item in the literature was also an article of B. Brümmer, T. Glauben and G. Thijssen (2002)[44]. A. Henningsen and S. Kumbhakar (2009) which proposed an eclectic approach to the analysis of the technical efficiency of farms in Poland, with a combination of parametric and non-parametric methods. The assessment and analysis of the impact of CAP instruments on the technical efficiency of European households were the objectives of more than 140 thousand publications. However, due to lack of clarity about the results and the direction of these relationships, researchers continue to search for new methodological solutions. Therefore, recently extended methodological framework for semi-parametric approach, was an parameterized impact of the independent variables. For example, this approach applied by Kazukauskas' team[45] in 2014.

X. Zhu and A. Oude Lansink (2010) showed the negative effects of subvention in publication entitled "Impact of CAP subsidies on technical efficiency of crop farms in Germany, the Netherlands and Sweden". Research conducted by a team of L. Latruffe, L. Bakucs, S. Bojnec, I. Ferto, J. Fogarasi,

[42] G.E. Battese, G.S. Corra, *Estimation of production frontier model: with application to the pastoral zone of Eastern Australia*, „Australian Journal of Agricultural Economics", vol. 21, no. 3, 1977.
[43] M. Gorton, S. Davidova, *Farm productivity and efficiency in the CEE applicant countries: a synthesis of result*, „Agricultural Economics", vol. 30, no. 1, 2004.
[44] B. Brümmer, T. Glauben, G. Thijssen, *Decomposition of productivity growth using distance functions: the case of dairy farms in three European countries,* „American Journal of Agricultural Economics", vol. 84, no. 3, 2002.
[45] K. Kazukauskas, C. Newman, J. Sauer, *The impact of decoupled subsidies on productivity in agriculture: a cross-country analysis using microdata*, „Agricultural Economics", vol. 45, no. 3, 2014.

C. Gavrilescu, L. Jelinek, L. Luca, T. Medonos, C. Toma, where four countries were chosen for analysis: Hungary, the Czech Republic, Slovenia and Romania, showed that the proportion of the grants affected the technical efficiency in a positive way, but some of them – in a negative. Details of these studies are presented in Comparison 2.

Comparison 2. Determinants of technical efficiency

Country	The positive dependency	The negative dependency
Romania	Location/province (dummy), Subsidies for crop output, per hectare, Family farm dummy, share of liabilities in total assets,	Subsidies for seeds and pesticides purchase, per hectare
Hungary	accession to the EU, legal form (legal entity), location, Soil quality index,	Time trend, Livestock output to total output ratio, Share of operating subsidies in total production value, Land to labour ratio,
Czech Rep.	Time trend, Share of crop production in total agricultural production,	Share of the farm's area not in Less Favourable Area, Limited liability company dummy, Total operational and investment subsidies,
Slovenia	Time trend, Share of hired labour, Share of rented land, Herfindahl specialisation index,	Operational subsidies to revenue Ratio, Share of marketed output.

Source: L. Latruffe, L. Bakucs, S. Bojnec, I. Ferto, J. Fogarasi, C. Gavrilescu, L. Jelinek, L. Luca, T. Medonos, C. Toma, Impact of public subsidies…, op. cit.

On the other hand, F. Lambarraa and Z. Kallas (2009) carried out the impact of LFA payments on the technical efficiency of Spanish farms producing olives. The areas eligible for LFA payments in Spain constitute up to 80% of rural areas. The results showed that LFA and several other factors impacted negatively on technical efficiency indicators. It is worth noting that the LFA payments reduced the indicators the most. L. Latruffe and S. Bojnec (2013) conducted a study in the later years of Slovenian farms. As a result, it is managed to establish the impact of subventions and the amount of agricultural area for efficiency. It has been found that subsidies had a negative effect on the results of technical efficiency. Enlarging UAA acreage had its stimulant. Further study of literature (Comparison 3) has shown both positive and negative impact of grants on the effectiveness of farms.

Comparison 3. Impact of subventions on technical efficiency

Author	Country	Impact
Brümmer, Loy, 2000	Germany	negative
Rezitis, 2003	Greece	negative
Iraizoz, 2005	Spain	negative
Hadley, 2006	Great Britain	positive
Ooms, 2007	Netherlands	positive
Zhu, Demeter, Oude Lansink, 2010	Germany, Netherlands, Sweden	negative

Source: X. Zhu, R.M. Demeter, A. Oude Lansink, Technical efficiency and productivity differentials of dairy farms…, op. cit.

A slide (fall) of the technical efficiency was probably greater in the case of coupled payments, because those subsidies had a direct impact on production decisions of farmers. This led to distortion of proportion, allocation of costs and benefits. Encouraged to focus on the most subsidized types of production and abandonment of these more efficient from the point of view of market demand. In the case of decoupled payments determination of the farmer production decisions is weaker and deterioration of technical and allocative efficiency also is smaller. Nevertheless, this is evidenced by A. Bhakar and J.C. Beghin (2007)[46].

A review of the literature shows that there remains a certain degree of connection between direct payments and agricultural production. This is due to the complexity of the mechanisms of their impact on the agricultural farm and their owners decisions. In no doubt, most of the previous studies focused on the insurance and wealth effect as a consequence of use of decoupled subsidies. The issue of the impact of subventions on the technical efficiency of farms included more than 555 thousand publications. In contrast, evaluation and impact analysis of the CAP instruments on the technical efficiency of European farms were the object and purpose more than 140 thousand publications.

In the literature we can find publications on issues of technical efficiency of large-scale farms. An example of such work is a comprehensive analysis of technical efficiency and its determinants prepared by M. Gospodarowicz (2009)[47], or analysis of that assessment in conjunction with the environmental performance made by the team composed of J. Bieńkowski, J. Jankowiak,

[46] A. Bhakar, J.C. Beghin, *How coupled are decoupled farm payments? A review of the evidence,* Working Papers Series, Iowa State University, Department of Economics, August 2007; A. Bhaskar, C.J. Beghin, *Decoupled farm payments and the role of base acreage and yield updating under uncertainty*, „American Journal of Agricultural Economics", vol. 92, no. 3, 2010.

[47] M. Gospodarowicz, *Zmiany w technikach i organizacji produkcji gospodarstw wysokotowarowych oraz ich wpływ na kondycję ekonomiczną tych jednostek*, PW nr 159, Program Wieloletni 2005-2009.

J. Marcinkowski, A. Sadowski (2005)[48]. However, these studies involved a much smaller-area farms, but with market-oriented and with a large-scale market production. It is worth noting that the latter authors had obtained results showing the possibility of convergence between the analyzed efficiencies. It means that strategies for achieving higher technical and environmental performance were not opposed to each other in the case of farms (the Wielkopolska voivodeship) if the basis for assessing the effectiveness admitted to minimize production inputs.

Summing up, in most cases greater degree of dependence on subsidies farms got worse the results of their technical efficiency. Grants can increase the technical efficiency if they are a stimulus for innovation and enable the transition to new technologies. Otherwise, they reduce the level of technical efficiency and weaken the incentive for farmers to improve competitiveness.

3.5. Own research

The study was conducted on panel data from a random sample of large-scale farms[49] that were annually surveyed by employees of the Economics of Farm Holdings Department of the IAFE-NRI. Data analysis included period 2007-2011 (78 farms in each year). The sample was divided into two groups: (1) farms with a dominance (60%) of crop production and (2) other farms (with a dominance of livestock or with the mixed production). Next, the author established vectors of variables needed to estimate the technical efficiency:

a) an effect:

- the first variant: the sales revenue of agricultural production (sum of items "revenues from sales and equivalent" and "other operating income");
- the second variant above the value was increased by the amount of all subsidies;

b) inputs (variables representing the material production factors):

- amount of labour (wage costs and their derivatives);
- area of owned and leased land (in comparative fiscal hectares);
- capital expenditures broken down by:
  - fixed capital (depreciation/amortisation)
  - working capital (expressed in costs of materials, energy and external services excluding internal consumption).

[48] J. Bieńkowski, J. Jankowiak, J. Marcinkowski, A. Sadowski, *Efektywność techniczna i środowiskowa różnych typów gospodarstw rolnych na przykładzie badanej grupy z Wielkopolski*, XII Kongres SERiA, Warszawa 2005.

[49] A large-scale farm – means a farm with area of more than 100 hectares of agricultural land and with a market production.

Then, for each of the farm groups (crop and other) was calculated technical performance indicators. The author used:

- parametric approach (TE SFA and TE SFA $_{\text{with subsidies}}$);
- non-parametric method (TE DEA and TE DEA $_{\text{with subsidies}}$).

Author examined three different variants of the impact of the grants on technical efficiency:

- first variant – I. subsidy rate (all subsidies to operating revenue ratio) was taken to the set of independent variables;
- second variant – II. subsidy rate (direct payments to operating revenue ratio) was taken to the set X;
- in the last variant subsidies in absolute values were taken: direct payments (in thousand zlotys) as the independent variable, the Less Favoured Areas (as quota in thousand zlotys), the II Pillar of the CAP payments (in thousand zlotys), agri-environmental subsidies (in thousand zlotys).

3.5.1. Methodology

Efficiency is one of the most important term in economics. It is the most frequently used term to characterize and evaluate the companies. It can be considered that effective organization is the one that achieves its objectives. The efficiency of farms or companies is examined in different ways. We can use one of the three groups of methods:

- classical (e.g. financial ratios);
- parametric (e.g. econometric models);
- non-parametric (e.g. the envelope data).

The division into parametric and non-parametric method was created due to the necessity of the definition of the form of analytical functions (production, costs etc.). In the former case it should be determined *a priori*, and the latter does not need to be defined. According to this division, there are two approaches to measure the effectiveness of methods:

- non-parametric (*Data Envelopment Analysis* – DEA, *Free Disposal Hull* – FDH),
- parametric (*Stochastic Frontier Analysis* – SFA, *Distribution Free Approach* – DFA, *Thick Frontier Approach* – TFA).

Author used the parametric approach and then it was supplemented by non-parametric method. Non-parametric models (CCR and BCC) were inputs orientated. Farms with large-scale production more often rationalize expenditures (minimalize the inputs) than maximize the effect of production due to the limits of production existing in some of the EU agricultural markets.

3.5.2. The results of own research

For the measurement of the technical performance indicators (TE SFA) parametric method of stochastic type was used. This approach requires the adoption of certain assumptions about the production function or cost and takes into account the existence of statistical noise, which is recognized as an additional random variable. In contrast to the deterministic model, stochastic model includes a parameter representing random measurement error. The latter may be due to the influence of weather conditions. In addition, stochastic model is less susceptible to the influence of outliers. For this reason, the parametric approach is more preferable to the analysis of technical efficiency in agriculture than nonparametric method[50]. A typical operating algorithm is a two-stage approach.

In the first stage coefficients of technical inefficiency are estimated. In the second – the determinants of inefficiency. But more popular method is: treatment of inefficiency factors as the dependent variable and then incorporating it into a set of variables determining inefficiency. The study considered the form of the Cobb-Douglas and translogarithmic production function. The choice of the function was preceded by a test procedure. The model that best fits the data, shows a higher value of the log-likelihood function. In this case, it was a translogarithmic production function. After determining the form of analytical functions, its parameters was estimated.

The level of technical efficiency (TE DEA) was determined by using CCR and BCC models oriented on inputs. Then, the technical efficiency indicators were considered as dependent variables of tobit models. They have been censored from below by 0 and up through 1. The set of an independent variables was determined on the basis of literature overview and own research experiences (Appendix 1).

The results of performance indicators are shown in Table 26. Moreover, in the framework of non-parametric methods two variants of estimates (CCR and BCC) were awarded. The resulting ratios revealed that in all cases the positive impact of the aid on technical efficiency measurement was visible.

The results of the analysis showed that the parametric approach was more resistant to the heterogeneity of the sample (the inhomogeneity) than the envelope data (DEA).

[50] The envelope data is better suited to study the results of different branches of the same company or bank than to the analysis of agricultural holdings. Farms operate under different soil conditions and pursue different goals.

Table 26. Technical efficiency of large-scale farms in period 2007-2011 (panel data)

Specification		TE DEA (CCR model)		TE DEA (BCC model)		TE SFA	
		Without subsidies	**With subsidies**	Without subsidies	**With subsidies**	Without subsidies	**With subsidies**
Crop farms	**Arithmetic mean**	**0.72**	**0.73**	**0.82**	**0.84**	**0.76**	**0.80**
	Standard deviation	0.21	0.20	0.18	0.18	0.12	0.12
	Minimum	0.23	0.27	0.31	0.32	0.27	0.24
	Maximum	1.00	1.00	1.00	1.00	0.96	0.98
	Variability coefficient	0.29	0.27	0.22	0.21	0.16	0.15
Other farms	**Arithmetic mean**	**0.67**	**0.73**	**0.78**	**0.82**	**0.75**	**0.78**
	Standard deviation	0.20	0.18	0.19	0.17	0.16	0.14
	Minimum	0.17	0.28	0.40	0.43	0.11	0.17
	Maximum	1.00	1.00	1.00	1.00	1.00	0.98
	Variability coefficient	0.30	0.24	0.24	0.21	0.21	0.19

Source: own calculation.

3.5.3. Determinants of technical efficiency

Tobit model is an example of a normal censored regression. This follows from the assumption that the dependent variable is observable, but its values are censored. The estimation of the parameters is possible only using the maximum likelihood method, but the degree of mathematical complexity is much higher. Below are the determinants of technical efficiency. In Table 27 we have a visible (positive and negative) impact of I. subsidy rate on technical efficiency indicators. In addition, determinants of technical efficiency were:

- legal and organizational form,
- soil quality index,
- profitability indicator of economic activity,
- share of arable land in the agricultural area,
- specialization of production (Herfindahl-Hirschman Index)
- crop insurance,
- level of consumption of mineral fertilizers (nitrogen, phosphorus and potassium) per hectare,
- number of managers (full time equivalent),
- leasing,
- the II Pillar of the CAP payments,
- livestock units per 100 hectares.

Similarly, at others farms the I. subsidy rate has an inconsistent impact on the technical efficiency. Here, in set of control variables (X), were included:

- legal and organizational form,
- profitability rate of economic activity,
- share of crop production in the sale revenues,
- indicator of financial stress,
- location on the LFA areas,
- leasing,
- level of education manager,
- ratio of fixed assets to current assets,
- labour ratio.

Results from the model TE SFA were the best and this model was the most reliable tool for analyzing the determinants of technical efficiency.

Table 27. Determinants of technical efficiency (the first variant)

Dependent variables (*Y*) / Independent variables	TE DEA (CCR model)	TE DEA (BCC model)	TE SFA
Crop farms			
Constant	1.087*** (0.157)	1.435*** (0.198)	0.673*** (0.042)
I. subsidy rate	**-0.951***** **(0.154)**	**-0.715***** **(0.184)**	**0.423***** **(0.091)**
Legal and organizational form (dummy)		-0.141*** (0.032)	
Soil quality index	0.071*** (0.027)	0.092*** 0.034	-0.046*** (0.013)
Profitability indicator of economic activity	0.083*** (0.022)	0.064*** (0.022)	-0.022** (0.009)
Share of arable land in the agricultural area	-0.003* (0.002)	-0.004** 0.002	
Herfindahl-Hirschman Index		-0.128** (0.063)	
Crop insurance (dummy)		-0.122*** (0.037)	0.033** (0.017)
Fertilizer application (kg NPK per hectare)		-0.0003* (0.0001)	
Number of managers		0.039*** (0.009)	
Leasing (dummy)			0.036** (0.018)
Livestock units per 100 hectares			0.002*** (0.000)
Number of observations	215	215	215
Log likelihood ratio	2.412	-27.855	187.655
Other farms			
Constant	0.758*** (0.049)	0.887*** (0.049)	0.666*** (0.031)
I. subsidy rate	**-1.224***** **(0.168)**	**-0.559***** **(0.207)**	**0.0284**** **(0.123)**
Legal and organizational form (dummy)	-0.058** (0.023)		
Profitability indicator of economic activity	0.057*** (0.011)	0.044*** (0.016)	
Share of crop production in sales revenues	0.001** (0.0006)		
Financial stress index	-0.009*** (0.002)		
Location on the LFA areas (dummy)	0.075** (0.030)	0.114*** (0.034)	0.071*** (0.020)
Leasing (dummy)	-0.075** (0.030)	-0.118*** (0.039)	
II. Pillar payments	-0.069*** (0.023)	-0.188*** (0.032)	
Level of manager's education	0.050*** (0.019)		
Fixed assets to current assets ratio	-0.007** (0.003)	-0.011*** (0.003)	
Mechanization of work	0.0001*** (0.000)	0.0002*** (0.00005)	
Number of observations	180	180	180
Log likelihood ratio	58.747	-20.012	89.287

*** 1 percent level of significance; ** 5 percent level of significance; * 10 percent level of significance

Source: own calculation.

The following table shows the effect of the II. subsidy rate on the technical efficiency indicators. This independent variable had variable impact. The differences between tobit models DEA TE and tobit model TE SFA were quite significant. The value of the log-likelihood confirmed a better fit of the model TE SFA. The quality of fit of models TE DEA for crop farms presented in Table 28 was very poor. In the set of determinants for variable TE DEA and TE SFA we could find:

- soil quality index,
- profitability rate of economic activity,
- share of arable land in the agricultural area,
- share of leased land in the agricultural area,
- location in the Wielkopolska voivodeship,
- livestock units per 100 hectares.

In the case of other farms in Table 28 the differences between the models were even greater. The value of the log-likelihood confirmed the superior quality of the fit model TE SFA. A set of other control variables was very large and consisted of:

- legal and organizational form,
- profitability indicator of economic activity,
- the share of leased land in the agricultural area,
- the share of crop production in sales revenues,
- the share of arable land in the agricultural area,
- financial stress indicator,
- current liquidity,
- soil quality index,
- crop insurance,
- equity to debt ratio,
- the II. Pillar payments,
- fertilizer application (kg NPK per hectare),
- educational level of manager,
- the number of managers,
- the share of cereals in sowings,
- fixed assets to current assets ratio,
- work experience,
- mechanization level.

Table 28. Determinants of technical efficiency (the second variant)

Dependent variables (*Y*) / Independent variables	TE DEA (CCR model)	TE DEA (BCC model)	TE SFA
Crop farms			
Constant	0.850*** (0.072)	1.081*** (0.144)	0.760*** (0.026)
II subsidy rate	**-1.292*** (0.247)**	**-0.759*** (0.226)**	**0.604*** (0.092)**
Soil quality index	0.052* (0.031)	0.094** 0.046	-0.055*** (0.015)
Profitability indicator of economic activity	0.071*** (0.023)	0.080*** (0.018)	-0.023*** (0.006)
Share of arable land in the agricultural area		-0.003** (0.002)	
Share of leased land in the agricultural area		0.001** (0.000)	
Location in the Wielkopolska voivodeship		0.108* (0.062)	
Livestock units per 100 hectares	-0.001** (0.001)		
Number of observations	215	215	215
Log likelihood ratio	-0.224	-51.514	186.359
Other farms			
Constant	0.968*** (0.059)	0.841*** (0.157)	0.519*** (0.100)
II. subsidy rate	**-1.425*** (0.221)**	**-0.453* (0.276)**	**0.233* (0.150)**
Legal and organizational form (dummy)	-0.050* (0.028)		
Profitability indicator of economic activity	0.060*** (0.011)		
Share of leased land in the agricultural area	-0.001*** (0.0004)	-0.001*** (0.000)	
Share of crop production in sales revenues	0.002*** (0.0006)		
Share of arable land in the agricultural area		0.001* (0.000)	0.002** (0.0009)
Financial stress index	-0.011*** (0.003)	-0.006** (0.003)	
Current liquidity	0.00008** (0.00004)	0.00009* (0.00005)	-0.0001*** (0.000)
Soil quality index		-0.173*** (0.065)	
Crop insurance	-0.080** (0.032)	-0.110*** (0.035)	
Equity to debt ratio		0.001 (0.000)	0.001*** (0.000)
II Pillar payments (dummy)	-0.060** (0.024)	-0.122*** (0.030)	
Fertilizer application (kg per hectare),	-0.0003** (0.0001)		
Level of manager's education	0.061*** (0.019)		
Number of managers		0.030*** (0.008)	
The share of cereals in sowings		0.003*** (0.001)	
Fixed assets to current assets ratio			0.005*** (0.002)
Work experince of manager	-0.003*** (0.001)		
Technical devices		0.0002*** (0.000)	
Number of observations	180	180	180
Log likelihood ratio	51.893	1.885	95.344

*** 1 percent level of significance; ** 5 percent level of significance; * 10 percent level of significance

Source: own calculation.

Table 29 was built for other group of farms for which technical efficiency was determined. It shows: the LFA payment, sugar payments, the refund of excise, other subsidies and a participation in the agri-environmental program. A set of other control variables, outside variables that capture subventions in various forms, was similar to those of Tables 27 and 28.

Table 29. Determinants of technical efficiency (the third variant)

Dependent variables (*Y*) / Independent variables	TE DEA (CCR model)	TE DEA (BCC model)	TE SFA
Crop farms			
Constant	0.519*** (0.056)	0.946*** (0.064)	0.834*** (0.021)
Direct payments (thousand zlotys)	**-0.0001*** (0.000)**		**0.0002** (0.000)**
Agri-environmental payments (thousand zlotys)		**-0.0005** (0.0002)**	
II Pillar payments (thousands zlotys)		**-0.002*** (0.000)**	
Soil quality index	0.088*** (0.027)	0.097*** (0.032)	-0.063*** (0.016)
Profitability indicator of economic activity	0.093*** (0.028)	0.080*** (0.027)	-0.031*** (0.006)
Fixed assets to current assets ratio	-0.004*** (0.001)	-0.005*** (0.001)	0.001* (0.001)
Share of leased land in the agricultural area	0.001*** (0.000)		
Financial surplus to liabilities ratio	-0.003*** (0.001)		
Equity to debt ratio		-0.001*** (0.0003)	
Investment rate		0.0003** (0.001)	
Crop insurance (dummy)		-0.092*** (0.036)	
Fertilizer application (kg NPK per hectare)	0.0002* (0.0001)	-0.0003*** (0.0001)	
Number of managers	0.019** (0.009)	0.055*** (0.013)	
Legal and organizational form (dummy)		-0.138*** (0.032)	
Number of observations	215	215	215
Log likelihood ratio	-8.283	-27.307	169.589
Other farms			
Constant	0.694*** (0.059)	0.815*** (0.040)	0.552*** (0.047)
Direct payments (thousand zlotys)	**-0.00008*** (0.00002)**		
LFA payments (thousand zlotys)	**0.007*** (0.002)**	**0.004*** (0.001)**	**-0.004*** (0.001)**
Sugar payments (thousand zlotys)	**0.0003*** (0.000)**		
Refund of excise (thousand zlotys)			**0.001*** (0.000)**
Location on LFA area (dummy)	**-0.170*** (0.051)**		**0.156*** (0.034)**
Other subsidies (thousand zlotys)			**-0.001*** 0.000**
Agri-environmental programme (dummy)			**0.044** (0.019)**

Table 29 (cont.).

Legal and organizational form (dummy)	-0.058* (0.032)	-0.088*** (0.033)	
Share of arable land in the agricultural area			0.002*** (0.000)
Share of crop production in sales revenues			-0.002*** (0.000)
Profitability indicator of economic activity	0.090*** (0.011)	0.068*** (0.015)	
Share of leased land in the agricultural area	-0.001** (0.000)		0.001*** (0.000)
Financial stress index	-0.006** (0.003)	-0.007** (0.003)	
Leasing (dummy)	-0.062* (0.032)	-0.139*** (0.036)	
Current liquidity			-0.00007** (0.00003)
II Pillar payments	-0.068*** (0.026)	-0.149*** (0.031)	
Level of education of manager	0.115*** (0.024)		
The share of cereals in sowings			0.001*** (0.000)
Work experience of manager	-0.003** (0.001)		
Numer of managers	0.023*** (0.006)	0.032*** (0.007)	-0.022*** (0.004)
Number of observations	180	180	180
Log likelihood ratio	42.071	-14.968	140.866

*** 1 percent level of significance; ** 5 percent level of significance; * 10 percent level of significance

Source: own calculation.

In summary, own calculations were confirmed in the research hypothesis. Subsidies have an uncertain impact on technical efficiency of large-scale farms. Current forms of the CAP subsidies do not realize the objectives of the policy. The financial support reduces farmer's entrepreneurship and competitiveness. That was a reason why many farms were inefficient. Subsidies can improve technical efficiency, only if a farmer spends the money on innovation and new technologies. Moreover, a completely different results from TE DEA and TE SFA models. These results are in opposite to each other. A quality estimation TE SFA models was much better.

3.6. Summary and conclusions

The issue, in which the efficiency in the economy is one of the major challenges and key problems, technical efficiency is one of the components of economic efficiency. Subventions in many ways determine the technical efficiency. Hence, there is justification for analyses describing these relationships and their scale. With detailed research for each type of farms we must specify a set of determinants of technical efficiency. Many scientists already have it established. Created a set of control variables, independent of country, time, research or other characteristics of farms. This collection should be supplemented with information on the external environment, including general economic situation. The group of farms is subjected to various restrictions in access to grants. In the European Union the biggest beneficiary of financial support are family farms. In previous subsidies many goals were combined (allocative, redistributive, environmental, competitiveness). It hindered control of the degree of their implementation and evaluation of their effectiveness.

Our study showed a strong influence on the analyzed technical efficiency, but the impact was consistent. The analysis of the results showed that the parametric approach was more resistant to the heterogeneity of the sample (its inhomogeneous) than the envelope data (DEA). Own research failed to establish a set of determinants of technical efficiency, which largely corresponds with those of other authors.

The methods used here are the most popular ways of calculating technical efficiency. Due to the nature of the agricultural sector the superior properties of the SFA method was confirmed. It is now a model and basis for testing effectiveness.

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Annex 1.

The set of independent variables:

- I. subsidy rate – all grants to sales revenues ratio;
- II. subsidy rate – direct payments to sales revenues ratio;
- legal and organizational form – dummy variable (1 – legal entity, 0 – private individual);
- profitability indicator of economic activity – financial result to all revenues;
- share of soft (preferential) credits in total sum of credits;
- Herfindahl-Hirschman index (HHI) – measure of production concentration. It is calculated by squaring the crops, livestock and other production share in total production of farm, and then summing the resulting numbers;
- share of leased land in the agricultural area;
- share of arable land in the agricultural area;
- soil quality index

$$WBG = \frac{\sum_{i=1}^{n} P_i \times K_i}{P}$$

where:

n – number of valuation classes,

P_i – farmland area in each valuation class,

K_i – conversion factor for each class,

P – total farmland area;

- equity to borrowed capital ratio – share of equity in borrowed capital;
- fixed assets to current assets ratio – share of fixed assets in current assets;
- share of crop revenues in all sales revenues – share of crop sales revenues in total sales revenues from agricultural production of farm;
- investment rate – quotient gross investment in year and annual amortisation;
- financial stress index – interest and rental fees to sales revenues ratio;
- liquidity payments –current assets to current liabilities ratio;
- financial surplus to liabilities – quotient of net financial result (increased by amortisation) and total farm liabilities;
- equipment used in support of operation (work) / technical devices – ratio of total fixed assets (gross) to average number of full-time workers;
- technical equipment of ground – ratio of total fixed assets (gross) to the total area of farmland (hectare);
- crop insurance – dummy variable (1– yes, 0 – no);
- location on LFA (Less Favoured Areas) – dummy variable (1 – yes, 0 – no);

- participation in agri-environmental programme – dummy variable (1 – yes, 0 – no);
- participation in II Pillar programme – dummy variable (1 – yes, 0 – no);
- using of leasing – dummy variable (1 – yes, 0 – no);
- fertilizer application (kg NPK per hectare);
- age of manager (years);
- work experince of manager (years);
- level of manager's education – dummy variable (1 – higher, 0 – secondary education);
- direction of education (1 – agricultural, 0 – others);
- number of managers (full-time employees);
- livestock units per 100 hectares;
- share of cereals in sowings;
- location of farm (voivodeship) – dummy variable;
- subsidies included in absolute values (alternatives of subsidy rates):
  - direct payments (thousand zlotys),
  - LFA payments (thousand zlotys),
  - sugar payments (thousand zlotys),
  - refund of excise (thousand zlotys),
  - subsidies to seeds (thousand zlotys),
  - II. Pillar payments (thousand zlotys),
  - other subsidies (thousand zlotys),
  - agri-environmental payments (thousand zlotys),
  - total subsidies (thousand zlotys).

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