

Model of the Impact of Area Payments on the Engagement and Remuneration of Production Factors in Agriculture

Modelo do impacto dos pagos por superficie na participación e remuneración dos factores de produción na agricultura

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Abstract

Area payments are a key instrument of the European Union's Common Agricultural Policy. However, their effectiveness as a tool for supporting farmers' incomes is weakened by the phenomenon of capitalisation. The aim of this study is to identify the mechanism by which area payments stimulate inputs of agriculture production factors and to examine how subsidies granted in the form of area payments are transformed into remuneration for production factors. The research methodology used includes economic modelling and marginal analysis. It is demonstrated that area payments change the allocation of resources compared to the allocation driven by the market mechanism (resulting in a greater engagement of production factors in agricultural production than would be the case in the absence these subsidies) and also affect the level and structure of the remuneration for production factors in agriculture. A theoretical decomposition of the remuneration of production factors into income from non-land production factors and land rent has been carried out.

Keywords: Agricultural financial support; Area payments; Land rent; Lease rent; Payments' capitalization.

Resumo

Os pagos por superficie son un instrumento chave da Política Agraria Común da Unión Europea. A pesar disto, a súa eficacia como ferramenta de apoio á renda dos agricultores vese debilitada polo fenómeno da capitalización. O obxectivo deste estudo é identificar o mecanismo polo cal os pagos por superficie estimulan a entrada de factores de produción agraria e examinar como as subvencións concedidas en forma de pagos por superficie transfórmanse en remuneración dos factores de produción. A metodoloxía de investigación utilizada inclúe a modelización económica e a análise marxinal. Demóstrase que os pagos por superficie modifican a asignación de recursos en comparación coa asignación impulsada polo mecanismo de mercado (o que se traduce nunha maior dedicación dos factores de produción á produción agraria da que se produciría en ausencia destas subvencións), e tamén afectan o nivel e a estrutura da remuneración dos factores de produción na agricultura. Levouse a cabo unha descomposición teórica da remuneración dos factores de produción en renda dos factores de produción non agrarios e renda da terra.

Palabras clave: Apoio financeiro agrícola; Pagos por área; Renda da terra; Arrendamento; Capitalización dos pagos.

JEL classification: H23; Q12; Q15; Q24; R38.

1. INTRODUCTION

EU agricultural subsidy instruments under the Common Agricultural Policy (CAP) have evolved from supporting agricultural production to supporting farmers' incomes and stimulating the supply of public goods (Czyżewski & Poczta-Wajda 2011; Sadłowski 2012a; Majewski et al. 2018; De Castro et al. 2020; Gołasa et al. 2023). Area payments introduced several decades ago, remain a key instrument of CAP's Pillar I. However, many agricultural economists argue that, despite reforms, these payments are still insufficiently effective in encouraging farmers to provide public goods and are inadequately tailored to the environmental and social dimensions of sustainable development (Morkunas & Labukas 2020; Pe'er et al. 2020; Scown et al. 2020; Sadłowski et al. 2021).

Direct payments, including area payments that dominate in terms of the EU agricultural budget expenditures, are intended by lawmakers to support farmers' incomes and stimulate the production of public goods while minimizing unintended side effects. Unintended side effects of area payments include distorting the volume and structure of the agricultural output shaped by the market mechanism and perpetuating production systems or agricultural practices that have a significant negative impact on the environment (Stonkutė 2009; Sadłowski 2012b; Ciliberti & Frascarelli 2018; Czyżewski et al. 2019; Szerletics & Jámbor 2020; Pilvere et al. 2022; Chatellier & Guyomard 2023; Ciliberti et al. 2023; Mata et al. 2024). Area payments also influence farms' demand for production factors, including agricultural land (Van Herck & Vranken 2011; Wilkin 2015; Morkunas & Labukas 2020).

The purpose of this study is to identify the mechanism by which area payments stimulate the input of production factors in agriculture and the mechanism through which subsidies in the form of area payments are transformed into remuneration for production factors.

The structure of the article is as follows. After the introductory section, which briefly presents the research topic, objective, and structure of the study, a review of literature on the phenomenon of "capturing" area payments by non-farming entities or individuals who own agricultural land is provided (this is referred to in the literature as the capitalization of area payments into lease rents or agricultural land prices). The next section is devoted to the description of the methodology of the theoretical research conducted. In the section titled "Results and Discussion", the essence of the proposed model of the impact of area payments on the level of utilization and remuneration of production factors in agriculture is presented, along with definitions of indicators derived from this model using analytical tools, namely (i) the degree of agricultural activity subsidization, (ii) the level of state co-financing of land rent, and (iii) the conversion of area payments into land rent. In the summary section, conclusions are drawn, along with the advantages and limitations of the presented model.

2. LITERATURE REVIEW

The phenomenon of area payment capitalization has been addressed as a key research problem or one of the aspects of studies by many agricultural economists (Table 1). Among the relatively numerous publications in this field, many are empirical studies based on data of varying temporal and spatial scope. Additionally, different research methods are often employed. This section summarizes the main findings of studies related to instruments used under the CAP.

Table 1. General characteristics of the major studies on capitalization of payments

| Reference to publication | Type of studies | Spatial scope | Subject scope |
|---|-----------------|---|------------------------|
| Kilian and Salhofer (2008) | theoretical | EU Member States applying the Single Payment Scheme (SPS) | land rents land prices |
| Patton et al. (2008) | empirical | Northern Ireland | land rents |
| Latruffe and Le Mouél (2009) | review | EU | land rents land prices |
| Ciaian and Kancs (2012) | empirical | EU Member States applying the Single Area Payment Scheme (SAPS) | land rents |
| Kilian et al. (2012) | empirical | Bavaria (Germany) | land rents |
| Feichtinger and Salhofer (2013) | review | EU | land prices |
| Michalek et al. (2014) | empirical | EU Member States applying the SPS | land prices |
| Czyżewski and Trojanek (2016) | empirical | Wielkopolskie Voivodeship (Poland) | land prices |
| Feichtinger and Salhofer (2016) | empirical | EU | land prices |
| O'Neill and Hanrahan (2016) | empirical | Ireland | land rents |
| Klaiber et al. (2017) | empirical | Bavaria (Germany) | land rents |
| Ciaian et al. (2018) | empirical | EU | land prices |
| Forstner et al. (2018) | review | Germany | land rents land prices |
| Graubner (2018) | theoretical | EU | land rents |
| Hennig and Breustedt (2018) | empirical | West German federal states | land rents |
| Ciaian et al. (2021) | review | EU | land prices |
| Guastella et al. (2021) | empirical | EU Member States applying the SPS | land prices |
| Salhofer and Feichtinger (2021) | empirical | Bavaria (Germany) | land rents |
| Varacca et al. (2022) | review | EU | land prices |
| Baldoni and Ciaian (2023) | empirical | EU | land rents land prices |

The CAP reforms, including the reform that decoupled payments from production, provided an impetus for research on the impact of changes on the intensity of capitalization. [Feichtinger and Salhofer \(2016\)](#), summarizing the results of their research on the impact of the Fischler CAP reform on agricultural land prices, found that a reduction of payments by 50 EUR/ha would decrease land sales prices by 445 EUR/ha before and by 984 EUR/ha after the reform. [Ciaian et al. \(2018\)](#) also focused on the impact of the 2013 CAP reform on the capitalization of payments. They concluded that on average in the EU, the non-farming landowners' policy gains are 27% of the total decoupled payments in the post-reform period, compared to 18% in the pre-reform period. [Patton et al. \(2008\)](#) found that the impact of direct payments on rental values depends on the type of payment (coupled or decoupled payments) and the nature of the production of the associated agricultural commodity. According to [Varacca et al. \(2022\)](#), the introduction of decoupled payments increased the capitalization rate, although the extent of this increment hinges on the implementation scheme adopted by the EU member state. [O'Neill and Hanrahan \(2016\)](#) noted that in Ireland coupled direct payments were highly capitalized into land rents (67–90 cents per 1 EUR of subsidies). [Forstner et al. \(2018\)](#) emphasize that with the decoupling of direct payments from production, given the overall high share of rents in Germany, an increasing share of payments

indirectly goes to landowners, with the size of this transfer varying considerably depending on the period, region and share of tenancy.

Numerous studies were aimed at identifying the extent to which individual systems and models of direct payments applied under the CAP contribute to the intensification of the capitalization phenomenon. According to [Kilian and Salhofer \(2008\)](#), the capitalization outcome crucially depends on the proportion of eligible agricultural areas to payment entitlements and which model of SPS (historical, regional, or hybrid) has been implemented. [Michalek et al. \(2014\)](#) estimated a 6–10% SPS capitalization rate. They found that on average in the EU, the nonfarming landowners' gains from the SPS are 4%, however, there is a large variation in the capitalization rate for different SPS levels and between different member states (3–94%). [Guastella et al. \(2021\)](#) find that between 28 and 52 cents per 1 EUR of additional subsidy capitalize into land prices in EU member states that adopted the hybrid and the regional model, respectively, whereas in EU member states that adopted the historical model subsidies do not capitalize in farmland prices. The specificity of SAPS applied in most new EU Member States was also addressed. According to [Czyżewski and Trojanek \(2016\)](#), SAPS contributes to land value mainly in the peripheral areas and payments for public goods under SAPS decapitalize the value of land, because they do not compensate for the opportunity costs related to alternative ways of deriving rent from the land. [Ciaian and Kancs \(2012\)](#) found that land rents capture 19 cents of the marginal SAPS, and around 10% of the SAPS benefit nonfarming landowners through higher farmland rental prices.

The capitalization phenomenon has been well recognized and measured in Bavaria. [Kilian et al. \(2012\)](#), based on research conducted using data for this German federal state relating to the year 2005, found that decoupled direct payments are capitalized into rental prices to a larger degree than the coupled payments of the time before the 2003 CAP reform. [Klaiber et al. \(2017\)](#) investigated the impact of the gradual harmonization of direct payments on the level of rents, concluding that strong capitalization effects increased substantially in the period since 2010 when Germany began harmonizing payments: on average, the marginal effect on rental rates of an additional 1 EUR paid under SPS is 37 cents, growing to 53 cents as harmonization develops. [Salhofer and Feichtinger \(2021\)](#), also based on data for Bavaria, find that on average 30% of direct payments are capitalized into land rental prices, and the capitalization ratio varies considerably across regions.

[Feichtinger and Salhofer \(2013\)](#) generalized the results of earlier studies, finding that a 10% reduction in agricultural support would reduce land prices by 3–5%. Later research results of [Baldoni and Ciaian \(2023\)](#) indicate that 10–12% of the overall CAP payments were leaked to non-farming landowners in 2016. However, there is a sizeable variation in the non-farming landowners' gains across EU member states, ranging from 2% to 37%. [Graubner \(2018\)](#) noted that the effect of direct payments on land rental prices depends on the competitiveness of the market; under certain conditions, the transfer of subsidy may be total, but in practice, it is usually relatively low.

The issue of payments' capitalization was also addressed about a specific type of land use, namely permanent grassland. [Hennig and Breustedt \(2018\)](#) found that landlords of grassland in West German federal states have benefited strongly from the decoupling of direct payments. At the end of the observation period, covering the years 2001–2013, after regional standardization of the payments, the estimates show marginal capitalization rates of 87–94 cents per additional 1 EUR, which means almost complete capitalization of the subsidies into the rental price for grassland.

[Latruffe and Le Mouël \(2009\)](#) concluded that agricultural support policy instruments contribute to increasing the rental price of farmland and that the extent of this increase

closely depends on the supply price elasticity of farmland relative to those of other factors/inputs on the one hand and the range of the possibilities of factor/input substitution in agricultural production on the other hand. In addition, they stated that land prices are more responsive to government-based returns than to market-based returns. These conclusions have not lost their significance, however, a more recent summary of research in this area is the work by [Ciaian et al. \(2021\)](#). Taking into account the results of theoretical analyses and empirical research on the capitalization of agricultural subsidies into land prices, they concluded that the theoretical literature predicts that agricultural subsidies are capitalized into land prices when land supply is inelastic and land markets function well, and the capitalization rate significantly depends on the shape of subsidies, level of development of local land-market institutions, and spatial effects. Simultaneously, most empirical studies have shown that agricultural subsidies are only partially capitalized into land prices, and decoupled payments and land-based subsidies exhibit higher capitalization than coupled payments and nonland-based subsidies, respectively.

Capitalization of support in lease rents and land prices can be considered the main cause of the inefficiency of financial transfers, which are intended to improve farmers' income situations ([Góral & Kulawik 2015](#); [O'Neill & Hanrahan 2016](#)). This should be viewed as an undesirable side effect of the direct support system, which increases the wealth of agricultural landowners and creates barriers to entry into the sector ([Van Tongeren 2008](#); [Sadłowski 2019](#)).

3. MATERIALS AND METHODS

The theory explaining the mechanism of the impact of area payments on the production sphere (the level of engagement of production factors) and the distribution sphere (remuneration of production factors) was developed using economic modelling. In the model, land remuneration is interpreted, in line with Ricardo's land rent theory ([Ricardo 1996](#)), as a residual amount remaining after the costs of other production factors have been covered.

The research method employed is marginal analysis (i.e., analysis of marginal changes in economic variables). In the model, marginal revenue is not defined as the increase in total revenue due to an increase in production (and simultaneously sales) by one unit, but rather as the increase in total revenue resulting from the use of an additional unit of land. Similarly, marginal cost is understood as the ratio of the increase in total cost (non-land production inputs) to the increase in land input by one unit.

The model adopts the perspective of a farm that is a "price taker" – both in the agricultural product market and in the market for production factors. This means that the individual decisions of a single farm regarding production volume or resource engagement do not affect their market prices.

The structure of the model is dual. The baseline scenario, in which no area payments are applied (zero variant), is compared with a scenario where this form of government intervention in agriculture is applied (alternative variant). This allows for the identification of the economic effects of the intervention. Understanding the mechanism of converting area payments into the remuneration of production factors provided a framework for describing and measuring the phenomenon of "capturing" support paid to farmers by landowners.

The developed model is a tool for analysing the behaviour of a farm as an economic entity, making it a microeconomic model. It allows for determining the optimal level of land resource utilization in the farm, thus making it an optimization model. At the same time, it is

an equilibrium model, as it indicates the operation of an automatic mechanism by which the farm reaches a state of equilibrium, where there are no further incentives for change.

The impact of financial incentives in the form of area payments on the decisions of a single farm was modelled. Since this instrument affects the entire community of farms in the same way, it causes typical adjustments of these farms in the same direction in relation to the size of inputs. This makes it possible to generalize the findings made at the microeconomic level to the national level. This is because equilibrium across the entire agricultural sector corresponds to individual (farm) equilibrium.

The essence of the model is presented using graphical methods of visualizing relationships (charts) accompanied by descriptive methods. The analysis is theoretical in nature and therefore not based on specific figures or statistics relating to the general population or a part (subset) of it. As no empirical data were used directly, an indication of the temporal and spatial scope of the study is not applicable here. Although the inspiration for the considerations was the area payments applied in the EU under the CAP, the proposed model is universal. This nature of the model made it possible to formulate conclusions of general applicability, abstracting from time and place. The analysis carried out should be considered static, as it focuses on comparing two states (without and with area payments), using equilibrium modelling.

4. RESULTS AND DISCUSSION

4.1. Area Payments and Land Input

4.1.1. Optimal Level of Land Engagement

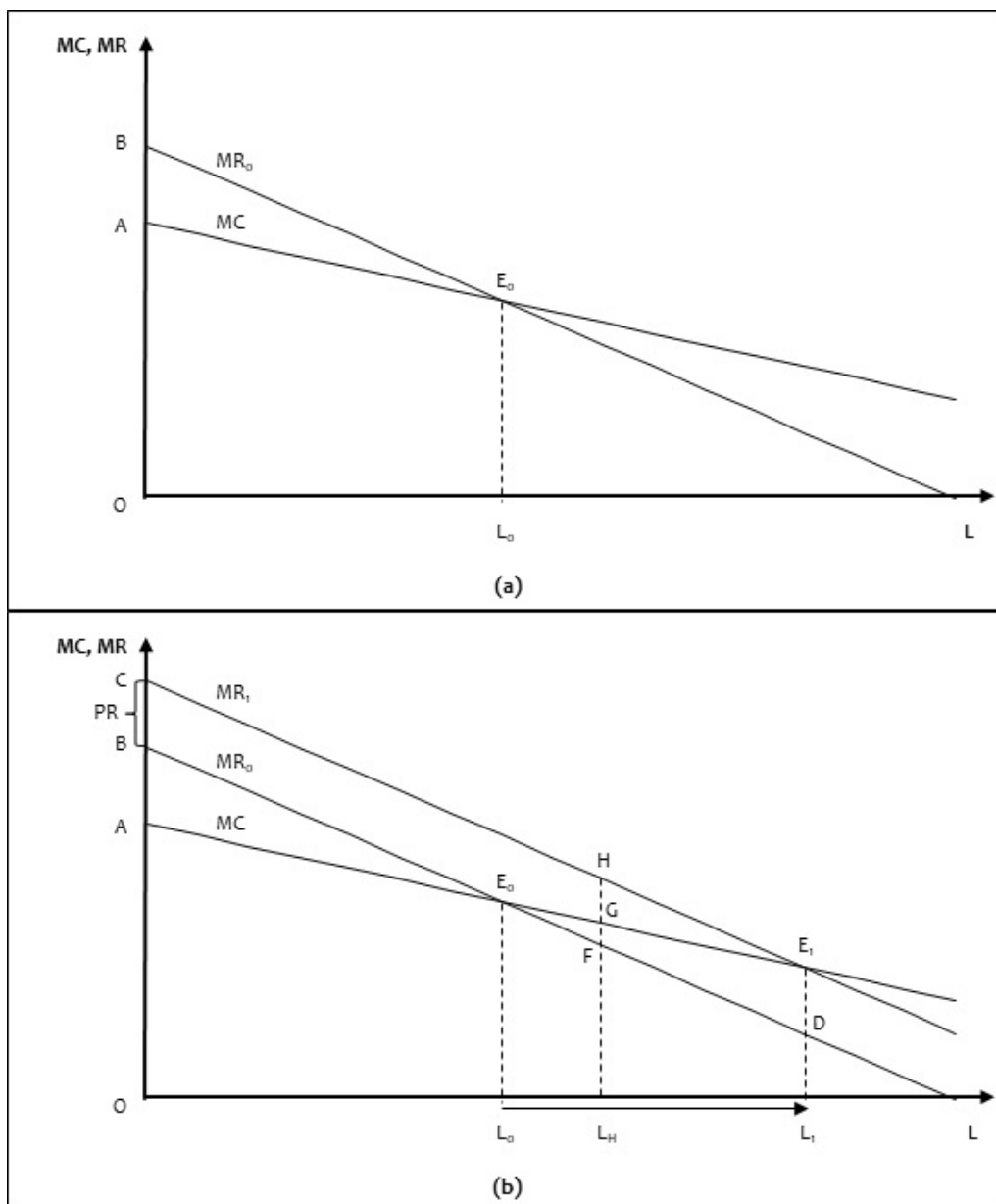
Area payments are characterized by linking the amount of granted support to the area of agricultural land used. [Figure 1\(a\)](#) illustrates the zero variant, i.e., a situation where this instrument is not applied. On the horizontal axis of the coordinate system, the amount of land input (in surface units, e.g., hectares) is plotted. Moving rightward along this axis reflects decreasing agricultural suitability of the land, as the most fertile and easily accessible plots are engaged in production first. Meanwhile, the vertical axis represents the level of a given economic variable, expressed in monetary units per unit of land input (homogeneous, single agricultural plot). The economic variables included in the chart in [Figure 1\(a\)](#) are marginal production cost, covering inputs of non-land production factors (i.e., labour and capital in the classical sense), and marginal revenue from the sale of agricultural produce. In the chart shown in [Figure 1\(b\)](#), the marginal revenue function graph in position MR_1 – besides revenue from the sale of agricultural products – also includes revenue from area payments.

The graph of the marginal cost (MC) function, understood as the increase in total costs (i.e. non-land production inputs) resulting from an increase in land input by one unit, is a declining line because the less fertile the land, the lower the amount of labour and capital required to maximize economic result ([Sadłowski 2017](#)). The graph of the marginal revenue function (MR_0), understood as the increase in total revenue from an increase in land utilization by one unit, is also a declining line. The negative slope of this line results from the fact that the most productive lands, generating the highest revenue from the sale of agricultural produce at given inputs, are engaged in production first. As less fertile and more peripherally located lands are engaged in the production process (moving rightward along the horizontal axis), the marginal revenue from each subsequent unit of land decreases.

The relative position of the graphs of the marginal cost and marginal revenue functions in Figure 1 is a consequence of the assumption that there are lands on which agricultural production is profitable even without area support (MR_0 runs above MC ; these are lands located to the left of L_0 , i.e. those with the greatest agricultural usefulness), and at the same time there are lands on which agricultural production would result in a loss (MR_0 runs below MC ; these are lands located to the right of the L_0 point).

The area under the marginal cost (MC) curve represents total costs (TC), while the area under the marginal revenue (MR_0) curve represents total revenue (TR). The optimal level of land resource utilization in agricultural production is determined by the first coordinate of the intersection point of the MC function with the MR_0 function (E_0), i.e., L_0 . At this level of land input, the economic result, understood as the surplus of total revenue over cost, is maximized, so the input of production factors other than land is also optimal.

Figure 1. Level of land resource utilization in the variant without area payments (a) and with area payments (b)



In contrast, [Figure 1\(b\)](#) illustrates a situation where agricultural activities are subsidized through the provision of financial support to farms proportional to the area of agricultural land used. In this case, production factors engaged in the production process are remunerated not only by the market (in the form of revenues from the sale of agricultural produce) but also by the state (in the form of area payments).

The rates of direct payments can be counted among the parameters of the economic calculation, which constitute the systemic conditions of management in agriculture. Farmers are forced to take payment rates into account in their economic decisions, although this is not enforced administratively, but by the threat of obtaining a worse economic result ([Sadłowski 2023](#)).

The area payment rate is uniform (not differentiated regionally or by land quality), so the introduction of this instrument can be graphically represented by a parallel upward shift of the MR_0 revenue function graph – by a segment $|BC|$, the length of which corresponds to the area payment rate PR – into position MR_1 . As a result, the new equilibrium point for the farm will be point E_1 , corresponding to a higher level of land input ($L_1 > L_0$). Thus, lands that were previously not used for agricultural production (in the absence of area support) will be engaged in agricultural production. The length of the $|L_0L_1|$ segment reflects the size of the additional land area (i.e., land engaged in production due to the introduction of area payments).¹

Thus, area support provides an incentive for farms to increase land input, leading to an increase in the total area of agricultural land used in the country. However, if resource management is to be rational, there is no justification for increasing this area for reasons other than improved market conditions in agriculture.

4.1.2. Effects of Price Changes

The model allows for the consideration of price changes (in any direction) in both the markets for production factors and agricultural products. An increase/decrease in the prices of agricultural inputs or wages would result in an upward/downward shift of the marginal cost (MC) function graph. Meanwhile, an increase/decrease in the prices of agricultural products would be reflected in an upward/downward shift of the marginal revenue (MR) function graph.

4.1.3. Impact of Agricultural Tax

The presented model can also incorporate the impact of agricultural tax on the analysed variables. Given that the amount of agricultural tax decreases with the declining agricultural suitability of land, its effect can be represented by a non-parallel upward shift of the marginal cost function graph, proportional to the tax amount, such that the new function (MC_1) converges with the original function (MC_0) as it moves rightward along the horizontal axis. However, in the first quadrant of the coordinate system (where the analysis is conducted, as it corresponds to the values of the examined variables that make economic sense), there would be no intersection of these function graphs.

¹ In the EU Member States applying the SPS, the stimulating effect of area payments on the overall level of land use in agriculture was prevented by establishing an area limit on a national scale as a resultant of the total (fixed) number of payment entitlements.

4.2. Area Payments and Remuneration of Production Factors

4.2.1. Land Rent as a Residual Amount

The remuneration for land, as a resource engaged in the production process, is a residual amount representing the surplus of revenues from the sale of agricultural produce (in the variant with area payments – increased by the revenues from these payments) over the production costs, which include inputs of non-land production factors. This is equivalent to economic profit. This conclusion recalls the Physiocratic thesis that land is the only surplus-generating production factor (Landreth & Colander 2001).

In the variant without area payments, as shown in Figure 1(a), the total remuneration for land at the farm's equilibrium point (E_0) is represented by the area of triangle AE_0B . Meanwhile, the amount of land rent per unit of land area (homogeneous in terms of agricultural suitability) is symbolized by the vertical distance between the marginal cost (MC) function graph and the marginal revenue (MR_0) function graph. The amount of land rent decreases as we move rightward along the horizontal axis of the coordinate system, corresponding to the engagement of increasingly less agriculturally suitable land in the production process. The marginal cost (MC) function graph lies below the marginal revenue (MR_0) function graph for land that, at given production costs and agricultural product prices, is sufficiently suitable for profitable engagement in production.

4.2.2. Measures of the Impact of Area Payments

This section proposes the concept of three indicators, consistent with the presented model, for measuring the scale of area payments' impact on the distribution sphere:

- the subsidy coefficient for agricultural activities,
- the state co-financing coefficient of land rent, and
- the land rent-creation coefficient by area payments.

The subsidy coefficient for agricultural activities is defined as the ratio of the amount of granted area support to the farm's total revenue, which includes revenue from the sale of agricultural products (sourced from the market) and revenue from area payments (sourced from the state). Thus, it indicates the portion of total revenue represented by area support. In other words, it shows what percentage of production factor remuneration is financed by the state.

The subsidy coefficient for agricultural activities (C_{ASS}) is expressed by the formula:

$$C_{AAs} = \frac{PR \times L}{TR_1} \times 100\%, \quad (1)$$

Where PR is the area payment rate, expressed in monetary units per area unit (m.u./ha); L is the land area covered by area support, expressed in area units (ha); and TR_1 is the total revenue from land covered by area support, including revenue from the sale of agricultural products and revenue from area payments, expressed in monetary units (m.u.).

The subsidy coefficient for agricultural activities is thus dimensionless and can take any value in the closed interval from 0 to 100%. The coefficient equals zero when the remuneration of production factors is entirely derived from the production of goods, which only occurs when the sole source of funding for inputs is the market. This situation

corresponds to the zero variant shown in Figure 1(a). In contrast, in the variant shown in Figure 1(b), the value of this coefficient is greater than zero and increases as the agricultural suitability of the land decreases (i.e., the lower the land's productivity, the greater the portion of production factor remuneration that comes from area support). However, it does not reach 100%, as long as agricultural activities on the marginal land L_1 generate any revenue from the sale of agricultural products (in Figure 1(b), the amount of this revenue is represented by segment $|L_1D|$). The development of the subsidy coefficient for agricultural activities about the land's agricultural suitability is illustrated by the dotted line graph in Figure 2. The second coordinate of the points on the graphs presented in Figure 2 should be interpreted as the value of a given coefficient in relation to a unit, homogenic agricultural plot (with area close to zero), included in a farm, which is in the equilibrium point under the conditions of application of area support of a given payment rate (E_1), and thus involves L_1 agricultural land inputs in the production process. The graph is illustrative; it shows the development of the analysed variables at a given relation of the payment rate to the production costs and revenue from the sale of the cultivated agricultural product.

In Figure 1(b), the value of the subsidy coefficient for agricultural activities for a specific homogeneous, one hectare land plot is the ratio of the vertical distance between the MR_0 line and the MR_1 line (i.e., the area payment rate PR) to the vertical distance between the horizontal axis and the MR_1 line. Meanwhile, the value of this coefficient for a farm at equilibrium point E_1 (i.e., using land input of size L_1 for production) is the ratio of the area of parallelogram $CBDE_1$ to the area of trapezoid COL_1E_1 .

Within the proposed model, a theoretical decomposition of production factor remuneration is made into income from non-land production factors and land rent. For the variant with area payments, these two fractions of remuneration are further divided into part financed by the market and part financed by the state. This allows for the introduction of two additional indicators: the state co-financing coefficient of land rent and the land rent-creation coefficient by area payments.

Based on Figure 1(b), it can be concluded that area support entirely contributes to land remuneration in the case of land that was used for agricultural production even in the absence of area payments ($0 < L \leq L_0$). However, for land that was brought into production only after the introduction of area payments at rate PR ($L_0 < L \leq L_1$), area support partly constitutes land remuneration and partly constitutes remuneration for other production factors. It is worth noting that, as we move rightward along the horizontal axis of the coordinate system from L_0 , an increasing portion of area support contributes to the remuneration of labour and capital, while the portion allocated to land remuneration decreases. This means that, as land productivity decreases, the market's role in remunerating labour and capital diminishes, while the state's role increases. In the extreme case of the marginal land plot L_1 , area support entirely contributes to labour and capital remuneration, while land rent equals zero.

To measure what portion of land remuneration is financed by the state, we can introduce the state co-financing coefficient of land rent (cLRf) expressed by the formula:

$$C_{LRf} = \begin{cases} \frac{PR \times L}{TR_1 - TC} \times 100\% & \text{dla } L \in (0, L_0], \\ 100\% & \text{dla } L \in (L_0, L_1] \end{cases} \quad (2)$$

Where TC is the total cost, i.e. non-land production inputs, in relation to the land area covered by area support, expressed in monetary units (m.u.).

Like the subsidy coefficient for agricultural activities, the state co-financing coefficient of land rent is dimensionless and can take any value in the closed interval from 0 to 100%.

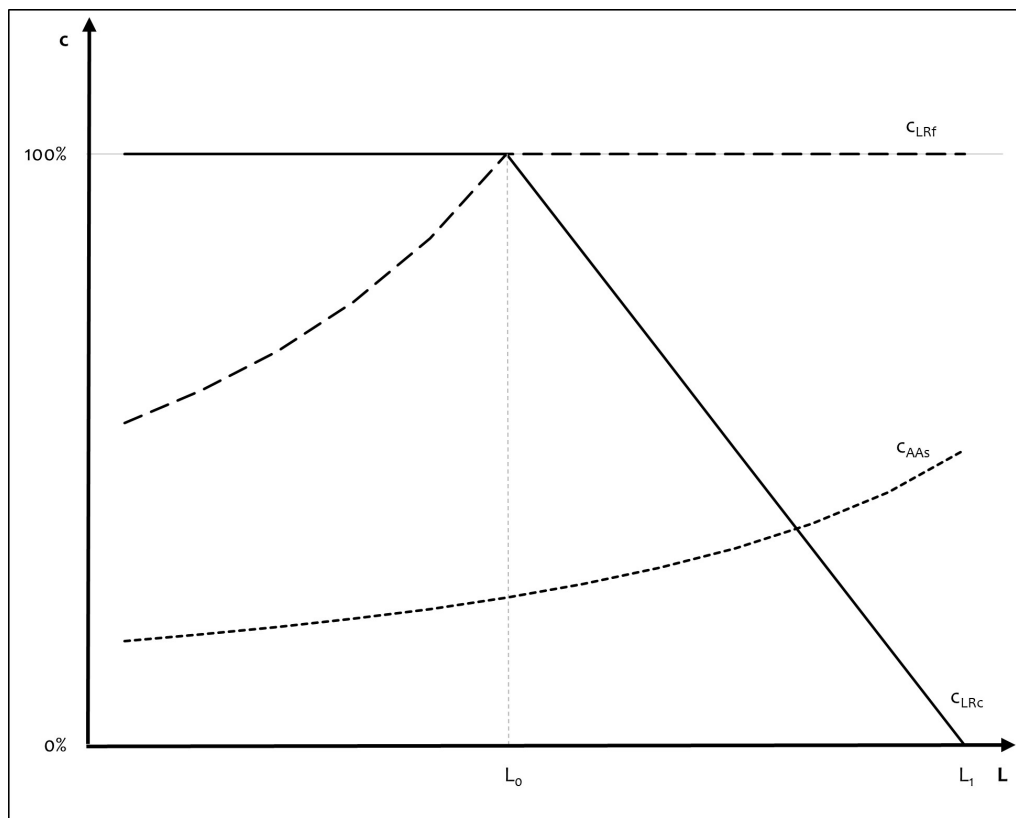
Taking into account Figure 1(b), we can see that for the unit plot L_0 and for plots located to the left of it, the state's contribution to financing land rent is expressed by the ratio of the area payment rate (PR) to the vertical distance between the MC line and the MR1 line. This ratio increases as one moves rightward along the horizontal axis. For plots located to the right of L_0 (up to and including L_1), the state's contribution to financing land rent is 100% (since, in this case, both the numerator and the denominator of the fraction expressing this contribution represent the same number corresponding to the vertical distance between the MC and MR1 lines). However, this does not change the fact that, in absolute terms, land rent decreases as one moves rightward along the horizontal axis of the coordinate system. The dashed line graph in Figure 2 illustrates how the value of the state co-financing coefficient of land rent changes depending on the agricultural suitability of the land. In relation to the entire farm located at the equilibrium point E_1 , the state's contribution to financing land rent is expressed as the ratio of the area of trapezoid CBE0E1 to the area of triangle CAE1 (Figure 1(b)).

The land rent-creation coefficient by area payments (C_{LRc}) indicates what portion of area support increases land rent. This indicator can be expressed using the following formula:

$$C_{LRc} = \frac{\Delta LR}{PR \times L} \times 100\%, \tag{3}$$

Where ΔLR is the increase in land rent due to the introduction of area payments, expressed in monetary units (m.u.).

Figure 2. Values of the indicators measuring the impact of area payments on the distribution sphere depending on the agricultural suitability of the land



Just like the indicators expressed by formulas (1) and (2), the land rent-creation coefficient by area payments is dimensionless, and the possible values for this indicator range from 0% to 100%. Based on Figure 1(b), it can be concluded that for land that was

used for agricultural production even in the absence of area support ($0 < L \leq L_0$), the value of this coefficient is 100%. However, for land that was brought into production only after the introduction of area payments at rate PR ($L_0 < L \leq L_1$), this coefficient is less than 100% and decreases as one moves rightward along the horizontal axis of the coordinate system (reaching zero for the unit plot L_1). For example, for a homogeneous, one hectare unit plot L_H , the land rent-creation coefficient equals the percentage ratio of the length of segment $|GH|$ to the length of segment $|FH|$ (segment $|FH|$ reflects the area payment rate PR). Observing the continuous line graph in Figure 2, one can see how the value of this coefficient changes depending on the agricultural suitability of the land. Meanwhile, the value of the land rent-creation coefficient by area payments for all land included in the farm located at the equilibrium point E1 can be calculated as the percentage ratio of the area of trapezoid CBE_0E_1 to the area of parallelogram $CBDE_1$ (Figure 1(b)).

4.2.3. Implications for Lease Rent and Agricultural Land Prices

In cases where the user of the land is not its owner, land rent takes the form of lease rent. As a result of area payments being at least partially transformed into land rent, there is a phenomenon of “capturing” support by landowners through corresponding increases in lease rent or land sale prices. In situations where land ownership is separate from land use, the land rent-creation coefficient measures the extent to which area payments are “captured” by landowners.

The “capture” of area support by agricultural landowners manifests itself in higher lease rent rates and higher agricultural land prices, i.e., the capitalization of payments. This occurs when the landowner is not identical to the land user, and when the land is subject to market transactions. “Capturing” the payments involves factoring part or all of the area support into the lease rent (in the case of leasing) or the land price (in the case of selling), as a consequence of increased discounted income from agricultural land due to the area payments.

The increase in the stream of discounted income from area payments (ΔDIS_{AP}) can be calculated using the following formula:

$$\Delta DIS_{AP} = L \times \left(\frac{C_{LRc0} \times P R_0}{(1+r)^0} + \frac{C_{LRc1} \times P R_1}{(1+r)^1} + \frac{C_{LRc2} \times P R_2}{(1+r)^2} + \frac{C_{LRcn} \times P R_n}{(1+r)^n} \right), \quad (4)$$

Where C_{LRc} is the land rent-creation coefficient by area payments (dimensionless); r is the annual interest rate; and $(n+1)$ is the number of years of area payment application.

The increase in lease rent for a given year following the introduction of area payments corresponds to the increase in the annual income stream due to these payments, while the entire increase in the stream of future discounted incomes will be capitalized in the land price. Therefore, the first component of the sum in formula (4) represents the theoretical increase in lease rent in the first year of area payment application, while the entire sum represents the theoretical increase in land price in the event of a sale at the time the payments are introduced.

Calculating the future stream of income from area payments requires predicting payment rates in subsequent years. In addition to issues related to predicting future income streams from area support, various institutional conditions influence the process of “capturing” area payments by agricultural landowners. In particular, the long-term nature of lease agreements and their inflexibility result in inertia in lease rent rates (Góral & Kulawik 2015), while legal restrictions on the agricultural land market may slow the process of payment capitalization into land prices (Sadłowski 2017).

4.3. Sensitivity analysis

A sensitivity analysis was carried out using illustrative numerical data. It allows an assessment of the impact of the level of area support, measured by the payment rate (PR), on selected variables, namely:

- Optimal land input (L_E),
- The subsidy coefficient for agricultural activities (c_{AAs}),
- The state co-financing coefficient of land rent (c_{LRf}),
- The potential degree of “capture” of payments by landowners (by increasing lease rents), which is the same as the land rent-creation coefficient by area payments (c_{LRc})

Table 2. Level of area support and the value of key variables characterizing the production sphere and the distribution sphere – sensitivity analysis using illustrative data

| Area payment rate (PR) | Optimal land input (L_E) | Subsidy coefficient for agricultural activities (c_{AAs}) | State co-financing coefficient of land rent (c_{LRf}) | Potential degree of payments “capture” by lessors (c_{LRc}) |
|------------------------|------------------------------|---|---|---|
| m.u./ha | ha | % | % | % |
| 0 | 6 | 0,00% | 0,00% | 0,00% |
| 0,25 | 7,5 | 6,25% | 36,00% | 90,00% |
| 0,5 | 9 | 12,50% | 55,56% | 83,33% |
| 0,75 | 10,5 | 18,75% | 67,35% | 78,57% |
| 1 | 12 | 25,00% | 75,00% | 75,00% |
| 1,25 | 13,5 | 31,25% | 80,25% | 72,22% |
| 1,5 | 15 | 37,50% | 84,00% | 70,00% |

Based on the results compiled in [Table 2](#), it can be concluded that as the subsidy rate in the form of area payments increases:

- The optimal land input increases (linearly), which means that farmers engage more and more of the available agricultural land in the production process, even those of lower quality or located more peripherally;
- The share of the state in financing the remuneration of the factors of production is increasing (linearly), which means that the state plays an increasing role in financing agriculture, and thus the market efficiency of resource allocation is decreasing;
- The share of the state in financing the remuneration of land as a factor of production is increasing, with the rate of increase in the state’s role in financing land rents falling faster than the rate of increase in the payment rate;
- The potential degree of “capture” of payments by landowners through increases in rents is declining, and the rate of decline in the degree of “capture” being less rapid than the rate of increase in the payment rate.

5. CONCLUSIONS

The article presents an original model of the impact of area payments on the level of engagement and remuneration of production factors in agriculture, including the concept of three indicators measuring the scale of area payments' impact on the distribution sphere. Regarding the production sphere, the model allows for determining the optimal land input on a farm. In terms of the distribution sphere, the model makes it possible to establish the structure of non-market (i.e., state-funded) remuneration for production factors into which area payments are converted. The practical usefulness of the model lies in its ability to indicate the maximum lease rent level depending on the agricultural suitability (productivity) of the land.

Based on the analysis conducted using the proposed model and a review of the relevant literature, the following conclusions can be drawn:

- 1) Due to the direct support system, the production factors engaged in agriculture generate remuneration that exceeds the monetary equivalent of the agricultural products produced by farms. This additional remuneration, which goes beyond the monetary value of the produced goods, is paid by the state in the form of direct payments, which in the EU usually take the form of area payments.
- 2) The application of area payments promotes the inclusion of less fertile or peripherally located land in cultivation, thus increasing the extensiveness of production.
- 3) The measure of relative support level is the subsidy coefficient for agricultural activities, and its value increases as less agriculturally suitable land is brought into production, because the lower the productivity of a plot of land, the greater the portion of remuneration for production factors that comes from area support.
- 4) The state's contribution to financing land rent increases as the agricultural suitability of the land decreases. This contribution does not exceed 100% only for land that would be cultivated even in the absence of area support.
- 5) Area support is wholly or partially transformed into land rent, and the measure of this phenomenon is the land ent-creation coefficient. If the conversion of payments into land rent is partial, besides supplementing land remuneration, they also co-finance the input of other production factors, such as labour and capital. This occurs for land that was brought into production as a result of the introduction of support.
- 6) Only for land that would be used for agricultural purposes even in the absence of area payments is it possible to completely "capture" the area support by landowners from land users.
- 7) If area support is reflected in the amount of lease rent, it indicates the presence of the phenomenon of "capturing" area payments by landowners. This phenomenon also manifests in land market transactions when the stream of discounted income from area payments is capitalized into the price of land.
- 8) The "capturing" of area payments by landowners is countered, especially in the early years of support applying, by the inertia of lease rates due to the inflexibility of land lease agreements and the inertia of land prices caused by legal restrictions on the agricultural land market.
- 9) Due to the direct link between the amount of payment and the area of agricultural land used, area support is relatively susceptible to "capture" by landowners. Thus, the

effectiveness of this type of aid as an income support tool for farmers is therefore greater the smaller the discrepancy between land ownership and land use.

In summary, the presented economic model demonstrates that area payments alter the allocation of resources compared to the allocation driven by the market mechanism (resulting in greater engagement of production factors in agricultural production than would occur without these subsidies) and affect the size and structure of remuneration for production factors in agriculture.

The added value of this study is manifested in three dimensions – cognitive, methodological, and practical. Understanding the mechanism by which area payments stimulate the input of production factors in agriculture and the mechanism through which subsidies granted as area payments are converted into production factor remuneration is of cognitive value. The model of area payment transformation into production factor remuneration can serve as a basis for econometric modelling to predict the economic effects of agricultural policy (ex-ante assessment) and to measure the effectiveness and efficiency of agricultural policy instruments (ex-post assessment), which adds value in improving research methodology. The knowledge gained from such studies facilitates the design of agricultural policy tools and the adaptation of the instrumentation to changing socio-economic conditions or revised political objectives, demonstrating the practical potential of the presented model.

The proposed theoretical model may be particularly useful in a variant analysis of alternative directions for agricultural policy reform, serving as a starting point for an ex-ante assessment of the proposed changes. For instance, the model can be used to identify the economic effects of the following adjustments in relation to area-based support:

- Changes in area payment rates – the model demonstrates how an increase or decrease in these rates affects the engagement of production factors in agriculture and the level of land rent;
- Differentiation of payments based on land quality – the model allows for an assessment of how adjusting support levels to land productivity could help mitigate the phenomenon of subsidy “capture” by landowners;
- Introduction of additional environmental conditions – indirectly, the model indicates how linking payments to ecological practices could contribute to reducing the scale of subsidy “capture” by landowners.

The model highlights the issue of payment capitalization in land prices and rental rates. The essence of this problem is that a portion of the support – rather than benefiting active farmers (land users) – instead increases the incomes of landowners, making them the actual beneficiaries of agricultural policy. In this sense, the model exposes the shortcomings of area payments as an instrument for supporting farmers' incomes. The proposed model can facilitate the design of solutions that ensure more effective targeting of area-based support, enhancing the efficiency of this instrument in achieving its intended objectives.

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