Summary of the doctoral dissertation entitled: **The determinants of agricultural incomes in European Union regions after 2003**

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State of the art and research problem

Agricultural income belongs to fundamental analytical categories in agricultural economics. It is the subject of numerous empirical studies, both in Polish and foreign literature (cf. Kołoszko-Chomentowska, 2007). Polish studies are often of a comparative and comprehensive nature (cf. Gołaś, 2010; Szuba and Poczta, 2013). Income in EU countries is examined using several factors that may have an impact of this. The English literature is dominated by more fragmented research, often at the local level. However, they are usually characterised by a higher degree of formalisation and use more advanced quantitative methods.

There are many trends in agricultural income research. These are studies of a review nature (e.g. Nadolny Dzator and Nguyen, 2015), methodological (Vogel and Johnson, 2000), including socio-cultural phenomena and education (Panda, 2015), agricultural policy (cf. Hansen and Teuber, 2011; Severini and Tantari, 2013) or environmental and climate factors (cf. e.g. Reidsma et al, 2009; Burke and Emerick, 2016). However, particularly rich literature on the subject concerns studies on economic determinants of agricultural income. On the basis of a review of domestic and foreign literature it is possible to identify three basic research perspectives, which are discussed in more details in the first chapter of the dissertation.

The first possible perspective for the agricultural income research is the macroeconomic perspective (cf. Czyżewski B. 2017; Czyżewski B. et al. 2019; Boehlje et al., 2012; Baek and Koo, 2009). In this type of research, econometric models are constructed, where factors such as: price scissors (the relationship between the prices of products sold by farmers and the prices of means of production), exchange rate, interest rates (as a result of monetary policy), GDP level or other economic indicators appear among independent

variables. The most important income determinant in this perspective are price relations (cf. Czyżewski B. and Majchrzak, 2018; Beckmann and Schimmelpfennig, 2015).

The second direction of income research in agriculture can be described as technical optics. The starting point for this type of research is that an increase in agricultural income requires an improvement in productivity levels, while prices determine the production profitability only in the short term. If we assume that purchase prices do not show an unambiguous upward trend, the increase in means of production prices must be compensated by an improvement in productivity (Rembisz, 2010). This last category (in the sense of Total Factor Productivity - TFP) is of a residual nature, i.e. it results from the difference between the production growth rate and the weighted growth rates of factor inputs (Bezat-Jastrzębowska and Rembisz, 2015). In agriculture of developed countries a decrease in the use of the labour factor in relation to the capital factor is observed. The increase in agricultural income (in particular income per labour unit) therefore requires an increase in productivity of this factor. In the conditions of inelastic food demand, the key to increasing productivity (and thus wages of the labour factor) becomes concentration understood as an increase in the labour to land ratio and/or an increase in the capital to labour ratio.

This thesis is a part of the third stream of studies (here referred to as the endogenous approach), which is particularly relevant to the case of a representative farm. In particular, the endogenous approach forms the basis for empirical analyses. Thus, it is assumed that the assumptions characteristic for classical economics, i.e. excellent competition, hold - first of all, the assumption that the main (though not exclusive) objective of the farm manager is to maximise income. At the same time, a single farmer is not able to influence the price level. Furthermore, it is assumed that changes in the relationship between resources and productivity of production factors are slow and are not entirely influenced by the farmer in the short or medium term. They are partly determined by historical and natural factors. For example, reducing employment in agriculture with unchanged production levels (resulting in improved labour productivity) is a process observed at the macro level, but in the short term at the micro level is difficult to carry out and depends,

for example, on the availability of jobs outside agriculture (Rembisz, 2013). In the research optics outlined above, the emphasis is on the activities of a single entity, which under given conditions results in an increase in agricultural income.

Using the distinction made by North and Thomas (1973) on the fundamental and direct causes of economic growth, it is also possible to speak of direct determinants resulting from the relationship between the factors of production, i.e. labour, land and capital, and the fundamental ones, primarily of an institutional and macroeconomic nature. Thus, although the work is mainly embedded in classical economics, due to the analysis of the conditions and models of agriculture that the Common Agricultural Policy (CAP) co-creates, an institutional perspective is also present in the thesis. In the conditions of the CAP, it is not possible to disregard the existing 'rules of the game' and, above all, the associated subsidies, which constitute additional income for farms but also stimulate specific production behaviour.

Despite the functioning of the CAP, farms in the regions of the European Union operate in a strongly diversified environment, which is visible through differences in natural and climatic conditions and economic relations (e.g. agrarian structure, capital to labour ratio), including diversified productivity of production factors (labour, land and capital). This may result in different paths of agricultural income growth in different groups of regions. However, the often used division into EU countries or regions before and after 2004 is not sufficient.

In practice, the conditions of farms' functioning (e.g. agrarian structure) in some regions of southern Europe (e.g. southern Italy) are more similar to the situation in Central Europe than e.g. German specificity. Given the diversity also within individual countries, the wrong conclusions can only be drawn at national level, which is why this dissertation focuses on the analysis in a regional context.

The heterogeneity of conditions for the functioning of agriculture in the European Union influences the dynamics of structural changes, which results in different types and models of agricultural development in particular regions. However, on the basis of the literature review on the issues of agricultural models conducted in the second chapter, it is

possible to formulate a general conclusion: relations between production factors (resource relations) and productivity of these factors may serve as the basic distinguishing feature of both development models of agriculture and its types. Social and natural factors are further reflected in these relations.

In this context, a research problem is revealed, which is summarised in the question of which areas of farms' activity are key to increasing their income under given productivity and resource conditions? Potentially the income growth paths in areas where small farms are predominantly small and poorly equipped with a capital factor are different in comparison to the case of domination of large, capital-intensive farms.

Goals of the research

The main aim of the work is therefore to identify the determinants of farm income in EU regions at the level of a representative FADN farm, taking into account the differences in the relation of resources and productivity of production factors (i.e. labour, land and capital). The main objective will be achieved through five specific objectives, which are directly linked to the different phases of research:

- Operationalisation of the term of "agricultural income" and identifying of potential income determinants on the basis of literature research, the results of which are presented in the first chapter of the thesis. This chapter is mainly of an overview nature, but also contains some empirical illustrations. It refers to the discussion on the concept of agricultural income and problems related to its calculation, and reviews the literature on potential determinants of agricultural income in different research perspectives. Moreover, reference is made to the concept of market treadmill and the phenomenon of the so-called fallacy of composition as theoretical problems related to the income calculation and its determinants;

- the location of the problem of resource relations and factor productivity in the theory of agricultural development models, which became the content of

chapter two. The chapter is an overview of agricultural development models and related structural changes. Existing classifications of stages, types and models of agriculture are analysed, with a particular focus on structural changes and relations between production factors. Moreover, the specificity of the so-called European agricultural model is discussed;

- designation of clusters of the European Union FADN regions with similar resource relations and factor productivity in agriculture, which is the main content of chapter three. In the first part of the chapter, the characteristics of the FADN regions in terms of the relationship between the production factors and their partial and total productivity are presented. In the second one, regional clusters are determined. Finally, the dynamics of productivity indicators in individual regional clusters are calculated;

- evaluation of the level and dynamics of the basic agricultural income categories and evaluation of the financial situation of agricultural holdings in the FADN regions, which were undertaken in chapter four. The financial situation is assessed

  and income of agricultural holdings in static and dynamic terms, and its relations with productivity of production factors are indicated. The monetary efficiency of income generation is further calculated using the DEA method;

- assessment of the interaction between the level of farm income and its determinants - identification of differences in direction and strength of influence of the distinguished determinants on the income level in particular groups of regions. These studies are undertaken in chapter five. First, the values of measures that are determinants of agricultural income are calculated. Next, regression models (panel models) of farm income are constructed on the basis of calculated measures together with testing of their robustness. A set of explanatory variables is formed by endogenous (microeconomic) determinants of income from the agricultural holding based on the theoretical model from

chapter one. Interdependencies are examined for the whole panel of farms representative in regions, as well as separately for individual clusters.

The thesis was designed to provide answers to some important questions about agricultural income in the EU regions. Is intensification of production still having a satisfactory effect on income growth in regions with lower land productivity, while the effectiveness of this strategy has been undermined in more developed regions? Does improving of assets turnover really have significant positive effects on income growth? In a context of high capital saturation and high productivity in some EU regions, is management of the asset and cost structure the only way to maintain income growth?

The main objective, as well as the specific objectives, is achieved by the designed layout of the doctoral dissertation, the essence of which is to divide considerations into the first part, which aims to determine the types of agriculture characteristic for particular clusters (chapters 2 and 3) and the second part, the content of which is to identify changes in income, their determinants and relations between them (chapters 4 and 5). However, the two parts remain functional, intertwined and allow conclusions to be drawn of a general and specific nature. The scope of the thesis covers representative agricultural holdings in the FADN regions of the European Union and the income of agricultural holdings and their determinants in representative FADN farms. The time scope is from the EU enlargement in 2004 to 2015. This is a period long enough to build reliable econometric models that provide a sufficient number of observations and at the same time short enough to determine clusters of regions with relatively fixed resource relations and relatively stable factor productivity. The *spatial* scope was in turn made up of 115 EU FADN regions, which belonged to the EU during the whole period considered. For technical reasons, in some empirical analyses, this scope had to be slightly reduced, as was noted in individual parts of the dissertation.

Hypotheses

This thesis formulates the main hypothesis that resource relations and productivity of agricultural production factors in EU regions differentiate the influence of particular determinants on the level of income from the farm. In order to clarify it, four partial hypotheses were also formulated:

- H1: agricultural holdings in regions with high labour productivity are characterised by higher labour profitability but less favourable financial situation;
- H2: improving of financial indicators (on debt and performance) and reducing the share of external costs have a stronger impact on income growth in regions with relatively low capital productivity than in other groups of regions;
- H3: intensification of production and increasing investments in relation to the depreciation have a stronger impact on the growth of farm income in the regions with on average the lowest land productivity than in other groups of regions;
- H4: higher level of production specialisation and the use of subsidies have a stronger impact on income growth in regions with relatively low labour productivity than in other groups of regions.

The verification of the above hypotheses was possible thanks to the implementation of the specific objectives formulated above, especially objective five, i.e. the assessment of interdependence between the level of income and its determinants in particular clusters of FADN regions, reflecting the types (models) of agriculture prevailing in a given area.

Main results

The first chapter discusses the concept of agricultural income and makes it more specific. It has been indicated that "agricultural income" is a broad but also ambiguous concept, therefore empirical studies should each time specify whether the income of farmers' households, income at the level of the agricultural sector or income from farming is mentioned. In practice, the concept of income from the agricultural holding can also be understood in many ways, depending on the aggregate adopted (net income, gross income, labour factor remuneration) and the calculation principles used in the databases. From the

farmer's point of view, however, it is crucial to maximise income per work unit, hence this aggregate is particularly useful for model analyses conducted in the microeconomic perspective. The farm income survey may be undertaken from different research perspectives. Apart from the research that focuses on the influence of natural and cultural factors, it was possible to determine three main approaches in the theory of agricultural economics. However, macro-economic optic, which assesses better the relationship between income and variables such as interest rates, economic growth and the level of trade, is mainly appropriate for sector-wide research. In the surveys at the level of a representative holding, technical optic - income as a function of inputs and their productivity - or its development, i.e. microeconomic perspective can be used. The latter makes it possible to assess the impact of managerial decisions which may also concern the stimulation of production growth, management of farm assets and its cost structure. In addition, it is possible to extend the analysis by institutional factors with the particular emphasis on common agricultural policy and various types of subsidies associated with it that are particularly important for revenue.

The content of the second chapter of the thesis was to situate the problem of factor productivity in the theory of agricultural development models. To this end, classifications of types, epochs and development models were discussed. Reference was made to the theory of regional development and structural change. A review of the literature has shown that the development of agriculture in the long term can be described in a synthetic way by means of changing relations between resources of production factors and their productivity. What is more, these relations may also constitute a basic distinguishing feature of the main types and periods of agricultural development in the classifications proposed by individual authors. The transition from more traditional forms of farming to modern types of agriculture usually meant a decrease in the productivity of capital, while increasing the productivity of labour and land. The return to sustainable agriculture may, in turn, be associated with a drop in productivity, although it depends, among other things, on how much the volume effect is compensated for by the price effect (assuming that when examining productivity, value and not production volume is analysed). The analyses

conducted in this chapter also allowed to distinguish the agricultural type (static dimension) as a certain predominant mode of operation in a given area from the development model (dynamic dimension) understood as a description of the ongoing changes. Despite the longstanding functioning of the common agricultural policy mechanisms, it is impossible to distinguish one dominant type of agriculture in the EU. Although there are some distinctive features of EU agriculture compared to other parts of the world, such as the important role of its non-productive functions, there is a strong heterogeneity at the level of EU regions in terms of economic and natural conditions for production.

The research conducted in the third chapter allowed to assess the level and dynamics of partial productivity and resource relations in farms representative for FADN regions. First of all four clusters of FADN regions differing in the predominant type of agriculture were determined on the basis of partial productivity indicators. Some of the regions of Northern Italy and Benelux formed a cluster where an extremely intensive type of agriculture prevailed. In central and southern Italy, Greece, Portugal and coastal regions of Spain, a characteristic Mediterranean type prevailed, with small and medium-sized farms, low labour productivity but high capital and land productivity values. In much of Western Europe (especially Great Britain, Scandinavia, Northern Germany and France), agriculture is industrial in nature - large, recapitalised farms with very high labour productivity values but low capital productivity predominate. In Central and Eastern Europe, but also in southern France or central Spain, family and/or extensive agriculture prevails. In the regions with a lower average level of a given factor productivity, a faster growth was most often observed, which would indicate the existence of a convergence process. Less developed regions have also seen faster implementation of technological progress, but thanks to improvements in technical efficiency, the fastest increase in total productivity was recorded in the cluster of regions with a predominance of industrial agriculture.

The study on determinants of income from agricultural holdings was preceded by an analysis of the level and dynamics of particular income categories, as well as an analysis of financial situation and monetary efficiency of holdings. A broad approach to these

problems was to avoid hasty and simplistic conclusions being drawn. These studies are included in chapter four. Farms in regions with a predominance of industrial agriculture received high income per unit of labour. Although labour productivity in these regions no longer increased or grew at a low rate during the period considered, significant differences persisted as the improvement in labour productivity in agriculture in regions with a predominance of family and/or extensive agriculture was too slow. The worsening profitability (especially in industrial agriculture) and strong dependence of income on the general economic situation may also be of great concern. Another problem proved to be the high level of opportunity costs - after deducting the valuation of own means of production, the income from the farm was in many cases negative. Large farms are more often in debt and can benefit from the financial leverage effect, but their profitability is usually low and a satisfactory level of labour profitability is achieved thanks to a significant scale of production. The overall financial situation as measured by the synthetic indicator was most favourable for farms in regions with a predominance of intensive agriculture and in the Mediterranean type. It correlated positively with total productivity and capital productivity and negatively with labour productivity. In these two clusters, the level of monetary efficiency of income generation was also the highest, with intensive agriculture mainly due to high income levels and, in the Mediterranean type, to low input levels.

The fifth chapter presents descriptive statistics of variables used as explanatory variables in econometric farm income models, as well as the results of the modelling itself. Significant differences in the level and dynamics of potential determinants of income from the farm were noted. In regions with a predominance of intensive agriculture, the highest level of inputs on plant protection products was recorded, however, in the cluster covering regions with a predominance of extensive and/or family agriculture, the highest dynamics of these inputs were noted. In this group of regions (similarly to regions with a dominant industrial type of agriculture), a less favourable cost structure was noted, especially due to the high share of overall economic costs. Moreover, the farms in these two clusters were the most indebted. The regions with a predominance of industrial agriculture also recorded

the highest subsidy rate, measured by the ratio of the subsidies received to the value of production, although it was in the cluster that mainly covered the regions of Central and Eastern Europe where the use of payments for public goods was higher. On average, the most specialised farms were those in regions with a predominance of intensive farming, while where industrial farming prevailed, the highest level of reproduction, i.e. investments in relation to the consumption of assets, was recorded.

The results of estimations of econometric models made it possible to state that the intensification understood as an increase in expenditures on fertilizers and plant protection products did not translate into an increase in income in regions with a predominance of industrial agriculture. This does not mean, however, that the increase in inputs in other areas should not have been made - this mainly refers to other inputs directly related to specific production directions. As in other groups of regions, a higher level of specialisation was a factor contributing to the increase in income. The problem for farms in these regions may be the dependence on subsidies. The increase in subsidies was most strongly translated into income growth in the light of the within-between models, but the high level of subsidies in relation to production (subsidy rate) had a strong negative impact on income levels. Farm managers in this group of regions should pay close attention to their financial structure and asset turnover. Estimated models do not allow for a clear conclusion about the role of long-term debt, however, the overall high level of debt, understood as the ratio of assets to equity, was a strongly negative income determinant, while income growth was stimulated by a larger share of current assets. Managers should therefore place emphasis on reducing the level of fixed assets that can weigh on the farm, reduce its flexibility and make it difficult to make quick and accurate decisions. The rational use of assets, understood in terms of the ratio of sales volume to assets (or equity) had a positive impact on the level of income in all clusters, but in this cluster the marginal effect was strongest. Referring to one of the supporting questions posed in the introduction, it can be said that the increase in the use of subsidies and the management of the property and cost structure are not the only areas affecting the income of these farms, but they are

particularly important for farms operating in regions with a predominance of industrial agriculture.

In regions where the type of farming called 'Mediterranean' was implemented, the financial management of the farm was less important, although the income stimulus may have been an increasing ratio of current assets to total assets. These farms should make greater use of external inputs and increase direct inputs (excluding plant protection products and fertilisers). As already mentioned, farms in the Mediterranean basin should specialise in selected labour-intensive production lines related to the creation of high added value. Just as in cluster with a predominance of industrial agriculture, also in the Mediterranean type an important determinant of income was the effective assets turnover.

In the cluster of regions with a predominance of traditional and/or family farming, financial management can play a relatively important role, mainly through the prism of debt control. On the one hand, an increasing level of reproduction has been identified as a stimulus of farm income in this cluster, which is associated with investments. On the other hand, a negative impact of the debt level as well as the share of long-term debt was noted. The optimal strategy would therefore be a strategy for the development should be based mainly on own resources, which may be difficult to implement in practice. Referring to another of the questions posed in the introduction, it can be said that the path of intensification as a strategy for increasing farm income was applicable to this cluster. Important income stimuli were increasing intermediate consumption per hectare, increasing use of foreign production factors and, in the light of *within-between* models, also the inputs of fertilisers and plant protection products. At the same time, specialisation and the high share of payments to public goods in total subsidies also had positive effects on income growth. The results of the modelling for this cluster show, on the one hand, the need to recapitalise and modernise farms and, on the other hand, indicate the role of searching for a more specific, dominant agricultural type. The advantages of sustainable agriculture can be an indication here.

The paper verifies the main hypothesis that resource relations and productivity of production factors in agriculture of EU regions differentiate the influence of particular

determinants on the level of income from a farm. The main hypothesis has been elaborated on by four partial hypotheses. On the basis of empirical analyses it was found that the highest labour productivity was recorded in the cluster of regions with a predominance of industrial agriculture. In this cluster, high values of labour profitability were also recorded (in the case of value added per full-time employee, these were the highest), and at the same time the financial situation in the light of the synthetic measure was relatively the least favourable in both sub-periods (2005-2007 and 2013-2015). Thus, the first partial hypothesis was confirmed. In turn, the lowest average values of capital productivity were recorded in cluster with a predominance of industrial agriculture. At the same time, the effect of debt understood in terms of the relationship between assets and equity and the positive effect of efficient asset turnover were particularly strong compared to other clusters. However, no significant impact of reducing the share of external costs of the factors of production has been noted, so the second sub hypothesis can only be partially confirmed. The lowest average land factor productivity was recorded in cluster with extensive and/or family farming predominating. In this cluster, a positive impact of reproduction level (investments in relation to depreciation) and increase of outlays, including traditionally understood intensification, i.e. fertilizers and plant protection products, was identified. Similarly strong impact of these variables was observed in the cluster with a predominance of industrial agriculture, where on average the land productivity values were higher. Thus, the third partial hypothesis was verified negatively. The lowest average labour productivity in the period considered was recorded in a Mediterranean type cluster. Specialisation (in two of the three specifications) and subsidies under the agricultural policy were important determinants of farm incomes in these regions, but the strength of the impact of these factors in other clusters was higher, hence the fourth sub hypothesis was verified negatively. However, the identified differences in significance and strength of the impact of the analysed determinants on the level of income from farms in particular clusters of FADN regions allow concluding that the main hypothesis was verified positively, although the identified dependencies were sometimes different than assumed.

Policy recommendations:

On the basis of the conducted analyses, it has also become possible to formulate several recommendations for the agricultural policy:

- agricultural policy at European Union level should remain common in terms of funding and general policy objectives. At the same time, it should be as flexible as possible so that farms in particular regions can realise their competitive advantages in particular types of farming. Agricultural policy should therefore take into account the diversity of agriculture in the EU. Support is needed for problem areas in particular types, which should not, however, imply a desire for unification. In this context, the direction of CAP reforms after 2020 seems appropriate;

- In almost all clusters, the level of specialisation has proved to be an important income determinant. The existing mechanisms of the CAP, especially the Pillar II programmes, have rather supported the diversification of production for environmental reasons. Strong specialisation in the case of large farms may lead to the emergence of monocultures, but it seems that mechanisms to support specialisation for small and medium-sized farms should be considered. Focusing on a selected area of activity may be an opportunity for these entities to improve their income situation;

- Problems related to the negative impact of debt were noted in some regions, while at the same time it was found that the income from the farm is positively influenced by investments. Agricultural policy should therefore not only be geared to supporting small farms that provide public goods, but should also facilitate access to finance for farms that want to increase their activities;

- current agricultural policy gives preferential treatment to small farms. DEA monetary efficiency analyses indicate that the largest farms in regions with a predominance of industrial agriculture have low scale efficiency (probably too

high). However, small farms, unless they are strictly specialised, do not provide sufficient income for the farming family. Without denying the policy of supporting small farms, it seems that the aim of the CAP should be to shape the agrarian structure in which medium-sized farms dominate. While the marketing of agricultural land and the shaping of the agricultural system is regulated at Member State level, the appropriate design of the subsidy system (e.g. even stronger degressivity for the largest operators combined with premiums for medium-sized farms) could support the development of the desired agricultural structure.

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