The fallacy of composition on the example of incomes in European agriculture[1]

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DOI: 10.14595/CP/01/010

Abstract: Determinants of agricultural income are often analysed both on sectoral and farm level. The results of this research are frequently contradictory. They may indicate the existence of the fallacy of composition. In the case of agriculture, it occurs when actions undertaken by the farmers to maximise their incomes bring opposite results to incomes analysed on a sectoral level. The aim of the paper is to examine in a systematic way whether this problem is real for agriculture in the European Union. Based on a literature review, a set of agricultural income determinants was established, as well as measure of that income. We constructed panel regression models based on a FADN (microeconomic) and EAA (sectoral) data. The results obtained indicate different sets of determinants of income on the farm and sector level. From the perspective of the individual farm, the intensification strategy proved to be effective despite higher dynamics of input prices than agricultural output prices, while in the sector as a whole, intensification growth has insignificant impact on income levels. In the case of specialisation, from the point of view of the whole sector, moderate specialisation may be optimal; in micro terms, either a high or low level of specialisation is more beneficial. Modernisation was a determinant of income in both sectoral and farm perspective. Overall our results indicate that the fallacy of composition exists also in the context of agricultural income.

Keywords: fallacy of composition, agricultural income, FADN, panel data

JEL: Q10 i Q12

Introduction

The fallacy of composition is a phenomenon consisting in the erroneous transfer of dependences true on one level of analysis (e.g. microeconomic) to another level (e.g. macro, global) [Grzelak 2015, p. 578]. The fallacy arises due to a failure to understand "the fact that the way the parts relate, interact, or affect each other often changes the character of the whole" [Damer 2009, p. 140]. Classic two examples of this phenomenon are the "tragedy of the commons" and "the paradox of thrift". The former was popularised by Hardin (1968) and refers to a situation in which agricultural producers seek to maximise their income by using common pasture and increasing the intensity of its use, and thus increasing the herd and grazing time.

[1] The article was written under a project funded by the National Science Centre in Poland allocated on the basis of the decision: UMO-2016/23/N/HS4/03453.

This action is rational for a single producer. However, if such behaviour becomes a rule for all producers, it would lead to a tragedy for all of them, due to overgrazing and depletion of their pasture. The latter example refers to an idea known for centuries, but reintroduced by Keynes (1936). He argued that an increase in autonomous saving leads to a decrease in aggregate demand and thus a decrease in gross output, which will in turn lower total savings. In this context, a decision to increase savings, which is rational from the point of view of a single consumer, may be harmful to the economy, if undertaken by all citizens.

In this article we analyse a specific case of the fallacy of composition in agricultural sector analyses. Although earlier studies [Grzelak 2015]; [Czyżewski and Stępień 2010] identify numerous manifestations of this problem on the theoretical ground, there is a noticeable lack of studies attempting to empirically verify these observations. This research gap is partially covered by this study, which aims to identify differences in the set of determinants of agricultural income analysed at farm and agricultural sector levels. To achieve this research goal, panel regression models based on corresponding variables from alternative databases were constructed. If the set of significantly statistical determinants differ between the two research perspectives, this means that there are grounds for identifying the fallacy of composition. This would mean that actions taken by farmers to maximise income at farm level do not lead to the same results at sector level.

The first two parts are for review purposes. They present previous approaches to the analysis of the fallacy of composition in economics, in particular agricultural economics, as well as conclusions from the previous studies of determinants of agricultural incomes. The next part has a methodological nature. It contains a description of the data and quantitative methods used in the research. The following part contains the results of the research together with a discussion, whereas the last part concludes.

The fallacy of composition and its agricultural context

Research concerning the fallacy of composition has not been common in recent years. It can be attributed to the fact that in neoclassical theory, dominant in the mainstream of economics, such fallacy is not supposed to arise, at least not to any considerable degree. The "invisible hand" is supposed to coordinate self-interested agents and ensure the good standing of the whole group. Therefore, self-interest is sufficient to satisfy group-interest [Al-Suwailem 2014]. This constitutes very serious grounds for criticism of the neoclassical approach, coming from the Keynesian and post-Keynesian school of economic thought [Cingolani 2016, Keen 2011]. Authors representing this perspective argue that macroeconomic general equilibrium models, constructed within the neoclassical paradigm, are flawed because they simply

extrapolate microeconomic relations valid for a single company or consumer to the scale of a sector or the whole economy. This procedure is justified only under a series of assumptions, which are considered counterfactual in the Keynesian and post-Keynesian perspectives.

This criticism has become even stronger since the last financial crisis, which neoclassical economics failed to predict, and was even considered the cause of the crisis by some experts [Al-Suwailem 2014]. That may be the reason why a deal of interest in the fallacy of composition is concentrated in the financial sector, especially in the context of risk assessment in the banking sector. Banking regulations derived from the models used nowadays focus solely on individual bank risk, without regard to the problem of the fallacy of composition; namely, even if individual banks function well, the banking system can fail. To avoid this, it is proposed to widen the scope of assessment to measures taking into account systemic risk as well [Sum 2016]; [Shin 2015]; [Markose 2013].

Another common area where the fallacy of composition occurs is international relations and trade. Arnim, Tavani and Carvalho (2014) found that it may emerge in the case of redistribution. Home can benefit from redistribution towards labour in Home, in terms of its own level of output and employment, while Foreign can benefit in the same way from redistribution towards labour in Foreign. Both, however, might pursue policies of relative wage suppression, in order to prevent the other country from reaping most of the benefits of demand expansion. As a consequence, global economic performance would be weaker than otherwise. Similarly, we can recognise the fallacy of composition in the growth strategies of developing countries, which are trying to simultaneously export similar types of manufactured goods to the same industrialised country markets. Greater exports may contribute to further development of any single country, but in the case of competition between them, the overall effect is negative. The occurrence of this mechanism was empirically tested by Blecker and Razmi (2009). These issues in the context of Sub-Saharian Africa were tested by Kaplinsky and Morris (2008). Similar doubts in the context of foreign-direct-investment-led growth strategy were raised by Kozul-Wright and Rowthorn (1998). A wide literature review of the fallacy of composition analysis in the context of international trade was provided by Mayer (2002).

The fallacy of composition was also identified in the context of many other research areas, including the ones presented below. Holcombe (2017) considers the fallacy of composition one of the explanations of malinvestment. He states that the interpretation of price signals from the market which is proper for a single investor, may be not right for a whole economy. A research approach similar to ours was presented by Chun, Kim and Morck (2016), but in the context of company productivity growth and stock returns. They

constructed two regression models for the USA, explaining this relation on a company- and aggregate-level. Their results show that company-level stock returns are generally positively associated with a company's own productivity growth, but generally negatively associated with aggregate productivity growth. The fallacy of composition has been also empirically identified in the music industry, where the correlation between file sharing and album sales was evaluated using OLS and panel fixed-effects regression. The finding that file sharing is not harmful to individual artists was not consistent with the well-documented fact that file sharing is harmful to the music industry as a whole [Hammond 2014]. In the context of economics of consumption, da Graça and Masson (2013) identify an "ignorance is bliss" effect which refers to the quality of consumer information. For any individual, providing information can be beneficial, as they would be more likely to make the right purchase decision. Providing better information to all individuals, though, would alter the demand structure and the equilibrium price may rise endogenously. Through this mechanism, truthful information can reduce consumer surpluses.

Finally, the fallacy of composition is also present in the context of agriculture. Grzelak (2015) lists the following premises of this issue in agricultural sector:

- the costs of environmental degradation resulting from excessive fertiliser use, livestock density, and monocultures are not included in the (micro) economic calculation conducted by a single farm. However, the burden of those costs is carried by society, so an economic balance estimated on the micro and macro levels will differ greatly. This aspect is a part of a larger issue concerning the problem of externalities and public goods in agriculture;
- from the macro perspective, the existence of some small farms might be highly unfavourable. By staying out of the market, they create serious costs since the resources they use (land and labour) are not used in an efficient way. Furthermore, those production factors are characterised by low mobility and "equilibrium in poverty", in which this kind of farm remains, which may be optimal from their individual, micro perspective;
- in the specific conditions of economic transformation from a planned to market economy, the ability of the farm sector to absorb the negative social effects of this process may lead to an interpretation opposite to the one stated above. At the micro level, farms may be perceived as inefficient, because of excess employment, but in the macroeconomic perspective their assessment can be positive, due to their ability to create jobs and limit state social expenditure;

- in the context of global market liberalisation, which is believed to have a positive impact on social welfare (on the macro scale), some negative impacts can appear on the micro level of farms. An open market, which usually brings lower prices of food products, is definitely not beneficial for local food producers.

Some features of the fallacy of composition can be found in the concept of the market treadmill. In the original theory by Cochrane, farmers, in spite of their constant adoption of new technologies, lose any profits which might result from this adoption. "Early adopters" make profits for a short while, because of their lower unit production costs. As more farmers adopt the technology, however, production goes up, prices go down, and profits are no longer possible even with the lower production costs. Average farmers are nonetheless forced by lower product prices to adopt the technology and lower their production costs if they are to survive at all.

The "laggard" farmers who do not adopt new technologies are lost in the price squeeze and leave room for their more successful neighbours to expand [Levins and Cochrane 1996]; [Czyżewski 2017]. We can also see the fallacy of composition in this mechanism. Technological improvement which is profitable for single farms, in the macroeconomic scale of the whole sector brings no change or even worsens the situation of farmers, who now have to invest just to survive.

Another facet of the fallacy of composition can be identified in the analysis of the Common Agricultural Policy and its social impact [Czyżewski, Stępień 2010]. We can distinguish four main types of this fallacy:

- income vs. public-goods-provisioning function of direct payments – direct payments are perceived by farmers (on microeconomic level) mostly as additional income, while society (on macroeconomic level) consider them as a payment for public goods provisioning;
- income vs. public-goods-provisioning function of rural development funds – from the farmers' point of view the most favourable situation is spending the whole CAP budget on direct support, while it is in the interest of society to maximise rural development funds, which are more directly connected with public goods provisioning;
- social and environmental role of modulation vs. interests of the largest farms – modulation, which means limiting support for the largest farms, is driven purely by macroeconomic goals of increasing general efficiency of support, while the microeconomic perspective of large farms is to keep financing on the same level;
- social vs. farm perspective on market intervention – measures of market intervention under CAP cause food prices in the EU to be higher than the world average, which

is unfavourable from the societal point of view, while it creates higher profits for the farmers.

Therefore, to our best knowledge, the fallacy of composition has not so far been analysed empirically in the context of agriculture, although problem was described in theory. Our research aims to fill this research gap. In our research strategy we will compare determinants of agricultural income identified on farm and sectoral level. Similar research tasks have been undertaken, but not simultaneously. There is some farm level analysis of income determinants, but they simply identify the determinants, without comparing results on different levels. On the sectoral level, labour profitability is more often analysed as a part of total factor productivity [Giannakis and Bruggeman 2014]; [Bojnec et al. 2014]. That's why, to find a set of income determinants, we follow the microeconomic perspective.

Determinants of agricultural income – literature review

Studies on agricultural income are hampered by the fact that the set of potential variables influencing them is very broad. Some of these variables are indirect and others direct, resulting from the income statement itself. Therefore, research on income determinants requires a specific research perspective[2]. The approaches listed below are not entirely separable, but identifying their characteristics contributes to a better understanding of the complexity of agricultural income issues.

The first possible view on income studies in agriculture is the macroeconomic perspective [Czyżewski B. 2017]; [Boehlje et al. 2012]; [Baek and Koo 2009]; [Baek and Koo 2010]. In this type of research, econometric models are constructed where independent variables include such factors as: price gap (the relation between prices of products sold by farmers and the prices of means of production), exchange rates, interest rates (as a result of monetary policy), GDP level or other indicators of the economic situation.

Price relations are a key variable from the perspective of macroeconomics and the importance of their relationship with agricultural income has been confirmed in many other empirical studies [Czyżewski and Majchrzak 2015]; [Beckmann and Schimmelpfennig 2015]; [Liefert and William 2005]. The impact of exchange rates and interest rates on agricultural income levels is not entirely clear and depends, among others, on the research perspective adopted, e.g. a long vs. short research period [Beckmann and Schimmelpfennig 2015]; [Ivanova

[2] There is a rich body of literature on the relationship between agricultural income and natural conditions (cf. Reidsma 2009); (Deryugina and Hsiang 2104); (Burke and Emerick 2016) and issues related to culture and education (cf. Panda 2015). In this paper, we are confined to economic problems and agricultural policy. Other factors are not the focus of analysis.

et al. 2003]; [Orden1986]; [Czyżewski B. 2017]. For example, an increase in the exchange rate results in a decrease in exports. The decline in the level of agricultural products sold abroad translates into a fall in domestic prices, which over time makes exports more attractive again. The increase in exports contributes to an improving income situation of farmers. Moreover, the effect of an increase in relative foreign prices linked to the appreciation of the domestic currency is not stable, as foreign countries gradually become accustomed to the new price levels.

The link between agricultural income and the general economic situation is also unclear. Some researchers [Gradzewicz et al. 2010]; [Da-Rocha Restuccia 2006] describe agriculture as an anti-cyclical sector. Basic economic variables characterising a given sector (such as the level of production and employment) are subject to greater fluctuations in agriculture than in other branches of the economy, and at the same time are negatively correlated with values for the economy as a whole.

The second line of research on agricultural income could be described as a technical approach. The starting point for this type of research is that an increase in agricultural income requires an improvement in productivity levels, whereas prices determine the profitability of production only in the short term. If we assume that output prices do not rise, the increase in input prices must be compensated by productivity improvements [Rembisz 2010]. Productivity (in the sense of TFP) is of a residual nature, i.e. it results from the difference between the production growth rate and the weighted factor growth rates of factor inputs [Bezat-Jastrzębowska and Rembisz 2015]. In the agriculture of developed countries, there is a decrease in the use of the labour factor in relation to the capital factor.[3] An increase in agricultural income (in particular income per unit of work) therefore requires an increase in the productivity of this factor. This can be expressed as the product of the productivity of the land and land to labour ratio (Y/L×L/W) or the product of the productivity of capital and capital to labour ratio (Y/K×K/W) [Sielska et al. 2015]. Empirical research has identified the improvement of capital to labour ratio as a key determinant of this factor's productivity growth [Gołaś 2010].

The third possible research perspective on agricultural income is referred to as an endogenous (microeconomic) approach, which is particularly applicable to the case of individual farms. In this context, in accordance with the principles of perfect competition, it is assumed that a farmer alone is not able to shape prices on the market, hence price relationships are treated as given data and are not analysed separately. In addition, it is accepted

[3] In some European countries, the process has been halted or even reversed in recent years as a result of a shift towards sustainable agriculture, which is characterised, among other things, by higher labour intensity and a relatively lower level of capital utilisation.

that changes in resource ratios and factor productivity are slow and are not entirely influenced by a farmer in either the short or medium term. They are partly conditioned by historical and natural factors. For example, the reduction of employment in agriculture at unchanged production levels (resulting in the improvement of labour productivity) is a process observed at the macro level, but in the short term it is difficult to carry out at the micro level and depends on the availability of jobs outside agriculture [Rembisz 2013]. In this research perspective, the emphasis is placed on the practices of a single entity which may result in an increase in agricultural income in a certain macroeconomic, institutional, natural and cultural environment.

Firstly, a farmer can choose the type of production. He or she is partially limited by climatic conditions, however, observations made in the long term should translate into more rational actions, i.e. taking up such types of production which are characterised by a higher degree of profitability. Profitability observation must be of a long-term nature, otherwise the phenomenon known as the cobweb theory may occur [Kaldor 1934]. This is based on the fact that farmers in a given year undertake such production types which turned out to be particularly profitable in the previous period. If many farmers follow this pattern, prices will fall and profitability will decrease. In this paper, we do not analyse the profitability of specific production directions, but rather test the hypothesis that a moderately high level of specialisation is a determinant of an increase in agricultural income [Ziętara 2014].

Investment decisions are also made at farm level. However, it should be mentioned that they are not completely autonomous, as they may also be conditioned by the current economic situation, or the availability of investment support under agricultural policy. Investments exceeding depreciation rates result in extended reproduction [Grzelak 2014] and contribute to the increase of farm assets and thus to an increase in the capital to labour ratio. At the same time, they constitute a potentially endogenous variable, as they may, on the one hand, be a determinant of income and, on the other hand, an effect of income.

On the basis of available production techniques, as well as the farmer's own knowledge and abilities, he or she makes a decision on production methods, including in particular fixed and circulating capital expenditure. Mechanisation, consisting of an increased use of machinery and intensification, understood as an increase in the use of fertilisers, plant protection products etc. should result in higher yields, which, assuming price stability, translates into higher income. On the other hand, increased investment also means higher costs, which, to a certain extent, limits the effectiveness of the intensification strategy.

From the microeconomic perspective, it is assumed that it is not possible to increase revenues (production) and reduce costs at the same time. It is possible to minimise costs at

a given level of production or to maximise revenues at a given level of costs. Competitive farms focus mainly on increasing production, while in terms of costs it is only possible to manage their structure. This mainly concerns the reduction of overhead costs in favour of specific costs, as well as the relationship between their own costs and external factors of production. On the one hand, the use of so-called foreign production factors is connected with the need to pay a margin to the owner of this factor, on the other hand, a farmer who rents some of his equipment does not have to bear the cost of its acquisition and maintenance.

Another aspect of a farm's functioning at the microeconomic level is the management of the financial and asset structure of the farm. The development of agricultural activity is usually linked to the need for commitments. On the one hand, funds obtained from external sources for development purposes may in the long run improve the farm income situation, and on the other hand, in the short term, interest rates are a burden. Relationships between individual assets, such as current vs fixed assets or the extent to which assets are covered by equity [Kulawik, Płonka 2014] may also play an important role. The excessive value of fixed assets may overburden the holding with fixed costs. However, due to the lack of data at sector level, we do not include financial factors in our analysis.

The common element to be analysed from all 3 income perspectives are subsidies within the agricultural policy (our focus here is on the EU's common agricultural policy). From the macroeconomic perspective, subsidies may be treated as an additional control variable which creates conditions for the development of income in the agricultural sector. Similarly to other variables, subsidies are external in the sense that decisions on the allocation of funds for agricultural support and the level of subsidies are made in the course of political decisions. Farmers only have an indirect influence on them, through voting in elections and lobbying. In the technical approach, subsidies can potentially have two roles. First of all, they may influence the pace of changes in resource relations. For example, investment subsidies may stimulate the pace of improvement of capital labour ratio, whereas direct payments may reduce the rate of concentration, as the existence of this system limits the willingness of the owners of smaller farms to sell land to bigger entities. Theoretically, the agricultural payments system may also constitute a substitute for pro-efficiency-oriented changes. An increase in agricultural income can be achieved by increasing the level of payments without an effort to improve productivity. From an endogenous point of view, it should be assumed that a single holding has no impact on the level of payments available in the country concerned. However, it is possible to manage the payment structure and to apply for subsidies which are dependent on the fulfilment of specific criteria. For example, the owner of a farm maximising income should

analyse whether it is economically justified to apply for agri-environment payments. To this end, he or she should carry out an account of the benefits (additional subsidies) and losses (additional costs, output reduction) associated with entering the scheme.

Data and methods

The data sources for this empirical analysis were two open-access databases: FADN (Farm Accountancy Data Network) and Eurostat (Economic Accounts for Agriculture – EAA) plus FAO Stat for agricultural utilised agricultural area data. Both databases provide information on, among others, agricultural income, but there are significant differences between them. The most important difference concerns their scope. The EAA covers the entire agricultural sector of a country or a region. On the other hand, the data in the FADN database refer to an average representative farm in a given country. However, representativeness does not apply to the entire population of the holding, but only to 'commercial' units. The objective of FADN is to cover 90% of a country's standard agricultural production. Due to the varied agrarian structure and uneven distribution of production among farms, FADN's field of observation covers from 16% of farms in Slovakia to 78% in Belgium. Unlike the EAA, the FADN database offers many more variables determining the economic and financial situation of farms. Its drawbacks include a longer delay in publishing data, as well as the impossibility to retrieve data in national currencies and at fixed or real prices, which is possible with the use of the EAA. In both databases agricultural income is understood by several different indicators (see *Manual... 2000* and *Standard Results Indicators* for the details of income calculation). The most basic income categories, similar to the so-called disposable income, is entrepreneurial income in the EAA database and net income in the FADN database. In this study we use these income categories increased by the compensation of employees. In this way, we achieve a total compensation of labour factor.

The timescale of this research covers the 2005-2015 period, while the spatial scope covers 23 EU countries (all EU countries apart from Romania, Bulgaria, Croatia, Malta and Cyprus). Table 1 gives an accurate description of the explained and explanatory variables used, while Table 2 contains descriptive statistics. A number of potential variables were initially selected to characterise the areas of activity of a holding. Ultimately, the models included those variables with the best statistical and factual values. In order to maintain comparability over time, raw data from the FADN database were deflated with the appropriate deflators from Eurostat (nominal prices indices) and converted at a fixed exchange rate (2004 or, for countries which joined the euro zone during the reference period, the rate of one year's entry into the

euro zone). This eliminates income changes linked to price volatility and exchange rate fluctuations[4].

Tab. 1. Specification of variables used

Variable	*Economic Accounts for Agriculture*	*Farm Accountancy Data Network*
Agr_Inc (1)	Entrepreneurial income + compensation of employees in real prices in mln of euro	Farm net income + wages paid in real prices (GDP implicit deflator is used) in euro
Intens_level (1)	Energy and lubricants + fertilisers and soil improvements + plant protection products in constant prices per ha of total agricultural area in thousands of euro	Fertilisers + Crop protection + Energy in constant prices per ha of total utilised agricultural area in thousands of euro
Intens_level (2)	Total intermediate consumption in constant prices per ha of total agricultural area in thousands of euro	Total intermediate consumption in constant prices per ha of total utilised agricultural area in thousands of euro
Intens_level (3)	Fixed capital consumption in constant prices per ha of total agricultural area in thousands of euro	Depreciation in constant prices per ha of total agricultural utilised area in thousands of euro
Intens_level (4) (%)	The share of intensification (1) in total intermediate consumption	The share of intensification (1) in total intermediate consumption
Reprod_ratio	The ratio of gross fixed capital formation to fixed capital consumption	The ratio of gross investements to depreciation
Special_ratio	The share of main type of production in total output of agricultural 'industry' (values of production were in constant prices)	The share of main type of production in total output (values of production were in constant prices)
Concentr_ratio	The ratio of total agricultural area to total labour input (AWU)	The ratio of total utilised agricultural area to total labour input (AWU)
Subsid_ha	Subsidies on production in real prices per ha of total agricultural area in thousands of euro	Balance of subsidies and taxes (current and on investments) in real prices per ha of total utilised agricultural area in thousands of euro
Subsid_rate (1) (%)	The share of subsidies on production (real prices) in output of agricultural industry (constant prices)	The share of balance of subsidies and taxes (current and on investments) in real prices in total ouput (constant prices)
Subsid_rate (2) (%)	The share of subsidies on production (real prices) in Agr_Inc (1) (real prices)	The share of balance of subsidies and taxes (current and on investments) in real prices in Agr_Inc (1)(real prices)
Price_gap	The ratio of nominal price index of output of agricultural 'industry' and nominal price index of total intermediate consumption	The ratio of nominal price index of output of agricultural 'industry' and nominal price index of total intermediate consumption

Source: Own elaboration based on Eurostat and FADN.

The starting point for empirical analysis of the occurrence of the fallacy of composition on the example of agricultural income is the endogenous perspective. We analysed the

[4] It is worth noting that the values in real prices differ from values in constant prices by the adopted deflator. Fixed prices may be used for material variables (e.g. agricultural output). In the case of variables of a purely monetary nature (e.g. subsidies) this is not possible, so these figures are deflated using either a GDP deflator or inflation rates.

relationship between farm income and the independent variables which are its potential determinants (levels of intensification, concentration, specialisation and investment in terms of reproduction rates) at the level of a single average farm in the light of FADN data (see data and methods for details). The level of subsidisation and the price gap was a control variable. We did not include all the possible independent variables based on the literature review but only those which have potential equivalents in the EAA database. In the next step, we analysed the same interdependencies on the basis of data for the whole sector using data from the Economic Accounts for Agriculture. We looked for an answer as to whether potential strategies of increasing farm income at the level of an individual farm are appropriate for the whole sector as well. Another possible hypothesis could be that some of these strategies, such as intensification, at sectoral level, could reveal not only environmental limitations but also economic ones.

We ran panel models with fixed effects on FADN and Eurostat data separately. The dependent variable was agricultural income in real prices. From a farmer's point of view, the aim is to make the highest disposable income possible, the final value of which depends on changes in prices of production and means of production. This can be used as a reason in favour of using real income, i.e. nominal income adjusted for GDP deflator (or inflation rate).

Ultimately, the model of interdependence takes the following form:

$$lnAgr\_Inc_{it} = \beta_0 + \beta_1 Intens\_level(2)_{it} + \beta_2 Reprod\_ratio_{it} + \beta_3 Special\_Ratio^2{}_{it} + \rho X_{it} + \alpha_i + \varepsilon_{it}$$

where:

- lnAgr_Inc_{it} denotes the logarithm of the level of agricultural income of a country or single farm;
- X_{it} is a set of control variables (logarithm of the level of land concentration, subsidies rate (2) and price gap);
- α_i is the country fixed effect;

All the models were estimated using Panel Corrected Standard Errors [Beck and Katz 1995], as the problem of cross-sectional dependence and heteroscedasticity were identified. At the same time, the resistance of some models was also tested using equations on first differences to control for autocorrelation of residues[5]. The model with fixed effects was selected on the basis of merit criteria (agricultural income is also influenced by country-specific factors such as climate), but it was also confirmed by the Hausman test.

[5] We do not present these specifications for clarity and brevity reasons.

Results and discussion

In table 1 is a descriptive statistics for the variables used (data on agricultural income are provided per working unit in order to maintain greater comparability). The agricultural income per unit of labour (AWU) in the whole panel surveyed was higher in the FADN sample (15,600 euro/AWU vs. 13,800 euro/AWU), due to the fact that the FADN field of observation does not include the smallest farms with generally low income. The level of volatility of quoted income in both databases can be described as comparable. As regards the level of intensification measured in terms of per hectare expenditure, it is very similar in both databases, although slightly higher in the EAA database. In the case of this database, there is also a larger variation in the level of intensification, which is evidenced by higher values of standard deviation from average values. The average reproduction rate in both databases was higher than 1, which means that the level of investment exceeded the depreciation value and extended reproduction was observed. The degree of specialisation of production, understood as the share of the main direction of production in total output, was higher in the case of FADN farms and amounted to 31.2% as compared to 28.6%. Larger farms are most likely to be characterised by a higher degree of specialisation. The farms included in the FADN observations also had a larger area on average: almost 32 ha, compared to 25.7 ha of all farms. The average share of subsidies in production and income is significantly higher for FADN farms, which may be due to the increased use of additional payments (e.g. investment) by FADN farms. The price gap ratio by nature is volatile, but on average it was negative for agricultural producers over the period, considered on the scale of 23 countries.

Table 2. Descriptive statistics of the variables used (*in thousand of euro*)

Variable:	*Economic Accounts for Agriculture*				*Farm Accountacy Data Network*			
	Mean	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**
Agr_Inc (1)/AWU	13,800	8,990	-11,930	37,620	15,620	9,512	-9,756	48,402
Intens_level (1)	0.256	0.215	1.234	0.071	0.247	0.173	1.046	0.084
Intens_level (2)	1.294	1.412	7.512	0.251	1.185	1.153	6.636	0.270
Intens_level (3)	0.330	0.324	1.767	0.034	0.296	0.246	1.311	0.047
Intens_level (4) (%)	23.5	7.4	42.8	10.5	24.3	6.7	44.1	9.4
Reprod_ratio	1.253	0.595	0.382	4.688	1.282	0.613	-0.482	3.659
Special_ratio	28.6	6.7	14.3	48.1	31.2	11.9	14.0	66.0
Concentr_ratio	25.66	13.56	5.46	61.54	31.89	18.03	5.50	78.33
Subsid_ha	0.273	0.159	0.011	0.763	0.354	0.182	0.092	0.902

Variable:	*Economic Accounts for Agriculture*				*Farm Accountacy Data Network*			
	Mean	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**
Subsid_rate (1) (%)	16.4	8.9	1.7	44.3	23.6	12.4	1.9	70.8
Subsid_rate (2) (%)	52.4	29.4	7.2	160.5	77.2	59.4	9.2	701.0
Price_gap	0.948	0.105	0.676	1.253				

Source: Own elaboration based on Eurostat and FADN.

Initially, interdependencies were estimated using FADN data (Table 3). In the first step (specification 1) three variables which can stimulate the level of agricultural income in the light of the endogenous perspective were introduced into the model. Both the intensification as an input of intermediate consumption in constant prices per hectare of utilised agricultural land and the reproductive rate had a positive impact on agricultural income at farm level which is in line with expectations and other studies. Poczta, Średzińska and Mrówczyńska-Kamińska (2009) demonstrate that an increase in current capital expenditures was a statistically significant and positive determinant of agricultural income in all types of farms they studied. The previous results indicated that agricultural income is a significant determinant of investment processes on a farm [Czekaj 2011]; [Kusz, Gędek, Ruda 2013]. The present results show that there may also be an inverse relationship – a high reproductive rate translates into a high income.

The values of the 'specialisation rate' variable were squared, assuming that agricultural income initially increases with an increase in specialisation, while if a certain level is exceeded, income may decrease as a result of increased risk [Ziętara 2014]. The impact of this variable proved to be significant only if standard errors were not taken into account, or in the models with control variables. What is more, it turned out that from the micro perspective a more rational strategy is either a very high level of specialisation or a balance between different types of production.

The concentration ratio variable was included in the next step (2). According to the theory, in the conditions of inelastic demand for food, concentration, understood as an increase in the land to labour ratio, is one of the keys to increasing productivity and, therefore, the compensation of labour factor. However, the statistically significant impact of this variable on agricultural income cannot be confirmed in a model with robust errors. Then the robustness of the identified relationships was tested by including in the models subsidies rate (3), price gap (5) and both of these variables (4). The introduction of these variables (particularly price gap) improved the R-squared significantly, which indicates an important role of these variables in income formation. This is in line with the statement that a faster increase in prices of products

sold by farmers than in input prices should lead to a linear increase in agricultural income [Liefert and William 2005], or Czyżewski and Majchrzak's research (2015) in which they pointed out that a price gap is a key determinant of income in a function in which they also included productivity and subsidies. Most importantly, however, despite the effect of agricultural subsidisation and price volatility, two of the identified agricultural income growth strategies remain relevant, and the related marginal effects can be assessed as similar to the specification (1). Thus, it can be concluded that the impact of intensification and reproductive rates on agricultural income is statistically significant and the relationship is robust. As the level of concentration increased, agricultural income increased, while in the case of specialisation, agricultural income initially increased with its growth, but then decreased. At the same time, the impact of concentration and specialisation should be interpreted with caution, as it was not statistically significant in specifications which did not take account of the control variables (at least by using corrected standard errors).

Table 3. The impact of selected determinants on agricultural income – single farm

Variable:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Const	9.34*** (0.16)	8.54*** (0.74)	8.62*** (0.79)	6.44*** (0.73)	6.34*** (0.74)
Intens_level (2)	0.00044*** (0.00009)	0.00042*** (0.00009)	0.00041 (0.00009)	0.00032*** (0.00009)	0.00033*** (0.00009)
Reprod_ratio	0.120*** (0.034)	0.136*** (0.038)	0.137*** (0.038)	0.147*** (0.033)	0.145*** (0.034)
Sq_Special_ rate	1.33 (0.85)	1.245 (0.869)	1.194 (0.811)	1.349* (0.759)	1.417* (0.801)
ln_Concentr_ratio		0.246 (0.221)	0.240 (0.222)	0.649*** (0.189)	0.653*** (0.192)
Subsid_rate(1)	No	No	Yes	Yes	No
Price_gap	No	No	No	Yes	Yes
Within R^2	0.13	0.14	0.15	0.23	0.22
LSDV R^2	0.94	0.94	0.94	0.94	0.94
Akaike criterion	-47,3	-49.4	-47.9	-70.2	-71.1
Observations	250	250	250	250	250

Note: standard errors in parenthesis. *, **, and *** denote 10%, 5%, and 1% significance levels, respectively.
Source: Own calculations based on Eurostat and FADN.

The second part estimates agricultural income models for the whole sector on the basis of Eurostat data (Table 4). The equivalents of variables contained in the FADN database were used (see Table 1). As the first step, a model was estimated which assessed the impact of three

potential farm income stimulants at a farm level, to check whether these variables also shape income in terms of the whole agricultural sector. The only statistically significant variable proved to be the reproduction rate, but its marginal impact on agricultural income was lower than in the case of a single farm model. It suggests that modernisation embodied in the form of investments exceeding the consumption of fixed assets creates conditions for an increase in agricultural income not only at a farm level, but also at the level of the whole sector. However, this strategy is especially important from the single entity's point of view. At the same time, the effect of intensification proved to be statistically insignificant, and the whole model exhibits worse statistical properties. The inclusion of the level of concentration (2) and subsidy rates (3) in the variable model does not alter the previous conclusions. Still, intensification has no significant impact on income, and the reproductive rate is characterised by a relatively high resistance.

Table 4. The impact of selected determinants on agricultural income – agricultural sector

Variable:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Const	7.45*** (0.15)	7.36*** (0.40)	7.48*** (0.50)	5.65*** (0.40)	5.51*** (0.39)
Intens_level (2)	0.067 (0.082)	0.065 (0.081)	0.067 (0.077)	-0.06 (0.069)	-0.053 (0.068)
Reprod_ratio	0.090** (0.034)	0.093*** (0.037)	0.088** (0.038)	0.066** (0.04)	0.082*** (0.028)
Sq_Special_ rate	-1.32 (1.53)	-1.23 (1.37)	-1.087 (1.35)	-2.32* (1.215)	-2.58** (1.163)
ln_Concentr_ratio		0.023 (0.105)	-0.035 (0.140)	0.22*** (0.096)	0.350*** (0.091)
Subsid_rate(1)	No	No	Yes	Yes	No
Price_gap	No	No	No	Yes	Yes
Within R^2	0.04	0.04	0.04	0.27	0.24
LSDV R^2	0.98	0.99	0.98	0.99	0.99
Akaike criterion	-144.3	-142.3	-141.6	-70.2	-200.0
Observations	251	251	251	250	251

Note: standard errors in parenthesis. *, **, and *** denote 10%, 5%, and 1% significance levels, respectively.
Source: Own calculations based on Eurostat and FADN.

Specifications 4 and 5 also introduced price gap into the analysis, which is an important determinant of agricultural income, especially from a sector-wide perspective. The inclusion of this variable clearly improved the informative properties of the model (especially specification 5) and the variable itself proved to be statistically significant. Combining the lack of statistical

significance of intensification with the significant role of price scissors, it can be assumed that King's effect still exists in European agriculture. In practice, the price mechanism usually depreciates farmers, which is related to relatively inelastic demand for agricultural products. Increasing production as a result of intensification usually leads to a greater fall in prices. The fall in prices is not matched by a corresponding increase in demand, with negative consequences for agricultural incomes [Tweeten and Zulauf 2008].

On the basis of specification 5, a significant impact of reproductive rates on income levels can be confirmed. There is also a strong and positive influence of concentration and a significant influence of specialisation. Regarding the latter, in contrast to the models for the individual FADN farm, the relationship is here different, that is to say a higher income level results from a moderate level of specialisation. Such results are in line with Ziętara (2014) and Purdy et al. (1997) who claim that, compared to diversification, specialisation is at the same time a strategy with a higher level of risk. Once more, given the lack of relevance of this variable in some other specifications, its interpretation should be treated with caution.

It is also worth noting that in all the specifications LSDV R-squared is much higher than *within*, which indicates a very significant impact of individual, country specific and time-invariant conditions on the level of agricultural income.

Conclusions

In this paper, we examine the occurrence of the phenomenon of the fallacy of composition on the example of incomes in European agriculture. We develop panel regression models for the whole sector and for a single representative farm. We use an inductive approach in this context. This is because we are introducing into the models further potential determinants of agricultural income from an endogenous perspective, in order to assess whether the impact of these variables is the same also in the case of the whole sector.

On the basis of the analyses presented in the article, it can be stated that the fallacy of composition in European agriculture manifests itself primarily through different practices at microeconomic and sectoral agricultural income levels. First of all, this concerns intensification expressed in the level of intermediate inputs. From the perspective of an individual farm, an intensification strategy proved to be effective, despite a higher dynamics of input prices than agricultural output prices.

In the sector as a whole, intensification growth has insignificant impact on income. The role of potential growth channels for agricultural income, such as concentration, manifested by an increase in the land to labour ratio, or specialisation, understood as a limitation of production diversification in favour of concentration on the dominant direction, is not entirely

clear. Our models do not indicate a positive impact of concentration (both at farm and sector level). In the case of specialisation, the issue is more complex. From the sectoral point of view, moderate specialisation may be optimal; whereas in the micro perspective, either a high or low level of specialisation is more beneficial. Our research has also shown that when it comes to modernisation, understood in terms of investments in relation to the consumption of assets, there is no contradiction between the objectives of an individual farm and the whole sector. However, it is relatively more important for the single farm. Price relations also remain an important determinant of agricultural income, especially at sectoral level. However, individual farmers do not have a direct influence on the development of these relationships, so they have to look for ways to increase their incomes in an unstable environment.

Our results show that agricultural policy mechanisms that support investment and modernisation processes should be supported and developed in agriculture. It is also important to support dualism, based on the existence of small, multidirectional farms and large specialised farms, as a moderate level of specialisation is optimal from the perspective of the entire sector. The existence of a direct payment system makes it possible to increase the intermediate consumption level, which is beneficial from the point of view of the farm. On the other hand, one should remember that an excessive increase in inputs may have adverse effects on the environment. Furthermore, the high level of dependence of income on price mechanism is an incentive to develop risk mitigation policies, as well as support for vertical and horizontal integration. Providing an appropriate methodology and empirical verification of the occurrence of the fallacy of composition in agriculture, which would take into account not only income, but also the issues of public goods and externalities, may be a fruitful line for future research.

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