

Determinants of income of agricultural holdings in EU countries

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Abstract: The main aim of the study is to recognise the determinants affecting agricultural income in the EU countries. The time scope in the analysis refers to the period 2004-2013. The spatial range of the research concerns agricultural holdings from EU countries (25). The evaluation has been made using the aggregated results within the agricultural accounting system of the EU's FADN (Farm Accountancy Data Network). Comparative studied phenomena and panel regression models were used. Among the most important factors for the formation of the agricultural income, are the scale of production, subsidies under the common agricultural policy and the indicators reflecting the importance of the business outlook and price fluctuations.

Keywords: income of agricultural holdings, the common agricultural policy, subsidies

JEL: Q12, Q18

Introduction

Incomes of agricultural holdings are among the most important economic categories in agriculture because they reflect the development potential of this sector. However, it is known that the agricultural sector in the EU is developing in highly diverse circumstances. This concerns climatic and environmental factors, as well as the differences stemming from the quantity and relations between production factors (labour, land, capital). Secondly, agriculture in EU countries is one of the sectors covered by a high level of support, which in practice is carried out by the instruments of the Common Agricultural Policy (CAP). Thanks to the mechanism of agricultural policy, it was possible in some highly-developed countries to solve the problem of agricultural vs. non-agricultural income parity, and incomes in this first sector were sometimes even higher [Czyżewski and Kułyk, 2010]. However, in a number of the so-called new EU member states, agricultural incomes are still significantly lower in comparison to earnings from different sources [Baer-Nawrocka, 2013].

It can be stated that agriculture is increasingly dependent on external factors, that the head of a farm has no influence over. This results in the increasing integration of the world's food markets [Rembeza and Seremak-Bulge, 2009], and in the case of EU countries, in the increasing importance of a strong institutional factor (CAP). Moreover, in recent years we had to deal with the biggest EU enlargement (in 2004), when accession led to 10 new member states, and also with unprecedented fluctuations in agricultural prices and the global economic crisis that started in 2008. On the other hand, there is a need to search for the paths of agricultural income growths on the micro level. Therefore, the question may appear of the importance of factors influencing agricultural income in EU countries. Hence, the main aim of the study is to recognise the determinants affecting agricultural income in EU countries using different perspectives.

There are many studies concerning agricultural income in the literature. The Polish studies are dominated by research related to dynamics, level, creation and division and income diversification [Zegar, 2006; Woś, 2000; Czyżewski, 1986; Floriańczyk, 2003] or to links between incomes and CAP [Idczak 2001]. In the case of foreign studies, research related to the impact of direct payments on income are widely represented [Severini and Tantari, 2013, Agrosynergie, 2011]. These are recommended for their stabilising and liquid function. Interesting research, from the perspective of this issue, was included in the paper of Beckman and Schimmelpfening (2015). It indicates that in agricultural holdings in the USA, incomes are determined by variables such as GDP, technological changes, exchange rates, prices of products sold and purchased by farmers, interest rates, and prices of agricultural land. At the same time, the last three have a negative impact. The issue of determinants of agricultural holdings income is important in the context of the anticipated changes in CAP in the EU after 2020, further liberalisation of trade in agri-food in the WTO, as well as the impact of various factors.

Methodology of the research

The evaluation of the determinants of incomes of agricultural holdings in EU countries has been made using the aggregated results within the agricultural accounting system of the EU's FADN (Farm Accountancy Data Network). In the field of observation of this system there are market farms which, in a given region or country, produce at least 90% of the standard value of production. The timescale in the analysis refers to the period 2004-2013, which results from the availability of data. The spatial range of the research concerns agricultural holdings from EU countries (25), and so those countries that have belonged to this group since at least 2004. The study sample was divided according to the so-called "old" EU countries (15) and "new" EU members (10). On the one hand, in the EU15 the common agricultural policy mechanisms

have been working for longer. On the other hand, the resource relations and the productivity of production factors in both groups of countries vary considerably. This results in serious differences in the environment for the economic development of the sector.

To begin with, we start with a comparative study of the phenomena. Then we run a panel analysis in two steps. First we model agricultural income (net value added per hectare in FADN as a dependent variable¹) in nominal terms. As explanatory variables, we consider total output (as a proxy for the intensification of production), total workforce in AWU² (use of labour factor), total subsidies (institutional factor), gross investments from the previous period and Economic Sentiment Indicator³ as a proxy for the business outlook factor. In the second step, we recalculate the models in real terms. To do this, we used the following procedure:

1. We deflated the raw data from FADN using the appropriate index of prices for each country and period taken from the Economics Accounts for Agriculture, Eurostat. For total output, we used the *agricultural output* price index, for intermediate consumption we used the *intermediate consumption* price index. For current subsidies and balance of current subsidies and taxes we used the *intermediate consumption* price index. We assume here that current payments within CAP (mostly decoupled) are spent on the means of production. For depreciation and subsidies on investments, we used the *fixed capital consumption* price index as gross fixed capital formation price indexes were not available for the whole group of countries.
2. We computed the variables we need again. Net value added is calculated as: total output – total intermediate consumption + balance of current subsidies and taxes – depreciation. Total subsidies are the sum of current subsidies and subsidies on investments.
3. Data in FADN is expressed in Euros using different exchange rates for each year for countries with currencies other than the Euro. We recalculate all the data using a fixed exchange rate from 2004. The exception is Slovakia, which joined the Euro zone in 2009, so we use the exchange rate for this year.

¹ As we include in the model the total resources of the labour factor, as well as total output, it is better to use net value added than net income, which is remuneration, to the production factor that was owed to the family of a farmer. It represents the income for a farmer and his family.

² AWU (Annual Work Unit) – “corresponds to the work performed by one person who is occupied on an agricultural holding on a full-time basis. Full-time means the minimum hours required by the relevant national provisions governing contracts of employment” [Eurostat, Glossary, accessed 30.04.2017].

³ The Economic Sentiment Indicator (ESI) “is a composite indicator made up of five sectoral confidence indicators with different weights: Industrial confidence indicator, Services confidence indicator, Consumer confidence indicator, Construction confidence indicator Retail trade confidence indicator. Confidence indicators are arithmetic means of seasonally adjusted balances of answers to a selection of questions closely related to the reference variable they are supposed to track (e.g. industrial production for the industrial confidence indicator)” [Eurostat, Product Dataset, accessed 30.04.2017].

When the panel model is taken into consideration, it is possible to use a simple pooled OLS model (this means that differences between countries are not significant), a model with fixed effects (FE) or random effects (RE). The equation for the fixed model takes the form (1)

$$(1) \quad y_{it} = \beta_0 + x_{it}\beta' + \varepsilon_{it}$$

The equation for the fixed model takes the form (2)

$$(2) \quad y_{it} = x_{it}\beta' + \alpha_i + \varepsilon_{it}$$

where: β – the vector of structural parameters expressing the effect of the explanatory variable x_{it} , α_i – individual time-fixed effect, ε_{it} – net random error.

In turn, in the random effect model, we assume that the individual effect α_i is a random variable and we do not estimate its value [Kufel, 2007]. The equation is therefore as follows:

$$(3) \quad y_{it} = \gamma + x_{it}\beta' + v_i$$

Where v_i is the sum for the individual random parameter (α_i and ε_{it}). In our modelling, we choose logarithmic form, as it was the most appropriate.

In the case of rejection of the hypothesis of applicability of the OLS model (based on the Breusch-Pagan test), we computed panel models with fixed (FE) and random (RE) effects. The evaluation of which of these models (FE or RE) was more appropriate was made based on the Hausman test [Hausman and Taylor, 1981]. In each case, the multicollinearity of the variables was evaluated based on Variance Inflation Factors (VIFs). Variables not exceeding VIF=10 were retained in the model [Chatterjee and Hadi 2006].

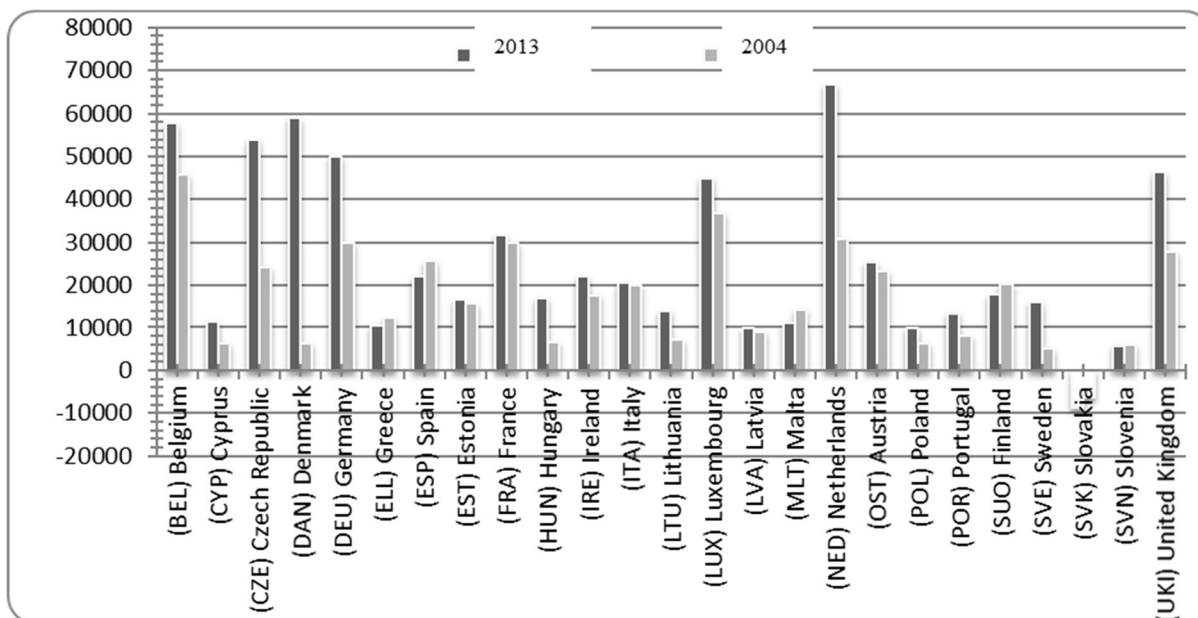
Findings

According to the accounting system of the Farm Accountancy Data Network, agricultural incomes per farm have increased between the years 2004 and 2013 in nominal terms⁴. Only in four countries has a decline been noted, while in the remaining 21, incomes have increased (fig.1). The average increase amounted to 79%. This resulted mainly from an increase in the scale of production and prices of agricultural products (fig. 2). Agricultural incomes are very unstable. The research indicates [Hill and Bradley 2015] that in the years 2012-2014 circa 55% of large and 38% of small farms experienced income change exceeding 30% of the average income from past three years. The incomes of agricultural holdings from the new member states were growing, but in comparison to farms from the “old” member states, they remained at a lower level. This was related to the lower scale of production (the farms are

⁴ Reference to these two years result from the limits of observation for the timescale of the studies. Moreover, in these years, we were dealing with a favourable business outlook in agriculture.

usually smaller, both in terms of economic size and utilised agricultural area), technical devices and the level of subsidies.

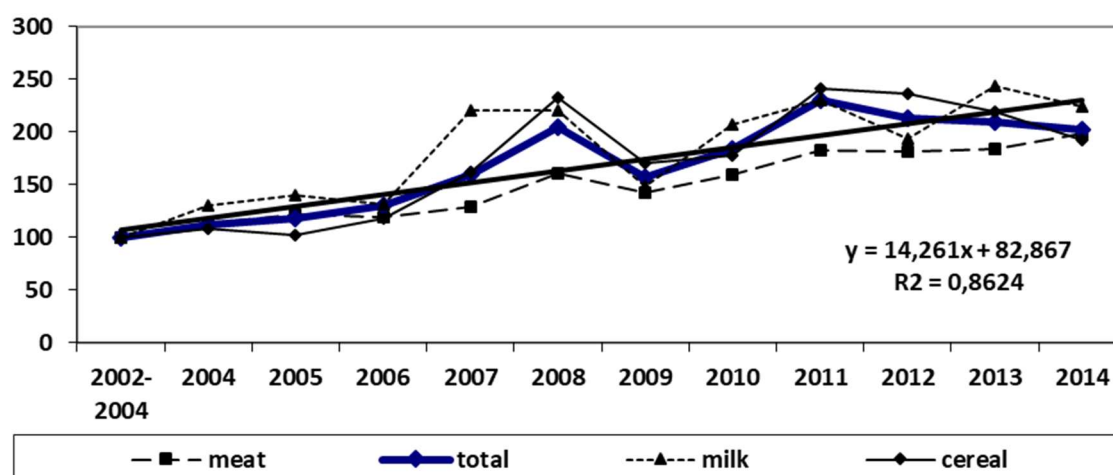
Fig. 1. Level of income (in EURO) in EU countries (25) in 2004 and 2013



Source: own calculations based on FADN database.

It is widely known that economic effects in agriculture depend on weather conditions. Combined with low elasticity of agricultural production, this leads to the greater volatility of prices than production. Thus, the sector's reactions to changes in economic conditions take place mainly via the volatility of prices of agricultural products, and this is one of the main determinants of incomes [Grzelak, 2016]. In the years 2004-2012, we were dealing with high volatility in agricultural commodity prices on food markets in the world (fig. 2). Simultaneously, cyclically repeated fluctuations around the trend line were observed. In total, during this period, we could observe an upward trend when it comes to agricultural commodity prices, especially for cereals (wheat). Up till 2008, prices of agricultural products increased. Then, when the economic crisis started in 2009, there was a rapid decline. In the period of 2009-2011, a significant growth could be observed, but in the following three years there was another decline in agricultural prices. This situation determined the general economic conditions in agriculture. Such significant fluctuations in agricultural product prices resulted from, among others, crop failures, market speculation, growing demand for food, as well as demand for plant products used for non-food purposes.

Fig. 2. The FAO index of agricultural commodity prices in the years 2004-2014



Source: based on the FAO data for the relevant years.

Price fluctuations have become one of the major risks in the agricultural sector. Risk management is now among the most important challenges facing the agricultural sector [Jerzak 2008]. It has been stated that prices of agricultural products react strongly to changes in the global business outlook, and on the other hand, the processes of change in these prices affect agricultural income⁵. This is especially true in the case of the price of wheat and oilseeds. The prices of these products react more flexibly to changes in the supply-demand relationship, which means that they can quickly make up for declines [Kavallari et al. 2011].

It is true that prices are among the most important factors shaping income levels [Czyżewski and Majchrzak 2015]. Additionally, prices influence the process of outflow of economic surplus from agriculture. However, from the microeconomic perspective, the farmer appears on the market as a price-taker. Prices are therefore an exogenous variable in farm management. A simple question arises: what are the paths of agricultural income growth under these conditions? The main aim of CAP is to maintain a fair standard of living for farmers, so the subsidies within CAP should increase incomes. It is not clear, however, what the impact of increasing output, investments and the labour factor has on income changes. To answer these questions, we constructed the models for agricultural income per hectare in nominal terms (table 1) as well as in real terms (table 2) in order to capture the effect of price and exchange rate changes (see details in methodology section).

⁵ The correlation coefficient between the price index of agricultural commodities FAO and income of agricultural holdings of the EU (25) amounted to 0.74.

The results of the panel models of agricultural income in nominal terms (logarithmic models) are presented in table 1. Beck-Katz standard errors were used to deal with both autocorrelation and heteroscedasticity where possible.

Table 1. The determinants of agricultural income (net value added per hectare, nominal terms) in EU countries (2004-2013)

Variable	EU14 ^a (Fixed effect) N=126	EU9 ^b (Fixed effect) N= 77
Constant	-1.99** (0.79)	-4.701** (1.44)
Total workforce in AWU/ha	0.497*** (0.10)	-
Total output/ha	0.976*** (0.06)	0.589** (0.17)
Total subsidies/ha	0.246** (0.08)	0.382*** (0.10)
Lag gross investment/ha	-0.115*** (0.03)	0.080 (0.06)
Economic sentiment indicator (ESI)	0.461*** (0.07)	0.873*** (0.19)
Explanatory power	Within R ² =0.73 LSDV R ² =0.98	Within R ² =0.51 LSDV R ² =0.98
Dornik-Hansen test for normality (<i>p value</i>)	0.03	0.64
Hausman test (<i>p value</i>)	0.05 ^c	0.003

***, **, * denotes 99%, 95%, 90% statistical significance, respectively.

Standard deviation values in parenthesis.

a for Ireland there was no data for economic sentiment indicator

b without Slovakia (outlier)

c Hausman's test results do not give unambiguous results. We choose the fixed effect in order to compare with the EU9 model.

Source: Own calculations based on FADN database.

The impact of the labour factor on agricultural income (both nominal and real terms) turned out to be statistically insignificant in the EU9 countries. This can be explained by the phenomenon of hidden unemployment in rural areas. Labour resources in agriculture in these countries are too large compared to needs. This results in the fact that the increasing the use of this factor does not translate into higher incomes. In the EU15 countries, increasing use of labour resulted in higher incomes, but the marginal effect is not very strong, and (when it comes to real terms) declines from 0.497 to 0.205.

Interesting conclusions are related to the influence of total output on incomes. Regressor values indicate that the marginal effect of increasing output (or land productivity, as we use production value per unit of land) is relatively strong and statistically significant, both

in nominal and real terms. This is in line with the results of other studies which pointed to a strong link between income growth and production [Baer-Nawrocka 2013, Szuba and Poczta 2013]. However, it should be noticed that in nominal terms the impact of output on incomes is substantially higher in EU15 countries, whereas in real terms this situation changes.

Table 2. Determinants of agricultural income (net value added per hectare, real terms) in EU countries (2004-2013)

Variable	EU15 (Random effect) N=133	EU9 ^b (Fixed effect) N=77
Constant	-0.518 (0.57)	-3.145* (1.30)
Total workforce in AWU/ha	0.205*** (0.048)	-
Total output/ha	0.837*** (0.051)	1.25*** (0.17)
Total subsidies/ha	0.218*** (0.054)	0.16* (0.08)
Lag gross investment/ha	-0.112*** (0.02)	-0.08* (0.04)
Explanatory power	R ² =0.76	Within R ² =0.47 LSDV R ² =0.98
Variance ^a	<i>Between</i> = 0.011 <i>Within</i> = 0.007	-
Mean theta ^a	0.75	-
Dornik-Hansen test for normality (<i>p value</i>)	0.76	0.19
Hausman test (<i>p value</i>)	0.079	0.009

***, **, * denotes 99%, 95%, 90% statistical significance, respectively.

Standard deviation values in parenthesis.

a only for random effect model

b without Slovakia (outlier)

Source: Own calculations based on FADN database.

In the EU15 countries the marginal effect of output is only slightly smaller, whereas in the EU9 it is substantially higher. This means that price mechanisms on agricultural markets in the EU9 are less favourable from the farmers' point of view. Farmers in these countries, if they want to increase their income, must increase real productivity. Farmers in the EU9 cannot expect income growth only through favourable price relationships to the extent that farmers in the EU15 can. On the other hand, the efforts to increase real productivity in the new member states bring relatively large benefits in the form of increasing real income. In other words, intensification strategy is relatively more effective in these countries [Czyżewski and Kryszak 2016].

Agricultural incomes in the EU9 are also less resistant to economic fluctuations. In nominal terms, the general economic situation (measured by ESI) was the most important factor that shaping incomes in the EU9. This may indicate that the agricultural sector in so-called new EU member states is highly unstable and is particularly sensitive to cyclical changes. As we noted before, agricultural prices are pro-cyclical. The level of horizontal and vertical integration in agriculture in the EU9 countries is low, and farmers do not have enough bargaining power, which makes this sector more dependent on the economic climate.

It is not surprising that in both groups of countries a significant impact of payments on incomes can be noticed. In real terms, its impact is slightly smaller, and the differences between EU15 and EU9 countries are not substantial (tab. 2). The interesting thing is that the investment from the previous period has a negative sign, and in EU9 countries (nominal term) it was even insignificant. As the impact was negative, so investment spending did not translate into the expected higher incomes. Perhaps the positive effects of investment will be seen in later years.

Conclusions

The income situation of agricultural holdings in the EU (25) is highly varied, and depends primarily on natural factors, changes in the scale of production, the level of support and economic environment factors, including the prices of agricultural products. The existing, expanded system of support, while stabilising income levels, doesn't eliminate significant variability. In the case of holdings from some EU countries, eg. Denmark, Ireland, Sweden, Finland or the Czech Republic, the level of subsidies was higher than incomes in most of the analysed years. Among factors that are important for the formation of the agricultural income can be listed the scale of production, subsidies under CAP and the general situation in the macroeconomic environment that affects agricultural prices. The role of gross investments and labour factor was smaller, and in some specifications even statistically insignificant. In the case of the first of those, it may be due to the relatively high capital-intensity of production and the associated costs of depreciation that consume a significant proportion of the investment. On the other hand, the minor importance of the employment factor can be identified, taking into consideration the diversification of economic activity in rural areas, which allows for the optimisation of use of this resource, depending on economic conditions. Increase in production remains the most important factor in income creation, however, this was especially noticeable in the so-called "new" EU member states. This indicates that intensification strategy may be still appropriate in these countries. In addition, when analyzing the differences between the nominal and real income approach, one can conclude that EU farms (15) benefit more (in an income sense) from the effects of rising agricultural prices. This can result from more advanced

vertical and horizontal integration processes, as well as higher levels of support of CAP instruments. On the other hand, farms in the new member states are more sensitive to business outlook fluctuations. Systems of support will be still needed, but their main goals and mechanisms should be reconsidered somewhat in order to help farmers with risk management. As differentiations in the conditions for agricultural production are often demonstrated on a regional scale, research at this level can be a fruitful line for further research.

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