Managerial Economics
2017, vol. 18, no. 1, pp. 47–62
http://dx.doi.org/10.7494/manage.2017.18.1.47

Andrzej Czyżewski*, Łukasz Kryszak*

Agricultural income and prices. The interdependence of selected phenomena in Poland compared to EU-15 member states

1. Introduction

In the 1950s and 1960s, Europe entered a period of dynamic development as well as a demographic explosion. High food demand oriented the farming policy of forming the European Economic Community (EEC) toward the increase of agricultural production in order to satisfy the growing demand and achieve food self-sufficiency. This objective was accomplished relatively quickly; therefore, farming incomes became a basic problem for a common agricultural policy (CAP); more precisely, a problem concerning the necessity to increase and stabilize incomes in order to make farming profitable. Thus, the decrease in the significance of agriculture (concerning its share in GDP creation) and, above all, the properties of land (cf. Czyżewski, 2007) and the phenomenon of the outflow of economic surplus from agriculture make farming incomes lower than in other sectors. Furthermore, the process of creating incomes does not always tie in with surplus (Woś, 2004). One should note that, in some highly-developed countries, farming incomes exceed incomes from other businesses. However, this is not caused by the internal efficiency of farming but mainly by intensive support policies. Despite the relative loss of its significance and lively debates concerning its effectiveness and validity (cf. Gąsowski, 2015), agricultural policy still constitutes approximately 40% of the EU budget. The level of farming support in the EU amounts to about 20% (as measured by the Producer Support Estimate (PSE) index), while in Japan, South Korea, and Norway (for instance), it is more than 50% (OECD 2014). However, agricultural incomes remain lower than in the non-agricultural environment in some countries; for example, in the new member states of the EU – like Poland (Baer-Nawrocka, 2013). Therefore, farmers can be considered to be in an underprivileged position.

* Poznan University of Economics and Business, Faculty of Economics, Department of Macroeconomics and Agricultural Economics, e-mails: andrzej.czyzewski@ue.poznan.pl, lukasz.kryszak@ue.poznan.pl

Yet, the concept of farming incomes may not be accurate enough. Particular characteristics must be taken into account, including; e.g., farmers seeking employment in other economy sectors and having difficulty keeping the functions of one's household separate (as a place of residence and consumption as well as an agricultural holding as a place of work and source of income). Hence, a single universal measure of farming incomes does not exist. Additionally, the subject matter is further complicated by the fact that farming incomes are influenced by a number of factors, including those connected directly with agricultural production as well as those of an external character. As Polish farming has been included in the CAP mechanisms since 2004, the revenues of agricultural holdings should be expected to improve. According to the convergence hypothesis, one can suppose that such changes in Poland should arise relatively faster than in the member states of the so-called "old EU"; that is, in the EU-15. Hence, the main objectives of the paper are as follows: (1) examination of the level of changes in various types of farming incomes, including the role of payments from the Common Agricultural Policy (CAP) in Poland as compared to the member states of the EU-15; and (2) an analysis of the relationship between price changes (as one of the factors that shapes farming incomes) and agricultural incomes in Poland after 2004. The period of research covers the years 2004 through 2013. The Farm Accountancy Data Network (FADN) is the main source of data. The first part of the paper presents information on the specific nature of the FADN database. The subsequent parts show the data on farming incomes and its relationship to prices with the use of panel regression models. In the case of data concerning incomes (which is used to compare Poland with other countries), the differences in current prices were taken into consideration. It was assumed that the price level for the EU-27 is 1; then, original data was subsequently divided by a coefficient determining the level of prices in an individual country in comparison to the EU average. For instance, that coefficient in the analyzed years was about 0.6 for Poland, while for Denmark, it was 1.35.

2. Propaedeutics of the FADN database

Much significant data on the economic situation of agricultural holdings is provided by the FADN database. It is publicly accessible and contains nearly 150 variables concerning agricultural holdings, including production, revenues, costs, subsidies, and taxes. The collected data widely presents the economic conditions of agricultural holdings. Thanks to the managerial accounting used instead of the financial approach, the data describes the results of agricultural holdings more adequately, since using financial accounting is substantially conditioned by legal regulations that vary in individual member states (IERIGŻ 2015). Furthermore,

the FADN presents data in various sections; i.e., geographical, sectorial, and structural (Goraj, 2000). Therefore, it is possible to check the net income of an average agricultural holding located in Burgundy involved in winemaking, for example. It must be emphasised that the presented data concerns an average agricultural holding and not all agricultural holdings in a given category. However, it is crucial to note the FADN scope of observation only includes economically active farms. The potential of a farm is measured by its economic size. Since 2009, the economic size of an agricultural holding is measured by the total SO coefficient (expressed in Euros). The Standard Output (SO) is the average monetary value of the agricultural output at farm-gate price of each agricultural product (crop or livestock), with some exceptions. Prior to 2009, the economic value was measured by the Standard Gross Margin (SGM). The concept of that measure was similar; however, its formula was slightly more-complicated. Nevertheless, all of the data in the FADN database since 2000 has been recalculated according to the new methodology.

The aim of the FADN research is to study at least 90% of all standard output in the EU member states' agriculture. The highly diverse farming structure of individual member states results in a different threshold of economic size required for an agricultural holding to be included into the FADN research for each country. In countries such as Belgium, France, Germany, or the Netherlands, this threshold is fi25,000. However, in countries that are characterized by a low concentration of arable land and where most of the production is provided by small and very-small farms, the threshold for being included in the research is much lower (out of necessity). This is, for instance, fi4000 for Poland, while for Bulgaria and Romania, it is only fi2000 (European Commission http://ec.europa.eu/agriculture/rica/methodology1_en.cfm). A large number of small farms are not only characteristic of the new member states but also of Mediterranean countries. For Italy, Spain, Greece, or Portugal, the aforementioned threshold is as low as Poland's (fi4000).

The nature of the farm structure in individual countries determines not only their varied thresholds of the FADN field of observation but also the extent of research in the farming area, labor input, or even number of agricultural holdings. For instance, nearly half of the farms are being studied in Poland compared to only 37% in Portugal. In turn, in countries dominated by big farms, this number rises to 60% or even 70% (e.g., Belgium, the Netherlands, and Ireland). Noticeable differences among the analyzed countries are also outlined including the labor input covered by the research. In Portugal, only 53% of the AWU labor force input (Annual Work Unit – means a person employed full-time; in Poland, this amounts to 2120 hours per annum) fell under the scope of FADN observation (in Poland and Finland, this was 68% and 90%, respectively. This shows that not only are there many small farms in Poland and Eastern European countries but also that the labor force input is significantly high. However, lesser differences are

noticeable as far as the field of observation of arable land is concerned. In Poland, this is 85%, while in Denmark (for example), this amounts to 96% (source: European Commission http://ec.europa.eu/agriculture/rica/methodology2_en.cfm). Therefore, a valid conclusion is that there are many small farms in Poland, and the total area on which they operate is also small. Among the agricultural holdings included in the FADN observation, a representative sample has been chosen. Importantly, the method of sampling is stratified (multidimensional). This means that the representative sample must include farms representing all kinds of production within a specified region and an economic size category (if possible).

3. Agricultural incomes in Poland compared to EU-15

As mentioned in the introduction, the specific nature of agricultural incomes allows us to present them using several categories. The FADN database presents many measures of agricultural incomes, among which we can list gross income (gross added value), net value added, and the income of a family-run agricultural holding. The most-basic category (as well as the simplest) is gross income, which is calculated by subtracting the amount of indirect use from the total level of production. The difference is then adjusted by the balance of subsidies and taxes relevant to the current business operations. Data concerning the shape of gross income in an average FADN agricultural holding in Poland and in the member states of the EU-15 is presented in Table 1.

Despite the fact that the differences of prices (see Table 1) were taken into consideration, agricultural incomes (gross incomes) in Poland remain much lower when compared to countries such as Belgium, Denmark, the Netherlands, or the United Kingdom. Gross income in an average Polish FADN farm reaches fi29,100, while in the above-mentioned member states, this exceeds fi100,000. The highest is in the Netherlands – it reaches fi182,700. However, the income of a farm in Poland was higher than in Portugal and Greece and only slightly lower than in Italy (fi33,300). One must remember, however, that the data in Table 1 concerns an average agricultural holding within the field of an FADN observation, and as it is widely known that the average size of such farms is much lower in Poland and eastern Europe than in Western Europe. If big farms were included (e.g., an economic size of fi100,000 to 500,000), the gross income of Polish farms would not deviate from the average (Czyżewski and Kryszak, 2015a). Taking these constraints into consideration, more-significant questions concerns the tendency of changes in incomes in Poland compared to the member states of the EU-15 as well as the issue of whether the rate of these changes in Poland is higher. In 2013, gross income (nominal approach) was higher by 42% than it was in 2004. A higher increase was noted only in Denmark (104%), Germany (51%), and the Netherlands (57%). However, this information

must be approached with caution. Agricultural incomes are unstable by nature, and they do not grow linearly. For instance, in the case of Poland, the lowest income in the analyzed period was fi19,000, and that value was noted in 2005; however, the highest income was found in 2012 (fi29,600). Comparing two particular years is not fully justified, especially in the case of Poland, Denmark, Sweden, and the United Kingdom (where changes of exchange rate are an additional factor). Nevertheless, an increasing tendency in gross incomes can be observed in the analyzed period of ten years. These incomes grew on average by 4.7% year-to-year while the average value of the HCPI (Harmonised Consumer Price Index) was 2.8% per year during the same period. An average rate of gross income growth in Poland was higher by approximately 1 percentage point than the average for the examined member states. On the other hand, one must remember that incomes grew even more rapidly in Denmark, Germany and the Netherlands, for example – countries where incomes were high already at the beginning of the research period.

Another important category concerning agricultural incomes is net income, which is regarded as the income of a family-run agricultural holding as it represents the payment for privately owned resources involved in the production of and for the risk connected with farming. This income is calculated by subtracting depreciation from gross income (the result is the net added value) and the cost of external factors. Next, the balance of subsidies and taxes concerning investment activity is added. Thus, this category is similar to disposable income (Czyżewski and Kryszak, 2015a). Table 2 includes the data in this category.

The income of a family-run farm in an average Polish agricultural holding was fi17,200 in 2013; although this was relatively low, it must be stressed that it was higher than in Greece and Portugal as well as in Sweden and Finland. The level of net income of agricultural holdings in individual countries differed significantly.

In Sweden, this type of incomes barely reached fi12,000, and in the Netherlands, it was up to fi61,200. Again, these rate of change must be closely studied, because the differences in income levels depend on the size of the farms. In 2013, the net income in Poland was 37% higher than it was in 2004. The fluctuations of incomes of family-run farms must be regarded as stronger than in the case of the gross income. During the entire period of research, the income of family-run agricultural holdings in Poland grew annually by 6% on average; however, in other analyzed countries, the situation was highly diverse. It is worth remarking that net income grew rapidly in Germany and the Netherlands (each with a high original level of income per farm) but also in Sweden where incomes were highly unstable. Such important changes in income in this latter country can be explained to some extent by the fluctuations of currency exchange rates (Swedish Krona to EUR). However, we must remember that instability of income also concerns many other countries where the Euro is the official currency.

Table 1

Gross income and its changes over time, including differences in prices in FADN agricultural holdings in Poland and member states of EU-15 (in thousands of Euros) in 2004–2013

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2013/ 2004	Average year-to-year change
Belgium	83.2	83.9	89.8	96.7	83.9	85.0	109.8	100.3	111.9	108.6	31%	3.6%
Denmark	74.8	83.6	92.9	103.3	94.5	85.0	122.2	138.1	154.6	152.6	104%	9.2%
Germany	80.6	81.6	87.5	101.0	85.1	83.4	101.3	104.1	118.2	121.4	51%	5.2%
Greece	20.5	22.6	22.2	22.4	21.1	20.4	21.1	19.8	19.9	19.7	-4%	-0.3%
Spain	38.2	31.8	35.7	42.4	39.6	32.8	34.7	34.3	34.9	35.1	-8%	-0.3%
France	70.6	71.2	75.5	87.4	79.2	67.5	91.0	95.7	96.8	86.6	23%	3.2%
Ireland	24.4	24.1	25.5	29.4	26.8	18.8	26.3	31.6	34.5	33.6	38%	5.3%
Italy	29.8	30.6	31.7	36.4	34.4	35.2	35.0	35.4	35.6	33.3	12%	1.4%
Luxemburg	80.7	79.3	82.8	96.3	92.6	73.8	79.1	102.9	103.7	99.7	24%	3.2%
Netherlands	116.3	122.6	138.0	148.0	140.8	138.6	178.5	164.9	187.0	182.7	57%	5.7%
Austria	41.0	40.6	41.9	47.3	47.2	39.2	39.5	44.3	44.2	43.8	7%	1.1%
Poland	20.5	19.0	21.3	26.0	22.5	21.1	26.7	29.0	29.6	29.1	42%	4.7%
Portugal	17.4	17.7	19.7	20.6	21.4	20.7	22.7	22.5	23.6	24.7	42%	4.0%
Finland	40.7	40.4	40.9	51.3	47.2	42.0	50.4	48.9	48.9	44.9	10%	1.8%
Sweden	43.9	47.6	47.1	60.1	59.0	40.5	52.8	56.5	60.7	58.4	33%	4.8%
United Kingdom	74.2	79.6	81.8	97.2	93.0	95.3	104.2	114.4	107.0	105.5	42%	4.3%

Source: Authors' calculations on the basis of FADN and Eurostat (prices levels) databases from 2004 to 2013

Table 2

Incomes of family-run agricultural holding (net) and changes in them over time, including differences of prices in FADN farms in Poland and member states of EU-15 (in thousands of Euros) from 2004 to 2013

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2013/2004	Average year-to-year change
Belgium	43.0	44.5	49.7	52.9	39.2	36.9	59.1	46.8	58.1	52.3	22%	5%
Denmark	4.7	11.3	15.0	1.9	–38.4	–33.7	6.8	23.2	46.1	43.8	832%	–201%
Germany	28.2	28.6	31.8	42.6	26.3	21.6	35.1	36.7	46.5	47.5	69%	10%
Greece	14.8	16.5	16.4	16.7	15.2	14.1	15.1	13.2	12.9	12.6	–15%	–2%
Spain	28.5	22.5	27.0	31.9	27.7	21.3	23.6	23.5	23.3	24.2	–15%	–1%
France	26.9	26.8	30.4	39.5	30.8	16.0	39.0	42.3	42.3	28.5	6%	10%
Ireland	14.7	15.1	14.9	18.2	15.5	13.6	15.7	21.8	20.6	20.0	36%	5%
Italy	19.3	20.2	21.0	24.8	21.5	22.1	22.5	22.3	22.4	20.6	7%	1%
Luxemburg	33.7	32.9	34.8	44.2	36.4	21.4	22.1	42.7	31.6	37.2	10%	7%
Netherlands	28.6	37.3	45.1	44.1	28.9	20.6	54.0	36.9	60.5	61.2	114%	20%
Austria	22.6	22.2	23.7	28.1	28.2	20.0	21.2	27.2	25.1	23.4	4%	2%
Poland	**12.5**	**10.5**	**12.8**	**16.7**	**12.1**	**11.3**	**16.8**	**18.5**	**18.6**	**17.2**	**37%**	6%
Portugal	9.6	10.2	12.3	12.7	13.7	13.5	15.4	15.3	16.1	17.0	77%	7%
Finland	17.7	17.1	15.5	22.5	17.1	12.7	20.2	18.1	18.2	14.5	–18%	1%
Sweden	4.4	9.8	7.1	20.9	22.4	4.9	13.6	13.1	12.4	12.0	173%	43%
United Kingdom	25.1	29.4	30.6	43.6	43.2	41.4	49.9	57.9	45.9	42.2	68%	7%

Source: Authors' calculations on the basis of FADN and Eurostat (prices levels) databases from 2004 to 2013

Quick changes in income going in different directions cause problems in carrying out long-term analyses; as a result, the cognitive value is limited. A question arises: why do agricultural incomes (regardless of the adopted measurement category) vary so widely despite a common agricultural policy? If this policy is supposed to be of a pro-income and stabilizing character (cf. Deluga, 2014), one should think that, in times of decreased farm incomes, the role of union payments and the institutional framework for agriculture in general should be greater. Hence, we should examine which part of the net income comes from the balance of subsidies and taxes connected to a farm's current operations (Table 3).

In Poland, the balance of subsidies and taxes connected with the current operations represented 31% and 75% of the income of family-run farms in 2004 and 2009, respectively. During the whole analyzed period, this represented 50% on average. The scale of dependence on subsidies in Poland can be considered moderate compared to the other EU-15 member states. The relatively low level of dependence of Belgian and Dutch agricultural holdings (42% and 33% on average, respectively) is worthy of attention, since the high efficiency of farms in these countries is evident considering their high incomes. On the other hand, the fact that the balance of subsidies and taxes of current business in countries like Germany, Finland, and Sweden exceeds 100%, which means that farming production in these regions would become unprofitable without agricultural subsidies.

Based on the data from Tables 3 and 4, the claim concerning the stabilizing role of union payments can be confirmed. In most of the countries, the year with the lowest farm income was the year in which the balance of subsidies and taxes related to their current activity was the highest. This was particularly true in 2009 when the financial crisis developed; the agricultural sector suffered greatly then. It can be stated that, if not for the payment system, the fluctuation of agricultural incomes would have been even greater. On the other hand, the fact that there is such a strong correlation between farming production and subsidies is alarming. It is also an argument against the industrial model of farming development. It can be noticed that even big and very-modern French or German agricultural holdings are not able to function independently[1].

Finally, one more question remains considering agricultural incomes: is the relative weakness of Polish and Mediterranean farming caused only by their less-efficient economic structure or is it conditioned by the smaller average area? To answer this question, it is reasonable to present the data concerning the income of family-run farms in Poland and the member states of the EU-15 per hectare of arable land – again, taking into consideration the differences in prices (Table 4).

[1] It is worth mentioning that, nowadays, the problem of risk and instability in the farming business has become significant and was included among the problems covered by the CAP reform after 2013. Mutual funds can be mechanisms used to limit the risk, and they often do not operate for profit. They operate successfully in the Netherlands (Sulewski et al., 2014).

Table 3

Balance of subsidies and taxes connected with current operations as percentage of income of family-run agricultural holding (including differences in prices level) from 2004 to 2013 (%)

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average
Belgium	36	35	37	39	53	57	38	46	37	40	42
Denmark	391	166	140	1225	−61	−70	332	104	52	54	233
Germany	97	98	100	76	120	156	102	97	76	73	100
Greece	40	38	48	44	52	54	51	54	52	56	49
Spain	28	36	31	25	36	47	49	49	48	46	39
France	87	91	84	65	82	157	67	62	61	88	84
Ireland	96	99	105	92	107	115	109	78	92	89	98
Italy	27	28	29	22	22	23	23	23	22	25	24
Luxemburg	105	108	111	90	110	186	187	120	167	122	131
Netherlands	22	23	27	28	45	68	27	43	25	20	33
Austria	87	91	85	68	68	98	86	61	65	71	78
Poland	31	35	47	38	60	75	55	52	49	57	50
Portugal	63	62	53	52	49	54	50	49	50	51	53
Finland	201	218	230	176	238	311	209	226	228	277	232
Sweden	547	254	388	139	131	617	220	234	236	247	301
United Kingdom	141	129	126	89	90	106	80	66	80	89	100

Source: Authors' calculations on basis of FADN and Eurostat (prices levels) databases from 2004 to 2013

Table 4

Income of a family-run farm (net income) per hectare of arable land in FADN agricultural holdings in Poland and EU-15, including differences of prices

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2013/2004	Average change year to year
Belgium	1.05	1.08	1.20	1.22	0.89	0.78	1.22	0.97	1.18	1.06	1%	3%
Denmark	0.06	0.14	0.18	0.02	-0.42	-0.36	0.07	0.24	0.48	0.45	650%	–203%
Germany	0.38	0.37	0.41	0.54	0.34	0.25	0.41	0.43	0.54	0.55	45%	8%
Greece	1.98	2.07	2.09	2.20	2.02	1.72	1.78	1.46	1.39	1.35	–32%	–4%
Spain	0.84	0.67	0.76	0.88	0.74	0.59	0.65	0.64	0.61	0.62	–26%	–2%
France	0.34	0.33	0.37	0.47	0.36	0.19	0.45	0.48	0.50	0.33	–1%	9%
Ireland	0.35	0.36	0.33	0.40	0.34	0.31	0.36	0.50	0.41	0.39	11%	3%
Italy	1.27	1.29	1.30	1.68	1.45	1.33	1.42	1.40	1.46	1.32	5%	1%
Luxemburg	0.50	0.46	0.46	0.58	0.48	0.27	0.28	0.54	0.37	0.47	–5%	6%
Netherlands	0.94	1.23	1.44	1.30	0.86	0.58	1.49	1.01	1.70	1.77	87%	19%
Austria	0.74	0.70	0.77	0.91	0.90	0.62	0.68	0.89	0.80	0.72	–2%	1%
Poland	0.80	0.61	0.74	0.91	0.62	0.61	0.91	1.00	0.99	0.90	13%	4%
Portugal	0.40	0.43	0.50	0.50	0.54	0.52	0.63	0.61	0.67	0.67	66%	6%
Finland	0.38	0.35	0.31	0.44	0.33	0.24	0.37	0.33	0.33	0.26	–32%	–1%
Sweden	0.05	0.11	0.08	0.23	0.25	0.05	0.14	0.13	0.12	0.12	134%	41%
United Kingdom	0.18	0.20	0.21	0.28	0.29	0.26	0.32	0.37	0.28	0.25	45%	6%

Source: Authors' calculations on basis of FADN and Eurostat (level of prices) databases from 2004 to 2013

In 2013, the income of a family-run farm per hectare of arable land on Polish farms reached fi90 on average. During the whole analyzed period, this was the highest in 2011 – reaching fi1000. Interestingly, net incomes per hectare were higher only in four EU-15 countries; these were Belgium and the Netherlands (countries with modern agriculture and relatively big farms) and also Italy and Greece (where the income per agricultural holding was relatively low). It appears that the income efficiency per hectare is relatively high in these countries (as well as in Poland).

Denmark is also an interesting example of where the gross income of farms is high while net income (family-run farm) (including per hectare) is low. This is caused by the very high costs of external production factors (e.g., rent, interest, non-family member employees). These costs in Denmark are so high that the net income in this country was negative in 2008 and 2009.

On the basis of the data above, one should not jump to the conclusion that enlarging the farming area of farms in Poland, Greece, or Italy would automatically cause proportional (and significant) growth of income per farm. It should be noted that the growth of area of farms can contribute to increased external costs (e.g., the need to employ workers). Then, the gross income of a farm can grow significantly while the income of a family-run farm grows to a lesser extent or remains stable.

4. Relationship between prices, subsidies, and agricultural incomes in Poland

On the basis of the thoughts above, a follow-up question arises: why are agricultural incomes subject to significant fluctuations despite the existing policy? There are a number of factors that shape the level of income, both on the micro and macro levels. In the long term, one may indicate the role of productivity growth. Otherwise, we can list determinants such as interest rates, wages, and salaries in economy, global trade distortions, etc. However, when it comes to yearly fluctuations, prices are the factor shaping this situation; therefore, the relationship between the changes in price and income of farms are worth tracking in the example of Poland. To do so, net agricultural income (translated into Family Work Unit – FWU, which means the number of family members employed full-time) was compiled with the price gap index in the panel regression model. The price gap refers to an index representing the relationship between the prices of goods sold by farmers and the prices of goods that they buy. These are expressed in the form of indexes, so a level above (or below) 100 shows that the price rate has changed in favor of (or against) farmers as compared to the previous period. To check the robustness of our model, an extra variable is added in the second step:

the balance of subsidies and taxes per hectare (also in index form). Therefore, we may check how the sensitivity of changes in income is shaped as compared to the changes in the price gap and subsidies. Firstly, a panel regression model for 16 countries is computed (EU15 and Poland). Then, the whole group is divided into two smaller groups: countries with higher-than-average agricultural net income per farm (for 16 countries) and the second with lower-than-average values. The equations is as follows:

$$NI_{it} + PG_{it} + \beta' x_i + \lambda' x_t + u \tag{1}$$

where:

- i denotes the country,
- t denotes the year,
- NI denotes net farm income per Family Work Unit (index, previous year =100),
- PG denotes price gap (index),
- β' is a vector of dummy variables for countries,
- λ' is a vector of dummy variables for years,
- u is a random error

and in the second step:

$$NI_{it} + BS_{it} + \beta' x_i + \lambda' x_t + u$$

where BS denotes the balance of subsidies and taxes per hectare (index, previous year =100).

Ordinary least squares (OLS) basic models were computed. Then, we computed panel models with fixed and random effects (FE and RE, respectively). The evaluation regarding the suitability of the models was examined by the Breusch-Pagan (BP) and Hausman tests. The BP is useful when comparing OLS and panel models. The Hausman test indicated which panel model was more appropriate (FE or RE). The final models were computed taking into account of the Beck–Katz robust standard errors (PCSE) (Table 5).

In nearly all the cases, the OLS model proved to be valid (however, we decided to include also of the appropriate panel models). This means that, among the countries studied, there was no significant individual effect, and the data used could be interpreted as cross-sectional. As for the models with price gap as the only variable, it can be said that the changes in price relations influence changes in agricultural income in a statistically significant way, but the marginal effect is stronger for those countries with relatively lower income per farm.

Table 5

Effect of changes in balance of subsidies and taxes and price gaps in changes in Farm Net Income/FWU[a]

Group of countries	UE15	UE15	8 countries	8 countries	7 countries	7 countries
Model type	OLS	RE	OLS	RE	OLS	RE
Changes in net income/FWU vs. price gap						
Number of observations	135	135	**72**	72	**63**	63
Constant	**−211.801***** **(69.930)**	−211.801*** (69.930)	**−175.619**** **(57.540)**	−175.619*** (57.540)	**-284.439*** **(137.697)**	−280.957** (138.361)
Price gap	**3.222***** **(0.6923)**	3.222*** (0.693)	**2.841***** **(0.571)**	2.841*** (0.571)	**3.976**** **(1.392)**	3.945*** (1.398)
Breusch-Pagan or Hausman test p value	0.57	0.95	**0.15**	0.64	**0.84**	0.57
Changes in net income/FWU vs. price gap and balance of subsidies and taxes per hectare index						
Number of observations	**135**	135	72	**72**	**63**	63
Constant	**−250.586***** **(68.0474)**	−250.586*** (68.0474)	−231.583*** (69.1912)	**−231.583**** **(0.0008)**	**−308.352*** **(136.677)**	−306.682*** (137.670)
Price gap	**3.168***** **(0.698)**	3.168*** (0.698)	2.731** (0.564)	**2.731***** **(0.564)**	**3.964**** **(1.391)**	3.913** (1.398)
Balance of subsidies and taxes per hectare index	**0.432** **(0.285)**	0.432 (0.285)	0.656 (0.518)	**0.656** **(0.518)**	**0.245** **(0.214)**	0.277881 (0.219)
Breusch-Pagan or Hausman test p value	**0.54**	0.99	0.07	**0.82**	**0.80**	0.58

Source: Authors' calculations on basis of FADN and Eurostat databases

[a] As an outlier, Denmark was excluded from the models. The group of 8 countries consists of Belgium, Germany, Spain, France, Luxembourg, the Netherlands, Austria, and the United Kingdom. They have a net income higher than average in the whole group. The group of 7 countries consists of Greece, Ireland, Italy, Poland, Portugal, Finland, and Sweden. *, **, and *** denote 10%, 5%, and 1% significance levels, respectively; standard deviations in parenthesis.

One should remember that these are usually countries with more-fragmented (and thus, economically weaker) agriculture. The models indicate that this structure is conducive to instability in the agricultural sector, which, in turn, is one of the basic risks in agriculture. The inclusion of a further variable (which is the index of change in the balance of subsidies and taxes in agriculture) makes that marginal effect of price gap on incomes decrease only slightly, and its statistical significance is preserved.

This confirms the existence of the relationship between fluctuations in incomes and volatility of price relations. The index of the balance of subsidies and taxes was statistically insignificant in all models; however, when comparing OLS models, the marginal effect was stronger for countries where income per farm is relatively high. This corresponds with the earlier conclusions concerning high dependence of farm incomes on the payment system in the developed countries.

When analyzing these models, one should be cautious. Their ability to explain changes in the income index is relatively small. It is known that agricultural incomes depend on a number of other factors that were not included, such as productivity, interest rates, the level of unemployment in other sectors of the economy, etc. However, our main goal was to highlight the relationship between price gap and income changes. The set of potential factors influencing farm income also depends on the adopted research perspective: micro- or macro-economic. In this first approach, one could go as far as to completely ignore the impact of price relations when looking for a pattern of growth of single-farm income. This requires the assumptions of perfect competition in which a single farm is a price-taker and, therefore, has no effect on the market price level. In the macro perspective, one can turn to studying the reactions of agriculture in changing fiscal policy or monetary policy options (Czyżewski and Kułyk, 2010). However, if the changes in income (indexes) are tested, the price gap remains one of the most important factors influencing this variability. The purpose of the construction of the abovementioned models was, thus, to verify the occurrence of this dependence.

5. Conclusions

This paper analyzes various phenomena concerning agricultural incomes and the correlation between them and price relations. On the basis of the information presented above, the following conclusions can be made:

– agricultural incomes per farm in Poland (gross as well as net) remain significantly lower compared to most member states of the EU-15; in all countries, the characteristic feature of farming incomes is their instability, especially in the net approach; attention should also be paid to the fact that agricultural

incomes in Poland demonstrate an upward trend (higher than the average in the examined group), though agricultural income increases relatively quickly in countries with highly efficient farming;
– the instability of agricultural incomes is connected, among other things, with the change of the price relations; these relations strongly influence the changes in farm net income; however, the marginal effect is stronger in countries with smaller farms and, thus, smaller income per farm;
– during times of lower agricultural incomes due to the deterioration of price relations, for example, the subsidies of CAP have a stabilizing role. In these times, their share in incomes tends to be higher; however, the share of subsidies in the incomes of Polish farms remains relatively low;
– the efficiency of Polish farms conceived as their ability to create net income (per hectare) is one of the highest among the studied countries; hence, it seems that the best way to strengthen the economic potential of Polish farms and partly to become more independent from price fluctuations is to enlarge their area; however, enlarging farms can lead to the growth of costs of external factors and to the emergence of negative effects concerning the natural environment.

References

[1] Baer-Nawrocka, A. (2013) 'Dochody producentów rolnych w krajach Unii Europejskiej', *Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu*, 15(6), pp. 11–15.
[2] Czyżewski, A. (2007) (red.) Uniwersalia polityki rolnej w gospodarce rynkowej. Ujęcie makro- i mikroekonomiczne, Poznań: Wydawnictwo AE Poznań.
[3] Czyżewski, A. and Kryszak, Ł. (2015) 'Sytuacja dochodowa gospodarstw rolniczych w krajach UE-15 i w Polsce w latach 2007–2013 w świetle statystyki FADN', *Zeszyty Naukowe Szkoły Głównej Gospodarstwa Wiejskiego w Warszawie. Problemy Rolnictwa Światowego*, vol. 15(1), pp. 21–32.
[4] Czyżewski, A. and Kryszak, Ł. (2015) 'Relacje cenowe w rolnictwie polskim a dochodowość gospodarstw rolnych i gospodarstw domowych rolników', *Zeszyty Naukowe Szkoły Głównej Gospodarstwa Wiejskiego w Warszawie. Problemy Rolnictwa Światowego*, vol. 15(1), pp. 17–29.
[5] Czyżewski, A. and Kułyk, P. (2010) 'Relacje między otoczeniem makroekonomicznym a rolnictwem w krajach wysokorozwiniętych i w Polsce w latach 1991–2008', *Ekonomista*, vol. 2, pp. 189–214.
[6] Czyżewski, B. and Majchrzak, A. (2015) 'Związek dochodów, cen i produktywności w rolnictwie w Polsce – ujęcie makroekonomiczne', *Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu*, vol. 17(2), pp. 26–31.

[7] Deluga, W. (2014) 'Wybrane aspekty finansowania polskiego rolnictwa w ramach wspólnej polityki rolnej Unii Europejskiej', *Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu*, vol. 6(16), pp. 101–108.
[8] European Commision 2016, FADN Methodology, [Online], Available: ec.europa.eu/agriculture/rica/methodology1_en.cfm [10 Jan 2016].
[9] Gąsowski, A. (2015) 'Wspólna polityka rolna – czy faktycznie?', *Zeszyty Naukowe Szkoły Głównej Gospodarstwa Wiejskiego w Warszawie. Problemy Rolnictwa Światowego*, vol. 15(2), pp. 52–64.
[10] Goraj, L. (2000) Sieć danych rachunkowości gospodarstw rolnych w Unii Europejskiej (FADN). Warszawa: Fundacja Programów Pomocy dla Rolnictwa (FAPA).
[11] Instytut Ekonomiki Rolnictwa i Gospodarki Żywnościowej – Państwowy Instytut Badawczy (2014) Wyniki Standardowe 2013 uzyskane przez gospodarstwa rolne uczestniczące w polskim FADN, Część I. Wyniki Standardowe, Warszawa.
[12] Majchrzak, A. and Stępień, S. (2016) 'Flows of rents as an economic barometer for agriculture: the case of the EU-27', in Czyżewski B. (ed.) Political Rents of European Farmers in The Sustainable Development Paradigm. International, national and regional perspective, Warszawa: Polish Scientific Publishers PWN.
[13] Organisation for Economic Co-operation and Development (2014) Agricultural Policy Monitoring and Evaluation 2014: OECD Countries, Paris.
[14] Sulewski, P., Majewski, E. and Meuwissen, M. (2014) 'Fundusze ubezpieczeń wzajemnych jako forma ograniczania ryzyka w rolnictwie', *Zagadnienia Ekonomiki Rolnej*, vol. 2, pp. 127–144.
[15] Woś, A. (2004) W poszukiwaniu modelu rozwoju polskiego rolnictwa, Warszawa: Instytut Ekonomiki Rolnictwa i Gospodarki Żywnościowej.