

Article

Income Variability of Agricultural Households in Poland: A Descriptive Study

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Abstract: Among the different types of households, agricultural ones are perceived as the most exposed to the problem of income instability. Income fluctuations pose a threat not only to the financial stability of farming families but also to the sustainable development of the agriculture sector. Investigating the scale and factors of the variability of farmers' household incomes is important in designing and monitoring agricultural policy measures that aim to stabilize farmers' incomes. In this context, the main objective of this article is to assess the income variability of agricultural households in Poland and to identify the main correlates of farmers' income fluctuations in the period 1996–2022. To emphasize the significance of the problem of income instability for agricultural households, a comparative assessment of income variability was performed (relative to non-agriculture households). Furthermore, two research subperiods (1996–2003; 2004–2022; before and after EU accession) were distinguished to capture the association between the Common Agriculture Policy (CAP) and the stability of agricultural income. The study focusses on associations between variables (regression and correlation analyses were used). The income of agricultural households was shown to exhibit greater variability (year-on-year) than the income of households of workers and of self-employed people, with a lower scale of fluctuations after 2004. Furthermore, the study reveals a group of factors that could be correlated with the variability of the income of agricultural households: income structure (share of income from agriculture), natural and climatic conditions (variability of the yields and agricultural production), and changes in prices of the means of agricultural production. The findings raise, however, a question about the effectiveness of CAP instruments in stabilizing agricultural income.

Keywords: farmer households; available income of households; variability of farmers' household incomes; gross disposable income in the households sector



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1. Introduction

Households, in addition to private companies and public institutions, constitute a major entity of the national economy. In short, “the economy begins and ends in households” [1]. The essential function of a household is to meet the needs of its members and the household as a whole. In this context, the level and stability of the income obtained by a household are of fundamental importance, as they constitute the basis of the financial resilience and security of the household [2]. A higher and more stable income not only allows one to cope with sudden events which generate financial needs over a short period, but also creates the ability to deal with financial problems of a medium- or long-term nature [3,4]. It should be emphasized that the income of individuals not only constitutes an economic category, but also a social category. This is because it is an indicator of the social status of a household.

Among the different types of households, including the aspect of their socio-economic characteristics, agricultural households are among the most exposed to the problem of income instability. This results from the fact that the sole or major source of income for these households is income from the family's (individual) farm holding. Due to the specificity of

agricultural activity, this income is often subject to considerable fluctuations. The economic outcomes for agricultural producers depend on climatic and natural factors [5,6], as well as on macroeconomic and market factors, and especially on price variability [6–8]. The combination of the production risks creates an ongoing pressure on income obtained from farming, and thus on the income of farmers' households. As a result, the crisis in agriculture is often related to the crisis of agricultural income, especially including the problem of the high instability of this type of income.

The variability in the revenue and costs and, as a result, in the income of agricultural households is a common phenomenon. However, the problem is the scale at which income varies. If the income fluctuation is too high and is characterized by the occurrence of relatively long or regular periods of significant decreases in income, it poses a threat not only to the financial stability of a farmers' household, but also to the operational activity of a farm holding [9,10]. The literature underlines that deviations in income level constitute one of the key measures of economic resilience in the agricultural sector [11–14]. The resilience of agriculture and farmers to various types of income-destabilizing factors has been indicated to be an important aspect, or even a characteristic, of the sustainable development of the sector [15]. A higher and more stable income contributes to the better resilience of farmers' households to crises and constitutes a form of protection for the farm holding against the materialization of negative risks related to natural and economic factors [16]. Moreover, a fair and stable income enables farmers to use a more extensive set of economic possibilities for the development of their farm holding.

This problem was also acknowledged by the Common Agricultural Policy (CAP). One of the key targets of the CAP for 2021–2027 is supporting viable farm income and the resilience of the agricultural sector across the EU, in order to enhance long-term food security (objective 1) [17]. Within this objective, a detailed goal is also distinguished: ensuring the stability of farm incomes through a mitigation of the results of price risk (resulting from the variability of economic situations) and production risk (resulting from the variability of climate and weather conditions and the occurrence of natural disasters and other catastrophes). Therefore, the CAP objective is not only to support an appropriate level of income for farmers, but also to do so in relative terms, i.e., with regard to other social and professional groups [18,19]. It also includes increasing the stability of agricultural income, which is, *de facto*, their resilience to various factors affecting its variability. Thus, within the CAP, the creation of an appropriate framework has been assumed for the management of risk related to income variability, and this increases the resilience of the entire agricultural sector in the long term [20].

The literature has covered only some topics of the complex issue of farmers' income stability [7,10,21–23]. Moreover, different interpretations of the stability itself can be found depending on the point of view taken by the researchers on the problem. Further research is still underway, with different approaches and data from other countries required to deepen the discussion.

The current study contributes to the nascent literature on the income variability of agriculture households by investigating this issue in Poland, a central Eastern European country that relies relatively heavily (compared to other EU countries) on agriculture, as evidenced by its relatively high employment in the agriculture sector (8% in 2021; 4% was the EU average) [24]. A methodological approach enables this study to bring added value to the literature on the descriptive analysis of the European agricultural sector in general.

The main goal of this study is to assess the income variability of agricultural households in Poland in the 1996–2022 period. This study also aims to identify the main correlates of the income variability of agricultural households. The study focusses on associations between variables (correlation and regression analyses were used); it does not provide an impact evaluation.

Income variability is measured by fluctuations in real income levels in year-on-year terms. To capture the significance of the problem of income instability for agricultural households, an assessment of the variability, and thus stability, of agricultural income was

conducted using a comparative approach, relative to the income of other socio-economic groups (non-agricultural households).

Furthermore, the analysis is enriched by considering two research subperiods:

- (1) 1996–2003, before Poland acceded to the European Union (EU),
- (2) 2004–2022, i.e., under the conditions of Poland’s membership in the EU.

The distinction of these two subperiods enables a search for an answer to the question of the impact of the association between the CAP and the stability of agricultural income, which, in recent years, has constituted a significant CAP objective [10]. A long period of analysis makes possible capturing the medium- and long-term trends in the scope of the fluctuation of agricultural income and the application of a regression model (OLS estimation) to find the main factors determining the variability of this income.

Establishing the scale of the variability of farmers’ household incomes in Poland is significant in the context of forming agricultural policy, including the creation of intervention tools (in particular through appropriate public spending on agriculture) that would alleviate the problem of income variability for farmers. The results of this study could lead to interesting conclusions, not only from the perspective of Poland, but also for other EU member states, because the issue of the considerable instability in agricultural income is universal, and potentially efficient tools for its mitigation could be incorporated into the set of CAP instruments.

The rest of the paper is structured as follows. Section 2 presents a brief literature review of previous studies on the variability/stability of incomes for agricultural households. Section 3 details the materials and the research methods. Sections 4 and 5 present the research results and their discussion. Finally, Section 6 presents our conclusions in reference to the hypotheses and research questions.

2. Literature Review

The word stability originates from the Latin word *stabilis*, which means to stand in a firm and stable manner. It can also be defined as permanency, and, with this primary meaning, the term is used in a variety of scientific disciplines, including mathematics and natural and social sciences, including economics, where it is used to express the ability of an item or phenomenon to remain in balance [25]. Stability can also be understood with this meaning for agricultural economics, where the term, which refers to the constancy of yielding agricultural production or income, is used to assess long-term time series and intra- and inter-group comparisons [25].

Fluctuations in yield levels and, to a lesser degree, variable animal production results are determined by natural factors, mainly climatic, weather, and biological factors [5,6]. This variability is expected to increase, mainly due to climate change [26]. As shown in recent years, the important factors affecting farmers’ income and agricultural production costs have also included the COVID-19 pandemic, animal disease epidemics (e.g., ASF, avian flu), political tensions, and armed conflicts, all of which may result in difficulties in international food trade as well as increases in energy prices [27–33].

The sources of the income variability of agricultural households can also be found in the technical, production, organizational, and economic characteristics of the farm holdings themselves, and in the course of agricultural and economic policy [6–8]. In agriculture, this risk has the form of not only pure risk (e.g., a drought), but also speculative risk, i.e., a risk that may bring both loss (disbenefit) and profit (benefit) to the income of agricultural producers [34]. However, the problem is the scale of income fluctuations resulting from the materialization of a specific single risk or a whole range of risks [9,10,21,35].

A holistic look at farmers’ income stability requires an investigation of the income obtained from agricultural activity (from an individual/family farm holding), as well as the overall income obtained by farmers’ households. Some of the income comes from non-agricultural sources, which is of significance to the level of income of farming families and their exposure to risk, and thus income fluctuation [23,36–38]. Considering the strong relationship between a farmer’s household and the farm holding, there are strong connec-

tions between agricultural income and income from other sources [39]. Income from a farm holding is used to support a farming family, but it is often the case that non-agricultural income is utilized to finance the costs of agricultural activity.

Diversification of the income structure obtained both within agricultural activity (on-farm diversification), as well as outside of it (off-farm diversification), is one of the strategies for the risk management for farm holdings [40], and thus the stabilization of farming families' incomes [25,41]. In general, business diversification is viewed as the condition for a flexible response to market opportunities or disturbances [42], as well as weather-related disruptions [43]. Increasing the diversity of agricultural production enhances the economic resilience of individual farm holdings [10], and the agricultural sector, on the macro scale [44]. The pursuit of non-farming activity is also perceived as a factor that increases the stability of the income of agricultural households by ensuring them a more stable source of income [45–47]. The compensation of risk related to agricultural activity due to work outside the farm holding is determined by the size of the farm holding. Small family farm holdings especially tend to expand their income base outside of the farm holding, and, in this case, the share of their income obtained outside of agriculture is more important for the stabilization of their income than it is on larger farms [7].

Subsidies within the framework of CAP also offer a more stable source of income for farm holdings [35]. This is where their positive impact on farmers' income stems from [48,49]. However, budget transfers to agricultural holdings affect the level and stability of their income not only directly but also indirectly, through changes in farm holding productivity [50,51], changes in the prices of production means and agricultural commodities [52], and by affecting the farm holdings' behaviour relative to the diversification of its business activity, both within the farm holding as well as outside of it [53]. Studies verifying the effects of CAP subsidies on the stability of agricultural income reveal different possible mechanisms and directions of the impact. Harkness et al. [10] indicate that the influence of agricultural subsidies on the stabilization of agricultural income can depend on the financing mechanism (type of subsidy). The greater the share of agri-environment payments in the transfers, the lower the income variability. However, the increase in the direct subsidies paid to farmers depending on their crop surface area can be linked to a decrease in the stability of the holdings' incomes. Research shows that direct subsidies may encourage farmers to pursue more risky directions of agricultural production [49,54]. Moreover, they can reduce the farmers' willingness to diversify their source of income outside of the farm holding [53,55]. The indirect mechanism of the impact of CAP subsidies is also linked to increasing the prices of the means of production (increasing farmers' demand in this market) and reducing the prices of agricultural commodities (increasing the supply in that market) [52]. The final effect of the CAP subsidies on the stabilization of farm holdings' incomes depends on the scale of all the direct and indirect effects discussed above.

Significant determinants of the level and variability of the income of farm holdings include the prices of the means of agricultural production, agricultural production prices, and the retail prices of food. The relationships between the prices of outlays and the effects of agricultural production create what is known as price scissors, and their related price fluctuations translate into the level and variability of the income of farm holdings. However, the influence of price relationships on income changes is not a symmetrical one. Research shows that the income of an agricultural producer reacts more deeply to changes in the prices of the means of production than the prices of agricultural products (due to their higher short-term flexibility) [7].

For agricultural businesses, not only the level of farm income but also the stability of that income remains a key issue. Fluctuating incomes can affect farmers' decisions and the ability of a farm to sustain its operations year by year [21,35]. Long or regular periods of significant decreases in income pose a threat not only to the financial stability of a farmers' household, but also to the operational activity and development of a farm holding [9,10]. The instability (or variability) of farm income still represents a significant challenge for farm management and the design of public policies.

An innovative way to address downward fluctuations in agricultural income includes the Income Stabilization Tool (IST), which is potentially available to EU farmers. It is a risk management tool supported by Rural Development Programmes (RDPs) and based on a public–private partnership that provides financial compensation to farmers who experience a severe income drop [56]. The IST is regulated by a mutual fund (MF) managed by associated farmers. Farmers pay an annual financial contribution to the MF to become eligible for receiving compensations when their whole farm income decreases by more than 30% of their expected income [Article 39 of Regulation (EU) No 1305/2013]. The problem is that, despite some positive features, the IST is still in a pioneering phase in the EU. According to Moellmann et al. [57], only one Spanish region (Castile-León) and two member states (Hungary and Italy) have planned an IST, but none had been implemented until 2020 [20,58].

The considerations presented above show that investigating the stability of agricultural producers' incomes, and, more broadly, of agricultural households' incomes, is a current and important issue. There is still a gap in the literature in this respect. It should also be emphasized that the stability of the income obtained by farmers' households depends on many factors which have their sources in conditions specific to individual countries or regions, such as agrarian structure, climatic and soil conditions, or the possibility of obtaining non-agricultural income in rural areas. Therefore, research on the factors affecting the stability of the income of farming families should consider the specific conditions of agriculture and the rural areas of a given country or region.

3. Materials and Methods

In this study, to emphasize the significance of the problem of income variability for agricultural households, the variability of farmers' household incomes is analysed against the variability of the incomes of other household groups. Thus, the study subject consists of three groups of households [59]:

- Farmers' households—households whose exclusive or main (prevailing) source of maintenance is income from the use of a private farm in agriculture. The income gained from additional sources is lower than that from the private farm in agriculture;
- Employees' households—households whose exclusive or main (prevailing) source of maintenance is income from hired work in the public or private sector;
- Self-employed households—households whose exclusive or main (prevailing) source of maintenance is self-employment (other than a private farm in agriculture) or a free profession.

As the measure of household income variability, the change rate of income was used (in real terms, i.e., in constant prices, following correction with the consumer price index, CPI, in comparison with the previous year).

The analysis included two types of household income, i.e.,

- (1) Average monthly available income per capita in households—that is income obtained from all sources, reduced by taxes and social and health insurance contributions. This category of income is the resulting figure from household budget studies, which are the microeconomic studies conducted by the Polish Central Statistical Office (GUS). The results of this research are presented in annual studies entitled the *Household budgets survey*.
- (2) Gross disposable income in the household sector—calculated according to the “gross” terms of the ESA 2010 methodology, i.e., including depreciation. This income is obtained as a result of correcting the primary gross income for income tax, property tax, etc.; net social insurance contributions; and social benefits and transfers [60]. This category of income is determined by the GUS in studies of a sectoral nature. The sub-sectors distinguished in these studies correspond to the groups of households distinguished in studies on household budgets.

Three hypotheses were assumed:

H1. *The income of agricultural households is characterised by greater variability (in year-on-year terms) in comparison with the incomes of other groups of households living off of income sources.*

H2. *Fluctuations in agricultural product prices and the prices of the means of production purchased by farmers, expressed by the price scissors index, are positively associated with the fluctuation of farming households' incomes.*

H3. *The variability of farming households' incomes in Poland is mitigated by subsidies for operational activities and income obtained from non-agricultural sources.*

Correlation and regression analyses were used to recognise the associations between the variability of farmers' income and its factors (identified in the literature review). The following equation was estimated:

$$Y_{it} = \alpha_0 + \beta_i X_{it} + \varepsilon_{it} \quad (1)$$

where Y_i —rate of change of farmers' income (year-on-year), X_i —set of explanatory variables, ε_i —random component, α_0 and β_i —parameters of the regression function, and t —time.

The change rate ($t - 1 = 100$) of the following income types was used as the explained variables (Y_i):

Y_1 —average available income per person in a farmer's household;

Y_2 —gross disposable income in the sub-sector of individual farm holdings.

Based on a review of the literature [7,10,14,61], a set of eight potential explanatory variables was considered, which described, directly or indirectly, the price relationships between the agricultural market (X_1), the macroeconomic situation (X_2), budget subsidies for agriculture (X_3), production volume and intensity (X_4 , X_7 , X_8), the structure of the farm holdings' income (X_5), and the natural and weather conditions for agricultural production (X_6). The descriptive statistics of the variables are presented in Table 1.

Table 1. Descriptive statistics of explanatory variables (1996–2022).

	Variable	Mean	St. Dev.	Min.	Max.	V
X_1	Price ratio index ("price scissors")	1.01	0.08	0.82	1.1	8.03
X_2	GDP dynamics, at constant prices	104.16	2.08	98.00	107.1	1.99
X_3	Budget expenditure on agriculture, at constant prices (PLN million)	54,358.7	16,632.7	29,332.82	86,074.6	30.60
X_4	Final production in agriculture, at constant prices (in PLN million)	86,478.2	17,125.2	61,200.81	115,473.3	19.80
X_5	Share of farm income in disposable income (%)	70.17	3.33	62.20	76.2	4.74
X_6	Cereal yields (dynamics)	9.78	0.97	8.66	11.4	9.96
X_7	Mineral fertilizers use (kg NPK/ha)	113.57	20.34	83.20	141.6	17.91
X_8	Productivity: final production, at constant prices (PLN) per ha of arable land	5468.5	1410.7	3497.7	7823.7	25.80

Source: own study based on Central Statistical Office data.

Due to the results of the ADF stationarity test ($p > 0.05$), the X_3 – X_5 and X_7 and X_8 variables were expressed as the change rate. The results of the Jarque–Bera test ($p > 0.05$) indicate that all variables have a normal distribution.

The selection of variables for the regression equation was performed based on the a posteriori elimination procedure. The OLS technique was used to estimate the regression function parameters. To verify the quality of the estimates, the following were assessed: the normality of the distribution of the residuals (Jarque–Bera test), the homogeneity of variance

of the residuals (White's heteroskedasticity test), the autocorrelation test (Breusch–Godfrey test), the linearity of the analytical form of the model (White's test for non-linearity), and the multicollinearity of the explanatory variables (VIF).

CSO data served as the source of empirical material, originating from cyclical publications of the *Household budgets survey* for the period 2003–2022, the *Polish Statistical Yearbook of Agriculture* for the period 2007–2022, and the *Statistical Yearbooks of the Republic of Poland* for the period 1995–2004.

4. Results

4.1. Volatility of Farmers' Household Income: A Descriptive Analysis

During the investigated period (1996–2022), an income disparity was visible between farmers and other socio-economic groups in Poland [62]. Poland's accession to the EU in 2007 and the covering of agriculture with CAP instruments coincided with a successive improvement in farmer's income, both in nominal and relative terms, i.e., relative to other socio-economic groups (Figure 1). The income gap between the monthly available income per person in agricultural households and the average income of general households was particularly high in the years 1998–2004, amounting to 23.9% on average. It was a couple of percent higher relative to employees' households, (29%), whereas, relative to non-farming self-employed households, it was as high as 51% in that period.

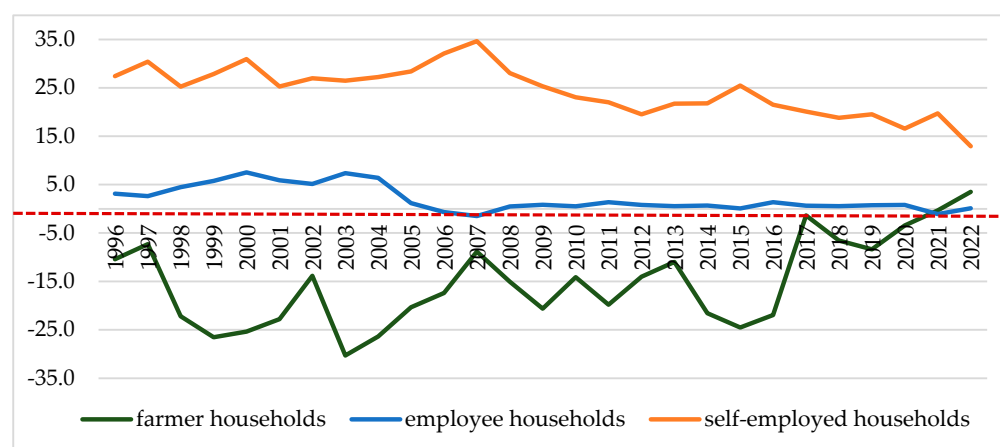


Figure 1. Disparity of the average monthly available income per capita of agricultural households compared to other groups of households (in %). Source: own study based on the *Household budget survey*, 2003–2023. Central Statistical Office, Warsaw. The dotted red line indicates the average income for all households in Poland.

The farmer's income disparity relative to other socio-economic groups started to gradually reduce in the following years, characterized by the support of farmer's incomes with EU funds, particularly in the form of direct subsidies. In the period 2005–2016, the income disparity of farmers relative to general households and employees' households was 17.4% and 17.9% on average, respectively. Only in relation to the households of the self-employed was the difference still high, amounting in this period to 42% on average. In the period 2017–2022, the farmers' incomes increased relative to other socio-economic groups. The income disparity between farmers and general households and employee households amounted, in this period, to 2.8% and 3.1%, respectively, whereas in relation to the self-employed it was reduced to 20.7%.

The faster real increase in the income of farmers' households, in relation to other groups of households, but with a higher variability in the farmers' incomes, is also confirmed by the observation of the dynamics of household income in Poland against the background of GDP dynamics (Figure 2). The increase in GDP in Poland in the period 1996–2022 was accompanied by an increase in household income, yet the rate and scale of the increase for households living off of income sources in nominal and real terms was lower than the GDP

dynamics. This means that labour was relatively depreciated with respect to the remaining production factors influencing the income distribution in the economy.

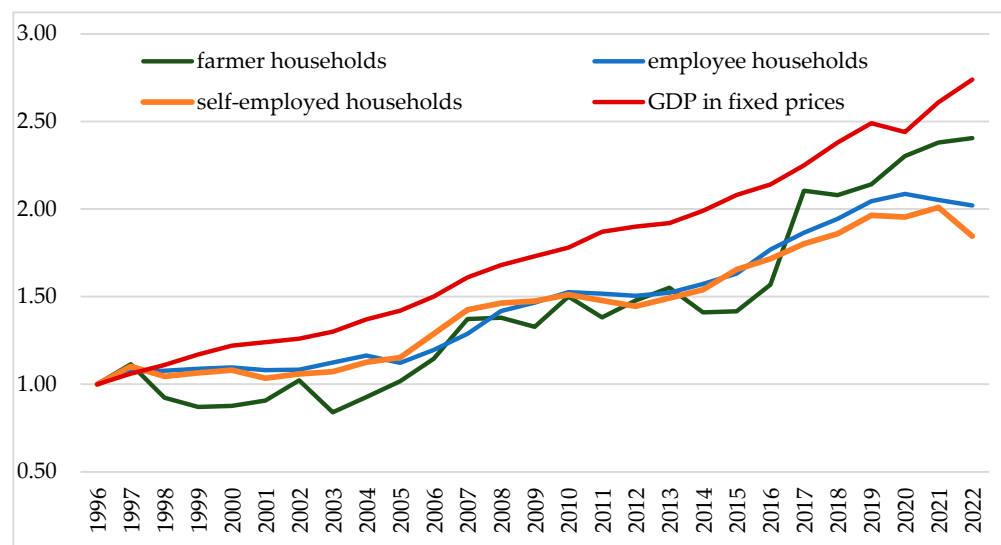


Figure 2. Households' available income growth index versus GDP growth dynamics (constant prices, 1996 = 1.00). Source: same as Figure 1.

The income of agricultural holdings in the period 1996–2004 was characterised by a real decrease. Only since 2005 has the income of farmers increased in real terms on a year-on-year basis since 1996, and it achieved a similar dynamic in growth to the income of the compared groups of households (Figure 2). From 2017, the real annual growth rate of agricultural households' incomes overtook the growth rate of employee households and self-employed households (Figure 2). As shown above, this translated into a reduction in the farmers' income disparity relative to these socio-economic groups.

On the scale of the entire investigated period, the income of farmers reached its highest actual growth in 2022, as it was almost 2.5 times higher than in 1996, whereas the income of employee households and of the self-employed was nearly 2 times higher (Figure 2). This might be linked to the transfers that have been reaching farmers as part of the CAP instruments since 2004 [63]. EU funds, as well as transfers from the state budget to the agricultural sector, increased particularly dramatically in the period of 2004–2009, from PLN 26.7 billion to PLN 57.2 billion. In the later period, public expenditure on agriculture was relatively stable and amounted to between PLN 46.8 billion and PLN 55.2 billion per year [63].

In the first years of Poland's membership in the EU, the increase in farmers' income was largely associated with the increased budget transfers to the sector (subsidies directly supporting the farmers' incomes and pro-development subsidies). From 2010, and especially in recent years of the investigated period, i.e., 2017–2022, the increase in income was linked to the improved productivity of agriculture and, in some years, favourable price relationships on the agricultural market [59].

The data presented indicate that farmers constitute the social and professional group that benefited the most from Poland's membership in the EU. Supporting agriculture with public funds within the framework of the CAP instruments coincided with actual and relative (with regard to other socio-economic groups) improvement in agricultural income. However, the question remains of the efficiency of agricultural policy with regard to the issue of the instability of agricultural income.

Analysis of the variability of the average monthly available income per person in various socio-economic groups of households reveals the high instability of the farmers' incomes (Figure 3). This is visible on the scale of agricultural households' income fluctuation, but also when comparing its variability with the variability of the income of other

households. In the period 1996–2022, the average rate of change in the real income of farmers, year-on-year, was as high as 8.8% and it was almost 2.5 times higher than the average rate of change in the income of employees' households and more than 2.0 times higher than the annual average change rate of the available income of self-employed people (Figure 3; Table 2).

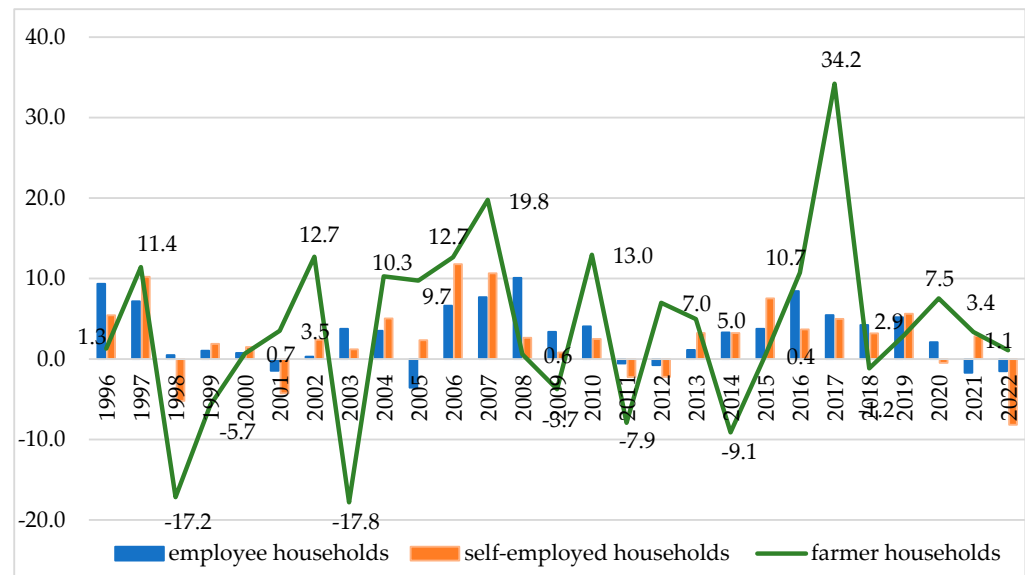


Figure 3. Change rate (y/y, in %) of average monthly available income per person (at constant prices) of selected households in 1996–2022. Source: same as Figure 1.

Table 2. Average change rate (in %) of the monthly available real income of households in 1996–2022 (absolute values).

Specification	All Households	Farmer Households	Employee Households	Self-Employed Households
Average change rate (%), 1996–2022	3.6	8.8	3.8	4.1
- range R	8.6	33.8	9.8	11.3
- coefficient of variation V (%)	79.7	86.1	75.6	72.7
Average change rate (%), 1996–2003	2.4	8.9	3.0	4.0
- range R	7.6	17.1	9.0	9.0
- coefficient of variation V (%)	121.9	78.4	113.6	75.1
Average change rate (%), 2004–2022	4.1	8.7	4.1	4.3
- range R	8.5	33.8	9.5	11.3
- coefficient of variation V (%)	67.3	91.5	63.7	73.7

Source: same as Figure 1.

The available income of farmers exhibited a particularly high variability in the pre-accession period (1996–2003). The annual average changes in farmers' incomes were almost three times higher compared to the changes in the available income of employees and more than two times higher than the changes in the income of the self-employed (Table 2). In the post-accession period, the scale of the disparities in the amplitude of the available income fluctuations of agricultural households was only slightly lower than in 1996–2003. However, the disparity between the variability of farmers' incomes and compared household groups decreased. This may indicate that budget transfers from CAP funds contributed to stabilising farmers' incomes, at least in inter-sectoral terms, relative to other household groups.

Another factor linked to the variability of the income of agricultural households is the share of the income from a farm holding in the available income of a farming family [45–47]. In Polish agricultural households during the period 1996–2022, this share was 70% on

average. From 1996 to 2016, this index exhibited a decreasing tendency, as it reduced from 75.6% to 62.2%. This tendency was reversed in 2017, when the share of the income from agricultural activity increased to 68.2%. At the end of the investigated period, in 2022, this share amounted to 69.5%.

The annual average change rate of available income, in absolute values for the overall income, amounted to 8.1%, whereas for farm holdings it amounted to 10.1% (Figure 4). From this it follows that, in farmers' households, income from non-agricultural sources could be an element stabilizing the variability of their total income. This is further confirmed by the study by J.S. Zegar [46], which showed that obtaining income outside of a farm holding significantly alleviates the variability of their income for farming families.

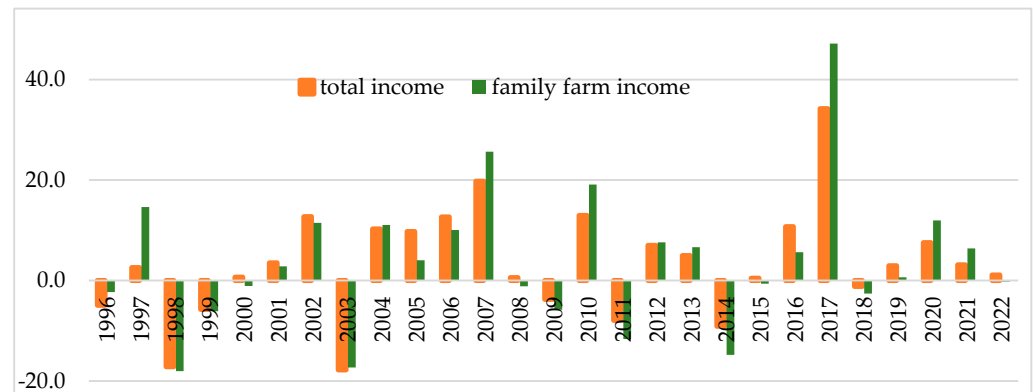


Figure 4. Change rate (y/y, in %) of the family farm income and the overall average monthly available income per person in agricultural households; Source: same as Figure 1.

The gross disposable income estimated in national accounts in the subsector of individual agricultural farms in the years 1996–2021, similar to the available income per capita, was subject to much greater fluctuations than the income of other households (Figure 5).

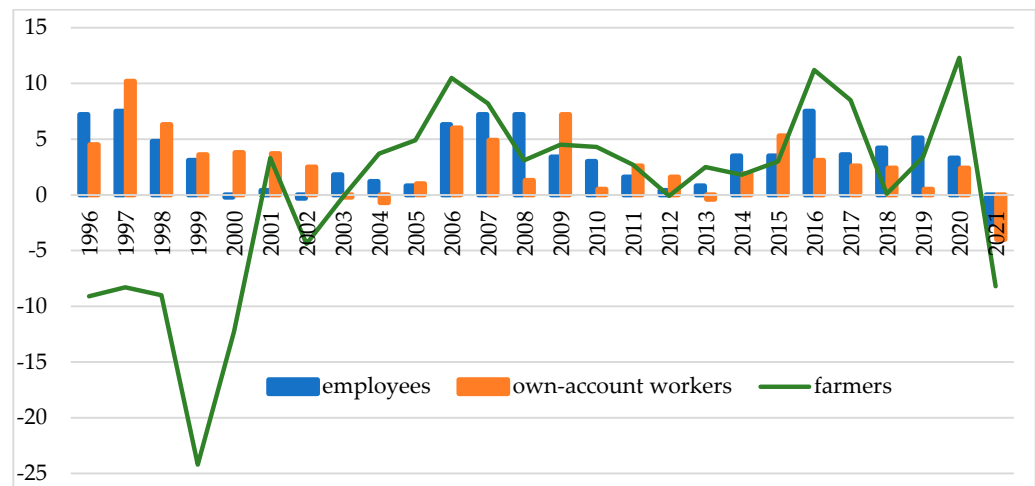


Figure 5. Change rate (y/y, in %) of real gross disposable income in selected household subsectors in 1995–2021. No data available for 2022. Source: own study based on the *Polish Statistical Yearbooks of Agriculture*, 2007–2021. Central Statistical Office, Warsaw.

The fluctuation in the gross disposable income of agricultural households was lower in the post-accession period versus 1996–2003 (Figure 5). In the pre-accession period, the average farmers' income change rate in absolute values amounted to 9.4%, whereas in 2004–2021 it was almost halved (5.2%)—Table 3.

Table 3. Average change rate (in %) of the gross real disposable income of selected household subsectors in 1996–2021 (absolute values).

Specification	All Households	Subsector:		
		Farmer Households	Employee Households	Self-Employed Households
Average change rate (%), 1996–2021	3.2	6.6	3.7	3.1
- range R	6.7	24.1	9.6	10.0
- coefficient of variation V (%)	61.2	82.6	74.4	77.0
Average change rate (%), 1996–2003	3.3	9.4	3.9	4.1
- range R	6.6	24.0	7.3	10.0
- coefficient of variation V (%)	77.8	82.5	95.8	67.3
Average change rate (%), 2004–2021	3.1	5.2	3.6	2.7
- range R	5.1	12.2	7.1	6.8
- coefficient of variation V (%)	56.0	72.9	64.4	77.0

Source: same as Figure 5.

Farmers' incomes exhibited approximately two times greater variability than in the case of that of the non-agricultural self-employed. This fact demonstrates the significance of the issue of farmers' income instability. Agricultural activity, even with the current state of agrotechnical and zootechnical knowledge, combined with the achievements of modern biotechnology, does not enable us to eliminate the considerable uncertainty in the scope of its economic results. Therefore, this activity does not guarantee stable fulfilment of the living needs of a farmer's family and the needs related to the sustainable development of their farm.

4.2. Variability of Farmers' Household Income: Correlation and Regression Analyses

The variability in the income of agricultural households was most strongly associated with changes in agricultural productivity (X_8). A higher variability of productivity in agriculture was associated with higher dynamics in agricultural income. This correlation is statistically significant, but its interdependence is moderate (0.4–0.5). The increase in the share of income from a farm holding (X_5) was similarly positively associated with the change rate of the available income per capita (Y_1). In addition, changes in gross disposable income (Y_2) were positively correlated with the higher dynamics of the value of final production (X_4). The analysis reveals the negative correlation between increasing budget expenditures on agriculture (X_3) and the variability in available per capita income (which may suggest a stabilizing association). This correlation is, however, relatively weak (−0.23), but significant at the 10% level (Table 4).

Table 4. Pearson correlation between independent variables (X_i) and the change rate of the disposable income per person (Y_1) and gross disposable income (Y_2) of agricultural households.

Variable	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
Y_1	−0.11	−0.01	−0.23 *	0.29	0.56 ***	0.25	0.29	0.45 **
p -value	0.57	0.96	0.094	0.136	0.002	0.22	0.14	0.00
Y_2	0.14	−0.30	0.05	0.68 ***	0.112	0.32	0.28	0.53 ***
p -value	0.48	0.14	0.82	0.00	0.59	0.107	0.17	0.005

Statistical significance: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Source: own research based on Central Statistical Office data (see Tables 1 and 2).

Table 5 presents the results of the regression analysis on agricultural households' income variability for the entire period covered by the study, that is 1996–2022 and 2004–2022, the latter being the period of Poland's membership in the European Union.

Table 5. Regression estimations for the variability of the disposable income per person (Y_1) and gross disposable income (Y_2) of agricultural households.

Variable	1996–2022	2004–2022	1996–2021	2004–2021
	Y_1		Y_2	
Const.	−238.89 *** (43.96)	−209.52 *** (34.57)	37.32 (66.17)	−37.70 ** (16.35)
X_2	-	-	−1.02 * (0.59)	-
X_4	0.35 * (0.19)	-	0.71 *** (0.18)	-
X_5	1.66 *** (0.39)	1.744 *** (0.35)	-	-
X_6			-	0.14 * (0.07)
X_7	0.41 ** (0.18)	0.406 ** (0.14)	-	0.27 ** (0.12)
Adj. R^2	0.372	0.552	0.482	0.244
Diagnostic tests (p -value)				
F (model)	0.00003	0.00004	0.001	0.064
Normality of residuals	0.10	0.421	0.89	0.13
Heteroskedasticity	0.97	0.094	0.13	0.99
AR(1)	0.84	0.306	0.65	0.15
Model linearity	0.15	0.103	0.63	0.12

This table includes statistically significant X_i variables. Robust standard errors in parentheses. Statistical significance: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. VIF: [1.001–1.409]. Source: own research based on Central Statistical Office data (see Tables 1 and 2).

The results (Table 5) indicate that the increase of the share of income from a farm holding in the available income of a farming family (X_5) coincided with the increase in the variability of available per capita income (Y_1). This effect was observed both in the case of the 1996–2022 period and in the post-accession period. The higher dynamics of the use of mineral fertilizers (X_7) was also positively associated with the variability in the available per capita income. Also, in this case, the results of the estimations are robust to the change in the analysed period.

Furthermore, in 1996–2022, the association between the changes in the value of final production at fixed prices (X_4) on the variability of the available per capita income (Y_1) was marked. Interestingly, when the analyses are narrowed down to the post-accession period, the relationship between these variables becomes statistically insignificant (Table 5).

The variability of the gross disposable income in the sector of agricultural households (Y_2) was lower in the period of GDP growth (X_2). However, shortening the analysed period to 2004–2022 resulted in a weakening of the association between these variables. Similarly, the effect of other explanatory variables (X_4 , X_6 , X_7) on the variability of the gross disposable income of agricultural households was sensitive to the shortening of the analysed period. Throughout the 1996–2022 period, the variability of gross disposable income (Y_2) was positively associated with the final production dynamics (X_4). After 2004 this relationship was replaced by the association with the variability in cereal yields (X_6) and the dynamics of mineral fertilizer usage (X_7).

5. Discussion

The results obtained align with the findings of other authors, indicating that an increase in income from non-agricultural sources (reducing the share of income from farm holdings) increases the stability of the income of farmers' households [45,46]. Polish agriculture is characterised by a fragmented agrarian structure, with a high percentage of very small farms (up to 2 ha of agricultural land) and small (2–5 ha) farms. In this type of small family holding, the stabilising effect of income from non-agricultural sources is of greater importance [7].

A diversification of income sources in farmers' households may be achieved by increasing the diversity of their agricultural production or by increasing the share of non-agricultural income (from employment or non-agricultural business activity) in the disposable income of the farmer's family. The diversification of crop and livestock activities is commonly recognized as an effective tool for managing business and climatic risks, as it reduces the effects of variable commodity markets and weather at the farm level [41,64,65]. In the case of fragmented agriculture, where small farms dominate, the possibilities of diversifying agricultural production are very limited. However, this does not mean that such actions cannot be implemented effectively. A particularly interesting path in this regard may be the implementation of activities aimed at using the ecological functions of farms, including organic food production [66]. The research findings suggest that in order to increase the resilience of farmer households to income fluctuations, it is necessary to support the rural economy and local labour markets in order to increase the possibilities of farmers obtaining non-agricultural sources of income.

Furthermore, it could be observed that, in the post-accession period (compared to the entire study period of 1996–2022), the association between income variability and variables describing market conditions (X_2 , X_4) has weakened. This may to some extent result from the fact that although in the pre-accession period the farmers' income was almost solely obtained on the market, meaning that their changes had a decisive impact on changes in agricultural production (X_4), in the post-accession period their income earned on the market was supplemented by subsidies transferred from EU funds and the state budget [59,63]. With regard to the effect of macroeconomic frictions (X_2), the study by Beckman and Schimmelpfennig [7] also indicates that GDP growth has a positive impact on changes in agricultural income, but the effect is not significant (changes in the prices of the means of production or land had a more significant impact).

Additionally, this study reveals that, post 2004, the association between income variability and changes in the value of final production (X_4) was replaced by the association with variability in cereal yields (X_6) and the dynamics of mineral fertilizer usage (X_7). The X_6 variable largely reflects the impact of climate and weather conditions on the income obtained by farmers. On the other hand, the variable X_7 to some extent reflects the changes in market conditions, particularly in the prices of the means of agricultural production and in the intensity of agricultural production. For Poland, an increase in mineral fertilizers use from 83.2 kg to 132.9 kg (NPK/ha) was observed in the period 1996–2021. A study by Harkness et al. [10] shows that the increase in the intensity of agricultural production (increasing expenditures on fertilizers, pesticides, etc.) is linked to an increase in the variability in the income of agricultural holdings, which is also captured by the regression results presented in Table 5.

Larger farms may benefit from greater economies of scale, as well as a wider range of soils and landscapes, and therefore may be better able to cope with extreme or adverse weather across the farm [10,67]. For large farms conducting intensive and often specialized agricultural production, the problem of the high variability of farm income cannot be solved by diversifying their agricultural activities. Alternatively, such an action may encounter many barriers and limitations. In the case of this type of farm, institutional solutions and agricultural policy instruments that create limits on the variability of the prices of agricultural products and the prices of agricultural production inputs may be more appropriate in reducing income fluctuations. These include contractual agreements and regulated prices (e.g., energy prices). These instruments are used in Poland, but still on a relatively small scale [68].

In alleviating the problems of excessive variability and the uncertainty of agricultural producers' income, agricultural insurance should play an important role, i.e., yield and livestock insurance and revenue insurance. The latter are not used in Poland, while across the world insurance programs offering protection for farmers' income (or other incomes) are rare (e.g., such a program was implemented in Canada) [6]. Furthermore, such programs are criticized in the context of excessive financial interventionism in agriculture [69,70].

More accepted and more common, including in Poland, are instruments supporting the liquidity and solvency of agricultural producers (e.g., loan funds, preferential working capital, and disaster loans).

The public policy intervention tools in agriculture also include compensations for farmers in the event of serious declines in income, paid regardless of the cause of the decline in income (e.g., crops, prices of agricultural products, costs of raw materials). As previously mentioned, such instruments (e.g., the Income Stabilization Tool) can be implemented as part of the CAP measures, but currently they are rarely used by member states or are still at the conceptual stage.

6. Conclusions

Considerable fluctuations in the income of agricultural households result mainly from the instability of their income from agricultural activity. This situation creates specific tensions in the financial stability of farm holdings and the income stability of agricultural households. The CAP, initially oriented at supporting agricultural production, and later the level of farmers' incomes, increasingly notices and takes into account the need to reduce the instability and uncertainty of agricultural income.

In Poland, in the post-accession period, characterised by considerably higher budget expenditures in the agricultural sector (vs. the pre-accession period), a decrease in the variability of agricultural income can be clearly observed. It had both an intra-sectoral and inter-sectoral nature (reduction in the fluctuations in farmers' incomes and a reduction in comparison to the other socio-economic groups). However, the variability in farmers' incomes remains high. This study confirmed its hypothesis (H1) that the income of agricultural households in Poland exhibits significantly higher variability than the income of other households.

This study reveals a group of factors that could be associated with the variability of the agricultural households' incomes. These are factors that display the impact of natural and climatic conditions (the variability of the yields and agricultural production), market conditions (the value of agricultural production, outlays), and macroeconomic conditions (GDP dynamics). In the post-accession period (since 2004) in particular, the association between agricultural income variability and changes in the prices of the means for agricultural production and in the intensity of agricultural production were of importance. However, the "price scissors index" was not among the statistically significant determinants of the variability in farm holdings' incomes. Thus, no evidence was obtained directly confirming the H2 hypothesis.

The results of the study partially confirm the H3 hypothesis. It has been shown that a higher share of income from agricultural activities was positively associated with increases in the fluctuations in farmers' household incomes, while income from non-agricultural sources was characterized by smaller fluctuations. However, despite a decrease in the scale of variability of agricultural income after Poland's accession to the EU, a weak association of budget expenditure on agriculture with the rate of change of available income per capita raises a question about the role of CAP instruments in stabilizing agricultural income. This issue requires further investigation.

These results may be sensitive to the research's limitations. It should be noted that the study does not provide an impact evaluation, but focusses on associations between variables. The analyses generally covered budget transfers for agriculture without taking into account their diversity. Furthermore, the available data did not allow for including the structure of the farm holdings, such as their size or type of activity. Taking into account the research cross-sections indicated above, as well as the use of other econometric methods modelling the dynamic relationships between variables or considering the conditions of other national economies (e.g., other Central and Eastern European countries), these offer interesting directions for future research. One important strategy considered to increase the ability of agricultural systems to cope with shocks and variability is increasing agricultural diversity. The diversification of agricultural income, i.e., increasing the diversity of agri-

cultural activities in the context of the variability of farmers' household incomes, was not the subject of this research. It constitutes a field for further in-depth analyses, taking into account the structural conditions of agriculture, as well as the conditions of the quality of the agricultural production space (climate, soil, etc.) and social conditions (labour resources in agriculture).

Despite these research limitations, our findings contribute to an explanation of the economic reality, in terms of the scale and possible factors of variability, of the incomes of agricultural households. They also provide value to policy makers. The results suggest that the role of budget subsidies in alleviating the variability of income in agriculture could be less pronounced than expected. Thus, increasing the stability of agricultural income via various instruments, for instance, by supporting the areas of agricultural insurance or risk management in food chains, constitutes one of the most important challenges for agricultural policy.

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