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The Impact of Price Volatility of Agricultural Commodities in Poland on Alternative Incomes of Conventional, Ecological and Agritourism Farms

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The Impact of Price Volatility of Agricultural Commodities in Poland on Alternative Incomes of Conventional, Ecological and Agritourism Farms

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Abstract

The objective of the paper is to recognize price volatility of main commodities and to measure the impact of price level on agricultural incomes of farms and the number of farms having alternative income sources. First we focused on price volatility changes in European Union and Poland. Economic and econometric analysis tools were used to measure the impact of the price volatility.We collected observations from the Ministry of Agriculture and Rural Development in Poland. The analysis found big differences in price volatility for Polish commodities. The price volatility was connected with the global crisis. The Polish agricultural sector faced global problems, but could not fully overcome them. The rise of agricultural commodity prices created market problems such as increased bread and food prices. Polish consumers adjusted their purchases and their expenditures on food. This situation is common for many EU states and the price volatility can be reduced only through the Common Agricultural Policy. Poland's markets are related to global and stabilization is achievable only by active EU rural policy. We have found that the greatest grain price volatility took place after EU integration during the global crisis. We also evaluated the changes of farmers' income in Poland. We found that farmers incomes increased in Poland after EU integration. Moreover, in the aftermath of the integration the number of ecological farms increased in Poland and the agro- tourism sector expanded. It is apparent that Poland's entry into the European Union had a positive impact on price volatility and income levels of farms.

Key words: Alternative incomes, European integration, Price volatility, Regression model

Introduction

Poland joined the European Union in May 2004. Since then the economic situation of farmers has changed greatly. All Polish farmers have benefited from the direct EU payments. Additionally, Polish farmers benefited because dairy quotas helped keep milk prices high. But even these payments were not enough for offsetting the problems that arose in world markets with the financial crisis and the accompanying price volatility.

What is more, Polish farmers have increased milk production while the number of dairy farms has decreased. Polish products are rather ecological and EU consumers demand high quality products. That is why Polish products can compete in European Union markets even though new European Union regulations on aflutoxins will result in trade outflow (Otsuki et al. 2001). However, output prices exert a great influence on input purchases, and variable transaction costs that affect input use decisions. Transport costs in input and output markets have clear effects on transport-intensive use of agricultural inputs (Winter-Nelson and Temu 2005).

We examine agricultural commodity price volatility for Poland. Price volatility of agricultural commodities can negatively impact producer income, but it especially can create problems in planning production. In the whole, market price volatility can lead to loss of trading position as well as welfare loss of consumers (Kemény et al. 2012).

Literature Review

The impact of price volatility can be twofold. First, high volatility may involve quickly declining prices. On the other hand high price volatility may rapidly increase the price, although if the price volatility persists the price can come down even faster (Pietola et al. 2010). Price volatility creates uncertainty about future prices, leading to high risks in the market due to farmers' inability to forecast prices and thus, welfare losses for market participants (Apergis and Rezitis 2003).

The market problems in 2007/2008 have led to price increases and wide fluctuations in agricultural commodity prices. Possible price stabilization strategies include government intervention utilizing instruments such as production quotas and other supply management tools (Mitra and Boussard 2012). Price volatility has also an impact on deficit and surplus products. It can encourage producers of scarce products to increase supply, while producers of surplus products can be discouraged from investing in production assets. (Poulton et al. 2006).

Given the income situation of Polish farmers and the possibilities of alternative incomes development, we consider the impact of price volatility of main commodities on income development as a very interesting and important research topic. Our goal is to recognize if the economic situation of farms depends on price changes. We used statistical measures to evaluate the impact

of price changes for the main commodities on agricultural incomes and the number of farms having alternative incomes. Alternative incomes are important on agritourism and ecological farms. These activities create incomes for farmers and the number of farms specializing in agritourism and ecology in Poland increased from 1994 to 2010. Many countries have established different rules to control the problem of price volatility. That is why in the next part of the paper we describe price volatility of agricultural commodities in the European Union. There are various strategies of price stabilization, for example production quotas, direct subsidies and national supply management (Mitra and Boussard 2012). One of the most important tools is direct subsidies, which can reduce the price that entrepreneurs must pay at harvest, with private storage boosting price volatility (Avalos-Sartorio 2006). Price stabilization strategies can contribute to increase agricultural growth and economic development and reduce vulnerability (Cummings et al. 2006).

Price volatility of agriculture commodities has been an issue of growing interest for economists in the European Union. There are various reasons why this topic is important. Of the 27 countries belonging to the European Union, each has a different level of integration and the prices of commodities are regulated by the national and European market forces of supply and demand. However, some rules regulating milk production and the purchase of agriculture commodities interfere with the dynamics of the markets in the European Union. For example, each country has milk production quotas. It is accepted that major policy changes in the EU dairy sector have increased price volatility and the process can be compared to the past. Many management mechanisms to stabilize price volatility were introduced for the development of markets and clarify the links between farm milk and dairy product prices. Large price volatility can create financial problems of farmers on one hand and the stability of consumers is limited by lack of possibility of planning (Keane and O' Connor 2009).

European grain prices vary with world prices. Grain price volatility in EU grain markets is the result of wide swings in production because of weather conditions, weak agricultural policy, the global financial crisis in the Euro zone, and exchange rates. Hamulczuk and Klimkowski (2011) provided evidence supporting the fact that a number of EU countries such as Hungary, Czech Republic, Germany, France, Lithuania and Poland face the most wheat price volatility.

Method of Analysis

In the first part of the paper we study the volatility of agriculture commodities prices in Poland, based on descriptive statistics of 487 series of agricultural commodities' prices to measure the level of integration.

In the second part of our paper, we measure the impact of price volatility on agricultural incomes and alternative incomes on the basis of regression

analysis. This method estimates the linear correlation between variable X to Y as described with following equation *(Sobczyk 2005):*

$$\hat{Y}=F(X)=£_0+ £_x\zeta$$

where:

$\hat{Y}$: theoretical value of regression function F(X) responsible for level of x variable,

$£_0$, $£_1$: parameters of structural literal function of regression Y according to X,

ζ: lost element.

The Milk Market in Poland

Poland is a newer member of the European Union and for various reasons the EU integration EU did not have a strong impact on Polish milk markets. First, the European Union has introduced milk quotas. This means that the output of milk is regulated. Secondly, the price of milk is more stable because the changes in production are small. The production of milk in Poland has increased by 4.7% during 2000-2009; from 11,889 thousand tons in 2000 to 12,447 tons in 2009. In 2009 the production of milk per capita was 326 kg. Poland produces 8.5% of European Union milk production. Only Germany (19%), France (15.9%) and Great Britain (9.0%) produced and delivered more. However, the production of milk per cow is rather small (4,776 kg in 2009 while the average production per cow in the European Union was 6,117 lt with many countries have an even higher annual production. *The highest world producer is the USA with the production of 10,000 kg of milk per year from one cow (Ministry of Agriculture and Rural Development 2011).* In this paper, we argue that Poland could catch up fast by using new production methods and genetics.

The Wheat Market in Poland

The production and intervention processes in the wheat market changed once Poland came under the EU policy pertaining to grain trade. Wheat prices fell in 2004 because of a large crop. Moreover, the introduction of the EU intervention system pressed the prices in the same direction. The change in the intervention period triggered severe outcomes. In the harvest period, market forces shaped supply prices. Then, in November, the floor was determined by the intervention price. The empirical results show that the impact of integration on the Polish grain market was certainly non-negligible.

The biggest changes of wheat price were observed two months after the integration date. Moreover, the surplus of 0,4-1,4 million tons of cereals has appeared in the market as the result of the increase of cereal share at the level of 0.3% and cereal crops at the level of 12%. In addition, the decline in market capacity caused by the 0.5% reduction of feed use decreased wheat prices. The effects of international grain price rises began to feed into Polish markets in the

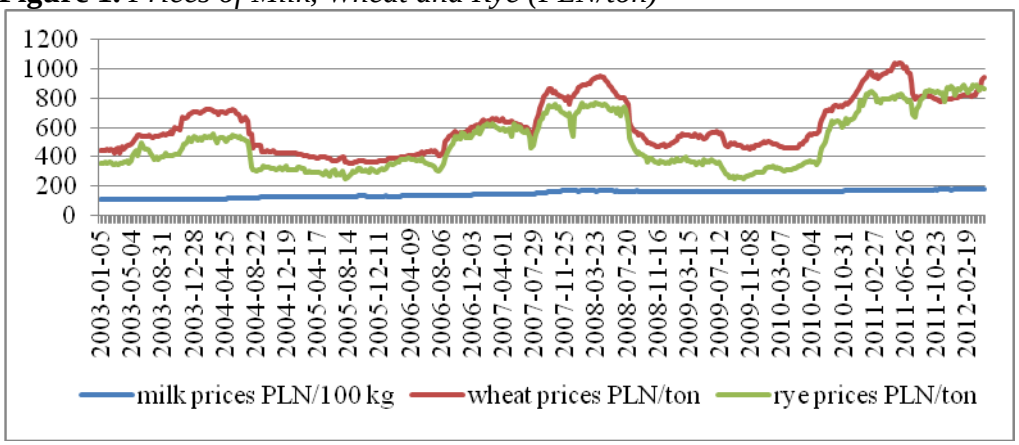
latter part of 2006. Cereal crop production in 2005 has dropped by 8.0%-12% and the yields were by 10%-14% lower than 2004. Domestic use of cereals during 2005 and 2006 has been 2.0% higher with the 2.8% increase in feed demand. These changes in the market fundamentals caused the price shifts in 2006.

Rye Market in Poland

Cereal crops were down by 8.0-12% in 2006 compared to the 2004 record level of 26-27 million tons. Cereal supply was estimated at 8,5 million ha in 2006 versus 8,3 million ha in 2004. Average yield of rye in 2006 was 10%-15% lower than in 2004. A similar situation is observed in other EU countries where cereal prices are expected to rise in the near future. That is why we can observe the increase of rye price in 2006.

As in the case of wheat, the highest changes of rye prices were observed just after the accession date. Another important change in rye prices was observed in 2006. Under present conditions, an inflow of cereals from EU founder members and newcomers into the Polish market is unlikely to occur. Imports to Poland from the EU-15 are relatively unprofitable. However, some imports from neighbouring countries (Czech Republic, Slovakia) or Hungary are possible.

Figure 1. *Prices of Milk, Wheat and Rye (PLN/ton)*



Source: Ministry of Agriculture and Rural Development Data 2011.

Price Volatility of Agricultural Commodities in Poland-Analysis of Results

Agricultural commodity prices vary seasonally. During the harvest time grain prices are especially low, because of the supply inflow of grain on the market. This is an inducement for farmers and others to store grain. Although every December the Rural Market Agency makes intervention purchases, not all Polish farmers can benefit from direct purchase. First of all the minimum amount of purchase is 80 tons of grain and small scale farmers do not produce this much. Secondly, the quality of grain must be high and not all farmers can

produce this quality. What is more, not all farmers have on-farm storage to keep grain from August to December. Thus only big producers can sell into intervention. ***The degree of intervention in agricultural markets and pricing within the EU are expected to stabilize agricultural commodity prices.***

In Table 1, agricultural commodity price volatility is presented. Stable milk prices, in the aftermath of intervention in the market, can be observed. Wheat and rye prices are more prone to fluctuation because of global markets forces.

Table 1. *Average Prices of Agricultural Commodities in Poland*

Years	Milk (PLN/100 kg)	Wheat (PLN/ton)	Rye (PLN/ton)
2003	105.6	552.6	420.0
2004	114.9	584.1	433.7
2005	128.2	385.8	297.6
2006	133.9	466.1	415.7
2007	149.3	695.8	623.6
2008	164.8	725.6	593.9
2009	160.5	513.1	327.5
2010	162.3	596.9	442.7
2011	171.2	900.2	805.2
2012	174.9	836.1	867.1

Source: Own Calculation on the Basis of Central Statistical Office Data (GUS 2013).

Grain price volatility was calculated using basic descriptive statistics in Table 2. Over the period 2003-1012, the average monthly Polish grain prices were 609.7 PLN/ton for wheat, 498.2 PLN/ton for rye and 145.0 PLN/ton for milk. The data show that Polish grain prices did not change normally. Descriptive statistics in Table 2 suggest that the changes in Polish grain prices over the last four years can be described as following a flexible trajectory.

Statistical analysis of the data enabled a calculation of the Hurst coefficient (H). When H is higher, the risk level is smaller (Sobczyk 2005). If H is between (0.5-1.0) the elaborated rank is persistent and characterized by a long memory effect. When the H coefficient is between (0.0-0.5), the correlation is minus with the market being expected to change movement direction. For H=0.5 the variables are not dependent. The H coefficients calculated in the survey were very high. The test suggests that there is almost a 95% chance that this rise of milk will be preserved in the future (the relevant probabilities for wheat and rye prices are 91% and 89% respectively). This prognosis seems to be rather optimistic for Polish grain producers.

The descriptive statistics show that the price distribution for grain in Poland was positively skewed. The asymmetry in grain distribution can be described as right-sided.

The kurtosis analysis indicates that the values of the variables are less concentrated around the mean than in the normal distribution (-1.3288 for milk, -0.82862 for wheat, -1.0246 for rye).

Table 2. *Descriptive Statistics for Grain Prices*

Specification	Milk	Wheat	Rye
Mean	**145.09**	**609.72**	**498.20**
Median	**150.10**	**558.00**	**428.00**
Minimal	**106.80**	**352.00**	**245.00**
Maximal	**175.70**	**1042.0**	**892.00**
Standard deviation	**22.237**	**181.33**	**189.42**
Coefficient of variation	**0.15326**	**0.29739**	**0.38022**
Skewedness	**-0.33826**	**0.54637**	**0.58795**
Kurtosis	**-1.3288**	**-0.82862**	**-1.0246**
Hurst coefficient (H)	**0.95**	**0.91**	**0.89**

Source: Own calculation on the basis of Central Statistical Office data (GUS 2013).

GARCH Modelling

The Generalized Autoregressive Conditional Heteroscedasticity (GARCH) models, introduced by Engle (1982) and Bollerslev (1986), are designed to capture certain characteristics of time series.

Our processes can be modelled as AR (p)-GARCH$(1,1)$, given by the following equations:

$$y_t = \phi_0 + \sum_{i=1}^{p} \phi_i y_{t-i} + e_t, \tag{1.2}$$

$$e_t \,|\, \psi_{t-1} \sim t(\upsilon, 0, h_t), \tag{1.3}$$

$$h_t = \alpha_0 + \alpha_1 e_{t-1}^2 + \beta_1 h_{t-1}, \tag{1.4}$$

where ψ_{t-1} denotes series history up to time $t-1$, $t(\upsilon,0,h_t)$ stands for Student t distribution with υ degrees of freedom $(\upsilon > 2)$, location being equal to zero and conditional variance h_t. Given the regularity conditions $\alpha_0 > 0, \alpha_1 \geq 0, \beta_1 \geq 0$ the required stationarity condition is $\alpha_1 + \beta_1 < 1$. Also, due to the presence of autocorrelation the roots of the polynomial $z^p - \phi_1 z^{p-1} - \phi_2 z^{p-2} - ... - \phi_p = 0$ lie inside the unit circle.

A commonly used test for ARCH is the Lagrange multiplier (LM) test. The residuals e_t (1.2) from a preliminary OLS estimation can be tested for ARCH behaviour. Consider the null hypothesis that there is no ARCH, that is, $\alpha_1 = \alpha_2 = ... = \alpha_q = 0$. The LM statistic (Bollerslev 1986) has an asymptotic χ^2 distribution with q degrees of freedom under the null hypothesis. LM and Jarque-Bera test results are presented in Table 3. First looking at Table 3, we look for significant ARCH lags. It appears that ARCH components are significant for milk and wheat. The kurtosis and Jarque-Bera test results

suggest that our data are non-Gaussian. GARCH - *t* model (1.2) - (1.4) exhibits fat tails and Student's - *t* distribution allows for excess kurtosis in the conditional distribution.

Table 3. *Testing for ARCH in Residuals* e_t

	Milk		**Wheat**		**Rye**	
Order of ARCH	ARCH LM	*p*-value	ARCH LM	*p*-value	ARCH LM	*p*-value
$q = 2$	13.5832	0.0011	2.1513	0.3410	3.5138	0.1725
$q = 4$	13.6499	0.0085	3.2924	0.5101	4.4193	0.3522
$q = 8$	16.1321	0.0405	15.1857	0.0556	6.7328	0.5657
Jarque-Bera	161.897		40.215		10.470	
Kurtosis	15.847		3.7463		2.2660	

Source: Own calculation on the basis of Central Statistical Office data (GUS 2013).

Table 4. *AR(p)-GARCH(1,1) with Conditional t-Student Distribution*

Variable	**Coefficient**	**Std. error**	***t*-Statistic**
Dependent variable: Milk			
ϕ_0	-0.0196	0.2183	-0.0900
α_0	0.9192	0.5995	1.5332
α_1	0.5721	0.0945	6.0539
β_1	0.4279	0.0127	33.692
υ	2.9720	1.2321	2.4121
Likelihood =-352.6691			
Dependent variable: Wheat			
ϕ_0	0.2794	0.1644	1.6996
α_0	1.2967	0.6822	1.9007
α_1	0.4363	0.0224	19.477
β_1	0.5624	0.0754	7.4588
υ	2.8872	0.0714	40.4369
Likelihood =-365.5439			
Dependent variable: Rye			
ϕ_0	0.2541	0.1574	1.6653
α_0	1.3451	0.6933	1.9352
α_1	0.4536	0.0116	19.511
β_1	0.5542	0.0852	7.5188
υ	2.9113	0.0843	40.5296
Likelihood =-384.2751			

Source: Own Calculation on the Basis of Central Statistical Office Data (GUS 2013).

Table 4 presents maximum likelihood estimates for the GARCH model (1.2) - (1.4). The empirical evidence suggests that there is no serial correlation

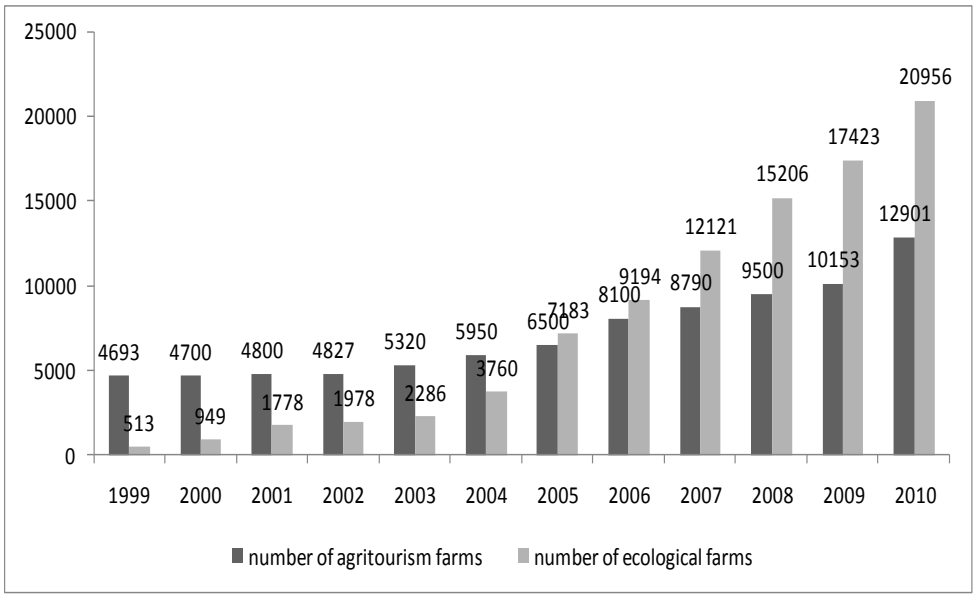
in the analysed series. The degrees of freedom are equal to 2.97, 2.88 and 2.91. The conditional t -distribution is distinctly fatter-tailed than the normal. In the two cases where $\alpha_1 > \beta_1$, the conditional variance depends more on price volatility observed in the previous period (Bórawski and Kwiatkowski 2007).

Income Situation of Polish Farmers

We have analysed how the economic situation of farms has changed in Poland. Since 1994, Polish farmers have increased their incomes. The highest rate of income increases has been observed in Poland after integration with the European Union. There are many reasons for the increase of farms' income in Poland with the most important one being the direct sources of financing from the European Union budget. Polish agriculture has benefited mostly from direct payments and additional money from Sectoral Operational Programme.

Another important source of incomes of farms in Poland is agritourism. This activity is closely linked to the overall farm and agricultural activity. In 2010 Poland had nearly 13,000 agritourism farms (Figure 2). This increase in the number of farms is the result of favourable natural conditions for agritourism development. It is a good way for farm's incomes development, especially smaller farms located close to natural resources such as lakes, rivers, forests, meadows and environment monuments. Customers choosing agritourism can rest well in the farm and take part in simple activities. This helps them to recover and relax in the village, far away from urban areas. What is more, the prices of bed and breakfast in agritourism farms are somewhat cheaper than hotels. The average price of a bed in a typical agritourism farm is calculated to approximately 30-40 PLN which is equivalent to around 10 Euro and $12. As a result of this low cost, agritourism is considered to be very competitive to other tourism activities.

Figure 2. *Number of Agritourist and Ecological Farms in Poland*



Source: http://www.ijhar-s.gov.pl/.

Another important branch of activity is ecological farming. Lately, the number of ecological farms in Poland has been increasing each year. Poland has good conditions for ecological farm development. Also ecological farms get a special payment for unconventional production. The market for healthy biologic products has been increasing in Poland. Each year more customers buy healthy products. This is the effect of development of consumer awareness. When the economic situation of customers improves they buy more ecological products. Each consumer is behaving rationally from his or her point of view. Another factor stimulating the development of ecological faming is the increasing demand for healthy products in the European Union and world markets.

Table 5. *Average Incomes of Conventional Farms in Poland*

Year	Average monthly income of farms per farm (PLN)	Average monthly income of farms per person (PLN)
1994	856	205,2
1995	1,158	282,4
1996	1,417	343,2
1997	1,820	439,3
1998	1,667	406,8
1999	1,693	411,4
2000	1,930	456,0
2001	2,072	497,5
2002	2,307	571,8
2003	1,985	474,3
2004	2,298	539,9

2005	2,595	606,2
2006	2,986	689,8
2007	3,682	846,8
2008	3,816	887,3
2009	3,809	884
2010	4,443	1,024.5

Source: Own Calculation based on Central Statistical Office Data (GUS 2013).

The Impact of Commodities Prices on Farms Income in Poland

We have used regression analysis to measure the impact of agricultural commodities price volatility on alternative incomes of conventional, ecological and agritourist farms. We have found that price volatility indeed had a significant, positive effect on alternative income. When the *p-value* is smaller than 0.05 then the impact is important at the 95% level. Price volatility positively affects incomes of conventional farms as well as agritourism and ecological farms. For conventional farms, the profits from good years more than offset the losses of bad years, and of course the volatility creates incentives for farms to have alternative income sources to help weather the periods of low prices (Table 6).

The regression analysis indicates that price volatility has a strong impact on farm incomes. Of course, this means that price volatility of agricultural commodities had a strong impact on farmers' economic situation.

Table 6. *Regression Analysis Measuring the Impact of Price Volatility on Economic Results*

Dependent variable	**Average monthly income of farms calculated by farm (PLN)**	**Average monthly income of farms per 1 person (PLN)**	**Number of agritourism farms**	**Number of ecological farms in Poland**
R^2	0.932	0.943	0.881	0.957
Test F	23.092	27.605	12.397	37.256
p value	0.002	0.001	0.034	0.000
Regression	0.671	0.706	0.673	0.989

Source*: Own calculation based on data from Ministry of Agriculture and Rural Development 2011.*

Conclusions

Polish accession to the EU affected agriculture price volatility. Polish agriculture commodity prices had to be adjusted to the Common Market and, finally, decreased. However, the economic situation of farmers has improved because they gained income from direct payments and other financial sources.

Another important period, during which price volatility emerged as a phenomenon sweeping through the European as well as the international markets, was the financial crisis. This affected mainly grain markets and did not have a strong impact on milk prices, since milk production is regulated by milk quotas. The crisis pulled agricultural prices down and limited farmers' income.

The analysis conducted in the context of this paper shows a low impact of integration with the EU and the world financial crisis on agricultural and alternative income development in Poland. We observed stable increase in incomes in Poland, providing evidence that economic tools and mechanisms implemented to protect agricultural production worked properly. The tendency of agricultural commodity prices to increase had a positive impact on farmers' income and improved the overall economic situation of grain processing enterprises.

In conclusion, Polish agricultural commodity price volatility had a significant and positive impact on the economic performance of the farms. Despite this positive impact of volatility, the management challenges which are presented in this context are very important. Accordingly, actions should be taken to reduce the price volatility. For instance the development of modernization and mechanization of Polish agriculture could lower production costs, resulting in higher farm incomes. For this purpose, further research needs to focus on new varieties of grain and their set of advantages and disadvantages in order to achieve lower production costs

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