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Common agriculture policy and price stabilisation – the case of wheat market

Abstract: *Agricultural prices volatility plays important role in the variety of economic processes. It directly impacts stability of farmers' income and has impact on economic efficiency of agricultural production. In this paper volatility of prices on Polish, European Union and global wheat market is quantified. The aim of the article is to answer the question whether Polish wheat price volatility changed after joining the European Union. Using monthly prices for two subperiods 1993-2004 and 2005-2014 absolute and relative volatility was estimated. The results indicate that there was a substantial volatility growth after accession to the European Union. However when the relation of volatility on Polish market to that observed on European and global market was estimated, there was a fall in the level of relative volatility, especially when short-term fluctuation were excluded from analyzed time series. To identify changes in volatility transmission patters Granger causality tests were also conducted. Change in wheat price volatility transmission was revealed. Before joining the European Union volatility of Polish wheat prices was Granger caused by fluctuations on global market, while after 2004 European prices volatility was found to be a Granger cause of Polish wheat prices volatility*

Keywords: *Wheat prices, volatility, Polish wheat market, Granger causality.*

Introduction

The issue of price risk in agriculture has always attracted considerable attention of policymakers, farmers, and agricultural economists. There is a vast literature that deals with the problem of growing agricultural commodities price volatilities. Since food crisis in 2007/08 there is observed even growing number of studies approaching a question of unstable prices in agri-food sector (Kornher, Kalkuhl, 2013).

In this paper the small fraction of this broad issue is taken into consideration. The author focuses on problem of Polish and international wheat prices and changes in its volatility. The main question is whether the wheat price volatility after joining the European Union (EU) decreased or increased on Polish market. On the one hand joining the EU should minimize price volatility since impact of exogenous shocks like extreme weather conditions on total production is more heterogeneous and less significant. On the other hand Common Agricultural Policy (CAP) became in last decades more market-oriented and agricultural commodities price volatilities on EU market rose considerably. Trade liberalization also matters since price shocks are quickly transmitted from international markets to domestic ones. Wheat, prices on Polish, European, and International market covering the period 1993-2014 are used to find the answer to the question whether EU accession created more favorably market conditions for Polish farmers in terms of price risk. The annualized standard deviation of logarithmic price ratios is used as a volatility measures. Prices from EU and global market are used as a benchmark. The assessment of Granger causality between analyzed time-series is employed to identify the nature of price volatility transmission.

Literature review

There is wide scientific literature concerning with problems of price volatility in agriculture. This issue is of great importance since high price risk can cause loss of economic efficiency, diminish economic growth and lower farmers' welfare (World Bank, 2005). Higher price volatility can also discourage agricultural investment in terms of cropland expansion (Haile and Kalkhul 2013).

Although food prices have always been more volatile than any other commodity (However, Chand, 2010), substantial upward shift in agricultural price volatility since the beginning of food crisis in 2007/08 drove even more intensified attention on topic of price volatility and its main causes. Growing global biofuel sector and increased strength of linkage between prices of energy and agricultural products was one of the most important factor of this growth (Tyner, 2010, Patton et al., 2012). Development of food commodity futures markets was found to be another cause of increased agricultural prices volatility (von Braun, Tadesse, 2012, Gilbert, 2010). Among other factors of observed price volatility growth supply shocks due to unfavourable weather conditions and growing demand for food due to dynamic economic growth in China and

throughout Asia (Gilbert, 2010) or volatile exchange rates (Balcombe, 2009) should also be mentioned. Hamulczuk et al. (2012) presented the extended list of factors influencing volatility of agricultural commodity prices.

Although there are many studies concerning issues of price volatility in agriculture, the majority of papers refers to price changes in highly developed or developing countries. Some authors judge the number of analysis of food price volatility in New Member States as inadequate. In their study Bakucs and Jambor (2014) using the Eurostat monthly food price indices for years 2005-13 found that food price volatility differs significantly among NMS and different products. In another study concerning the agricultural price volatility in selected East European countries authors evaluated levels and components of wheat price volatility in years 2004-2011 and examined the sensitivity of volatility to spatial aggregation of the price data (Figiel et al., 2012). Despite fact, that on EU single market price levels follow similar trends differences in volatility of national prices were demonstrated. Smaller countries like Lithuania, Slovakia or Hungary experience higher volatility, while prices in France or Germany are more stable. Polish wheat prices volatility was close to the EU average. Agricultural price volatility on the German markets were analyzed by von Ledebur and Schmitz (2012). They focused on an agricultural policies impact on price volatility and showed that after Mid-term-Review of CAP, historical volatility increased significantly in Germany.

Data and Methods

Monthly wheat prices for Polish, German and USA market are used to assess the level of volatility in period from January 1993 to December 2014. German wheat prices are used as a proxy for EU market and wheat prices for USA are used as a proxy for world price. Central Statistical Office (CSO) is a source of data for Polish wheat prices. In the case of German prices data are taken from Eurostat database. In this database data for average EU price are also available. However due to the fact, that aggregated prices are less volatile than those from any single member state, German prices are used. World prices are taken from International Monetary Fund (IMF) database. Time series analyzed in the paper are American soft red winter wheat export price delivered at the US Gulf port for prompt or 30 days shipment.

All prices are converted from nominal to real prices using Consumer Price Indices for analyzed countries from Federal Reserve Bank of St. Louis Database. X12ARIMA RSA3 procedure using Demetra+ software is employed for decomposing time series of real prices into following components: trend-cycle (TC), seasonal changes and random fluctuations (Grudkowska, 2013). Seasonal components were excluded from time series since this part of volatility should not be considered as a price risk for farmers. So, in further analysis only trend-cycle component and random fluctuation are taken in to consideration. In this paper two different time series for every price are used: desea-

sonalized time series, and T-C component. Two periods are compared in the analysis. The pre-accession period that last from 1993 up to the end of 2003 and the post-accession one that start from the beginning of 2004. Year 2004 was exempt from analysis since significant instability during this one-year period was distinctive due to integration of the EU and Polish agricultural commodity market. The author employed annualized standard deviation (ASD) of logarithmic price ratio to estimate price volatility. It is defined as follows:

$$\sigma_t = \left[T * \left({}^{1}/_{n-2} \right) \sum_{t=2}^{n} (r_t - \bar{r})^2 \right]^{1/2}$$

where r_t is rate of return in moment t defined as $r\_t = ln(Y\_t / Y\_(t - 1)$, $\bar{r}$ is the average rate of return in the period from 1 to n (number of observations) and T is the number of periods in year (12).

To identify the occurrence and direction of volatility transmission between analysed time series Toda and Yamamoto (T-Y) procedure to test for Granger causality is employed (Toda Yamamoto 1995). To determine order of integration the Augmented Dickey-Fuller (ADF) and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) tests were used (Lütkepohl, Krätzig, 2007). The formula for Vector Autoregression (VAR) model that is set up is presented below (Tsay 2010):

$$Y_t = \psi D_t + A_1 Y_{t-1} + \ldots + A_p Y_{t-p} + u_t$$

where: Y_t – stochastic process, Ψ – matrix of deterministic variable parameters, D_t – vector of deterministic variables, A_i – coefficient matrices, p – order of VAR model.

When employing T-Y procedure one must not differentiate data in VAR model. Maximum lag length p is sum of maximum order of integration (m) and number of lags suggested by AIC (q) for the best fitting model.. If there is a significant correlation in the residuals, p can be increased to resolve the problem.

The Granger causality means that forecasts of y variable are more accurate when values of x are used than without them (Lütkepohl, Krätzig, 2007). Granger causality test is based on following formula:

$$y_t = a + \sum_{j=1}^{k} \alpha_j y_{t-j} + \sum_{j=1}^{k} \beta_j x_{t-j} + \varepsilon_t$$

where: a, α_j, β_j – model parameters, k – maximum lag length, ε_t – random component. Null hypothesis states that there is no Granger causality ($\beta_1 = \ldots = \beta_k = 0$)[1].

[1] Testing Granger causality using T-Y procedure it is essential to test the hypothesis that only first q lagged values (number obtained by using AIC) of x equals 0.

Results

The changes in Polish wheat price are presented in Figure 1. Cyan blue line represents real prices and violet line – nominal prices. Two main conclusion can be found from graphical analysis. First one is that there are significant differences between nominal and real prices due to high level of inflation during the last decade of XX century. The second one is that there were many price peaks and price troughs on Polish wheat market during the whole analyzed period. Significant price growths occur in 2007/2008 and in 2011. The nature of the first growth can be considered as a rather short-term since prices decreased in 2009. The second price increase lasted longer, however one can observe that Polish wheat prices decreased again after 2013. There were also significant fluctuation before year 2004, however these changes – except changes in 1996 – were quite smaller. There were also large instability during the period of Polish accession to EU. That was the effect of Polish and EU market integration.

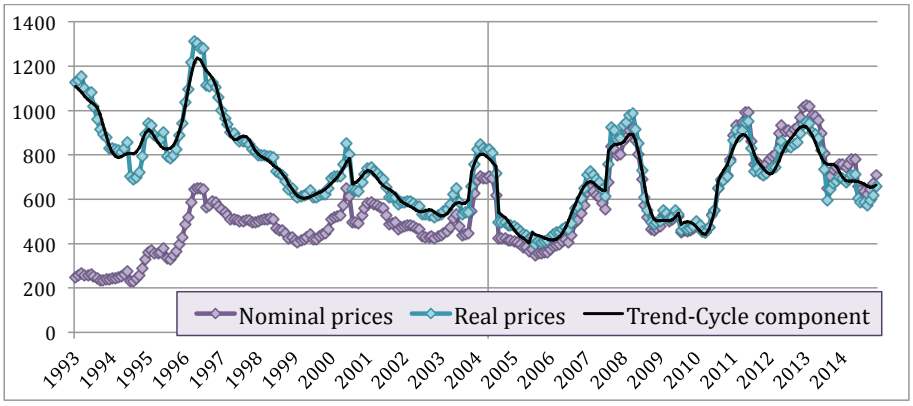

Figure 1. Nominal prices, real prices (fixed prices 2010) and Trend-Cycle component of Polish wheat in years 1993-2014 (PLN/t)

Source: Own calculations based on GUS.

Price fluctuations on EU and global wheat markets are presented in Figure 2. It is easily seen that up to year 2003 wheat prices on global and EU markets followed different patterns. Global wheat prices were set up on the free-market basis on the international market. Its changes reveal the occurrence of supply shocks and changes in the trade policies. In the same time the level of EU wheat prices was the reflection of intervention price determined by the Common Agricultural Policy rules (Ledebur, Schmitz, 2012).

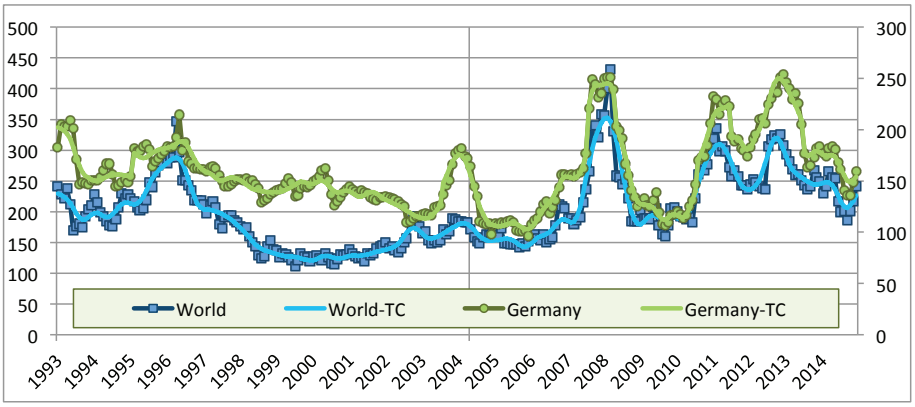

Figure 2. Real prices (fixed prices 2010) and Trend-Cycle component of European (€/t – right axis) and world ($/t – left axis) wheat in years 1993-2014

Source: Own calculations based on Eurostat and IMF.

Before 2004 there was no price convergence between these two markets at all. Since Common Agricultural Policy became more market-oriented and dynamic agricultural commodity price growth occurred during food crisis 2007/08 the previous situation became history. One can observe that through last years, price peaks and troughs were appearing in the exactly the same moments on both markets. There were significant wheat prices growths, during food crisis 2007/08, then in 2010/11 and 2012/13 years on these markets.

Since X12ARIMA RSA3 procedure let to take a look into the changes of seasonal component through the years it is possibly to answer the question whether seasonal component is really so stable that can be excluded when price volatility is estimated. Changes in seasonal variation of polish and world wheat prices are presented in Figure 3. The shape of seasonal changes in European market are similar to those observed on Polish market. Graphical analysis indicate that there were no significant changes in seasonal component in Polish market. Substantial drop in monthly prices is observed always in post-harvest period in August and September. World prices monthly bottom appears in June and July. One can also notice that through the years seasonal changes range decreased. Wheat prices in 2014 are more smooth than two decades before. Still, the general shape of the world wheat price seasonal fluctuations remain more or less the same.

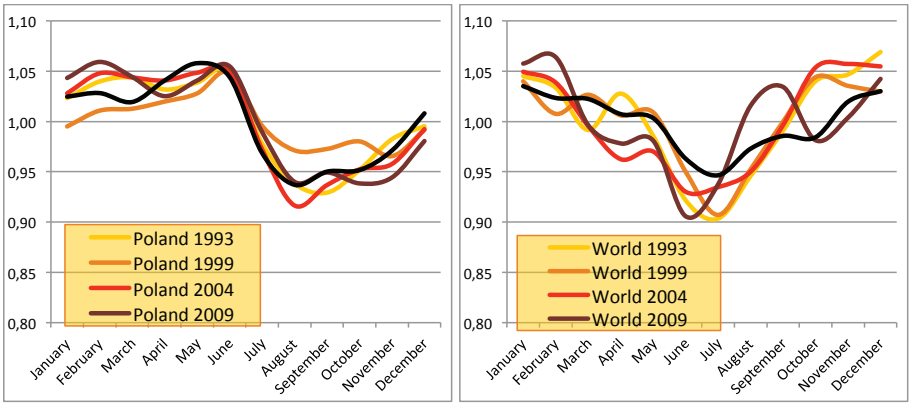

Figure 3. Changes in seasonal variation of polish and world wheat prices in year 1993, 1999, 2004, 2009, and 2014.

Source: Own calculations based on GUS and IMF.

Using the formula for annualized standard deviation (ASD) of logarithmic price ratio the level of volatility of Polish wheat prices was calculated for consecutive months of analysed period. Since there is a need for 12 previous observation to calculate the level of volatility for a given moment, the length of analysed time series was shortened, as it can be seen in figure 4, which present changes in the volatility of Polish wheat prices. The level of volatility was calculated for two time series: deseasonalized prices, and Trend-Cycle component. The volatility of the latter one is of course lower in most cases, since there are no random fluctuation in this time series. However in specific situation there can be opposite relation if the direction of random changes is opposite to some mid- and long-term changes, as it was the case in Polish wheat prices at the end of 2010.

As it is presented on Figure 4, the level of Polish wheat price volatility was slightly higher after joining the EU. One of the reason of this growth is the difference between agricultural policies in Poland and UE. The Polish agricultural policy before joining the EU was aimed at keeping cereals – including wheat – prices stable. Minimum price for wheat at relatively high level was set. Moreover there were significant intervention purchasing and high import tariffs in Poland before 2004. For instance during marketing year 1995/95 Agricultural Market Agency purchased nearly 70% of all registered purchasing. After year 2004 volatility of Polish wheat prices increased significantly, due to changes in Common Agricultural Policy that became more market-oriented that previous Polish agricultural policy.

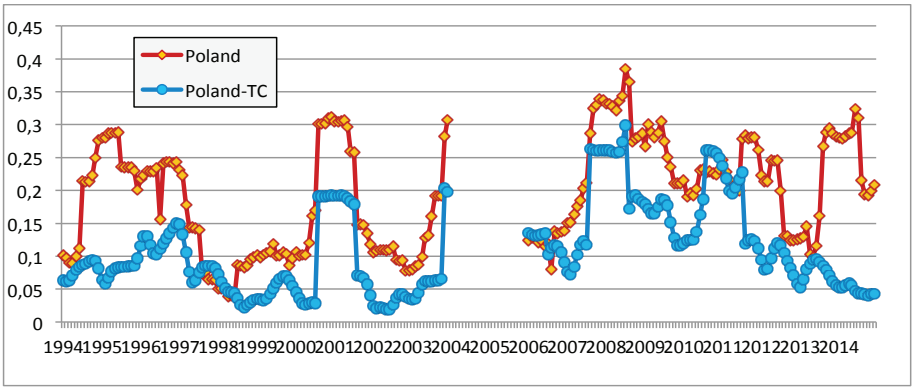

Figure 4. Volatility of Polish wheat prices in 1994-2004 and 2006-2014
Source: Own calculations based on GUS.

Figures presented in Table 1 confirm conclusions from drawn from graphical analysis. In the case of ASD of deseasonalized time series mean, median, 1st and 3rd quartiles were higher after 2004. The same turns out when one analyses the annual standard deviation of Trend-Cycle components. There is a twofold increase of the volatility level after 2004.

Table 1. Descriptive statistics of ASD of Polish wheat prices

	Mean	Median	SD	1st quartile	3rd quartile
Deseasonalized before 2004	0.164	0.137	0.082	0.098	0.235
Deseasonalized after 2004	0.227	0.226	0.072	0.172	0.281
T-C component before 2004	0.081	0.067	0.050	0.042	0.095
T-C component after 2004	0.140	0.123	0.070	0.085	0.187

Source: Own calculations based on GUS.

Changes in the policy over the wheat market in Poland and EU are not the only ones important reasons for the increase of Polish wheat price volatility. Since Poland is small economy there is a dependence between domestic and international prices. Taking this into the consideration it is interesting to observe the international conditions on wheat markets. As it is presented in Figure 5. where changes in a volatility of EU and world wheat market are shown, price volatility growth concerned not only Polish, but international wheat markets as well. When it comes to EU market there is considerably large growth in the volatility level after 2004. After reducing the intervention price, the market wheat price fluctuation became much larger. Moreover EU market price started to be dependent on processes determining world price and as it was presented before there were few serious shock prices on international cereal markets. All these fluctuation was transmitted to EU market. When analysing world wheat price volatility it is also worth to mention that 2004 is not only the year of the EU enlargement. This year is also used as a threshold year in studies concerning effect of biofuel productions to agricultural prices volatility (da Silveira, Mattos, 2015). Biofuel production growth is one of many factors that influenced world wheat price volatility.

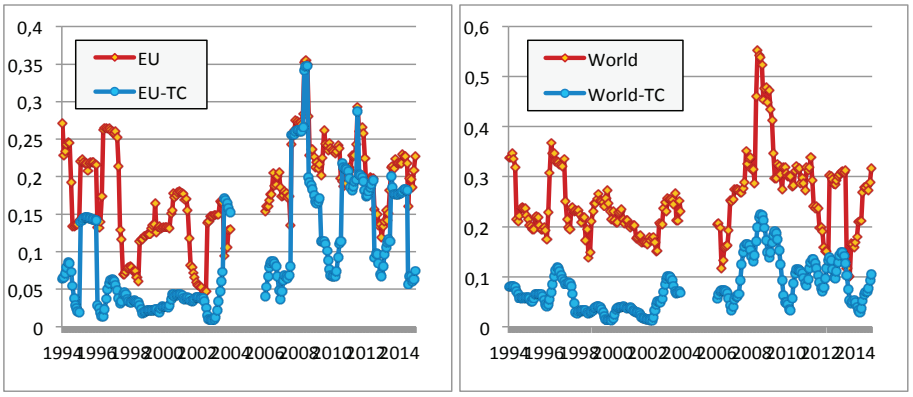

Figure 5. Volatility of EU and world wheat prices in 1994-2004 and 2006-2014

Source: Own calculations based on Eurostat and IMF .

In the table 2. selected descriptive statistics of ASD for EU and world wheat prices are presented. Significant increase of wheat price volatility is observed on both analysed markets. This growth is larger for a T-C component than of deseasonalized time series for both markets. It is also worth to mention that there was smaller volatility growth for world market than for EU market.

Table 2. Descriptive statistics of ASD of EU and world wheat prices

	Mean	Median	SD	1st quartile	3rd quartile
		EU market			
Deseasonalized before 2004	0.151	0.138	0.062	0.117	0.196
Deseasonalized after 2004	0.213	0.213	0.045	0.185	0.236
T-C component before 2004	0.052	0.037	0.043	0.024	0.059
T-C component after 2004	0.147	0.167	0.074	0.080	0.193
		World market			
Deseasonalized before 2004	0.230	0.220	0.050	0.201	0.249
Deseasonalized after 2004	0.284	0.287	0.095	0.230	0.315
T-C component before 2004	0.052	0.046	0.027	0.031	0.069
T-C component after 2004	0.106	0.103	0.049	0.066	0.140

Source: Own calculations based on Eurostat.

As it was shown Polish wheat price volatility increased substantially after 2004. However this was the case not only on Polish market, but also on EU and world wheat market. Since that it is interesting to compare relation of changes in wheat price volatilities on different markets. Relation of Polish to EU wheat price volatility during two analysed subperiods is presented in Figure 6. When T-C component of analysed time series are taken into considerations it can be seen that before 2004 volatility on Polish market was significantly higher than volatility on EU market – the value of the relation is above value 1. However after 2004 the value of this relation is much lower (violet line is oscillating near value 1). In the case of deseasonalized time series (green line) it is not easy to answer the question whether the relation of Polish to EU wheat price volatility increased after the year 2004.

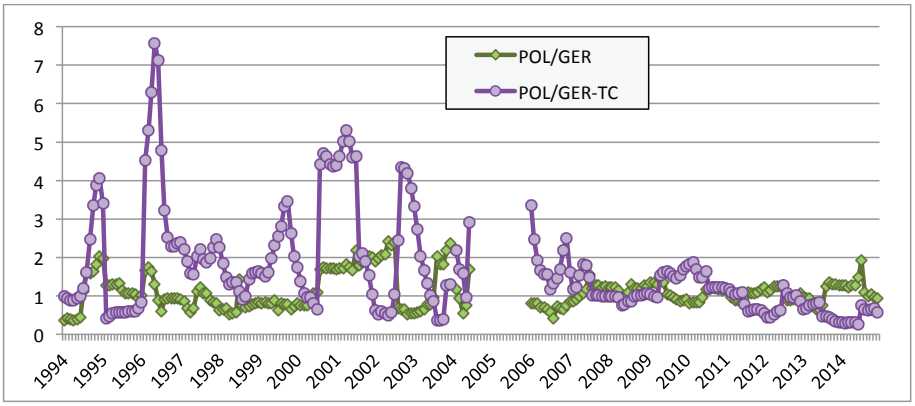

Figure 6. Relation of Polish to EU wheat price volatility in 1994-2004 and 2006-2014
Source: Own calculations based on GUS and Eurostat.

Descriptive statistics included in table 3. indicate that there was growth in volatility of Polish wheat price in relation to EU wheat price volatility only if T-C component is taken into consideration. There was a drop in mean, median and two quartiles for relation of Polish to EU ASD of wheat prices after 2004. The changes for this relation in the case of deseasonalized prices where ambiguous.

Table 3. Descriptive statistics of Polish to EU ASD wheat prices relation

	Mean	Median	SD	1st quartile	3rd quartile
Deseasonalized before 2004	1.164	0.930	0.555	0.746	1.702
Deseasonalized after 2004	1.055	1.080	0.237	0.885	1.230
T-C component before 2004	2.187	1.701	1.578	0.971	2.918
T-C component after 2004	1.081	1.019	0.534	0.658	1.472

Source: Own calculations based on GUS and Eurostat.

Similar results are get when relation of Polish to world wheat price volatility is analyzed. Changes of this relation is presented in figure 6. The same as in the previously analyzed relation there is a significant decrease when T-C component (violet line) is taken into consideration. However when relation of deseasonalized prices ASD (green line) are analyzed it is difficult to find if there were any changes in average level between the first and the second subperiod.

The values of mean, median and other quartiles show substantial drop of Polish wheat price volatility comparing to world price volatility when analyzing T-C component. Opposite to the relation between Polish and EU wheat prices, in this case it can be seen, that in the case of deseasonalized time series there is a slight increase of Polish wheat price volatility relatively to the world price volatility.

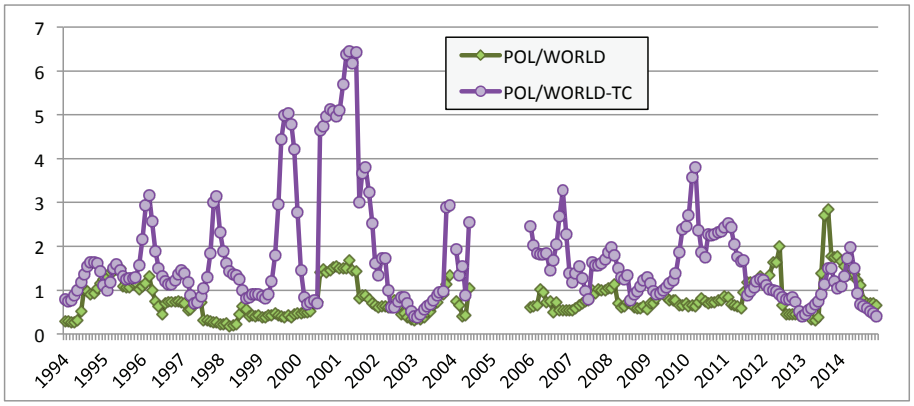

Figure 7. Relation of Polish to world wheat price volatility in 1994-2004 and 2006--2014

Source: Own calculations based on GUS and IMF.

Table 4. Descriptive statistics of Polish to world ASD wheat prices relation

	Mean	Median	SD	1st quartile	3rd quartile
Deseasonalized before 2004	0.739	0.650	0.402	0.414	1.036
Deseasonalized after 2004	0.880	0.720	0.437	0.633	1.034
T-C component before 2004	1.938	1.328	1.549	0.882	2.544
T-C component after 2004	1.448	1.300	0.684	0.950	1.851

Source: Own calculations based on GUS and IMF.

Summing up, there was a substantial growth of Polish wheat price volatility after joining the EU. It was partly due to change in policies determining the wheat price stability. However, when comparing this growth to changes on EU and world wheat market it is easily seen that another reason of this growth was significant increase in wheat prices fluctuation on EU and world prices. Polish accession to EU coincided with changes in Common Agricultural Policy that became more market-oriented during the first decade of the XXI century. It is now interesting to identify what was the main reason of Polish wheat price volatility changes during two analyzed subperiod. To answer these question Granger-cause analysis was conducted. The results of this analysis is presented in Table 5.

Table 5. Granger-causality test results for wheat prices volatility

		1993-2003		2005-2014	
Cause	**Effect**	**F Statistics**	**p value**	**F Statistics**	**p value**
Germany	Poland	0.90334	0.553266	**2.64472**	**0.003754**
World	Poland	**2.99286**	**0.054243**	1.58542	0.112487
Poland	Germany	1.20116	0.294894	0.79572	0.683890
Poland	World	1.43667	0.242142	1.53650	0.128394

Source: Own calculations based on GUS and IMF.

This analysis included testing stationarity of analyzed time-series (all analyzed time series were integrated of order 1), setting proper VAR models and conducting Granger-causality tests. The results of Granger-causality tests are presented in Table 5. Null hypothesis states that there is no Granger causality, low p values indicate presence of Granger causality. The change in the pattern of price volatility transmission is in line with intuition It was proven that volatility of Polish wheat prices during pre-accession period was Granger-caused by fluctuations on world wheat markets. However after joining the EU, wheat prices volatility was transmitted to Polish market from EU market.

Conclusions

There is a growing concern about issues related to high agricultural commodities price volatility since the food crisis in 2007/08. The analysis of Polish wheat price volatility revealed that there was a substantial volatility growth after joining the EU. It was partly due to differences in the shape of agricultural policy in pre-accession Poland and Common Agricultural Policy in EU. However when comparing observed volatility growth to the changes of volatility level on EU and global markets this growth should be considered as a relatively small. In fact, relation of wheat prices volatility on Polish to EU and global market decreased after 2004, especially when T-C component (short-term fluctuation were excluded from analyzed time series) is scrutinized.

Another interesting conclusion is that there was a change in the pattern of price volatility transmission. Before 2004 wheat prices volatility was transmitted from world market, while after joining the EU, European price volatility started to determine Polish wheat price volatility.

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