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RESPONSE OF THE POLISH WHEAT PRICES TO THE WORLD'S CRUDE OIL PRICES

CITLIVOSŤ POĽSKÝCH CIEN PŠENICE NA SVETOVÉ CENY ROPY

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Agricultural commodities prices play crucial role both in farmers' income determination and in price relationship establishment for the whole economy. Among the factors influencing the wheat prices, crude oil prices are considered as one of the most important. The aim of this paper was to assess the character of linkage between world crude oil prices and Polish wheat prices. Results of the research confirm the existence of such linkage although the nature and the strength of this relationship changes over time. However, the long-run relationships between the crude oil and Polish wheat prices were not proven. Moreover, growing impact of crude oil prices on Polish wheat prices over time was not detected. The results suggest that exchange rates may strongly influence wheat prices. This in turn may weaken response of Polish wheat prices in relation to world's crude oil prices.

Key words: wheat price, crude oil prices, price transmission, VAR, cointegration

In the last years relationships between energy and agricultural sectors have become a very important economic issue. The most important reason for growing attention given to this problem is the growing global biofuel sector. In the first decade of this century the liquid biofuel production expanded from 18.2 to 105 billion liters (the vast majority refers to bioethanol) (Rosiak et al., 2011). Such a significant growth is an effect of high crude oil prices and implementation of policies supporting biofuel production. State support is explained by concern for energy self-sufficiency, environmental benefits and agricultural sector needs. This support includes such instruments as financial subsidies, tax reliefs, or statutory requirements of minimal biofuel use (i.e. in 2010 8.25% in the USA; 5.75% in the EU). It is worth mentioning that without financial incentives – according to present and previously observed price relations – costs of biofuel production would exceed costs of acquisition fossil fuels. Since supporting biofuel sector is quite costly, its expansion occurs mainly in the developed countries. Presently, almost 90% of global biofuel production comes from the USA, the EU and Brazil. Globally, bioethanol is mainly produced from corn and sugar cane. In the EU wheat is also an important raw material.

Biofuel use of crops in Poland is relatively small. The bioethanol production in Poland is estimated at 88, 131, 166 and 132 thousands tons in the years 2008, 2009, 2010, and 2011, respectively. The main crops used for ethanol production are corn and wheat. About 200 – 300 thousand tons of wheat are allocated for ethanol production, which is less than 4% of the whole wheat production in Poland. Production and use of biofuels in the European Union is regulated by the Directive 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources, which determines that the minimal share of renewable energy in the transport sector in 2020 will be 20%. It was 4.63% in 2009 in Poland.

Growing importance of biofuel sector raises questions about its possible consequences. Economists analyze if and how prices of crude oil influence agricultural raw materials prices. There are three main instruments used to measure this impact: general and partial equilibrium models, optimization methods, and time series analysis. Although many researches were conducted into the biofuels impact on agricultural prices, their results were ambiguous.

Until recently the prices of agricultural products and energy were considered to be very weakly or even negatively correlated (Hertel and Beckman, 2011). According to Tyner (2010) correlation between corn and oil prices in USA in years 1988 – 2005 was -0.26. The situation changed together with biofuel market development. As agricultural commodities are increasingly being used as a raw material for biofuels, the linkage between energy and agricultural markets begins to intensify, although the nature of this relation is not clear.

Brazil was the first country to promote the use of agricultural products in biofuel production. Ethanol market emerged after governmental intervention, as a response to the petroleum shortage in 1973. Now there are many large ethanol plants in Brazil. Most of them are dual, which means that they can easily switch from ethanol to sugar production, depending on the price relations. Causal chain running from crude oil to Brazilian ethanol and finally to the sugar market in this country was shown by Serra and Zilberman (2011). They proved that oil price level influences the volatility and price level of ethanol. The growth of oil price volatility has a positive influence on variability of ethanol prices. Ethanol prices have a direct impact on level of sugar prices and indirect impact on sugar price volatility.

It was proved that spillover effect of crude oil prices volatility to agricultural markets was not statistically significant in the period November 1998 – October 2006, but this situation changed and data from October 2006 – January 2009 show the significant volatility spillover effect from crude oil prices to the corn prices. Results of research conducted by Saghaian (2010) show that although there is a strong correlation among oil and commodity prices, the nature of this linkage is mixed. Results also indicate that crude oil prices Granger-cause corn, soybeans, and wheat prices. Muhammad and Kabede (2009) argued that emerging ethanol market has integrated oil and

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corn prices and agricultural sector is importing instability from the crude oil market. This conclusion was confirmed by Conley and George (2008). According to them rotational nature of crop production causes that biofuel market influences not only corn prices, but also the prices of other crops such as wheat, soybean, and even cotton. On the other side Cooke and Robles (2009) showed that among various potential causes of commodity prices growth in 2006 – 2008, intensified speculation on futures market was the only significant factor in Granger's sense, although the changes in the length of analyzed time series significantly modified results.

It is worth mentioning that linkage between energy and corn prices varies over time. Coefficient of correlation between American monthly oil and corn prices is low (0.32) during the period of low oil prices (January 2001 – August 2007) and high (0.92) when oil prices remained above $75.barrel^{-1} (September 2007 – October 2008) (Hertel and Beckemann, 2011). Harri, Nalley and Hudson (2009) found that commodity prices are linked to oil in the case of corn, cotton, and soybean, but not for wheat. Mutuc (2010) quoted list of articles confirming and disproving hypothesis about cointegrating relations among crude oil and agricultural commodity prices.

Although there is a general agreement among economists that due to development of biofuel market relation between prices of agricultural commodities and crude oil will be getting stronger, particular research results differ depending on analyzed datasets. It makes this issue even more interesting.

In this paper we focus on the linkage between crude oil and Polish wheat prices. Contrary to majority of other studies, we concentrate on the situation of small open economy, where even in the absence of strong domestic biofuel sector, the linkage between crude oil and agricultural commodities' prices would be substantial due to dependence on global processes. Since Poland has its own currency, exchange rates play an important role in forming the relation between domestic agricultural commodities and globally traded crude oil.

Material and methods

Empirical analysis was conducted with the use of various methods. Since we dealt with time series we started with decomposition approach. We decomposed time series into long term tendency (TC_t), seasonal variation (S_t) and irregular (random) component (I_t). We used X-12-ARIMA procedure implemented in Demetra Plus software. The X-12-ARIMA program contains methods developed by both the U.S. Census Bureau and Statistics Canada. These methods estimate seasonality mainly by applying moving average filters to a possibly modified version of the input series. The modifications might include adjustments for extreme values, trading day effects, or holiday effects also estimated by the program and extension of data with the use of ARIMA modeling (Findley et all 1998; X-12-ARIMA 2011).

For extraction of trend T_t linear locally weighted scatterplot smoothing (LOESS) method was applied. LOESS is a way of estimating regression surface to data through multivariate smoothing. The dependent variable is smoothed as a function of independent variables in a moving fashion (similarly, a moving average is fitted to time series data). It combines the simplicity of linear least squares regression with the flexibility of nonlinear regression and hence does not require specifying of any form to fit a model to the data (Cleveland and Devlin 1998).

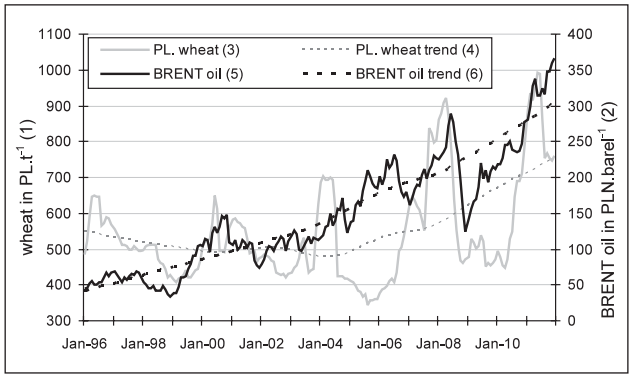

Figure 1 Monthly procurement wheat prices in Poland and crude oil (U.K. Brent 38` API, f.o.b. U.K ports) spot prices denominated in PLN (solid lines) and their trends (dashed lines)
Source: own calculation based on the Polish Central Statistical Office (GUS) and the World Bank data

Obrázok 1 Mesačný vývoj cien pšenice v Poľsku a ropy (U.K. Brent 38` API, f.o.b. U.K prístavy) v PLN (neprerušované línie) a ich trendy (prerušované línie)
Zdroj: vlastné výpočty založené na údajoch Poľského centrálneho štatistického úradu (GUS) a Svetovej banky
(1) pšenica v PLN.t^{-1}, (2) ropa Brent (PLN.barel^{-1}), (3) poľská pšenica, (4) poľská pšenica – trend, (5) ropa Brent, (6) ropa Brent – trend

As seasonality could influence results (especially when analysis is based on the first differences) the rest of calculations was performed on the basis of seasonally adjusted data. The co-movements of wheat, crude oil and exchange rates were examined with the use of rolling (moving) correlation technique. The length of the rolling window was one year (12 months). The value of correlation coefficient in a t moment for a pair of variables *x*, *y* was calculated according the following formula:

$$r_t = \frac{\sum_{t-5}^{t+6}(x_t - \bar{x})\cdot(y_t - \bar{y})}{\sqrt{\sum_{t-5}^{t+6}(x_t - \bar{x})^2 \cdot \sum_{t-5}^{t+6}(y_t - \bar{y})}} \quad (1)$$

To test stationarity of various time series, we applied Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. Null hypothesis states that time series is stationary. If it is rejected, time series is integrated of order (at least) 1. Assuming no linear trend, y_t can be formulated as follows (Lütkepohl and Krätzig 2007):

$$y_t = x_t + z_t \quad (2)$$

where:
x_t is a white noise process $x_t = x_{t-1} + v_t$, in which vt is a stationary $v_t \sim IID(0,\sigma^2_v)$, and z_t is also a stationary process in the form of $z_t \sim IID(0,\sigma^2_z)$. Stationarity is tested using two hypotheses: H_0: $\sigma^2_v = 0$ against H_1: $\sigma^2_v > 0$. *KPSS* test statistic formula is as follows:

$$KPSS = 1/T^2 \sum_1^T S_t^2 / \hat{\sigma}_\infty^2 \quad (3)$$

where:
$S_t^2 = \sum_{j=1}^{T}(y_j - \bar{y})$, and $\hat{\sigma}_\infty^2$ is long-term variation estimator (Lütkepohl and Krätzig 2007)

Evaluating the nature of relation between wheat and crude oil prices, the concept of Granger causality was employed.

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A variable x is said to Granger-cause y if we can better forecast y using lagged values of x than without them (Lütkepohl and Krätzig 2007). Applied Granger causality test formula is presented below:

$$y_t = A_0 D_t + \sum_{j=1}^{k} \alpha_j y_{t-1} + \sum_{j=1}^{k} \beta_j x_{t-1} + \sum_{j=1}^{k} \alpha_j \varepsilon_t \quad (4)$$

where:
A_0, α_j, β_j, are model parameters, D_t – deterministic variables, y and x are analyzed variables, k – the greatest lag length, ε_t – white noise. Null hypothesis, stating no Granger causality, assumes that $\beta_1 = \beta_2 = \ldots = \beta_k = 0$. Alternative hypothesis asserts that statistically significant lagged values of x exist. Determining number of lag length we applied VAR model

Vector autoregression model (VAR) consists of regression of every non-lagged variable on all lagged variables. VAR models are used for stationary data or data which were transformed into stationary series. Its formula is presented below (Kusideł, 2000; Tsay, 2010):

$$Y_t = \psi D_t + \Gamma_1 Y_{t-1} + \Gamma_2 Y_{t-2} + \ldots + \Gamma_p Y_{t-p} + \varepsilon_t \quad (5)$$

where:
Y_t – stochastic processes collected in $n \times 1$ vector, D_t – deterministic variables vector, ψ – matrix of deterministic variables parameters, Π_i are ($n \times n$) coefficient matrices, p means order of VAR model. These causal impacts were summarized with impulse response functions (IRF) analysis

The nonstationary time series are cointegrated if there is a linear combination of them that is stationary I(0). The linear combination is referred to as a long-run equilibrium relationship. To test existence of long-term behaviour of series a Johansen cointegration framework was applied. The cointegrating relations become evident if the levels of VAR are transformed to the vector error correction model (VECM) (Kusideł, 2000; Tsay, 2010):

$$\Delta Y_t = \psi D_t + \Pi Y_{t-1} + \Gamma_1 \Delta Y_{t-1} + \ldots + \Gamma_{p-1} Y_{t-p+1} + \varepsilon_t \quad (6)$$

where:
$\Pi = \Pi_1 + \ldots + \Pi_p - I_n$ and $\Gamma_k = -\sum_{j=k+1}^{p} \Pi_j$, $k = 1, \ldots, p-1$. The matrix Π is called the long-run impact matrix and Γ_j are the short-run impact matrices

Since the rank of the long-run impact matrix Π gives the number of cointegrating relationships in Y_t, Johansen formulates likelihood ratio (LR) statistics for the number of cointegrating relationships as LR statistics for determining the rank of Π. Two sequential Johansen procedures used to test for the number r of cointegrating relationships are as follows:

$$LR_{trace} = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_i) \quad (7)$$

$$LR_{\max} = -T \ln(1 - \hat{\lambda}_{r+1}) \quad (8)$$

where:
LR_{trace} – trace statistic, $LR_{\max}$ – maximum eigenvalue statistic, T is the sample size and $\hat{\lambda}_i$ is the i-th largest canonical correlation (eigenvalues of the matrix Π). The trace test tests the null hypothesis of r cointegrating vectors against the alternative hypothesis of n cointegrating vectors. The maximum eigenvalue test tests the null hypothesis of r cointegrating vectors against the alternative hypothesis of $r + 1$ cointegrating vectors

Results and discussion

Performance of the Polish wheat procurement prices and crude oil prices for the period from January 1996 to December 2011 is presented in Figure 1 together with calculated trends (T). In the first part of the analyzed period trends are not correlated contrary to the second period when wheat and oil prices increase their values.

Around trends some cyclical, seasonal and irregular variation is observed. X-12-ARIMA procedure, multiplicative model, allowed us to calculate seasonal indices for both series. X-12-ARIMA method does not assume constant seasonal pattern over the whole period and can be used in analyzing time varying seasonality. Seasonal indices for selected years (1998 and 2011) are presented in Figure 2. We can conclude that seasonal pattern in both series is time varying. In 1998, the highest wheat prices during a year were in June (1.05) whereas the highest crude oil prices were in September (1.11). In the last analyzed year (2011) seasonal patterns in wheat and crude oil series are closer to each other than they were in 1998.

The variance of the seasonal component, which is the most known type of variability in agricultural commodity markets, constitutes only around 3.3% of total variance of the wheat price series. The share of seasonal component in the oil Brent price series variance is estimated at 1.3%.

When examining the price variability we can notice that the most important part of it is connected to cyclical component. Observed cycles show recurring values of the variable of interest above or below the trend line over a multiyear time horizon. The cyclical component describes more or less regular fluctuations caused by the economic cycle. Cycles are treated by many economic analysts as a part of the long-term tendency, the so-called stochastic trend.

Cycle components of the Polish wheat and Brent oil series are shown in the Figure 3. They were calculated according to a multiplicative formula as quotient of long term tendency (TC) obtained from X-12-ARIMA and trend from LOESS. The lengths of cycles as well as their amplitudes are not constant. It all together makes the prediction of economic cycles quite

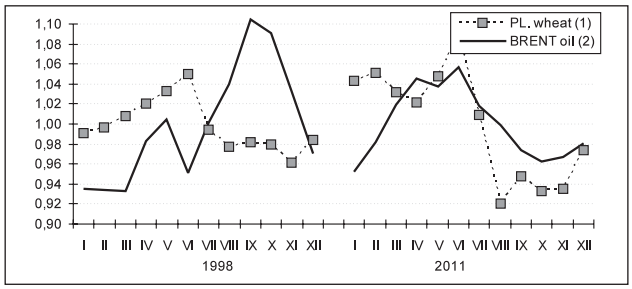

Figure 2 Seasonal indices of Polish wheat and Brent crude oil price series for 1998 and 2011 calculated with the use of X-12-ARIMA procedure
Source: own calculation according to Polish Central Statistical Office and World Bank

Obrázok 2 Sezónne indexy cien poľskej pšenice a ropy Brent v rokoch 1998 – 2011 vypočítané použitím X-12-ARIMA procedúry
Zdroj: vlastné výpočty podľa Poľského centrálneho štatistického úradu a Svetovej banky
(1) poľská pšenica, (2) ropa Brent

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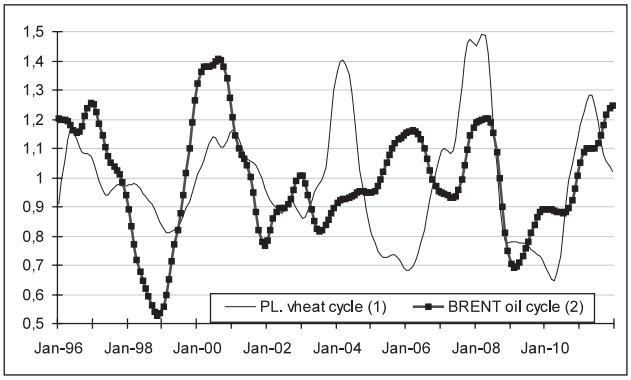

Figure 3 Cyclical indices of Polish wheat and Brent crude oil price series
Source: own calculation
Obrázok 3 Cyklické indexy cien poľskej pšenice a ropy Brent
Zdroj: vlastné výpočty
(1) cyklus poľskej pšenice, (2) cyklus ropy Brent

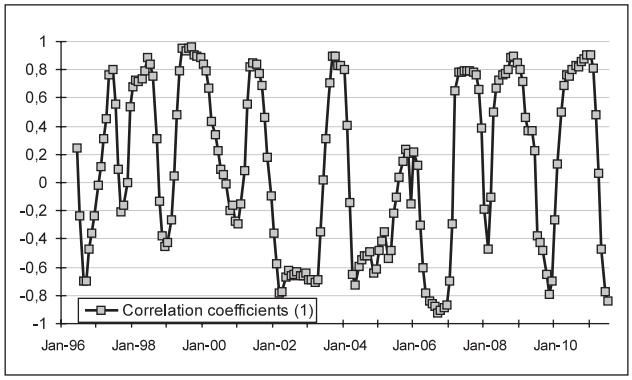

Figure 4 12-months rolling correlation coefficients between seasonally adjusted Polish wheat and crude oil prices series expressed in PLN
Source: own calculation
Obrázok 4 12-mesačné korelačné koeficienty medzi sezónne upravenými cenami poľskej pšenice a ropy, vyjadrenými v PLN
Zdroj: vlastné výpočty
(1) korelačné koeficienty

challenging. The average length of cycle of the wheat prices in Poland is around 43 months. On the other hand there are two dominant Brent oil cycles, with lengths of (according to ACF and periodogram) 50 – 60 months and around 32 months. So price cycles in the oil and wheat markets differ substantially. Neither of them is leading the other one as the highest correlation coefficient for them is for 0 lag.

Figure 3 suggests that the relation between wheat and oil price series may not be constant over time. So it will be better to use flexible method of measuring correlation between variables. We applied a 12-months rolling correlation coefficient to assess the relation between seasonally adjusted prices over time (Figure 4). Obtained result suggests that there are no clear long-term relationships between above mentioned prices. There are periods when correlation coefficient is close to 1 as well as periods when correlation is negative. Such behavior occurs due to various cycle lengths between markets.

To analyze long-term behavior of the Brent oil and Polish wheat series we used a cointegration framework. It helps to avoid spurious regression which reveals itself in determining relationships statistically significant where no such relationship exists. Such threat occurs when analyzed price series are non-stationary. All price series (logs of seasonally adjusted series) are integrated of order one (Table 1). Null hypothesis stating that log levels of price series are stationary were rejected both in the model with constant and the model with constant and trend. The first differences of all logarithms of prices are stationary (null hypothesis could not be rejected).

Two non-stationary price series are said to be cointegrated if there are linear combination between them that do not have a stochastic trend even though the individual series contain stochastic trend. In our research we used Johansen procedures (eq. 6 – 8) with two lags. The obtained statistic for trace test (LR_{trace}) and maximum eigenvalue test ($LR_{\max}$) indicate that null hypothesis (no integration, zero integrations vectors) cannot be rejected at the 5% significance level. Similar results were obtained when US_Wheat price series were included (as well as EUR/USD exchange rate). It suggests that there is no long-run equilibrium relationship between Polish wheat prices and crude Brent oil prices.

Since logarithms of seasonally adjusted Polish wheat and Brent oil price series (whose are I(1)) are not cointegrated, further analysis was performed with the use of their first differences (*ld*). We also started with a simple 12-month rolling correlation analysis for a pairs of variables (Figure 5). According to the first plot the co-movement of Polish wheat prices and oil Brent prices is rather weak. Starting from 2004 correlation coefficients are even lower than values of these coefficients in 1996 – 2003.

Table 1 Testing unit roots for seasonally adjusted time series for years 1996 – 2011 with the use of KPSS test statistic (statistic and critical value at 5%)

Price series (1)	Levels (2)		First differences (3)
	statistic/critical value constant (4)	statistic/critical value constant and trend (5)	statistic/critical value constant (4)
l_BRENT.OIL in USD (6)	5.7802/0.464	0.288/0.148	0.066/0.464
l_US.WHEAT in USD (7)	3.20773/0.464	0.667/0.148	0.190/0.464
l_PLN/USD	2.23872/0.464	0.892/0.148	0.245/0.464
l_EUR/USD	3.32406/0.464	0.845/0.148	0.255/0.464
l_BRENT.OIL in PLN	5.71646/0.464	0.205/0.148	0.040/0.464
l_US.WHEAT in PLN	2.76044/0.464	0.328/0.148	0.079/0.464
l_PL.WHEAT in PLN (8)	1.06678/0.464	0.375/0.148	0.072/0.464

Source: own calculation Zdroj: vlastné výpočty

Tabuľka 1 Testovanie jednotkových koreňov pre sezónne upravené časové rady pre roky 1996 – 2011 s použitím KPSS testovacej štatistiky (štatistická a kritická hodnota na úrovni 5 %)
(1) časové rady cien, (2) úrovne, (3) prvé diferencie, (4) štatistická/kritická hodnota, konštanta, (5) štatistická/kritická hodnota, konštanta a trend, (6) ropa Brent v USD, (7) USA – pšenica v USD, (8) Poľsko – pšenica v PLN

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Table 2 Johansen cointegration test results between logs of seasonally adjusted PL.WHEAT and BRENT.OIL series denominated in PLN (model with unrestricted constant)

H_0	Eigenvalue (1)	LR_{trace}		LR_{max}	
		statistic (2)	P-value (3)	statistic (2)	P-value (3)
r = 0	0.063	12.462	0.137	12.306	0.099
r ≤1	0.001	0.157	0.692	0.157	0.692

Source: own calculation Zdroj: vlastné výpočty

Tabuľka 2 Výsledky Johansenovho testu kointegrácie medzi logaritmami sezónne upravených cien poľskej pšenice a ropy Brent v PLN (model s absolútnou konštantou)
(1) vlastné čísla korelačnej matice, (2) štatistika, (3) P-hodnota

It is quite surprising when we compare them with correlation coefficients between US Wheat and Brent oil prices expressed in USD. Co-movements of first differences of log prices are rising each year indicating higher and higher linkage between crude oil and wheat markets. It is interesting that we can observe increasing correlation between Brent oil prices (in USD) and EUR/USD exchange rate. It might suggest that USD exchange rates play crucial role in the oil price dynamics. The low correlation between Polish wheat prices and crude oil prices could be an effect of negative co-movement of crude oil prices and PLN/USD exchange rate.

As there is no long-run relationship between Polish wheat and Brent oil price series, VAR modeling instead VECM is relevant. According to information criteria such as Akaike information criterion (AIC), Bayesian information criterion (BIC), and Schwarz information criterion (SIC), the lag 1 is the most suitable for bivariate VAR model. As it is mentioned in the literature (i.e. Tyner 2010) starting from 2006 relationships between oil and agricultural markets could change its previous characteristics. That is why we estimated three different models: for the whole analyzed period, for years 1996 – 2005 and for years 2006 – 2011 (Table 3). The coefficients for Brent oil are relatively similar in all models. The main difference is in the coefficients signs of Polish wheat prices in crude oil equation (from negative for a whole analyzed period to positive for 2006 – 2011).

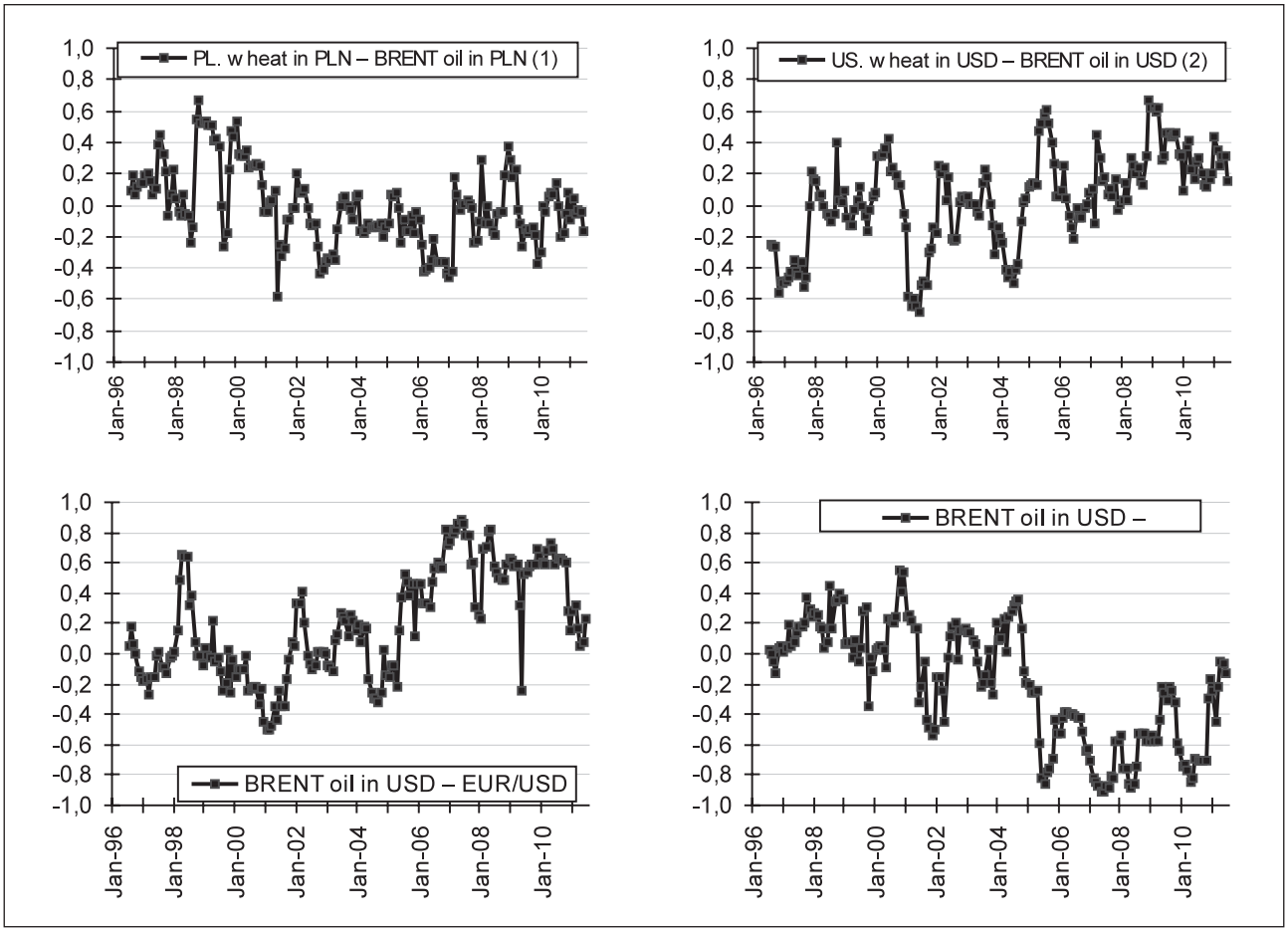

Figure 5 12-months rolling correlation coefficients between seasonally adjusted first differences of price series
Source: own calculation

Obrázok 5 12-mesačné korelačné koeficienty medzi sezónne upravenými prvými diferenciami cenových radov
Zdroj: vlastné výpočty
(1) poľsko pšenica v PLN – ropa Brent v PLN, (2) USA pšenica v USD – ropa Brent v USD, (3) ropa Brent v USD – EUR/USD, (4) ropa Brent v USD – PLN/USD

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Table 3 VAR estimated results of seasonally adjusted Polish wheat prices and crude oil price denominated in PLN (first differences natural logs – ld)

Variable (1)	Coefficient (2)	P-Value (3)	Coefficient (2)	P-Value (3)	Coefficient (2)	P-Value (3)
Period (4)	1996 – 2012		1996 – 2005		2006 – 2012	
Model for Polish Wheat (5)						
Const	0.000	0.973	-0.004	0.389	0.004	0.557
ld_PL.WHEAT_PLN (-1)	0.421	0.000	0.286	0.001	0.527	0.000
ld_OIL.BRENT_PLN (-1)	0.106	0.022	0.109	0.031	0.118	0.231
Model for Crude Oil (6)						
Const	0.010	0.102	0.011	0.180	0.005	0.545
ld_PL.WHEAT_PLN(-1)	0.084	0.411	-0.100	0.538	0.260	0.033
ld_OIL.BRENT_PLN(-1)	0.065	0.371	0.048	0.607	0.127	0.275

Source: own calculation Zdroj: vlastné výpočty

Tabuľka 3 VAR modelom odhadnuté výsledky sezónne upravených cien poľskej pšenice a ropy v PLN (prvé diferencie prirodzených logaritmov -ld)
(1) premenná, (2) koeficient, (3) P-hodnota, (4) obdobie, (5) model pre poľskú pšenicu, (6) model pre ropu

Table 4 Granger causality test results, lag 1

Independent variable (1)	Dependent variable (2)	F-statistics (3)	P-value (4)
1996 – 2011			
ld_BRENT.OIL in PLN	ld_PL.WHEAT in PLN	5.308	0.022
ld_PL.WHEAT in PLN	ld_BRENT.OIL in PLN	0.678	0.411
1996 – 2005			
ld_BRENT.OIL in PLN	ld_PL.WHEAT in PLN	4.756	0.031
ld_PL.WHEAT in PLN	ld_BRENT.OIL in PLN	0.382	0.538
2006 – 2011			
ld_BRENT.OIL in PLN	ld_PL.WHEAT in PLN	1.460	0.231
ld_PL.WHEAT in PLN	ld_BRENT.OIL in PLN	4.736	0.033

Source: own calculation Zdroj: vlastné výpočty

Tabuľka 4 Výsledky Grangerovho testu kauzality, časové posunutie 1
(1) nezávislá premenná, (2) závislá premenná, (3) F-štatistika, (4) P-hodnota

Granger causality test performed for three different periods brings us quite unexpected results (Table 4). In years 1996 – 2005, as well as for the whole period, past oil price values provided statistically significant information about future values of Polish wheat. In 1996 – 2011 such an impact was statistically insignificant. Moreover, wheat prices in Poland Granger-cause Brent oil prices (PL.WHEAT was also cause for EUR/USD and PLN/USD changes but not for US.WHEAT). Interpreting such results, we have to bear in mind that Granger test may produce misleading results when the true relationship involves three or more variables. It is possible that other factors like exchange rates may distort results. Also VAR framework is very sensitive to the quality of data and fact that data comes from different sources.

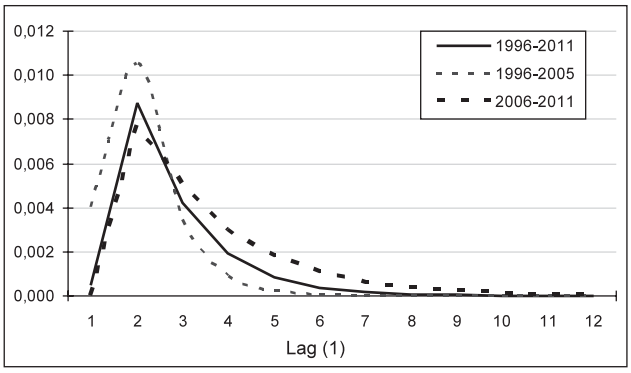

Figure 6 Impulse response functions of Polish wheat prices (ld_PL.WHEAT) to one S.D. innovation of Crude Brent oil (ld_BRENT.OIL)
Source: own calculation

Obrázok 6 Impulzné funkcie poľských cien pšenice k S.D. (smerodajná odchýlka) inováciám ropy Brent
Zdroj: vlastné výpočty
(1) časové posunutie

In the next step a impulse response function (IRF) was calculated for dependent variables to measure the magnitude of response to the impulse from one standard deviation of random disturbance term. The results presented in Table 4 were taken into account for ordering of variables. Analyzing results of IRF presented in Figure 6 we need to bear in mind that one of the drawbacks of IRF is its sensitivity to variables ordering.

Results shown in Figure 5 indicate that wheat prices respond to oil price changes. The highest value of IRF is after 2 months and it is gradually decreasing. However, the pace of decreasing in 1996 – 2005 was faster than in 2006 – 2011. Results also indicate that the direct influence of crude oil prices on Polish wheat prices is slightly lower after 2006 than it was before. That confirms conclusions drawn from simple rolling correlation analysis.

Concluding remarks

A review of literature indicates importance of oil market in the determination of agricultural commodity markets. However, conclusions about the strength of such an impact vary among the researchers mostly due to differences in the analyzed markets, data, and time periods. National biofuel policies play important role in strengthening relationship between oil sector and agricultural commodity prices. The crude oil-wheat linkage

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in Poland is also evident due to rising domestic use of wheat in biofuel production and, above all, due to linkage between Polish wheat prices and the European and world wheat prices.

Results presented in this paper indicate that trends of price series of Polish wheat and Brent Oil in 1996 – 2004 are not correlated contrary to the second period (2005 – 2011) when they started to rise nearly at the same rate. Seasonal patterns in both series are time varying and of lesser importance than cyclical components. The analysis shows that the seasonal patterns of wheat and oil prices tend to be getting more similar to each other over the years. The length of cycle in the wheat prices in Poland is around 43 months while there are two dominant Brent oil cycles, with lengths of 50 – 60 months and approximately 32 months.

Due to different length of the price cycles the relation between wheat and crude oil is not constant over time. 12-Months rolling correlation coefficients for levels of seasonally adjusted data vary in a cyclical manner from -0.9 to +0.9. Johansen cointegration test did not confirm long-run equilibrium relationship between Polish wheat and crude Brent oil prices.

Rolling correlation analysis performed on first differences of prices indicates decreasing co-movement of Polish wheat prices and oil Brent prices (expressed in PLN). It is contrary to the growth of correlation coefficients between US Wheat and Brent oil prices expressed in USD. It suggests that low correlation between Polish wheat prices and crude oil prices could be an effect of negative co-movement of crude oil prices and PLN/USD exchange rate. This also reduces a risk of exposure of producers and consumers to the volatility of oil prices.

Applied IRF based on VAR models confirms that wheat prices respond to oil price changes. It is also proven that the influence of crude oil prices on Polish wheat prices has been slightly lower after 2006 than it was before. Moreover, according to a Granger causality test, in 2006 – 2011 Polish wheat prices were leading oil prices. Such behaviour could be attributed to factors like exchange rates which were not taken into account.

The performed analysis still needs to be refined. Especially deep insight into the role of exchange rates in the Polish wheat price formation is needed. Asymmetric and threshold price transmission analysis can also be employed. An extremely important issue worth consideration is the impact of oil price volatility on the volatility of the agricultural commodity prices.

Súhrn

Ceny poľnohospodárskych komodít hrajú významnú rolu jednak pri určovaní príjmov poľnohospodárov, jednak pri stanovovaní cenových vzťahov v celom hospodárstve. Za jeden z najvýznamnejších faktorov vplývajúcich na cenu pšenice sa považuje cena ropy. Cieľom tohto príspevku je zhodnotiť charakter vzájomnej previazanosti medzi svetovými cenami ropy a cenami poľskej pšenice. Výsledky výskumu potvrdzujú existenciu takéhoto prepojenia, hoci jeho charakter a sila sa v čase menia. Dlhodobé vzťahy medzi cenami ropy a poľskej pšenice sa však nepotvrdili. Naopak, rastúci vplyv cien ropy na ceny poľskej pšenice nebol v priebehu času zistený. Výsledky naznačujú, že ceny pšenice môžu byť silne ovplyvnené výmennými kurzmi. To môže oslabiť citlivosť cien poľskej pšenice vo vzťahu k svetovým cenám ropy.

Kľúčové slová: ceny pšenice, ceny ropy, cenová transmisia, VAR (vektorový autoregresný model), kointegrácia

References

CLEVELAND, W. S. – DEVLIN, S. J. 1998. Locally-Weighted Regression: An Approach to Regression Analysis by Local Fitting, In: Journal of the American Statistical Association, vol. 83, 1998, no. 403, p. 596 – 610.

CONLEY, D. M. – GEORGE, A. 2008. Spatial Marketing Patterns for Corn under the Condition of Increasing Ethanol Production in the U.S. In: International Food and Agribusiness Management Review, vol. 13, 2008, no 3, p. 81 – 98.

COOKE, B. – ROBLES, M. 2009. Recent Food Prices Movements. A Time Series Analysis. In: IFPRI Discussion Paper No. 00942, 2009 http://www.ifpri.org/sites/default/files/publications/ifpridp00942.pdf (2012–03–01).

DU, X. – YU, C. L. – HAYES, D. J. 2009. Speculation and Volatility Spillover in the Crude Oil and Agricultural Commodity Markets: A Bayesian Analysis, Paper presented at the Agricultural and Applied Economics Association, Milwaukee, Wisconsin. 2009.

FINDLEY, D. F. – MONSELL, B. C. – BELL, W. R. – OTTO, M. C. – CHEN, B. Ch. 1998. New Capabilities and Methods of the X-12-ARIMA Seasonal Adjustment Program. In: Journal of Business and Economic Statistics, vol 16, 1998, no. 2, p. 127 – 152.

HARRI, A. – NALLEY, L. – HUDSON, D. 2009. The Relationship between Oil. Exchange Rates. and Commodity Prices. In: Journal of Agricultural and Applied Economics, vol. 41, 2009, no. 2, p. 501 – 510.

HERTEL, T. W. – BECKMAN, J. 2011. Commodity Price Volatility In the Biofuela Era: An Examination of the Linkage between Energy and Agricultural Markets. In: Working Paper. NBER, 2011, p. 1 – 51.

KUSIDEŁ, E. 2000. Modelowanie wektorowo-autoregresyjne VAR. Metodologia i zastosowanie w badaniach ekonomicznych, Absolwent, Łódź, 2000. ISBN 83-88384-16-3.

LÜTKEPOHL, H. – KRÄTZIG, M. 2007. Applied Time Series Econometrics. Cambridge University Press. New York. 2007. ISBN: 978-0521547871.

MUHAMMAD, A. – KEBEDE, E. 2009. The Emergence of an Agro-Energy Sector: Is Agriculture Importing Instability from the Oil Sector? In: Choices, vol. 24, 2009, no. 1. http://www.choicesmagazine.org/magazine/article.php?article=57 (2012–03–01).

MUTUC, M. M. 2010. What Drives Commodity Prices More: Oil Demand or Supply Shocks? Poster presented for presentation at the Agricultural & Applied Economics Association, Denver. 25 – 27 June, 2010.

ROSIAK, E. – ŁOPACIUK, W. – KRZEMIŃSKI, M. 2011. Produkcja biopaliw i jej wpływ na światowy rynek zbóż oraz roślin oleistych I tłuszczów roślinnych. Warszawa : IERiGŻ – PIB, 2011. ISBN 978-8376582023.

SAGHAIAN, S. H. 2010. The Impact of the Oil Sector on Commodity Prices: Correlation or Causation? In: Journal of Agricultural and Applied Economics, vol. 42, 2010, no 3, p. 477 – 485.

SERRA, T. – ZILBERMAN, D. 2011. Price volatility in ethanol markets, In: European Review of Agricultural Economics, vol. 38, 2011, no. 2, p. 259 – 280.

TSAY, R. S. 2010. Analysis of Financial Time Series. New Jersey : John Wiley & Sons, 2010. ISBN 978-470414354.

TYNER, W. E. 2010. The Integration of Energy and Agricultural Markets. In: Agricultural Economics, vol. 41 s1, 2010, November, p. 193 – 201.

X-12-ARIMA Reference Manual. version 0.3. US. Bureau of the Census. February 28, 2011. http://www.census.gov/ts/x12a/v03/x12adocV03.pdf (2012–03–01).

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