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Linkage of grain prices in Ukraine with the world crude oil prices

Abstract
Over the past decade, we have observed an increased use of renewable energy sources based on agricultural commodities. It is stimulated by a wide range of political tools in developed countries and leads to the linkage of agricultural markets with energy markets even in the countries which do not have own peculiar policies regarding renewable energy. In this context, the purpose of the paper is to assess the linkage between corn and wheat prices in Ukraine and Brent crude oil prices. The price analysis was carried out on the basis of monthly data covering the period between January 2001 and December 2018 with the use of ARDL-ECM models and bound tests approach. The obtained results indicate time varying relationships between the Ukrainian grain prices and the world crude oil prices. The strongest price linkage was observed between 2008 and 2013, a period characterised by a substantial increase in bioethanol production, low grains inventory levels and high crude oil prices.
It should be noted that reaching planned mandatory blending levels in most countries promoting biofuel policy and relatively low crude oil prices does not constitute a motivation to increase the use of cereals for biofuel production. The increase of stocks in the world grain markets also contributes to reducing the strength of price connections.
Keywords: Grains; Crude Oil; Biofuel; Price Transmission; ARDL-ECM
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Зв'язок цін на зерно в Україні зі світовими цінами на нафту
Анотація. Протягом останнього десятиліття спостерігається збільшення використання відновлюваних джерел енергії на основі сільськогосподарської сировини. У розвинених країнах це стимулюється широким спектром політичних заходів та призводить до збільшення зв'язків між сільськогосподарськими та енергетичними ринками навіть у тих країнах, які не мають власної політики щодо відновлюваних джерел енергії. У даному контексті метою статті є оцінка зв'язку між цінами на кукурудзу й пшеницю в Україні та цінами на нафту марки Brent. Аналіз цін проведено на основі щомісячних даних із використанням моделей ARDL-ECM та граничного тестування.
Отримані результати свідчать про часові коливання зв'язків між українськими цінами на зерно та світовими цінами на нафту. Найбільш високий зв'язок між цінами спостерігався в період 2008–2013 рр., який характеризувався значним збільшенням виробництва біоетанолу, низьким рівнем запасів зернових та високими цінами на нафту.
Ключові слова: зерно; нафта; біопаливо; цінова реакція; ARDL-ECM.

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Связь цен на зерно в Украине с мировыми ценами на нефть
Аннотация. В течение последнего десятилетия наблюдается увеличение использования возобновляемых источников энергии на основе сельскохозяйственного сырья. В развитых странах это стимулируется широким спектром политических мер и приводит к увеличению связей между сельскохозяйственными и энергетическими рынками, даже в тех странах, которые не имеют собственной политики по возобновляемым источникам энергии. В данном контексте целью статьи является оценка связи между ценами на кукурузу и пшеницу в Украине и ценами на нефть марки Brent.
Анализ цен проведен на основе ежемесячных данных с использованием моделей ARDL-ECM и предельного тестирования. Полученные результаты свидетельствуют о временных колебания связей между украинскими ценами на зерно и мировыми ценами на нефть. Наиболее высокая связь между ценами наблюдалась в период 2008–2013 гг., который характеризовался значительным увеличением производства биоэтанола, низким уровнем запасов зерновых и высокими ценами на нефть.
Ключевые слова: зерно; нефть; биотопливо; ценовая реакция; ARDL-ECM.

1. Introduction

In the last decade, there has been an increasing emphasis on the use of renewable energy sources (RES) as an alternative to conventional fossil energy resources. RES include biofuels, production of which is based on agricultural commodities such as sugar cane, cereals or oilseeds. The dynamic development of biofuel production is grounded in environmental issues (Kretschmer et al., 2012), high world energy prices (de Gorter et al., 2013) and downward trends in real prices of agricultural products (Tyner, 2010; Wright, 2014). The general belief is that RES could be an opportunity for the development of agriculture and the increase of agricultural producers' incomes (Makarchuk et al., 2007).

Grains demand for biofuel production is one of the main factors underlying price linkage between agricultural and crude oil markets. The second channel linking both markets is via input costs (Potori & Stark, 2015). The dynamic growth of agricultural raw materials used for biofuels was reflected in the increase in the level and volatility of world agricultural commodity prices (Abbot, 2013; Galchynska et al., 2015; Wright, 2014). Due to globalisation, decisions of main world biofuel players have heavily affected agricultural and food prices in the countries that didn't support biofuel production and consumption (Lagi et al., 2011; HLPE, 2013).

Ukraine is one of such countries, where biofuel production, in particular ethanol, doesn't play any important role, despite the adoption in 2009 low promotion of the production and use of biofuels (Verkhovna Rada of Ukraine, 2009). Ukraine is one of the major producers and exporters of grains in the world and Ukrainian grain prices are significantly linked with world prices (Götz et al., 2012; Goychuk & Meyers, 2014). Therefore, we expect that the linkage between the grain prices and crude oil prices in Ukraine is also visible. The main question is the nature of such linkages and their strength over time. We could not find any research assessing the impact of crude oil prices on Ukrainian grain prices. In this context, the study attempts to fill this gap and makes a contribution to the knowledge by providing evaluation of the linkage of corn and wheat prices in Ukraine with the world crude oil prices.

2. Brief Literature Review

Biofuel demand becomes more and more important part of the balance sheet of grains in the world (Schmitz & Meyers, 2015). Policy decisions in the biofuel era have led to the competition of grain and oilseeds demand for food, feed and energy purposes (McPhail & Babcock, 2012; Kretschmer et al., 2012). Thus, state policies have resulted in the increasing links between agrifood markets and the energy markets (Tyner, 2010; Wright, 2014). According to some authors, crude oil prices and energy prices are probably the main factors determining the growth of food prices during the so called food crisis (de Gorter et al., 2013; Wright, 2014).

Most researchers indicate that in recent years world crude oil prices have influenced agricultural crops production and prices (Abbot, 2013; Zafeiriou et al., 2018). The linkage between crude oil prices and agricultural commodity prices is reflected by the existence of long-run economic relationships, price co-movement or granger-causality (Katrakilidis et. al., 2015). M. Bakhat and K. Wurzburg (2013) indicate that increased biofuel use created new links between prices of foods and crude oil, especially for those agrifood products that have been used for biofuel production. On the other hand, in some authors' opinion, biofuels have not been the most dominant contributor to the agrifood price inflation (Zilberman et al., 2013).

The nature and strength of price links strongly depend on the period being analyzed (de Gorter et al., 2013, Tyner, 2010). W. Tyner (2010) and M. Hamulczuk & C. Klimkowski (2012) have found that correlations between prices of grains and oil in the USA and Poland have changed from negative to positive along with biofuel introduction. D. Kumar (2017) points that existing volatility spillover from crude oil to agricultural commodities does not remain stable but exhibit multiple structural breaks.

3. Purpose

The paper aims at presenting an econometric analysis showing the nature of the linkage of the Ukrainian grain prices with the world crude oil prices. The empirical analysis of monthly price series is carried with the use of the ARDL-ECM framework attempted at finding time varying relationships between crude oil and grains prices.

4. Data and methods

To analyse the linkage between grain prices and crude oil prices, we used a monthly price series data covering the period between January 2001 and December 2018 (Figure 1). Wheat and corn price series express procurement prices in Ukraine, whereas oil price series is for Brent crude oil. All variables were expressed in USD. The source of data was the FAOSTAT (corn and wheat) and the World Bank (crude oil).

To test stationarity of time series, we applied the Augmented Dickey Fuller (ADF) test (see Enders, 2010). The empirical analysis of the price linkage was carried out with the use of the bound test and ARDL-ECM model (Pesaran et al., 2001). The applied procedure has several advantages over the conventional co-integration testing because it can be used regardless of whether the underlying series are I(0), I(1) or even fractionally integrated. An unrestricted ARDL-ECM model was specified:

$$\Delta Y_t = \varphi_0 + \sum_{i=1}^{p} \varphi_i \Delta Y_{t-i} + \sum_{i=0}^{q} \alpha_i \Delta X_{t-i} + \pi_1 Y_{t-1} + \pi_2 X_{t-1} + \varepsilon_t, \quad (1)$$

where:
Y_t, X_t are dependent and independent variables, respectively;
φ_0 is drift component;
ε_t is white noise errors;
φ_i and α_i represent short run dynamics;
π_1 and π_2 is long-run relationship.
The lag length of the model (p, q) was chosen according to AIC.

The existence of a long-run relationship among the variables was tested basing on F-test statistic. The null hypothesis of no cointegration (H0: $\pi_1 = \pi_2 = 0$) is tested against an alternative, assuming the presence of cointegration among the variables (H1: $\pi_1 \neq \pi_2 \neq 0$). The calculated F-test statistic values are compared with two sets of critical values according to Pesaran et al. (2001). If the F-statistic is below the lower bound critical value, then the null hypothesis of no co-integration cannot be rejected. If the F-test statistics exceeds the upper critical value, then the null hypothesis of no co-integration can be rejected. If the computed F-statistic

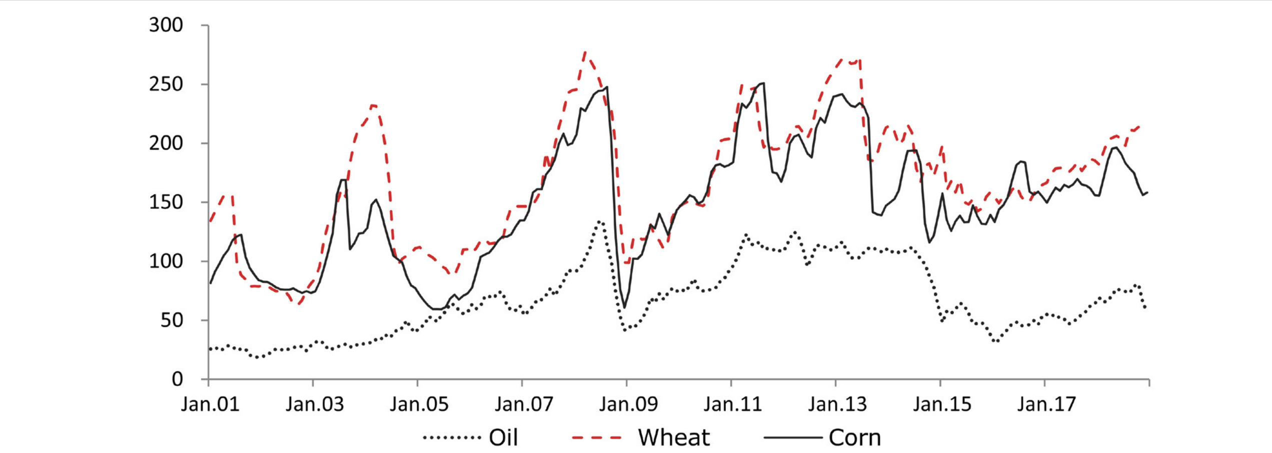

Fig. 1: **Monthly price series used in the analysis (USD/tonne and USD/barrel)**
Source: Compiled by the authors based on the World Bank and FAO data

falls between the lower and upper bounds, then the results are inconclusive.

Bearing in mind that such relationships might be unstable stable over time, we tested the stability of the parameters using a CUSUM test. Moreover, to test the parameter instability and the structural change in the ARDL-ECM models, Bai-Perron multiple breakpoint test was applied (Bai & Perron, 1998). Three procedures were used to test structural breaks, each allowing heterogeneous error distributions across breaks. We tested: L+1 vs. L sequentially determined breaks, L+1 vs. L globally determined breaks and 1 to M globally determined breaks. After assuming structural breaks, new ARDL-ECM models for each subsample were estimated. The whole analysis was summarised by computing dynamic multipliers which show the amount of information each exogenous variable contributes to the endogenous variables.

5. Results

The empirical analysis started with testing unit roots in the logarithmic price series. The null hypothesis for crude oil price series (assuming non-stationarity) cannot be rejected at the 5% and 10% significance levels (p = 0.268). The null hypotheses for the wheat price series (p = 0.087) and the corn price data (p = 0.058) can be rejected at the 10% significance level but not at the 5% level. The ADF test applied for first differences of all log price series allows us to reject the null hypothesis. The inconclusive results of the ADF test for the price levels justified the use of the ARDL-ECM framework, which is a robust for non-stationarity assumption, during testing long run relationships.

According to AIC, the most suitable models were ARDL (1.1) for the wheat-oil analysis and ARDL (2.1) for corn-oil modelling. However, the model for wheat-oil was subject to autocorrelation. Therefore, it was extended to ARDL (2.1). The estimated ARDL (2.1) models for the whole sample are presented in Table 1. Errors of these models are not serially correlated. Thus, we can use them for co-integration testing.

The calculated F statistics are 5.23 for the first model and 5.08 for the second model. The lower and upper bounds for the F-test statistic at the 10% and 5% significance levels are (4.04, 4.78) and (4.94, 5.73), respectively. In both cases, the Wald-test statistics are over the upper bound critical value at the 10% significance level. At the 5% significance level, the bound test results are inconclusive. Therefore, we can conclude that there exist long-run relationships between the Brent crude oil series and the grain prices in Ukraine series, however only at the 10% significance level. Relaying on the ARDL-ECM models, we estimated the long-run relationships (Table 1). In the long run, a 1% increase in crude oil prices leads to 0.48% and 0.42% increase of wheat and corn prices, respectively. From Table 3, we can conclude that that the adjustment to the long-run relationship is mainly from grain prices. Therefore, we can assume that crude oil prices are weekly exogeneity for the Ukrainian grain prices.

The CUSUM test (cumulative sum of residuals) indicates stability of the parameters of both the models which validates bound test results. However, the visual price analysis suggests time varying price co-movements. To verify this presumption, we applied three versions of the Bai-Perron multiple break point test for the models presented in Table 1. All explanatory variables were used as breakpoint variables. We assume that error distribution may vary over regimes.

The results of the application of three procedures are included in Table 2. The sequential procedure indicates three breakpoints for the wheat model and two structural breaks for the corn model. The remaining two procedures suggest two structural breakpoints in both models. According to the sequential, the procedure break dates for the wheat model are October 2010, June 2013 and February 2016. Global procedures indicate the break dates in October 2010 and December 2014. According to all procedures, the structural break dates for the corn model are September 2008 and September 2013.

For further analysis, we determined two structural breaks (Table 3). It seems to be in line with our expectations and the fact that most procedures of the Bai-Perron test envisage such a solution. All the explanatory variables are regime varying, therefore the models in each subsample can be treated as separate. In most of the subsamples, the null hypothesis

Tab. 1: **Estimates of unrestricted ARDL (2.1) models and bound test for cointegration in the whole sample (2001-2018)**

Endogenous variable: d_l_wheat				Endogenous variable: d_l_corn			
Variable	Coefficient	t-Statistic	Prob.	Variable	Coefficient	t-Statistic	Prob.
const	0.207	2.684	0.008	const	0.226	2.813	0.005
l_wheat_1	-0.067	-3.235	0.001	l_corn_1	-0.070	-3.153	0.002
l_oil_1	0.033	2.272	0.024	l_oil_1	0.029	1.830	0.069
d_l_oil	0.046	0.747	0.456	d_l_oil	0.182	2.598	0.010
d_l_oil_1	0.129	2.099	0.037	d_l_oil_1	0.037	0.521	0.603
d_l_wheat_1	0.428	6.404	0.000	d_l_corn_1	0.503	7.417	0.000
d_l_wheat_2	-0.048	-0.695	0.488	d_l_corn_2	-0.154	-2.232	0.027
Cointegration testing: F-stat =5.23, 10%cv (4.04, 4.78), 5%cv (4.94, 5.73)				Cointegration testing: F-stat =5.08, 10%cv (4.04, 4.78), 5%cv (4.94, 5.73)			
Long run relationship: l_wheat= 3.08 + 0.48*l_oil				Long run relationship: l_corn= 3.23 + 0.42*l_oil			

Source: Compiled by the authors

of no cointegration between the grains series and the crude oil series cannot be rejected.

The role of Brent crude oil prices in determining Ukrainian wheat and corn prices appears to be clear with regard to Figure 2, which portrays a cumulated response of grain prices on 1% shock in crude oil prices both for the whole period and particular subsamples. Two graphs represent impulse response functions calculated for the unconstrained models (Tables 1, 3). Constructing the model by removing insignificant variables in first differences doesn't significantly modify the obtained results.

The estimated impulse response functions look pretty similar for both markets. In the whole analysed period (2001-2018), a 1% change in crude oil prices leads to a 0.41% change in wheat and corn prices in a 12-month span. The responses of grain prices on shocks from crude oil prices vary significantly between sub-periods.

In 2001-2008, the 1% increase/decrease in crude oil prices lead to approximately a 0.4% increase/decrease in grain prices within 12 months. Such a shape of the function may indicate that the crude oil shock in this period is transmitted first into the cost of production and transportation and then into grain markets. We observe completely different price linkages in 2008-2013 (corn) and 2008-2014 (wheat) with a strong reaction of grain prices on crude oil price shocks. A 1% change in crude oil prices leads to a 0.85-0.87 change in wheat and corn prices within a 12-month span. In the short term, we can even observe overreaction of corn prices due to a low level of corn stocks. Since 2013 (corn) and 2014 (wheat), a very limited impact of crude oil on grain prices has been observed.

6. Conclusions

The purpose of the research was to analyse the linkage of Ukrainian grain prices with Brent crude oil prices. The theoretical framework indicates a possible impact of world crude oil prices on grain prices in Ukraine via world grain prices. The crude oil-wheat and the crude oil-corn linkage in Ukraine might be especially evident due to a significant share of Ukrainian grain export on the world market.

Tab. 2: **Multiple breakpoint tests for models from Table 3**

Bai-Perron tests of L+1 vs. L sequentially determined breaks					
Break test	Critical value	Wheat model		Corn model	
		F-statistic	Scaled F-statistic	F-statistic	Scaled F-statistic
0 vs. 1	21.87	3.17	22.18	4.25	29.72
1 vs. 2	24.17	3.56	24.89	6.37	44.59
2 vs. 3	25.13	4.46	31.19	2.41	16.85
3 vs. 4	26.03	1.23	8.58	-	-
Break dates:		2008M10; 2013M07; 2016M02		2008M09; 2013M09	
Bai-Perron tests of L+1 vs. L globally determined breaks					
Break Test	Critical value	Wheat model		Corn model	
		F-statistic	Scaled F-statistic	F-statistic	Scaled F-statistic
0 vs. 1	21.87	3.17	22.18	4.25	29.72
1 vs. 2	24.17	3.56	24.89	6.37	44.59
2 vs. 3	25.13	1.13	7.90	2.41	16.85
3 vs. 4	26.03	0.87	6.09	2.41	16.85
4 vs. 5	26.65	1.77	12.37	0.00	0.00
Break dates:		2008M10; 2014M12		2008M09; 2013M09	
Bai-Perron tests of 1 to M globally determined breaks					
UDMax critical value	WDMax critical value	Wheat model		Corn model	
		UDMax statistic	WDMax statistic	UDMax statistic	WDMax statistic
22.04	23.81	36.30	41.83	38.25	44.08
Break dates:		2008M10; 2014M12		2008M09; 2013M09	

Source: Own calculations

Tab. 3: **The estimates of unrestricted ARDL models and bound test for cointegration in different subsamples**

Endogenous variable: d_l_wheat				Endogenous variable: d_l_corn			
Variable	Coefficient	*t*-Statistic	Prob.	Variable	Coefficient	*t*-Statistic	Prob.
2001M01 - 2008M09				**2001M01 - 2008M08**			
const	0.167	1.500	0.135	const	0.066	0.638	0.525
l_wheat_1	-0.060	-2.197	0.029	l_corn_1	-0.039	-1.560	0.121
l_oil_1	0.034	1.603	0.111	l_oil_1	0.033	1.741	0.083
d_l_oil	-0.081	-0.763	0.447	d_l_oil	0.059	0.605	0.546
d_l_oil_1	0.039	0.360	0.719	d_l_oil_1	-0.129	-1.287	0.200
d_l_wheat_1	0.460	4.265	0.000	d_l_corn_1	0.424	3.871	0.000
d_l_wheat_2	0.063	0.569	0.570	d_l_corn_2	0.028	0.252	0.802
Cointegration testing: F-stat =2.52, 10%cv (4.04 , 4.78), 5%cv (4.94 , 5.73)				Cointegration testing: F-stat =1.85, 10%cv (4.04 , 4.78), 5%cv (4.94 , 5.73)			
2008M10 - 2014M11				**2008M09 - 2013M08**			
const	0.170	1.125	0.262	const	0.285	1.846	0.066
l_wheat_1	-0.163	-2.801	0.006	l_corn_1	-0.256	-2.687	0.008
l_oil_1	0.150	2.683	0.008	l_oil_1	0.230	2.283	0.024
d_l_oil	0.518	5.101	0.000	d_l_oil	0.764	6.404	0.000
d_l_oil_1	-0.018	-0.146	0.884	d_l_oil_1	0.154	1.076	0.283
d_l_wheat_1	0.495	4.735	0.000	d_l_corn_1	0.473	4.277	0.000
d_l_wheat_2	-0.297	-3.172	0.002	d_l_corn_2	-0.308	-2.949	0.004
Cointegration testing: F-stat =4.05, 10%cv (4.04 , 4.78), 5%cv (4.94 , 5.73)				Cointegration testing: F-stat =3.97, 10%cv (4.04 , 4.78), 5%cv (4.94 , 5.73)			
2014M12 - 2018M12				**2013M09 - 2018M12**			
const	0.090	0.228	0.820	const	1.808	4.215	0.000
l_wheat_1	-0.025	-0.233	0.816	l_corn_1	-0.361	-3.910	0.000
l_oil_1	0.012	0.206	0.837	l_oil_1	0.003	0.099	0.921
d_l_oil	-0.161	-2.044	0.042	d_l_oil	-0.057	-0.464	0.643
d_l_oil_1	0.163	2.138	0.034	d_l_oil_1	0.148	1.235	0.219
d_l_wheat_1	-0.198	-1.227	0.221	d_l_corn_1	0.402	3.360	0.001
d_l_wheat_2	-0.099	-0.670	0.504	d_l_corn_2	0.022	0.178	0.859
Cointegration testing: F-stat =0.03, 10%cv (4.04 , 4.78), 5%cv (4.94 , 5.73)				Cointegration testing: F-stat =9.04, 10%cv (4.04 , 4.78), 5%cv (4.94 , 5.73)			

Source: Compiled by the authors

The application of the cointegration bound test proves the existence of a long-run relationship between the crude oil prices and the grain prices in 2001-2018. The long run elasticity of corn prices, with respect to Brent crude oil prices, is 0.42 whereas the long run elasticity of wheat prices is 0.48. The Bai-Perron multiple breakpoint test indicates possible structural breaks in 2008 and 2013-2014. The estimated ARDL-ECM models confirm the time varying relationship between the crude oil series and the grain price series.

In 2001-2008, the shocks in crude oil were slowly transmitted to the corn prices, confirming that cost of production and transportation are the main channel linking crude oil and grain markets. In 2008-2013, we could see evidence of strong co-movements of crude oil prices and grain prices, which was caused by a rapid increase in biofuel demand, depletion of grain stock and relatively high crude oil prices increasing profitability of biofuel production.

Since 2013-2014, the price linkages between crude oil and grain prices seem to have been insignificant. Reaching the planned mandatory blending levels in most countries promoting biofuel policy and, relatively, low crude oil prices does not constitute a motivation to increase the use of cereals for biofuel production. The increase in stocks of the world grain markets also contributes to the reducing strength of price connections.

The extension of this study may include the application of the threshold or other regime switching models, which can

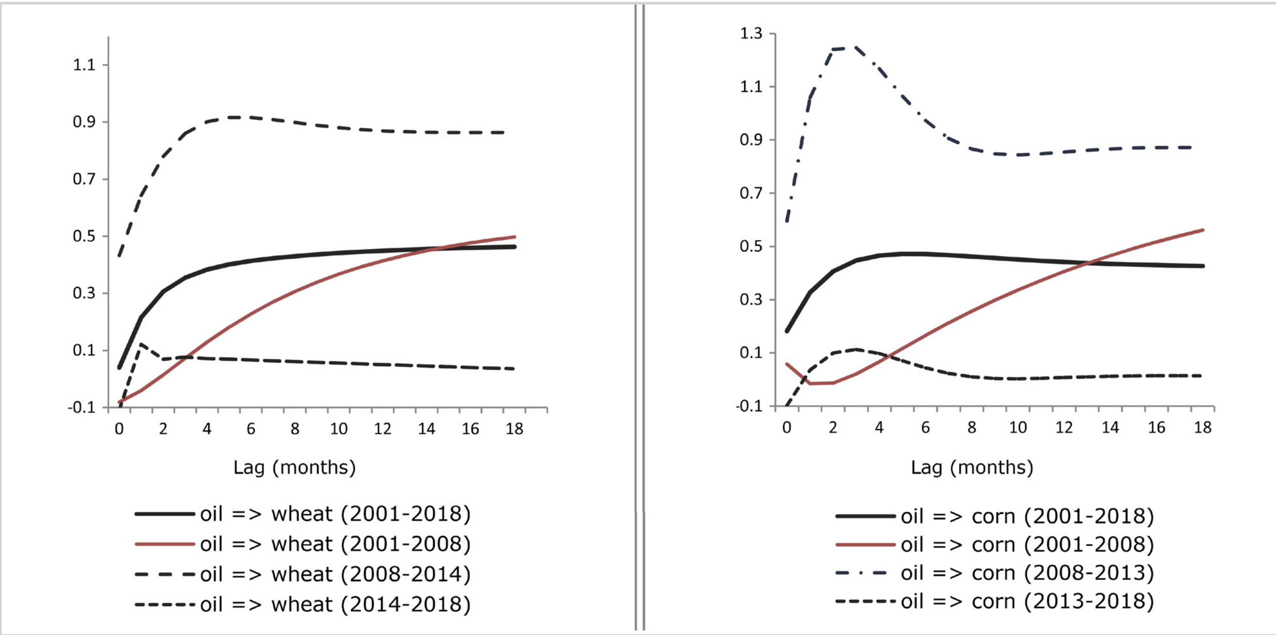

Fig. 2: **Cumulated response of grain prices on 1% change in crude oil prices**
Source: Compiled by the authors

be useful when assessing asymmetric and time varying relationships. Further study may be related to the inclusion of the world grain and bioethanol series into the models, which will make it possible to assess the interconnection between the world crude oil prices and the Ukrainian cereal prices more accurately.

References

1. Abbot, P. (2013). Biofuel, Binding Constrains and Agricultural Commodity Volatility. *National Bureau of Economic Research, Working Paper No. 18873.* Retrieved from https://www.nber.org/papers/w18873.pdf
2. Bakhat, M., & Würzburg, K. (2013). Price Relationships of Crude Oil and Food Commodities. *Economics for Energy, Working Papers No. FA06-2013.* Retrieved from http://eforenergy.org/docpublicaciones/documentos-de-trabajo/WPFA06-2013.pdf
3. Bai, J., & Perron, P. (1998). Estimating and Testing Linear Models with Multiple Structural Breaks. *Econometrica, 66*(1). Retrieved from https://www.jstor.org/stable/2998540?seq=1#page_scan_tab_contents
4. de Gorter, H., Drabik, D., & Just, D. R. (2013). Biofuel Policies and Food Grain Commodity Prices 2006-2012: All Boom and No Bust? *AgBioForum, 16*(1). Retrieved from http://www.agbioforum.org/v16n1/v16n1a01-degorter.htm
5. Enders, W. (2010). *Applied Econometric Time Series* (3rd edition). New York: John Wiley & Sons.
6. Galchynska, J., Orlikowskyi, M., & Maciejczak, M. (2015). Development of bioenergy from biomass in Ukraine. *Problemy Rolnictwa Światowego (Problems of World Agriculture), 30*(15), 56-61 (in Ukr.).
7. Götz, L., Qiu, F., Gervais, J. P, & Glauben, T. (2012). The Law of One Price under State-Dependent Policy Intervention: An Application to the Ukrainian Wheat Market. *Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2012 AAEA Annual Meeting, Seattle, Washington, August 12-14, 2012* (pp. 1-36). Retrieved from https://pdfs.semanticscholar.org/f35e/f6fb2bb2c3072314d494d24cb9cd2712647a.pdf
8. Goychuk, K., & Meyers, W. H. (2014). Black Sea and World Wheat Market Price Integration Analysis. *Canadian Journal of Agricultural Economics, 62*(1), 245-261. doi: https://doi.org/10.1111/cjag.12025
9. Hamulczuk, M., & Klimkowski, C. (2012). Response of the Polish Wheat Prices to the World's Crude Oil Prices. *Acta Oeconomica et Informatica, 15*(2), 50-56. Retrieved from http://purl.umn.edu/133169
10. HLPE (2013). *Biofuels and food security.* A Report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome. Retrieved from http://www.fao.org/3/a-i2952e.pdf
11. Katrakilidis, C., Sidiropoulos, M., & Tabakis, N. (2015). An empirical investigation of the price linkages between oil, biofuel and selected agriculture commodities. *Procedia Economics and Finance, 33,* 313-320. doi: https://doi.org/10.1016/S2212-5671(15)01715-3
12. Kretschmer, B., Bowyer, C., & Buckwell, A. (2012). *EU biofuel use and agricultural commodity prices: a review of the evidence base.* Report of the Institute for European Environmental Policy (June) (pp.1-65). Retrieved from https://ieep.eu/uploads/articles/attachments/9d109cf4-8b49-4ed0-9ac7-4c5678d83b53/IEEP_Biofuels_and_food_prices_June_2012.pdf?v=63664509780
13. Kumar, D. (2017). On Volatility Transmission from Crude Oil Agricultural Commodities. *Theoretical Economics Letters, 7*(2), 87-101. doi: https://doi.org/10.4236/tel.2017.72009
14. Lagi, M., Bertrand, K. Z., & Bar-Yam, Y. (2011). *The Food Crises and Political Instability in North Africa and the Middle East.* New England Complex Systems Institute (NECSI), Cambridge. Retrieved from https://necsi.edu/the-food-crises-and-political-instability-in-north-africa-and-the-middle-east
15. Verkhovna Rada of Ukraine (2009). *«On amendments to some laws of Ukraine regarding promotion the production and use of biofuels». Law of Ukraine from 21.05.2009 No. 1391-VI.* Retrieved from https://zakon.rada.gov.ua/laws/show/1391-17 (in Ukr.)
16. Makarchuk, O., Hokmann, H., & Lissitsa, A. (2007). Bioenergie as a source of income of agricultural enterprises *Leibniz Institute of Agricultural Development in Central and Eastern Europe, Discussion paper No. 111* (pp. 1-45). Retrieved from https://www.econstor.eu/handle/10419/28461
17. McPhail, L. L., & Babcock, B. A. (2012). Impact of US policy on US corn and gasoline price variability. *Energy, 37*(1), 505-513. doi: https://doi.org/10.1016/j.energy.2011.11.004
18. Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds Testing Approaches to the Analysis of Level Relationships. *Journal of Applied Econometrics, 16*(3), 289-326. doi: https://doi.org/10.1002/jae.616
19. Potori, N., & Stark, A. (2015). Do crude oil prices influence new crop sunflower seed futures price discovery in Hungary. *Studies in Agricultural Economics 117*(3), 126-130. doi: https://doi.org/10.7896/j.1527
20. Schmitz, A., & Meyers, W. H. (Eds.). (2015). *Transition to Agricultural Market Economies: The future of Kazakhstan, Russia and Ukraine.* University of Missouri, Colombia. doi: https://doi.org/10.1079/9781780645353.0000
21. Tyner, W. E. (2010). The integration of energy and agricultural markets. *Agricultural Economics, 41*(s1), 193-201. doi: https://doi.org/10.1111/j.1574-0862.2010.00500.x
22. Wright, B. D. (2014). Global Biofuels: Key to the Puzzle of Grain Market Behavior. *Journal of Economic Perspectives, 28*(1), 73-98. doi: https://doi.org/10.1257/jep.28.1.73
23. Zilberman, D., Hochman, G., Rajagopal, D., Sexton, S., & Timilsina, G. (2013). The Impact of Biofuels on Commodity Food Prices: Assessment of Findings. *American Journal of Agricultural Economics, 95*(2), 275-281. doi: https://doi.org/10.1093/ajae/aas037
24. Zafeiriou, E., Arabatzis, G., Karanikola, P., Tampakis, S., & Tsiantikoudis, S. (2018). Agricultural Commodities and Crude Oil Prices: An Empirical Investigation of Their Relationship. *Sustainability, 10*(4) 1199. doi: https://doi.org/10.3390/su10041199

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