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Tetyana Kuts[1], Oksana Makarchuk[2]
National University of Life and Environmental Sciences of Ukraine – NULES of Ukraine

Ukrainian Sunflower Market on the Background of EU and US Markets

Abstract. This paper aims to provide market analysis of the sunflower market in Ukraine (UA) and research the existence of integration between the sunflower oil markets in Ukraine, the European Union (EU) and the United States (US). To fulfill the aims in the paper, yearly balances of sunflower seed, sunflower oil and sunflower cake were analyzed and price analysis was conducted. Price integration was assessed with the use of the error correction model (ECM) which was applied to monthly prices for sunflower oil from 2000 to 2020. Our findings provide evidence of high price transmission between the UA and EU markets, conversely lower price transmission was observed between the UA and the US.

Key words: market integration, Ukraine, European Union, United States, sunflower oil market

JEL Classification: F1, F6, Q1, C5

Introduction

The main traditional factors underlying increases in the production of oilseed crops and their products in the world are: the growth in population need for vegetable oils; high-protein feeds for livestock; and the need for raw materials the chemical and bio-fuel industries. Through the processing of oilseed crops, products of primary processing (vegetable oil and meals), products of deeper processing (mayonnaise, margarine, soap, confectionery fat, oils), meal, protein acids and biodiesel are obtained.

A number of publications show that the sunflower seed market is especially important for the UA; its effective functioning is of primary importance for ensuring food and energy security. Additionally, Ukraine is one of the largest players on the world market of oilseed and vegetable oils (Barsuk, 2017).

Researchers identify the following trends in the sunflower market in the Ukraine over the past 20 years: a significant increase in the supply of seed in accordance with growing demand for raw materials by processing enterprises in the domestic market (Kuts, 2010); and an increase in production and export of sunflower oil, which is described by linear trends that confirm a stable situation on the oil market (Seliuchenko and Kosar, 2018; Slavkova, 2018). Natorina analyzed the positive dynamics of growth capacity in the sunflower oil market in Ukraine and described this market as moderately concentrated and competitive (Natorina, 2014).

The sunflower market in Ukraine is integrated with the world market, which is emphasized by the export orientation of its processed products, i.e. sunflower oil and sunflower cake. Evaluation of market integration is becoming popular. Farmers, agricultural economists and traders are interested in the question of how and to what extent price shocks

[1] Phd, e-mail: stdkuts@ukr.net; https://orcid.org/0000-0002-8389-6070
[2] Phd, e-mail: makarchukoks@gmail.com; https://orcid.org/0000-0002-5997-5879

are transmitted between markets. This concern is one of the results of the increase in trade in agricultural commodities on financial markets. Often market integration is defined as the level of price transmission among vertically or spatially distinct markets. In turn, this transmission can also be used as a proxy for market efficiency, similar to a competitive model viewpoint (Goychuk and Meyers, 2014; Fackler and Goodwin, 2001; Vermeulen, 2016).

Hamulczuk et al. searched for market integration between Ukrainian and European markets. There were confirmed results about direct and indirect integration of both markets due to physical trade flows of rapeseeds, rape cake, and rape oil, providing evidence that Ukrainian and European rapeseed prices are co-integrated (Hamulczuk et al., 2019).

Vasciaveo et al. investigated market integration for crude oil and three agricultural commodities (wheat, corn and soybean) in Italy and the United States. They came to the conclusion that in the US markets there is evidence of market integration between crude oil and US agricultural commodity prices, with non-linear causality that goes from oil to agricultural commodity prices; and that integration existence between US and Italian agricultural markets (Vasciavo et al., 2013).

Linkages between prices of agricultural products at the producer level with the prices of the same products at the consumer level in South Sumatera and Indonesia were researched by Marwa et al. (2017). They confirmed integration between the price of rice at the producer level and consumer level. In addition, they stated that researched markets have vertical integration in the short run (Marwa et al., 2017).

Ukraine is a global leader in the production of sunflower seed and sunflower oil for export. Sunflower oil is also one of five products that occupy the largest share in the internal commodity structure of UA exports. However, growth of the sunflower market also has negative consequences related to agricultural development in general. Indeed, the increase in sowing areas and non-compliance with cultivation technologies threatens land depletion and as a consequence also leads to a reduction in yields.

Given the rapid increase in sunflower cultivation in Ukraine, the active development of the oil-fat industry and the export-oriented nature of its products, the purpose of this article is to analyze the sunflower market and identify the level of integration between the UA, EU and US. In order to evaluate the extent to which the UA, EU and US sunflower markets are closely integrated, we first conducted a market analysis based on yearly sunflower seed, sunflower oil, and sunflower crush balance sheets. To evaluate the long-run equilibrium relationship between UA, EU and US sunflower oil prices, the Engle-Granger co-integration test was applied. Then, we investigated price linkages between the UA, EU and US sunflower oil markets using ECM that is based on monthly price data. In turn, ECM modeling allowed us to draw conclusions about price adjusting, and to evaluate the periods in which Ukrainian sunflower oil prices influenced EU and US prices, and vice versa.

The sunflower market was chosen for this research paper because we could not find any studies that related to the integration of the UA sunflower market with world markets, and sought to fill this knowledge gap.

The paper is organized as follows: Section 2 discusses the data and methods of empirical investigation; Section 3 reports the results; and Section 4 ends with conclusions of obtained results.

Materials and methods

To analyze the UA sunflower oil market and find its integration with EU and US sunflower oil markets, we used two types of data: 1) empirical research based on data from yearly sunflower seed, sunflower oil, and sunflower crush balance sheets for the UA, EU and US that were taken from the United States Department of Agriculture (USDA-FAS, 2020). This data showed us the production, domestic use and international trade of sunflower oil with a specific focus on the trade flows with the UA and the EU.

The paper consists of an analysis of the price linkages between the UA, EU, and US sunflower oil markets. It is important to emphasize that the EU and US remain big players in production, processing and delivery of vegetable oils. Thus, their vegetable oil markets could affect the UA sunflower oil market. 2) Another source of data was the APK-inform (2020), IMF (International Monetary Fund) (2020). Sunflower oil prices were analyzed as a means to evaluate the sunflower market. Cultivated sunflower seeds are delivered mainly for oil processing – 90% of which is exported, with the rest used for domestic consumption. In the case of Ukraine's high level of sunflower oil export, market price analysis of the UA, EU and US sunflower oil markets was conducted. To compare world sunflower oil prices with Ukrainian prices, monthly price series data was used from January 2000 till April 2020 (Figure 1).

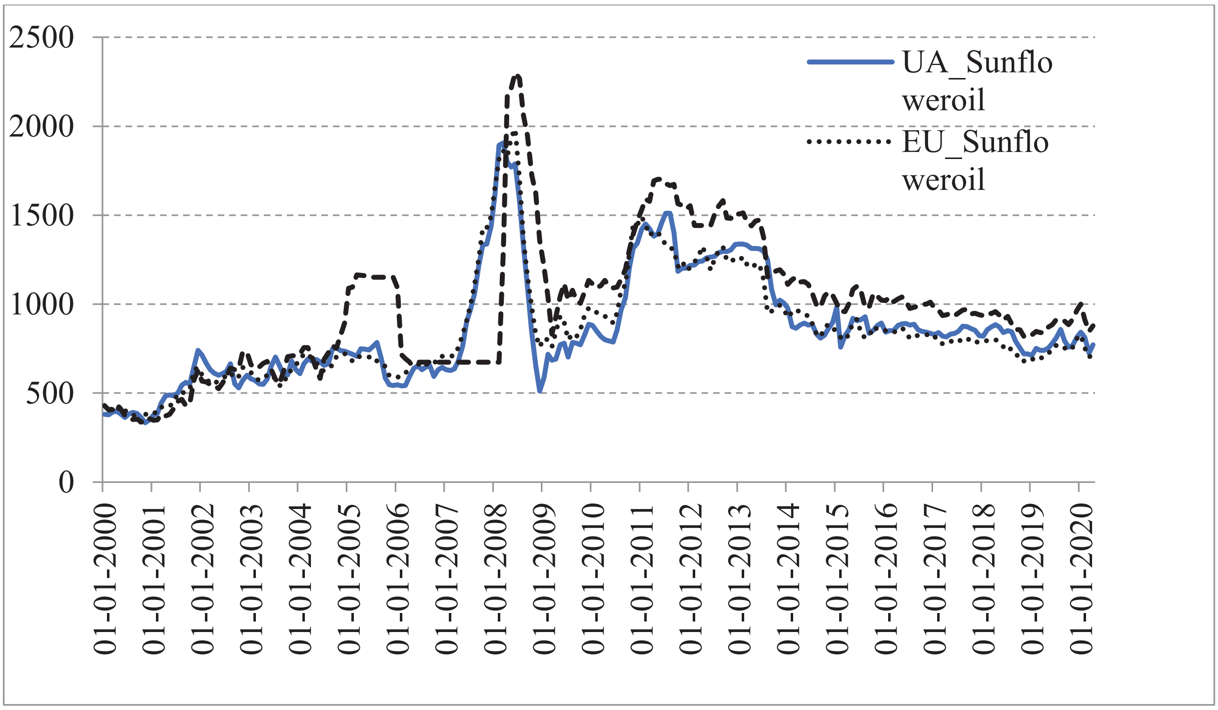

Fig. 1. Monthly UA, EU and US sunflower oil price series (USD/ton)

Source: Based on APK-inform, IMF.

As we can see in Figure 1, the price shows that UA sunflower oil prices follow closely to their EU and US counterparts, suggesting that significant linkages may exist between prices. In 2006-2009, prices on this commodity in the UA, EU and US were not stable. As we compared data of UA prices to EU and US prices, it was apparent that during some periods of time, UA prices were lower than world prices. From the figure we could also observe several sharp increases in sunflower oil prices, most notably between 2007-2008. All variables were expressed in USD.

In order to implement the price analysis, we first investigated the statistical properties of the price series. To test series stationarity, an Augmented Dickey Fuller (ADF) test was applied (model with constant). The null hypothesis states that the time series is non-stationary (has unit root); the alternative is that it is stationary. ADF test statistic is based on tau-statistic of coefficient φ from OLS estimation of the following formula (Enders, 2001):

$$\Delta y_t = \alpha_t + \varphi y_{t-1} + \sum_{i=1}^{p} \delta_i \Delta y_{t-i} + \varepsilon_t \qquad (1)$$

where: y_t – analyzed price series; α_t – deterministic term (constant, trend); p – the number of lags ensuring white noise properties of random component ε_t, δ_i – coefficients describing the short-run persistence of Δy_t.

Further the ADF-GLS test was applied, which is a modification of the ADF test which Elliott et al. (1996) suggested. In a first step, price series y_t is detrended and demeaned via a generalized method of least squares. In the second, the residuals of the equation ($\tilde{y}_t$) are used for testing the unit root by using the ADF equation:

$$\Delta \tilde{y}_t = p\, \tilde{y}_{t-1} + \sum_{i=1}^{p} \delta_i \Delta \tilde{y}_{t-p} + \varepsilon_t \qquad (2)$$

where: ρ and δ are model coefficients, p - maximum augmentation lag. A value of the ρ coefficient that is significantly different from the null one makes it possible to reject the null unit root hypothesis (Hamulczuk et al., 2019).

The structural parameters of the model were estimated using the OLS. The purpose of the lagged components is to remove the autocorrelation of the random parameter. The number of lags was chosen with the use of Akaike's Information Criterion (AIC). The null hypothesis is δ=0 (non-stationarity) versus the alternative δ <0 (stationarity).

Testing the price series for cointegration gives the possibility to identify the long-run equilibrium (relationship). The analysis of the correlation between the first differences is used to examine the short-run dynamics (Hamulczuk et al., 2013). In the case of nonstationary time series, they are cointegrated if their linear combination is stationary I(0). To test the existence of a long-term relationship in the series, the Engle-Granger cointegration test (E-G) was applied. It is based on the following regression (Enders, 2001):

$$y_t = \beta_0 + \beta_1 x_t + \varepsilon_t \qquad (3)$$

where: x_t, y_t – variables tested for cointegration; $\beta_0, \beta_1, \beta_2$ – structural parameters; ε_t – residuals.

The variables x_t and y_t are co-integrated if the residuals ε_t are stationary. To verify this assumption, we can apply equation 1 for residuals from equation 2.

A further analysis was performed with the use of an Error Correction Model (ECM). The basic form of the ECM model seems to be as a follows (Hamulczuk et al., 2013):

$$\Delta y_t = \sum_{i=1}^{r} a_i \Delta Y_{t-i} + \sum_{i=0}^{r} \beta_i \Delta X_{t-i} + \gamma EC_{t-1} + \varepsilon_t \qquad (4)$$

where: γ – error correction coefficient, measures the speed of convergence to long-run equilibrium, EC_{t-1} is a stationary error correction term obtained from the cointegrating equation $EC_{t-1} = Y_{t-1} - \beta_0 - \beta_1 x_{t-1}$.

The error correction coefficient γ informs about the speed of convergence to the long-run equilibrium path. It shows how much of the deviation from the long-term path is corrected in a subsequent period. The system will be restored to equilibrium, if the value of the γ coefficient belongs to the interval (0; -1). If γ > 0 there is no error correction mechanism, the variables are not cointegrated; when γ < -1 there are oscillations around the long-term trajectory of the increasing amplitude. Parameters α_i and β_{ij} of the model relate to short-run dynamics to equilibrium (Hamulczuk et al., 2013).

Results

1) Market analysis

The sunflower seed market is an important segment of the world market. According to research, this market is becoming more predictable: from 2000/01 MY to 2019/20 MY the world harvested areas of sunflower seed increased by 32% and amounted to 26.4 million ha; the levels of world production of sunflower seed (54976 MT) and consumption (54905 MT) increased by 39.8% (USDA-FAS, 2020).

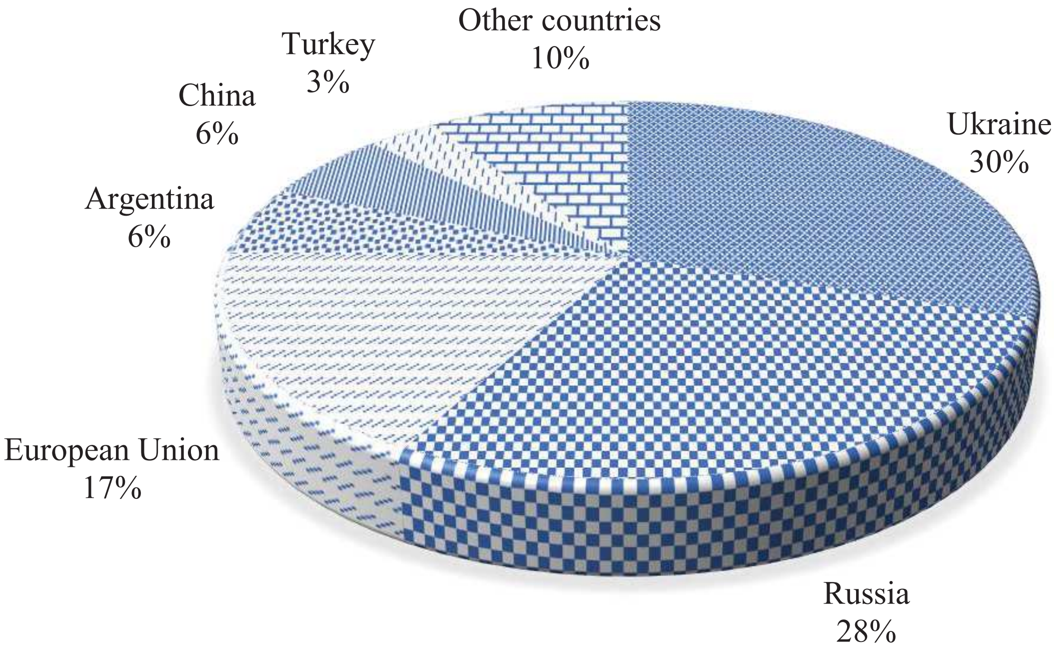

Fig. 2. The main producers of sunflower seed in the world in 2019/20 MY

Source: Authors' own calculation based on the State Statistics Service of Ukraine (2020).

The situation on the sunflower seed market, oils and meal is mainly determined by its key participating countries. Sunflower seed production is concentrated in 6 countries, the total share of which is near 90%. In 2019/20 MY the largest producers were: Ukraine – 16.5 MT (30% of world production), Russia – 15.3 MT (28%), European Union – 9.6 (17%), Argentina – 3.3 (6%), China – 3.25 (6%) and Turkey – 1.8 (3%) (Figure 2).

A peculiarity of the sunflower oil market is the significant difference in the planting and harvesting periods in these countries, which determined the specifics of the marketing period. This discrepancy in production periods allows a certain stable level of supply in the sunflower oil market to be maintained throughout the year (except for some unforeseen situations) (Expla, 2020).

The main oil crop in Ukraine is sunflower, the share of which in the structure of sown areas of oilseeds in 2019 was 66%. Sunflower is mainly grown in the southern and eastern regions of Ukraine. Agricultural enterprises grow 85.8% of seeds from their total production by all categories of farms.

Analyzing data on the balance of market demand and supply for sunflower seeds, we can conclude that the Ukrainian market is developing dynamically and is balanced (Table 1).

Table 1. Sunflower seed balance sheets for Ukraine, thousand MT

Marketing year	2000/2001	2005/2006	2010/2011	2015/2016	2018/2019	2019/2020
Beginning Stocks	87	113	483	149	172	140
Production	3457	4900	8100	11900	15000	16500
Imports	1	5	12	22	23	30
Total Supply	3545	5018	8595	12071	15195	16670
Exports	1020	220	444	83	105	80
Domestic Consumption	2510	4613	8005	11820	14950	16540
Total Demand	3530	4833	8449	11903	15055	16620
Ending Stocks	15	185	146	168	140	50
Self-sufficiency ratio	1.38	1.06	1.01	1.01	1.01	0.99

Source: Authors' own calculation based on USDA-FAS (2020).

The total supply of sunflower seed on the market in Ukraine consists of: beginning stocks, which in 2019/20 MY amounted to 140 thousand tons; sunflower production, in the amount of 16.5 MT; and imports of 30 thousand tons. This figure was equal to 16.67 MT, or 4.7 times more than the total supply of 2000/01 MY.

The total available supply of sunflower seed is determined primarily by the level of its production. The significant growth of the gross harvest is due to the constant expansion of sown areas under the crop and the growth of the yield twice during the analyzed period (Figure 3).

Import operations for sunflower in Ukraine are due to the supply of seed (varieties and hybrids of foreign selection) mainly from the United States, Turkey, and EU countries. During the analyzed period, there was a slight increase in imports of sunflower seeds to Ukraine in accordance with the dynamics of growth of sown areas (up to 23 thousand tons).

The total demand on the sunflower seed market consists of exports and domestic consumption, e.g. in 2019/20 MY it amounted to 16.62 MT. Sunflower seed exports decreased during the analyzed period by 92%.

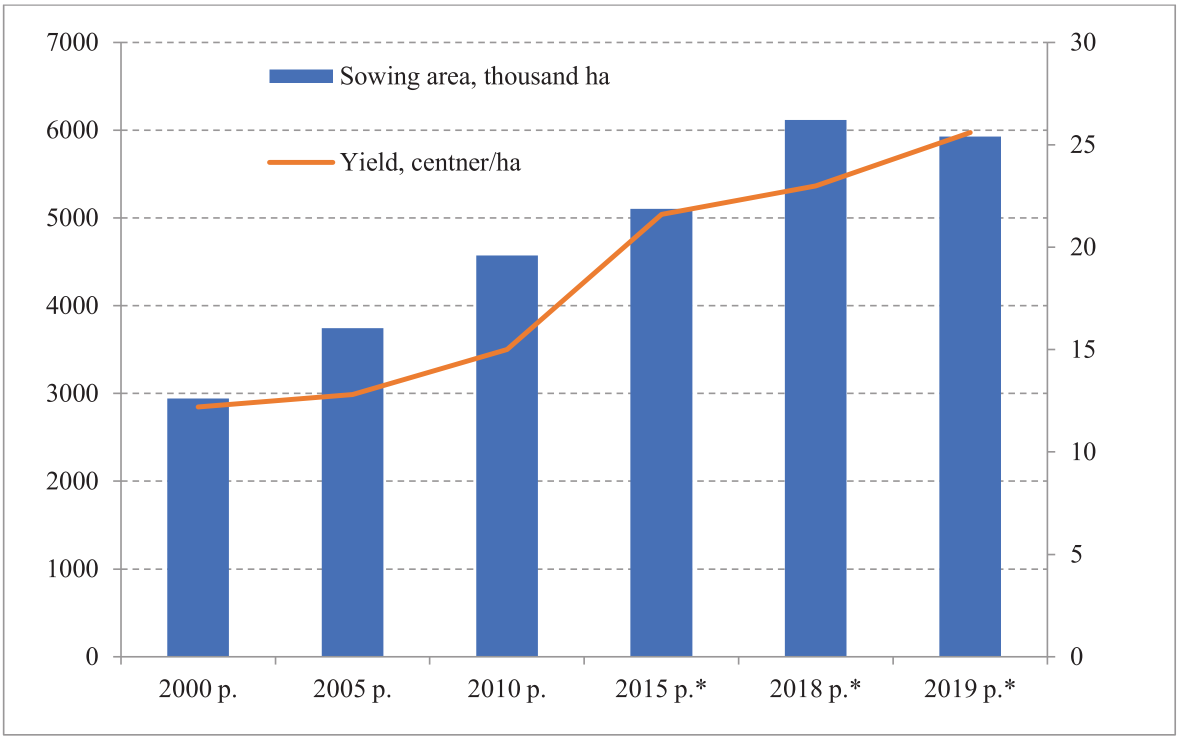

Fig. 3. Dynamics of sown areas and sunflower seed yield in UA

Source: Authors' own presentation based on the State Statistics Service of Ukraine data (Data are given without the temporarily occupied territory of the Autonomous Republic of Crimea, the city of Sevastopol and part of the temporarily occupied territories in Donetsk and Luhansk regions) (2020)

Cultivated sunflower seed goes mostly for domestic consumption and processing for sunflower seed oil. According to the results of the 2019/20 MY, the UA industry produced 7 million tons of sunflower oil, 6.4 million tons were exported (90 %) (Table 2).

Table 2. Sunflower oil balance sheets for Ukraine, thousand MT

Marketing year	2000/2001	2005/2006	2010/2011	2015/2016	2018/2019	2019/2020
Beginning Stocks	12	293	144	344	279	40
Production	970	1925	3335	5010	6364	7055
Imports	0	0	1	1	0	0
Total Supply	982	2218	3480	5355	6643	7095
Exports	550	1514	2652	4500	6063	6350
Domestic Consumption	417	417	530	550	540	545
Total Demand	967	1931	3182	5050	6603	6895
Ending Stocks	15	287	298	305	40	200
Self-sufficiency ratio	2.33	4.62	6.29	9.11	11.78	12.94

Source: Authors' own calculation based on USDA-FAS (2020).

Ukrainian sunflower oil is shipped out in more than 120 countries. The main regions that are supplied with these products are the EU countries, South Asia, North Africa, the Middle East and the countries of the former Soviet Union.

Considering the self-sufficiency ratio for sunflower seed oil, we can observe its high level each year; i.e. in 2019/20 MY, its value was 5.6 times higher than in 2000/01 MY. This means that domestic consumption is very low; for example, in 2019/20 MY, the domestic consumption in total production amounted to only 8.5%. The same situation applies to sunflower seed cake, where, for instance, in 2019/20 MY, 73% was exported (Table 3). This could indicates the high direct integration of the Ukrainian sunflower seed oil market with world and EU markets in terms of trade flows.

Table 3. Sunflower cake balance sheets for Ukraine, thousand MT

Marketing year	2000/2001	2005/2006	2010/2011	2015/2016	2018/2019	2019/2020
Beginning Stocks	2	5	127	265	334	293
Production	950	1880	3296	4811	6112	6773
Imports	0	0	1	1	5	8
Total Supply	952	1885	3424	5077	6451	7074
Exports	600	1337	2927	3817	4808	4950
Domestic Consumption	350	543	390	1000	1350	1600
Total Demand	950	1880	3317	4817	6158	6550
Ending Stocks	2	5	107	260	293	524
Self-sufficiency ratio	2.71	3.46	8.45	4.81	4.53	4.23

Source: Authors' own calculation based on USDA-FAS (2020).

Observing the sunflower seed oil market, it is important to note that crucial development of sunflower seed processing began in 1999 when an export duty was introduced at 23% of the customs value according to the Law of Ukraine "On export rates (export) duties on seeds of certain types of oilseeds cultures" (from 10.09.1999, No. 1033-XI). This was the beginning of the reorientation of the oil and fat sub-complex of Ukraine from the export of sunflower seeds to trade in sunflower seed oil (Antonyuk et. al., 2013). Joining to the World Trade Organisation (WTO) in 2008, Ukraine kept its export duty for sunflower seed; however from the beginning of 1 January 2007 it was yearly decreased by 1% to reach 10% (Law of Ukraine…, 2012).

As a result, UA and foreign enterprises were invested intensively in the oil and fat branch. According to the Ukroliyaprom Association, 64 oil processing plants have been built in the last 20 years, including 48 oil extraction plants, each of which is a $100-150 million investment (Ukroliyaprom, 2020). 16 terminals in 6 ports, elevator complexes were built, logistics was developed. The total production capacity for oilseed processing in UA is 24 million tons/year: thus, they provide complete processing of oilseeds within the country.

Another important impetus for the growth of the industry was the use of sunflower husk as an alternative fuel for energy production, and not only in oil refineries. All branch plants are converted to boilers with secondary heating, and surplus husks are sold to the EU.

2) Price analysis

Price analysis was based on logarithmic data. First, stationarity of price series was tested using ADF and ADF-GLS test. ADF results were not clear, thus we applied an ADF-GLS test, which suggested all series are integrated in order 1. Results are presented in Table 4.

Table 4. Unit root testing results

Variable	ADF			ADF-GLS		
	tau	p-value	lag	tau	p-value	lag
l_UA	-2.922	0.043	3	-0.854	0.346	2
dl_UA	-7.129	1.47E-01	2	-6.079	3.04E-01	3
l_EU	-2.567	0.099	3	1.086	0.252	3
dl_EU	-6.587	4.08E-01	2	-2.843	0.004	3
l_US	-2.514	0.112	2	-0.954	0.304	2
dl_US	-10.190	8.12E-02	1	-8.540	1.74E-15	0

Source: Authors' own calculation.

Getting results showed that log levels are not stationary, because value *tau* for all variables are lower than critical value *tau*=3.398, therefore we accept the null hypothesis about non-stationarity. In turn, first differences are stationary. The following values of the test statistics (*tau*) were obtained for the model for first differences of price series with a constant: dl_UA– -6.08; dl_EU– -2.84; dl_US– - 8.54. The critical value *tau*=3.398; this means that the null hypothesis was rejected for the first differences of price series. It leads to the conclusion that all price series are integrated in order one I(1).

To evaluate the nature of the linkage between Ukrainian sunflower oil prices, EU and US prices, the Engle-Granger co-integration test was applied (Table 5).

Table 5. Engle-Granger co-integration test results

Specification	Cointegration equation UA-EU: $l\_UA_t=0.15+0,98*l\_EU_t+\varepsilon_t$	Cointegration equation UA-US: $l\_UA_t=1.97+0.69*l\_US_t+\varepsilon_t$
Estimated φ	-0.1654	-0.1408
Tau-value	-3.8045	-4.9254
P-value	0.0134	0.0002

Source: Authors' own calculation.

Getting results for the models with constant (l_UAt=0.15+0,98*l_EUt+εt; l_UAt=1.97+0.69*l_USt +εt) gave evidence for the existence of co-integration that confirmed the stationary of residuals in both models. In the case of UA-EU, model P-values are higher than critical ones (0.05 or 0.01) which allows us to reject the null hypothesis about no existence of co-integration, and accept the alternative hypothesis about co-integration of prices, vice versa to the UA-US model. It means that in the long-run, there could be significant force for upward prices on a common path. The existence of co-integration confirms the fact that Ukrainian sunflower oil mostly goes for export. Therefore, the further analysis was based on ECM for the first differences. The resultant models are presented in Table 6.

ECM results allow us to conclude that in the short term, EU sunflower oil prices significantly influence UA prices, confirmed by low P-values. UA prices are adjusting to the long-run relationship and they are adjusting to the long-run equilibrium relationship. At the same time, EU sunflower oil prices are not adjusting to the long-run relationship because they are weakly exogenous. In the short term, UA prices have moderate impact on EU prices (less significant than vice versa).

Table 6. ECM estimates

Ukraine –European Union			Ukraine –US		
Variable	Coefficient	P-Value	Variable	Coefficient	P-Value
Dependent variable dl_UA			Dependent variable dl_UA		
dl_EU_{t-1}	0.6164	3.45E-11	dl_US_1	0.0792	0.1637
dl_EU_{t-2}	0.0053	9.57E-01	dl_US_2	-0.0703	0.2125
dl_UA_{t-1}	0.1098	0.1501	dl_UA_1	0.4151	3.09E-09
dl_UA_{t-2}	−0.0392	0.575	dl_UA_2	-0.0856	0.2359
EC_{t-1}	−0.1708	2.00E-04	EC_{t-1}	-0.0084	0.7279
Dependent variable: dl_EU			Dependent variable: dl_US		
dl_UA_{t-1}	−0.0361	0.5894	dl_US_1	0.4132	6.56E-011
dl_UA_{t-2}	0.1419	0.0218	dl_US_2	-0.2031	0.0008
dl_EU_{t-1}	0.5394	4.14E-11	dl_UA_1	0.1593	0.0274
dl_EU_{t-2}	−0.2405	0.0055	dl_UA_2	0.0758	0.3243
EC_{t-1}	−0.0071	0.8594	EC_{t-1}	0.1463	3.48E-08

Source: authors' own calculation.

In the short run, US prices do not significantly impact UA prices. On the other hand, in the short run UA prices have significant impact on US prices. UA prices are weakly exogenous and they are not adjusting to the long run relationship (however US prices are adjusting to the long run relationship). The lower price linkage between UA and US could be explained by the fact that the US vegetable oil market has a more diverse assortment, and in US sunflower oil is consumed less than other vegetable oils. In 2019/2020 MY, according to the USDA-FAS data, 187 thousand tons were produced and 136 thousand tons were imported. This fact shows that UA prices could potentially influence US sunflower oil prices.

Conclusions

Summarizing the literature review, we can draw the following outcomes: sunflower seed will remain a strategic crop in the UA agribusiness, ensuring the profitability of producers; sunflower seed and sunflower oil producers have mainly competitive price advantages; increasing the competitiveness of UA companies in domestic and foreign markets can be achieved by intensifying the technology of growing raw materials and optimizing costs; diversification of products that are produced, namely high oleic oil, organic sunflower oil and production using environmentally friendly technologies.

It is essential to emphasize that the sunflower market is important for UA in terms of agricultural and food markets. Cultivated sunflower seed is used mostly for processing to oil, with domestic consumption of 8% in 2019/2020; the rest goes for export. It is also important to emphasize that the role of Ukraine in the sunflower oil world market is vital, as 52% of the world sunflower oil export in 2019/2020 was originated from UA (USDA-FAS, 2020). Indeed, EU countries became the largest importer of Ukrainian sunflower oil, i.e. more than 32% of total exports according to the results of September - April 2019/20 MY (Ukroliyaprom, 2020). Taking into account these facts shows the importance of analyzing sunflower oil market prices in UA, EU and US, and finding linkages between them.

Results presented in this paper point to the correlation between UA and EU prices; however, they indicated low linkages between UA and US prices. The Engle-Granger co-integration test confirmed the long-run equilibrium relationship between UA sunflower oil prices, EU and US. Based on getting results of stationarity and co-integration, the ECM model was implied. ECM modeling allows us to conclude that UA sunflower oil prices depend on EU sunflower oil prices and they are adjusting to the long-run equilibrium relationship. In the case of EU sunflower oil prices, they are weakly exogenous and not adjusting to the long-run relationship. However, in the short term, UA prices have moderate impact on EU prices. Models for UA and US sunflower oil prices indicate that US prices do not significantly influence UA prices in short term. In turn, UA prices are not adjusting to the long run relationship due to being weakly exogenous. Indeed, in the short term, UA prices have moderate impact on US prices.

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