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Food Security in Times of Covid-19: Price Aspects in Ukraine and Neighboring EU Countries

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ABSTRACT

So far, all countries around the world have to deal with the Covid-19 challenge. As imperative, it includes providing food security subject to pandemic restrictions and consequences. The study purpose took focus on exploring price dynamics observed for basic crop and animal products. The research hypothesis supposed different volatility of their prices linked with a certain similarity across the considered Eastern European countries. The utilized methods involved candlestick charting and analysis of variance ANOVA to compare the food price indices and changes in times of the Covid-19 between February and December 2020 with regard to the corresponding pre-Covid-19 period. The research findings revealed stable pricing for bread and cheese with fluctuations below 4%. The study outcomes indicated the most disruptive Covid-19 impact on potato and pork. The latter largely associated with Hungary, Poland, Romania, and Slovakia. Prices for sugar and eggs in Ukraine gained by 46.2% to 30.4% and illuminated unhealthy shifts in dietary patterns. The basic research conclusions are as follows. Firstly, food chains in animal husbandry need special enhancements to face the Covid-19 crisis. Secondly, the evidenced price volatility coupled with the decreasing purchasing power are the reasons to concern on providing balanced nutrition and healthy diets in Ukraine and the neighboring EU countries.

INTRODUCTION

Currently, mankind has to face a new global challenge of the ongoing Covid-19 pandemic. It affects people's health and livelihoods, disrupts economy and exacerbates food security. The latter implies diminishing food availability and affordability owing to ruined food chains and reduced purchasing power of consumers across the world. It is hard to forecast exact scope, scale and duration of the unfolding Covid-19 consequences. Nevertheless, scholars should make their relevant contribution in order to mitigate such negative outcomes. One of plausible approaches originates from comparing experiences in fighting against Covid-19.

Given the similar natural and climatic conditions, close locations, lifestyles, and dietary patters, this research is focused on exploring the Covid-19 impact on food security in Ukraine and neighboring EU

countries including Hungary, Poland, Romania, and Slovakia. To confirm the marked involvement in the Covid-19 crisis, it is worth noticing that GDP in 2020 vs 2019 shrank by 3.6% in Poland, 4.8% in Romania, 6.1% in Hungary, 7.1% in Slovakia, 7.2% in Ukraine (IMF, 2020). Besides, as of 21 January 2021 there were 36.7 thousand of total Covid-19 cases per 1 million of population in Hungary, 38.4, 36.6, 41.9, and 27.1 those ones in Poland, Romania, Slovakia, and Ukraine (Worldometers, 2021). Unfortunately, the latter indicator is the signal of insufficient testing for coronavirus rather than the sign of a safer situation in Ukraine where food security even in the pre-Covid-19 period was far from adequate (Vasylieva, 2019).

Since the beginning of the Covid-19 pandemic the Food and Agriculture Organization of the United Nations put emphasis on price aspect in providing food security. Namely, on 14 February 2020 FAO established the FAO Big Data tool to monitor food prices on the daily basis in all countries (FAO, 2021). As of 21 January 2021, Covid-19 caused the growth in the consumer food prices by 3.7% in Slovakia, 5.3% in Romania, 8.2% in Poland, 8.8% in Ukraine, and 16.3% in Hungary. Certainly, these numbers are not crucial but they do not reveal a comprehensive picture about price dynamics for the most demanded crop and animal products whose imbalanced intakes would result in nutrition insecurity especially dangerous in the era of Covid-19. For such reasons, this research was intended to check hypothesis about different effects of Covid-19 on prices for prime food products and some common attributes of these effects experienced in Ukraine and four neighboring EU countries.

The remainder of this article is arranged as follows. Section 1 presents the specific literature review on the topics in question. The applied research methodology is covered in section 2. Section 3 incorporates empirical part of the study. The relevant discussion of the paper's findings is introduced in section 4. The last section contains the articulated research conclusion.

1. LITERATURE REVIEW

Agricultural pricing is the core topic of numerous studies. Inter alia, Tomek and Kaiser, (2014) detected agricultural and food price differences over space as well as their variability with the passage of time. Recently, the entrenched theories of agricultural supply and demand, food marketing channels and pricing schemes in both domestic and international trade were specified in Norwood and Lusk (2018). Rezitis and Sassi (2013) clarified that new millennium brought frequent coherent surges of food and agricultural commodity prices. It complicates capturing expected trends, seasonality, and cyclicality and also links with distorting food supply chains. Volatile prices mislead their relationships with nutritional value of diets assessed per unit of food mass, energy or portion and also entail food insecurity manifested via negative effects on human health and quality of life (Jones and Monsivais, 2016). This phenomenon is especially dangerous in times of Covid-19.

As such, Hobbs (2020) examined resilience of food supply chains influenced by the Covid-19 pandemic. He identified their short-run bottlenecks including low stocks incapable to meet initial customers' hoarding and quarantine restrictions on transportation. To tackle the long-run issues of the Covid-19 pandemic, Hobbs (2020) prioritized the workforce safety and shortage as well as investments in online food sales and delivery. In the same manner, Bene (2020) looked into 'ripple effects' across food systems when disturbances, shocks, and stresses of any chain actor like farmers, processors, wholesalers, retailers, and final food consumers are transmitted to both 'downstream' and 'upstream' actors. In more detail, with regard to food supply Siche (2020) showed food prices to be a measure of the Covid-19 impact on agriculture which can cope with this challenge through advanced diversification, cooperation, competition, entrepreneurship, insurance, and risk-management. In this fashion, food processors should rely on innovative enhancements (Karamushka et al., 2018). Wholesalers ought to adjust their trade costs (Xu, 2015). Retailers should give particular attention to logistic improvements (Christopher and Peck, 2015; Velychko et al., 2019). With regard to food demand, Schmidt et al. (2020) addressed real-time tracking of consumer preferences which appeared to be non-perishable food items, local food sourcing, takeout and delivery options, food aid and banks.

The latter are largely associated with the developing countries where additional 130 million individuals were affected by hunger by the end of 2020 (Workie et al., 2020). However, experience of China,

the first country encountered with the crisis of Covid-19, demonstrated successful food provision and minor instability in food prices (Yu et al., 2020). The anti-Covid-19 campaign is also the top issue on the European agenda. Among other things it concerns reinforcing nutritional food security (Toffolutti et al., 2020) and encourage new scientific studies on the topic in question.

Therefore, the research *goal* of this paper was focused on the selected Eastern European countries and aimed to explore dynamics in their current food prices relative to those of the pre-Covid-19 period. The research *hypothesis* supposed different volatility of prices for crop and animal products linked with a certain similarity across the considered Eastern European countries.

2. RESEARCH METHODOLOGY

The ongoing globalization and urbanization foster coinciding shifts in dietary patterns in both Ukraine and neighboring EU countries (Kearney, 2010). Thus, the basic food basket chosen for further examination contained five crop products including

- bread, vegetable oil, sugar, fruit, and potato,
- as well as five animal products comprising, and
- pork, poultry, milk, cheese, and eggs.

Granted, Ukraine is less developed country than Hungary, Poland, Romania, and Slovakia. Nevertheless, their food prices are mostly lower than average ones in the EU. In particular, in 2019 price level indices for food amounted to 65.4% in Romania, 68.8% in Poland, 84.7% in Hungary, 94.0% in Slovakia relative to 100% in the EU-27 on average. Besides, Romania was the least expensive country for bread, fruit, vegetables, potato, and meat. Sugar and dairy products had the lowest price levels in Poland (EUROSTAT, 2020). Thus, the experiences in providing food security in times of Covid-19 seem to be applicable to Ukrainian reality.

The first part of the presented study utilized a theory of the candlestick charting (Lambert, 2008; Corbitt, 2011). It made possible to accomplish a visualized comparison of price cycles in 2019 and 2020. For these purposes every analyzed food product k in country m was described by the price change (in %) like

$$PC_{nkm} = 100 \cdot (P_{nkm}^{2020} - P_{nkm}^{2019}) / P_{nkm}^{2019} . \quad (1)$$

There index n denoted a month starting from March. The annual time frame covered N months. P_{nkm}^{2019} and P_{nkm}^{2020} were the corresponding prices in 2019 and 2020. Index ranges were $n = 1...N$, $k = 1...10$, $m = 1...5$.

Candlesticks were specified by four indicators (1) as follows

$$(PC_{1km}, \underset{n}{Min}\, PC_{nkm}, \underset{n}{Max}\, PC_{nkm}, PC_{Nkm}) . \quad (2)$$

They revealed initial and final prices by food products as well as limits of their relative fluctuations and resulting trends over the Covid-19 period.

The second part of the presented study based on the analysis of variance ANOVA (Vik, 2013; Iacobucci, 2016). It made possible to delve into comparing price seasonality observed in 2019 and 2020. For such reasons every considered food product k in country m was characterized by the price indices (in %) like

$$PI_{nkm}^{2019} = 100 \cdot P_{nkm}^{2019} / P_{0km}^{2019} ,$$

$$PI_{nkm}^{2020} = 100 \cdot P_{nkm}^{2020} / P_{0km}^{2020} . \quad (3)$$

There P_{0km}^{2019} and P_{0km}^{2020} denoted the respective baseline prices as of February. Like before, index ranges were $n = 1...N$, $k = 1...10$, $m = 1...5$.

The ANOVA technique reduced to checking the F-test computed by means of a formula

$$F_{calc} = (2 \cdot N - 2) \cdot N \cdot ((API_{km}^{2020} - API_{km})^2 + (API_{km}^{2019} - API_{km})^2) /$$

$$/(\sum_n (API_{km}^{2020} - PI_{km}^{2020})^2 + \sum_n (API_{km}^{2020} - PI_{km}^{2020})^2). \quad (4)$$

There API_{km}^{2019}, API_{km}^{2020}, and API_{km} associated with the average price indices for a food product k in a country m in 2019, 2020, and over this period, i.e.

$$API_{km}^{2019} = \sum_n PI_{nkm}^{2019} / N,$$

$$API_{km}^{2020} = \sum_n PI_{nkm}^{2020} / N,$$

$$API_{km} = \sum_n (PI_{nkm}^{2020} + PI_{nkm}^{2019}) / (2 \cdot N). \quad (5)$$

Given an alpha level of significance as well as degrees of freedom 1 and $(2 \cdot N - 2)$ to set F_{crit}, the F-test inequality

$$F_{calc} \le F_{crit} \quad (6)$$

carried the message that seasonal dynamics of price indices were similar and their average values appeared to be relatively equal in the pre-Covid-19 period and at times of coronavirus pandemic. In contrast, the F-test inequality

$$F_{calc} > F_{crit} \quad (7)$$

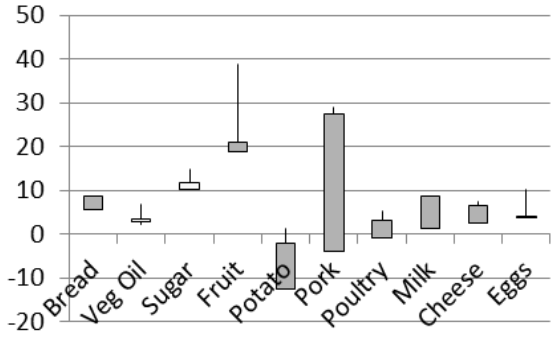
detected essentially different dynamics in price indices subject to the Covid-19 crisis.

3. RESULTS

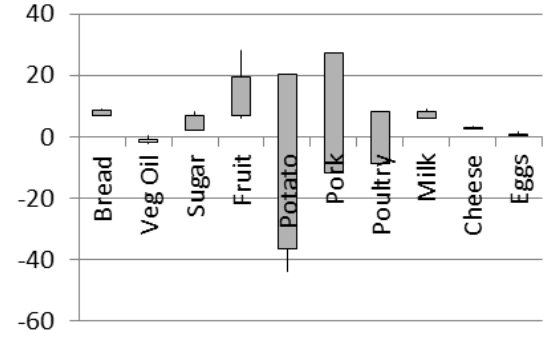
The research empirical outcomes derived from official statistics about Ukraine (State Statistics Service of Ukraine, 2021) and the EU countries (EUROSTAT, 2021). The performed calculations on comparing food price changes and indices drew on panel data about ten crop and animal products in five countries according to the accessible time frame of the Covid-19 period, i.e. March to December 2020 and $N = 10$.

The developed candlestick charts for the encompassed period of the Covid-19 pandemic were collected in Figure 1. Its composition enables picturing price changes by country and product in a uniform way. Namely, every candlestick chart converted numerical data of (2) into visual open and close food prices as well as their low and high levels distinguishing increasing from decreasing price dynamics by means of white and gray colors.

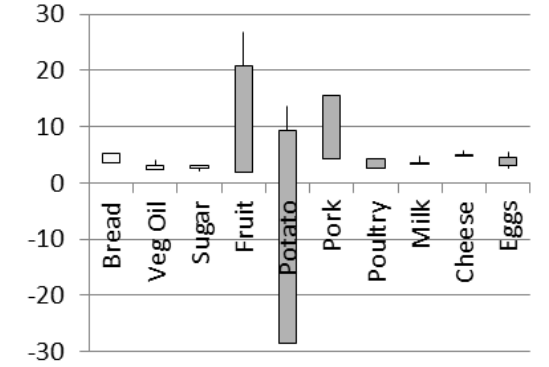
The output of ANOVA applied to the price indices (3) for the selected food products in five countries were aggregated in Tables 1 and 2.



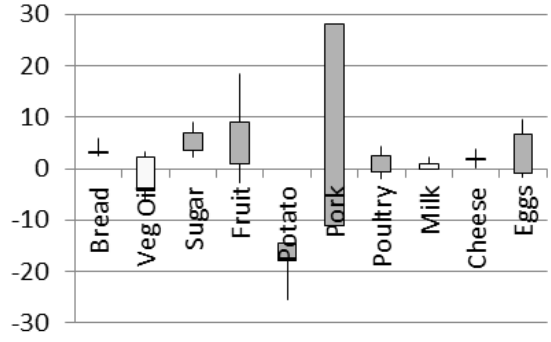
a – Hungary



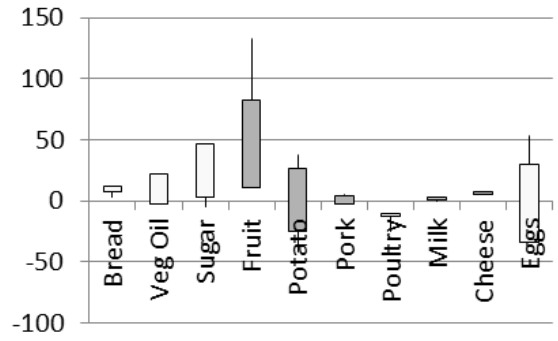
b – Poland



c – Romania



d – Slovakia



e – Ukraine

Figure 1. Food price changes by country, a – Hungary, b – Poland, c – Romania, d – Slovakia, e – Ukraine
Source: author's development, 2021.

Table 1. Dynamics of price indices for crop products

Product	*Indicator*	*Ukraine*	*Hungary*	*Poland*	*Romania*	*Slovakia*
Bread	API_{km}^{2020},%	104.1	102.4	102.7	102.9	101.7
	F_{calc}	0.28	0.23	1.64	17.41	1.28
	F-test result	EQ	EQ	EQ	DIF	EQ
Vegetable oil	API_{km}^{2020},%	105.2	102.9	99.6	101.7	100.5
	F_{calc}	4.77	19.36	32.58	30.15	15.52
	F-test result	DIF	DIF	DIF	DIF	DIF
Sugar	API_{km}^{2020},%	115.4	106.2	102.7	101.9	99.3
	F_{calc}	4.55	46.14	15.72	0.00	6.90
	F-test result	DIF	DIF	DIF	EQ	DIF
Fruit	API_{km}^{2020},%	144.2	123.0	103.1	107.4	100.4
	F_{calc}	0.31	6.54	0.51	0.06	3.03
	F-test result	EQ	DIF	EQ	EQ	EQ
Potato	API_{km}^{2020},%	93.0	100.7	81.3	90.3	97.7
	F_{calc}	22.98	0.00	43.66	5.70	12.17
	F-test result	DIF	EQ	DIF	DIF	DIF
Crop products in total	$API_{m\,crop}^{2020}$,%	112.4	107.0	97.9	100.8	99.9

Source: author's calculation, 2021.

Tables 1 and 2 report average food price indices $API_{km}^{2020}(5)$ by distinct products and according to their crop or animal origins, i.e.

$$API_{m\,crop}^{2020} = \sum_{k=1\ldots5} API_{km}^{2020} / 5,$$

$$API_{m\,animal}^{2020} = \sum_{k=6\ldots10} API_{km}^{2020} / 5.$$

The calculated values of F_{calc} (4) were utilized for running F-test with degrees of freedom 1 and 18 as well as the typical alpha level of 0.05 which established $F_{crit} = 4.41$. The F-test results are presented through the mark EQ linked with the true inequality (6) or the mark DIF associated with the true inequality (7).

Table 2. Dynamics of price indices for animal products

Product	*Indicator*	*Ukraine*	*Hungary*	*Poland*	*Romania*	*Slovakia*
Pork	API_{km}^{2020},%	102.5	98.6	95.2	101.7	95.2
	F_{calc}	8.18	28.80	58.26	8.38	43.52
	F-test result	DIF	DIF	DIF	DIF	DIF
Poultry	API_{km}^{2020},%	92.5	100.6	95.6	101.4	98.7
	F_{calc}	44.41	0.20	49.90	0.98	12.30
	F-test result	DIF	EQ	DIF	EQ	DIF
Milk	API_{km}^{2020},%	100.4	99.7	102.1	102.4	100.3
	F_{calc}	4.91	12.13	17.16	28.46	0.05
	F-test result	DIF	DIF	DIF	DIF	EQ
Cheese	API_{km}^{2020},%	100.5	100.9	101.3	102.1	100.4
	F_{calc}	2.13	4.40	20.98	4.39	21.41
	F-test result	EQ	EQ	DIF	EQ	DIF
Eggs	API_{km}^{2020},%	113.6	101.8	99.7	97.9	98.6
	F_{calc}	17.14	17.73	76.57	4.29	1.88
	F-test result	DIF	DIF	DIF	EQ	EQ
Animal products in total	$API_{m\ animal}^{2020}$,%	101.9	100.3	98.8	101.1	98.6

Source: author's calculation, 2021.

The offered compositions of Table 1 and 2 facilitate both horizontal and vertical analysis of food price resistance against the Covid-19 crisis by products across countries or within each country to compare price fluctuations for food of crop and animal origins.

4. DISCUSSION

The research findings retrieved from Figure 1 reported the similar stability and resilience in prices for bread and vegetable oil in all of the investigated countries. It agrees with conclusions of Brewin (2020) about effective handling the impact of Covid-19 on food safety, transportation infrastructure, and market access in the grains and oilseeds sectors.

All of the considered countries experienced essential cuts in prices for fruit and potato. It complies with the findings from Richards and Rickard (2020) concerning dramatic drops in the sales of perishable and even more storable fruit and vegetables down to the complete loss of some distribution channels in foodservice. The Covid-crisis brought benefits to sugar only in Ukraine. It correlates with the findings of Bracale and Vaccaro (2020) on unhealthy changes in dietary patterns caused by the Covid-19 restrictions when less wealthy people have to offset calories via excessive intakes of the sweetened food.

Figure 1 illuminated that the Ukrainian animal husbandry demonstrated stronger price resistance than those in the neighboring EU countries. In particular, their pork production appeared to be the most

vulnerable to the impediments in supply and distribution chains triggered by the Covi-19 pandemic (Seleiman et al., 2020). In times of Covid-19 eggs price in Ukraine gained the most. It is kind of expected, since eggs substitute more expensive meat protein (Kearney, 2010). Indeed, the latter is less affordable in Ukraine where GDP per capita in 2020 was only $3420 while those in Hungary, Poland, Romania, and Slovakia amounted to $15370, $15300, $12810, and $18670 (IMF, 2020).

The research findings emerged from Table 1 disclosed a prevailing distortion of prices for vegetable oil, sugar and potato in the explored Eastern European countries. Besides, the price index for potato mainly dropped below 100%. High price fluctuations appeared to be typical of fruit. The most advantages pricing of +12.4% for food of crop origin was observed in Ukraine. It reflects the existing misbalance in favor of crop industry peculiar to Ukrainian agriculture (Vasylieva, 2019).

According to the data from Table 2, animal products, except for cheese, featured major differences between contemporary pricing and that of the pre-Covid-19 period. Totally different seasonal trends were detected in prices for animal products in Poland which had to redirect its export to the domestic market. The most affected animal husbandry appeared to be in Slovakia where price indices for pork, poultry, and eggs reduced to 95.2%, 98.7%, and 98.6%. Clearly, the identified price changes for animal products aren't a threat to food security in the analyzed Eastern European countries. However, the observed price volatility hampers to provide healthy nutrition and balanced diets (Rippin et al., 2020).

CONCLUSION

The ongoing Covid-19 crisis penetrated into all spheres of economic activity and social life at the global scale which is evidenced by the total decrease in real GDP by 4.4% in 2020. To a great extent, it exacerbates providing food security and healthy nutrition. The world authorities express their unanimous commitment to addressing such pressing issue. In particular, the Food and Agriculture Organization of the United Nations launched the daily Food Price Monitoring to examine the impact of the Covid-19 pandemic on supply and demand in food chains.

Overall, the research hypothesis was verified positively.

Firstly, given the study focus on applying mathematical techniques to statistical data for the selected Eastern European countries, the research findings reported similar patterns of stable prices for bread and cheese. As of December 2020, they varied from 101.7% to 104.1% for bread and from 100.4% to 102.1% for cheese.

Secondly, the explored neighboring EU countries shared essential fluctuations and final falls in prices for complementary products such as pork and potato.

Thirdly, unlike the wealthier Hungary, Poland, Romania, and Slovakia, food prices for affordable sugar and eggs in Ukraine raised on average by 15.4% and 13.6% for February to December 2020 or by 46.2% and 30.4% with regard to the pre-Covid-19 period.

Finally, food chains in animal husbandry appeared to be less resistant to the stresses and disruptions caused by the Covid-19 pandemic which determine vital objectives to develop food industry and agriculture in the foreseeable future.

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