








# “Assessment of global food demand in unexpected situations”

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# ASSESSMENT OF GLOBAL FOOD DEMAND IN UNEXPECTED SITUATIONS

## Abstract

The methodological approach for assessing the formation of food demand in unforeseen situations using digital Internet-technologies and the assessment itself, is substantiated in the paper (in the context of the COVID-19 pandemic of 2020). Comparison and theoretical generalization, as well as statistical test-assessment of hypotheses and structural regularities based on the data of Google Trends Internet platform, is used to analyze consumer preferences and intensity of demand changes for meat, milk, sugar, bread, and flour during the pandemic and quarantine, both in developed and developing countries. It is discovered that the biggest changes can be observed in the developed countries: consumer preferences shifted from rather expensive food products (milk and meat) to much cheaper ones (flour and bread). It is asserted that a decrease in consumer demand for basic food products will have a negative impact on the global economy. In 2020, a considerable decrease in GDP is expected for the developed countries; in the developing countries, GDP decline will not be as large, but prices are expected to rise much more noticeably. The following anti-crisis measures are proposed: support of the most vulnerable population and increase of food accessibility; temporary reduction of the VAT and other taxes influencing the price of food; reduction of central banks' lending rates, etc. With the correct measures applied, the stabilization of consumer demand for food and gradual growth of the global economy is expected by the end of 2021.

## Keywords

product, value chain, global market, COVID-19, Google Trends, big data, lockdown

## JEL Classification

I18, L66, Q11, Q18, R21

## INTRODUCTION

The modern world operates in conditions of uncertainty and constant change, analyzing unforeseen situations in real time most important. The most pressing uncertainty of today for the whole world is the coronavirus: a global health emergency as a loud reminder that "fragile economic recovery may be threatened by unforeseen events" (Ukrinform, 2020).

According to OECD forecasts, in the context of the COVID-19 pandemic, global economic growth is likely to be 2.4% (compared to 2.9% previously forecast) and will be the lowest level since the 2008 financial crisis. Nor can it be ruled out that the long-term and intensive persistence of the COVID-19 pandemic may even reduce this number to 1.5% (OECD, 2020a). According to the International Labor Organization, depending on the different economic consequences of the pandemic, the number of unemployed in the world can reach from 5.3 million (soft option) to 24.7 million people (hard option). For reference: the financial crisis of 2008 left 22 million people unemployed (International Labor Organization, 2020).

The slowdown in the world economy poses a threat to food security. A slowdown in the economic development of 1% will lead to an in-

crease in poverty, and with it, the number of people experiencing food shortages will increase by 2% (Food and Agriculture Organization of the United Nations, 2020).

The impact of the pandemic on food chains will affect food supply and demand. The proposal is violated due to the impact of the disease on people's lives and well-being in connection with efforts to curb the spread of the virus, limit the transportation of goods, increase the cost of doing business.

Reduced investment, increased credit risk, and tight credit policies in developing countries will not contribute to large-scale macroeconomic support programs. Slow economic growth may lead to a gradual decline in demand for value-added products, including meat and fish products, increasing demand for bread and flour.

Under the influence of COVID-19 in the short term, the real cost of healthy nutrition may increase due to the rising cost of perishable products, which will have particularly negative consequences for low-income households and delay implementing the Sustainable Development Goals. This effect, as noted in the report "The State of Food Security and Nutrition in the World in 2019", will be stronger in countries with high dependence on imports of raw materials, as increased raw material imports dependency leads to an increase in malnutrition by an average of 3.8% per year (FAO, 2019).

Of course, the consequences of the spread of coronavirus can have an extremely negative impact on the activities of small and medium-sized farms that risk losing access to markets for their products or procurement of material and technical resources.

Under the conditions mentioned above, it is very important for the modern food market operators to correctly assess consumer demand, which can help governments solve food problems; food producers, on the other hand, ought to ensure a rational ratio of production and consumer demand, effectively manage their stocks and product range, develop production programs and apply effective methods of product promotion.

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## 1. LITERATURE REVIEW

The analysis of the structure and dynamics of consumer demand for food products has been reflected in a wide range of works, as it is related to one of the most global problems – food security.

Among the studies concerned with the factors influencing the structure of the food products demand, the work of Andreyeva et al. (2010) should be mentioned. Based on the analysis of 160 studies, it highlighted the effect of price on the demand for healthy and unhealthy food and the consumption of substitute products, depending on the price elasticity of these products. This reveals additional aspects of the change in demand for food products in the context of COVID-19, as the pandemic period in Ukraine and other countries is characterized by the loss of income, thus reducing the effective demand. Janssen and Hamm (2012) presented a study in which the growth in demand for

organic food products was associated with introducing the new EU logo for such products. Lem et al. (2014) noted the role of demographic and geographical factors in changing the structure of consumption in the future. According to their forecast, the world should increase aquaculture production, which, in turn, will lead to an increase in consumption of quality protein-intensive products, especially in the countries possessing access to oceans.

Several works by Ukrainian scientists of the National Academy of Agrarian Sciences are devoted to the factors of changes in consumer demand for food in the global and domestic markets. Thus, Lupenko et al. (2015) identify the role of the Ukrainian agricultural sector in meeting the needs for food products in the domestic market and foreign markets, taking into account the impact of the free trade zone with the EU. The scholars identified the leading trends in the global

food market, namely: the dynamic transformation of the structure of consumption and social needs, which leads to the disappearance of traditional and the active formation of new markets; intensive development of scientific and technological progress, which significantly affects the processes of internationalization; formation of new areas of economic activity, models and forms of relationships and connections in business, which create new opportunities and, at the same time, generate new risks.

Gadzalo et al. (2016) investigated the changes in the volume and structure of sales of raw materials and food resources in unstable socio-economic conditions and outlined the directions of state policies for food industry development and increasing effective demand. The decline in effective demand and the decline in food production in Ukraine and the growth of food imports, are confirmed by Sychevskiy (2019). He notes the increasing role of rural areas and the development of farms in them to reduce import dependence and reach price equalization in the food market. In the structure of consumption, the author finds the dominance of high-calorie cheap products, such as bread and flour products and cereals. The paper also shows an inverse correlation between the share of food expenditures and GDP per capita. A later work by O. Kuts and D. Kuts (2019) notes that in Ukraine, 90% of food consumed is produced by domestic industrialists, and ensuring its safety for the consumer is monitored as part of the tasks to achieve SDG 2030. The scholars noted a decrease in caloric intake of Ukrainian consumers in 2018, which amounted to only 68 percent from the level of consumption in 1990, and, if compared to 2000, increased only by 2 percent.

From this, it can be concluded that the key factor influencing the demand for food and the structure of its consumption in Ukraine in recent years, as before, was the purchasing power of the population and the structure of supply due to the resource potential of the Ukrainian food industry.

Modern household demand studies are beginning to use the latest methods and approaches, such as big data analysis. Databases of various international organizations and commercial platforms, serve as data sources for the analysis of consumer

demand for food products. One of the most relevant is the Google Trends platform.

In his publication, Schaefer (2017) considers Google Trends as an accessible data source and a tool for analyzing consumer demand. Using Google Trends data, Huarng et al. (2020) conducted a quantitative analysis of housing demand using a fuzzy set/qualitative comparative analysis. In their conclusions, the researchers noted that more attention should be paid to identifying a significant correlation between the data. Önder (2017), in her study on forecasting the demand for tourism services, noted the usefulness of Google Trends indexes for improving the accuracy of forecasts of demand for tourism compared to a purely autoregressive baseline model. At the same time, she warns that this tool cannot be the only source for analysis and conclusions, as the internal and external motivation of users to search online is unknown.

However, as of now, insufficient attention is paid to the study of demand for food products during unforeseen situations, particularly in the context of the COVID-19 pandemic. Recent studies on food security during the COVID-19 pandemic have focused on food supply, the value chains of food production, and, as a result, some aspects of changing demand. For example, the report "Food Supply Chains and COVID-19: Impacts and Policy Lessons" (OECD, 2020b) noted the unprecedented impact of the pandemic on productivity in agriculture, and thus in the food industry and catering. It was determined that the demand of the population for food outside the home (in restaurants and cafes) collapsed, while the demand for food consumed within the households increased. A study by the High-Level Panel of Experts from the Committee on World Food Security (2020) noted the emergence of a steady trend towards purchasing pre-packaged foods as an individual security measure.

Johansson (2020), analyzing the price dynamics for food supply in the United States, revealed that the shrink in meat sales and demand is related to meat processing plants shutdown. That has caused a shift in demand structure for food products because the prices on meat were growing; thus, the consumers preferred less expensive

products like bakery, vegetables, etc. Studies of separate countries that used mostly the survey method also showed a change in food consumption structure, but these changes became more individual in different countries. For example, in Qatar, the population has switched to a healthier diet; the consumption of products of domestic producers increased compared to imported ones; ways of purchasing products were changed (transition to online shopping commenced) (Hassen et al., 2020).

Mouloudj et al. (2020) noted that poor countries had suffered the most from COVID-19 because they are most dependent on food products supplies, especially on the perishable ones.

The change in demand for food products due to the population movement restrictions during the pandemic was highlighted in the report of Deloitte (2020). The authors of the report note the complexity of market signals for food producers and sellers due to changes in the expectations of each group. Retail chains have restricted the sale of some goods for fear of shortages; the urban population tried to access fresh and high-quality products, and farmers and other suppliers tried to find new markets for their products, which were previously purchased by restaurants and cafes. This caused significant financial losses to market agents.

Despite the presence of works that to some extent analyze changes in consumer behavior and food consumption, methods of purchase and supply during the coronavirus pandemic, analysis of the structure of consumption by type of food products in countries with different levels of development has not yet been fully reflected in them.

In light of the mentioned above, the paper aims to substantiate the methodological approach and assess the development of food demand in the context of the COVID-19 pandemic in 2020 using digital Internet technologies (Google Trends).

## 2. HYPOTHESES

In the research, it is hypothesized that, in developed and developing countries, the pattern of consumption of basic food products during unfore-

seen situations (such as the COVID-19 pandemic) will change. Besides, the second hypothesis is that lockdown and self-isolation affect incomes and purchasing power of the population in both groups of countries, which, in turn, changes the structure of demand towards cheaper goods.

In the context of the aim, the scientific hypotheses were formulated, which are connected with the change of consumer behavior during COVID-19 pandemic:

*H1: In the developed and developing countries, the structure of consuming food products in the unforeseen situations (like COVID-19 pandemic) should change.*

*H2: Lockdown and self-isolation affect the income and purchasing power of the population in both groups of countries, which influences the change of the demand structure towards more cheap goods.*

To confirm the formulated hypotheses, the following tasks were set out:

- 1) to determine the countries for the study;
- 2) to determine main food products for the analysis;
- 3) to assess the changes in the demand structure in the determined countries;
- 4) to analyze the changes in the intensity of demand for main food products;
- 5) to formulate the findings and give the proposals.

## 3. RESEARCH METHODOLOGY

This study uses general scientific, economic, statistical, and mathematical methods. In particular, theoretical generalization and comparison methods were used to determine consumer behavior and consumer preferences of certain groups of goods. To analyze the intensity of changes in consumer demand and its structure, methods of statistical test evaluation of hypotheses and structur-



al patterns based on data from the Internet platform Google Trends were used. The practice of using the big data provided by the Google Trends platform for various studies has been summarized in the work of Jun et al. (2018). The authors found that more and more studies each year use big data for forecasting in various fields of science, particularly in economics, and highlighted the results of these studies.

Given the caveats for using the Google Trends online platform pointed in the paper mentioned above, the big data are used just to detect statistically significant changes in users' online searches. The choice of this tool was also influenced by the unavailability of official statistics in some countries at the time of the study. Simultaneously, the development of state food security policy must be flexible and respond quickly to changes in consumer demand in unforeseen situations.

To analyze the structure and intensity of changes in food demand in the context of the COVID-19 pandemic, the countries with the highest demand were selected and grouped according to the classification of the International Monetary Fund (2020). Indicators reflecting the state of the economy – GDP and consumer prices – were chosen as the classification features of the grouping. Change indices in these indicators make it possible to predict the development of the economy in the future. For this purpose, a statistical criterion for estimating the similarity of structures was used, which is defined as the ratio of the difference of sample particles to their standard error. The similarity of the demand structure or its slight changes in the periods before and during the epidemic is evidenced by the value of  $p$ , which is less than 0.05. If the value of  $p$  is greater than 0.05, it indicates statistically significant and considerable differences in demand for basic food products in the world in comparable periods due to the impact of the pandemic. The criterion was calculated in the SPSS Statistics statistical analysis program.

To assess the intensity of the pandemic's impact on food demand changes, a meta-analysis was used, which is usually employed in modern research to summarize the effectiveness of different object groups (Yashchenko & Lesnikova, 2015). In the research, this method was used to generalize

the change in product demand, which was determined based on search queries tracked weekly by Google Trends worldwide.

$RR$  (Risk Ratio) was chosen as the main indicator for assessing the intensity of the pandemic impact – a risk ratio that shows how many times demand has changed under the influence of the pandemic. This indicator is calculated separately for each country and following a revised formula (Yashchenko & Lesnikova, 2015):

$$RR = \frac{a \cdot N_0}{b \cdot N_1} = \frac{a \cdot 100}{b \cdot 100} = \frac{a}{b}, \quad (1)$$

where  $a$  – demand before the pandemic, points,  $b$  – demand during the pandemic, points,  $N_0$  i  $N_1$  – maximum demand before and during the pandemic, accordingly ( $N_0 = N_1 = 100$ ), points.

The total value of  $RR$  by a group of countries is calculated, taking into account the weights of each country (the values of weights are shown in Figures 1-3).

If the Risk Ratio ( $RR$ ) equals 1, there has been no change in consumer demand for basic food products under the influence of the pandemic. The closer ratio is to 0, and the farther from 1, the stronger the changes are.

If the  $RR$  is greater than 1, there is a decrease in demand for staple food products during a pandemic compared to the pre-crisis period. The values of the changes, in this case, will be equal to the value of  $RR$ .

If the  $RR$  is in the range from 0 to 1, then under the influence of the pandemic, there is an increase in demand. The value of the changes, in that case, will be equal to the ratio of 1 to  $RR$ .

Generalized values of statistical criteria (criterion  $\chi^2$  and  $F$ -test) were used to check the homogeneity of demand by countries of the world. The  $Z$ -criterion was calculated to assess the statistical significance of changes under the influence of a pandemic. The main indicators of these criteria are the values of  $p$  and  $F$ . If the value of  $p$  in the criterion  $\chi^2$  and  $Z$ -criterion is less than 0.05, it indicates a statistically significant heterogeneity of

data and a significant impact of the pandemic on changes in consumer demand for basic food products. If the  $F$  test result constitutes more than 50%, it indicates the existence of heterogeneity among the data.

To compare food consumption structure in both groups of countries based on meta-analysis, changes in consumption intensity have to be calculated. The calculations were performed using the RevMan application.

## 4. RESULTS AND DISCUSSION

The use of Internet resources to assess food demand seems to be quite promising. According to a study of the Internet audience of Ukraine (Ukrainian Media Association, 2020) in 2019, 71% of the Ukrainian population had access to the World Wide Web. With an average annual growth rate of 3.9% Internet penetration, the country's full coverage may be achieved by 2026.

To reach that goal, modern digital Internet technologies were used, particularly the Google Trends service, which provides additional and timely information on consumer demand (search queries) for food (Kovalenko & Yashchenko, 2020).

According to the Google Trends online platform, at the beginning of the pandemic's outbreak of mid-March 2020, a significant increase in demand for certain foods (such as flour) was observed in many countries. This appears to be connected to the turmoil caused by reports in media and social networks. Concerns that "animals could spread the virus" have significantly reduced animal protein intake. Demand for fish, vegetables, and fruits also declined.

In developing countries, the demand for food products is more related to the level of income of the population, and the loss of earning opportunities immediately affects consumption. This trend threatens the food security of such countries.

**Table 1.** Description of countries to analyze the structure and intensity of the demand changes for basic food products

Source: Own calculations based on International Monetary Fund (2020).

Country	2019		2020 (forecast)		2021 (forecast)	
	GDP change, %	Consumer prices change, %	GDP change, %	Consumer prices change, %	GDP change, %	Consumer prices change, %
<b>Developed countries</b>						
Australia	1.8	1.6	-6.7	1.4	6.1	1.8
The United Kingdom	1.4	1.4	-6.5	1	4.0	1.9
Hong Kong	-1.2	2.9	-4.8	2	3.9	2.5
Ireland	5.5	1.8	-6.8	0.3	6.3	1.9
Spain	2	0.8	-8	-1	4.3	1.4
Italy	0.3	0.5	-9.1	0.2	4.8	0.7
Canada	1.6	2.1	-6.2	0.2	4.2	1.6
Germany	0.6	1.5	-7	0.2	5.2	1.3
Singapore	0.7	0.8	-3.5	-0.4	3.0	0.9
The USA	2.3	1.9	-5.9	0.8	4.7	2.4
Average	1.5	1.53	-6.45	0.47	4.65	<b>1.64</b>
<b>Developing countries</b>						
Vietnam	7	2.8	2.7	3.2	7.0	3.9
India	4.2	4.5	1.9	3.3	7.4	3.6
Indonesia	5	2.6	0.5	3.1	8.2	3.0
Malaysia	4.3	1	-1.7	0.1	9.0	2.8
Nigeria	2.2	12	-3.4	13.9	2.4	11.3
UAE	1.3	-1.9	-3.5	-1	3.3	1.5
RSA	0.2	3.7	-5.8	0	4.0	4.3
Saudi Arabia	0.3	0.2	-2.3	0.9	2.9	2.0
Ukraine	3.2	4.1	-7.7	7.7	3.6	5.9
The Philippines	5.9	2.5	0.6	2.6	7.6	3.0
Average	3.36	3.15	-1.87	3.38	5.54	<b>4.13</b>

It is possible to estimate the demand for individual foods by analyzing changes in its structure, i.e., by comparing the share of a particular product in different periods and the relative intensity, defined as the ratio of two different values of one economic phenomenon at certain intervals.

Countries with the highest demand were selected as the study objects, divided into two groups: TOP-10 countries with developed economies and TOP-10 developing countries (Table 1).

The results of the study show that the pandemic affected different groups of countries in different ways. It was most impactful on countries with developed economies, as it caused a higher GDP decline in 2020 compared to the second group and a slight increase in prices, which the IMF forecasts to return to the pre-crisis levels in 2021. The growth rates of prices in the second group of countries increased significantly (the highest increase is observed in Nigeria and Ukraine). The obtained conclusions confirm the relative homogeneity within the groups of countries and different intergroup development

trends, which allows using the proposed grouping for further research.

For each country, the groups obtained are analyzed for the consumption structure by selecting five (due to the limitations of Google Trends) most consumed product categories. Next, a statistical assessment of the similarity of structures before and during the pandemic is performed, using the probability of  $p$  as a statistical criterion (Table 2).

The study results presented in Table 2 indicate a significant impact of the pandemic on the consumption structure of basic foods in most countries ( $p > 0.05$ ). The pandemic did not significantly impact the consumption structure of basic foods only in Vietnam and India ( $p < 0.05$ ).

During the pandemic, changes in consumers' priorities were observed – they replaced milk and meat with flour and bread. The structure of demand for basic food products has changed the most in the following countries: Australia (during the crisis, the share of demand for milk decreased by 7%, meat – by 10%, and the share of demand for

**Table 2.** Comparison of the structure of consumer demand for basic food products for the period from May 2019 to May 2020 (before and during the COVID-19 pandemic)

Source: Own calculations based on Google Trends (2020).

Country	Before the pandemic, %					During the pandemic, %					p
	Meat	Milk	Sugar	Bread	Flour	Meat	Milk	Sugar	Bread	Flour	
Developed countries											
Australia	22	30	17	19	12	12	23	10	28	27	0.887
The United Kingdom	22	28	17	21	12	8	10	7	21	54	0.178
Hong Kong	26	31	12	24	7	19	11	22	22	26	0.072
Ireland	19	29	19	23	10	12	17	13	20	38	0.229
Spain	34	33	8	15	10	15	12	14	31	28	0.353
Italy	33	22	9	25	11	25	16	7	32	20	0.196
Canada	28	23	17	22	10	16	17	10	31	26	0.730
Germany	31	23	20	15	11	21	27	12	20	20	0.753
Singapore	19	39	14	18	10	12	27	13	26	22	0.420
The USA	29	21	19	23	8	25	18	13	24	20	0.486
Developing countries											
Vietnam	27	31	10	20	12	24	33	12	19	12	0.005
India	12	41	24	14	9	16	42	20	14	8	0.005
Indonesia	26	34	19	14	7	27	28	12	25	8	0.153
Malaysia	20	39	15	17	9	24	26	8	20	22	0.421
Nigeria	18	32	15	23	12	23	32	10	19	16	0.074
UAE	20	39	14	16	11	23	23	7	20	27	0.734
RSA	28	27	17	18	10	17	20	15	30	18	0.935
Saudi Arabia	19	34	14	18	15	18	22	12	26	22	0.591
Ukraine	17	44	12	14	13	14	33	13	23	17	0.055
The Philippines	15	39	16	18	12	12	37	8	21	22	0.097



bread and flour increased by 10% and 15% respectively); Great Britain (shares in demand for milk and meat decreased by 18% and 14%, and flour increased by 42%); Hong Kong (the share of demand for milk and meat decreased by 20% and 7%, respectively, and flour increased by 19%); Spain (the share of milk and meat decreased by 21% and 19%, respectively, and the share of demand for bread and flour increased by 16% and 18%, respectively); Ireland (the share of demand for milk and meat decreased by 12% and 7%, respectively, and the share of flour increased by 18%). These results correlate with the findings of the study by Johansson (2020) and are related to the decline in the products availability due to the shutdown of processing plants.

To conduct a meta-analysis of the intensity of the pandemic's impact on food demand before and during the pandemic, the data from Table 3 are used.

The main results of the meta-analysis, including the Risk Ratio (RR) value for individual countries

and the generalized risk value ("large diamond") are shown in the Forest plot (Figure 1, the generalized RR value greater than 1; Figure 2, the generalized RR value is in the range from 0 to 1; Figure 3, the generalized value of RR is close to 1). The calculations were performed in the RevMan application.

A similar trend can be observed in the demand intensity graph for meat in developing countries, so it was not duplicated in the paper.

The vertical line in the middle of the graph ( $RR = 1$ ) corresponds to a situation where the demand before the pandemic does not differ from the demand during the pandemic. Country marks are the larger, the greater the statistical weight of a particular country in the general pool. The horizontal lines ("whiskers") near each country's mark reflect a 95% confidence interval. The "large diamond" mark is a generalized result, and the length of the diamond reflects the combined estimate of

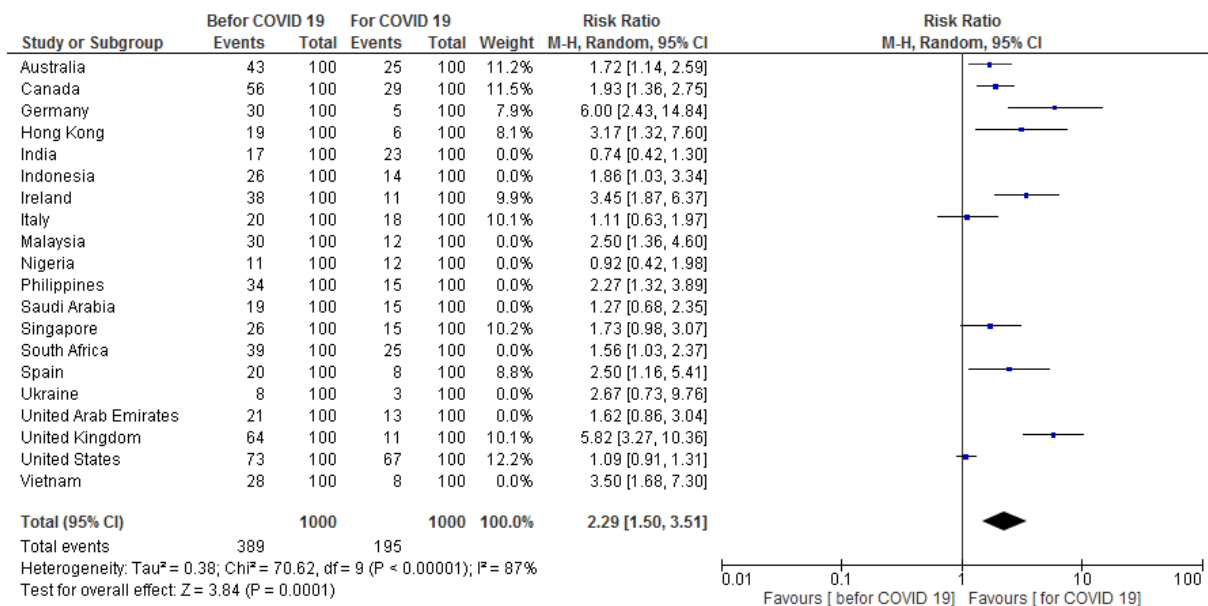
**Table 3.** Comparison of the intensity of consumer demand for basic food products in the period from May 2019 to May 2020 (before and during the COVID-19 epidemic), the number of search queries in points \*

Source: Own calculations based on Google Trends (2020).

Country	Before the pandemic					During the pandemic				
	Meat	Milk	Sugar	Bread	Flour	Meat	Milk	Sugar	Bread	Flour
<b>Developed countries</b>										
Australia	43	61	35	39	27	25	33	23	40	42
The United Kingdom	64	79	50	63	33	11	14	10	29	67
Hong Kong	19	23	10	16	11	6	15	11	20	22
Ireland	38	41	34	38	29	11	20	16	32	39
Spain	20	18	9	13	11	8	11	5	13	11
Italy	20	17	13	20	18	18	3	11	12	25
Canada	56	51	36	44	23	29	32	28	49	43
Germany	30	31	22	15	11	5	11	2	3	6
Singapore	26	44	28	27	18	15	20	15	30	24
The USA	73	55	50	59	20	67	47	36	66	56
<b>Developing countries</b>										
Vietnam	28	35	14	21	10	8	16	18	6	5
India	17	55	31	20	15	23	57	29	25	16
Indonesia	26	35	17	17	12	14	11	18	13	3
Malaysia	30	49	27	29	20	12	20	9	23	24
Nigeria	11	17	10	15	8	12	20	9	8	4
UAE	21	27	11	23	18	13	10	11	11	21
RSA	39	43	34	39	20	25	20	23	30	25
Saudi Arabia	19	22	11	11	12	15	15	10	17	11
Ukraine	8	30	8	8	7	3	7	11	19	14
The Philippines	34	62	32	38	27	15	21	9	18	16

Note: \*Google algorithms assign the maximum value of 100 points to the highest number of queries, i.e. when the query is most popular. All other points are determined as a percentage of the maximum.

Source: Authors.



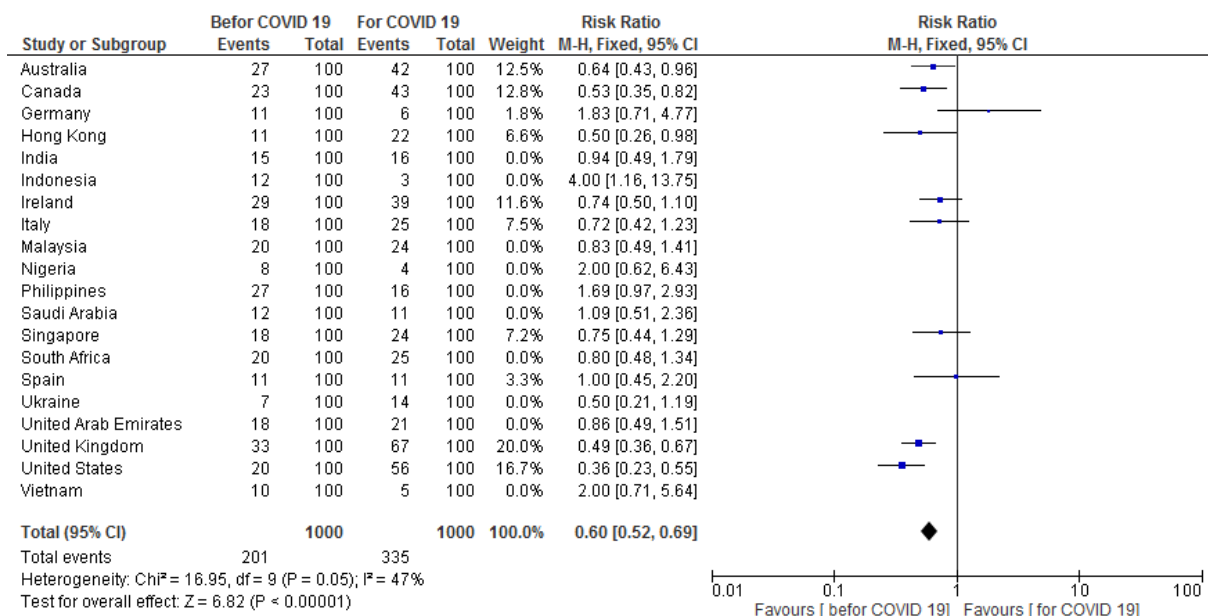
**Figure 1.** Results of the meta-analysis of meat demand intensity in the context of the COVID-19 pandemic in developed economies (demand has decreased)

95% of the confidence interval. The lower horizontal scale reflects the intensity of changes under the influence of the pandemic. The area to the left of the vertical “1” corresponds to the increase in demand for basic food products during the pandemic compared to the pre-crisis period. The area to the right of the vertical “1” corresponds to the de-

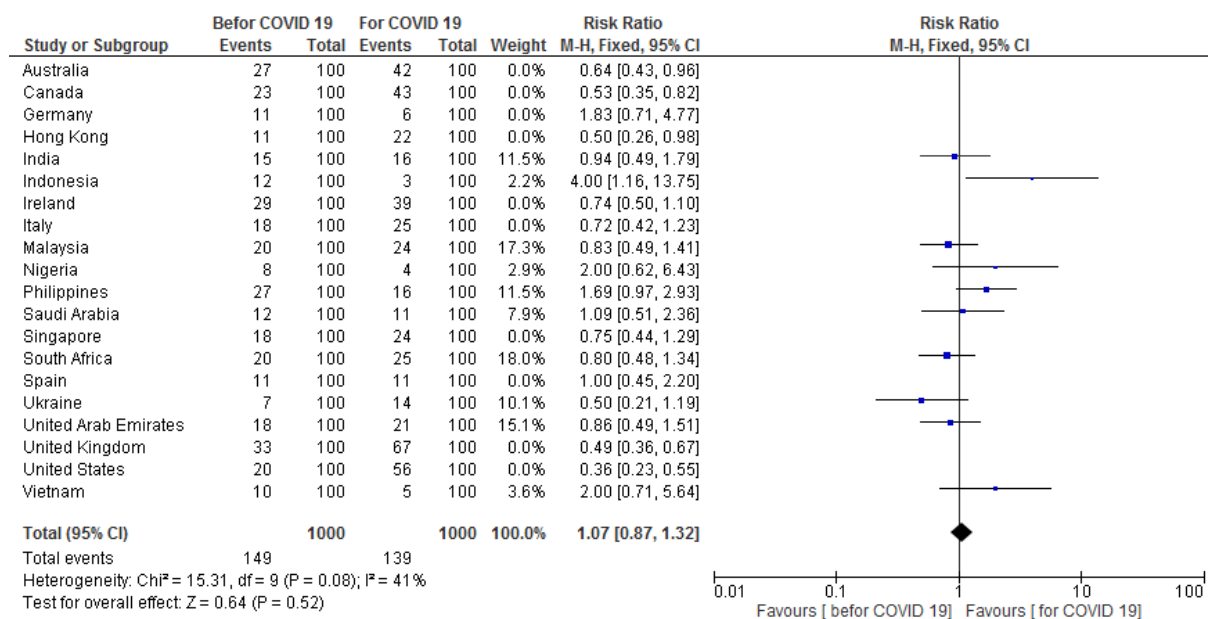
crease in demand during the pandemic compared to the pre-crisis period.

The lower-left corner of Figures 1-3 shows the generalized values of statistical criteria for evaluating the homogeneity of demand by country (criterion  $Chi^2$  and  $I^2$ -test) and the statistical significance

Source: Authors.



**Figure 2.** Results of the meta-analysis of flour demand intensity in the context of the COVID-19 pandemic in developed economies (demand has increased)



**Figure 3.** Results of the meta-analysis of flour demand intensity in the context of the COVID-19 pandemic in developing economies (demand has not changed)

**Table 4.** Changes in the intensity of consumer demand for basic food products during the pandemic, according to the results of the meta-analysis

Source: Authors.

Country	Meat		Milk		Sugar		Bread		Flour	
	Increase (↑) or decrease (↓) in demand	changes, times	Increase (↑) or decrease (↓) in demand	changes, times	Increase (↑) or decrease (↓) in demand	changes, times	Increase (↑) or decrease (↓) in demand	changes, times	Increase (↑) or decrease (↓) in demand	changes, times
<b>Developed countries</b>										
Australia	↓	1.72	↓	1.85	↓	1.52	↑	1.03	↑	1.56
The United Kingdom	↓	5.82	↓	5.64	↓	5.00	↓	2.17	↑	2.04
Hong Kong	↓	3.17	↓	1.53	↑	1.10	↑	1.25	↑	2.00
Ireland	↓	3.45	↓	2.05	↓	2.13	↓	1.19	↑	1.35
Spain	↓	2.50	↓	1.64	↓	1.80	–	1.00	–	1.00
Italy	↓	1.10	↓	5.67	↓	1.18	↓	1.67	↑	1.39
Canada	↓	1.93	↓	1.59	↓	1.29	–	1.11	↑	1.89
Germany	↓	6.00	↓	2.82	↓	11.00	↓	5.00	↓	1.83
Singapore	↓	1.73	↓	2.20	↓	1.87	↑	1.11	↑	1.33
The USA	↓	1.09	↓	1.17	↓	1.39	↑	1.12	↑	2.78
Generalized value* / (P)	↓	2.29 / (0.00)	↓	2.11 / (0.00)	↓	1.81 / (0.00)	↓	1.16 / (0.25)	↑	1.67 / (0.00)
<b>Developing countries</b>										
Vietnam	↓	3.50	↓	2.19	↑	1.28	↓	3.50	↓	2.00
India	↑	1.35	↑	1.04	↓	1.07	↓	1.25	↑	1.06
Indonesia	↓	1.86	↓	3.18	↑	1.06	↑	1.06	↓	4.00
Malaysia	↓	2.50	↓	2.45	↓	3.00	↓	1.26	↑	1.20
Nigeria	↑	1.09	↑	1.18	↓	1.11	↓	1.88	↓	2.00
UAE	↓	1.62	↓	2.70	↓	1.00	↓	2.09	↑	1.16
RSA	↓	1.56	↓	2.15	↓	1.48	↓	1.30	↑	1.25
Saudi Arabia	↓	1.27	↓	1.47	↓	1.1	↑	1.54	↓	1.09
Ukraine	↓	2.67	↓	4.29	↑	1.37	↑	2.38	↑	2
The Philippines	↓	2.27	↓	2.95	↓	3.56	↓	2.11	↓	1.69
Generalized value* / (P)	↓	1.65 / (0.00)	↓	2.03 / (0.00)	↓	1.28 / (0.12)	↓	1.29 / (0.13)	↓	1.07 / (0.25)

Note: \*Italic marks statistically significant changes.

of changes under the influence of the pandemic (Z-criterion). In most cases, the calculated values of the indicators of the  $\chi^2$  criterion ( $p$  less than 0.05) and  $F$ -test ( $F^2$  above 50%) indicate heterogeneity of data, i.e., the impact of the COVID-19 pandemic on the consumption of basic products in different countries had different effects. Homogeneity of the data is observed only in the demand for flour (Figures 2 and 3).

A meta-analysis was used to estimate the intensity of changes in demand for meat, milk, sugar, bread, and flour for both groups of countries. The results of the meta-analysis obtained by calculations in the RevMan program are summarized in Table 4.

It was found that during the anti-pandemic quarantine period, the demand for meat and milk decreased significantly in both groups of countries (a decrease of 2.29; 1.65; 2.11; 2.03 times, respectively). Demand for meat fell the strongest in Germany (6 times) and the United Kingdom (5.82 times); for milk – in the United Kingdom (5.64 times) and Italy (5.67 times).

Demand for sugar in developed economies decreased by 1.81 times. The heaviest fall occurred

in the United Kingdom (5 times) and Germany (11 times). The pandemic has had little effect on sugar demand in developing countries ( $p$  greater than 0.05). Only in a couple of countries of this group has fallen significantly: Malaysia by 3 times; the Philippines by 3.56 times.

Demand for bread in both developed and developing countries has hardly changed ( $p$  is greater than 0.05).

Demand for flour has grown 1.67 times in developed economies. Growth occurred in most countries, including: in the United States – 2.78 times, the United Kingdom – 2.04 times, Hong Kong – 2 times. This can be explained by the fact that consumers in developed countries have begun to refuse to buy ready-made pastries and started baking themselves. Demand for flour in developing countries has not changed significantly ( $p$  is greater than 0.05).

During the quarantine period in Ukraine, there was a decrease in demand for meat (2.67 times) and milk (4.25 times). Demand for bread increased 2.38 times, flour 2 times, and sugar 1.37 times.

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## CONCLUSION

In the study, the methodological approach to analyzing food demand in the context of the COVID-19 pandemic in 2020 using digital Internet technologies (Google Trends) has been developed and substantiated. It was confirmed that the COVID-19 pandemic had been found to have changed the pattern of consumption of staple foods in most countries around the world, confirming the first hypothesis. The pandemic has had little effect on food consumption only in Vietnam and India. Particularly significant changes in the structure of food demand were observed in countries with developed economies. In the previous year, the highest consumer demand in Ukraine, as in the rest of the world, was aimed at meat and milk. However, during the pandemic, consumer preferences changed from more expensive food products (milk and meat) to much cheaper ones (flour and bread). Changes in consumer priorities occurred due to a significant decrease in income and purchasing power of the population, which confirmed the second hypothesis.

The sharp decline in the consumption of basic protein products (milk and meat) was confirmed by analyzing the changes' intensity in demand. It was found that the intensity of demand for food in both groups of countries during the pandemic was different. Compared to the developing countries, demand for meat, milk, and sugar has declined more rapidly in the developed economies. Simultaneously, the epidemic had almost no effect on the intensity of bread consumption, as demand for this product has hardly changed in both groups of countries. Simultaneously, the demand for flour in the first group increased significantly due to the refusal to buy ready-made flour products to save money, and in the second group, no significant changes were observed.

Declining consumer demand for basic protein foods has negative consequences for the global economy. According to expert estimates, in 2020, GDP is expected to fall significantly in developed economies. In developing countries, the fall in GDP is somewhat smaller, but a significant rise in prices is expected, which will pose a threat to food security. As a result, budget spending in both groups of countries, which need to support the livelihoods of the most vulnerable and their access to food, may increase significantly. Based on the mentioned above, some policy implications can be offered for national governments:

- 1) VAT and other taxes can be temporarily reduced what may affect the value of food; a tax policy on exported goods should be revised to offset the potential increase in costs;
- 2) it is advisable to reduce lending rates of central banks;
- 3) food producers should direct their supplies to countries where demand remains stable or growing.

Overcoming the effects of the pandemic and completion of quarantine measures by the end of 2020 gives hope that the global economy's growth will begin in the second half of 2021, and the impetus for this will be a gradual recovery of consumer demand.

The proposed methodological approach to assessing food demand based on big data, including those obtained from the Google Trends online platform, can be applied to other unpredictable situations, thus forming the scientific basis for future research.

## AUTHOR CONTRIBUTIONS

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