Ukraine Food Crisis: Understanding the Impacts of War on the Global Supply Chain and Applying to Future Events

A Technical Report submitted to the Department of Engineering Systems and Environment

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Spring, 2022

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Ukraine Food Crisis: Understanding the Impacts of War on the Global Supply Chain and Applying to Future Events

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***Abstract* - The Russian invasion into Ukraine impacted global trade and economic networks a year after the COVID-19 pandemic did the same. The effects of the war are far reaching; among the areas affected are global food supply and prices, international export controls, energy supply, and the environment.**

The focus of the technical report is to understand the impact that a military invasion has on a major global food exporter and the countries that it supplies. Ramifications of the pandemic, extreme weather, and the energy crisis laid the groundwork for surging food prices, and Russia's invasion of Ukraine exacerbated this issue. The decrease in the production capabilities of Ukraine as a result of the conflict with Russia caused massive disruptions in the global supply chain.

The technical report will use the Russian invasion into Ukraine as a case study, compiling datasets on topics such as changes in global GDP, wheat and edible oil prices, oil and natural gas exports, and research about Ukraine's crop production and food supply, to understand how potential future military aggression could impact global supply chains.

1. Prelude

Before analyzing the effects of the Russian invasion of Ukraine, it is important to understand the role that these countries have historically played in the international economy. In 2019, prior to the invasion and the COVID-19 pandemic, Russia and Ukraine accounted for about 30% of the world's wheat exports (2), providing more than 25 countries with over half of their wheat supply (1), some of which are visible in Figure 1.

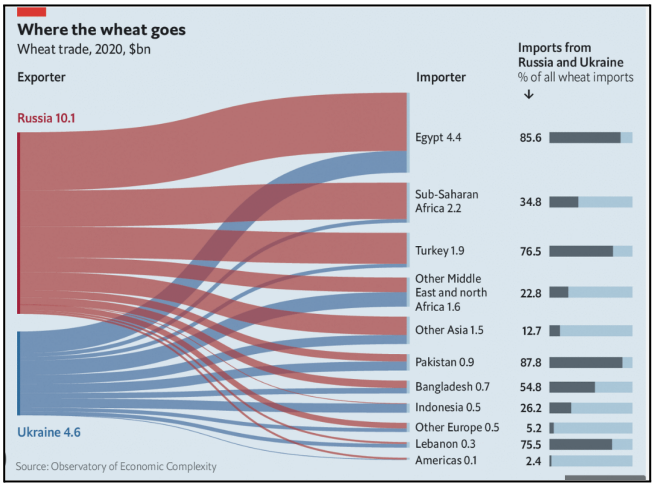
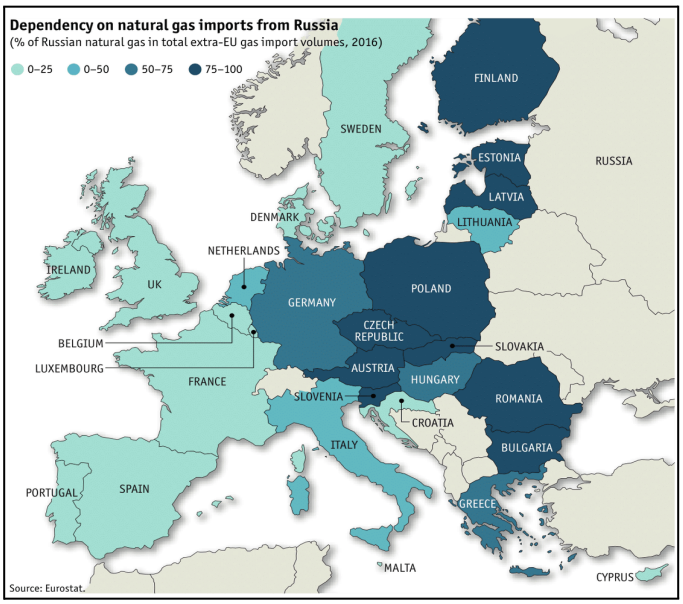


Figure 1: Countries That Import Wheat From Russia and Ukraine (1)

In addition to raw grain, Russia is also the world's largest natural gas exporter, and second-largest exporter of crude oil (3). In 2021, the European Union (EU) imported 45% of their gas from Russia (4). Individual countries' dependencies are illustrated in Figure 2. Natural gas is the starting point for all mineral nitrogen fertilizers, directly impacting agricultural input costs and thus Natural gas prices are closely correlated with food prices (2).

Figure 2: The EU's Reliance on Russian Natural Gas (5)



COVID-19 has an important contextual role as well. The pandemic disrupted the global supply chain, causing the FAO's Food Price Index to increase by 55.2% between May 2020 and February 2022 (6). The highest price increase was seen in the edible oils industry, another top export from Ukraine, with a rise of 159.4% (6). As the price of food dramatically increased, with no change to the demand for cooking oils and other food, a crisis began to emerge. According to the World Food Programme, "the number of people facing acute food insecurity more than tripled between 2017 and 2021" (2). The GDP of countries in the G20 fell by 6.3% in the second quarter of 2020, and countries in the EU fell by 11.1% (7). These compounding factors resulted in a dangerous mix of events, creating a global environment ripe for catastrophe.

2. Invasion of Ukraine

On February 24th, 2022, Russian forces began a full-scale invasion of Ukraine. Putin's troops entered over land, airstrikes were reported in major cities, and a naval blockade was established in the Black Sea (8, 9). Since 98% of the country's grain exports typically pass through the Black Sea ports, the blockade prevented large sums of commodities from reaching global markets and stranded 25 million tons of grain in Ukraine (1).

In addition to the strain on grain supply, the war has limited farmers' ability to harvest. With frontlines in farmland, fields have come under attack and grain silos have been destroyed (10). More than 200,000 hectares of land are contaminated with mines, shells, and debris which saturate the once fertile soil with heavy metals and toxic chemicals (11). Bombings have destroyed crop land, changed the groundwater flow, and completely transformed the landscape. Additionally, battles leave behind large fires that burn any remaining harvest.

For the 2022/23 growing season, Ukraine is tracking toward a grain and oilseed harvest of 54 million tons, concerningly low compared to the 100 million ton harvest in the 2021/22 season. (12).

Russia's attack on Ukraine also had tremendous implications for global energy. Immediately following the invasion, countries across the globe began to pressure Russia economically, isolating the nation from international trade. Major oil companies like Shell and BP announced their divestment from Russian ventures and President Biden imposed a ban on all imports of Russian energy (13, 14). When the EU attempted to reduce their heavy reliance on Russian oil and gas in the months following the war, Russia responded by cutting supplies to Europe. On August 31st, 2022, the flow of the ord Stream 1 Pipeline, the biggest gas pipeline from Russia to Europe, was halted for several days and returned to just 20% capacity upon resumption of supply (15).

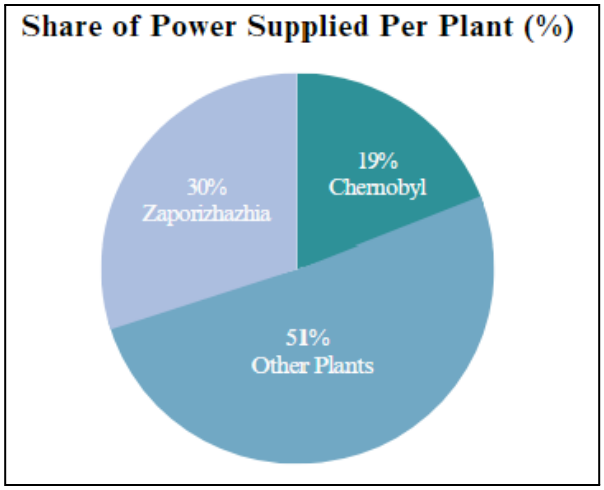


Figure 3: Ukrainian Domestic Energy Supply from Nuclear Power Plants

Ukraine's access to electricity has also been jeopardized by the Russian invasion. As depicted in Figure 3, Ukraine's nuclear energy supply is heavily reliant on four nuclear power plants, which together account for more than 50% of the nation's electricity supply (16). In the first few days of the war, Russia began taking control of Ukrainian nuclear power plants. The Chernobyl power plant in northern Ukraine was seized on the first day and the Zaporizhzhya power plant was captured a week later, eliminating 49% of Ukraine's nuclear production (17).

Additionally, the Russian invasion has sent global food prices soaring. The strain in supply has contributed to a 23% global increase in prices, with the price of grain reaching a 14-year high (18). This growth is visualized in Figure 4.

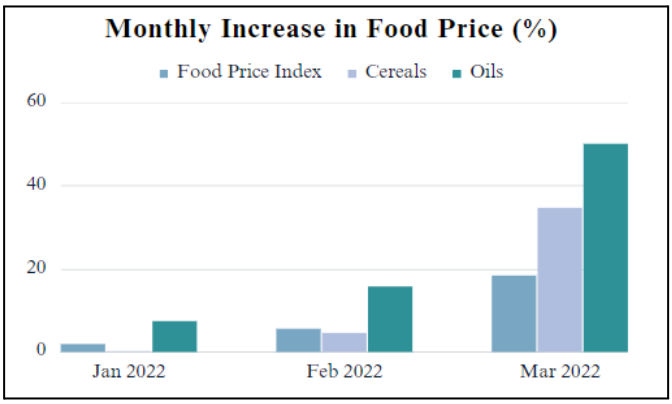


Figure 4: Changes in Food Price in 2022 Q1

3. Disruptions

3.1 Energy Crisis

While the larger spike in global food prices can be attributed to the Russian invasion, the increase in food prices also results from the ongoing global energy crisis, which was exacerbated by the war. Post-invasion, the EU elected to sever relations with Russia and wean off of their reliance on Russian energy (21). In retaliation, Russia began to dramatically decrease oil and natural gas exports to Europe. This resulted in a drop of the contribution of Russian energy imports to the European supply from 40% to 7% (21, 22). This constitutes a major problem for food production because natural gas is the primary source of ammonia production, the main ingredient in all mineral nitrogen fertilizers (2). Increasing agriculture input costs like fertilizer causes a strain in the food supply chain, directly affecting global food prices.

3.2 Food Insecurity

Global food insecurity was already on the rise due to the Covid-19 pandemic, and the Russian invasion of Ukraine that led to food supply strain and food price increase only intensified the concern. The impact of the food crisis is most severe to countries who are net importers. Often these countries are emerging economies that must rely on these global food supply chains due to water and land limitations preventing them from producing their own crops. Ukraine provided the United Nations World Food Programme – the body that provides food aid in humanitarian crises – with almost half of its wheat (18). This is no longer possible after the invasion, and as a result, UN sponsored emergency humanitarian food responses must find other sources for their emergency food rations (23). Many countries who relied

on grain imports to feed their population shifted to rice to fill the demand gap, which has placed unexpected stress on the global rice market, creating shortages and price hikes (24). Regions including Africa, the Middle East, and Asia will feel the brunt of the impact from these developing trends where basic food commodities face inflated prices; just one example of the many far reaching, direct impacts of the war (24).

3.3 Environmental Impacts

Black "chernozem" soil makes up 68% of Ukraine's arable land, and is highly vulnerable to compaction (25). Wartime events like bombings and tank movements make the soil clump and stick together in such a way that makes it more difficult for water and nutrients to penetrate, temporarily cutting crop yields anywhere from 10% to 60% (26). Additionally, wreckage from the war can release harmful pollutants, including "heavy metals, motor oil and fuel, persistent organic pollutants… alongside explosives, which have varying degrees of toxicity and environmental persistence" (27). When farming is able to resume, every potentially contaminated plot of soil must be screened for contaminants to ensure safe crop production is possible. Additionally, water supplies for crops are particularly vulnerable to this contamination.

To offset wartime grain export shortages, agricultural production would have to significantly increase and millions of hectares of land would need to be converted to farmland, further disrupting the local climate and hydrological budget. Furthermore, as agricultural production increases, so too does the amount of industrial fertilizer, pesticides, and agricultural pollutants. There is already damage to industrial infrastructure, water supply lines, and sanitary infrastructure. All of this infrastructure would have to be rebuilt in order to remove the heavy amounts of pollution in the environment before a healthy harvest can be sowed. The full extent of the environmental damage caused by the war is still uncertain, but the recovery process will take years.

4. Policy Reactions

Observing the worrying food supply trends caused by climate change and energy shortages which have been significantly amplified by the invasion of Ukraine, global leaders have made difficult decisions in the effort to ensure the safety and security of their populations.

Since Russia invaded Ukraine, at least 23 nations have issued either outright export bans or curbed export licensing to ensure their populations remain fed (28). As a result of this growing trend, one sixth of the world's traded food supply is now restricted (29). The growing list of countries curbing exports includes India, the world's second largest producer of grain, which has banned all wheat exports barring a few negotiated exemptions (24). This ban was the most impactful for the global food market: immediately after implementation the global wheat benchmark price rose by 6% and was 39% higher than at the beginning of the Russian invasion (30).

Recognizing the significant humanitarian implication and burden that these trends were placing on the global economy, Türkiye brokered a deal between Russian and Ukrainian governments in July 2022 known as the "Black Sea Grain Initiative," which allowed Russian fertilizers renewed access to global markets in exchange for an exemption to the blockade of Ukrainian Black Sea ports for ships carrying grain and food. In the past 8 months, this agreement has allowed for the resumption of near pre-war level cereal exports, and the export of more than 23,000,000 tons of grain (31).

In Europe, energy supply concerns resulting from the Ukraine conflict dominate the political environment. Initial reactions called on populations to reduce energy usage by minimizing the use of heating systems, taking shorter showers, and limiting electricity use (21). As the conflict dragged on, leaders recognized the need for more long term solutions, setting the target to get storage facilities across the continent back to at least 80% capacity before the 2022-23 winter (20). This initiative was successful by obtaining almost 90% of total possible storage capacity in November, 2022 (20).

5. Further Analysis

The Russian invasion of Ukraine amplified significant issues regarding the global supply of various critical resources and highlighted how vulnerable international supply chains are to the impacts of expanded conflict, something that has not been able to be analyzed since the end of the Vietnam War.

The impact of the Russian invasion of Ukraine magnified the importance of diversifying energy supply. Having various energy sources available allows countries to rely more on an alternate source if the main source no longer becomes reliable, keeping production up and prices down. Even with the loss of 80% of the Nord Stream pipeline capacity, many German industrial companies have still been able to use less natural gas. However, this reduction in demand is not due to loss of output or economic downturn, but instead to "flexibility in production or the ability to find import substitutions" (32). Germany's capability to continue production is due to their various domestic energy sources, such as coal and nuclear power.

Not all EU countries have had this same diverse array of energy sources. Countries like Estonia that do not have the necessary resources to invest in diversifying their energy sources have suffered more severely from the loss of Russian supply and have needed to continuously increase domestic oil and gas prices. In Germany, the EU's largest economy, natural gas prices only increased by 24.6% between 2021 and 2022, while in Estonia, one of the EU's smallest economies, a 154.3% increase was recorded (33). The Estonian example demonstrates a common trend among poorer European nations: countries that do not have the energy infrastructure needed to be able to diversify their energy sources are susceptible to major energy commodity price increases, as energy infrastructure is closely linked to economic wealth.

Unfortunately Eastern Europe is not an outlier, tensions have risen in recent decades all over the world. Recent developments have sparked the potential for conflict in Africa,

Asia, and the Middle East. The war in Ukraine has shown that the most worrisome of these conflicts are those which involve countries that make up large percentages of the global supply of a critical resource. As Ukraine is to grain and cooking oil, Taiwan - another nation who is vulnerable to the serious threat of invasion - is to semiconductors.

Semiconductors are the essential components to the advanced electronic systems that are used in everything from smartphones to critical national security infrastructure. Taiwan, a nation under threat from invasion of China, produces 65% of the world's semiconductors and almost 90% of the world's advanced chips (34). If conflict in Taiwan materializes in the way that it did in Ukraine, the world's semiconductor and advanced chip supply would be crippled. This would have drastic consequences for global communication, transportation, economic, and military systems. In a world where supply chains are so interconnected, even between allies and enemies, global leaders must recognize the impacts that conflict will have outside the battlefields.

6. Summary of Insights

The impacts that the war in Ukraine have had on the global food and energy supply showcase the dangers of heavy reliance on one or two dominant suppliers of a particular commodity. This relatively isolated conflict has had an enormous impact on food insecurity, economic instability, energy access, and political action in countries all over the globe.

In order to maintain global market systems, especially in the face of increasing regional conflicts, it is necessary for governments to diversify trading partners to reduce dependencies on individual countries for a critical resource. Additionally, it is in the global economy's, and therefore most countries', best interest to negotiate free access to trade during conflict. The success of the Black Sea Grain Initiative demonstrates the utility of this difficult-to-achieve concept.

In recent history, when a country exercises military force or other similarly frowned upon aggression, the most common global response has been to institute trade bans or other forms of economic sanction. The conflict in Ukraine has demonstrated the extended ramifications of this type of action, where poorer, net importing countries usually end up suffering more than the intended country. Looking ahead, if a similar situation were to occur with another country that is a large exporter of an important commodity, like Taiwan and semiconductors, crises of unprecedented magnitude will occur if global reactions and approaches do not change.

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