

An Analysis of the Energy Crisis under the Ukraine Conflict

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Abstract: The Ukraine Conflict has had far-reaching implications for energy security, geopolitical dynamics, and various sectors. This study examines the impact of the conflict on Russia's energy supply chain to Europe, specifically in terms of natural gas, oil, and coal. Before the conflict, Russia played a crucial role in supplying Europe with natural gas, oil, and coal through pipeline networks, maritime transportation, and export routes. However, the conflict disrupted these supply chains and resulted in significant price fluctuations. The conflict led to economic and energy sanctions imposed on Russia by the United States, the European Union, and Japan, causing a decline in Russia's oil exports. The natural gas supply faced disruptions, leading to increased prices and supply shortages in Europe and globally. The coal market also experienced price hikes and supply disruptions. In response to the energy crisis, countries implemented measures to diversify their energy sources, reduce dependence on Russian imports, and accelerate the transition to renewable energy. The European Union, in particular, introduced the REPowerEU plan to enhance energy independence and promote green energy. The conflict also had implications for various sectors, including agriculture, manufacturing, and defense. Additionally, the US dollar strengthened as it became a safe haven currency during the conflict. Looking ahead, the Ukraine conflict will continue to shape the global energy landscape and geopolitical relationships, influencing strategies for energy resilience, security, and sustainability.

Keywords: energy crisis, Ukraine conflict, responses

1. Introduction

The Ukraine Conflict has had profound implications for the global energy market. In 2022, the world witnessed an unprecedented and far-reaching energy crisis, reminiscent of the two oil crises that occurred in the 20th century. This crisis was characterized by three prominent features: soaring prices of oil, natural gas, and coal, which are the primary commodities in the global energy trade. Remarkably, all three resources reached either periodic or historical highs, impacting the global energy market in significant ways.

Oil prices, in particular, crossed the \$100 per barrel mark for the third time, marking the highest annual average price since 2014. The volatility in oil prices can be attributed to the uncertainty surrounding the Russo-Ukrainian conflict and its potential impact on oil production and transportation routes. The disruption of supply chains and the possibility of trade restrictions have heightened market anxieties, leading to increased oil prices. Natural gas and coal prices have also reached unprecedented

levels, driven by similar concerns over supply disruptions and the growing demand for alternative energy sources.

As the Ukraine conflict continues to escalate, European nations find themselves grappling with a severe energy crisis. On the basis of a set of energy price scenarios, we show that total energy costs of households would increase by 62.6–112.9%, contributing to a 2.7–4.8% increase in household expenditures, since that Russia is a major exporter of oil (12.3% of global supply in 2021) and natural gas (23.6%). European countries reliant on oil and natural gas imports from Russia [1]. This has had a cascading effect on households and businesses, as they struggle to cope with the surge in energy costs. In response to the crisis, numerous nations are actively working towards reducing their reliance on traditional energy sources through energy transition and upgrading. They are investing in renewable energy technologies, such as wind and solar power, as well as exploring alternative sources like hydrogen and geothermal energy. These efforts aim to diversify their energy mix and decrease their vulnerability to geopolitical conflicts and price fluctuations. European countries affected by the energy crisis are also seeking to strengthen regional energy cooperation and develop interconnections to facilitate the flow of energy across borders. Moreover, countries are advocating for energy conservation and the reduction of overall energy consumption. Energy efficiency measures, such as improving insulation in buildings, implementing smart grids, and promoting sustainable transportation, are being prioritized. Governments are also encouraging behavioral changes through public awareness campaigns and incentivizing energy-saving practices.

In addition to influencing the prices of the three major energy resources, the Ukraine conflict has had repercussions on other factors such as the stock market, the US dollar, and food shortage. The fluctuating prices of these resources have created ripple effects in financial markets, causing shifts in stock prices and affecting the value of the US dollar. Investors and businesses are closely monitoring the situation, adjusting their investment strategies, and hedging against potential risks associated with the energy crisis [2]. The consequences of the energy crisis are not limited to Europe. As energy prices soar globally, industries across various sectors face challenges, including higher production costs, reduced profit margins, and potential job losses. Developing countries, in particular, are vulnerable to the impact of rising energy prices, as they often rely on imports for their energy needs. The disparity between energy-rich and energy-poor nations further widens, creating socioeconomic imbalances and exacerbating existing inequalities.

2. Data Analysis

Before the Ukraine conflict, Russia's energy supply chain to Europe is vital, particularly in terms of natural gas, oil, and coal. Cooperation agreements and the interdependence between European countries and Russia have profound implications for energy security and geopolitical dynamics. Here are key points regarding Russia's energy supply chain to Europe before the Ukraine conflict.

First is the natural gas supply (see Figure 1). Russia is one of Europe's major natural gas suppliers. It transports natural gas through pipeline networks like Nord Stream and Nord Stream 2, ensuring a significant supply to meet Europe's industrial, commercial, and residential energy demands. Second is the oil supply (see Figure 2). Russia also plays a significant role in supplying oil to Europe. European countries import Russian oil through both maritime transportation and pipeline networks. Russian oil exports, primarily facilitated by ports along the Baltic Sea such as Primorsk and Novorossiysk, cater to the diverse energy needs of European nations. Third is the coal supply (see Figure 3). Russia is one of the largest coal-producing countries in the world, with abundant coal resources within its borders. In the past, a portion of Russia's coal production has been exported to European countries to meet their energy demands. Russia exports coal to European countries through both land and maritime transportation. Land transportation primarily utilizes the railway system,

while maritime transportation involves ports along the Baltic Sea and the Black Sea. These export routes enable Russia to transport coal to various destinations across Europe.

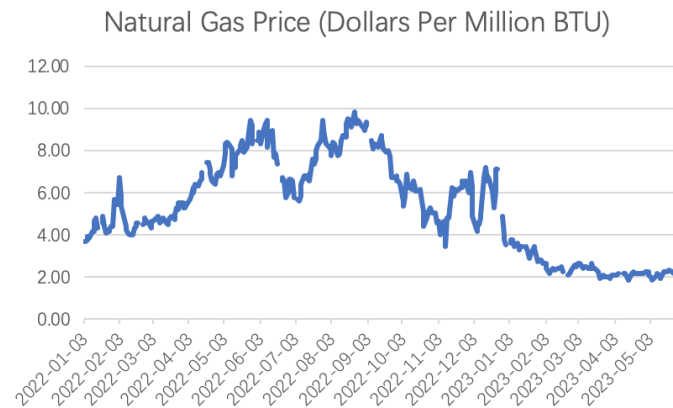


Figure 1: Natural gas price.

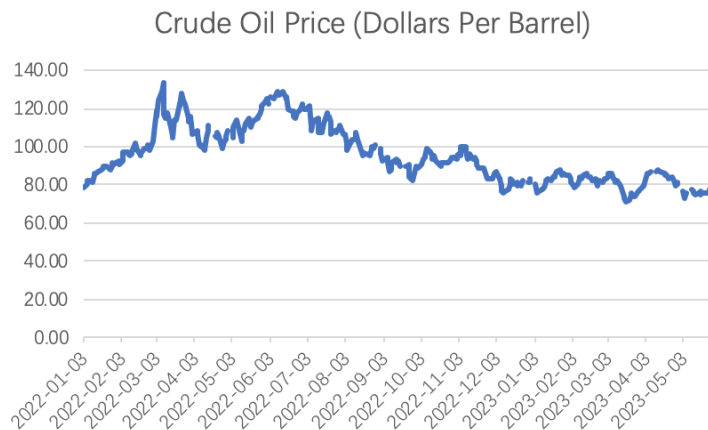


Figure 2: Crude oil price.

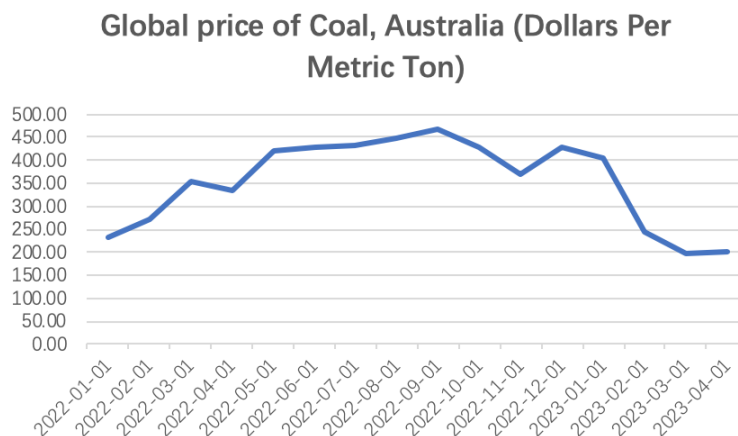


Figure 3: Coal price.

The price went through turmoil in these three major energy resources. At the beginning of the conflict, there is an increasing trend in crude oil, natural gas, and coal. Due to the impact of the Ukraine conflict, Russia's oil exports have experienced a significant decline. In February 2022,

Russia faced economic and energy sanctions from several nations including the United States, the European Union, and Japan. In response, On March 3rd, the International Energy Agency (IEA), an international organization based in France and whose goal is the energy security of energy importing countries, published a ten-point contingency plan for its member states to reduce their energy imports from Russia by over a third within ten months. [3]. As can be seen from the above graph, due to the escalation of the Russia-Ukraine conflict, oil prices have continued to rise since February, and experienced severe fluctuations in March and April. Since June, they have shown a steady downward trend. Until May 2023, the price of crude oil shows a decreasing trend from around 130 dollars to 80 dollars in a very smooth way since the price reached its peak in June 2022.

The natural gas price suddenly skyrocketed since the start of the conflict from 4 dollars per million btu to 9 dollars per million btu. Then it began decreasing in June to 6 dollars per million btu. The sudden incident happened that Russian energy company Gazprom announced plans to further decrease the gas flow from a compressor station supplying the Nord Stream 1 pipeline to Germany. In June 2022, Russia reduced flows through the Nord Stream 1 pipeline by around 60 percent, and Russian gas flows into Germany at Waidhaus on the Czech border fell some 69 percent. If they persist, these cuts will amount to 56 bcm a year. [4]. This incident drove the natural gas price high again to the highest 10 dollars per million btu in September. The conflict between Russia and Ukraine has caused disruptions in the natural gas supply, primarily impacting Europe, which heavily depends on Russian gas imports. This has resulted in a significant rise in household energy prices due to supply disruptions, increased demand during colder weather, and a lack of alternative energy sources. It is important to note that the increase in energy costs is not confined to Europe alone. The global impact of the conflict has led to substantial price hikes in energy across regions such as Asia, Africa, and the Americas. Consequently, households worldwide are facing financial burdens, making it challenging for many to meet their basic energy requirements. After reaching its peak, the natural gas price went down until May 2023 to 2 dollars per million btu. The expected price of natural gas should be much higher but it didn't meet its expectation. Due to an exceptionally warm winter season, heating demand has been lower than usual, leading to higher gas inventories in storage facilities. These inventories are currently approximately 21.5% higher than the average levels observed over the past five years [5].

In the coal market, While the price of natural gas and oil increased to a certain extent, the price of coal experienced an increase of almost 150% immediately after February 24, 2022 [6]. In 2022, global demand for energy reached unprecedented levels, reaching an all-time high. One of the driving factors behind this increase was the shift of electricity-generating facilities away from natural gas, as they sought to compensate for the decline in production from other sources such as nuclear and hydropower. Following its peak in September, the price of coal has been on a downward trend, eventually settling at around 250 dollars per metric ton. This price level is slightly lower than the one observed prior to the conflict between Russia and Ukraine.

3. Responses to Energy Crisis

The responses of each country highly depend on natural resources within each country. Countries possess different energy resources, including fossil fuels, renewables, and nuclear power. For a long period before the Ukraine conflict, Russia is a resource-rich country Russia supplies about one-third of European natural gas consumption, which is utilized for various purposes including winter heating, electricity generation, and industrial production. Russian energy is connected with European energy through various channels, primarily in the form of natural gas and oil exports. Nord Stream is a pipeline network that enables the direct transportation of natural gas from Russia to Germany through the Baltic Sea. It comprises two parallel pipelines, known as Nord Stream 1 and Nord Stream 2, collectively capable of transporting up to 110 billion cubic meters of gas annually. Another important

gas transportation route is the Yamal-Europe pipeline, which runs from Russia through Belarus and Poland, providing natural gas supply to various countries in Central and Eastern Europe. The pipelines transiting Ukraine are designed to supply gas to Western Europe and to Balkan countries and have a capacity of more than 100 bcm (billion cubic meters) per year [7]. Portugal and Spain have a relatively low reliance on Russian energy sources. However, Germany, being the largest economy in Europe, heavily depends on Russia for its energy needs. Over half of Germany's natural gas and more than 30% of its crude oil supplies come from Russia. France, on the other hand, primarily relies on nuclear power for its electricity generation. However, it still relies on Russian imports to fulfill its fossil fuel requirements. The Ukraine conflict pushed the EU to give sanctions on Russia. The EU took significant steps to reduce its reliance on Russian energy resources. In August 2022, the EU implemented an embargo on the import of Russian coal. Additionally, a similar measure was introduced to restrict Russian seaborne crude oil exports to the EU. Furthermore, Germany went a step further by completely banning the purchase of Russian oil by the end of 2022. These actions highlight the EU's commitment to diversify its energy sources and lessen its dependence on Russian energy imports.

In order to deal with the energy shortage, The government in European countries is calling for a reduction in energy consumption and electricity supply. The government played multiple measures including providing energy subsidies to residents, government intervention in residential energy prices, and installing photovoltaic panels on rooftops. The political and economic circumstances of a country play a crucial role in shaping its response to energy transitions. The United States aspiration to reduce Europe's dependence on Russian energy and increase imports of American energy may be realized. According to the Natural Gas Monthly report, the United States witnessed a growth in its liquefied natural gas (LNG) exports in 2022. The average daily export volume reached 10.6 billion cubic feet per day (Bcf/d), indicating a 9% increase (0.8 Bcf/d) compared to the previous year, 2021. Particularly noteworthy is the significant surge in U.S. LNG exports to Europe, which rose by 141%, equivalent to 4.0 Bcf/d, when compared to 2021 figures [8]. Russian gas and oil have been the main competitors of shale oil and gas in the United States, and clamping down on Russia is good for this side of the revenue. In the long term, Russia's capacity to export oil and gas to Europe will be weakened, and the self-sufficiency of major consumer countries in ensuring energy security may further increase. The energy transition will accelerate the restructuring of the global energy landscape. However, changes in the buyer-seller dynamics based on market principles could trigger a new supply-demand game among Europe, the United States, Russia, and OPEC.

For Europe, besides diversifying oil and gas imports that the share of American shale oil and gas in the European market significantly increased, accelerating the transition to green energy will also enhance energy independence and reduce excessive reliance on Russian energy. The REPowerEU plan aims to convert a large part of the energy to consumption renewable energy. Europe has committed to reducing its dependence on Russian fossil fuels by 2027 through the expansion of renewable energy sources. This shift away from oil and gas was already a significant objective for the European Union. The European Union (EU) has the ambitious goal of being climate neutral by 2050, a roadmap set out in the European Green Deal [9]. To achieve these goals, the EU has implemented various measures. These include increasing the share of renewables in the EU energy mix to 45%, surpassing the current target of 40%. Initiatives like the European Solar Rooftop Initiative have been introduced to promote the use of solar energy, and there are plans to accelerate the deployment of photovoltaic (PV) energy through a dedicated EU Solar Energy Strategy. Furthermore, the EU has raised its binding energy savings target for 2030 to 13% and is implementing other strategies to support its transition towards a more sustainable energy future. The REPowerEU plan initiative aims to enhance energy security and foster energy independence for the European Union by diversifying energy sources and promoting domestic renewable energy production. This

transition from fossil fuels to green energy not only benefits the environment but also improves public health. The expansion of renewable energy capacity under the REPowerEU plan has the potential to create new job opportunities within the renewable energy sector. Investments in renewable energy projects not only drive economic growth but also attract private investments. Additionally, these investments stimulate innovation and research in clean energy technologies, further advancing the development of sustainable energy solutions.

4. Discussion

The conflict in Ukraine has had multiple implications for various sectors of the stock market. From a hedging perspective, investors have sought safe havens such as gold and non-ferrous metals. In the grain sector, Ukraine is projected to become a major exporter of corn and wheat, ranking among the top global exporters. Subsequently, previous researchers have found that geopolitical risk is a major catalyst of world stock market fluctuations. [10]. Russia, on the other hand, holds the position of the largest exporter of wheat globally. The conflict between these two countries could drive up prices for corn and wheat, thus impacting the agricultural sector. Thirdly, in the manufactory sector, Ukraine is a significant global supplier of semiconductor raw materials gases, including neon, argon, krypton, and xenon. Neon gas, in particular, is responsible for nearly 70% of the world's production supplied by Ukraine. The ongoing conflict is expected to temporarily increase manufacturing costs in the wafer production sector, thereby affecting the semiconductor gas industry chain. Fourthly, in military sector, Military events can have an impact on the defense sector, potentially leading to shifts and fluctuations in defense-related industries.

The US dollar has been consistently strengthening over the past year, experiencing its most rapid appreciation since the onset of the Russia-Ukraine conflict. The US Dollar Index (DXY) measures the weighted average value of the US dollar against six major currencies. In mid-May, it reached a 20-year high, marking a 9% increase since the eruption of the Russia-Ukraine conflict on February 24th. One contributing factor to the US dollar's strength is its perception as a safe haven. US assets, particularly US Treasury bonds, are viewed as reliable stores of value during market volatility. These assets are highly regarded due to the depth and stability of the US markets. As demand for these assets rises, it often leads to an appreciation of the US dollar during times of global instability.

In addition, the food shortage poses a severe threat to food security in Africa, with the Ukraine conflict exacerbating the situation. Previously, Ukraine and Russia were major suppliers, jointly providing over 40% of the wheat consumed in Africa. However, the conflict has resulted in a significant shortage of 30 million tons of food across the continent, leading to a staggering 40% increase in food prices. This surge in prices burdens African households, as many families struggle to afford the higher costs, surpassing their economic capabilities. Additionally, farmers in rural areas face challenges in selling their products due to inadequate income growth in proportion to the price hikes. Consequently, they find themselves trapped in a cycle of financial difficulties, unable to meet their basic needs solely through food sales. Moreover, food scarcity poses a long-term threat to food security, particularly for vulnerable groups such as children, as it can lead to malnutrition and hinder proper growth and development. Until July 2022, the United Nations, Russia, Turkey, and Ukraine reached the Black Sea Grain Initiative in Istanbul. The aim of this initiative was to restore Ukraine's grain, food, and fertilizer exports through a secure maritime humanitarian corridor while ensuring that Russia's grain and fertilizer could also access the international market. The food shortage problem got relieved finally.

5. Conclusion

In conclusion, the Ukraine conflict has had significant implications for energy security, geopolitical dynamics, and various sectors. The conflict exposed Europe's vulnerability to disruptions in Russian energy supplies, leading to price fluctuations and market instability in sectors such as natural gas, oil, and coal. Countries have responded to the energy crisis by diversifying energy sources, reducing dependence on Russian imports, and accelerating the transition to renewable energy. Efforts like the REPowerEU plan aim to enhance energy independence, promote green energy, and stimulate economic growth in the renewable sector. The conflict's impact extended beyond energy. Investors sought safe havens like gold, and the grain industry experienced price fluctuations affecting global trade. The semiconductor industry faced challenges due to supply disruptions, and military events influenced the defense sector. The US dollar strengthened as it became a safe haven currency, appreciating rapidly against other currencies. The perception of US assets as reliable stores of value contributed to its rise.

Looking ahead, the Ukraine conflict will continue to shape the global energy landscape and geopolitical relationships. Efforts to diversify energy sources, reduce dependencies, and transition to sustainable energy will be prioritized. Lessons learned from this conflict will inform strategies for energy resilience, security, and sustainability. The long-term implications will shape the energy sector's future and drive geopolitical shifts. In summary, the Ukraine conflict exposed Europe's energy vulnerabilities and prompted responses to enhance energy independence and promote renewables. Price fluctuations and market instability were witnessed across various sectors. The US dollar gained strength as a safe haven currency. The conflict's consequences will influence the energy landscape, geopolitical dynamics, and strategies for years to come.

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