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Economy-Wide Impact of Gas Cutoff Commitment in the European Union: A CGE Analysis

Achmad Rifa'i[1]

[1]Department of Development Economics, Universitas Terbuka, Indonesia
*Corresponding email: achmad.rifai@ecampus.ut.ac.id

Abstract

This paper aims to investigate the potential cessation of gas supply in the European Union (EU) amid Russian-Ukrainian war after the European Commission submitted a proposal to reduce gas supply to all EU member states. To identify economy-wide impact, we apply Computable General Equilibrium (CGE) approach and utilize Global Trade Analysis Project (GTAP) 10 database covering 141 regions and 65 sectors. Our empirical analysis reveals that the gas supply reduction policy will heavily affect EU macroeconomic indicators, including declines in GDP and welfare in all simulations. The trade balance position remains strong, which still recorded a surplus. Nevertheless, the competitiveness (ToT) and export-import performances in the gas sector are turning down. These findings contribute to the geopolitical phenomenon that these tensions caused only declining economic performance at regional and global levels. Therefore, we suggest that any forms of tension and potential political and economic policies that lead to slowing down the economy must be resolved.

Keywords: Gas, Import, EU, Economy-Wide Impact, CGE, GTAP

Abstrak

Studi ini bertujuan untuk menyelidiki potensi penghentian pasokan gas di Uni Eropa (UE) di tengah perang Rusia-Ukraina setelah Komisi Eropa mengajukan proposal untuk mengurangi pasokan gas ke semua negara anggota UE. Untuk mengidentifikasi dampak ekonomi secara luas, kami menerapkan pendekatan Computable General Equilibrium (CGE) dan memanfaatkan basis data Global Trade Analysis Project (GTAP) 10 yang mencakup 141 wilayah dan 65 sektor. Analisis empiris mengungkapkan bahwa kebijakan pengurangan pasokan gas akan sangat memengaruhi indikator ekonomi makro UE, termasuk penurunan PDB dan kesejahteraan di semua simulasi. Posisi neraca perdagangan tetap kuat dan mencatat surplus. Namun demikian, daya saing (ToT) dan kinerja ekspor-impor di sektor gas menurun. Temuan ini berkontribusi pada fenomena geopolitik bahwa ketegangan hanya menyebabkan penurunan kinerja ekonomi di tingkat regional dan global. Oleh karena itu, studi menyarankan bahwa segala bentuk ketegangan dan potensi kebijakan politik dan ekonomi yang menyebabkan perlambatan ekonomi harus diselesaikan.

Kata Kunci: Gas, Impor, UE, Dampak Ekonomi Secara Luas, CGE, GTAP

INTRODUCTION

Energy is essential for the country's stability (Atalla & Bean, 2017). Energy is crucial for national stability as it underpins the economy, public welfare, and national resilience. Conversely, an energy crisis can trigger inflation, distribution disruptions, and even social unrest. Furthermore, energy is closely linked to security and sovereignty, as dependence on energy imports can create geopolitical vulnerabilities. In recent years, energy issues have attracted great public attention amid rising international commodity prices (International Monetary Fund, 2022) and gas is one of the energy commodities that experience turmoil in the European Union (EU). Nevertheless, gas turbulence frequently occurs in the EU due to political aspects as the impact of Russian-Ukrainian war (Prohorovs, 2022). This war has a broad impact, not only on political issues, but also brings consequences to economic emergence and energy crisis in the EU (Guénette et al., 2022). Moreover, Ukraine is one of the transit countries for Russia in distributing gas to other EU countries (Božić et al., 2021).Thus, Russian-Ukrainian war has placed gas supply in the EU at risk.

The Russia-Ukrainian War has had a significant impact on the EU's energy sector. Before the conflict, Europe relied largely on Russia for its gas needs, but after the 2022 invasion, supplies were drastically reduced, triggering an energy crisis and a surge in gas, oil, and coal prices. This prompted the EU to launch a program, which focuses on energy savings, accelerating clean energy, and diversifying supplies. As a result, dependence on Russian gas dropped to around 10-15% by 2023, as LNG imports from the United States (US), Qatar, and supplies from Norway and North Africa increased. Energy infrastructure, such as LNG terminals, was also strengthened to ensure supply security. The crisis also accelerated Europe's renewable energy transition and prompted emergency measures such as gas price caps to stabilize the market and maintain public purchasing power (Joh & Alberto, 2022).

The EU countries are rather dependent on the Russian gas supply. According to (Eurostat, 2022), three-quarters of the EU's natural gas was supplied from Russia (43%), and the rest was supplied from Norway (21%), Algeria (8%), and Qatar (5%) in 2020. The share of Russian gas in the EU differs from country to country. In general, a certain number of Eastern European countries are more dependent on Russian gas, like Germany which imports 55% of gas from Russia per year (Bernd, 2022). As a result, the EU gas supply would be vulnerable, particularly at the approach of winter (Raf, 2022). It is demanding to find an affordable gas supply immediately amid relatively high commodity prices. In order to mitigate the impact of gas scarcity, the EU voluntarily submitted a proposal to reduce gas demand by 15% in all EU member states (European Commission, 2022a). The main objective of this proposal is to reduce dependence on Russian gas imports while obtaining new gas supply opportunities, either through increasing production from the countries outside or within the EU (Bartrum & Tetlow, 2022).

The EU's policy of cutting off gas supplies from Russia has both positive and negative aspects. On the positive side, this step reduces geopolitical dependence on Russia, accelerates the transition to clean energy, and opens up opportunities for supply diversification from the US, Qatar, and supplies from Norway and North Africa. This also strengthens the EU's long-term energy sovereignty. However, on the negative side, this policy triggered a spike in energy prices that burdened households and industry, raised the risk of a short-term economic crisis, and created unequal impacts among member states with varying levels of dependence. Furthermore, despite successfully reducing Russia's dominance, Europe still faces the risk of renewed dependence on other energy suppliers, with equally complex geopolitical dynamics.

The EU's commitment in reducing gas supply will have implications for economic indicators in the EU, Russia, and other countries, especially for sectoral and regional linkages. The EU's commitment to reduce gas supplies from Russia is expected to depress short-term economic indicators in the eurozone through spikes in inflation, increased energy costs, and pressure on energy-intensive industries. In the medium term, this policy has implications for accelerating the clean energy transition and diversifying supply, which can strengthen energy security and open up new investment opportunities. For Russia, the implications include reduced export revenues and a structural adjustment in energy trade, shifting markets to Asia. Meanwhile, alternative supplying countries have the potential to benefit from increased gas exports, highlighting the sectoral and regional impacts of this EU energy policy.

Unlike previous studies that generally use aggregate macroeconomic approaches or general simulations of energy tensions, this study offers several novelties. First, it uses the GTAP database version 10, which covers 141 countries and 65 sectors, allowing for more detailed analysis at both the sectoral and regional levels. Second, it designs a simulation scenario specific to the EU-Russia context, comparing the impact of global gas supply cuts with those originating solely from Russia. This approach provides a sharper picture of the consequences of EU energy policy on key partners, particularly Russia and Ukraine. Third, this study emphasizes welfare indicators through Equivalent Variation (EV) to capture the distributional impacts of energy policies, which are rarely highlighted in previous studies. With these novelties, this article makes a significant contribution to enriching the literature on energy geopolitics by combining macroeconomic, sectoral, and welfare perspectives in a more comprehensive manner.

Therefore, this paper aims to investigate the economy-wide impact of the EU gas reduction plan, provide empirical evidence of an issue concerning reducing the consumption of an international commodity in the world, give contribution to the current literature on gas reduction plan impact in the EU. To sum up, this paper will intensify the assessment of global economic conditions after implementing the EU commitment in reducing gas supply.

EU-Russia Trade Relations

Economic and political relations between the EU and Russia have been built on the bilateral Partnership and Cooperation Agreement (PCA) since 1997. PCA is made to encourage investment and trade and also to promote favorable economic cooperation among its members. When Russia took part in the World Trade Organization (WTO) in 2012, EU-Russia trade relations had also been structured by the WTO's multilateral regulations. On the contrary, Russia's illegal annexation of Crimea and its unstable role in eastern Ukraine have seriously influenced EU-Russia connections since 2014. As a result, several policy dialogues and cooperation mechanisms, including in trade sector, have stalled. However, Russia remained one of the major trading partners of the EU until 2022 (European Commission, 2022c).

In the energy sector, in 2020, the EU primarily imported petroleum products which composed mainly of crude oil. It was almost two-thirds of total EU imports. Then, the other imported petroleum products were natural gas with a share of 27% and solid fossil fuels with 5%. More specifically, in the natural gas sector, three-quarters of the EU supply was supported by Russia, Norway, Algeria, and Qatar, as shown in the following figure.

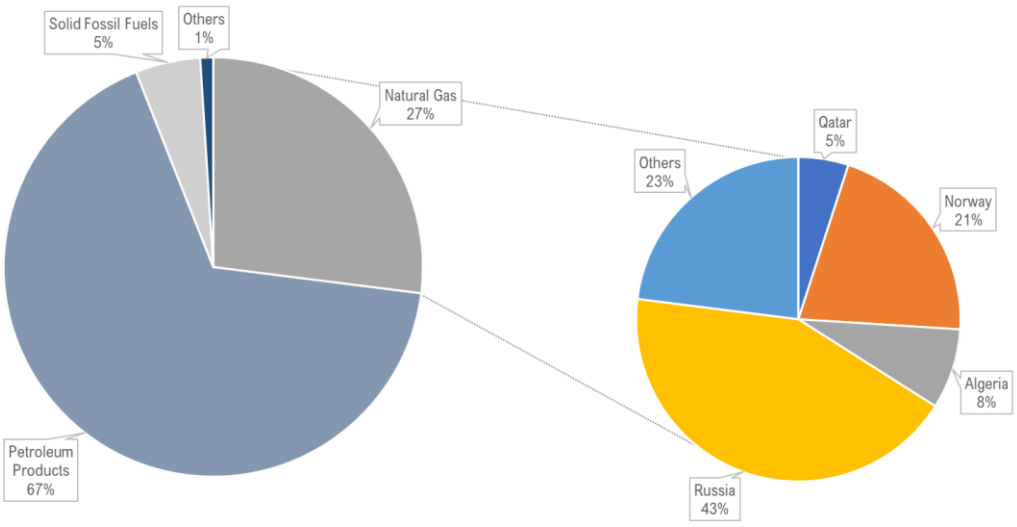

Figure 1.

Share of EU Energy and Natural Gas Imports by Country in 2020

Source: Eurostat, 2022 (processed)

Based on Figure 1, it is obvious that Russia dominates the largest supply of natural gas to the EU. The EU's dependence on Russian gas also puts Russia one step ahead in playing its political and economic role in the EU region, particularly in the energy sector (Hausmann et al., 2022). For that reason, the EU politically attempted to reduce dependence on gas supply from outside the EU region and submitted proposals for reducing gas supply to its member states (Ralf et al., 2014). However, the process is not straightforward since it requires a firm transition and commitment, and there is a possibility that the EU will return to conservative ways to meet its gas supply. This possibility is also closely related to the EU and Russia relationship that it has ups and downs along with the development of dynamic inter-regional political conditions. (di Bella et al., 2022).

Previous Research

The EU's commitment to cut off gas from Russia can be analyzed through several relevant theories. Dependency Theory explains how Russia's energy dominance creates economic and political vulnerabilities for the EU, thus making this policy an effort to reduce this dependency. From the perspective of the Interdependence Complex, the cutoff policy impacts not only the EU but also Russia and the global energy market because energy is an instrument of interconnectedness between countries. Meanwhile, Energy Security Theory emphasizes that the EU's measures aim to strengthen energy availability, affordability, and sustainability despite incurring short-term costs. Furthermore, Energy Transition Theory is relevant to explain how the energy crisis is driving the acceleration of renewable energy use and supply diversification, in line with the EU's decarbonization agenda.

The issue regarding gas commodities between the EU-Russia has been discussed in a lot of research extensively, yet frequently in the context of political relations. Locatelli (2015) has emphasized the urgency of gas security for EU energy policy while the EU seeks to define the relationship among its major gas suppliers, including Russia. They expect to privatize the gas industry in the EU and create a more competitive market. On the other hand, Russia, the leading gas supplier to the EU, is impossible to follow these rules. It is impossible for Russia to comply with EU gas market rules because its gas industry is state-controlled through the Gazprom monopoly, which integrates production and distribution. EU rules demand liberalization, price

transparency, and the separation of business functions, which, if implemented, would weaken Russia's strategic control over gas exports and diminish its position as a geopolitical actor. Therefore, Russia's political and economic interests' conflict with EU energy market regulations. The EU and Russia relations in the gas sector are invariably classified as a contractual relationship (each party has the force of law). Afterward, this kind of cooperation model makes the relationship between the EU and Russia increasingly complicated (Nitoiu, 2016).

Since the early 2000s, the EU-Russia relations in the energy sector have been relatively conducive (Siddi, 2017). However, it changed in 2010 and peaked in 2014 when Crimea was annexed (Siddi, 2022). This event brought various responses to Russia from all over the world, including the EU. After the incident, Russia remained the EU's largest gas producer and tended to grow before the Russian invasion of Ukraine in early 2022. (Schubert et al. (2014). Schubert even emphasized the importance of the EU-Russia cooperation in short term to secure energy supplies, including gas. Instead of increasing economic sanctions against Russia, it is wiser to approach this case through political solutions by maintaining geo-political conduciveness between the two countries.

To the best of our knowledge, no research explicitly addresses the economy-wide impact of the EU gas consumption reduction plan. Only a few related studies are found, such as Christen et al. (2015) that used a multi-country econometric input-output model. He found that export sanctions from the EU and the retaliatory actions that are supposed as Russia against the EU have caused the real value added and employments declined. It has been along with slowing-down of commodity exports and lower demand for tourism in the observation period. Meanwhile, in response to Russia's invasion of Ukraine, the OECD countries agreed to impose sanctions on Russia through restrictions on Russian energy exports. In the short term, the impact of the simulation will reduce real household income by around 0.7-1.7%. Due to this, energy prices in the EU had increased, in which the EU was Russia's largest energy export destination. However, the impact was relatively minor in the long term, reaching 0.04% (Chepeliev et al., 2022).

Prohorovs (2022) suggested that the companies and the number of countries must adapt to the impact of this war. It is due to the Russian-Ukrainian war has triggered high inflation significantly and worsened the world economic situation through trade restrictions which hampered global supply chains. Russia must also adapt to various external risks amid the threat of a decline in gas exports. One of them is by considering the potential demand for Russian domestic gas. The simulation conducted by Orlov (2015) used a comparative static, single-country, multi-sector Computable General Equilibrium (CGE), with an assumption that the increase in domestic gas prices in Russia will indicate the increase in domestic government revenue. In addition, the sectoral impact has encouraged the structure of the Russian economy to shift from energy-based to non-energy-intensive sectors, in response to the domestic gas prices increase. Furthermore, the increase in Russian domestic gas will also indirectly reduce CO_2 emissions.

Several other studies conducted simulations when Russia stopped gas supplies abroad. Barry (2014) built a simulation scenario of Russia shutting off gas exports to Ukraine using the CGE approach. He found that the two countries generally experienced a GDP decline, namely Russia by 2.16% and Ukraine by 2.47%. Furthermore, the manufacturing industry in both countries also experienced output adjustments due to declining gas supplies. The welfare levels lost in Russia and Ukraine due to this simulation amounted to US$11.8 billion and US$722 million, respectively. Afterward, the impact of the Russian-Ukrainian war also triggered an increase in food prices, while food was an essential commodity for a country (Saâdaoui et al., 2022). This war also harmed the

value of global currencies (Chortane & Pandey, 2022).

To address the research gap on the economy-wide impacts of the EU gas cutoff commitment recently, this paper will contribute significantly to fill the research gap. Finally, this paper contributes ideas to resolve the strategic commodity issues, particularly in assessing the possible impact of this EU policy proposal.

METHODOLOGY

Data

This paper employed a CGE analysis to assess the economy-wide impact of the EU gas reduction plan. One of the well-known CGE models is the Global Trade Analysis Project (GTAP), established and coordinated by the Center for Global Trade Analysis in the Department of Agricultural Economics at Purdue University since 1992. This paper utilized the GTAP 10 database covering 141 regions and 65 sectors as well as four reference years (2004, 2007, 2011, 2014). The underlying database came from various primary sources, including national Input-Output (I-O) tables, macroeconomic, trade, energy, and protection data. The database coverage represents 98% of the world GDP and 92% of the world population (Aguiar et al., 2019).

The core structure of the GTAP model closely aligns with that of other economy-wide CGE models. Consequently, it facilitates sectoral breakdown and captures the behavior of economic agents through comprehensive quantitative analysis at the macroeconomic level. According to Dixon & Rimmer (2010), the indigenous empirical economy-wide model is the input-output system (Leontief, 1936). The model captures the comprehensive structure of the economy by tracing the production processes of each sector through to final consumption. It offers a detailed depiction of the input-output relationships, highlighting the allocation and utilization of resources across various stages of economic activity.

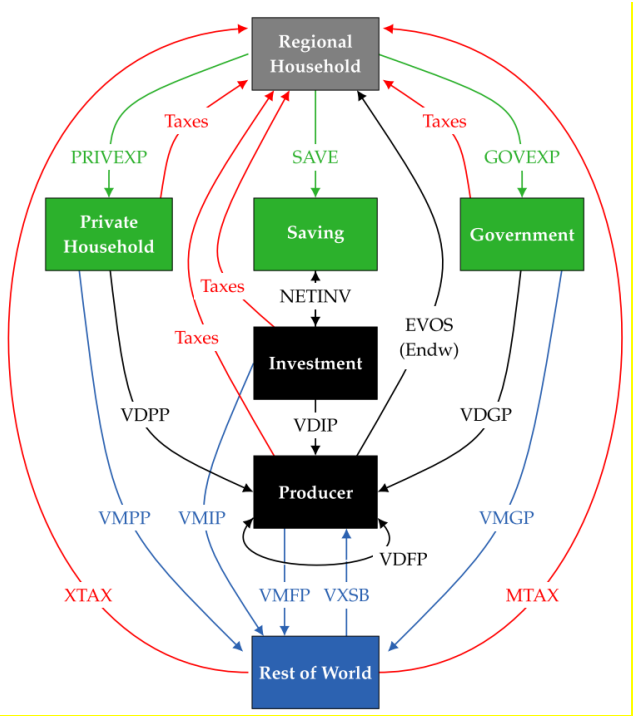

Figure 2.

Circular Flow in a Regional Economy

Source: Corong et al. (2017)

Figure 2 depicts macroeconomic circular flows within the framework of the standard CGE model used by the GTAP. At the core of the model are regional households that accumulate national income from various factors of production, such as labor and capital and then distribute it among three main components: household consumption (PRIVEXP), government expenditure (GOVEXP), and savings (SAVE). These savings are then allocated to investment (NETINV), which in this static model is not intertemporal and does not directly affect the production of goods and services, but reflects capital accumulation. Producers use inputs of factors of production and capital goods to produce output that is used both domestically and for export. The model also reflects bilateral trade flows through exports and imports between domestic producers and the Rest of the World (ROW), taking into account trade taxes such as import taxes (MTAX) and export taxes (XTAX). Taxes play a crucial role and affect all economic actors, including households, governments, and producers, as indicated by the red arrows. The model provides a comprehensive representation of economic activity, linking domestic production and consumption to global trade flows.

Aggregation

In line with the objective of this paper, we aggregated countries and sectors as follows. First, we aggregated 27 countries that were the members of EU, a group that proposed policies to reduce gas consumption. Subsequently, we put Russia, Ukraine, and the US, as separate countries to analyze the impact of the EU proposal more specifically. The US is included in the analysis because it is the EU's main gas supplier following the energy crisis, making it relevant to examine the shift in supply away from Russia. Furthermore, its presence allows for comparison of trade impacts and reflects the geopolitical-economic dimensions of EU energy policy. After that, other countries were aggregated based on their continents, such as Oceania, Asia, several countries in Europe and Americas, and the rest of the world. Second, based on the sector, we made the aggregation of seven sectors where gas and gas manufacture distribution were made into one leading sector, namely Gas. It became a sector that would be stimulated in experiencing a supply reduction.

Furthermore, other sectors were grouped into Agriculture, Mining, Manufacturing, Service, TransComm, and Util_Cons. Further explanations of regional and sectoral aggregation mapping as shown in Tables 1 and 2 below.

Table 1.

Regional Aggregation Mapping

Regions	Members
EU27	Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden
Russia	Russia Federation
Ukraine	Ukraine
US	United States of America
Asia	China, Hong Kong, Japan, Korea, Mongolia, Taiwan, Bangladesh, India, Nepal, Pakistan, Sri Lanka, Rest of South Asia, Bahrain, Iran Islamic Republic of, Jordan, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates, Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Philippines, Singapore, Thailand, Vietnam, Rest of Southeast Asia, Rest of Western Asia, Rest of East Asia
Oceania	Australia, New Zealand, Rest of Oceania
Rest of Europe	United Kingdom, Switzerland, Norway, Albania, Belarus, Kazakhstan, Kyrgyzstan, Tajikistan, Armenia, Azerbaijan, Georgia, Israel, Turkey, Rest of EFTA, Rest of Former Soviet Union, Rest of Eastern Europe, Rest of Europe

Regions	Members
Rest of America	Canada, Mexico, Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela, Rest of South America, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador, Rest of Central America, Dominican Republic, Jamaica, Puerto Rico, Trinidad and Tobago, Caribbean, Rest of North America
Rest of World	Egypt, Morocco, Tunisia, Benin, Burkina Faso, Cameroon, Cote d'Ivoire, Ghana, Guinea, Nigeria, Senegal, Togo, Rest of Western Africa, Central Africa, South Central Africa, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Tanzania, Uganda, Zambia, Zimbabwe, Botswana, Namibia, South Africa, Rest of South African Customs, Rest of North Africa, Rest of Eastern Africa, Rest of the World

Source: Authors' specification from GTAP 10 Database

Table 2.

Sectoral Aggregation Mapping

Sector Name	Group Description	Disaggregated Sectors
Gas	Gas Sectors	Gas, Gas manufacture distribution
Agriculture	Agriculture, Fishing, and Forestry	Paddy rice, Wheat, Cereal grains nec, Vegetables, fruit, nuts, Oil seeds, Sugar cane, sugar beet, Plant-based fibers, Crops nec, Bovine cattle, sheep and goats, Animal products nec, Raw milk, Wool, silk-worm cocoons, Forestry, Fishing, Bovine meat products, Meat products nec, Vegetable oils and fats, Dairy products, Processed rice, Sugar, Food products nec, Beverages and tobacco products, Wood products
Mining	Mining and Extraction	Coal, Oil, Minerals nec, Petroleum, coal products, Mineral products nec
Manufacture	Manufacturing Sectors	Textiles, Wearing apparel, Leather products, Paper products, publishing, Chemical products, Basic pharmaceutical products, Rubber and plastic products, Ferrous metals, Metals nec, Metal products, Computer, electronic and optic, Electrical equipment, Machinery and equipment nec, Motor vehicles and parts, Transport equipment nec, Manufactures nec
Service	Service Sectors	Financial services nec, Insurance, Real estate activities, Business services nec, Recreational and other service, Public Administration and defence, Education, Human health and social work, Dwellings
TransComm	Transportation and Communication	Transport nec, Water transport, Air transport, Warehousing and support activities, Communication
Util_Cons	Utilities and Construction	Electricity, Water, Construction, Trade, Accommodation, Food and service

Source: Authors' specification from GTAP 10 Database

Simulation Method

This study will conduct a simulation scenario in which the EU imposes gas import restrictions on its member countries. The simulation of shock magnitude will be in line with a proposal submitted by the European Commission, i.e., the plan to reduce gas consumption by 15% (European Commission, 2022b). To obtain deep analysis, the simulation scenarios will be divided into two parts; the EU reduces gas consumption by 15% over the gas exporting countries in the world, and the EU only reduces imports by 15% from Russia. Further explanation regarding the

simulation scenario is described as follows.

- Simulation scenario 1 (Sim 1): The EU reduces gas imports worldwide by 15% in response to energy supply uncertainty while they are saving and increasing domestic production.
- Simulation scenario 2 (Sim 2): The EU reduces gas supply by 15% from Russia as a commitment to reduce dependence and mitigate the possibility of cessation of gas from Russia.

According to Hertel (1997), the system of equations in GTAP contains two critical things. First, the accounting equation assumes that the relationship between the receipts and expenditures of each agent is in a balanced economy or general equilibrium. Lastly, the equations are built based on general microeconomic theory. The I-O table in the GTAP model is interrelated between each agent and industry. Furthermore, the mathematical relationships contained in the GTAP model are built upon assumption that thousands of markets are classified into some groups. The standard GTAP model is a multi-sector, multi-country, with perfect competition and constant returns to scale, as well as the CGE model. After that, like the CGE approach, GTAP can exercise an economy-wide examination of a shock or policy scenario and its impact on macroeconomics and other indicators by sector and between countries. Thus, the model in GTAP is considered primarily capable of examining real-world policy issues (Dixon & Jorgenson, 2013).

DISCUSSION AND FINDINGS

We highlighted several macroeconomic indicators as the impact of simulation scenarios of the EU gas supply reduction by 15%. First and foremost, we analyzed the impact on Gross Domestic Product (GDP).

Table 3.

Impact on GDP (% Change)

Country	Sim 1	Sim 2
EU27	-0.216	-0.044
Russia	0.231	-1.149
Ukraina	-0.033	0.157
US	0.053	0.046
Asia	0.041	0.004
Oceania	0.066	0.002
Rest of Europe	0.017	0.051
Rest of America	0.052	0.009
Rest of World	0.067	0.107

Source: GTAP Simulation Result (processed)

As expected, the gas supply cutoff will have implications for a decline in EU GDP (see Table 3). In general, the simulation of a decrease in certain commodities supplies and also exports and imports almost invariably causes the value of GDP to shrink (see Barry, 2014; Kutlina-Dimitrova, 2017; Yusuf et al., 2018). The EU economy has decreased by 0.216% when the plan to reduce gas supply from suppliers worldwide is implemented. When the EU only drops gas imports from Russia, the impact on the EU's GDP is relatively insignificant (less than 1%), namely 0.044%. Similar to the EU, the impact on the Ukrainian economy also tends to be more severe when gas supplies are reduced from exporters around the world. Ukraine's GDP is affected and decreased by 0.033% in simulation 1. Otherwise, Ukraine's GDP is triggered to climb by 0.156% as the EU decries gas supply only from Russia. Therefore, simulation 2 could be a preferable alternative for mitigating economic impact if the EU remains committed to reduce gas supply according to their proposals.

Moreover, simulation 2 covers more economic and international benefits for the EU since it encourages Ukraine's economy to expand. At the same time, Russia experiences pressure on its GDP by a decrease of 1.149%. The decline in Russia's GDP by more than 1% is quite reasonable, considering that gas is one of Russia's primary export commodities. As long as the EU does the mitigation by reducing gas supply from abroad, particularly from Russia, it certainly causes Russia's GDP decline significantly.

Then, the impact of the EU's commitment to reduce supply is relatively insignificant in other regions. However, this policy generally has resulted in GDP increase in other regions, such as the US, Asia, Oceania, Rest of Europe, Rest of America, and Rest of the World. More specifically, the US, Asia, Oceania, and Rest of America have the same characteristics in which simulation 2 can have a higher impact than simulation 1. In contrast, Rest of Europe and Rest of World in simulation 1 have a more significant impact than in simulation 2. The EU gas supply reduction has far-reaching consequences since that gas supply is not intended for household level only, but also for industrial sectors in the surrounding region. After that, a decrease in gas supply has impacted the regions around the EU, such as Russia, Ukraine, and other European countries (Protasov, 2010). In other regions, the impact is not too significant but it provides an opportunity to increase the economy, even though it varies between regions. However, simulation 2 which contains a scenario that the EU reduces gas from Rusia has a more notable impact on other regions than simulation 1, in terms of the magnitude of the impact generated.

The following discussion will review the welfare indicators proxied in the GTAP model by using Equivalent Variation (EV). In addition, EV welfare indicator is proxied by changes in regional household utility, calculated from private consumption, government consumption, and savings. This utility value is then converted into monetary terms to indicate how much income increase or decrease is required for households to achieve the same level of welfare after a policy or shock.

Table 4.
Impact on Welfare – Equivalent Variation (US$ Million)

Country	Sim 1	Sim 2
EU27	-27494.496	-4546.364
Russia	2283.356	-13252.716
Ukraine	-48.772	195.470
US	706.873	1065.219
Asia	792.108	-407.274
Oceania	191.015	-8.824
Rest of Europe	122.972	1378.764
Rest of America	510.504	-13.739
Rest of World	451.780	1080.624

Source: GTAP Simulation Result (processed)

Table 4 reveals that the level of welfare varies between countries due to the EU's gas reduction policy. In simulation 1, the EU experiences the most considerable welfare loss after Ukraine. Arguably, the EU's dependence on gas supplies from abroad has a broad impact, including a shortage of supply at the household level and in the industrial sector. The impact of the gas supply decline at the household level has suppressed individual productivity and made gas bills more expensive. On the contrary, gas supply leads to supply chain disruptions with other related industries in the industrial sector that ultimately reduces the overall industrial capacity (Mark et al., 2022). Ukraine also experiences welfare loss which is fewer than the EU's. It is due to the welfare loss was primarily driven by revenue loss from Russia's gas transit pipeline which passed through Ukraine before they were distributed to EU countries. At the same time, other regions underwent welfare improvement, primarily led by Russia, which experienced the highest welfare

among other regions in simulation 1. This potential has led Russian gas exports to not disappear, although it potentially reduces the shipments to the EU. However, Russia was considered to have other gas export destinations, such as Asia which also experienced the highest welfare gain after Russia.

Furthermore, simulation 2 shows that Russia is the most impacted region by the EU gas reduction policy scenario. The most significant decline in welfare level is in line with the potential loss of welfare of the Russian population, especially in upstream to downstream gas sectors. Then, the impact of the industrial sector is also inseparable. Furthermore, the EU might experience a decline in welfare because the gas supply to the EU is dominated by Russia. Other regions such as Asia, Oceania, and Rest of America also experienced a decline in welfare. An unusual finding is found in simulation 2 that Ukraine's welfare level has increased though it is the smallest welfare level increase among other regions, such as the US, Rest of Europe, and Rest of World. Plausibly, the rise in welfare level in Rest of Europe is expected to lead unidirectional increase of welfare in Ukraine, in terms of natural resources and the financial sector. This argument is also supported by the welfare increase in the regional level, i.e. Rest of Europe and Ukraine, as shown in simulation 2 and compared to simulation 1.

Table 5.

Impact on Trade Balance and Term of Trade

Country	Trade Balance (US$ Million)		Term of Trade (%)	
	Sim 1	Sim 2	Sim 1	Sim 2
EU27	11183.934	2786.625	-0.046	-0.018
Russia	233.192	-2589.184	0.134	-0.483
Ukraine	29.514	-192.493	-0.059	0.245
US	-3905.174	-1840.125	0.025	0.040
Asia	-4297.184	1485.644	0.009	0.007
Oceania	-360.812	92.126	0.043	0.007
Rest of Europe	-920.158	-345.892	0.009	0.071
Rest of America	-1523.230	658.830	0.021	0.003
Rest of The World	-440.224	-55.536	0.061	0.149

Source: GTAP Simulation Result (processed)

Other macroeconomic indicators that are highlighted involve the conditions of trade balance and trade terminologies (see Table 5). In terms of trade balance, these two simulations have shown that the plan to reduce gas supply does not affect the EU's trade performance. In simulation 1, the EU's trade balance achieves a US$11,183.934 surplus (which is relatively high) and diminishes to US$2,786.625 million as shown in simulation 2. Although it shrinks in simulation 2, the EU's trade balance remains in a relatively secure situation. In addition, Russia's trade balance also achieves a high surplus among three other regions which achieving surplus after the EU and Ukraine. Nevertheless, there is a reversed flow in Russian and Ukrainian trade balance, as shown in Simulation 2. In this case, Russia is the most affected country with a deficit of US$ 2,589.184. This deficit is in line with the gas supply reduction to the EU, particularly for Russia which has lost one of its primary export markets and Ukraine as its transit point for gas supply. On the other hand, other regions suffer from various deficits, as shown in simulation 1. It demonstrates the high interconnection of gas sectors in the world supply chain. In simulation 2, besides the EU, Asia, Oceania, and Rest of America merely recorded a surplus for trade balance.

The following discussion focuses on terms of trade (ToT). ToT represents the ratio of relative price of a good between countries that shows the competitiveness of a product or country. Even though the EU trade balance shows a surplus, ToT will describe the opposite. It suggests that simulations 1 and 2 have caused the decline in the EU competitiveness. Yet, they are insignificant

(less than 1%), namely 0.046% and 0.018%, respectively. This condition indicates that the competitiveness of relative price upon sort of goods from the EU has been less competitive due to the lack of gas supply. It particularly occurs when the EU conducts a scenario to cut off gas supplies from around the world.

On the contrary, the competitiveness of goods from Russia in simulation 1 tends to be more excellent, ToT rises to 0.134%. However, it declines in simulation 2 when Russian gas export supply decreases due to the EU policies. Ukraine's condition is in inversed proportion to Russia's. In simulation 1, the ToT of Ukraine decreases by 0.059% due to the lower competitiveness compared to other countries. Yet, in simulation 2, it increases to 0.245% when the EU reduces Russia's gas supply. Other regions tend to experience competitiveness growth that varies over simulations. Thus, the EU's proposal concerning reducing gas supply has adversely impacted the ToT of several countries in the same region, including the EU, Russia, and Ukraine.

Table 6.

Impact on EU27 Economic Sector (% Change)

Sector	Export		Import	
	Sim 1	Sim 2	Sim 1	Sim 2
Gas	-92.842	10.731	-5.392	1.258
Agriculture	0.057	-0.009	-0.165	-0.040
Mining	-0.775	-0.236	-0.080	-0.070
Manufacture	0.141	0.005	-0.120	-0.039
Service	0.350	0.050	-0.324	-0.068
TransComm	0.096	0.036	-0.257	-0.059
Util_Cons	0.102	-0.029	-0.153	-0.042

Source: GTAP Simulation Result (processed)

The following indicator is related to the performance of the EU's economic sector in international trade. Table 6 reports that gas sector is under extreme pressure as the impact of supply reduction from all over the world (simulation 1). In the export side, the performance of gas sector declines immensely by more than 90%. In the import side, however, it decreases by more than 5%. Arguably, simulation 1 has great consequences to be applied since it influences not only economic performance but also the foreign policy between the EU and its trading partners. Once the EU reduces gas supply from its suppliers around the world, the countries which encompassed the EU trading partners will also respond by reducing the supply from the EU itself. As a result, the EU's export performance will decline drastically. In addition, the EU's gas sector also depends on external supplies, which becomes very risky and sensitive when a shock or drastic policy is imposed. However, in simulation 2, it tends to increase both in exports and imports. Their focus in reducing gas supply from Russia has a more positive impact than forcing gas supply reduction from around the world.

In other sectors, they should apply some adjustments in controlling the influence of the EU's export and import performances as the impact of the EU's gas reduction policy. The performance in the mining sector experiences a decline in all simulations. It particularly occurs in export performance which experiences higher depreciation than import performance. It is in line with the lack of gas supply and the EU's dependence on the gas sector which is one of the mining commodities. The agricultural sector, particularly in exports, experiences an increase in simulation 1. Other sectors, such as manufacturing, service, transportation, and communication, also experience the increase in exports.

The utility and construction sector has an increase in simulation 1 only, while it decreases in

simulation 2. The whole EU's import performances have decreased variedly in all simulations due to gas supply reduction. Thus, this gas reduction impact places greater emphasis on import and export sides. With this condition, the EU's international trade performance is relatively excellent. It is due to a higher increase in exports, except the gas sector, so that it can offset the decline in imports, particularly for all economic sectors. It also has caused the EU trade balance to achieve a surplus besides the implementation of gas supply and the declines in goods competitiveness and the EU.

CONCLUSION

This study finds that the EU's commitment to reduce gas supplies has varying economic impacts depending on the scope of its implementation. Simulations show that cutting global supplies (Simulation 1) leads to a deeper economic decline, both in GDP and welfare, than cuts focused solely on Russia (Simulation 2). The most interesting finding is that while the EU experiences a decline in macroeconomic indicators in all scenarios, Ukraine actually experiences an increase in GDP and welfare when cuts focused solely on Russia, while Russia itself experiences a significant contraction. This reinforces the theory of energy dependency and security, which explains that energy dependence creates strategic vulnerabilities, and demonstrates how energy is used as a geopolitical instrument in international relations.

The implications of these results suggest that the gas supply reduction policy is not simply a political maneuver but also an economic strategy to strengthen the EU's long-term energy security. However, short-term costs in the form of reduced competitiveness, price increases, and reduced welfare remain unavoidable. Therefore, the policy needs to be implemented through mitigating measures such as diversifying energy supplies, accelerating the transition to clean energy, and strengthening energy infrastructure. Globally, this policy also redraws the international energy trade landscape: Russia risks losing significant market share in Europe and shifting exports to Asia, while other countries, such as the US, gain broader gas export opportunities. Thus, the EU's gas cutoff policy not only impacts the region's internal conditions but also alters the dynamics of energy trade and geopolitics globally.

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