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The Impact of the Pandemic and War on the State of Global Supply Chains

A Master Thesis within Production Management

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Master Thesis in Production Management

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Preword

The thesis has been conducted at the division of Production Management at Lund University. A special thanks is directed towards my supervisor Bertil Nilsson for his constant guidance throughout the thesis process.

This master thesis has been written with a main focus on the war in Ukraine and Covid-19 pandemic and how these events have affected global supply chains. Given the scope and complexity of the concepts discussed, the research material on the topic is quite extensive, including a large variety of perspectives on the matter. Moreover, the war in Ukraine has been ongoing throughout the timeline of the project and the long term effects of the war as well as the Covid-19 pandemic are still not certain. The thesis provides an understanding of the effects on the global economy and supply chains, but as they are ongoing, we have not seen the end of the long term impacts.

Abstract

Title: The Impact of the Pandemic and War on the State of Global Supply Chains

Purpose: The purpose of the thesis is to outline the current state of global supply chains and global energy supply as a result of the Covid-19 pandemic as well as Russia-Ukraine war. Current energy and supply chain issues are explored and discussed based on existing theory on the topic. When the overall issues are clarified, potential solutions to the problems are outlined and expanded on.

Methodology: The thesis is based on a literature study involving reviews of various relevant studies and articles in order to establish a thorough understanding of the topic as a basis for further analysis.

Research Questions:

- How will businesses need to change their handling of their global supply chains, as a consequence of the pandemic and war, and what trends could already be observed?
- What effects have the war and pandemic had on global energy supply and what are the solutions to the current problems?
- How will companies efficiently understand and recognize its weaknesses related to their operations and changing surrounding factors?

Findings: Both the Russia-Ukraine war and Covid-19 pandemic have exposed weaknesses in global supply chains. Strategies involving cost-efficiency have proved to be insufficient when faced with unprecedented disturbances. Major disruptions, shortages and delays on a global scale exemplify the issue. Businesses have to improve resilience throughout their supply chains. Examples of methods to achieve more resilient supply chains could involve inventory cushions, supplier diversification, localisation and gaining visibility throughout the operations.

Table of Content

1. Introduction

This chapter will serve to introduce the topic of the thesis and to outline in what way the thesis is going to cover it. The areas within the chapter include background information, context, problem formulation and presentation of research questions, the purpose of the thesis, what its limits are and finally a structure of how the thesis is going to cover the topic.

When analyzing global supply chains, there are various macro factors that need to be considered and evaluated as to what extent they have an impact on businesses' operations and networks. Examples of such factors include oil prices, labor costs, currency exchange rates and trade barriers (Fioravanti et al., 2009). Two recent global events that have affected supply chains through such factors are the Covid-19 pandemic as well as the Ukraine-Russian war. The consequences of these events have been severe in a number of ways. Apart from the humanitarian crises caused by these events, the global economy has been affected, as well as supply chains throughout the world.

In the spring of 2020, the Covid-19 virus was quickly spreading across the world, infecting people within most countries on the planet. As a result of the pandemic, many countries implemented lockdown policies, forcing numerous businesses to shut down, and many more to drastically reduce their operations. The humanitarian impact of the virus has been massive and as of July 20 2022, more than 500 million were reported to have been infected while more than 6 million were reported to have died from the virus (WorldOMeter, 2022). In addition, the pandemic has led to a drastic increase in unemployment rate, affecting millions of people all over the world. For instance, in July 2022, more than 31 million people were reported to not be able to work during the past 4 weeks as a cause of the pandemic, due to their employer closing or scaling down their business (U.S. BUREAU OF LABOR STATISTICS, 2020). In this thesis, the pandemic's impact on businesses will be explored, and more specifically, how it has impacted supply chain operations, short term as well as long term.

In February 2022, Russia invaded its neighboring country Ukraine. Similarly to the pandemic, the war has led to a humanitarian crisis. While the numbers of casualties are difficult to measure in war zones and vary through different sources, as of the end of January 2023, estimates state over 7000 civilian deaths(Cumming-Bruce, 2023). According to the United Nations, there are more than 8 million Ukrainians refugees recorded across Europe(UNHCR, 2022). In addition to this humanitarian disaster, the war has also had a strong negative impact on the global economy.

This thesis will further examine how the war has impacted the economy, and more specifically, global supply chain operations, short term as well as long term.

The global pandemic has created various new challenges as well as escalated existing ones for global supply chains. Since the outbreak caused the global economy to shut down in the spring of 2020, large-scale weaknesses within production strategies and supply chains have been exposed, underlined through trade restrictions and shortages of products(Shih, 2020). In addition, the Ukraine-Russian war has caused businesses to reduce their dependence on Russia concerning transportation and raw material. Consequently, businesses have been forced to increase domestic production, reducing dependency on high risk sources, and partly depart from the previous strong focus on lean manufacturing with minimal amount of inventory held. (Shih, 2020).

Moreover, the pandemic has caused global disruption in terms of trade, finance, health and education systems. A survey conducted by Ernst & Young LLP determined that out of 200 senior-level supply chain executives, 2 % claimed that they were fully prepared to deal with the pandemic. Serious disruptions had an effect on 57 % of the respondents while 72 % reported a negative effect. Certain sectors were impacted more than others, with all automotive and almost all of industrial companies claiming a negative effect from the pandemic. Additionally, businesses reported a disruption in the workforce, with many having to work from home and adapting to new requirements. (Harapko, 2021)

Considering the Ukraine-Russian war, there are several disruptions that will have global effects for years to come. Apart from the invasion causing a massive humanitarian crisis, the war will impact energy policy, food security, critical material, equipment and commodities, global technology and financial systems, to name a few of the affected areas. The war is causing supply chain leaders to further examine their sourcing capabilities, as part of long term resilience goals. Specifically the area of global energy supply has been particularly affected by the ongoing war. The thesis will explore the extent of these impacts and what implications they lead to, short term as well as long term. (McKinsey, 2022f)

1.1 Context

The pandemic and ongoing war has had an effect on the global economy in a number of ways. Certainly considering supply chain operations, the war has led to several countries, particularly in the west, reducing their import of Russian energy, leading to rising energy prices and inflation. (Simchi-Levi and Haren, 2022). Regarding the pandemic, Just-In-Time supply chains have been affected by Covid-19, as raw material manufacturing disruptions, bottlenecks at ports across the world as well as imbalances with supply and demand have made the previous strategies seem

out-dated to some degree (SearchERP, 2022). The two global events certainly relate to global supply chain operations, and this thesis will further explore the context of the configurational changes being made, currently ongoing as well as future implications.

1.2 Problem Formulation and Research Questions

The implications on global supply chains that have been observed as a result of the pandemic as well as the Russia-Ukraine war has led to general supply chain challenges becoming more apparent and visible on a worldwide scale. Short term problems involve insufficient critical products and materials, disruption on food production systems, shortage of energy supply, and temporary trade restrictions. In combination with more long term issues such as energy transition, efficient use of new technology, a digitalizing landscape and overall exposed weaknesses of the Just-In-Time supply chains, they pose some major challenges for supply chains to be solved. Previous strategies involving lean manufacturing and minimizing inventory held as a way to optimize total costs have experienced problems when it comes to meeting customer demands. The challenges generally revolve around increasing resilience, improving flexibility, gaining end-to-end visibility, improving disruption and change management and getting value from data. (Hoey, 2020)

This thesis aims to contribute to a further understanding of what is lacking, what needs to be improved and what the necessary steps are concerning these matters. Some of the research questions to be investigated and explored in this report include:

- ☐ How will businesses need to change their handling of their global supply chains, as a consequence of the pandemic and war, and what trends could already be observed?
- ☐ What effects have the war and pandemic had on global energy supply and what are the solutions to the current problems?
- ☐ How will companies efficiently understand and recognize its weaknesses related to their operations and changing surrounding factors?

1.3 Limits and Scope of Thesis

Exploring how the Russia-Ukraine war and Covid-19 pandemic have impacted and will impact global supply chain operations is quite a large scope for one thesis. An extensive amount of research has been done and is being conducted as of today. In order to carry out a thorough analysis on a given topic, the thesis therefore needs to be limited to cover certain areas of the

concerning issue. For this specific case, this would imply the possibility of the thesis either not covering the whole spectrum of small-scaled concepts that make up the overall subject at issue, or adopt a wide take on the topic, thereby lacking depth in answering and exploring the research questions. This thesis will serve to investigate the research questions stated in the section above, with aspects to several parts of supply chains and connecting themes, involving supply chains, value chains, sourcing, production management, risk & crisis management, energy supply, operations strategy, and trade agreements. All of these aspects and factors of global supply chains will be examined as thoroughly as possible, providing further theory, understanding and discussion revolving around the topic and research questions.

1.4 Purpose of Thesis

The purpose of the thesis is to outline the current state of global supply chains and global energy supply, discuss the major challenges and clarify the contributing factors and significant effects, as a result of the global pandemic and ongoing war. Background information will be provided, and an analysis of the situation will be carried out. The analysis will contain information on relevant strategies that could be used for current circumstances, and serve as a framework for how businesses can act and update their supply chains according to ongoing changes and new factors within the global economy.

The report intends to contribute with general knowledge and guidance as to how businesses, organizations and society should deal with significant events and changes. The Russia-Ukraine war and Covid-19 pandemic serve as relevant examples and illustrations as to what implications such events could have on supply chains, short term in the matter of disruption and long term as to how structures should be reconsidered when experiencing new types of problems.

1.5 Structure of Thesis

The thesis will be of qualitative nature, which indicates a report based on current material and literature on the subject. Apart from the introduction chapter, the report will contain an outline of the methodological approach, a thorough theoretical review on the topic, an empirical review, an analytical perspective, a presentation of relevant results, and further discussion and conclusion on the subject matter.

For the theory chapter, the aim is to present and outline the past and current state of supply chains on a global scale, as well as introducing some examples of how they have been affected by recent events . The empirical review will serve to provide collected and relevant data as to

present the information that comes from the research and illustrate how the pandemic and war has affected global supply chains. The methodological chapter will further outline how the research has been conducted, what approach is taken with regards to collecting material, what sources that will be used and why, what flaws the approach could mean for the thesis and why this approach was eventually chosen. The results will aim to provide the reader with the information, illustrations and explanations needed in order to answer the research questions as accurately as possible and provide solutions. Finally, the last chapter will provide conclusions and further discussion around the subject. Based on the analysis and results, the discussion part will include how to move forward, what this thesis has contributed with, what the thesis is lacking and how it could be improved as well as what future research around the topic could involve.

2. Methodology

This chapter will serve to outline the methodology used in order to conduct the research for the thesis. The areas within the chapter include a review of the research approaches, research objectives and research strategies used for the thesis as well as explanations as to why they were selected.

2.1 Research Approach

Identifying and selecting a suitable research approach is of significant importance and a factor to consider prior to writing a thesis. Depending on the topic as well as the purpose of the thesis, different approaches should be considered as they carry separate advantages and drawbacks. In "The Selection of a Research Approach", three main approaches of research are discussed, listed and outlined below. (The Selection of a Research Approach, n.d.)

- Qualitative approach - An approach more weighted at exploring and understanding. A research approach that often uses an inductive style of reasoning.

- Quantitative approach - An approach more weighted at testing objective theories. Variables are typically measured so that data could be analyzed using statistical methods. A quantitative approach often uses a deductive style of reasoning and testing theories.

- Mixed methods approach - An approach involving a mixture of a qualitative and quantitative research approach, with the assumption that a combination of them reaches a more complete understanding of a research problem.

(The Selection of a Research Approach, n.d.)

A qualitative research approach revolves around an inductive style of reasoning, which aims at developing a theory on the premise of specific observations. This method includes three phases: (Streefkerk, 2019)

1. Observation
2. Pattern recognition
3. Developing a theory

A quantitative research approach, on the other hand, often consists of a deductive research approach, which aims at testing an existing theory and includes four phases:

1. Use existing theory to establish a problem statement
2. Formulate a hypothesis based on the theory
3. Collection of data in order to test the hypothesis
4. Analysis and testing of data

(Streefkerk, 2019)

The journal article "Abductive reasoning in logistics research" elaborates on the contrast between the two approaches. A deductive approach could be explained as following a direction from general theory towards specific cases, whereas an inductive approach follows a direction from a collection of specific cases or observations towards a more general conclusion. (Kovács and Spens, 2005)

A combination of the two approaches is usually beneficial in order to provide a more complete perception of the overall issue. The mixed methods approach entails collecting both quantitative and qualitative data and integrating them. Abductive reasoning could be used for the purpose of handling the weaknesses of each approach. An inductive approach has the drawback of being limited in terms of too few or incorrect observations leading to a flawed theory building, while deductive reasoning lacks clarity in the aspect of selecting theory to be tested and formulating a hypothesis. (Kovács and Spens, 2005)

The purpose of this thesis is to analyze global supply chains on a macro level, and through a collection of observations, data and insights form a framework and conclusion regarding the current state and future prospects of various international supply chains. With regards to this premise, a qualitative research approach with an inductive style of reasoning is certainly more suitable for this thesis, since the thesis will review a large extent of material from various sources and develop general conclusions based on the information of the sources.

2.2 Research Objectives

As part of the methodology it is necessary to establish research objectives in order to characterize what type of research is pursued, what it is meant to achieve and why it is carried out. Research objectives clarify the scope and depth of the project, contribute to the research design and specify how the research will enrich existing knowledge within the subject(Ryan, 2022)

Four types of research purposes are generally classified, listed and outlined below.

- Exploratory
- Descriptive
- Explanatory
- Improving

(Runeson and Höst, 2008)

Exploratory research serves to determine what is happening, look for insights and bring new ideas for future research. Descriptive research aims to describe a situation or phenomenon. Explanatory research seeks to find an explanation of a certain condition or issue. Lastly, the purpose of improving research is to try to improve a certain part of issues within the subject matter.(Runeson and Höst, 2008)

Given the outlined four categories, the research purpose of this thesis is to be established. The purpose of this report certainly involves exploring how supply chains have been and are operating, including generating ideas for future research prospects. The thesis also aims to describe a situation or phenomenon, as well as trying to find an explanation for several issues and conditions. Moreover, the thesis serves to improve by providing an understanding of the issue, not through concrete solutions but from an overall perspective. Hence, the research purpose of this thesis is a combination of all four categories, but with a greater emphasis on exploratory and explanatory research.

2.3 Research Strategy

A research strategy sets the direction for which the research is to be conducted and clarifies the process for how the research is to be carried out. Establishing a research strategy is crucial for the further process of a thesis. The article “How to formulate a research strategy?” discusses different types of research strategies, each containing advantages as well as drawbacks and therefore a different level of suitability depending on various factors to be elaborated on. (Walia and Chetty, 2020)

- Qualitative research strategy - An observational strategy without the use of numerical data, providing insights into an issue. Examples of qualitative methods include interviews, observations and surveys. This strategy is typically used for the purpose of understanding the underlying reasons for a specific issue. (Walia and Chetty, 2020)

- Quantitative research strategy - A strategy involving collection of numerical data. Examples of quantitative methods include questionnaires, polls and surveys. This strategy

is typically used for measuring when, what, where and how often an event or situation occurs.(Walia and Chetty, 2020)

- Descriptive research strategy - A strategy involving observations and descriptions of patterns among individuals, communities or other groups. Examples of descriptive methods include surveys, observations and case studies. A descriptive strategy is often used for describing a certain situation.(Walia and Chetty, 2020)

- Analytical research strategy - A strategy studying and analyzing already existing information. An example of an analytical method would be to use a scientifically based problem-solving approach. An analytical strategy is mainly used to investigate the cause- and effect relationship between variables. (Walia and Chetty, 2020)

- Action-based research strategy - A strategy meant to find solutions to immediate problems. This strategy is mainly used by companies or governments with the aim to address and find solutions to a certain problem. (Walia and Chetty, 2020)

- Basic research strategy - No generalizations are made in order to understand the topic in a more effective way. The strategy involves investigation and analysis of a certain occurrence. The purpose of a basic research strategy involves increasing existing knowledge within a subject. (Walia and Chetty, 2020)

- Critical research strategy - A strategy which focuses on critically investigating previous research within the area. The purpose of this strategy is to analyze the claims concerning a certain topic or situation. An example of a critical research strategy would be a researcher focusing on a particular segment of a study and testing it empirically. (Walia and Chetty, 2020)

- Interpretive research strategy - Similar to a qualitative research strategy with the difference of interpreting a situation or phenomena instead of using hypothesis testing. The strategy involves using human experience to understand a certain issue. (Walia and Chetty, 2020)

- Exploratory research strategy - A strategy which aims to gain insights and provide solutions for a research problem. An exploratory strategy is often used when there is limited prior research on the subject matter. (Walia and Chetty, 2020)

- Predictive research strategy - A strategy which focuses on obtaining an understanding for the future of a certain research problem and bases its claims on probability. The strategy

is typically used within studies and issues that demand a prediction concerning future prospects and trends. (Walia and Chetty, 2020)

The article “Research strategy” discusses different ways to conduct research, not to be confused with types of research strategies, but rather methods to carry out research, suitable for different strategies. The various methods are outlined below. (Magusiak, 2019)

- Survey - A method used to collect information and data from a large number of people, where respondents could be chosen based on certain features. It is valuable for a researcher to use as a basis for deciding on a focus group. (Magusiak, 2019)

- Experiment - A method where theories or processes are tested using a general empirical method. A main method within an experiment is to select a specific variable to be changed and observe the impact it has on the remaining dependent variables. (Magusiak, 2019)

- Action research - A research method which seeks efficient solutions to problems occurring in certain situations and areas. This is used in order to increase efficiency of work and could be used by for example social organizations, agencies or companies. (Magusiak, 2019)

- Case Study - A method conducted in order to study a limited amount of entities within a larger structure. A case study is commonly used within large and complex organizations, providing an extensive amount of information and data, resulting in insights into a process. (Magusiak, 2019)

- Grounded theory - A type of qualitative research method used in order to develop a theory based on collection and analysis of data. (Magusiak, 2019)

- Ethnography - A method involving various field techniques such as interviews and observations from a perspective of the participant’s observation. (Magusiak, 2019)

- Cross-sectional studies - A method connected to observational studies. Cross-sectional studies measure the exposure and result of the participants taking part in the study. (Magusiak, 2019)

There are three important factors to consider when deciding on a research strategy. The first question that should be asked is if the strategy is suitable for the purpose of the research. The strategy has to follow a process that most efficiently strives to achieve the aim of the research. Moreover, the research strategy should be feasible with regards to resources available. The

strategy must be established in a way that allows for complete access to information and data resources. Lastly, ethical considerations have to be taken into account. The research should be conducted so that the process is handled responsively. (Walia and Chetty, 2020)

The aim of this thesis is to analyze global supply chains as a result of the Covid-19 pandemic and ongoing Russia-Ukraine war. The resources available are to a large extent reports and articles within the subject at matter. Considering the three factors of selecting a strategy as well as advantages and drawbacks of all research strategies and methods, the research strategy suitable for this thesis is a combination of qualitative, descriptive, exploratory and predictive. The methods that will be used for conducting research are a combination of action research, case studies and grounded theory.

3. Theoretical Background

This chapter will serve to provide the reader with necessary facts, background and theory to thoroughly understand the subjects of the thesis for the future reading of the report. Included areas within the chapter are the status of energy globally, the war in Ukraine and its impacts as well as global supply chain issues.

3.1 Energy

During recent years, rapid changes in terms of energy creation, distribution and storing are generating new opportunities in terms of energy supply, leading to a different relationship between industry and government. Another form of collaboration is motivated through societal and consumer pressure, as well as many companies in several fields setting targets of decarbonization at the center of their operations. Large economic stimulus packages are being used in order to move towards more resilient and sustainable economies and energy systems. The ongoing transition from current energy systems, largely based on fossil fuels, into renewable alternatives is on its way. (Coughlin, 2021)

However, despite significant investments, 80 % of energy used for generating electricity and refined products for transport, building and industry still flows from oil, coal and natural gas. Renewable and nuclear sources only account for a small percentage of the energy used for building and within the transport sector. Considering future prospects, 21 % of private companies and 61% of governments have set targets related to decarbonization and the International Energy Agency predicts that 47 % of the electricity market will be generated by renewable energy sources by 2040 as well as more than 90 % by 2050. (Coughlin, 2021)

3.1.1 Current status of energy sources and fuels

In order to understand today's global issues of energy supply, it is useful to firstly expand on the current status of various energy sources and fuels. The paragraphs below outline the most commonly used energy types and technologies and their status as of 2022, with information from the International Energy Agency.

Coal - Coal is the largest contributor of electricity generation as well as the largest source of CO2 emissions, which makes transitioning into low carbon-based energy systems a major challenge for many industries and governments. Coal-fired generation increased during 2021,

mainly caused by a rise in gas prices in Europe and USA as well as economic activity in China. Final investment decisions increased in 2020 but have been reduced by 80% during the last five years. According to Net Zero Emissions by 2050, coal power generation is set to decrease with around 11% per year up until 2030, while being completely outphased by 2040. Since the energy source is the single largest source of electricity generation and the single largest contributor to CO2 emissions, maintaining a secure and affordable energy system while at the same time reaching the target of net zero emissions poses some major problems for governments. A total of 21 countries have signed to remove coal-fired generation from electricity industries and sectors, which represents around 3.2 % of the world's total electricity production during 2020, as well as 1% of CO2 emissions. (IEA, 2021)

In the IEA's report "Coal 2021", there are a few key conclusions to reflect upon regarding recent years' development. First of all, international coal demand decreased by 4.4 % in 2020, the largest reduction in a few decades, yet not as heavily as initially expected. The main reasons for the decline were lower electricity and natural gas prices as well as less industrial activity as a result of the Covid-19 pandemic. However, a higher electricity demand than low-carbon supply and rising natural gas prices lead to coal power generation being set to increase by 9% in 2021. A 20 % increase of coal power generation in USA and Europe, and a corresponding increase of 12 % and 9% in India and China, respectively, as well as a spike in global industrial output, resulted in a forecasted overall coal demand increase by 6% in 2021. Additionally, China proceeds to have a major influence over the coal market, accounting for a third of the world's coal consumption, and the high coal demand in China is dependent on fast growing electricity demand as well as resilience of heavy industry. During the first half of 2021, coal production could not keep up with the rising demand, affecting stock levels and prices. Supply chain disruptions interfered with the main coal exporters, but in 2022, coal production was forecasted to spike. (IEA, 2021)

Electricity - As a global response to the issue of handling climate change, global electricity usage has increased rapidly within various industries, creating a spike in power demand and to generate electricity from renewable sources, to as large of an extent as possible. A combination of weather conditions and economic growth resulted in a 6% electricity demand increase in 2021, the largest growth since 2010. The overall energy demand recoil causes electricity prices to rise and even with a significant growth from renewable power, electricity production generated by oil and coal spiked. Even though higher energy prices and the pandemic cause uncertainty regarding forecasts, electricity demand is expected to increase by 2.7% annually during the following years. (IEA, 2021)

Every year between 2021 and 2026, the global electricity capacity is expected to increase by 305 GW, which suggests a 60% increase compared to the previous 5 year period. Despite this rise in renewable electricity, when comparing to the necessary quantity needed for the path of the Net

Zero by 2050 scenario, there is still a significant difference in the lack of renewable electricity capacity. Based on this scenario, the annual growth needs to be 80% quicker, which means that policy, ambition and implementation by governments needs to be higher. (IEA, 2021)

Natural gas - Natural gas contributes to around 25% of the world's electricity generation. Since the Russian invasion of Ukraine, an increased uncertainty and price volatility has occurred throughout European and Asian markets. Prices in Europe have reached unprecedented levels, a major factor being the decrease of Russian natural gas supply, also resulting in a shortage within other importing markets, such as Asia. (IEA, 2021)

Natural gas power generation decreased by 2% during 2020 but was predicted to increase 1% during 2021. According to the Net Zero Emissions by 2050 scenario, natural gas power generation will continue its rise in a short term perspective, compensating for the decline of coal-fired generation. However, in a longer term perspective, natural gas usage will have to start to decline by 2030, with a total decrease of 90% by 2040. (IEA, 2021)

One important factor to achieve the goal of the Net Zero Emissions scenario involves a large-scale reduction in flaring emissions. The global amount of natural gas flared in 2020 resulted in around 265 Mt CO2 and 8 Mt methane gas being emitted into the atmosphere, where five countries were responsible for half the volume of emissions. Part of the solutions to reduce flaring includes new gas monetisation strategies, business models and regulations. (IEA, 2021)

Nuclear energy - Nuclear power has for decades been one of the largest contributors to non-carbon produced electricity and has a considerable potential to have an impact on sector decarbonization. In the Net Zero Emissions scenario, nuclear power is expected to increase from 413 GW in 2022 to 812 GW in 2050. China is expected to become the leading nuclear power by 2030, and advanced economies are in total predicted to have a 10% increase, including mainly the United States, France, United Kingdom and Canada. The annual investment in nuclear energy will grow to around 100 million USD by 2030, compared to 30 million USD in the early 2010's. (IEA, 2021)

In order to be in line with the Net Zero Emissions by 2050 target, a doubling of the yearly nuclear capacity is needed. In 2020, global capacity was around 415 GW, including an added 6 GW, 5.4 GW permanently shut down, new projects launched, and renovations to secure long term operations. However, new nuclear infrastructure is not currently in line with meeting the Net Zero Emissions by 2050 scenario. At the moment, nuclear capacity is expected to be around 582 GW in 2040, compared to the requirement of 750 GW in the optimal case. Beyond 2040, the interval increases even more, bringing necessity to a nearly doubling of the current annual capacity addition rate. (IEA, 2021)

Moreover, nuclear power plays a vital role in the global energy transition. In the last 50 years, nuclear energy has contributed to avoiding around 55 Gt of CO2 emissions, which corresponds to approximately 2 years of total emission globally. In spite of this contribution of nuclear as well as renewable sources, CO2 emissions increased to a record amount in 2018, mainly as a consequence of higher electricity demand compared to low-carbon power supply. The increase in CO2 emissions as well as the fact that nuclear energy strongly contributes to avoiding such emissions highlights the importance nuclear power has on global energy transition. (IEA, 2021)

Oil - The international oil increased in 2021 following a decline as a result of the Covid-19 pandemic. Even though the demand is forecasted to rise in coming years, there is uncertainty regarding demand in a longer term perspective, mainly due to competition from alternative fuels and changing attitudes in society. As governments focus on clean energy results in concrete policy changes, the forecast for long term oil demand has lowered. In addition, the oil demand could peak earlier than previously expected. (IEA, 2021)

As of today, oil production accounts for approximately 40% of global methane emissions. Upstream oil and gas operations are responsible for more than 75% of total emissions with the downstream operations causing the remainder. The decline of oil and gas production in 2020 led to a 5% less methane emission rate. However, according to the Net Zero Emissions by 2050 scenario, methane emissions will have to decrease by 75% from 2020 until 2030. Contributing factors include various emission reduction technologies and methods. (IEA, 2021)

Renewable energy - Renewable fuels, including solar energy, wind energy, hydro and biofuels, play a vital part in the global transition into achieving more sustainable and less carbon-dependent energy systems. In 2019, 23.2 % of the global electricity production was generated from renewable energy sources. In 2020 even though global energy demand is expected to decline by 5%, renewable electricity is set to increase by 7%, as a result of long term contracts and continuous installation of new plants. On the other hand, less economic activity will lead to less bioenergy for industries as well as biofuels for transport, but in total, the renewable energy demand will increase by 1% in 2020. (IEA, 2021)

While there is a steady growth in usage of renewable sources, a rapid expansion is required in order to be on track with the Net Zero scenario. Strongly due to development within wind and solar technologies, the renewable electricity demand increased drastically in 2020, with renewable energy rising to almost 29% of annual electricity generation. It is however worth to note that a main factor causing this rise was the overall decrease of global demand as a result of the pandemic. In a longer term perspective, there has to be a significant increase in renewable power in order to meet the net zero target of 60 % by 2030. (IEA, 2021)

3.2 The war in Ukraine: Global impacts

3.2.1 Disruptions Related to the War

McKinsey's article "War in Ukraine: Twelve disruptions changing the world" outlines several consequences of the ongoing war, and how it will affect global supply chains and operations in various perspectives. One of the disruptions aims at a switch in energy policy towards secure access as well as source diversification. Europe has for many decades been dependent on Russian energy sources, the most significant ones being crude oil, fuel oil, coal and natural gas. In 2021, Europe imported 36 % of its natural gas from Russia, as well as 30 % of its coal and 10 % of its crude oil. Countries that stand out as distinctly reliant on Russia's energy supply include Germany and Italy, with Germany importing 65 % of its natural gas from Russia and Italy importing 43 %. (McKinsey, 2022f)

The short term impacts of changing energy supply policies could be severe if not handled effectively. Europe could seek to lower their total demand, for instance, reducing heating, lightning and gas usage within power generation. In addition, Europe needs to work towards diversifying their sourcing, increasing gas supplies from other countries and regions. Part of the solution could involve importing more liquified natural gas and producing more biofuel. (McKinsey, 2022f)

An effective procedure of demand restrictions together with increasing and diversifying supply has the potential of lowering Europe's dependency on Russian gas from 36% to approximately 10%. However, such a reduction would still indicate annually imported gas at around 30-40 million cubic meters. The intended outcome will strongly depend on the extent of the implementation of the various measures taken, mainly the extent of LNG imports from other countries and tolerance of households, employees and industries towards reduced energy usage. (McKinsey, 2022f)

Moreover, the article discusses another aspect of the war; food security in terms of the global food production system being disrupted. Ukraine and Russia combined produce approximately a third of the world's ammonia and potassium exports, 30 % of wheat and barley, 65 % of sunflower seed oil and 15 % of corn. Following the invasion, prices for food commodities and fertilizers grew by 20-50 %. Figure 1 illustrates various regions and their wheat dependency on Russia and Ukraine. (McKinsey, 2022f)

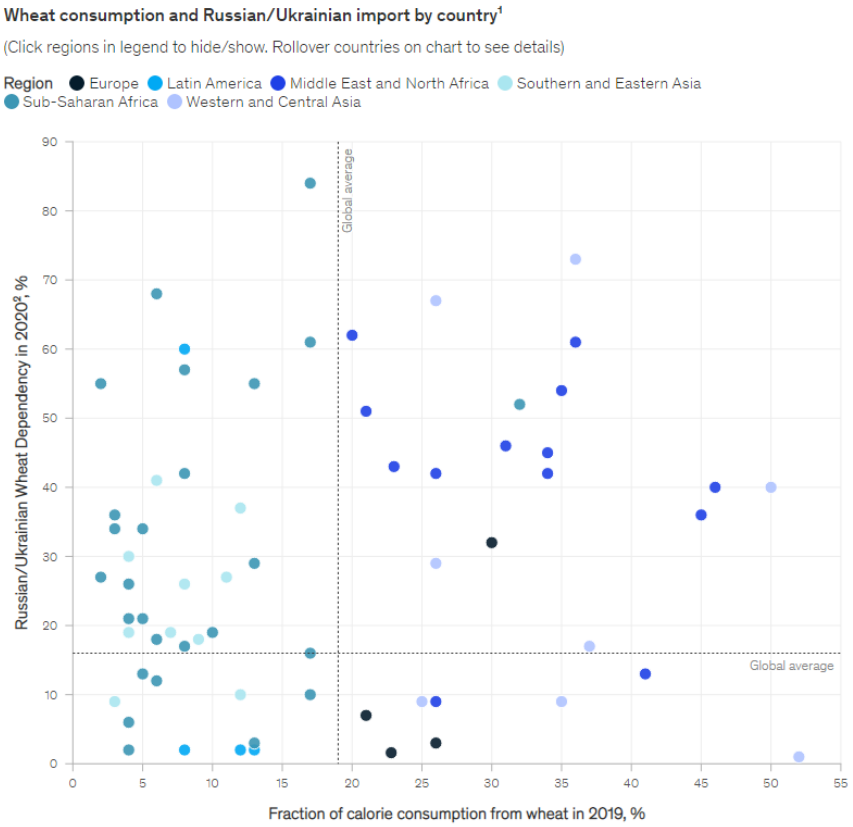

Figure 1: Wheat consumption and import by country (McKinsey, 2022f)

As indicated by figure 1, several countries are dependent on imported wheat produced in Ukraine and Russia, mainly within the regions of Central Asia, Western Asia, Middle East and North Africa. Specifically, countries that during recent years have had issues regarding refugee crises and food security will be affected by the decreasing export through higher prices and shortages, but all importing countries will face the impact to some extent. Additionally, Russia and Ukraine account for approximately 20 % of the UN's World Food programme's total food commodities. According to estimates of the UN, Ukraine's harvest in the autumn of 2022 is likely to be reduced by 30-40 %, and lack of fertilizers will also contribute to harming total production. Measures to be taken by governments in order to solve the problems of food security involve various programs for direct supply to affected areas, methods to increase regional production, control of prices and subsidies to consumers. (McKinsey, 2022f)

Furthermore, various types of industrial materials and commodities were in high demand prior to the invasion. As a result of the war, prices of commodities exported from Russia and Ukraine have strongly increased. The two countries together account for 10-50 % of shares of the markets within the sector, exemplified by the two countries being responsible for 48% of global trade of palladium. Further examples of such materials and commodities include coal, steel and nickel. Considering the significance of these materials to several industries, shortages of commodities

and increasing prices, consequences could involve spot price increases of 15-25 %, affecting manufacturers and customers throughout different sectors and industries. (McKinsey, 2022f)

For a certain number of the materials, prices have stabilized. However, the changes could be short term as well as long term, depending on the product and industry. For instance, iron ore seemed to experience a short term disruption, but for other materials, the war has led to a long term supply vacuum with constantly increasing prices. Concerning metals used within the automaking industry, a new global balance is thought to be established and eventually stabilized, although at a higher price range than previously. (McKinsey, 2022f)

3.2.2 Energy Crisis Connected to the War

During the first quarter of 2022, the European energy market went through a shocking increase of gas-prices. The short term prices were during this time period five times higher than average levels of 2021. As a result of several factors, including changing attitudes and behavior from customers and investors, carbon pricing, a surge in global demand after Covid-19 and the conflict in Ukraine, Europe is experiencing rare price pressures. The overall trend is affecting many industries, in particular energy-intensive sectors, where the increases in energy prices could lead to production prices 50 % higher than previously, as illustrated in figure 2. The prices are predicted to continue at a high level, staying at more than double the rate of 2021 for the coming few years. Increasing gas prices and thereby production costs are causing challenges for companies operating in these sectors, forcing a need to take action in terms of maintaining their businesses' competitiveness as of today as well as coming years. (McKinsey, 2022b)

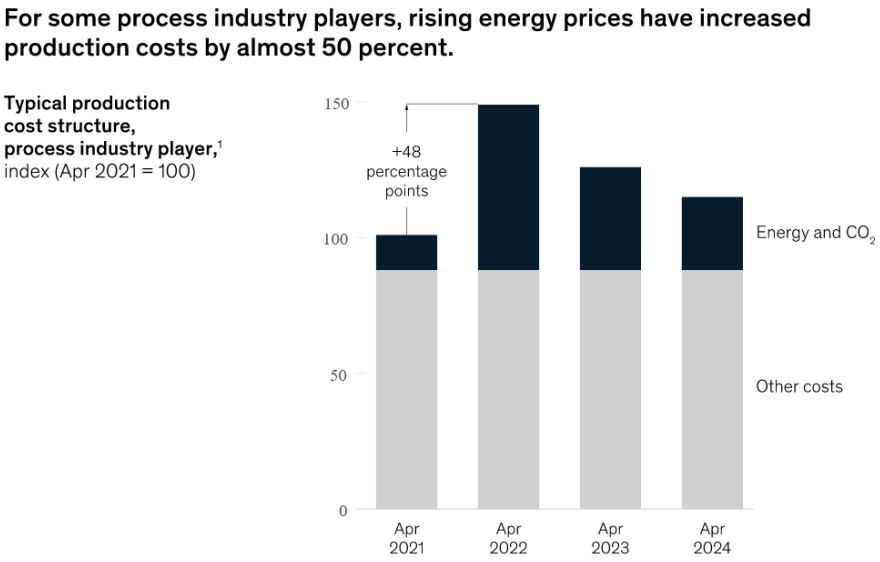

Figure 2: Production cost structure illustrating rising energy costs (McKinsey, 2022b)

In McKinsey's "Outsprinting the energy crisis", two major solution options in terms of dealing with the energy crisis are explored. Companies either need to approach energy procurement differently, or focus on a more rapid change regarding energy efficiency and decarbonization. McKinsey's modeling indicates that quick action within these two areas could improve margins by 10 % as well as decreasing carbon emissions by 40 %. Companies operating in energy-intensive sectors already have decarbonization strategies put in place, usually involving reducing energy consumption by approximately 50 % over the coming 10 years. By implementing these new methods and structural changes more rapidly during upcoming years, companies will be able to adapt to predicted price increases and additionally, gain a competitive advantage which will serve to increase future profit. The scenario of accelerating already established decarbonization strategies in order to adapt to increasing energy prices is illustrated in figure 3. (McKinsey, 2022b)

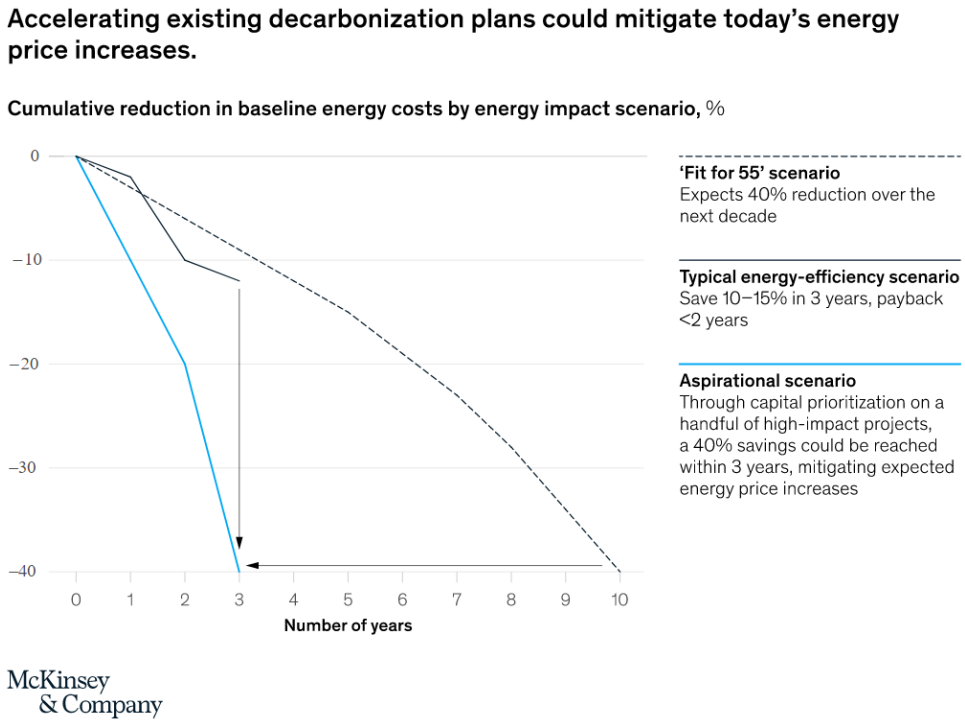

Figure 3: Acceleration of existing decarbonization plans (McKinsey, 2022b)

New methods and strategies needed for recent changes also have the potential to be part of future succeeding factors. One of the advantages of today is that projects invested in will take less time to pay back, transforming businesses in terms of energy efficiency. Projects to be invested in for future profit include high-efficiency cooling systems, pressure recovery technologies, optimized configuration and control, and replacement of hydraulic or pneumatic equipment, to name a few. McKinsey estimates that through various action taking methods within energy supply and demand, efficiency could improve by up to 40 % in three years. Areas where improvement could be made include heat demand, heat supply, electricity demand and electricity supply. (McKinsey, 2022b)

An example of a specific technology where updates could lead to significant improvements is heat recovery systems, converting heat waste into hot water or steam with a higher temperature. In some instances of practice, it has recently been shown that technologies can reduce process steam requirements by a significant amount, as designing the optimal configuration of these types of systems has been facilitated. This process exemplifies a way of drastically reducing cost of capital and saving operational costs. In order to further exploit the advantages of new technology developments, companies need to improve schedules, delivery capabilities, reallocate resources and to prioritize engineering and procurement capacity for the projects with the highest estimated impact. (McKinsey, 2022b)

3.2.2 Energy markets

McKinsey's "Global Energy Perspective 2022" serves to outline energy demand amongst 55 sectors, over 70 energy products and 146 countries. Five key insights are established and will be discussed below:

1. Energy markets are facing volatility as a cause of geopolitical tension as well as a rebound in energy demand. With markets already having been affected by Covid-19, the conflict in Ukraine has reinforced the effects, specifically regarding energy prices. During 2021, energy demand as well as emissions faced a 5 % increase, almost equivalent to levels before Covid-19 hit. Governments around the world, including 64 countries responsible for almost 90 % of CO2 emissions, as well as private sector companies have increased their work in order to meet the aspirations of the overall net-zero target. (McKinsey & Company, 2022)

2. The energy mix is expected to switch towards power, with electricity and enabling hydro fuel and synfuels predicted to make up 50 % of the mix by the year 2050. In the same time period, electricity demand is expected to reach levels three times higher than today given the fact that various sectors increase their resources within electricity, hydrogen and hydrogen-based fuels. By 2050, renewable energy is predicted to account for 80-90 % of total global energy mix, partly due to a significant growth within solar and wind. Additionally, hydrogen demand is expected to increase towards 350-600 mtpa, compared to today's 80 mtpa. Lastly, in the year 2050, the global demand for sustainable fuels is anticipated to reach 8-22 % out of liquid fuels. (McKinsey & Company, 2022)

3. The prediction for the global demand peak of fossil fuels is being pushed forward. As of today, the peak for global oil demand is projected to occur between 2024 and 2027. Moreover, coal demand had its peak in 2013 and it is expected to continue its decline after a short term increase in 2021. The Ukraine-Russian conflict has led to price rises. As of 2035, gas demand is expected to have increased by 10-20 % while the years after that are facing more uncertainty with regards to development within hydrogen fuels. In order to decarbonize industries where fossil fuels are frequently occurring, 2-4 Gt CO2 has to be captured by CCUS technologies by the year 2050. (McKinsey & Company, 2022)

4. Global warming is expected to reach 1.7 degrees celsius by 2100, given that all countries with aspirations of net-zero emissions deliver on targets. Significant shifts have to take place across all sectors involving energy production and usage and large investments are needed in order to introduce and establish new technologies within industries and supply chains. The 1.5 degrees C target will be difficult to meet given current policies,

commitments and trends. In order for the aim to be achieved, an accelerated transformation has to occur, switching from fossil fuels faster than current commitments in relation to emission targets. (McKinsey & Company, 2022)

5. Investments within the sectors of energy production are expected to continue to increase by 4 % annually, shifting towards decarbonization and non-fossil energy. Annual investments are predicted to have doubled by 2035 with 1.5-1.6 trillion, mainly due to increasing resources put on decarbonization and power generation. At the same time, profit is expected to grow by 5% yearly. However, models within decarbonized systems will continue to be uncertain. Strategies in order for efficiency within the new systems involve changes within market design, subsidies and other supporting methods. (McKinsey & Company, 2022)

The report continues to discuss the conflict in Ukraine and what consequences it might have on the energy transition and decarbonization, in a short term as well as long term perspective. The conflict involves a range of uncertainties, relating to duration and scale of disruption, and government and consumer response to the conflict. In terms of duration and scale of the conflict, uncertainties include total duration of the conflict, to what extent the conflict might expand, if the number of refugees will increase and how long energy markets will be disrupted for. In terms of government and consumer response, uncertainties include how governments will respond to inflation, what prospects governments will invest into, if there will be a major change in consumer behavior as a result of the conflict and to what extent governments will invest in energy infrastructure. (McKinsey & Company, 2022)

Furthermore, energy markets are affected as well as affecting GDP. With regards to this relationship, uncertainties depend on the extent of disruption in GDP, how inflation develops and how other sectors are affected by increasing focus on energy. Concerning demand, important developments relate to how increasing prices will affect energy demand and how policies will drive a shift in fuels. Considering supply, there are uncertainties regarding how much natural gas could be substituted by other alternatives. Lastly, in terms of infrastructure, questions relate to how Europe could allow for quicker build-out for renewable energy and what infrastructure bottlenecks there are concerning in order to further change the total energy mix. (McKinsey & Company, 2022)

Further insights from McKinsey's report involve power and hydrogen increasing within the global energy mix. Figure 4 illustrates final energy consumption by fuel, showing a growing share of hydrogen and electricity.

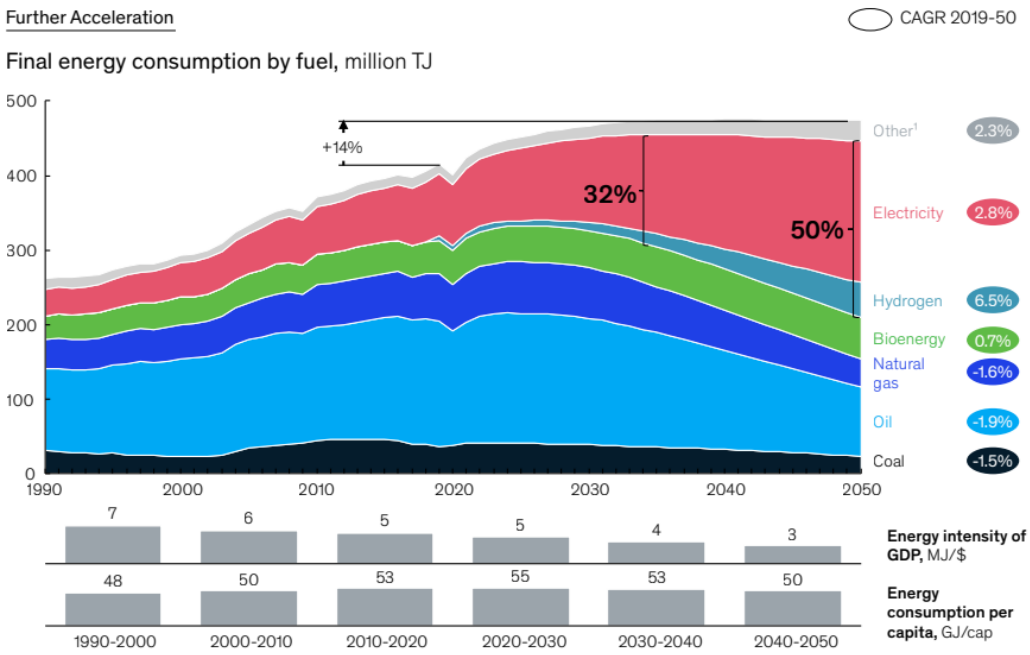

Figure 4: Final energy consumption by fuel(McKinsey & Company, 2022)

As can be observed in the graph, global energy consumption is predicted to have increased by 14 % by the year 2050. An important factor that causes flattening energy consumption growth is reduced energy intensity within GDP, which in turn is a result of more efficient end-use within building, transport and industry. As many sectors switch towards electricity, efficiency is improved. The electricity share within global energy consumption is predicted to grow from around 20 % today to approximately 40 % by 2050 and in combination with an increased use of hydrogen, this plays a role in the expected 40 % decrease within fossil-fuels. (McKinsey & Company, 2022)

The report continues to review the supply and demand within electricity power generation, including four key insights, outlined below:

1. The consumption of power is projected to be three times higher in 2050 compared to today's numbers. Electricity is often observed to be first in reaching targets of emission reduction as it is usually the cheapest and easiest to implement. The sector that is predicted to increase its share of electricity usage the most is transportation. Within building, a higher demand for space cooling and appliances is expected, doubling the electrification within the sector from 30 % today to 60 % in 2050. In a longer term perspective, green hydrogen generation is predicted to have the largest impact of power demand. (McKinsey & Company, 2022)

2. By 2030, renewable energy is expected to make up 50 % of power and by 2050, the share of renewables will increase to 85 %. Solar as well as wind power is already often less costly than fossil fuels, being even more competitive in terms of cost in a future perspective. Moreover, thermal generation share within the power mix is expected to decrease from 40 % in 2019 to 28 % in 2050. Factors to be considered within decarbonization involve policies, political landscape, economical factors and resources. These factors strongly differ between different countries and regions. (McKinsey & Company, 2022)

3. Flexible assets will play a main part in decarbonization and grid stability. Examples of such assets are gas plants, batteries and hydrogen electrolyzers. In order to establish system security, traditional as well as flexible capacity will be needed, with flexible additions expected to be 25 % of total additions between the years of 2030 and 2035, mainly due to EV's, batteries and hydrogen. Green hydrogen is expected to contribute with 28 % of the power demand by 2050, while reducing specific emissions by 15 % as a result of better integration of renewable sources. Additionally, green hydrogen has the benefit of being used as storage for power production and new technologies have the potential to be a main factor given that they are cost-efficient. (McKinsey & Company, 2022)

4. Use of CCUS and nuclear technologies are projected to increase. The build-out of intermittent renewables is likely to cause challenges in terms of use of land area, transmission capacity and acceptance. Given the potential problems that might occur, CCUS, nuclear and longer duration energy storage will arise as crucial in order to reach certain emission targets. Within land-constrained regions, nuclear technology becomes an important resource. Meanwhile, CCUS is expected to account for 8-17 % of fossil generation by the year 2050. (McKinsey & Company, 2022)

3.3 Global Supply Chain Issues

3.3.1 Global and Regional Supply Chains

The article "Global Supply Chains" outlines some of the key differences between global supply chains and more locally or regionally based networks. A supply chain network can be global, spanning across multiple countries and areas, as well as more regionally based. There are advantages and disadvantages connected to both structures. A global supply chain exploits the lower costs connected with sourcing from other parts of the world, including lower costs of labor and production. On the other hand, local supply chains utilize suppliers within the region. (CIPS, 2022)

The benefits related to global supply chains are often linked to decreasing the total costs of the production. Reduced costs of labor in other countries and lower operating costs for the manufacturer of certain products are factors contributing to reduced total costs. In addition, new opportunities arise in terms of supplier development. Global supply chains' use of foreign partners serve to encourage innovation and sharing expertise. On the contrary, there are disadvantages to employing a global supply chain and several factors to consider before outsourcing segments of the chain. A few of the drawbacks concerning global supply chains are listed below. (CIPS, 2022)

- Longer lead times - The lead time can oftentimes be much longer, even though the production time is rather fast. The longer lead time is largely a case due to the need for shipping, and could cause challenges in planning.

- Risk of reputation - The risk connected to labor conditions as well as financial risks could increase with a more global structure of the supply chain.

- Fluctuations - Regional factors that could have an impact on trading markets are more likely to affect global supply chains.

- Communication issues - Issues such as terminology and methods of communication need to be considered for international suppliers, in order to ensure that the information is received correctly.

- Increased risk - For a global supply chain with operations in a range of countries and regions, there is naturally increased risk for a crisis in certain areas, impacting the supply chain activities.

- Less control - As a consequence of a larger distance inbetween operations, managing communications and technical aspects could be more challenging.

3.3.2 Global Trends Impacting Supply Chains

In relation to recent major global events, there are a few trends within global supply chains, affected by the state of the world. The pandemic has affected all parts of supply chains, spanning from sourcing of raw materials all the way to the end consumer of products. As well as testing the operational, financial and organizational resilience of various companies, Covid-19 has also exposed key risks and gaps in several organizations.

KPMG outlines six of the largest global trends that impact supply chains extensively, further explored below. (KPMG, 2021)

1. Logistics disruptions - As a consequence of the Covid-19 pandemic, the flow of goods into key market areas, including North America, Europe, South East Asia and India, continues to be restricted as major global ports and airports in China, South Korea and USA experience shutdowns. Following the logistics disruptions, the ripple effect causes goods to be left in storage, transporting ships to slow down, which in turn limits the flow of trade and ultimately causing challenges for companies to import products for their inventory. Even considering a case where disruptions reduce and the flow returns to the state before the pandemic, it will likely take time to completely return to a normal state. In the meantime, higher prices and longer waiting times are to be expected.

2. Production delays - Manufacturers within production are competing for commodities and capacity which has led to longer purchase lead times and less availability of products for consumers. However, the pandemic has caused actors to focus more on evaluation and innovation, investing in long term supply chain strategies. While past focus has mainly been on extensive inventory and low costs, manufacturers are now considering risk as a larger factor within supply chain development. Many industries are evaluating long term supply issues and re-engineering product specifications in order to strengthen resilience in a cost-effective manner.

3. Over reliance on a limited number of third parties - Many companies have strong partnerships with one major supplier, one major customer and one major supply chain partner and are identifying the need for an alternative trading partner. Moreover, supply leaders are increasing their focus on strengthening cyber security, through third parties. Increasing agility as well as resilience can be done through collaborating with providers of new technologies. Examples of such technologies include new trading systems, planning and analytics capabilities. The results of such investments could lead to more risk resilient, flexible and cost effective future supply chains.

4. Doubling down on the technology investments - Continuing the trend from the past year, businesses keep investing in automating key processes within the supply chain for storages, warehouses, manufacturing facilities and offices. Businesses will seek to adopt digital enablers such as cognitive planning in order to improve planning capabilities. In addition, by implementing track and trace and blockchain technologies, businesses will increase integration, visibility and security into their systems. By increasing visibility through the whole extended chain of various processes and participants, companies will

strengthen their resilience towards disruptions and variability on a local, regional and global level.

5. Commodity pricing - A detailed break up of a category price, including material component, wastage, conversion, labor and premium added is often not sufficiently defined. Additionally, category prices are often not indexed in relation to commodity prices, and few businesses have a scientific method for indexing prices. This has led to commodity purchases often being based on experience rather than calculation. In order to meet this challenge, companies are working on digital transformation and technology, aiming for more accurate and faster decision making. Spend analytics tools and software programs are being used in order to improve visibility of their spending.

6. Workforce and labor - Implementation of new technologies have changed the way that supply chains operate globally, improving and evolving at a faster pace as a cause of consumer's increasing demand. As operations focus more on technology and innovation, supply chains become even more complex, requiring personnel with the right skillset. Supply chains and manufacturing need both physical and technological skills to secure further growth. Moreover, the pandemic has led to uncertainties and labor market shortages within various industries.

3.3.3 Future Supply Chain Priorities and Challenges

In the article "Future of Supply Chains 2025", BSR has identified top procurement priorities for 2025 as well as key forces of change. Based on the current knowledge and research carried out, recommendations for how companies should proceed to act on the key forces of change and achieve their procurement priorities are outlined. (BSR, 2019)

Based on BSR's engagement with procurement leaders and external insights, five procurement priorities have been established which will serve to impact supply chains through 2025. (BSR, 2019)

1. Realizing cost savings and optimizing working capital - Progress within real-time data availability leads to faster and more efficient decision-making, which in turn allows for more cost savings and effective handling of capital. An example of this would be the combination of real-time demand data and historic trends to predict shortages within stock and thereby direct necessary replenishment. Moreover, advanced technology will enable quicker transactions as well as invoice approval status by using real-time insights.

2. Rationalizing the supply chain base - Many procurement leaders state that decreasing the amount of suppliers as well as third parties in their chains is of a high priority. The aim is to increase efficiency and reduce risk and uncertainties. In order to achieve more collaboration in terms of development and innovation, a more streamlined supply chain is necessary. By reducing the amount of suppliers, improvements within traceability, partnership and innovation can be achieved.

3. Improving risk prediction and management - As a consequence of increasing stakeholder expectations and legal requirements, more advanced tools, data from more sources and a deeper monitoring of risks will be needed. As a cause of recent rapid development in terms of technologies for risk prediction, businesses will need to integrate these into existing systems and optimize their potential.

4. Providing strategic foresight to the business at the highest level - Leaders within businesses will need to increase their understanding of market dynamics, support agility through foresight and enable differentiation. For 2025, collaboration will need to be strengthened in order to further understand strategic foresight, forces of change and interpreting signals into business intelligence.

5. Innovating and collaborating with suppliers - Businesses will need to increase their collaboration with suppliers in terms of innovation and improvements within products and processes, such as improving demand planning and inventory management together with suppliers. In addition, working with suppliers could enable achieving various sustainability targets.

Following up on the established priorities, key forces of changes are identified and outlined. These forces of change have the highest probability of impacting supply chains in the years moving forward, and are briefly explained below. (BSR, 2019)

1. Widespread adoption of technology, including automation, across the value chain - Rapid technological development intensifies the digitalization of general supply chain management. Various products and services are being provided in a different manner than previously. By implementing and adapting to new technology, businesses are able to reshape their supply chains. Examples of such technologies include machine learning, blockchain and augmented reality. Additionally, implementation of such technologies increases visibility and transparency of supply chains as they are utilized by several actors for performance measurement. Particularly industries well suited for automation will benefit, improving factors such as costs of sourcing. As some procurement leaders will adopt new technologies in a more concrete way than others, the result will likely be a

changing landscape for global supply chains, as well as new challenges for many companies.

2. Global climate change and resource scarcity - Supply chains are especially impacted by global climate change as they often depend on raw materials and are situated in countries with a high probability of being affected by changing climate. Identified climate impacts on supply chains involve changes in quality and availability of raw materials, commodity price volatility and disruption of supply, to name a few. By 2030, losses in productivity due to heat-related workplace disruption are estimated to reach approximately 2 trillion USD. Many suppliers will not be able to evaluate or manage the impacts sufficiently.

3. Human migration on a mass scale - More than 240 million people are living in countries they were not born in due to large-scale migration across the globe in recent decades . As human migration affects labor dynamics, it also brings new opportunities as well as challenges.

4. Shifting consumer demands and changing market demographics - Related to previous topic of development in technology, additional opportunities involve a changing landscape with regards to personalized marketing, leading to a growing so-called "on-demand economy", with US consumers spending approximately 60 billion USD in on-demand products and services. Moreover, businesses are working to improve their delivery times and customs for specific goods in a complex climate. With these factors in mind, we are likely to see more companies engaging in site sourcing, finished goods manufacturing and a shift from national flows to more regionally and locally based networks.

5. Mixed signals on trade and transparency - With rising uncertainty around various global trade agreements, business models that served as a base for current global supply chains may be at risk. Several companies already experience the impacts, including reshoring, vertical integration and sourcing from other locations. An example of this trend is China's shift from a manufacturing actor to a service economy, a potentially weakened Dodd-Frank act and USA's withdrawal from the Paris agreement.

Building on the top priorities and key forces of change within global supply chain management, BSR have established five key recommendations for how supply chains should adapt to and maximize advantages in a changing environment. The five recommendations are listed and outlined below. (BSR, 2019)

1. Plan for the supply chain impacts of automation and migration - The two factors of mass migration as well as increasing automation, leading to volatility within the dynamics of

labor and workforce, forces companies to take responsibility. Actions that could be taken include businesses redirecting resources within affected regions, engaging with various industrial actors within those regions, making sure that suppliers in increasingly automated industries undertakes clear workforce transition plans, and supporting methods for empowerment of individual workers.

2. Build responsible regional sourcing hubs - Regarding previously mentioned growing on-demand economy and the changes in new markets it comes with, as well as changes in demographics, supply management will require a thorough understanding of the new consumption patterns. In order to meet sustainability targets as well as customer preferences, working with regional network hubs will need to be adopted. Managed correctly, procurement leaders will have the opportunity to incorporate social and environmental responsibility into their organizations.

3. Digitalize supplier assessment and engagement - As a result of more data provided than previously, collection and interpretation methods could be changed. Within industries that are being impacted by increased automation, new challenges will arise in terms of wages, working hours and work safety, including downsizing as well as development of new skills for supply chain workers.

4. Strengthen supply chain transparency and disclosure - By gaining visibility as well as disclosure within various supply chain practices, supply chain leaders will be able to prepare for a range of scenarios that might occur in a time of uncertainty regarding global trade and regulations. Gaining transparency will be useful in both the cases of political shifts towards economic nationalism as well as continuing free trade internationally. If regulations increase, improving disclosure will be useful.

5. Embed climate-smart supply chain planning - In order to prepare for potential risks related to climate change, supply chains will have to take the risks into account while developing models of planning. Furthermore, searching for new materials and resources and new ways of reducing disruptions will be necessary. For instance, collaborating with partners that share the visions of sustainable development will be useful as well as making sure there are incentives and technical tools to support. Sustainable supply planning will be needed in every industry in order to prepare for more climate-smart supply chains.

3.4 Risk Management within Supply Chains

The article “Supply Chain Risk Management Post COVID-19: How to Respond” outlines risk management within supply chains as to how to respond properly after the Covid pandemic. The pandemic outbreak has been referred to as a so called “Black Swan event”, defined as an “unpredictable event that is beyond what is normally expected of a situation and has potentially severe consequences” (Bloch, 2021). During such events, a thorough understanding of potential risks that could affect an organization's supply chain activities is crucial for further operations. In the article, measures to be taken are discussed in order to mitigate and navigate the risks following Black Swan events. (PublicisSapient, n.d.)

Director of strategy and transformation at Publicis Sapient, Nitin Dsouza, states that organizations must sort out planning strategies, considering the best and worst case of the event in question. In the case of the Covid pandemic, an optimistic scenario involves the pandemic being completely eradicated by 2027 while a more pessimistic scenario would leave it largely uncontrolled by the same time frame. In the short term , organizations need to work with existing suppliers, including identifying key suppliers within different regions to prevent shortages for products with longer cycles and lead times. Additionally, it is crucial for business models to allow buffers with additional inventory. For businesses with exposure in China, with longer time in between demand signals and delivery, it is of even greater importance. Moreover, while achieving resilience and flexibility within an organization balanced with cost factors has gained attention, it is reinforced by the demand for more personalized and custom made products as well as faster deliveries. (PublicisSapient, n.d.)

Further measures to consider include linking data sets across the supplier network. In order to improve visibility throughout the supply chain, gathering data from third-party actors is to be considered. With regards to demand volatility, risk management strategies need to be established. For instance, products such as surgical masks and first-aid kits spiked in demand in February of 2020, and as supplies were limited, prices increased. Measures such as halting promotions, prioritizing products and keeping inventory reserves could be taken into account. In relation to inflation, predicting decreasing demand becomes significant. As a result of increasing cost of material and fuels, profit decreases, and in order to maintain long term customer satisfaction, prices cannot be increased too heavily for an extensive period of time. To reduce profit loss, companies could consider logistical changes within operations as well as updating products marketed. (PublicisSapient, n.d.)

Additional measures to be considered in terms of risk and crisis management within supply chains involve using AI demand planning tools, improving safety and health conditions and implementing new technology for an unprecedented future. (PublicisSapient, n.d.)

4. Empirical Research

This chapter will serve to provide more recent and updated facts, information and trends, as opposed to the more general theoretical chapter. The areas included in this chapter are reports from companies, recent global economic data and trends and more current information on the war, the pandemic and energy as well as their respective impacts.

4.1 Annual and quarterly reports

How supply chain instability affects business is explored in "Supply chain instability worries businesses". Out of the member companies in *Swedish Enterprise(Svenskt Näringsliv)*, 77 % reported issues related to importing goods. Furthermore, 62 % reported problems in terms of price increases and 60 % stated issues with delivery delays. (Svenskt Näringsliv, 2022)

How large businesses are affected by and are handling impacts related to the pandemic and war can be underlined when reviewing their quarterly reports during the fall of 2022. In Volvo's Q3 report, they mention decreasing deliveries, mostly as a result of reduced demand in China as a consequence of less economic activity due to pandemic restrictions. Moreover, they mention that deliveries within Europe have increased compared to last year's levels, excluding Russia. (Volvo Group, 2022)

In Scania's Interim Report for January-September 2022, they mention the issues of uncertainty caused by the macroeconomics and geopolitical situation in the world. For instance, the order intake for trucks, buses and coaches reduced by 23 % during Q3 of 2022. Additionally, they mention a few material risks related to the ongoing war in Ukraine. Some of the risks discussed are decreased market demand and thereby decreased sales, less frequent delivery of components which in turn could affect the production system globally, as well as customers experiencing financial issues, affecting their purchases from Scania. (Scania Group, 2022)

Atlas Copco mentions various risks related to their industry. Economic recessions, geopolitical tensions, pandemics, changes in trade agreements and sanctions are a few of the mentioned factors that could affect the results of the business. In terms of production risks, the report mentions a risk of disrupted supply or capacity constraints for various suppliers, potentially impacting the overall production scheme. (Pressmeddelande från Atlas Copco AB, 2022)

4.1 Recent Economic Data and Trends

The Global Economics Intelligence by McKinsey executive summary examines recent economic trends globally as well as on a regional basis as of October 2022. (McKinsey, 2022a)

During the third quarter of 2022, both the US economy and China surpassed growth expectations, with a 1.8 % and 3.9 % increase in GDP, on a year over year basis, a significant increase in comparison to the previous quarter. Regarding China, new Covid restrictions were a large contributing factor to a slower growth rate in the second quarter while the growth in the USA was stimulated by consumption and export. In the meantime, central banks and forecasting institutions are predicting a slower growth, largely due to inflation and a decrease in economic activity. A slowing economy could also be indicated by the global purchasing manager's index(PMI). PMI is a measurement on the general direction of the economic trends within manufacturing and service sectors(Investopedia, 2019). The PMI for manufacturing dropped to 49.8 in September, for service it remained at 50. Sea freight rates continue to stand at quite a high level with approximately twice the pre pandemic rate in Western ports and three times as high in China and India. (McKinsey, 2022a)

Moreover, the latest months' unemployment rate has remained quite low, with 3.5 % in the United States and 6.6 % in the Eurozone. Consumer inflation reached 10.7 % in October in comparison to 9.9 % for the month of September, while remaining at approximately 8.2 % in The US in September in comparison to 8.3% in August. The development of the inflation rate for consumer prices as well as producer prices can be observed in figure 5 and 6. (McKinsey, 2022a)

Figure 5: Consumer-price index for the United States and the Eurozone(McKinsey, 2022a)

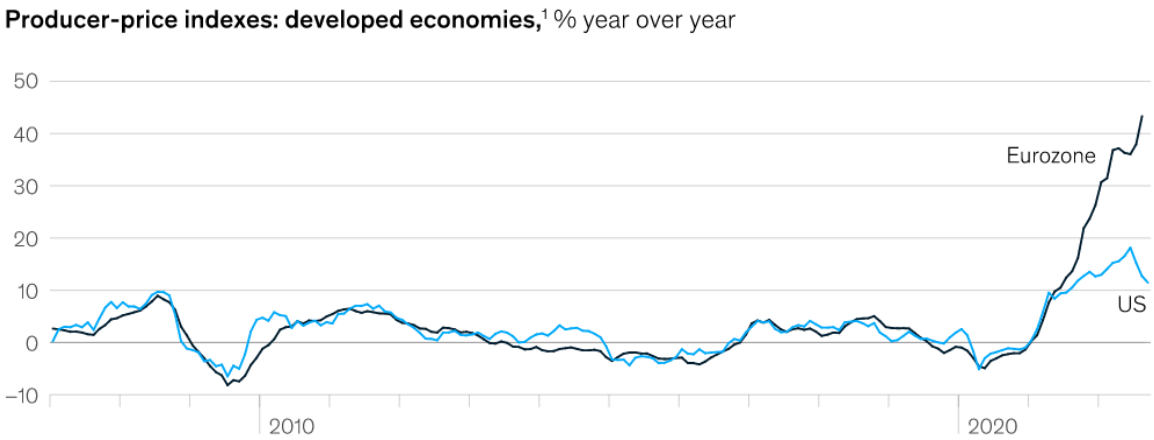

Figure 6: Producer-price index for the United States and the Eurozone(McKinsey, 2022a)

Regarding commodities, a majority of them decreased in price during October, including the price of gold and the FAO Food Price Index. Energy prices have declined from the previous extraordinary high levels, but remain very high. Fluctuations over recent years' prices of energy can be observed in figure 7-10. When observing the figures, it is clear that the prices of oil, heating-oil, natural gas and coal have increased during recent years. (McKinsey, 2022a)

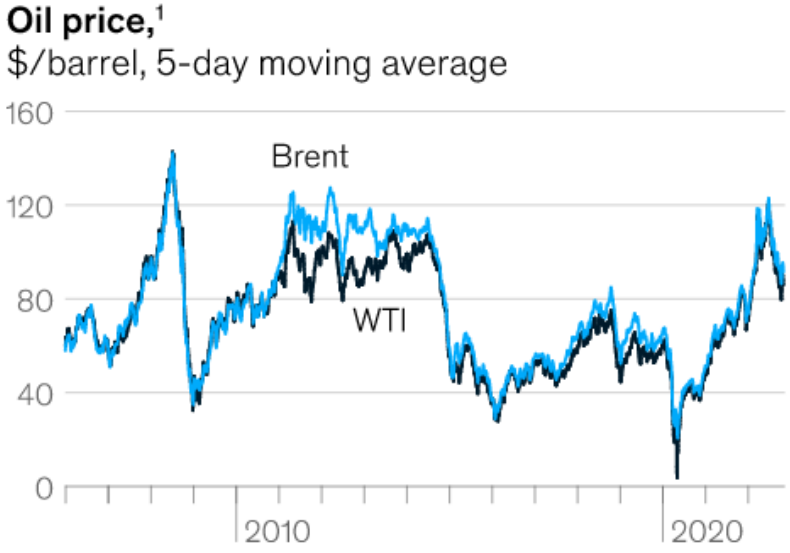

Figure 7: Price of oil during last decade(McKinsey, 2022a)

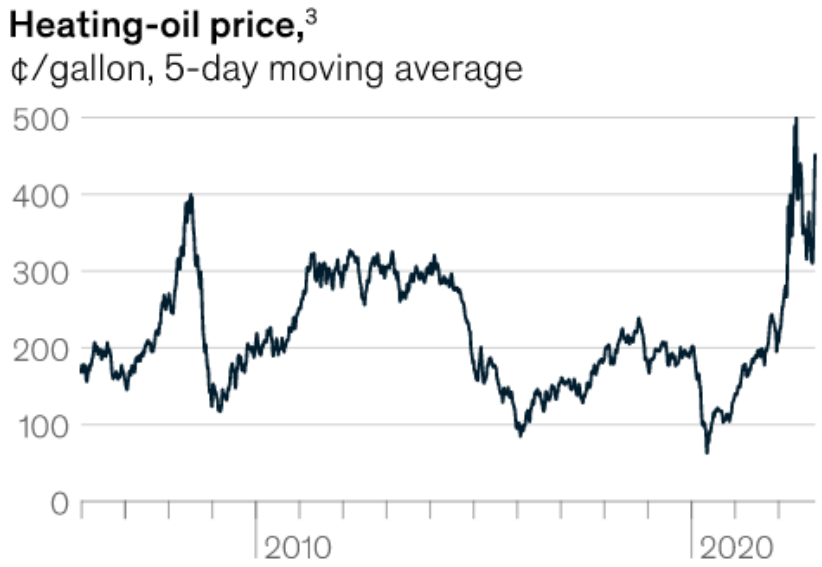

Figure 8: Price of heating-oil during last decade(McKinsey, 2022a)

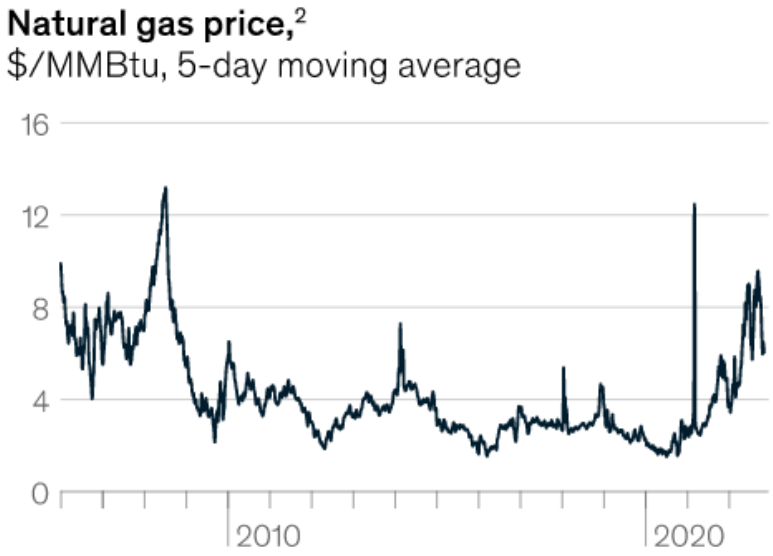

Figure 9: Price of natural gas during last decade (McKinsey, 2022a)

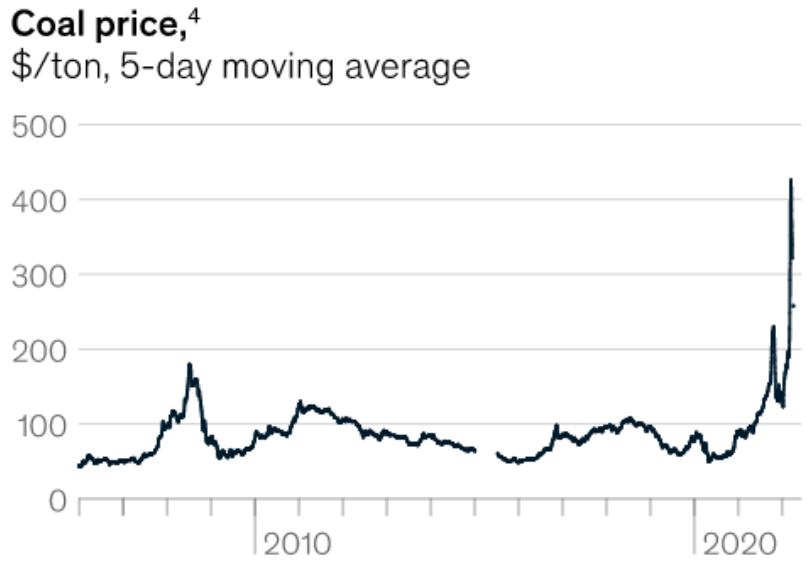

Figure 10: Price of coal during last decade (McKinsey, 2022a)

Based on the Global Economic Intelligence release of October 2022, economical data and indicators are updated for quarter 3 of 2022. Some of the significant points are outlined below, divided into regions and large countries to fully grasp recent economic trends globally. (McKinsey, 2022a)

4.1.1 United States

Growth increased to 1.8 % year over year in the third quarter from -1.6 % in the second quarter and -0.6 % in the first quarter. A main reason for the growth was increased exports. According to estimates by the US Federal Reserve, GDP growth is expected to be 0.2 % in 2022, 1 % in 2023 and 1.7 % in 2024. Due to high inflation, the Fed has responded with four consecutive raises of interest rates, with the latest resulting in a 3.75-4.0 % federal funds rate. The increasing interest rates are affecting the housing market, with an average 30-year mortgage rate of above 7 %. The unemployment rate decreased to 3.5 % in September of 2022, in comparison to 3.7 % in August. Sales within retail were at approximately 684 billion dollars in September 2022, which corresponds to an increase of 8.2 % in comparison to September 2021. The export in August decreased compared to July but remained at a high level while import had a stronger decrease, largely due to less import of crude oil. (McKinsey, 2022a)

4.1.2 Eurozone

Growth was at 2.1 % year over year in the third quarter and is predicted to decrease in the fourth quarter. Global petroleum prices are decreasing, as well as Europe's natural gas prices, following the high points of August 2022. However, both crude and natural gas prices continue to be many times higher than two years ago. Consumer inflation was at 10.7 % in October 2022, an increase from 9.9 % in September. Core inflation reached a historic high level of 5 %. According to the ECB, eurozone annual GDP growth is projected at 3.1 % in 2022, 0.9 % in 2023 and 1.9 % in 2024. The main challenges are caused by Russia's invasion and implications of the pandemic. ECB raised the policy interest rate in October, resulting in 2 % for the main refinancing rate, 2.25 % for the marginal lending facility and 1.5 % for the deposit facility. The eurozone industrial production index was at 1.5 % month over month and 2.5 % year over year in August 2022. At the same time period, the unemployment rate was at 6.6 %. Largely due to high energy prices, imports have risen in the past months. Exports remain quite high but all in all, the trade deficit was at a record high in August 2022. (McKinsey, 2022a)

4.1.3 China

GDP growth was at 3.9 % year over year in the third quarter of 2022, in comparison to 0.4 % in the second quarter. Both agriculture, industry as well as service sectors expanded. Investment growth within fixed-asset, manufacturing and infrastructure increased by 5.6 %, 9.7 % and 11.2 %, respectively, while real estate investment fell by 14.9 %. Sales revenue as well as floor space sold decreased by 21.3 % and 23.8 %, respectively, while the average price of housing increased by 3.3 %. Inflation was at 2.8 % in September, a slight increase from 2.5 % in August, largely due to the increase in food prices. Food inflation was at 8.8 % and producer-price inflation fell to 0.9 %. International trade grew by 5.8 % year over in quarter 3, including an export growth by 10.0 % and imports increasing by 0.6 %. (McKinsey, 2022a)

4.1.4 India

PMI has indicated growth for a consecutive three months period, including 55.1 in September and 56.2 in August. With prices increasing in nearly every sector, inflation grew to 7.4 % in September, including an increase in food prices, while producer-price inflation has declined for the past four months. In the month of August, industrial production declined slightly, partially due to reduced production of pharmaceuticals as well additional medicinal products. Additionally, both the manufacturing and mining sector contracted. In September, the value of Indian exports increased moderately in comparison to August, from 33.9 billion dollars to 35.5

billion dollars, while imports decreased moderately, from 61.9 billion dollars to 61.2 billion dollars. The Indian unemployment rate was at 6.4 % in September, a slight decrease from 8.3 % in August, the lowest rate since August of 2018. (McKinsey, 2022a)

4.1.5 Brazil

Consumer inflation declined to 7.2 % in September 2022, the lowest recorded since April 2021 and cost of transport and food have decreased. In addition, producer-price inflation also showed a decline, from 17.9 % in July to 12.2 % in August. The unemployment rate decreased to 8.9 % in September 2022, the lowest recorded since 2015. Industrial production index decreased in August while the PMI for manufacturing declined from 51.9 in August to 51.1 in September and the PMI for services also decreased. In September, the value of Brazil's exports and imports remained high, including 29 billion dollars for exports and 25 billion dollars for imports. (McKinsey, 2022a)

There are various factors and issues involved when assessing the current global economic situation and its future prospects. The energy crisis is the most urgent one since the 1970's, and the price spikes have mainly caused a higher inflation and less economical growth. It is predicted that international growth will decrease down to 2.2 % in 2023, the continents experiencing a slower growth being Europe, North and South America while Asia on the other hand is expected to have an increasing growth during both 2023 and 2024. (OECD, 2022)

In order to restrain inflation, central banks in many countries are raising interest rates with some results, for instance in Brazil and to some degree the United States. This could in turn cause other potential risks, including more expensive debt payment for households, companies and governments. In terms of the rise in prices, governments have taken action in the form of price caps, subsidies relating to prices and income as well as tax reductions, but the initiatives required in order to lower prices will be difficult to afford. (OECD, 2022)

4.2 Economic Recovery in the Aftermath of Covid-19

In a recent survey, most participants in a range of regions stated inflation as the main risk factor for economic growth. For Europe, energy prices along with inflation are the two main concerns followed by geopolitical factors. The Covid pandemic remains the highest stated risk factor in

China. The survey of the respondents' cited risks to economic growth is illustrated in figure 11. (McKinsey, 2022d)

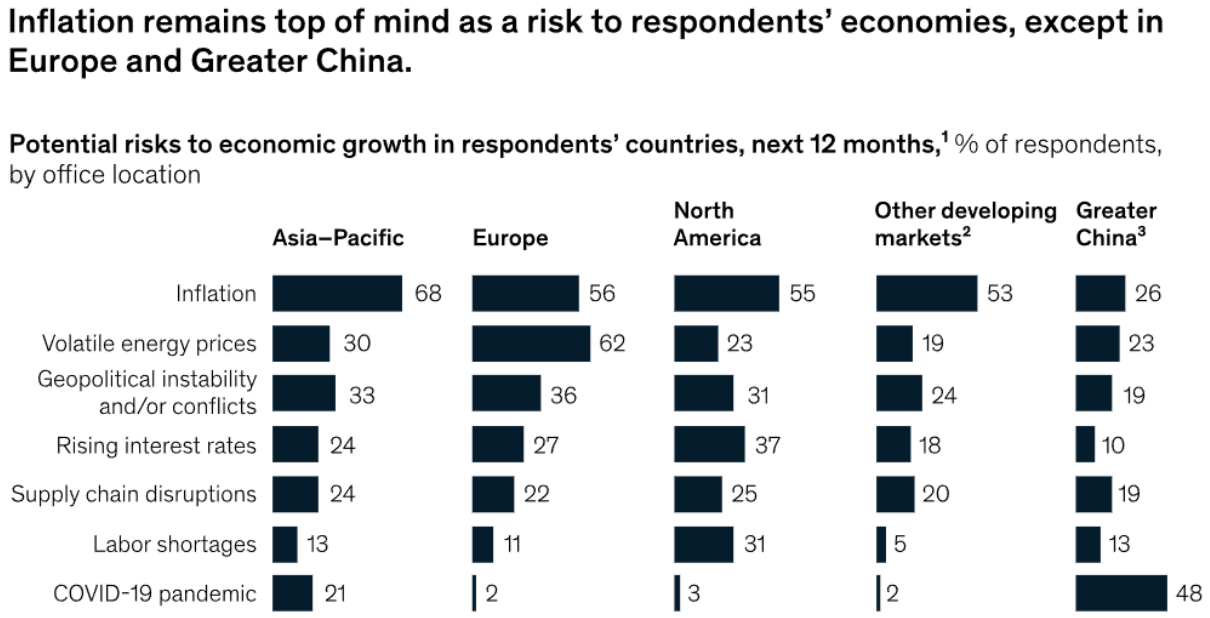

Figure 11: Survey on main risks to economic growth(McKinsey, 2022d)

The survey follows the trend of both geopolitical issues and conflicts as well as inflation being one of the most cited risks to economies all over the world. Additionally, over half of the respondents predict the conditions to weaken during the course of the next six months to come. (McKinsey, 2022d)

Eurostat covers how the economy is recovering from the Covid crisis. The index used to measure industry, construction and services levels decreased significantly during the months of March and April 2020. As shown by data from June 2022, the indices have recovered or even exceeded the levels before the crisis. In terms of industry, the index decreased by 26.8 % in April 2020, from a previous 105.5, but as of June 2022, it has increased by 1.9 % compared to numbers just before the pandemic. The corresponding numbers for construction showed a 25 % decrease in April 2020, with an almost full recovery by March 2021. As of April 2022, the index had increased by 1.9 % compared to the level right before the pandemic. The development of the index for production, services, construction and trade volume is illustrated in figure 12. (ec.europa.eu, 2022)

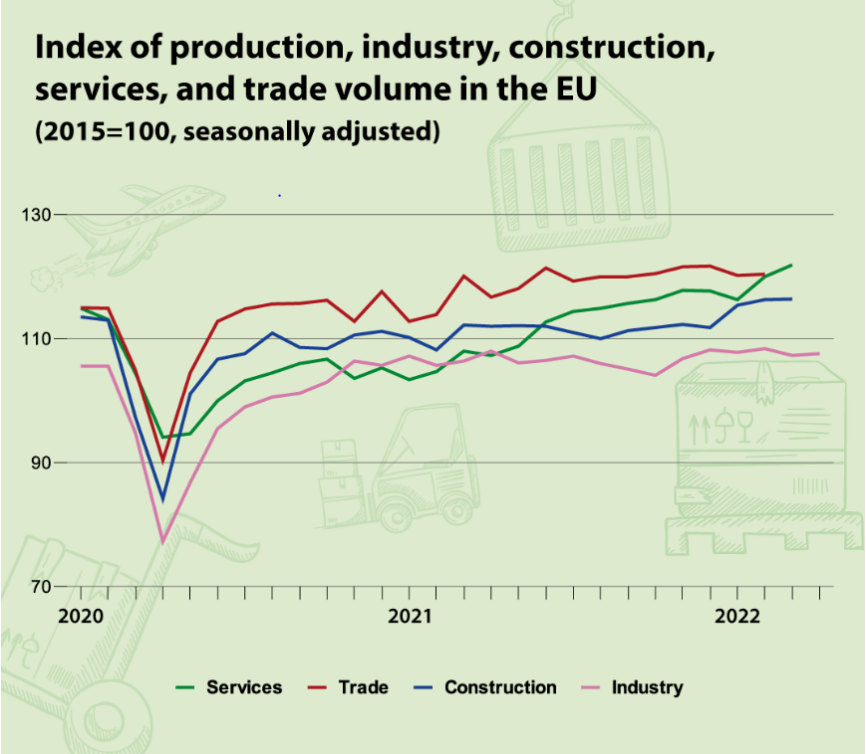

Figure 12: Index development of production, industry, construction, services and trade volume(ec.europa.eu, 2022)

Furthermore, Reuters outlines consequences on China's economy as a result of recent Covid developments. In October 2022, the factory production in China increased at a slower rate than accounted for and retail sales went down for the first time in almost half a year. This has caused a general slowdown within the economy. There are several issues facing the Chinese economy including extended Covid restrictions, risks of recession and housing prices, with investment in property decreasing at its fastest rate since the beginning of 2020. China's consumption over the past years is depicted in figure 13. (Zhang and Yao, 2022)

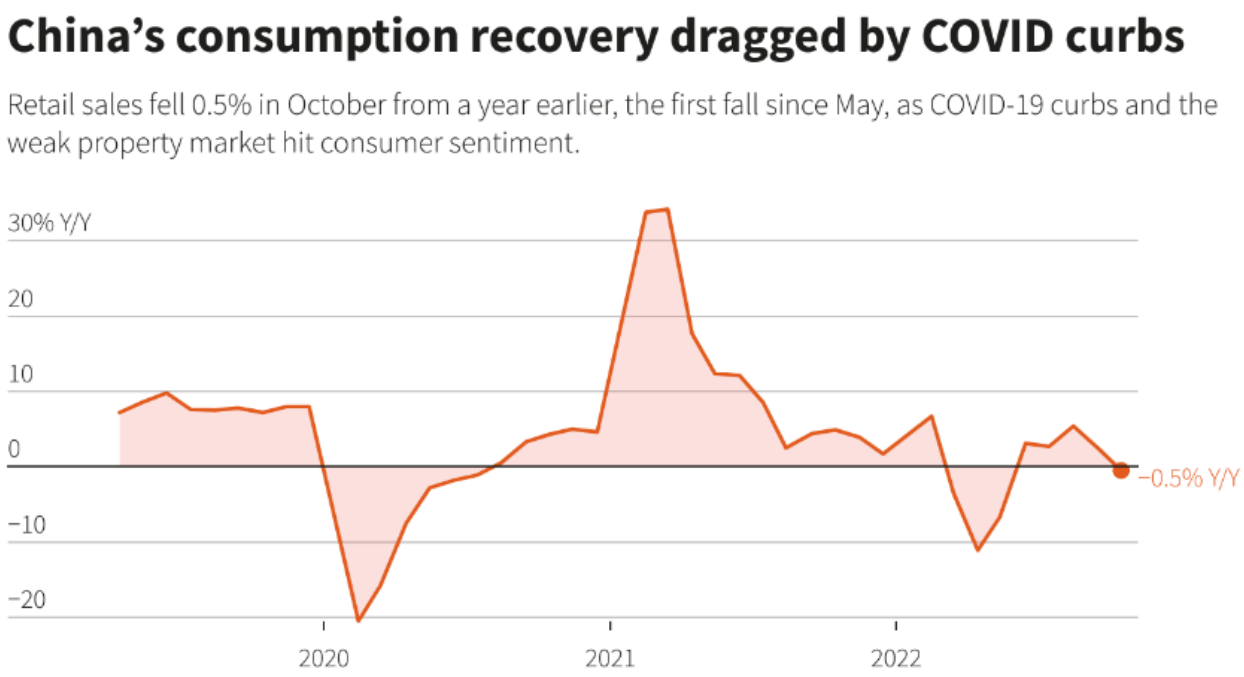

Figure 13: China's consumption trend during recent years(Zhang and Yao, 2022)

4.3 Russia-Ukraine War: Impacts on Economic Recovery

4.3.1 Effects of the Russia-Ukraine war: Economic recovery

The World Bank's economic update outlines the situation in the Ukraine and its economical impacts, stating that the war has slowed down the post-pandemic economic recovery, specifically for developing economies within Europe and Central Asia. A growth of 0.3 % is predicted for 2023, largely due to continued energy price spikes. The production within the region is predicted to decrease by 0.2 % in 2022, exceeding the forecasts. The economy of Ukraine is forecasted to decrease by 35 % in 2022 following damages to productive capacity, agricultural land as well as a significant reduction in labor since approximately 14 million people have been displaced. Recovery and reconstruction within industrial and productive sectors are expected to amount to around 349 million dollars. (The World Bank, 2022)

As a result of disruptions in trade and food as well as fuel price spikes, the war continues to affect the global economy. Developing economies within Europe and Central Asia have worsened during the fall of 2022 as supply chain disruptions and financial strains continue. Energy prices and cutbacks in Russian supply remain the highest contributing factor to an economic slowdown. (The World Bank, 2022)

The countries most affected by the energy price trends are the ones with a higher dependency on importing natural gas for heating, industry and electricity. Countries with a closer relationship with the EU market will also feel the impact. The mitigation strategy for these countries must involve preparation for scarcity and emergency plans, which includes saving and improving energy efficiency. (The World Bank, 2022)

4.3.2 Effects of the War: Global Activity and Risks

As indicated by the Federal Reserve, the Russian invasion of Ukraine will have noticeable effects on macroeconomic levels, contributing to a 1.5 % decrease in GDP as well as an inflation increase of 1.3 %. Parameters on firm levels also suggest that the European economies will be impacted the most, certainly in industries that produce various goods. (Caldara et al., 2022)

In order to measure geopolitical risks, an index could be utilized. The index is built upon searches for newspaper articles mentioning various negative events and the risks related to them, and marks mentions of different types of tensions between states and other actors on the geopolitical scale, for example wars and terrorist attacks. An illustration of the index variation since 1970 is depicted in figure 14. (Caldara et al., 2022)

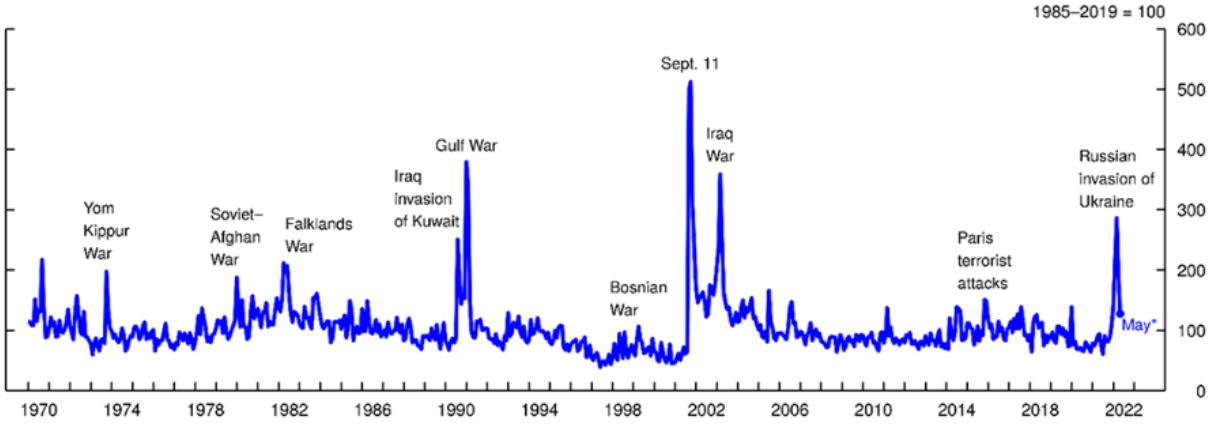

Figure 14: GPR Index since 1970(Caldara et al., 2022)

As could be observed in the graph, the beginning of the ongoing war caused the highest spike of the index since the start of the war in Iraq. The GPR index is obtained from two other indexes, geopolitical threats(GPT) and geopolitical acts(GPA). GPT involves the scope, time period and consequences of certain conflicts and tensions while GPA covers the major risk-related events. This year's variation of the GPR, GPT and GPA indexes is depicted in figure 15. (Caldara et al., 2022)

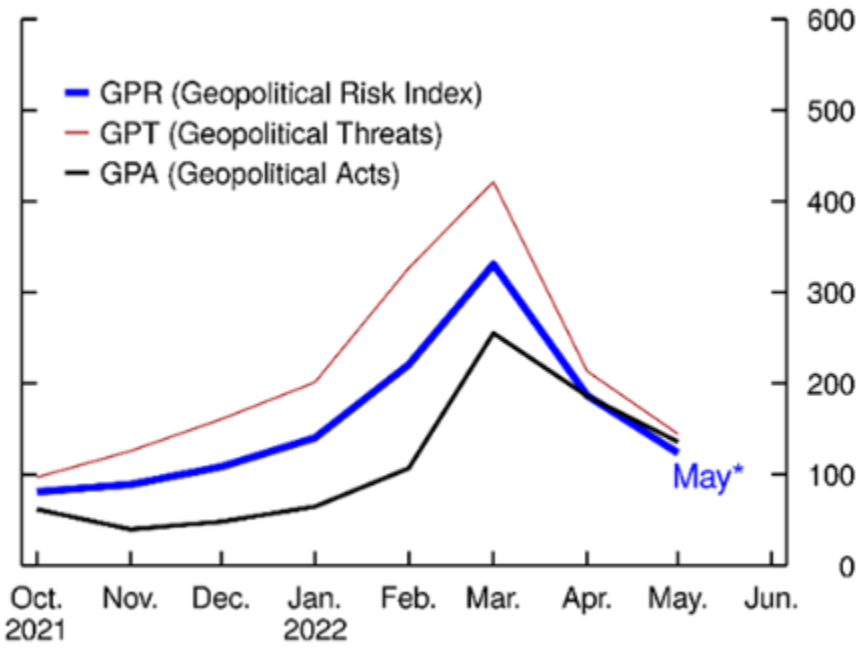

Figure 15: Various geopolitical risk indices(Caldara et al., 2022)

In a press release from CEPR, some of the most significant economical impacts of the ongoing war are pointed out. For Ukraine, their private consumption had been reduced by 25-30 % as of September 2022 and the government has put in place an inflation tax, besides various loans, grants and central bank financing. (CEPR, 2022)

In terms of impact on world trade and supply chains, global harm on the economy connected with trade disruptions is covered. The disruptions with Russia has its effects on prices, and certainly in terms of energy, which in turn impacts costs of transportation and a span of supply chain in different industries. In a long term perspective, there is significant risk that disruptions continue as a result of the war. Building up resilience and avoiding trade restrictions when possible are policies suggested as necessary methods. (CEPR, 2022)

Furthermore, the significant impact on developing countries is discussed. Food and energy shortages are part of the problems resulting from the conflict, as well as welfare losses and decrease in real income. The issues are particularly urgent for low-income countries relying on imports of food and energy. (CEPR, 2022)

4.4 Recent Energy Issues

4.4.1 Energy crisis

As has been stated previously, Russia's invasion of Ukraine has affected the global energy world in various aspects. Businesses as well as households will suffer due to volatile prices, as it changes the course of selecting fuels and reversing progress in terms of global access to energy. In relation to general policy, securing supply as well as protecting consumers has been a primary target in order to take on short term issues. In addition, several governments are taking long term actions towards policies regarding clean energy. In terms of energy trade, sanctions as well as cut backs on gas supply from the Russian side have their consequences in reshaping global trade flows, particularly concerning fossil fuels. An illustration of the reduced natural gas flow from Russia to the European Union can be observed in figure 16. Moreover, reduced real incomes together with increased fossil fuel prices create a risk of global recession. (IEA, 2022)

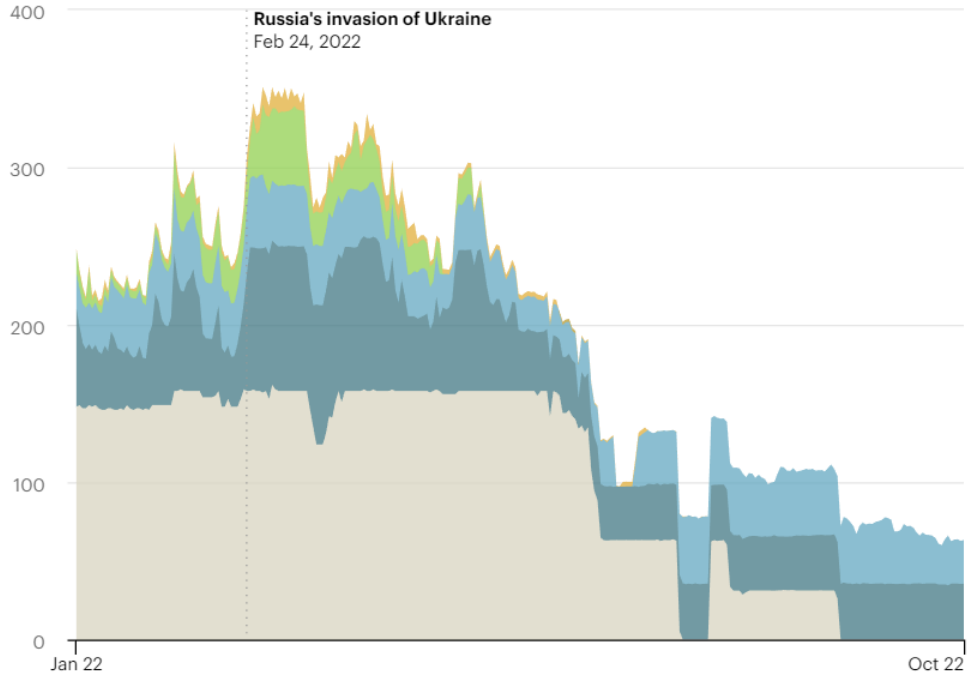

Figure 16: Flow of natural gas Russia-EU 2022(IEA, 2022)

The energy crisis and concerns regarding security may cause new investments in existing and additional fossil fuel infrastructure, thus slowing down development in terms of a transition to more renewable energy sources. On the contrary, increasing prices and emissions provides opportunities for exploring new options in order to reduce dependency on fossil fuels. In conjunction with the COP26 meeting in Glasgow, governments stated various commitments in relation to sustainability targets. The US inflation reduction act and the REPowerEU Plan are some of the additional measures that have been taken in terms of securing supply and quicken transitions. The world energy outlook 2022 by IEA outlines three scenarios regarding the future of energy and implications of new technologies, stated policies and trends within investments. (IEA, 2022)

1. Stated Policies Scenario - What governments are doing in order to achieve their stated objectives and how it affects the energy sector
2. Announced Pledges Scenario - How the energy sector is affected given that all announced targets and commitments are fulfilled.
3. Net Zero Emissions by 2050 Scenario - How to achieve a global average temperature stabilization and UN Sustainable Development goals.

(IEA, 2022)

5. Analysis

This chapter will serve to use the theoretical background and empirical research in order to analyze the situations for energy supply, global supply chains and risk management. The analysis is mainly based on recent external studies on the topic. The areas included in this chapter are implications on global supply chains, various risks and how to manage them as well as the energy crisis.

5.1 Implications of Supply Chain Disruptions

In order to understand the current problems occurring within global supply chains, previous vulnerabilities need to be understood, as well as what the potential risks were and why they are specifically exposed today. Before the pandemic, focus has largely been on cost efficiency, delivering goods fast and cheap to customers. In order to optimize the cost, companies have therefore been relying on outsourcing various parts of the chain. This reduces storage overheads and ensures that products arrive on time. Spare stock is also reduced in order to decrease costs for storage. These methods, while being effective as cost cutting and time saving mechanisms, cause supply chains to become complex and rigid, and sensitive to minor disturbances in different parts of the network. The complexity of the supply chains could thereby cause an accumulation of effects during disruptions and take time to solve. A clear example of this was the incident with the Suez Canal during March 2021. The blockage of the canal lasted for 6 days, delaying 369 ships and a value loss of 9,6 billion dollars each day, with global effects lasting several months afterwards. (FTI Consulting, 2022)

In figure 17, the Global Supply Chain Pressure Index is plotted. As could be observed in the figure, the index reached record numbers during 2021. The index is based on shipping costs, airfreight costs, delivery times, backlog costs and number of purchased stocks, to mention a few. (FTI Consulting, 2022)

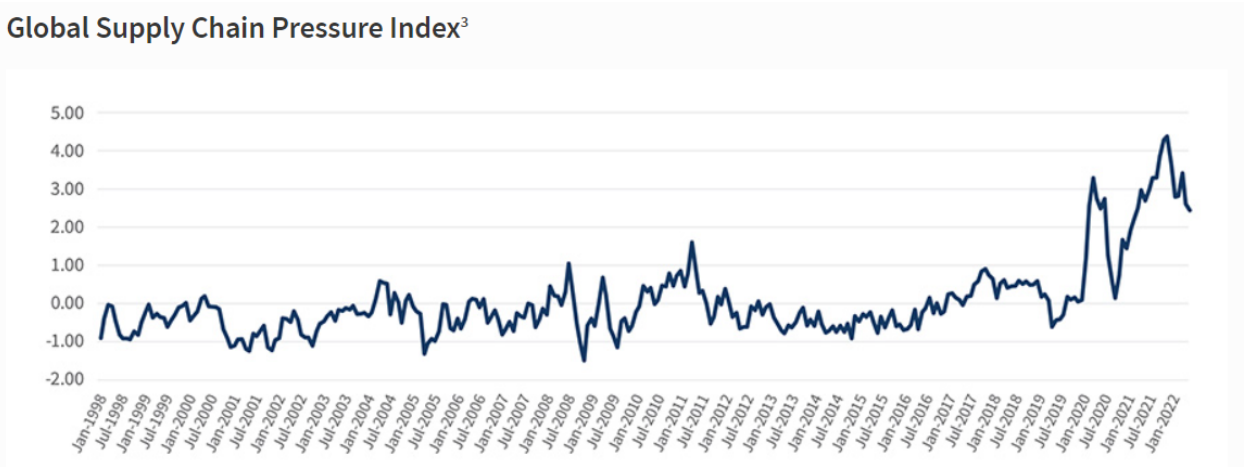

Figure 17: GSCP index over time(FTI Consulting, 2022)

Moreover, freight rates increased significantly during 2021. The problems arising from higher shipping costs affect the whole chain, eventually causing higher consumer prices. Additionally, port congestion has affected supply chains, including ships waiting to unload their goods, delayed trucks to move containers and delayed ships. The cost of shipping over past years is illustrated in figure 18. (FTI Consulting, 2022)

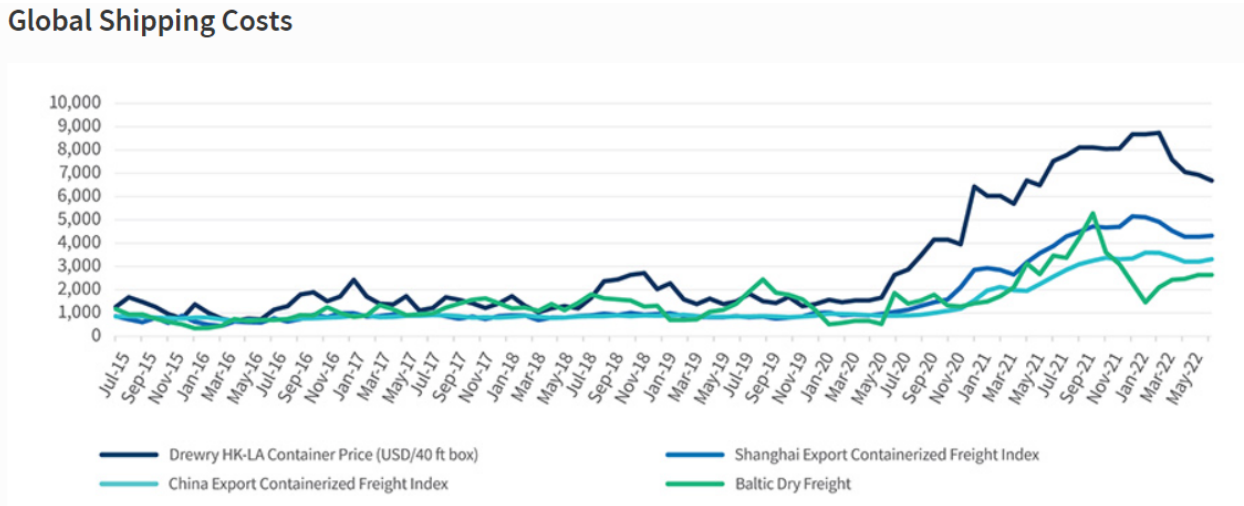

Figure 18: Global shipping costs over time(FTI Consulting, 2022)

Supply disruptions have significant impacts on a range of industries, including food, fuel and construction. Regarding the food industry, there are five key stages; agricultural production, post-harvest handling, processing, distribution and consumption. Since the industry is largely structured around seasons and weather, small disruptions could cause effects lasting over several seasons. The types of food products could be separated into two categories, capital-intensive and labor-intensive, with wheat, corn and oilseeds being examples of capital-intensive products and fish and vegetables being considered more labor-intensive. During the pandemic, shortage of

labor led to problems with labor-intensive processes, for example sowing and harvesting. Food processing plants were largely affected by lockdowns and restrictions during the pandemic, especially sites and processes that were regarded as high-risk, for example meat-production sites. Restrictions or closing down of these types of plants had long term-effects throughout the supply chains. All in all, the measures being taken during the pandemic lead to increasing food prices on a global scale. The changes of the food price index, divided into different product categories, is illustrated in figure 19. (FTI Consulting, 2022)

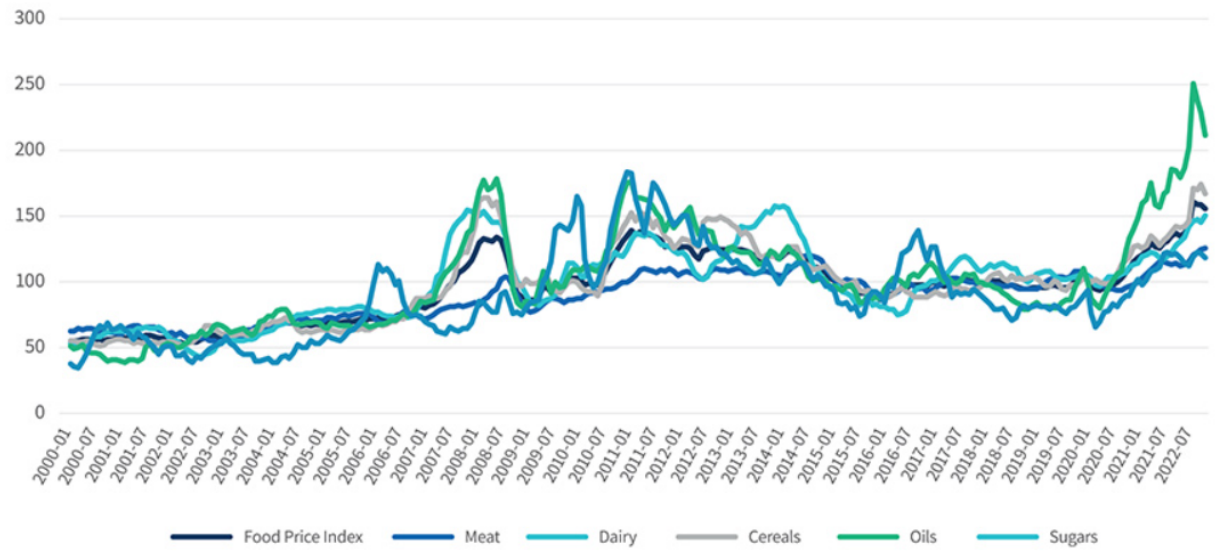

Figure 19: Food price index over time(FTI Consulting, 2022)

Within the construction industry, costs of material and labor have increased significantly and in some cases, essential construction materials, including reinforcing steel and structural timber, have grown by 40 %. The price increase within the construction industry is illustrated in figure 20, based on different construction materials. (FTI Consulting, 2022)

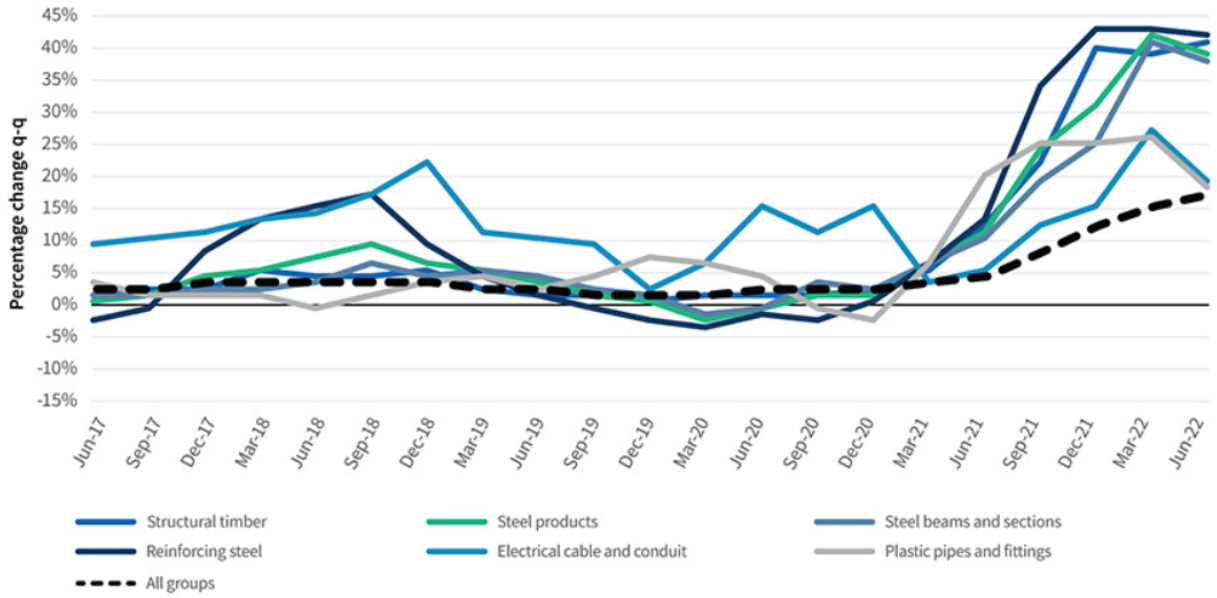

Figure 20: Price increase within construction (FTI Consulting, 2022)

J.P. Morgan discusses why supply disruptions have arised, to what extent supply chain bottlenecks will continue and where the effects will have their strongest impacts. In terms of supply chain bottlenecks, some of the key risks are outlined below. (J.P. Morgan, 2022)

- As production output increases in China, there is an increased risk for a return of port congestions within the United States. This is also related to the worker's labor negotiations.

- Northern European ports have been facing congestion prior to the Russian-Ukraine conflict and risk being impacted and experiencing more severe problems related to effects of the war.

- As airfreight transportation Asia-Europe usually travels through Russian airspace, they could be affected by the conflict.

- Further measures taken in terms of lockdown in China and specifically Shanghai could impact manufacturing and production.

- Similarly to airfreight, train cargo transporting between Asia and Europe could be affected by the conflict as rail infrastructure experiences uncertainty.

Even though supply chain issues are a reality on a global scale, there certainly are some sectors and industries that face greater risks than others. As Russia's role within energy, industrial metals

and soft commodities is larger than in other areas, some of the high-risk areas are explained below. (J.P. Morgan, 2022)

- Metals and Mining: Since bottlenecks within global logistics are increasing, export costs have become more expensive and delivery times longer. Russia has played a large role in global export of industrial metals, such as nickel, palladium, platinum, aluminum and copper. In the case of aluminum export, approximately 60 % of Russia's exports are either disrupted or completely closed. One of the major reasons for this is Australia banning some of the necessary components and products to Russia during the past years, previously accounting for 20-30 % of Russia's essential imports. Moreover, the largest exporter of alumina to Russia is Ukraine, which naturally shut down its exports in March 2022. Since aluminum is a critical material used within transport, packaging and energy infrastructure, among others, the shortage of aluminum could have severe impacts on global supply chains.

- Chemical supply: Russia is an important producer and exporter of several important chemicals. The extent to which they provide their exports globally include 18 % of the global potash production, around 10 % of the global ammonia production with 20-25 % of the global exports and 5 % of the global urea production. In combination with increased energy prices, scaling down or closing imports from Russia would severely disrupt global supply of fertilizers.

- The Automotive sector: As a consequence of lack of critical materials such as nickel, copper, platinum and aluminum as well as higher costs, the automotive industry is experiencing disruptions of supply. The complex nature of the structure of the automotive supply chains as well as a high reliance on critical metals causes a situation where volatile output is to be expected.

- Semiconductors: Regarding semiconductors, the production of neon-gas(a by-product of Ukrainian steel manufacturing) could be problematic. More importantly, supply of palladium and nickel to the auto industry and battery production is disrupted. Semiconductors have recently become a major bottleneck for end markets, with volumes being affected as a result.

- One of the effects of the lockdowns in China is a global shortage and disruption of the supply of silicon chips. The article discusses Apple, which could serve to exemplify the problems facing large tech companies. They are experiencing problems regarding potential decreases in consumer purchases due to rising prices from inflation. This could be further shown by a 26 % reduction in product sales in the first quarter of 2022. Yet, the focus is still on supply.

5.2 Risk Management

In McKinsey's *On the cusp of a new era?*, the theme related to structural changes as a result of economical and political tension is discussed. Factors brought up such as the pandemic, energy shortages, inflation and geopolitical risks have led to today's uncertainties. Connections are being drawn between the last few years' events and recent major shifts such as the repercussions after World War II, the oil crisis of 1976 and at the time period of the split of the Soviet Union. In the effects of the oil crisis, many of the tendencies are similar to today's issues, including an energy crisis, inflation, decreased supply, geopolitical tensions, competition for resources as well as a slowing productivity. In that time, in order to revert back to stability, measures had to be taken in terms of investments in energy and monetary stabilization, including high interest rates and a following recession. However, differences of today involve a more entangled world, more financial leverage and additional carbon related issues. (McKinsey, 2022c)

When reasoning around the topic of transition, the discussion could be divided into various categories, each with their own issues and uncertainties. In the article, the five areas of "World Order", "Technology platforms", "Demographic forces", "Resource and Energy Systems" and "Capitalization" are outlined, comparing the current "Era of Markets" to potential future aspects. (McKinsey, 2022c)

The article further states that the world order is leaning towards multipolarity, uncertainties regarding if the economy will continue being global, and how leaders will react and adapt to changing mechanisms around the world. One of the underlying questions is whether global connectivity can remain with increased polarization. In terms of technological platforms, while the current era's leading factors in relation to digitization and connectivity might be coming towards "saturation", new drivers such as artificial intelligence and bioengineering could contribute to the next era of technological progress. Questions remain on how new technology will interact with governments, businesses and institutions. With energy and resource systems, underinvestments compared to energy needs as well as political disruptions have created issues regarding the energy transition. Factors that will impact the speed of the transition include resilience, feasibility and affordability. Questions involve in what way these factors will play in towards the road to climate stability. (McKinsey, 2022c)

Furthermore, there is a discussion to be had whether the benefits associated with global supply chains are worth the risks that are involved. The increased risks during recent times could be derived from a number of factors, mainly increased focus on reducing emissions, geopolitical, the Covid-19 pandemic as well as the war in Ukraine, as has been discussed previously in the report. Along with the newly introduced or increased supply chain risks, four major areas of issues could be considered and analyzed for managers when they map out their supply chains. (Shih, 2022)

- **Geography and Geopolitics** - There are several factors on a geopolitical level that have contributed to risks and issues within global supply chains during recent years. Tariffs and trade restrictions, particularly in the trade war between the United States and China, is one factor that raises concerns. Additionally, the war in Ukraine has caused global issues related to supply of energy and raw materials. An example of changing supply chains was the lack of semiconductor chips in the times of the pandemic, leading a multiple of large nations to legislate and invest in domestic production, such as the United States, Japan and China. The trend of more restricted trade could lead to supply chain managers having to rely on more regional options, handling production capacity and consumption within regional areas. (Shih, 2022)

- **Logistics** - A large part of companies have experienced higher logistics costs, bottlenecks and blocks since the pandemic started, although companies that were able to discover the logistical issues early did not suffer as much. Consequences included drastic increases in air cargo as well as container costs and capacity shortages due to delays. Being aware and responding early to these signals is crucial to avoid losses. (Shih, 2022)

- **Decarbonization and sustainability** - As previously mentioned, carbon emissions related to the transportation within global supply chains have received more notice in recent times. The implications involve an increased demand to lower greenhouse gas emissions for shipping and logistics service providers. Many companies have agreed to include ESG Goals within their compensation plans. In 2023, logistics costs will increase due to an agreement by the International Maritime Organization in 2021 to lower carbon emissions for all shipping related to international trade. New demands on ships include showing yearly improvements in their operational carbon intensity, which could be costly and lead to expensive modifications as well as slower speed. Moreover, manufacturing plants could also face additional regulations, including carbon taxes on imports of products. (Shih, 2022)

- **Supplier's Health** - Several small suppliers have suffered from increasing raw material costs. Targeting flexibility and resilience, the shared planning of demand needs to be improved in order to facilitate for small suppliers in terms of sustaining capacity. (Shih, 2022)

5.3 Energy Transition

In McKinsey's "The energy transition: A region-by-region agenda for near-term action", several actions are outlined in the pursuit of dealing with energy transition. While countries could be categorized into different archetypes in terms of their different opportunities and priorities, these points listed are globally applicable. There are several stakeholders that could consider their actions and priorities, including governments, financial institutions, companies and individuals. Governments could encourage progress by new policies related to carbon standards and promotion of renewables, transforming net-zero targets into energy plans regarding reduction of emissions, resilience, affordability and energy security. Financial institutions have a crucial role in driving demand for new technologies related to green energy and investing in clean energy-projects. Companies in energy-intensive sectors will have to set new targets related to decarbonization and overall, companies could focus on developing strategies in terms of innovation and sustainability within supply chains. Some of the actions that could be considered on a global level are outlined below.(McKinsey, 2022e)

1. *"Streamlining access to land and simplifying permit processes to accelerate time to deployment for renewables and cleantech"*

In order to stimulate implementation of projects, the number of approving entities need to be scaled down and the permit process needs to be more effective. To increase the area of installation of renewable energy sources, efficient land usage and use of alternative lands could benefit the process.

2. *"Modernizing and repurposing legacy infrastructure and creating new assets to accelerate the integration of renewables and cleantech into the energy system"*
   In order to link the areas with beneficial conditions for generation of renewable energy with areas of high demand, investments in improving the power grid are required. Moreover, technological and flexible solutions to connect energy demand and generation will be required.

3. *"Strengthening global supply chains to secure critical raw materials, components, and labor competencies"*
   New and improved strategies for connecting resources needed, such as materials and components, with available supply of resources will be required by various countries. This process could involve product redesign, recycling and reuse, as well as promoting local supply chains.

4. *"Decarbonizing the industry and transportation sectors by investing in new technologies such as hydrogen solutions for energy and carbon capture, utilization, and storage(CCUS), alongside electrification and energy efficiency"*

Hydrogen and CCUS solutions could be incentivized in order to promote a greener product industry. Additionally, investments within electrification and energy efficiency could help accelerate decarbonization. For heavy-duty transportation, technology could decrease the difference in cost between electric vehicles and conventional ones and for light duty-transportation.

5. *"Limiting and mitigating emissions-intensive generation to reduce the carbon footprint of fossil fuels and lower the risk of stranded assets"*
   This includes limiting new fossil fuels assets in order to contain expansion and is especially important for high intensive sources. Methods to improve flexibility and capacity of sources that supply reliable energy can be implemented.

6. *"Managing economic dislocations to promote energy affordability and create fair opportunities for affected and at-risk communities"*
   In order to promote affordability and opportunities, several methods and mechanisms could be considered. Subsidies could be required for part of the consumers and regions that are highly dependent on fossil fuels will have to diversify their industries. Additionally, safety nets could be provided for workers in industries that are at risk and new programs can be implemented in order to generate more skill within needed areas related to the energy transition.

6. Results and Conclusions

This chapter will serve to provide results of various studies on how to manage the issues related to the topic of the thesis. As opposed to outlining problems, this chapter will investigate solutions. The areas included in this chapter are policy responses or suggested responses to the energy crisis as well as responses or suggested responses to global supply chain issues. The results are mainly based on external studies on the topic.

6.1 Policy Responses to Energy Crisis

The analysis "Economic Repercussions of Russia's war on Ukraine" covers EU's latest policy responses in relation to supply and demand as well as estimates regarding recent economical effects on Ukraine and Russia.

In order to address the energy crisis, EU member states have recently taken action. As of 21st of October, agreements were made concerning reducing demand, ensuring security of supply as well as to lower the prices of energy. Some of the particular measures discussed included joint gas purchases, additional gas price benchmark, a temporary "dynamic price corridor", improvements of energy markets functioning, efforts to save energy and frameworks to reduce gas prices within electricity generation. Recent proposals made by the European Commission are outlined below. (Economic repercussions of Russia's war on Ukraine -Weekly Digest, 2022)

1. **Regulation on fossil gas transaction prices, joint procurement and solidarity mechanisms between Member States.**

These measures consist of several parts, one of them being to establish a dynamic limit for the price of gas market transactions at the TTF(Title Transfer Facility), which is a virtual index used as the benchmark within the European gas market. The price limit is determined in order to not risk the security of gas supply but also to not cause an increasing gas consumption within the union. This cap would be a temporary measure following the development of an alternative to TTF for EU's LNG import prices which will serve to improve market transparency and reduce gas prices. Furthermore, the Commission plans a proposal for an intraday price cap mechanism, which will serve to restrict extreme variations during short time periods.This would mean that trading venues are required to set a price range for valid intraday transactions. Moreover, in order to improve the EU's bargaining power on global gas markets, joint purchases will be stimulated. This will be done by the Commission taking part in the process when companies pool their gas demand. The last part of this measure is to introduce certain mechanisms between member states

that will apply in case of gas shortages in order to increase solidarity between the states. (Economic repercussions of Russia's war on Ukraine -Weekly Digest, 2022)

2. **Using REPower EU to help SMEs, self-employed and households with cohesion funds.**

This proposal aims to assist households through covering energy consumption costs, support employees and self-employers and aid working capital to SMEs that are influenced by higher energy prices. The European Social Fund and the European Regional and Development Fund are examples of cohesion funds to contribute with the financial support. (Economic repercussions of Russia's war on Ukraine -Weekly Digest, 2022)

3. **Measures to alleviate liquidity problems in the energy sector**

Two delegated acts were embraced by the Commission in October of 2022 regarding energy derivatives.

- "Raising the threshold for mandatory commodity derivatives clearing from 3 billion dollars to 4 billion dollars".
- "Temporarily expand the list of eligible collateral".

The first act is done in order for companies to engage in more over-the-counter transactions and decrease their margin requirements. The second act is for meeting margin requirements, providing more use of guarantees. Both acts are limited to 12 months are will support companies having issues with meeting margin requirements when dealing with price volatility. (Economic repercussions of Russia's war on Ukraine -Weekly Digest, 2022)

4. **Coordination of Member States' action on critical infrastructure security**

A proposal was made in October 2022 to strengthen resilience of critical infrastructure within the union. The proposal was based on a perceived increased risk of both physical and cyber attacks. The priority lies within the areas of energy, digital infrastructure, transport and space. The security improvements are aimed to evolve around the three crucial areas of preparedness, reaction and international cooperation. An example of a preparatory measure is the encouragement of stress tests for various systems that operate critical infrastructure. In terms of reactions, plans for various incidents and crises will be implemented in order to describe the guidelines when responding to certain incidents. Concerning international cooperation, the Commission will need to strengthen the collaboration with NATO. (Economic repercussions of Russia's war on Ukraine -Weekly Digest, 2022)

In addition to the measures taken on EU level, member states have taken action with regard to rising energy prices. The measures consist of two major parts, the need for cutting demand and energy saving. (Economic repercussions of Russia's war on Ukraine -Weekly Digest, 2022)

6.1.1 Demand reduction measures

During the course of 2022, two major demand reduction measures have been decided upon between the member states. In July, the EU countries decided on a 15 % decrease of natural gas demand from August 2022 until March 2023 and in September, the countries agreed on a 10 % reduction of electricity demand, as well as a 5 % decrease during peak hours. These numbers stand in proportion to the average consumption during the last five years. These actions are necessary in order to avoid gas shortages during 2023. The affections of the demand cuts are illustrated in figure 21. (Economic repercussions of Russia's war on Ukraine -Weekly Digest, 2022)

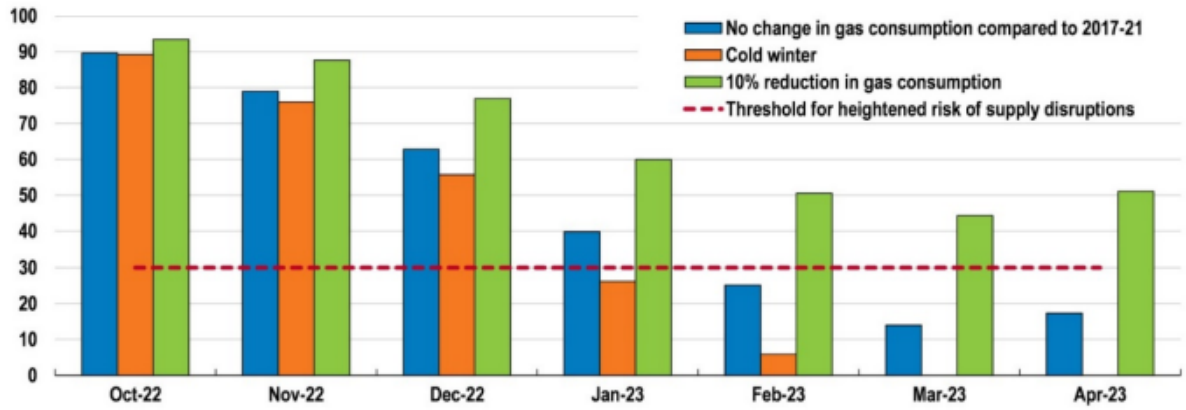

Figure 21: Gas storage levels dependent on demand reductions(Economic repercussions of Russia's war on Ukraine -Weekly Digest, 2022)

As the figure illustrates, a 10 % reduction serves to stabilize storage levels, which would otherwise risk to fall below the threshold for risk of further supply disruptions. Other variables affecting gas storage levels are gas flows from Russia, the extent of delivery from other suppliers and the temperature during winter months. Furthermore, the typical emergency plans within the EU serve to protect households, social services and critical infrastructure but are not sufficient to protect firms from gas reductions. Figure 22 illustrates to which extent different groups are protected through regulations. (Economic repercussions of Russia's war on Ukraine -Weekly Digest, 2022)

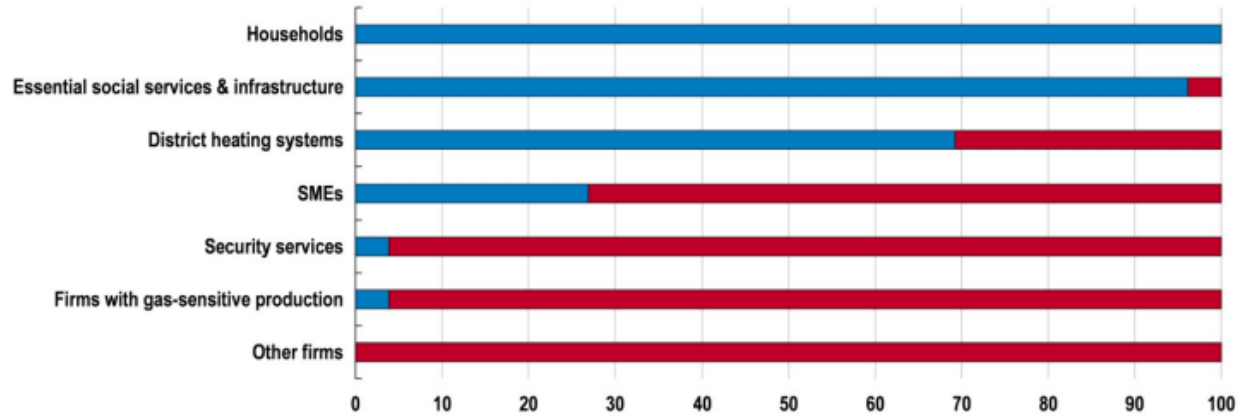

Figure 22: Share of member states protecting customer groups through regulations(Economic repercussions of Russia's war on Ukraine -Weekly Digest, 2022)

While measures taken within emergency plans serve to cover critical infrastructure and households, they cannot secure all customer groups to not lose access during times of shortages, according to the OECD. For companies, this implies larger economic costs. To avoid this situation, governments have to take action with regard to saving energy throughout different sectors.(Economic repercussions of Russia's war on Ukraine -Weekly Digest, 2022)

Additional publications by the Commission and IEA include various actions that could be taken by citizens in order to save money and support less dependence on Russian gas(energy.ec.europa.eu, 2022) as well as guidelines concerning actions that could be taken by small businesses(energy.ec.europa.eu, 2022).

6.2 Supply Chain Measures

In order to increase resilience for supply chains, there are some key strategies to be considered for various businesses. FTI Consulting lists and outlines a few of the key strategies needed to lower the effect of external impacts. These strategies could be less cost-effective in the short term, but provide positive long-lasting effects. (FTI Consulting, 2022)

- Inventory Cushions: A strategy which serves to keep extra stocks, either completed products or components to products. Added inventory causes additional costs but is needed when facing disruptions and delays. (FTI Consulting, 2022)

- Digitalisation: New technology could serve as helpful measures in several ways. One of the main uses could be to identify risks, shocks and weaknesses in the supply chain prior to the severe effects. The use of new technology could allow for more information,

including sales and forecasts, which allows for more precise decisions on, for example, stock levels. Moreover, technology could be helpful when mapping the supply chain in order to identify risks along the supply chain. (FTI Consulting, 2022)

- Localisation, nearshoring: In order to reduce the impacts of international trade, sourcing materials from more local sources could be a strategy. Nearshoring serves to reduce the cycle times, costs of transport and risks of the operations. (FTI Consulting, 2022)

- Supplier diversity: When experiencing a lack of components, the strategy of diversification could be implemented in order to reduce the risk of shortages and delays. (FTI Consulting, 2022)

- Monitoring free trade agreements: It is important to keep up with various trade agreements and understand their implications for supply chains. These types of agreements could have impacts when committing to locations, distribution functions and sales. (FTI Consulting, 2022)

In addition to the strategies businesses could implement to improve their supply chains, there are several measures that could be taken by governments. These measures could involve removing trade barriers and reducing for example customs and clearance checks. Moreover, taking measures in terms of price flexibility by providing restrictions to volatile price changes could be a method, as well as helping businesses and improving conditions for trade. (FTI Consulting, 2022)

Furthermore, studies have been conducted on how to manage recent years' supply chain disruptions. The strategy to minimize costs and optimize efficiency has been observed to not always be sufficient and improvements have to be considered. Various approaches could be used to handle disruptions and within these, several different tools and methods. (Deloitte Insights, 2022)

One of the approaches that should be considered to mitigate disruptions is to strengthen relationships within a supply chain network. Methods of conducting this approach include more frequent check-ins with suppliers, training of employees and allowing for better sharing of information within the network. In addition, improving visibility through different levels could serve to improve clarity. In terms of local production, domestic capacity could be increased. In some cases, this has been a necessity, as in the case of the semiconductor industry, and it could be a used as a more widespread tool. (Deloitte Insights, 2022)

An additional approach could be to diversify the number of suppliers on a regional basis. In a study by Deloitte, it is highlighted that those companies that pursued diversification on a regional

basis suffered less from disruptions. There are several factors to be included when engaging with and selecting suppliers. For OEM's, important points include to improve business continuity, diversify the suppliers and work for better flow of material. For Tier 1 suppliers, considerations also involve material flow and business continuity, but also sourcing for competitive pricing. For Tier 2 suppliers, it is also important to reduce concentration from only one region and improve resiliency in the whole network. A third approach has to do with using digital technologies and innovations for improved agility and visibility. Many companies have started using these technologies, mainly in order to reduce operational costs, for better quality of products, for more transparency and for better resiliency. (Deloitte Insights, 2022)

Lastly, many manufacturers have started to move from Just-In-Time strategies in order to deal with increasing costs of labor and material, bottlenecks and lack of labor. The strategy is a way towards balancing agility, resilience and efficiency. Processes of agility could include design flexibility, for example standardization of specific parts of a product. Resiliency could be important for managing issues of transportation, for example diversifying trade routes. In order to improve resiliency, manufacturers collaborating in investing for more production capacity is a method to be used. (Deloitte Insights, 2022)

6.3 Response to Research Questions

As relevant measures and responses to the issues have been elaborated on, this section will look back on the research questions stated in the introduction. Even though the content of the report has covered a large part of the responses, some points could be added or clarified in order to provide thorough answers. The research questions are stated in the introduction and are repeated below.

- ☐ How will businesses need to change their handling of global supply chains, as a consequence of the pandemic and war, and what trends could already be observed?
- ☐ How will companies efficiently understand and recognize its weaknesses related to their operations and changing surrounding factors?
- ☐ What effects have the war and pandemic had on global energy supply and what are the solutions to the current problems?

As has been reviewed in the thesis, there are several changes that companies could reflect upon considering their global supply chains, and that could be applied on a multiple of different organizations throughout different industries and on a global scale. Both the Covid pandemic and the Russia-Ukraine war have had their impacts in a different way but with the common

denominator that changes are necessary. Going back to the pandemic, numbers among the Fortune 1000 companies amplifies the implications on large companies, with 94 % reporting disruptions and 75 % reporting negative impacts. Challenges involve insufficient global resilience within supply chains, more expensive operations, not living up to sustainability expectations among stakeholders, lack of workforce and insufficient flexibility. (Accenture, 2021)

The adjustments that could be made could be divided into different categories such as planning, logistics, procurement and manufacturing within supply chains. Some of the actions to prioritize within the different areas are outlined below. (Accenture, 2021)

Planning & Scheduling

- Improve visibility within areas such as demand, inventory, capacity, supply as well as finances.
- Analysis of demand
- Organize teams to handle planning and execution
- Evaluation of different scenarios in order to understand when scarcity or surplus will take place as well as gaining insight into optimizing metrics.

(Accenture, 2021)

Logistics

- Gaining real-time visibility into the operations
- Improving flexibility in terms of structuring assets, inventory and capabilities in order to balance supply and demand.
- Improve communication with workers, suppliers and customers.
- Support of customers, suppliers and networks that are impacted by the pandemic.

(Accenture, 2021)

Procurement & Sourcing

- Managing the various supply uncertainties in collaboration with suppliers
- Minimize avoidable spendings to conserve for future initiatives
- Establish resilient procurement decisions by managing risks
- Innovation involving trust, transparency and customer centricity.

(Accenture, 2021)

Operations & Manufacturing

- Gain insights into the effects of demand disruption. Identification of critical products and coordinate critical competencies for short term and long term demand.
- Managing decisions on investments and requirements for distribution of assets as well as improving flexibility for current assets.
- Improving digital capabilities in terms of responding faster and more accurately to disruptions.

(Accenture, 2021)

As previously discussed, resilience will be a key factor moving forward. End-to-end visibility throughout the entire supply chain, including tier 2 and tier 3, is a part of this process. Additionally, switching from just-in-time to just-in-case strategies will be, at least partly, necessary. Diversification of suppliers, alternative routes for transportation and improving inventory are examples of adjustment methods. The main thread of the changes consists of planning for various supply uncertainties rather than cost optimization. (World Economic Forum, 2022)

In relation to logistics disruptions, including delays, damage to infrastructure and increasing rates, it is of importance to evaluate what items are causing issues and investigate new sources, changes within production as well as strategies of procurement and sourcing. These adjustments will serve to improve customer service levels. In terms of increasing costs of material, there are a few measures to consider. In order to secure supply, mergers and improved partnerships, including more local sourcing, are useful for crucial materials. Furthermore, considering risk management in terms of cyber security will be necessary to include in future strategies. Measures could involve increased monitoring of networks, mapping out and understanding various scenarios of cyber-attacks, the various effects it could have as well as the planning involved in incidents and resilience. (KPMG, 2022)

On the issue of energy supply and how it has been affected, several impacts have been discussed in the thesis. Particularly, policy responses to tackle the crisis in chapter 6.1. However, a few points could be clarified. First of all, the increasing energy prices is one of the main effects of the war and has impacted a wide range of people and systems. According to the IEA, 90 % of increases within generation of electricity is caused by higher costs of fuel. Examples of how the energy crisis has impacted people include 70 million no longer being able to afford electricity and 100 million not being able to make food with clean fuels. An additional global effect of the war is a switch in flows of energy supply. This is mainly due to Russia cutting 80 % of the supply to Europe, and increasing exports to other countries, such as Turkey, India and China. In terms of the global economy, the energy costs are leading to increasing prices of various goods and services. Increasing interest rates together with lower real incomes are leading the world

towards recession. Consequences for people include increasing rates of extreme poverty. Another aspect of the crisis is whether the crisis will lead to a trend towards increasing renewable energy. Energy security has been on the agenda, and according to the IEA, the energy crisis could lead to increasing usage of renewable energy. However, a short term focus within the policies to handle the situation and a negative economic trend may interrupt the process. It is not yet established exactly what the impacts will be. (Thomson, 2022)

7. Discussion and Future Research

This chapter will provide a discussion on the findings of the thesis, contributions and limits of the thesis as well as future research to be conducted on the topic of the thesis.

The future of global energy supply and demand is not yet certain, and will be interesting to follow both in the short term and long term. In the short term perspective, solutions to the current energy crisis need to be sorted out, finding ways to handle rising prices and shortages. In the long term perspective, dealing with sustainability targets, balancing conventional and renewable options as well as establishing alternative trade flows of energy are some of the main concerns. Unifying the various issues concerning global energy supply will be challenging and this thesis only covers a small fraction of them.

Regarding supply chains, several measures have been discussed and will be interesting to follow in the coming years. It is clear that companies have to rethink their structures in terms of risk management in order to handle the next crisis in a more efficient manner, whether it be more localized sourcing, sacrificing cost efficiency for improved resilience or various safety measures for prevention and reduction of risks.

The thesis is useful in a general sense, but somewhat lacks in more specific studies, given the width of the subject matter. Future research could involve expanding on certain areas within the report, for instance a case study on structural changes within a certain supply chain and how particular changes affect the economical results over a period of time.

One factor to consider relating to the sources is the fact that the topic of the thesis is very current. The pandemic started its global spread in 2020 and the war in Ukraine began in 2022, which means there has been development in both areas during the course of the writing of the thesis, especially in the case of the war. Therefore, the report has been aimed at providing information in a way that is not only relevant at the current time. That being said, perspectives from a year ago may not always be applicable as of January 2023, which is a factor to consider when reading the report.

The thesis has provided theoretical background, analysis and perspectives on recent years' development within global supply chains as a consequence of the Russia-Ukraine war and Covid-19 pandemic. Based on various studies as well as company reports on the topic, a thorough review of the global impacts has been conducted. The thesis could serve as a useful tool in order to understand how major global events affect organizations, companies and countries, directly or indirectly, and how businesses can act to mitigate negative impacts as well as preventing future similar trends.

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