Reelia Raudheiding

Comparative Analysis of European Supply Chains Security Regarding East Asia and North American Trade

Helsinki Metropolia University of Applied Sciences

Bachelor's Degree

European Business Administration

Bachelor's Thesis

22.05.2022

Abstract

Author(s):	Reelia Raudheiding
Title:	Comparative Analysis of European Supply Chains Security Regarding to East Asia and North American Trade.
Number of Pages:	51 pages
Date:	22 May 2023
Degree:	Bachelor's degree
Degree Programme:	European Business Administration
Specialisation option:	EBA
Instructor(s):	Michael Keaney

Keywords: European Economic Security, Far East Asia Trade, North America Trade, Supply Chains of Semiconductors, Supply Chains security.

Supply chains play a crucial role in the smooth functioning of the economy and contribute to the economic security of nations worldwide. This study analyses the impact of supply chain disruption on Europe's economic security, focusing on the semiconductor industry as a case study affected by recent events such as the COVID-19 pandemic and the Russia-Ukraine conflict. By providing a definition and contextualization of the term "supply chains" in relation to semiconductors, the study establishes a foundation for in-depth analysis. Through a comparative analysis of trade patterns between North America, Far East Asia, and Europe, the challenges faced within the semiconductor supply chain are explored. The findings underscore the urgent need for Europe to strengthen its semiconductor and battery manufacturing capacities, address supply chain vulnerabilities, and foster an environment conducive to technological innovation. By proactively addressing these issues, Europe can enhance its economic security, reduce dependence on external sources, and position itself as a global leader in these critical industries. This research offers valuable insights for policymakers, industry leaders, and stakeholders, providing a better understanding of the challenges and opportunities presented by the evolving landscape of the semiconductor industry and global supply chains.

Contents

Glossary

AMD	Advanced Micro Devices
ASML	Advanced Semiconductor Materials Lithography
CCP	The Common Commercial Policy
CFSP/CSDP	Common Foreign and Security Policy/Common Security and Defence Policy
CGEA	Commissioners' Group on External Action
CHIPS and Science Act	Creating Helpful Incentives to Produce Semiconductors and Science Act
ECSC	The European Coal and Steel Community
EEAS	European External Action Service
EEC	European Economic Community
EU	European Union
GDP	Gross Domestic Product
HR/VP	High Representative of the Union for Foreign Affairs and Security Policy/Vice-President of the European Commission
IBM	International Business Machine Corporation
ICT	Information and Communications Technology
IMEC	The Interuniversity Microelectronics Centre
IMF	International Monetary Fund

JIT	Just-In-Time as inventory model where management strategy increases efficiency and minimizes inventory.
LED	A light-emitting diode. A semiconductor device that releases light when current passes through it.
MERS	Middle East Respiratory Syndrome
METI	The Ministry of Economy, Trade and Industry
NGO	Non-Governmental Organisation
NPI	Non-Pharmaceutical Intervention
NSC	National Security Council
PCAST	The President’s Council of Advisors on Science and Technology
PLA	People’s Liberation Army
R&D	Research and Development
SARS	Severe Acute Respiratory Syndrome
SCM	Supply Chain Management
Taiwan’s UMC	Taiwan’s United Microelectronics Corporations
TSMC	Taiwan Semiconductor Manufacturing Company
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
WHO	The World Health Organization

1 Introduction

In today's globalized economy, trade has become an essential component of national economic growth and development. Countries across the world are increasingly looking to forge closer economic ties with one another, with the aim of promoting trade, investment and creating new business opportunities. Europe, East Asia, and North America are three key regions that have an important role to play in the global economy. These regions have long-standing trade and investment relationships, and as such, are vital drivers of world's economy. Hence, economic security of these region is of utmost importance of sustainable growth and development. To ensure economic security, it is crucial to have a reliable and efficient supply chain. This plays a critical role in smooth functioning of the world and is essential for the economic growth.

The aim of this thesis is to conduct a multidimensional comparative analysis of the implementation of circular economy by Europe, East Asia, and North America, with a specific focus on the supply chains that underpin their trade relationships. The thesis will examine how these supply chains are structured and how they are managed, with a view to understanding the economic risks and opportunities they present. The supply chains connecting these regions are complex and multifaceted, involving a range of different industries and sectors. Therefore, the thesis will include a case study on the semiconductor supply chain to address the complexities of global supply chains.

Semiconductors are essential components of modern electronic devices, including smartphones, computers, and cars. The semiconductor industry is a highly specialized and complex industry that relies heavily on global supply chains. The case study will examine the semiconductor supply chain, tracing the flow of products and services from raw materials to finished goods. It will explore how different regions contribute to the production of semiconductors and the economic risks and opportunities associated with their supply chains. As an important example, the impacts of the COVID-19 pandemic and the war in Ukraine on European and other regions supply chains are examined here.

Overall, this thesis aims to identify the economic security of Europe, East Asia, and North America associated with their supply chains, with a view to suggesting policy and strategy decisions. The goal will be to contribute to the development of secure and resilient economic relationships between these regions, with advantages for businesses, economies, and societies around the world.

2 Methodology

The methodology of this thesis uses a mixed methods which are quantitative in regards of given statistic and qualitative information as more precisely a case study approach to conduct a comparative analysis of the economic security of Europe, East Asia, and North America.

The advantages of the mixed methods approach include:

- Providing a more nuanced understanding a complex situation through the integration of numerous sources of materials and information.

- Improving study credibility by using founded details from multiple sources.

- Providing a more comprehensive understanding of the research topic by examining multiple aspects and perspectives.

To accomplish this, the quantitative facts has been collected mostly from the European Parliament Research Service site and other official sites, to analyse the trade goods of the countries within the scope of the study. The quantitative information was analysed using the statistic, numerical data methods to identify patterns and trends in the given facts. Qualitative information was collected from various articles, research works and reports by Guillaume Ragonnaud, which were analysed thematically to pick out key themes and patterns in the given fact.

Qualitative information, however, has been analysed thematically to identify the impact of how the COVID-19 pandemic and the war in Ukraine have affected

economic security supply chains in Europe, North America, and East Asia. Another key finding was that supply chains in the semiconductor industry face challenges, further worsening the issue of supply chain security.

The combination of the quantitative and qualitative analyses was provided a more comprehensive understanding of the research topic. Overall, the mixed methods approach, allowed for a more robust and comprehensive analysis of the economic security of Europe, East Asia, and North America, contributing to inform policy and strategic decisions by identifying key economic risks and opportunities associated with these supply chains.

3 Literature review and analyse

3.1 What is Supply Chains and what does it involve?

To understand a supply chain, Chopra and Meindl (2001) describe it as a set of movements of materials, information, and money that work together to meet the expectation of the last customer. During the supply chain is composed of different stages, which may include the manufacturer, retailers, warehouses, transporters suppliers, and even customers themselves. To satisfy the customer, various functions within each organization are necessary, such as marketing, new product development, distribution, finance, operations, and customer service. This flow of information, product, and funds makes a supply chain dynamic (Chopra and Meindl, 2013).

To optimize the processes involved and the responsibilities of each stakeholder in the supply chain, the traditional way of thinking is called the cycle view. The supply chain is separated into a series of cycles, each happening at the interface between two successive stages of the chain, and each cycle functions independently by separating the cycles via inventories. For instance, one process can fill up stores by delivering goods from the manufacturer's completed product stock, while another cycle may replenish the manufacturer's inventory by

producing new end-products (van der Vorst, 2004). This separation helps to identify the processes and the responsibilities of the stakeholders involved.

3.2 Supply Chain Phenomenon

3.2.1 The Bullwhip Effect

The Forrester or Bullwhip effect is a phenomenon which means when a buyer places an order with a supplier, the amount they order can have larger variance. This variation gets bigger as it moves back to the supplier, and this causes problems and can result in serious cost implications. This effect has been referred to in supply chain management literature as the starting point of supply chain research and can lead to increased costs, an ineffective use of resources, and material shortages due to poor product forecasting (van der Vorst, 2004).

Lewis and Naim (1995; cited in van der Vorst, 2004) point out that the amplification in the supply chain is not caused by external factors, but rather by the supply chain parties themselves. The factors leading to leverage are the assumed demand, the quality of information, and the inherent delays in the supply chain. Moreover, Sterman (1989; cited in van der Vorst, 2004) adds that the lack of timely information on demand changes and the long lead time between placing orders and receiving products result in a delayed reaction time.

For example, the Bullwhip effect as witnessed in semiconductors: these are important for modern devices, and the global semiconductor market was worth $527.88 billion in 2021. The ongoing shortage of chips has affected several sectors, including automotive, consumer electronics, LED, and lighting fixtures. The semiconductor shortage touches 169 industries, and companies were trying to address the problem by stockpiling as much as they can, but this has left smaller businesses struggling. The bullwhip effect explains the disturbed supply and demand dynamic where the distortion of demand travels upstream in the supply chain. The chip shortage has prompted many companies to order more than they need and thereby create an inventory safeguard. However, this is introducing additional uncertainty into the supply chain (Gep.com, 2022).

3.3 Supply Chain Management

The term ‘Supply Chain Management’ (SCM) was introduced in logistics literature in 1982 as an inventory management approach with a focus on the supply of raw materials (Oliver and Webber 1982; cited in van der Vorst, 2004). In the 1990s, academics explained SCM conceptually to differentiate it from traditional approaches of managing the movement of materials and related information (Cooper and Ellram, 1993; cited in van der Vorst, 2004). According to Lambert and Cooper (2000, as cited in van der Vorst, 2004), the SCM literature emphasizes highlights the importance that actors from primary producers to final consumers must work together to meet consumer demand at lower costs.

Thus, SCM concentrates on managing of relationships. Van der Vorst (2004) defines SCM as coordinated management of all business process and activities in the supply chain to provide better value to consumers, reduce costs, and meet the needs of other stakeholders such as governments and NGOs.

3.3.1 Three Key Decisions

The decision to "make or buy" is an essential decision that should be made before analyzing and remake a supply chain. The decision pertains to whether the lead firm should produce certain goods and services in-house or outsource them to other firms in the supply chain (Mentzer et al., 2001). The extent to which the supply or value chain is owned by the lead firm will depend on the make-or-buy decision. Firms that choose to make more of their products in-house will own more of the supply chain, while those that outsource more will have a more extended value chain.

The make-or-buy decision should be based on several factors, including the firm's core competencies, cost structures, product complexity, and efficient usage of capacity (Mentzer et al., 2001). For example, if a firm has specialized expertise in producing a particular component, it may be more cost-effective for it to produce the component in-house than to outsource it. On the other hand, if

outsourcing allows the firm to take advantage of lower labor costs or other benefits, it may be more profitable to outsource.

The make-or-buy decision should be reviewed regularly, as market conditions and cost structures can change over time. Firms should assess the risks and benefits of each option and determine which is most advantageous in the current market environment. Mentzer et al. (2001) suggest that firms should conduct a make-or-buy analysis periodically to evaluate the decision and ensure that it continues to align with the firm's supply chain objectives.

To analyse and remake a supply chain, the first step is to determine the organizations involved in the supply chain under investigation. As Lambert and Cooper (2000; cited in van der Vorst, 2004) note, for most manufacturers have a supply chain that looks less like a pipeline or chain that resembles a tree with many branches and roots, consisting of customers and suppliers. It is important to choose the right level of partnership for each member of the supply chain since resources are limited. Also, it is necessary to identify which members are important to the success of the company and supply chain goals and allocate resources accordingly. This is essential for managing the supply chain effectively (van der Vorst 2004).

The effective management of supply chains needs a shift from managing individual business processes within an organization to integrating activities across organizations into key supply chain processes. According to Lambert and Cooper (2000; cited in van der Vorst, 2004), there are eight key business processes that can be combined with the main members of the supply chain. However, it is not necessary to integrate all processes; the focus should be on the processes that align with the supply chain objectives. For example, if the order winner is responsiveness, then to improve the supply chain, it is essential to prioritize order fulfilment, however, if the order winner is innovation, then on joint product development. The SCM literature provides different ways to redesign businesses in the supply chain to make them more efficient and effective (van der Vorst, 2004).

The effective management of supply relationships requires attention to various components, as identified in the literature on business process re-engineering and SCM. Lambert and Cooper (2000; cited in van der Vorst, 2004) divide these components into two groups: physical and technical, and managerial and behavioural. The physical and technical group consists of tangible, measurable and changeable components, while the managerial and behavioural group defines organizational behaviour and influences the implementation of physical and technical management elements. If these components are not aligned to support supply chain objectives and operations, the supply chain may not be competitive or profitable. Any changes to physical and technical elements may require corresponding adjustments to managerial and behavioural components. However, the latter are known to be obstacles to SCM due to their impede trust, commitment, and transparency among supply chain members (van der Vorst, 2004).

3.3.2 The Advantages of SCM

The implementation of SCM can significantly improve delivery performance and increase information availability, resulting in operational efficiency, tactical and strategic benefits, and reduced inventory-carrying and transportation costs. Companies are restructuring and rationalizing their supply chain network to achieve these benefits. Collaborative production, such as product standardization, outsourcing of production volume, supplier partnerships, and sharing capacity of a single plant, are some of the practices that enhance the flexibility and efficiency of manufacturing processes. However, SCM projects usually handle with only a part of the supply chain and face challenges in building trust and gaining insight into each other's processes due to the competitive model (van der Vorst, 2004).

3.3.3 Communication with Suppliers

For the procurement process to be successful, both the company and supplier must acknowledge its importance. A communication plan should be established to manage the transition from old to new suppliers, with departments such as

finance and customer service impacted by this change. The decision to produce goods in-house or outsource to third-party suppliers in low-cost parts of the world can result in significant cost savings. However, developed countries can offset these costs by investing in activities like information technology, human resources, customer relations, and maintenance, which can generate profits and should not be overlooked (Fawcett et al., 2008; cited in Chopra and Meindl, 2013).

3.4 Semiconductors

This thesis uses the example of semiconductors to highlight the security issues arising from recent supply chain disruptions. The centrality of these products to so much production processes and outputs makes these a particularly illustrative example of the risks involved in JIT and the need for appropriate responses, not only from lead firms but also from governments and other bodies tasked with security-related functions.

Some of the most complicated and detailed technologies developed by humans are involved in the production of semiconductors. Also known as integrated circuits or chips, semiconductors are a breakthrough innovation that has led to significant advancements in technology and economic growth, much like the steam engine. They have become an essential component of the digital transition and are now appearing everywhere. In 2021, the semiconductor industry achieved a significant milestone by surpassing the trillion chips mark for the first time. Semiconductors can be categorized into three main types of logic chips – the electronic devices 'brains', performing complex computing operations; memory chips which stores information and data; and discrete, analogy, and other chips (DAO) (Ragonnaud, 2022).

Chips are considered as one of the "general-purpose technologies" that have ushered whole eras of technological progress and economic growth. These semiconductors or chips are used in a wide range of products, from computers to medical devices, security, and defence devices, as well as 5G and artificial

intelligence systems. Hence, chips have become widespread and a driving force of the digital transformation (Ragonnaud, 2022).

Semiconductor chips are an essential part of the global economy, with worldwide sales surpassing $341 billion in 2016 (Hsieh, 2018), $574.1 billion in 2022 (semiconductors.org, 2023), and expected to reach $681 billion in 2023 (Ragonnaud, 2022). This ever-growing market is forecasted to be worth around US$700 billion by 2025 and US$1 trillion in 2030. The content of semiconductors utilized in electronic devices reached an all-time high of 33% in 2021, and the smartphone incorporates about 160 different chips, while hybrid electric vehicles may include up to 3,500 chips (Burkacky et al., 2022).

The semiconductor industry, historically a costly and labour-intensive process, involves complex, multi-layered compositions that are composed of many smaller semiconductor devices. Companies such as Apple, Canon, Sony, Samsung, and Phillips use semiconductor chips in their electronic products. The leading semiconductor companies own micro-fabrication facilities in the United States also abroad in Asian countries, including Taiwan and China (Jennings, 2017).

3.5 Europe’s Supply Chain Security

The main stated goal of the EU's trade policy is to create jobs and increase economic growth by accessing new markets and expanding trade in goods and services. The EU has tried to expand its role beyond just economic relations to become a foreign and security policy actor. The Common Commercial Policy has been an EU responsibility since 1958, and it is widely agreed that trade policy is central to the EU's presence in global affairs. The EU has a supranational trade policy and an intergovernmental foreign and security policy, which makes it interesting to analyse in terms of both trade policy and foreign and security policy, and the contrasting processes and results (Stueber, 2022).

According to Magone (2017) and Chen (2016; cited in Ignatov and Augustin, 2020), the European Union is considered a dispersed region with weak centralised power, and its role in the world's architecture is much less prominent

than that of economic superpowers i.e., USA and China. The positions of the European Union as a global player are weakened by varying institutional efficiency rather than internal development differences. In the conditions of globalization, it has been argued that the European Union should change its policy framework, as noted by Ignatov & Augustin (2019), by strengthening the strictness of central economic authorities. This is controversial due to the resistance among member states and political movements to the concept of a powerful federal state structure that would effectively subordinate the member states even more than they have been already. Intergovernmentalism via the European Council, comprising heads of state and government, remains the dominant agenda-setting process (Bickerton, 2022: 67).

The EU has been characterized by various concepts such as a civilian power, normative power, regulatory power, ethical power, and market power. These characterizations overlap to some extent but fail to capture the complexity of the EU's multifaceted character. It is often assumed that the EU's economic strength as a trading entity can be leveraged to apply influence on foreign and security policy, but the reality is that the EU's external action involves a multitude of different actors and bureaucratic subsystems (Stueber, 2022).

3.5.1 Examining the Interplay of Trade and Security in the EU’s External Affairs

The EU aims to address political, economic, and security issues by fostering a more comprehensive European dialogue and aligning everyone’s goal of a common development strategy. The attitudes dynamics towards European integration are impacted by both external and internal factors, such as economic stability, social protection, migration settlement, and the international and political situation, particularly at the EU borders (Pipchenko et al., 2019).

However, the relationship between EU trade policy and foreign and security policy has been a topic of limited research. There is little knowledge about how the Common Commercial Policy (CCP) and the Common Foreign and Security Policy/Common Security and Defence Policy (CFSP/CSDP) interact with each

other. Although there is a vast amount of research on both the CCP and the CFSP/CSDP, the scholarly research on EU external action has not paid enough attention to the trade-security nexus. Only a few scholars have systematically examined the relationship between trade policy and security and foreign policy in EU external action (Stueber, 2022).

According to Stueber (2022), literature on the trade-security nexus in EU external relations has twofold shortcomings. Firstly, the theoretical and observational literature on the topic is not extensive. Secondly, the few existing explanatory approaches tend to emphasise institutional factors and tend to separate the main goals of EU trade policy and EU foreign and security policy, i.e., security and welfare. The relationship between welfare and security is interconnected and not separate, as both are necessary for each other in the short, medium, and long term. Conflicts between the EU trade policy and EU foreign and security policy may not be about having opposing goals, but instead, about the beliefs and rules guiding each policy domain.

3.5.2 Trade and Security in European Integration

Post-1945 European integration began with the belief that military alliance and economic integration would ultimately lead to a political union (Schwarze, 2006). In 1951, the European Coal and Steel Community (ECSC) was created to focus on a critical economic sector. This opened the way for wider economic integration, as the six member states of the ECSC decided to gradually merge their national economies and create a common market. As a result, economic integration became more important than political integration. In 1957, the Treaty of Rome created the European Economic Community (EEC), which was responsible, for creating policies for external trade. The EEC was the only organization allowed to propose policies and performs trade negotiations for the Community. However, because of the failure of the European Defence Community in 1954, foreign and security policy was kept out from EU. In the 1960s, people started talking about how to balance the European Community's increasing power in economic relations with its foreign policy goals. In 1992, the

Maastricht Treaty established a separation between trade policy and foreign and security policy. The Common Commercial Policy (CCP) was placed in the community pillar, while the newly made Common Foreign and Security Policy (CFSP) was placed in the intergovernmental pillar. This separation, known as pillarization, has been criticized as the "original sin of overall EU external action (Stueber, 2022).

This passage talks about the evolution of the European Commission's role in foreign policy and external relations. The Maastricht Treaty separated foreign and security policy matters in Pillar II and placed the Common Commercial Policy in Pillar I. This caused issues and delayed the implementation of CFSP decisions, but the Commission later improved its cross-pillar cooperation. In the 1990s, the Commission reorganized its external relations portfolio to increase usefulness. A 1999 review found fragmentation in external relations activities caused a lack of strategic overview, and the incoming Prodi Commission combined the services. The Treaty of Nice (2001) presented some reforms but did not address clarity and consistency in EU external action. The Lisbon Treaty (2007) aimed to improve the clarity and effectiveness of EU external action (Stueber, 2022).

3.5.3 The Lisbon Treaty

The Lisbon Treaty of 2009 created the position of High Representative of the Union for Foreign Affairs and Security Policy (HR) and abolished the pillar structure, giving the EU legal personality (Stueber, 2022). However, there is debate on whether these changes have enhanced foreign and security policy steering or resolved the tensions between trade policy practices and foreign and security policy practices. The treaty also introduced reforms to the EU's diplomatic missions to third countries, putting them under the authority of the HR/VP and the European External Action Service (EEAS), but still reporting to the Commission for competencies such as trade policy (Stueber, 2022). The Juncker Commission reorganized the College of Commissioners in 2014, and the HR/VP chairs the Commissioners' Group on External Action (CGEA) and "guides the work" of the commissioners for various policy areas (Stueber, 2022). The EU

also faces challenges in energy security, which is linked to both the common energy policy and common foreign policy (Pipchenko et al., 2019). The Treaty of Lisbon (European Union, 2007; cited in Pipchenko et al., 2019) requires collective responsibility if an EU Member State faces aggression, which could also apply to energy security. The common energy policy and common foreign policy of the EU are linked in the strategy 'Energy 2020' (European Commission 2011; cited in Pipchenko et al., 2019), which aims to provide affordable energy access to all. Negotiations are needed between energy consumers, suppliers, and transmitters to Europe (Pipchenko et al., 2019).

3.5.4 EU Trade Policy and its Role in Global Affairs

The EU uses its economic strength to increase its role in global foreign and security policy, with trade policy seen as a tool for economic growth and state resilience. Pursuing free trade agreements with countries like the US and Japan, the EU aims to build a global free trade network, while considering market potential, protection against EU exports, and balancing with EU competitors. However, contradictions between values and security may arise, as the EU seeks to promote its values in trade negotiations while also considering security concerns and member states' economic interests (Stueber, 2022).

According to Timmer et al. (2011), productivity growth in European Union (EU) countries has declined since the 1990s, while in the United States has seen an opposite trend due to EU countries' failure to capitalize on new markets such as ICT, among other reasons. This decline is expected to continue due to factors such as an ageing population, rigid capital markets, low investments in risky innovation projects, and over-regulation (Schwartz, 2022).

Technology is a crucial factor in enhancing a nation's economic and political positions and plays a vital role in enforcing a nation's economic security. High technology is decisive in improving a country's economic security and competitiveness, as it enhances economic potential through boosting productivity, resilience, and efficiency. Countries that utilize the benefits of

innovation are more competitive and have an increased adaptability capacity, making them less vulnerable to external threats (Ahlstrom, 2010).

The United Kingdom (before BREXIT) and France are the forefront of technological powers of the European Union, showing the best dynamics and best results. Advance of productivity is a strategic endeavour of governments worldwide, as productivity determines a country's future capacity to prosper and grow by providing more feasible outputs, leading to higher standards of living. Positive dynamics of economic efficiency come from innovation, technological, and logistics improvements, as well as increased human skills and competencies, all of which improve productivity and economic potential (Ignatov, 2019).

3.6 The COVID-19 Impact on Economy and Supply Chains

The COVID-19 pandemic has caused significant negative impacts on the global economy and supply chains, exposing their vulnerability and poor resilience. The World Health Organization (WHO) stated COVID-19 a global pandemic on 11th March 2020, after first announcing a public health emergency of international concern on 30th January 2020 due to the outbreak of the novel virus SARS-CoV-2. This crisis has affected countries worldwide and is considered equal to or worse than the 2008-2009 financial crisis, affecting both demand and supply, according to the International Monetary Fund (IMF, 2020, as cited in Fonseca and Azevedo, 2020).

During the crisis, many central banks have notably pumped liquidity into the market to help fund the dramatic expansion in government spending, especially in the United States, Eurozone, and Japan. Governments worldwide have declared stimulus plans amounting to $10.6 trillion as of April 10, 2020, highlighting the support of citizens' basic needs, the preservation of businesses and jobs, and the reinforcement of the health and care sectors (Mckinsey b, 2020; cited in Fonseca and Azevedo, 2020).

The pandemic has impacted various sectors, including Transportation, Tourism, Oil, Gas, Mining, Metals, Manufacturers, and Retailers, resulting in significant

decreases in demand and supply shortages (Deloitte, 2020). To address such crises, global coordinated actions, such as macroeconomic and financial imbalances, could have prevented severe consequences, as research has shown (Catte et al. 2001; cited in Fonseca and Azevedo, 2020). Fonseca & Domingues (2017) suggest that in today's fast-paced and interconnected digital era, businesses must monitor both internal and external environments and key concerns that impact their capacity to provide quality products and meet the expectations of customers and key stakeholders.

3.6.1 Impact on Supply Chains

The COVID-19 pandemic has exposed the vulnerability and fragility of global supply chains, revealing their low resilience. The pandemic created an issue that affects both supply and demand, making it complicated to respond effectively (Fonseca and Azevedo, 2020). Initially, there was a supply-side shock, followed by an important escalation on the demand side due to the implementation of containment policies. Governments' primary focus was to address the COVID-19 health issues by imposing social distance constraints on the population, ramping up hospital capacity, and gathering tests, medical supplies, and equipment (Fonseca and Azevedo, 2020).

One lesson learned from the crisis is the important need to design more robust, resilient, and smarter supply chains. The multi-sourcing, decentralization of capacity, and small batch digitization and production could be instrumental in structuring future supply chains (Fonseca & Azevedo, 2020).

Applying lean principles across supply chain echelons effectively can bring potential benefits for all parties. However, lean practices may not work well when there are sudden changes or unpredictability in external events. Supply chains are not made for once-in-a-lifetime disruptions and recovery (Simchi-Levi, 2015; cited in Fonseca & Azevedo, 2020).

The COVID-19 crisis revealed significant shortcomings in pharma and medical supplies industries, such as lack of personal protective equipment for health

workers in hospitals, leading Governments to emphasize domestic production of medical supplies (Mckinsey a, 2020; cited in Fonseca & Azevedo, 2020).

The pandemic has caused unprecedented global shocks with devastating effects on international trade, creating gaps in the supply of raw materials, interruptions in production and marketing due to logistical issues, and late product delivery (Dickinson & Zemaityte, 2021). Changes related to export-import operations have occurred due to the COVID-19 crisis, including alterations to export decisions, market prospecting, business relationship establishment, negotiation and contracting, and contract execution (Belu, 2021).

Export-import operations, strategic alliances/international cooperation, and implantation abroad are ways to enter foreign markets, with import being a premise for export operations (Popa & Belu, 2018, as cited in Belu, 2021). Global supply chains need to be more resilient and robust, with decentralized capacity, small batch production, multi-sourcing, and digitization to be better prepared for future disruptions (Fonseca and Azevedo, 2020).

The negative interdependence between energy prices and European exports may be caused by the confining impact of additional fuel taxes. The prices for energy resources in the European Union are known to be higher as compared to other regions of the world including the USA and China. Raising fuel excises will instantly lead to a further increase of energy prices. When energy prices increase, businesses try to save on energy costs, which leads to improved energy efficiency. However, higher energy prices also increase the cost of European products more expensive in external markets. Moreover, businesses may focus on markets with higher income, and it may not enter markets with lower income, limiting their export and opportunities. In this way, an apparent benefit for the economy i.e., the increase of energy effectiveness may determine reduce of competitiveness of European exports (Ignatov, 2020).

Deconinck, Avery, Jackson (2021) discusses the impacts of the COVID-19 pandemic on food supply chains. The authors identify several key challenges that the pandemic has created for the food industry, including supply chain

disruptions, reduced demand for certain products, and increased food waste. They also provide policy recommendations for how governments and industry stakeholders can work together to mitigate these challenges and strengthen the resilience of food supply chains in the face of future crises.

3.7 EU Semiconductor Supply Chain: Vulnerabilities and Challenges Exposed by the COVID-19 Pandemic

The COVID-19 pandemic emphasized the vulnerability of the semiconductor supply chain, which is impacted by a significant shortage since late 2020, hindering industry recovery (Bassot, 2022). Due to high geographic concentration, interdependence, and capital-intensive nature of the industry, the global supply chain is exposed to a wide range of potential disruptions. A large semiconductor company may rely on up to 16,000 suppliers globally, and there is one region over 50 choke points who holds more than 65% of the global market share (semiconductors.org, 2021).

3.7.1 EU's Struggle for Competitiveness in the Semiconductor Industry against East Asia and the USA

Europe has less than 10% of the world's manufacturing capacity, with 100% of advanced technology fabrication based in East Asia. Two companies only in Taiwan and South Korea can manufacture chips at 5nm, and Taiwan produces 92% of these chips. The EU's strategy to increase its share of the world's supply has failed, with the region only having a strong position in some segments of the chips supply chain. As shown in Figure 1, Europe has a good position in some parts of the chip supply chain but is behind in many other parts. Majority of the companies in the design and testing segment are based in Asia, while vendors of chip design software are in the United States. The EU's microelectronics sector employs around 219,000 people, with an annual growth rate of 3%. It is responsible for 455,000 high-skilled jobs and enables 2.6 million jobs in total. Each worker employed in the semiconductor industry supports an additional 5.7 jobs in other sectors (Ragonnaud, 2022).

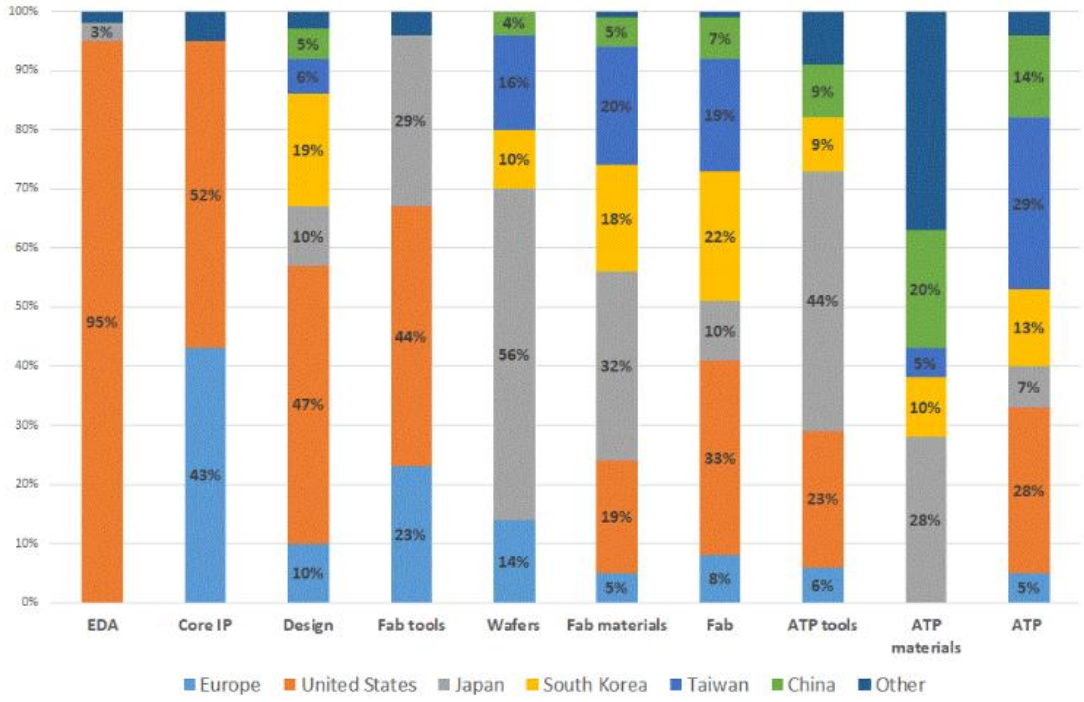

Figure 1. The different segments along the chips value chain in global market shares (Kearney 2021; cited in Ragonnaud, 2022).

3.7.2 Investing in Semiconductor Manufacturing in Europe: Factors to Consider

When considering whether Europe should invest in semiconductor manufacturing, there are two important factors to consider: the presence of competitive companies and whether the policy aligns with existing institutional frameworks (Hancké and Calvo, 2022). Looking at past examples such as aerospace and biotech, it's clear that investing in mature chips is not a good idea (European Commission, 2020). The European Chips Act was proposed in response to supply chain disruptions caused by the pandemic, “but investing in mature chips may not be the best option for Europe due to its limited capabilities and high costs" (Codagnone et al. 2021). Instead, Europe should focus on manufacturing leading-edge chips or investing in other parts of the value chain such as R&D and modern chip design (Varas et al., 2021). The semiconductor industry is highly capital and research-intensive, with significant R&D expenditure and high setup and operating costs for manufacturing plants (CLEPA, 2021). Only

two countries, Taiwan, and South Korea, dominate leading-edge logic chip manufacturing, making the industry vulnerable to disruptions caused by sudden shifts in demand or geopolitical tensions (Breton, 2021; cited in Hancké and Calvo, 2022).

Nevertheless, efforts to revitalise the regional semiconductor industry are underway in Europe. For example, Germany is urging Intel to expand its proposed €17 billion chip plant project in exchange for higher subsidies. Intel is set to receive €6.8 billion in subsidies from Berlin for its manufacturing plant in Magdeburg, but the company is requesting subsidies to be increased to at least €10 billion due to rising energy and construction costs. German officials are willing to raise support but expect Intel to invest more in return. The talks come as the Biden administration offers substantial subsidies to chipmakers in the US, putting pressure on the EU to match those efforts. The project is part of Germany's strategy to reduce dependence on Asian chip suppliers and is essential for the EU's goal of doubling its share of the global semiconductor market. However, rising energy costs and inflation have created a cost gap in the project, prompting discussions within the German government to address the situation (Chazan & Waters, 2023).

Additionally, demand for chips is difficult to predict and can vary significantly over time, making it challenging for manufacturers to operate profitably (Hancké and Calvo, 2022). Although the pandemic has caused supply and demand bottlenecks, leading producers have plans to increase their production capacity in the US and Japan which would make it difficult for Europe to compete (European Commission, 2020). Ultimately as previously mentioned, Europe should focus on investing in a leading-edge semiconductor ecosystem to safeguard its sovereignty and benefit from the strong growth prospects of the industry (Codagnone et al., 2021).

3.8 USA Supply Chains

According to Ngo and Dang (2023), U.S. manufacturing has become more cost-competitive with countries experiencing increased manufacturing costs due to higher wages and the U.S.-China tariff war. However, the ability of the domestic manufacturing sector to meet the country’s demands for products was exposed as deficient during the COVID-19 pandemic. This led to a deep tiering of supply chains with suppliers scattered around the world, making the country heavily reliant on global suppliers. As a result, the U.S. fought to secure important equipment and protective gear during the health crisis, as nearly every link in the global supply chain was disrupted.

The manufacturing sector was among the industries hit hardest by the pandemic's repercussions, which drastically upended the American economy by disrupting almost every link in the global supply chain (Congressional Research Service, 2020).

3.8.1 USA’s Semiconductor Strategy: Funding and Export Control

The Biden administration in the United States considers semiconductors as a critical good for the country's economic and national security interests. To support the domestic semiconductor industry, the administration has encouraged Congress to pass legislation for additional investment in the industry (Blum, 2021). As a result, President Biden signed the "CHIPS (Creating Helpful Incentives to Produce Semiconductors) and Science Act" into law in August 2022. The Act provides US$52.7 billion in funding for various initiatives to boost the semiconductor industry in the United States (Blum, 2021).

Out of the total funding, US$39 billion is allocated for manufacturing incentives, including US$2 billion to produce 'legacy chips' that are based on larger transistors. These types of chips are mainly used in the car and defence industries (Blum, 2021). The remaining US$13.2 billion is for workforce development, research, and development, and to foster the country's chip R&D ecosystem (Blum, 2021). The President's Council of Advisors on Science and

Technology (PCAST) put forward 10 recommendations to achieve this goal. Furthermore, the Act delivers a 25% investment tax credit for capital expenses incurred in the manufacturing of chips and related equipment, which corresponds to US$24.3 billion (Blum, 2021).

To qualify for the CHIPS Act funds, beneficiaries must invest significantly in their workforce and ensure well-paid jobs. They are also not allowed to build certain facilities in China or other specified countries. This provision aligns with the US government's strategic goal of reducing reliance on foreign semiconductor manufacturers, particularly those based in China (Blum, 2021).

In 2023, the CHIPS Act will add US$5.5 billion to public investment in chip research and development alone. (Blum, 2021) However, the United States' semiconductor strategy goes beyond funding domestic initiatives. In September 2022, the US government restricted exports of some Nvidia and AMD advanced chips used by artificial intelligence systems to China. The move is part of the US government's broader efforts to slow down Chinese military programs. Furthermore, in October 2022, the US government introduced strict export controls that forbid the export of advanced chips and tools and technologies to China. Americans and companies are not allowed to support Chinese companies involved in advanced chip manufacturing. The US government also prohibits all companies worldwide from supplying certain Chinese entities with hardware or software that contains American technology (Ragonnaud, 2022).

In summary, the US government has taken various measures to support the domestic semiconductor industry and reduce reliance on foreign manufacturers, particularly in China. The CHIPS Act provides significant funding for research and development and manufacturing incentives. At the same time, export restrictions aim to slow down Chinese military programs and prevent the transfer of advanced US technology to China.

3.8.2 Impact of US Incentives on European Companies and the Shift in Investment Priorities

Volkswagen has decided to pause its planned battery plant in eastern Europe and prioritize a similar facility in North America. The company estimates that it could receive €10 billion in incentives from the United States. This decision comes because of Joe Biden's substantial package of subsidies and tax incentives for green technology, which is attracting European companies to the US. Volkswagen expects to receive around €9 billion to €10 billion in subsidies and loans from US programs such as the Inflation Reduction Act. The company wants to assess the European Union's response to Washington's incentives before proceeding with the plant in eastern Europe. The progress in North America has surpassed the decision-making process in Europe. The US incentives, particularly the Inflation Reduction Act, have raised concerns among European policymakers as they fear losing high-tech industries to the US and facing increased competition from China. The European Commission is considering loosening rules on state aid and reassessing the deployment of EU-level subsidies. However, the current draft falls short according to industry executives, who feel that the conditions offered by US states are more appealing than those in Europe. Volkswagen has not finalized the locations for its plants in North America or Europe but remains committed to building more cell factories in Europe, contingent on favourable framework conditions. Other battery makers, such as Northvolt, are also considering the US as a potential location for their giga factories due to the more concrete support offered. European battery projects are at risk of being cancelled, delayed, or scaled back, posing a significant challenge for the EU. Volkswagen acknowledges that it would have eventually pursued a North American battery plant, but the new subsidies have accelerated their plans (Milne, Nilsson et al., 2023).

3.8.3 USA’s Taiwan Dilemma

The United States faces a difficult dilemma regarding Taiwan's semiconductor industry. As the world's most advanced and largest producer of semiconductors,

Taiwan has a critical role in the global supply chain of high-tech industries, from consumer electronics to aerospace and defence (Miller, 2022).

However, the threat of China's potential military invasion of Taiwan has become a growing concern for investors and policymakers alike. The People's Liberation Army has long considered Taiwan a renegade province, and tensions have been rising in recent years as Beijing seeks to exert greater control over the island. The situation reached a new level of urgency in July 2021 when dozens of Chinese military vehicles capable of conducting amphibious assaults were seen heading towards the Taiwan Strait. While TSMC's chairman, Mark Liu, tried to reassure investors that there was no need for concern, the threat of military conflict is not one that can be easily dismissed (Miller, 2022).

The potential disruption to Taiwan's semiconductor industry would have major implications for the world economy, given that Taiwan produces more than half of the world's semiconductors. The post-COVID semiconductor shortage has already shown how vulnerable the global supply chain is to disruptions, and any conflict in Taiwan could have catastrophic consequences. If China were to invade and seize control of Taiwan's semiconductor industry, it would gain significant leverage over the global high-tech industry, allowing it to dictate terms to other countries and companies. This would be a disaster for the US, which relies heavily on Taiwanese semiconductors, and could lead to a significant loss of economic and geopolitical influence (Miller, 2022).

The US faces a difficult balancing act when it comes to Taiwan. On the one hand, it is committed to supporting Taiwan's sovereignty and democracy, and has been providing military aid to the island. On the other hand, it cannot afford to escalate tensions with China or risk a military conflict that could have catastrophic consequences. Ultimately, the US and its allies will need to find a way to ensure the security of Taiwan's semiconductor industry without provoking China. This will require creative diplomacy and a willingness to compromise, but it is essential if the world is to avoid a major economic and geopolitical crisis (Miller, 2022).

3.9 East Asia Supply Chains

Several Asian countries have revealed lower COVID-19 cases and deaths compared to other regions like the USA and Europe, which is still a bit of a mystery. Researchers suggest that the pandemic has led to both supply and demand shocks to the economy. Miyawaki and Tsugawa (2022) note that reduced consumption and foreign visitors have resulted in lower demand. The difference between Asian countries and others could be attributed to several factors, including the implementation of strict non-pharmaceutical interventions (NPIs) in Asia earlier, younger age distribution, and the geographical characteristics of Asia, including many island countries.

Goto (2022) states that Miyawaki and Tsugawa (2022) should also consider the long-term effects of physical distancing policies, changes in habits and lifestyles, and the treatment and screening of other diseases like infectious diseases, noncommunicable diseases, traffic accidents, and psychological distress.

Tanaka (2022) provides a detailed summary of how previous infectious diseases, including SARS and MERS, impacted Asian economies and how governments in Asian countries responded to COVID-19. Tanaka notes that COVID-19 led to supply shocks due to NPIs interventions such as lockdowns, while SARS and MERS primarily resulted in demand shocks. This resulted in more significant economic damage from COVID-19. Additionally, higher-income countries tended to have larger fiscal expenditures relative to GDP in response to the pandemic.

3.9.1 China’s Ambitious Plan for Semiconductor Industry

While the European Union's policies towards the semiconductor industry have mainly focused on research, global governments have been providing significant support to the industry, leading to what is sometimes referred to as a "subsidy race." Such support includes grants and tax concessions for research and development, which are mainly funded by government budgets, and financial aid in the form of below-market borrowing and equity provided by state-owned enterprises, particularly in China. The Chinese government has set ambitious

goals for its domestic chip industry through its "Made in China 2025" plan, aiming to produce 40% of the country's chip consumption by 2020 and 70% by 2025. To achieve this, the Chinese government could provide up to US$200 billion in support to its domestic chip industry between 2015 and 2025 (Ragonnaud, 2022).

3.9.2 Japan’s Push for Semiconductor Industry Growth

In 2021, Japan announced a new growth strategy that prioritized the strengthening of its semiconductor industry (Meti.go.jp, 2021), which was once the world leader in chip technologies as recently as the late 1980s. The Ministry of Economy, Trade and Industry (METI) introduced a strategy for semiconductors and the digital industry that included promoting strengthening design and technological development of next-generation semiconductors for post-5G technologies, the manufacturing of cutting-edge logic semiconductors, and supporting the global chip ecosystem and supply chain. Japan's budget for 2021 included a substantial US$6.8 billion for domestic semiconductor investment (Ragonnaud, 2022).

In May 2022, Japan and the US agreed to collaborate on next-generation semiconductors, with the Japanese government contributing US$3.5 billion to a US$8.6 billion investment by Taiwan Semiconductor Manufacturing Co (TSMC) in a new chip manufacturing plant. Additionally, Japan has provided subsidies to Micron and Western Digital in 2022 to increase their chip production in the country, totalling US$320 million and US$644 million, respectively (Ragonnaud, 2022).

In July 2022, Japan and the US agreed to establish a new joint research centre for next-generation semiconductors. The goal of the centre is to develop faster and more power-efficient semiconductors at the 2nm node, and Japan plans to organize the centre by the end of 2022 (Ragonnaud, 2022).

In November 2022, Japan announced a new investment of around US$500 million in a new chip company called Rapidus, alongside companies such as Sony, Toyota, and IBM. The goal of Rapidus is to start producing next-generation

chips under 2nm in the second half of the decade. With these initiatives, Japan is aiming to regain its position as a leader in semiconductor technologies and support its domestic chip industry (Ragonnaud, 2022).

3.9.3 South Korea Growing Influence in the Semiconductor Industry

In May 2021, South Korea announced its plans to spend about US$450 billion by 2030 to strengthen its semiconductor industry, which includes eased regulations, tax breaks, and reinforced infrastructure. The country aims to create a 'K-semiconductor belt' in the south of Seoul, bringing chip designers, manufacturers, and suppliers together. This has resulted in South Korea's subsidies lowering the cost of facility ownership by approximately 25 to 30% (Ragonnaud, 2022).

Meanwhile, in East Asia, Singapore's Chartered Semiconductor, Taiwan's UMC and Vanguard Semiconductor, South Korea's Samsung, and TSMC are competing to produce chips designed elsewhere. Most of these companies are subsidized by their governments, lowering chip production costs, and benefitting the mostly American fabless semiconductor designers they serve. Consumers have benefited from low prices and previously unthinkable devices. As semiconductor production capacity moved to Taiwan and South Korea, the capability to manufacture many of these chips also moved. Today, Taiwan and South Korea mainly produce application processors, which are the electronic brain inside each smartphone, before components are sent to China for final assembly into a phone's plastic case and glass screen. TSMC is the only manufacturer with the capacity to exclusively produce the iPhone processors in Taiwan for Apple’s devices (Miller, 2022).

3.9.4 Taiwan’s Subsidies and Motivation to Boost Semiconductor Industry

Taiwan offers various subsidies to support the semiconductor industry, including subsidies for land construction, estate costs, and facilities, and semiconductor production, with an estimated 25-30% reduction in the total cost of owning a fab. Additionally, Taiwan provides R&D investments and other incentives. To attract

foreign companies to establish chip R&D projects, Taiwan announced a $1.3 billion annual fund in June 2020, subsidizing up to 50% of all R&D costs incurred. Furthermore, it plans to invest $335 million to incentivize foreign companies to establish chip R&D facilities in Taiwan. In 2021, 39 fab construction or extension projects were declared globally, with four of them in the EU (Ragonnaud, 2022).

3.10 EU's Efforts to Strengthen its Semiconductor Industry

In its resolution of 7 July 2021, the European Parliament wanted to have a dialogue with Taiwan about semiconductors. They believe it is important for trade between the EU and Taiwan. On 16 September 2021, Parliament emphasized that EU should invest in research and innovation. They would like to make their own semiconductors to reduce their need for China. The Parliament also said in March 2022 that the Chip Act is important as it will help to reduce the EU’s dependence on other countries like China and the US (Ragonnaud, 2022).

The European Commission made a new plan on 10 March 2020, to lessen reliance on important technologies like microelectronics and make Europe's business more self-sufficient. The Commission said the electronics industry is one of 14 important sectors that need to be watched, and the chips supply chain is under a threat for many reasons. The EU Commission would like to create 20% of the world’s best and eco-friendly semiconductors by 2030. The EU is working to make a framework to achieve these aims, and co-legislators reached a provisional decision on 14 July 2022. Unfortunately, European firms are not big enough to compete with the top 10 global chip manufacturers, and forming alliances has not helped. Europe’s institutional framework means that the region is not attractive place to invest in due to high wages and low levels of subsidies. Nevertheless, the fortunate collaboration between the Interuniversity MicroElectronics Center (IMEC) and ASML, the world’s leading lithographic equipment manufacturer, demonstrates how European businesses can create innovation through cooperation. (Hancké, 2022: 590).

3.11 Military Operation and its Effects on Supply Chain

In 2014, following another worsening bilateral relation between Ukraine and the Russian Federation, the EU created a plan for energy security due to the tension between Ukraine and Russia. (European Commission, 2014b, Pipchenko et al., 2019). This plan aimed to create a foreign energy policy, review energy agreements, diversify energy sources, increase internal energy production, and build infrastructure to quickly respond to energy disruptions. This plan became the basis for the EU Energy Union's strategy, which aims to reduce dependence on energy imports and overcome energy monopolies held by other countries. Current challenges to EU energy security include diversifying energy sources, using modern technologies for nuclear energy, developing alternative and renewable energy sources, reducing carbon emissions, and implementing energy-saving technologies to make the economy less energy-intensive. The EU Energy Union's strategy aims to reduce energy import dependency and overcome the existing energy monopolies held by other countries, based on these provisions (Pipchenko et al., 2019).

During the conflict, the EU faced energy supply difficulties as several EU nations rely on Russia for oil and natural gas. The EU imposed sanctions on Russian goods, but some countries like Germany continued importing oil and gas from Russia. To reduce dependence on Russia commerce, the EU sought alternative trading partners and developed energy-processing skills. Western nations have been attempting to limit imports of oil and gas from the US and its European allies since February 2022 (Naz & Kear 2022). The media has discussed sanctions, gas transit to Europe, energy interconnection among Russia and other countries, and the use of energy resources as a weapon of hybrid warfare. (Pipchenko et al., 2019) The Ukraine crisis provided an opportunity to analyse the interactions between trade policy practices and foreign and security policy practices in the EU's external action (Freedman, 2014).

3.11.1 Effects on Semiconductor Supply

Recent developments in the war in Ukraine have raised concerns for the chip sector. The supply of semiconductor-grade neon, a key gas used in chip lithography, could be in jeopardy as about half of the global supply of neon was provided by two Ukrainian firms that had to close production in Mariupol and Odessa. Additionally, in June 2022, Russia imposed restrictions on the export of helium and neon that chip firms sourced, which has further exacerbated the situation (Ragonnaud, 2022).

The ongoing war in Ukraine has highlighted the importance of a country's position in the semiconductor supply chain. About half of the global supply of semiconductor-grade neon used in chip lithography was produced by two Ukrainian firms, which were forced to close production due to the war. Russia's chip industry, which lagged Silicon Valley, has decayed since the Cold War, and even high-priority defence projects have faced delays due to problems sourcing semiconductors. As a result, Russia's drones and military continue to rely on foreign microelectronics, and the country's dependence on foreign semiconductor technology has given the US and its allies leverage. After Russia's invasion of Ukraine, the US implemented sweeping restrictions on the sale of certain types of chips across Russia's tech, defence, and telecoms sectors, leaving Russia with little recourse. The emerging Cold War between the US and China will also be a less lopsided match when it comes to semiconductors, given Beijing's investment in the industry and the proximity of much of the chipmaking capacity America relies on to PLA missiles. Thus, it is important to note that a war of conquest is not unthinkable and that the role of semiconductors in warfare should not be underestimated (Miller, 2022).

3.11.2 EU’s Issues within the Military Operation

Due to the Russian invasion of Ukraine in February 2022 and the ongoing war, the EU imposed many sanctions on Russia, including in the energy sector. In April 2022, a coal embargo was introduced, but natural gas imports were not affected because it is hard to find alternatives quickly, and stopping imports could

cause massive economic damage. However, the natural gas supply via Nord Stream 1 was discontinued in August 2022. Natural gas is essential for electricity generation, and a disruption in supply could cause a significant impact on electricity prices and security of supply in Europe. Studies show that disruptions could have a severe impact on the energy supply system, especially during peak demand periods. To avoid such scenarios, investments in renewable energy technologies could help to reduce Europe's dependence on fossil fuel imports and increase the resilience of its energy supply system (bp.com, 2022). Furthermore, access to semiconductor chips has become the primary obstacle for Russian military equipment, and Chinese chip exports to Russia have doubled, highlighting China's semiconductor production expansion efforts (Wieringen, 2022).

3.11.3 International Economic Relations and Sanctions Policy

The EU and Japan have expressed their opposition to a US proposal that calls for a complete export ban on Russia by G7 countries. The proposal, included in a G7 leaders' statement being prepared for an upcoming summit, aims to replace the current sector-by-sector sanctions regime with a comprehensive ban on exports to Russia, with a few exceptions for agricultural, medical, and other products. However, Japanese and EU representatives have argued that such a move would not be feasible. The disagreement highlights the limited options available to G7 leaders in increasing economic sanctions against Russia. Previous efforts to impose sanctions have faced challenges due to sanctions evasion and circumvention by third countries. The focus is now on cracking down on such practices and exerting pressure on countries that have increased trade with Russia since the imposition of Western sanctions. The G7 summit, scheduled for May 19, will address various issues related to Russia's conflict with Ukraine, economic security, green investments, and the Indo-Pacific region. While the EU has agreed to multiple packages of sanctions against Russia, reaching consensus among its 27 member states has often been a complex process. Replacing the current regime with a full export ban, along with exemptions, could reopen debates and potentially weaken existing measures.

The draft statement also includes measures to restrict sanctions evasion, combat financial support for Russia's war, reduce Russian energy imports, and establish a traceability mechanism for Russian diamonds. (Foy, Inagaki et al., 2023)

3.12 Military Operations' Impact in Far East Asia

Due to the ongoing hostilities in Ukraine, many grain elevators are unable to carry out essential measures such as pest control, grain protection from rainfall, and prevention of self-heating, which increases the risk of quality deterioration. This situation, coupled with limited export transport capacity, could lead to uncertainty in next year's crop and exacerbate the food shortage crisis. The reopening of Ukrainian seaports may not be enough to salvage the 2022 harvest season, as logistics and human resources may not be arranged promptly. Ukraine's grain exports are primarily carried out through seaports on the Black Sea and the Sea of Azov, which are currently blocked. This has immediate and potentially long-term consequences on global oilseeds and grains trade, affecting susceptible regions like Asia (Unctad.org, 2022).

3.12.1 Impact in China

According to UNESCAP (2022), global tourism will be held back due to higher consumer inflation, transport costs, and rising uncertainty over employment conditions caused by the war in Ukraine, in addition to pandemic-related lockdowns in China.

Russia and Ukraine are located between Asia and Europe and are strategic to the movement of products across global supply chains, as they are located on key transport corridors within the $26 trillion Belt and Road Initiative, which both countries have signed up for. The conflict in Ukraine poses a critical question about how China will react and how the rest of the world will respond to China (Wilson, 2022).

China and Russia have a close partnership that has no limits, trading minerals, grain, raw materials, and technology. While China has a long border with Russia,

the two countries have had a rocky relationship with the US due to its military and economic power. The US-China relationship has been fractious for many years, with the US taking measures to counter China's growth, such as the Trans-Pacific Partnership (Wilson, 2022).

The invasion of Ukraine has put China in a complicated position, as supporting Russia openly risks secondary sanctions and a boycott of Chinese exports. If should such a scenario come to pass, it would have a significant impact on some of the world's busiest trade lanes and many Western firms that depend on China for manufactured products. This situation has prompted companies and governments worldwide to re-evaluate their dependencies and re-analyse their manufacturing and assembly footprints, according to Larry Fink, founder of BlackRock Inc (Wilson, 2022).

3.12.2 Impact in Japan

Japan's economic security law has four main pillars, and one of them is to ensure robust supply chains. However, the invasion of Ukraine by Russia has revealed vulnerabilities in other areas, including the supply chains for energy and food. As the world's largest energy importer, Japan relies heavily on Russia for its supply of natural gas, crude oil, and coal. Since February 2022, the prices of these commodities have increased significantly, exacerbating Japan's short- and medium-term energy outlook. Energy security has become a central concern for Japanese Prime Minister Kishida Fumio's economic-security efforts (Lebreton, 2022).

To mitigate the effects of rising fuel and raw material costs on Japanese citizens, the government has enacted several relief packages and is reconsidering its stance towards nuclear energy. Kishida has called for the restart of Japan's idled nuclear reactors and the development of 'next generation' reactors. Additionally, the government is reinforcing its food security and supply chains by increasing domestic production, import diversification, and stockpiling. The yen's depreciation has further destabilized the domestic market for these critical goods,

reducing the purchasing power of consumers and companies and risking an increase in Japan's account deficit (Lebreton, 2022).

Despite these challenges, Kishida remains committed to international cooperation on economic security. Japan has already created a ministerial position for economic security and added an economic division to its National Security Secretariat, pioneering this concept. The fallout from Russia's invasion of Ukraine may cause Japan's strategy to shift further, but its experience thus far has demonstrated that economic robustness is a prerequisite for an effective economic security policy (Lebreton, 2022).

3.12.3 Impact in South Korea

South Korea established a task force to assess the economic consequences of growing tensions between Moscow and Kyiv before Russia’s invasion of Ukraine and before the extent of Russian actions became clear. (Park 2022a; cited in Pardo & Kim, 2023) Most notably, the Moon government established a task force on January 28 to assess the economic influence of the crisis in Ukraine, based on which the government convened an Economic and Security Strategic meeting on February 14, presided by Moon himself (Park 2022b; cited in Pardo & Kim, 2023). Moon's emphasized the need to address the challenges brought by the Ukraine crisis and the impact on global supply chains in his speech following the meeting. (Pardo & Kim, 2023)

On February 22, Moon chaired a National Security Council (NSC) meeting to address various measures including the protection the well-being of South Korean nationals and businesses in Ukraine (Lee 2022c; cited in Pardo & Kim, 2023). Despite Russia being South Korea's 10th largest trading partner, with total trade worth $27.3 billion, amounting to 2.2% of Korea's total trade, international sanctions cast a blow to the 13 Korean companies in Ukraine and the 40-plus South Korean companies that operate in Russia (Baek and Park 2022a, 2022b, 2022c; cited in Pardo and Kim, 2023). For instance, Hyundai Motor Co., the second-largest car manufacturer in Russia, shut down its production plant in St.

Petersburg because of component shortages, including automotive semiconductors (The Korea Herald, 2022).

Samsung, the biggest vendor of smartphone, and television in Russia, halted all exports to country, including consumer electronics chips, due to disruptions in global logistics and unstable exchange rates (Woo, 2022). Likewise, LG suspended shipments of its products to Russia, further impacting South Korean businesses. The invasion of Ukraine and the resulting sanctions also dealt a blow to South Korea’s New Northern Policy, which aimed to connect South Korea to Russia and other parts of Eurasia through North Korea, with plans to build railroads and roads (The Presidential Committee on Northern Economic Cooperation 2022, as cited in Pardo and Kim, 2023).

3.12.4 Impact in Taiwan

Taiwanese perceptions related to defence matters have been influenced by the Ukraine War (Hsiao, 2022). The ongoing US-China trade war and the Covid-19 pandemic have intensified the pressure to reform the supply chain, as the demand for supply-chain resilience has increased. The US and EU's official reviews on critical supply-chain vulnerability have made "strategic autonomy" the centre of policy considerations in reforming the supply chain (Lee 2022), and Russia's invasion of Ukraine has further added a sense of urgency. In particular, the possible supply disruption of Neon from Ukraine threatens the semiconductor industry, which has been strongly growing for two decades due to geographical specialization and cost efficiency. However, the over-concentration of supply chains in only a few countries has become a potential threat to national security as geopolitical tensions continue to escalate. As the majority of semiconductor manufacturing capacity is in China, Taiwan and South Korea, the situation needs to be carefully monitored (Hsu, 2022).

4 Conclusions

This study has shed light on the critical issues impacting the semiconductor industry and supply chains in Europe, particularly in the context of the disruptions caused by the military operation in Ukraine and the COVID-19 crisis. The increasing importance of semiconductors in various industries, coupled with the distribution challenges faced by Europe, has demanded a comprehensive understanding of the situation and the identification of potential solutions.

The findings of this study highlight the urgency for Europe to strengthen its semiconductor and battery manufacturing capacities, mitigate supply chain vulnerabilities, and foster a conducive environment for technological innovation. Firstly, the push by Germany to expand Intel's chip plant through higher subsidies emphasizes the need to bolster Europe's semiconductor production capabilities. The negotiations between Germany and Intel demonstrate the willingness of European countries to invest substantial financial resources to secure their position in the global semiconductor market. The proposed subsidies, under the European Chips Act, reflect the collective effort to mobilize public and private investments to strengthen the chip industry within the EU. However, it is essential for Europe to strike a balance between financial support and industry investment to ensure sustainable growth and competitiveness.

Secondly, the decision by Volkswagen to delay its planned battery plant in eastern Europe in favour of a facility in North America demonstrates the impact of US incentives on European companies. The substantial subsidies offered by the US government through the Inflation Reduction Act and other schemes have accelerated investment plans and raised concerns about the potential loss of high-tech industries to the US. This development underscores the need for the European Commission to reassess its state aid regulations and provide concrete support to battery manufacturers to prevent the erosion of Europe's competitive position.

Furthermore, the resistance from the EU and Japan to the US proposal for a complete export ban on Russia highlights the complexities involved in international economic relations and the limitations of punitive measures. The divergent perspectives on the feasibility of such a ban underscore the challenges faced by G7 countries in devising effective strategies to address Russia's actions. Instead, a focus on strengthening existing sanctions, preventing sanctions evasion, and reducing energy imports from Russia seems to be the preferred approach. Additionally, the emphasis on accountable mechanisms for Russian diamonds reflects the intention to curb the Kremlin's financial gains from their export.

Considering these developments, Europe must take proactive measures to enhance its economic security and reduce dependence on external supply chains. The implications of the COVID-19 pandemic and the military operation in Ukraine on semiconductor supply chains highlight the need for Europe to increase its domestic production capabilities. It is crucial for European countries to invest in the development of domestic semiconductor and battery manufacturing capabilities. This will require collaboration between governments, industry stakeholders, and research institutions to foster innovation, improve infrastructure, and create an enabling environment for these industries to thrive.

In conclusion, the insights provided in this study can inform policymakers, industry leaders, and stakeholders in making informed decisions and formulating effective strategies to address the challenges and seize the opportunities in the evolving landscape of the semiconductor industry. By strengthening its semiconductor and battery manufacturing capacities, mitigating supply chain vulnerabilities, and fostering a conducive environment for technological innovation, Europe can enhance its economic security, reduce dependence on external sources, and position itself as a global leader in these critical industries. The findings of this study recommend that Europe should invest in developing its semiconductor production capabilities to reduce reliance on imports and reduce the risks associated with supply chain disruptions. Additionally, policymakers should consider implementing policies that motivate semiconductor companies

to invest in domestic production capabilities. The implications of this research extend beyond the semiconductor industry, demonstrating the significance of supply chain resilience in ensuring economic security.

References

Ahlstrom D., (2010). *Innovation and growth: How business contributes to society*. The Academy of Management Perspectives, 24(3): 10-23.

Baek, B.Y. and Park, J.H. (February 2nd, 2022). *Korean companies on edge due to mounting Russia-Ukraine tension*. The Korea Times. Available at: https://www.koreatimes.co.kr/www/tech/2022/02/419_ 323183.html [Accessed at 20.02.2023].

Bassot É., (January 10th, 2022). *Ten issues to watch in 2022*. In-Depth Analysis. Available at: https://www.europarl.europa.eu/RegData/etudes/IDAN/2022/698852/EPRS_IDA(2022)698852_EN.pdf [Accessed at: 17.02.2023].

Belu, N. (2021). *COVID-19 Pandemic Impact on the Exports and Imports*. Romanian Economic Journal, 24(82), pp. 35-50. DOI: 10.24818/REJ/2021/82/03.

Bickerton, C. (2022). *Thinking like a member-state*. New Left Review, 138, pp. 67-78.

Blum, J. (2021). *The great chip race*. Nature Electronics, 4(9), pp. 619-621. https://doi.org/10.1038/s41928-021-00628-1.

Bp, (2021). *Statistical Review of World Energy*. 70th Edition. Available online: https://www.bp.com/content/dam/bp/country-sites/de_de/germany/home/presse/broschueren/bp-stats-review-2021-full-report.pdf [Accessed at: 18.04. 2023].

Burkacky, O., Dragon, J., and Lehmann, N., (April 1st, 2022). *The Semiconductor Decade: A Trillion-Dollar Industry*. McKinsey & Company. Available at: https://www.mckinsey.com/industries/semiconductors/our-

insights/the-semiconductor-decade-a-trillion-dollar-industry [Accessed at: 15.04.2023].

Chazan, G., & Waters, R., (April 14th, 2023). *Germany urges Intel to expand plans for €17bn chip factory*. Financial Times Europe. Available at: https://www.ft.com/content/ba5aa0c8-76a3-4241-88cc-b88b1d8dc0de [Accessed at 13.05.2023].

Chen Z., (April 20th, 2016). *China, the European Union and the fragile world order*. JCMS: Journal of Common Market Studies, 54(4): 775-792.

Chopra, S. & Meindl, P., (2001). *Supply Chain Management*. Prentice Hall.

Chopra, S., & Meindl, P., (2013). *Supply chain management: strategy, planning, and operation (5th ed.).* Pearson Education.

CLEPA, European Association of Automotive Suppliers., (June 2021). *Semiconductor manufacturing and supply chain resilience building on strengths and capturing opportunities*. Available at: https://clepa.eu/wp-content/uploads/2021/06/CLEPA-report-Semiconductor-manufacturing-and-supply-chain-resistance.pdf [Accessed at: 13.03.2023].

Codagnone, C., Liva, G., Gunderson, L., Misuraca, G. & Rebesco, E., (October 2021). *Europe's digital decade and autonomy*. Available at: https://www.europarl.europa.eu/RegData/etudes/STUD/2021/695465/IPOL_STU(2021)695465_EN.pdf [Accessed at: 17.04.2023].

Congressional Research Service., (December 7th, 2020). *COVID-19 and domestic PPE production and distribution: Issues and policy options*. Congressional Research Service. Available at: https://crsreports.congress.gov/product/pdf/R/R46628 [Accessed at: 17.04.2023].

Deconinck, K., Avery, G., & Jackson, P., (2021). *Food Supply Chains and Covid-19: Impacts and Policy Lessons*. EuroChoices, Vol.19 (3), 34-39. Hoboken, NJ: John Wiley and Sons Inc. https://doi.org/10.1111/1746-692X.12280.

Deloitte., (2020). *Addressing the financial impact of Covid-19 Navigating Volatility & Distress*. Available at: https://www2.deloitte.com/az/en/pages/about-deloitte/articles/covid-19-navigating-volatility-and-distress.html [Accessed at: 17.04.2023].

Dickinson, R., & Zemaityte, G., (August 8th, 2021). *How has the COVID-19 pandemic affected global trade?.* Available at: https://www.weforum.org/agenda/2021/08/covid19-pandemic-trade-services-goods/ [Accessed at: 10.04.2023].

European Commission., (2022). *Communication from the Commission to the European Parliament, the council, the European economic and social committee and the committee of the regions. A chips act for Europe.* Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52022DC0045 [Accessed at: 18.04.2023].

European Union., (December 17th, 2007). *Treaty of Lisbon amending the Treaty on European Union and the Treaty establishing the European Community*. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A12007L%2FTXT [Accessed at: 12.04.2023].

Fawcett, S. E., Magnan, G. M., & McCarter, M. W., (2008). *Benefits, barriers, and bridges to effective supply chain management*. Supply Chain Management: An International Journal, 13(1), 35-48.

Fonseca, L. M., & Domingues, J. P., (2018). *The best of both worlds? Use of Kaizen and other continuous improvement methodologies within Portuguese ISO 9001 certified organizations*. The TQM Journal, 30(4), 321-334.

Foy, H., Inagaki, K., & Sevastopulo, D., (April 24th, 2023). *Allies resist US plan to bar exports for Russia*. Financial Times. Available at: https://www.ft.com/content/ee8c2ade-4f94-426f-881b-d6f9621231b8 [Accessed at 13.05.2023].

Freedman, L., (May 2014). *Ukraine and the Art of Crisis Management*. Survival, 56(3), 8. 10.1080/00396338.2014.920143.

GEP., (September 13th, 2022). *Global Chip Shortage: Bullwhip Effect Is Worsening Semiconductor Crisis*. Market Intelligence Blogs. Available at: https://www.gep.com/blog/mind/chip-shortage-bullwhip-effect-worsening-semiconductor-crisis [Accessed 04 April 2022].

Goto, R., (August 29th, 2022). *Comment on "Health and public health implications of COVID-19 in Asian countries"*. Asian Economic Policy Review, 17(1), 39-40. https://doi.org/10.1111/aepr.12368.

Hancké, B. & Garcia Calvo, A., (2022). *Mister Chips goes to Brussels: On the Pros and Cons of a Semiconductor Policy in the EU*. Global Policy, 13(4), 585-593. https://doi.org/10.1111/1758-5899.13096.

Hsiao R., (2022). *The Ukraine War and Its Impact on Taiwanese Perceptions on Defense Issues*. Global Taiwan Brief, 7(9).

Hsu, K.T.T., (September 2022). *Taiwan as a Partner in the U.S. Semiconductor Supply Chain.* Wilson Center. Available at: https://www.wilsoncenter.org/sites/default/files/media/uploads/documents/2022-09_Taiwan_SemiconductorSupplyChain_Hsu.pdf [Accessed at 24.04.2024].

Ignatov, A., (February 2019). *Analysis of the dynamics of the European economic security in the conditions of a changing socio-economic environment.* Journal of Security and Sustainability Issues, 8(3), 77-87. DOI: 10.30682/nm1902b.

Ignatov, A., (February 2020). *Entrepreneurial performance of the European Union - pivot of its economic security*. New Medit, 19(2), 113-131. DOI: 10.30682/nm2002h.

Jennings, R., (November 9th, 2017). *China Looks to Chip Away at Taiwan's Semiconductor Dominance*. Forbes. Available at: https://www.forbes.com/sites/ralphjennings/2017/11/09/an-upstart-upstream-high-tech-sector-in-china-threatens-now-dominant-taiwan/ [Accessed: 26.04. 2023].

Johnson, D. W., (2017). *Social interdependence: Interrelationships among theory, research, and practice*. Routledge.

Kearney., (February 23rd, 2022). *Europe's urgent need to invest in a leading-edge semiconductor ecosystem*. Available at: https://www.kearney.com/documents/291362523/291371424/Europes+urgent+need+to+invest+in+a+leading-edge+semiconductor+ecosystem.pdf/f3ec1e30-b8ff-b367-417c-62cf476342ea?t=1636562554000 [Accessed at: 19.04.2023].

Lebreton, M., (September 8th, 2022). *Japanese supply chains and the fallout from Russia's invasion of Ukraine*. IISS Online Analysis. Available at: https://www.iiss.org/online-analysis/online-analysis/2022/09/japanese-supply-chains-and-the-fallout-from-russias-invasion-of-ukraine/ [Accessed at 26.04.2023].

Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., & Zacharia, Z. G., (May 10th, 2001). *Defining supply chain management*. Journal of business logistics, 22(2), 1-25. https://doi.org/10.1002/j.2158-1592.2001.tb00001.x.

Miller, C., (2022). *Chip War: The Fight for the World's Most Critical Technology*. Scribner.

Milne, R., Nilsson, P., & Campbell, P., (March 8th, 2023). *VW puts European battery plant on hold as it seeks €10bn of US support*. Financial Times. Available at: https://www.ft.com/content/6ac390f5-df35-4e39-a572-2c01a12f666a [Accessed at 13.05.2023].

Ministry of Economy, Trade and Industry., (June 4th, 2021). *Strategy for semiconductors and the digital industry*. Available at: https://www.meti.go.jp/english/press/2021/0604_005.html [Accessed at 20.04.2023].

Miyawaki, A., & Tsugawa, Y., (August 1st, 2022). *Health and public health implications of COVID-19 in Asian countries.* Asian Economic Policy Review, 17(1), 18–36. https://doi.org/10.1111/aepr.12358.

Naz, F., & Kear, M., (2022). *Impact of Ukraine War on Global Energy and Food Supply Chains: A Case Study of South Asia*. Institute of Strategic Studies Islamabad, Strategic Studies, Winter Issue, Vol. 42, No. 2, 2022, 38-53. Doi: 10.53532/ss.042.02.00236.

Ngo, C. N., & Dang, H. (July 5th, 2023). *Covid-19 in America: Global supply chain reconsidered*. World Economy, 46, 256-275. Doi: 10.1111/twec.13317.

Pacheco Pardo, R., & Kim, S. (February 28th, 2023). *South Korea: Siding with the west and distancing from Russia*. International Politics, 1-16. Doi: 10.1057/s41311-023-00431-1.

Pipchenko, N., (2019). *Current challenges to the EU integration policy*. Modelling the New Europe, (31), pp. 1-11. doi: 10.24193/OJMNE.2019.31.03.

Schwarz, H. M., (May 19th, 2022). *The European Union, the United States, and trade: metaphorical climate change, not bad weather*. Politics and Governance, 10(2), 186-197. DOI: 10.17645/pag.v10i2.4903.

Schwarze, J. (2006). *The development of the European Union from a common market to a political union*. Ritsumeikan Law Review, 23, 91-98.

Semiconductor Industry Association., (April 1st, 2021). S*tudy Identifies Benefits and Vulnerabilities of Global Semiconductor Supply Chain, Recommends Government Actions to Strengthen It.* Available at: https://www.semiconductors.org/study-identifies-benefits-and-vulnerabilities-of-global-semiconductor-supply-chain-recommends-government-actions-to-strengthen-it/ [Accessed at 11.04.2023].

Semiconductor Industry Association., (February 3rd, 2023). *Global Semiconductor Sales Increase 3.3% in 2022 Despite Second-Half Slowdown*. Available at: https://www.semiconductors.org/global-semiconductor-sales-increase-3-2-in-2022-despite-second-half-slowdown/#:~:text=WASHINGTON%E2%80%94Feb.,half%20of%20the%20year%2C%20however [Accessed at 28 April 2023].

Stueber, J., (2022). *The Trade-Security Nexus in EU External Action: A Practice Approach. Springer*. https://doi.org/10.1007/978-3-030-90796-9.

Tanaka, S., (January 2022). *Economic impacts of SARS/MERS/COVID-19 in Asian countries*. Asian Economic Policy Review, 17(1), 41–61.

The Korea Herald., (March 8th, 2022). *Hyundai Motor's factory in Russia remains closed amid Ukraine crisis: company officials*. Available at: http://m.koreaherald.com/view.php?ud=20220308000924 [Accessed at 22.04.2023].

UNCTAD., (June 28th, 2022). *Maritime trade disrupted: The war in Ukraine and its effects on maritime trade logistics.* Available at: https://unctad.org/system/files/official-document/osginf2022d2_en.pdf [Accessed at 25.04.2023].

UNESCAP., (2022). *The war in Ukraine: Impacts, exposure and policy issues in Asia and the Pacific.* Available at: https://www.unescap.org/sites/default/d8files/knowledge-products/ESCAP-2022-PB-War-in-Ukraine.pdf [Accessed at 25.04.2023].

van der Vorst, J.G.A.J., (2004). *Supply Chain Management: Theory and Practices*. The Netherlands: University Press.

Varas, A., Varadarajan, R., Goodrich, J., & Yinug, F., (April 2021). *Strengthening the global semiconductor value chain in uncertain times*. BCG/SIA. Available at: https://web-assets.bcg.com/9d/64/367c63094411b6e9e1407bec0dcc/bcgxsia-strengthening-the-global-semiconductor-value-chain-april-2021.pdf [Accessed at 14.04.2023].

Wieringen van K., (2022). *Global Semiconductor Trends and the Future of EU Chip Capabilities*. Available at: https://espas.eu/files/Global-Semiconductor-Trends-and-the-Future-of-EU-Chip-Capabilities-2022.pdf [Accessed at 06.05.2023].

Wilson, M., (2022). *The War in Ukraine and its Long-Term Impact on Global Supply Chains*. Cardiff University, Wales Governance Centre. Available at: https://www.cardiff.ac.uk/__data/assets/pdf_file/0004/2628166/PARC-Industry-Insight_The-War-in-Ukraine-and-its-Impact-on-Global-Supply-Chains_FINAL.pdf [Accessed at 24.04.2023].

Woo, J.Y., (March 7th, 2022). *Samsung forced to stop shipments to Russia over currency, logistics issues*. Yonhap News. Available at: https://en.yna.co.kr/view/AEN20220307007200320 [Accessed at 25.04.2023].