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Charging Forward or Draining Momentum: An Exploratory Comparative Analysis of EU and US Resilience Policy in Lithium-Ion Battery Value Chains

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CHARGING FORWARD OR DRAINING MOMENTUM?

AN EXPLORATORY COMPARATIVE ANALYSIS OF EU AND US RESILIENCE POLICY IN LITHIUM-ION BATTERY VALUE CHAINS

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Acknowledgements

This thesis will likely mark the end of my studies at Leiden University, a city and a university that I look back on with fondness. When I first conceptualized this research project, I did not expect the challenge to be as big as it has turned out to be. Very rarely have I struggled this hard. The finished thesis represents a confirmation of what I have considered one of the defining and least understood aspects of the transition to a sustainable, green economy. The field of lithium-ion batteries and resilience policies is still developing each day. Friend-shoring, a novel concept in this field, which indicates that supply- or value chains are recalibrated towards allies, had not yet reached the prominence that it has today. To watch these developments makes me confident that this research projects is absolutely vital, and I hope it will inspire more to study industrial policy and global value chains from both a theoretical- and empirical point of view.

When I started this project, the world seemed very different from what it is today. The lockdowns during the COVID-19 pandemic have really challenged me, and I have at times, struggled to cope with the isolation, restrictions, and difficult news that we as a society have had to endure. I feel blessed to have been given the time to work on the project, explore new avenues of industrial policy, and discover the insights at my own pace.

I want to finish this project by thanking some people that have helped me achieve this point. Firstly, my supervisor Fabio, whom I have never had the pleasure of meeting in person, but to whom I owe an incredible debt. Not just for introducing me to the wonderous world of industrial policy, but for allowing me to develop this project as I wanted. I hope he is proud of what I have put up. I also want to thank Djuul, Roel, and Anton, who have supported me during the writing of the thesis. And I want to dedicate this project to my Public Administration buddies: Rico, Terri, and Quinten. This thesis is dedicated to them, for their amazing efforts.

Abstract

Industrial policy has become one of the most pressing issues in contemporary policymaking. State intervention in the market has long been considered irrelevant, irreprehensible, or unsuccessful, but the recent crises, including the pandemic, have boosted its name amongst policymakers across the world. However, the academic literature on industrial policies within comparative political policy literature is still lacking, and would benefit from more research.

Taking an exploratory comparative approach, this thesis research variations of industrial policies related to the management of lithium-ion battery value chains in the United States and the European Union. Several researchers have observed different types policies that have been put forward by policymakers to strengthen global value chains, but these analyses have been lacking a strong link with theoretical frameworks on industrial policy and policy instrument literature. This research fills the gap by linking academic literature on industrial policy, value chain resilience, and policy instruments analysis to provide constructive insights into existing policy proposals and documents.

This thesis finds a strong link between the historical preferences of governments in industrial policy mixes and the specific policies put forward to strengthen lithium-ion value chains. It indicates that, although resilience policies of the United States and the European Union are in line with industrial policy in other areas, there are shifts in the instrument mix that warrant future research to improve our understanding of industrial policy in the twenty-first century.

Key words: Industrial Policy, Global Value Chains, Lithium-ion Batteries, European Policy, Comparative Political Economy, Policy Instruments Analysis, United States, Resilience, European Battery Alliance, Innovation policies

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List of Acronyms and Abbreviations

ATVM	Advanced Technology Vehicles Manufacturing Loan Program
CEU	Council of the European Union
CME	Coordinated market economies
CPE	Comparative political economy
DME	Dependent market economy
DPA	Defense Production Act
EBA	European Battery Alliance
EC	European Commission
EIB	European Investment Bank
EO	Executive Order
EP	European Parliament
ERMA	European Raw Materials Alliance
ESM	European Single Market
EV	Electric vehicle
EU	European Union
FCAB	Federal Consortium for Advanced Batteries
GFC	Global Financial Crisis
GM	Growth Model
GSC	Global supply chain
GVC	Global value chain
IPCEI	Important Projects of Common European Interest
JRC	Joint Research Centre (of the European Commission)
LME	Liberal market economy
LPO	Loans Programs Office

MEV	Main Explanatory Variable
MSSD	Most Similar Systems Design
OECD	Organization for Economic Co-operation and Development
PPE	Personal protective equipment
R&D	Research and development
TTC	Trade and Technology Council
US	United States
VoC	Varieties of Capitalism
WTO	World Trade Organization

1. | Introduction

Over the course of the COVID-19 pandemic, global supply chains (GSC), also known as global value chains (GVC)[1], went from relatively unknown but essential facets of globalization and consumer culture to the most watched and discussed facet of international trade (Baldwin & Freeman, 2021; The Economist, 2022; Siripurapu, 2021b). GVCs are broadly defined as the journey of a product, from the conception of an idea to the assembling of the components, and from the extraction of materials, either through mining or recycling, to the sale of the item (Golini et al., 2016). Prior to the pandemic, GVCs had been watched closely by policy analysts, academics, and businesses who rely upon their functioning for profits and their survival (Lund et al., 2020; Miroudot, 2020b; Tang, 2006). However, the pandemic-induced spending spree of millions stuck at home during lockdowns, requiring everything from laptop stands to exercise bikes, boosted global demand for goods to an unprecedented level. Additionally, public healthcare restrictions to combat COVID-19, for instance, in China, the world's primary location for production, have disrupted global shipping, further complicating the economic recovery from the pandemic (Hollinger et al., 2022; Wakabayashi, 2020). These more publicly visible disruptions to the GVCs have boosted public awareness of the risk resulting from global interdependencies in supply chains and boosted political and public interest in calling for more flexibility, robustness, and resilience of GVCs (Lund et al., 2020; Schneider-Petsinger, 2021; Siripurapu, 2021b).

Governments around the world have taken note of the severe consequences that disruptions such as a global pandemic can cause to GVCs, threatening the access of (multinational)

[1] The concepts of global supply chains (GSCs) and global value chains (GVCs) are often used interchangeably to describe a series of processes which include, the research and development (R&D) of a product, the extraction of raw materials, the construction of products, transportation of those products, and marketing to consumers. These processes occur across different operational levels of a company and at a global scale. For the purpose of clarity and accuracy, this thesis will refer to GVCs in its analysis. For a broader definition, and the differences between GSCs and GVCs, see Chapter 2 (See e.g., Golini et al., 2016; Schneider-Petsinger, 2021).

corporations to natural resources and goods, which impacts both public services and private businesses (Schneider-Petsinger, 2021). An example of how these disruptions can impact GVCs was seen early on in the pandemic, as desperate governments were scrambling to buy personal protective equipment (PPE), critical for frontline healthcare workers in hospitals and other care facilities. The sudden explosive demand for PPE caught policymakers in, for instance, Europe, both at the member state- and European level, off guard. European Union (EU) Member States faced pressure from citizens to adequately respond to the public health crisis (He et al., 2021; Stockton et al., 2020). Although the European Commission (EC) made several attempts to streamline coordination for collective procurement of PPE, medical equipment, such as ventilators, and the transportation of these goods, many EU Member States put in place unilateral policies aimed at guarding national supplies. These governments, including France, Germany, and Belgium, imposed export restrictions and set up individual supply chains with the goal of importing medical equipment and PPE for their respective national health services. This fractured the already fragile supply chains that supported the EU's response to the health crisis. Their actions to restrict supply chains for PPE in the interest of national security led to accusations of "undermining EU solidarity and the single market" (Martuscelli & Collins, 2021; Stockton et al., 2020, para. 90.) Similar restrictive responses to disruptions in the PPE and vaccine supply chains during the pandemic occurred in the United States (US) (Hannah, 2021), China, and other countries in Asia (Coveri et al., 2020; Mendoza & Linderman, 2020; OECD, 2021a).

Policymakers have taken note of the fragility of GVCs in light of the pandemic. In a speech, Thierry Breton, the European Commissioner for the Internal Market, proclaimed that the COVID-19 pandemic would mark a profound shift in how the EU approached economic and industrial policy. Breton argued that the dependencies of the EU and its corporations on

essential materials and products from China and the US during the pandemic were indicative of a much larger and urgent problem, a "new reality well beyond the health crisis" (European Commission, 2022b, p. 1; Stockton et al., 2020). US President Joseph R. Biden has made similar claims, pointing to the lack of PPE in the early days of the pandemic as a vulnerability in US economic security that has to be resolved by building "resilience in our supply chains" (White House, 2021e, para. 30). Both Commissioner Breton and President Biden identify the supply chains and GVCs that maintain international trade as vital facets of (inter)national economic security in many sectors, including, but not limited to PPE, vaccines, and health care. The existing GVCs that support, for instance, lithium-ion battery manufacturing, an integral element of a future low-carbon and competitive EU and US electric vehicle (EV) industry, are considered extremely vulnerable to external shocks because of the strategic dependencies on raw materials (European Commission, 2021a, 2022b; Lund et al., 2020; White House, 2021a, 2021d).

The literature on the management of GVCs, the business challenges, and the policy responses has been growing in recent years, in particular, following the unprecedented disruptions brought on by the pandemic (He et al., 2021; Miroudot, 2020b; Pietrobelli et al., 2021). In boardrooms and parliaments, policies have been, and are still being developed, to strengthen existing GVCs against external shocks. This thesis adds to the literature on public policy and the management of GVCs by analyzing specific policies that have been put in place to strengthen the resilience of lithium-ion battery value chains in the EU and the US. Batteries are considered essential for both the EU and the US as part of the digital and green industrial transformation. Specifically, the manufacturing of wind turbines and the production of EVs will require a growing and steady supply of next-generation lithium-ion batteries will be a necessary condition to maintain economic performance, achieve the energy transition, and generate millions of new jobs in

green industries (Abdelbaky et al., 2021; European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, 2019; Federal Consortium for Advanced Batteries, 2021a).

As the issues in GVCs are not limited to a single company or a single country, given that the network is transnational in scale, increased international cooperation amongst like-minded states or actors has been put forward as the most optimal solution for strengthening GVCs (Miroudot, 2020b; Pietrobelli et al., 2021; Schneider-Petsinger, 2021). By combining resources, knowledge, and economic power, governments are able to set up joint procurement procedures, exchange vital information and resources, and cooperate on limiting export restrictions that would hinder GVC functioning in the aftermath of a new shock (Lund et al., 2020: Pietrobelli et al., 2021). Schneider-Petsinger (2021) argues that cooperation amongst international actors, such as the US and the EU, is essential. The US-EU Trade and Technology Council (TTC), for instance, has met several times to coordinate policy initiatives on semi-conductor value chains between both sides of the Atlantic (White House, 2022).

However, whilst several initiatives have been launched that can facilitate long-term cooperation on GVC challenges, both at the bilateral and multilateral level, competition amongst the world's largest economies can derail these efforts. As seen during the pandemic, perceived national security interests can derail cooperation between governments on GVC policies related to acquiring and sharing medical equipment and PPE. (Matthews, 2021; Stockton et al., 2020). In the field of lithium-ion battery production, similar issues can derail cooperation on GVC policy. As Schneider-Petsinger (2021, p. 39) notes, "at the same time as the US and Europe are cooperating on strengthening supply chains, the transatlantic partners' differing approaches to industrial policy, competition policy, and regulatory issues could drive a wedge between them."

To better understand how their respective industrial policies can result in different and perhaps even confrontational policy outcomes, this thesis intends to answer the following research question: **To what extent have the European Union and the United States put forward different policies to strengthen the resilience of lithium-ion battery value chains?**

This thesis will make use of a comparative Most Similar Systems Design (MSSD) approach, based on two case studies of the EU and the US, to determine how their "differing approaches to industrial policy" have impacted policymakers' strategies for addressing GVC resilience (Schneider-Petsinger, 2021, p. 39; Toshkov, 2016). Chapter 2 will provide an overview of the academic literature on GVCs, focusing on the distinct features of GVCs, and how shocks can disrupt them. Furthermore, the concept of resilience and the policies that can strengthen or weaken resilience in GVC are considered. Finally, the chapter will also explore how historians and political scientists have come to understand industrial policy, that is, the intervention of government in the market for the benefit of its national industries, specific companies, or the broader economy. The goal is to distill a theoretical framework from this literature that provides insight into similarities and differences underpinning EU and US industrial policy.

Chapter 3 and Chapter 4 further develop the theoretical framework distilled from the literature in the previous chapter to develop several hypotheses concerning the thesis' research question. Additionally, the research design will be elaborated upon, looking at the benefits of the MSSD, the possible limitations, and the operationalization of the relevant variables. Chapter 5 and Chapter 6 will then present the empirical findings from the two case studies, followed by the comparison of policy outcomes in Chapter 7 based on the previous chapters. Chapter 8 provides a brief discussion of the research, reflects on the limitations of the research, and considers future research opportunities.

2. | Literature Review

This chapter provides an in-depth review of the existing literature on GVCs, the concept of resilience in supply- and value chains, and the public policy options available to policymakers to strengthen resilience. Firstly, this chapter will discuss the concepts of GVCs and GSCs, what aspects are important for businesses, and what concerns governments have in relation to their vulnerability to shocks. Furthermore, this chapter will take a close look at the concept of resilience, what factors drive governments to take action, and how can policies impact the resilience of GVCs. These policies will be further integrated in the final part of the chapter, wherein industrial policy, and, more specifically, the characteristics of EU and US industrial policy, are discussed to ultimately help develop several hypotheses concerning the research question.

2.1. | Value Chains and Supply Chains

Since the early 1990s, the offshoring of production processes by corporations has characterized the declining strength of manufacturing in Western economies, at the expense of a growing East-Asia region, and, in particular China. As trade barriers came down, international businesses, from smaller companies to large multinational corporations, have shifted from localized, specialized production to outsourced manufacturing by a network of companies. *A value chain*, which can be broadly defined to include, "the full range of activities that firms, farmers and workers carry out to bring a product or service from its conception to its end use, recycling or reuse. (Masi & Godsell, 2022; Ponte et al., 2019, 1). Within a GVC of, for instance, a mobile phone, the different stages of conception and production, in which producers add value to the final product, are spread across a broad and fragmented network (see figure 1). Whilst the design, marketing, and the conceptualization of the product are located in the US, the assembly of the phones takes place in Taiwan, with the parts arriving from European countries,

the US, and South-Korea. The components are, however, have often travelled from the Democratic Republic of Congo and China, where many raw materials are mined, through refineries in Asia, to their destination in factories where different smaller components are assembled before being shipped off (Masi & Godsell, 2022; Lund et al., 2020; West, 2018). Finally, at the end of their respective life-cycles, old phones are collected, recycled, and reusable components are reintroduced into the production value chain (Ponte et al., 2019).

Figure 1

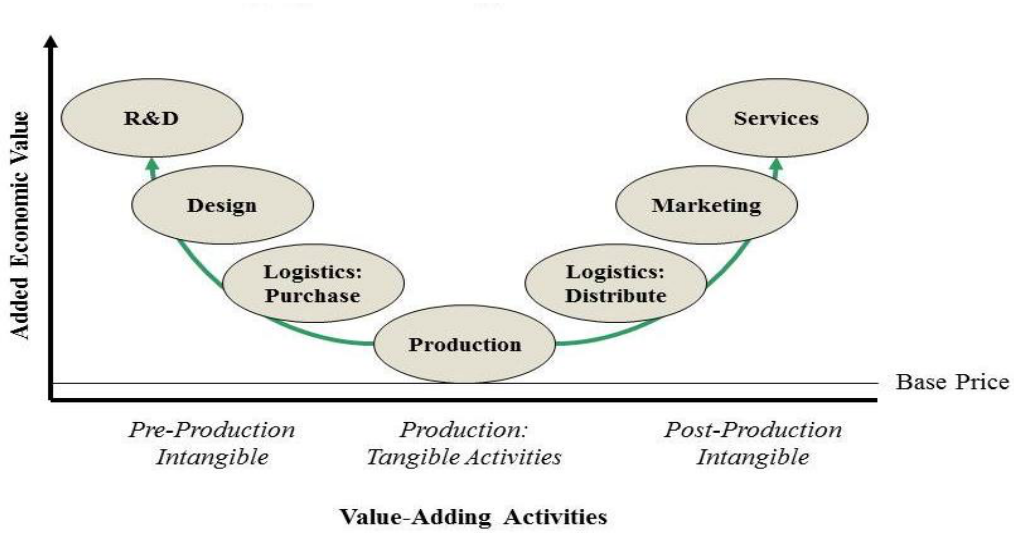

Figure 1. Source: Gary Gereffi, presentation at OECD workshop, September 2010, in Warwick (2013), Schematic of Value-Adding Activities. http://dx.doi.org/10.1787/5k4869clw0xp-en.

At every step in this process, every action that corporations undertake to change the product, from design to recycling, and from marketing to assembly, value is added. The GVC is designed to reduce cost of labor, by focusing on the specialization of tasks across a geographically broad network of companies, thus maximizing value for consumers and profits for businesses (Masi & Godsell, 2022; Pietrobelli et al., 2021; Szczepański, 2021). As seen in figure 1, the added value of labor costs is considerably lower as compared to other aspects of the value chain. This is characteristic for a lean GVC (Warwick, 2013). By offshoring labor to countries with

relatively lower wages, companies are able to take advantage of cost reductions, thus adding more value to the product or service at a lower cost. Lund et al. (2020) estimated that between 2000 and 2020, the value of goods traveling across the world by containership, cargo plane, or any other form of transportation exceeded $10 trillion. The transportation of goods and services, from mines in Africa, to manufacturers in East Asia, and to the customer somewhere in Europe or South-America, is part of GVCs design. This logistics process, wherein products travel across the world through an intricated network of (air)ports and roads, from mine to factory, and so on, is referred to in the literature as *supply chains*, although some authors have used the two terms interchangeably (Baldwin & Freeman, 2021; Schneider-Petsinger, 2021). Key features of both value chains are thus the relative complexity and diversity of actors (i.e., factories, mining companies) involved, the length of the production processes, the global scope of the network (Miroudot, 2020b). These features were long considered indispensable to the modern economic growth, but following the Global Financial Crisis (GFC) in 2008 and the pandemic they have been scrutinized more extensively by policymakers and public opinion for their fragility in the face of external shocks (Baldwin & Freeman, 2021; Lund et al., 2020; Pietrobelli et al., 2021).

2.1.1. | Literature Review

The current and evolving debate amongst analysts, policymakers, economists, and political scientists is characterized by diverging perspectives on the risks and causes of GVC fragility and how future policies can strengthen them (Baldwin & Freeman, 2021; Miroudot, 2020b; OECD, 2021a). The pandemic-induced disruptions of supply chains for PPE and medical equipment have further strengthened calls for some form of government intervention to incentivize companies to policies to reduce reliance of production on specific countries. These concerns, however, predate the pandemic, and suggestions that the GVCs that underpin

international commerce are in decline been part of the discourse for well over a decade (Lund et al., 2019, 2020; Tang, 2006). For instance, following the GFC in 2008, the share of goods and services flowing across borders has declined. Research by McKinsey found that in the period after the GFC, between 2007 and 2017, the volume of goods traded through GVC has slowed (Lund et al., 2019). The restructuring of GVCs has been caused by a range of developments, including rising labor costs in developing countries, which makes diverging production across multiple countries less rewarding, and a range of trade restrictions caused by geopolitical tensions (Lund et al., 2020; Schneider-Petsinger, 2021; Siripurapu, 2021b). Alongside these trends, research has also shown that the existing GVC have become "less global," suggesting that trade in GVCs has been occurring more at the regional level, for instance, amongst the members of the EU, than in previous decades (Lund et al., 2019, p. 9).

Despite these trends, calls for policymakers to return manufacturing of public goods 'back' within national boarders have been growing. As Baldwin & Freeman (2021) note, the policy debate has been partially driven by a political backlash from those who have felt left behind by economic growth brought on by globalization and the shift of manufacturing jobs overseas (Miroudot, 2020b). Spurred on by populist movements, and a backlash against globalization in the US and Europe and the interconnectedness of international trade, policymakers have been drawn to two types of directions in tackling the perceived risks of GVC disruptions. On the one hand, governments are considering and proposing options for reshoring manufacturing facilities, or bringing production back/closer to home. (Baldwin & Freeman, 2021). Proponents of reshoring policies argue that by returning value chain operations to within national borders, essential public goods such as PPE, or products of national security concern such as semi-conductors, will be more resistant to external shocks (Evenett, 2020; Federal Consortium for Advanced Batteries, 2021a; Pietrobelli, 2021). This type of policy would bring specific

industries or products further in line within agricultural policies, which are considered vital for economic and political stability, and are thus situated within countries and economic blocks (Miroudot, 2020b; Baldwin & Freeman, 2021).

However, critics have pointed out that localizing production and manufacturing would result in more vulnerable GVCs, as disruptions, for instance a flood or wildfire, could cause significant damage amongst several companies within the supply chain (Baldwin & Freeman, 2021). The appeal of reshoring policies for GVCs is that it would guarantee more control over production, which governments desire in light of disruptions caused by geopolitics, climate change, and pandemics (Pietrobelli, 2021). Miroudot (2020b) contends that these government policies could do more harm to corporations than good and that they are not grounded in sound business policy, but rather, driven by ideological and political considerations. Additionally, other academics have noted that reshoring policies can result in more protectionist policies and loss of efficiency by limiting companies' ability to operate freely, resulting in higher costs for consumers and a less attractive investment climate for businesses (Schneider-Petsinger, 2021; OECD, 2021a).

Another policy, on the other hand, which has been the subject of debates amongst policymakers and policy analysts is a strategy defined as diversification of supply. The subject of diversification is often discussed in relation to the (strategic) dependence of countries or industries on a singular (or very few) producer, country, or value chain (Miroudot, 2020b; Pietrobelli, 2021). In theory, by diversifying the existing GVCs, by investing in multiple manufacturers across a range of countries, businesses are less vulnerable to shocks. In current debates on dependency, China is nearly ubiquitous as the primary actor of concern for policymakers (Baldwin & Freeman, 2021; Miroudot, 2020b; Lund et al., 2020). Much of the

global production value chains are linked to manufacturing hubs in China, and has been steadily growing since the country's integration into the world economy since the 1980s (Baldwin & Freeman, 2021). Lund et al. (2019) estimate that before the pandemic, 20 percent of global manufacturing occurred in China, making it the central cog of many GVCs. During the pandemic, when exports of PPE and medical supply chains from China were, first, heavily disrupted by lockdowns in cities such as Wuhan, and then could not keep up with explosive demands for medical equipment and goods from the rest of the world, companies were unable to deliver products and services to consumers (OECD, 2021a; Pietrobelli et al., 2021; Stockton et al., 2020). These kinds disruptions have remained prevalent in GVCs as new and restrictive lockdowns in Chinese cities have hampered exports and production in 2022 (The Economist, 2022; Hille et al., 2022).

However, China's rise as an economic and military power in the region, and its growing authoritarian tendencies, have also worried policymakers and military analysist in the West about the potential consequences of knowledge transfers and economic dependency. Geopolitical considerations are therefore another important driver of reshoring and diversification policies in the EU, the US, and other western countries. Whilst reshoring implies moving production capacities away from China, diversification is more concerned with creating alternatives to the manufacturing (Evenett, 2020). Although government officials have only recently been pushing for policy interventions that will require companies to further diversify their respective GVCs, many companies have maintained some form of diversification of supplies for many years. The China+1 strategy, which entails having operational manufacturing capacity in China and at least one other country, have been around in business policy for over a decade (Enderwick, 2011; Lund et al., 2020). This design is intended to guard against severe disruptions of the value chain in case of a shock in China itself, resulting from anything from

trade restrictions enacted under the Trump administration, natural disasters worsened by climate change, or pandemic-related lockdowns.

2.1.2. | Global Value Chain shocks and disruptions

The perceived vulnerability of GVCs has been also been a topic of debate amongst actors involved in, or observing the disruptions in supply chains. Coveri et al. (2020) contend that because of the interconnectedness of GVCs between industrialized nations, they are more susceptible disruptions following externals shocks. Before looking at the specific designs of existing lithium-ion battery GVCs, it is important to consider the types of shocks that might disrupt them. This will also provide insight into how governments have approached GVCs, as they have been more concerned with the vulnerability and interdependence of GVCs, rather than their economic benefits (Baldwin & Freeman, 2021). Lund et al. (2020) provide a well-research and comprehensive overview of the type of shocks that companies and their GVCs should consider as part of supply- and value chain policies. Shocks can be distinguished between to what extent businesses are able anticipate the disruption to value chains (Baldwin & Freeman, 2021; Lund et al., 2020; Miroudot, 2020b).

These distinctions can best be exemplified with two examples. Firstly, companies (and governments) may have very little response time to prepare for a cyber-attack on digital infrastructures. In February 2022, multiple European ports were attacked with malicious software, which disrupted the ports' systems, delaying transportation, and causing chaos within the oil supply chain. The disruption was, however, not extreme, and caused relatively little financial losses for the companies involved (Lund et al., 2020; Payne, 2022). Whereas shocks, such as cyberattacks, thefts, and minor weather events may thus be less impactful, they occur more often than a once in century global pandemic. As discussed in early parts of this thesis,

the COVID-19 pandemic caused a major shock to the global economy, hitting GVCs, and costing companies severely. However, as Lund et al. (2020) note, governments and companies had more time to anticipate the spread of a novel coronavirus across the world. These distinctions are important, as the frequency and impact of different shocks determines what policies are necessary to lessen their impact.

2.1.3. | Battery Value Chains

Having established a definition of GVCs and the existing academic and political debates on how to strengthen the arteries of the global economy, this part of the chapter will provide a brief, more in-depth look into the value chains of lithium-ion batteries. The growing development and production of lithium-ion batteries is closely linked to decarbonization efforts in around the world. Demand for these types of batteries, which can store large amounts of energy, and are used primarily in wind-turbines and cars. Campagnol et al. (2022) predict that the demand will likely grow by more than 20 percent, every year, between now and 2030. This surge in demand will come from the customers in the US and the EU, where local production of battery components is still small compared to the major East Asian players in the GVC. China, which has long been a central cog in the GVCs of battery production, still dominates in the extraction of natural resources, and the processing of materials (European Commission, 2020b; Federal Consortium for Advanced Batteries, 2021a). Manufacturers in South Korea and Japan also play an important role in the production of the batteries (Zhang, 2021). Policymakers on both sides of the Atlantic have acknowledged that companies and their ability to grow the lithium-ion value chain, are largely dependent on China (Schneider-Petsinger, 2021; Szczepański, 2021). However, governments in the EU and the US are working to incentivize companies to build more capacity at home, thus expanding the number of processes within the GVC that occur within national boarders (European Commission, 2021a; Lund et al., 2019:

White House, 2021a). Figure 2 depicts the existing GVC for lithium-ion battery production, with distinctions made between upstream (mining), midstream (processing of mined materials), and downstream (manufacturing of batteries, production of EV/turbines/etc., and, finally, recycling). The value chain of lithium-ion batteries is global, as different steps of the process occur across geographical locations, and at each step of extraction or manufacturing, value is added to the product (Campagnol et al., 2022; Masi & Godsell, 2022; Szczepański, 2021).

Figure 2

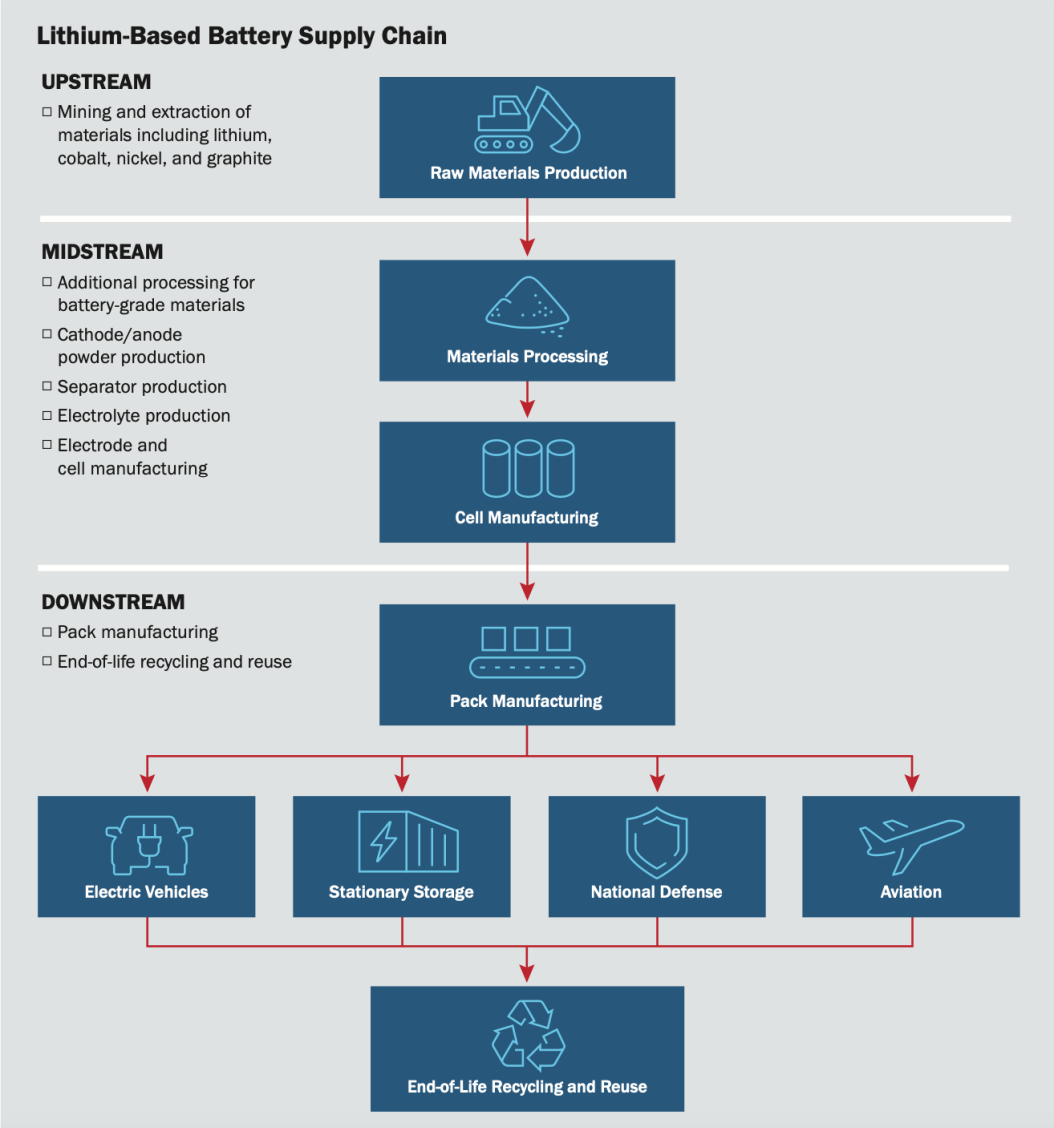

Figure 2. Source: Federal Consortium for Advanced Batteries (2021a), Outline of existing lithium-ion battery value chains. https://www.energy.gov/sites/default/files/2021-06/FCAB%20National%20Blueprint%20Lithium%20Batteries%200621_0.pdf.

Within the lithium-ion value chain, several components are crucial for understanding EU and US policymakers' options in dealing with, and preparing for external shocks. Firstly, within the value chain, East Asian countries (including China) are dominant in the upstream and midstream sections. The mining of raw materials critical for battery production, which include lithium, cobalt, and (natural/synthetic) graphite, are predominantly located outside the EU and US. Estimates from an analysis conducted by the European Commission (2021a) put the extraction of raw materials outside the EU and US at 98 percent, with both contributing just a single percent of the global supply. China accounts for one-third of all raw mining activities and Africa (primarily in the form of cobalt from the Democratic Republic of Congo) contributes another twenty percent to the GVC (European Commission, 2020b, 2021; OECD, 2021b). EU and US cell manufacturing capacity, the most valuable part of the chain, is around 10 percent of China's 567 GWh capacity (Campagnol et al., 2022). One GWh represents one-billion-watt hours of energy, and the GWh capacity refers to the total production capacity of batteries within a country or region. US production of cells at 59 GWh and the EU's capacity at 52 GWh (Federal Consortium for Advanced Batteries, 2021a).

There are efforts underway in the US and EU to upgrade their role in battery GVCs, by building new factories, infrastructure, and mines for processes in the upstream and midstream of the chain. (Evenett, 2020; Lund et al., 2019; Pietrobelli, 2021). However, given that these developments can take time, the severe dependence of both the EU and the US on China and other countries for the mining of raw materials and manufacturing of lithium-ion battery components will likely continue for a long time. If demand will grow as fast as it is currently predicted to do, additional capacity will likely be necessary to keep up. Therefore, in order to strengthen the existing GVCs, more policy solutions from both companies and governments

are needed to make the production of batteries more 'resilient' against external shocks (Campagnol et al., 2022; European Commission, 2020b; Pietrobelli, 2021).

2.2. | Resilience

The main research question of this thesis is concerned with government policies specifically related to the resilience of GVCs. Government policy interventions related to GVCs can be divided into four distinct types, based on policy goals and the available policy instruments. Pietrobelli et al. (2021) distinguish between participation, value capture, inclusiveness, and resilience policies. To specify, briefly, policies for participation are set up to improve an economy's share of the GVC by improving infrastructure and eliminating obstacles to business expansion. Value capture policies aim to upgrade the existing share of GVCs. Inclusiveness, as opposed to the previous two concepts, hopes to create better social and environmental standards, primarily through regulation. Resilience policies, finally, are designed to strengthen existing GVCs against external shocks, for instance, against cyberattacks or trade disruptions (Miroudot, 2020b; Pietrobelli et al., 2021; Schneider-Petsinger, 2021). Resilience literature has broad applicability in a range of disciplines, from medicine to business management, with resilience often linked to the time it takes for production or activities to resume after a shock. Resilience thus can be defined as "the ability of organizations and supply chains to plan for, respond to, and recover from disruptions in a timely and cost-effective manner" (Baldwin & Freeman, 2021, 7).

2.2.1. | Literature Review

Resilience has been something of a "buzzword" in the political discourse around supply- and value chains (Schneider-Petsinger, 2021, 8; Szczepański, 2021). In light of the severe shocks to the global economy after the GFC and pandemic, along with the increasing occurrence of

climate change related natural disasters, it is often touted as an effective and necessary solution for companies to focus on in their GVCs (Lund et al., 2020). The process of resilience is therefore linked to government policies and incentives for industries that are considered of interest to security. Introducing measures to strengthen resilience of GVCs is often equated with less globalization (Miroudot, 2020b; Schneider-Petsinger, 2021; White House, 2021e). However, this understanding of resilience ignores both the unique nature of different GVCs and the potential dangers of extensive government intervention. For example, the car manufacturers Volkswagen and Tesla, both corporations in the same industry, will have different up- and midstream companies and factories that extract resources and assemble parts, meaning that similar policy interventions can disrupt the value chain of one more than the other. Tesla has recently invested in new factories in the United States and Germany, whilst also spending on diversifying upstream processes in Indonesia (Trivedi, 2022). Volkswagen, on the other hand, has also be looking to diversify the battery GVCs, but will face more difficulty with production should tension on Europe's border escalate (Masters, 2022). Another car maker, Toyota, has also adopted diversification policies after the 2011 earthquake and tsunami in Japan (Baldwin & Freeman, 2021). Miroudot (2020b) warns that broad government policies to strengthen GVC resilience, aimed at the broader industry, or EV manufacturing specifically, would disrupt or even sever value chains that have for decades underpinned global trade. This could hit one corporation harder than the other.

Despite policymakers' interest in resilience as part of their strategic economic planning, academics and executives have warned of the related risks that resilience-centered approaches may hold for GVCs and broader economic security (Miroudot, 2020a, 2020b). Hoegl & Hartmann (2020), for instance, note that from a business management perspective, resilience is not concerned with strategic planning for disruptions or risks, but instead, on how to respond

to any disturbances that impact a specific process. It thus approaches resilience from a post-disruption perspective, focusing on designs that, in preparation for future shocks, accept some form of disruption to GVCs and supply of goods and services (Hoegl & Hartmann, 2020). What government policymakers envision more often is closer to continuation of production during a shock, for instance, the continued supply of PPE during the first months of the pandemic, rather than how GVCs return to normal production (Evenett, 2020; Miroudot, 2020b). The varying perspective in policy goals are distinguished in the conceptual differences between resilience and robustness. Within the definition of resilience, the concept of a "timely" recovery suggests that there can be some discussion on how long it would take for production to return to pre-shock levels (Baldwin & Freeman, 2021, 7).

Commissioner Breton, in his speech about the strategic autonomy of the EU, referenced to the need to prevent shortages, which he argued had long been perceived as avoidable, given the integration of the EU in the global economy (European Commission, 2022b). To put it differently, Commissioner Breton's push for a more autonomous EU is linked to a continuation of production and delivery of goods. This vision is more closely related to robustness, wherein GVCs continue to operate during crisis, than resilience, which accepts disruptions. For instance, localizing all mining operations and manufacturing within national boarders would make the value chain less global, but more susceptible to localized shocks (Pietrobelli et al., 2021; Schneider-Petsinger, 2021). Production could continue during a shock outside the geographical area, making it a robust system, but not resilient if there were to be a flooding or earthquake. Recovery would most likely take longer in this scenario. Therefore, enforcing resilience requires different policies than robustness (Miroudot, 2020a; Pires Ribero & Barbosa-Povao, 2018). Within this thesis, the rationale on resiliency policy, however, is considered to be more in line with those from academic literature and policy documents.

2.2.2. | Resilience Policies

What then, are the specific policies that governments can develop to strengthen the resilience of GVCs? Based on existing research, this part of the chapter sets out a range of policies, providing a framework that will allow for a comparative analysis. As discussed previously, the broader goals of resilience policies are to improve the recovery time of GVCs, that is the manufacturing and distribution of a company or industry, after a shock (Pietrobelli et al., 2021). Governments can employ a variety of policies aimed at strengthening the resilience of GVCs, but, as contended by Miroudot (2020b) and Petsinger-Schneider (2021), companies and their governance structure remain the primary avenue for adjusting policies and designs. Corporation, large and small, are responsible for assessing threats to their business model, which includes the management of supply- and value chains. Since a company's goal is to maximize profits through efficient production, marketing, and other value adding components, they are often less likely to be willing to prepare for large, and more uncommon, shocks (Lund et al., 2020). The cost-benefits analysis that companies make is based on assumptions about impact and financial capabilities. Governments and policymakers, on the other hand, view the delivery of goods and services to customers from an economic and national security perspective. Resilience policies therefore have to incentivize or force companies to bring their strategic calculation and vulnerability assessment in line with those of governments (Morris & Staritz, 2019; OECD, 2021b; Petsinger-Schneider, 2021).

Government policy thus can take many shapes and forms depending on the specific industry or company (Ponte et al., 2019). Two policy goals, diversification and reshoring, have previously been discussed. Diversification of supply is useful to lessen the impact of disruptions because of alternative locations of productions. A larger manufacturing network results in less dependency on a singular point in the value chain. Governments can incentivize companies to

diversify their GVC through favorable taxes for companies, subsidies, or by introducing regulation that forces companies to do so (Lund et al., 2020). Public procurement often also plays a role in diversification policies, as it provides companies with structural and steady demand for their products (Warwick, 2013). Government contracts are incredibly valuable for companies, not just because of steady demand, but also because of they are often linked to R&D grants, cooperation opportunities with government agencies, and publicity. Governments, on the other hand, can attach certain conditions to public procurement policies, for instance, that a company invests in the 'local' economy, or that it diversifies its supply away from certain regions. Finally, governments are also able to restrict access to public procurement contracts for foreign competitors of local companies. An excellent example is the federal ban on US government services buying Huawei equipment under the Trump administration (Geroski, 1990; Pietrobelli et al., 2021; Shepardson, 2020).

In addition to financial incentives, which require public funding to alter the considerations of companies, regulation and mandatory requirements can also be deployed to develop more resilience in the GVCs of specific companies (Miroudot, 2020). Countries may, for instance, require stress-testing and information sharing of companies, or introduce guidelines on product manufacturing and maintaining stockpiles. Requiring companies to stress-test their value chain, similarly to what has been introduced in banking regulation since the GFC, could help gain insight and design better strategies (Petsinger-Schneider, 2021). These types of regulation also signal the interests of governments on broader issues such as digitalization, consumer protection, and innovation. Because the twin-transition of energy and climate is a primary driver of the demand for lithium-ion batteries, this allows companies to better adjust financial and operational design to match the existing economic climate (Federal Consortium for Advanced Batteries, 2021a; Miroudot, 2020b; OECD, 2021b).

2.2.3. | Resilience Policy Framework

To the literature on resilience policies, further, this part sets out a framework of the different policies that government employ for GVCs resilience. Table 1 shows an adaption of the existing policy instruments that governments can utilize to achieve goals related to GVC resilience. Within this framework, distinctions are made between the perceived issues, the policy goals, the specific changes that government desire, and the instruments they have available to initiate changes. Within the framework of Table 1, a few aspects stand out. Firstly, and perhaps most obviously, there is an international component to any government policy related to GVC management (OECD, 2021b, Pietrobelli et al., 2021). Since the nature of international networks of consumers, businesses, manufacturers, and mines, amongst others, are at its core transnational, any policy adopted by a government within or linked to the value chain is likely to impact the whole operational chain (Miroudot, 2020a; Schneider-Petsinger, 2021). In similar fashion to how a shock, for instance, an earthquake in Japan, can impact the value chain of car manufacturers in the US and the EU, policies that are adopted influence the functioning of the companies and manufacturers abroad. Therefore, international coordination in bilateral or multilateral (World Trade Organization (WTO), OECD, EU) forums, is crucial for maintaining the balance of global trade. Experts on GVCs generally agree that the most constructive way of strengthening resilience is through international cooperation (Baldwin & Freeman, 2021; OECD, 2021a, 2021b; Miroudot, 2020b; Pietrobelli et al., 2021). However, competing interest, as well as, different economic thinking on certain topics can often lead to an impasse amongst the members of multinational organizations, thus hindering a constructive dialogue that can benefit all parties involved (Schneider-Petsinger, 2021).

Table 1

Perceived issues in GVC management	**Policy goal(s) for governments**	**Desired change for companies**	**Government policy intervention instruments**
Companies are considered unprepared for shocks to GVC	• Improving preparedness • Developing new strategies	• Risk monitoring to identify weak points • Information sharing • Stockpiling of goods	• Mandate stress-testing • Private/National held stockpiles • Public-private dialogue
GVCs are vulnerable to shocks because of geographical location	• Incentivizing or forcing to repatriate company value chain	• Reshoring • Upgrading existing local production	• Public procurement • Tariffs/taxes on foreign products
GVCs are too dependent on a single country/company or a few countries/companies	• Incentivizing diversification of value chain • Minimizing impact of shocks	• Diversification • Improving logistics and distribution • Simplification of production/design	• Public procurement • Regulatory guidelines on product and production • Infrastructure funding • R&D investments
GVCs have different business standards, production hubs, and regulatory regimes	• Reducing product complexity • Growing local innovation hubs	• More due diligence on human rights and environmental impact • Standardization of components	• R&D investments • Entrepreneurship policies • Product regulation
Lack of international cooperation with other countries on GVCs issues	• Lowering trade barriers • Working with allies • Coordination of GVC policies	• Cooperation amongst companies and countries • Sharing goods • Avoid protectionism	• Joint procurement of raw materials • Standardization of processes or products • Multinational dialogue

Table 1: Framework of resilience policies and government interventions. Adapted from OECD (2021b), Pietrobelli et al. (2021), Schneider-Petsinger (2021), Szczepański (2021).

Additionally, it is important to note is the different types instruments that government can use to intervene in the market to strengthen resilience. These instruments vary from broad, systemic, structural initiatives that deal with companies across industries, for instance, investments in infrastructure, or those that are aimed at very specific sectors or even individual companies, as can be the case with public procurement policy or tax breaks (Geroski, 1990; Pietrobelli et al., 2021). Another dimension is the costs associated with different policy instruments. Regulatory policies require less public funding as compared to public procurement policies or other investments (Warwick, 2013; Geroski, 1990). These considerations are all part of the calculus for governments that are linked to state intervention in the market.

2.3. | Industrial Policy

As the previous part of this chapter has shown, governments have a variety of concerns, policy goals, and instruments that incentivize them to intervene in the market to address GVC resilience. This part of the chapter explorers the concept of industrial policy, a term that has also received considerably more attention in recent years (Bulfone, 2022; Warwick, 2013). Of interest are the underlying goals and policies of government intervention, how they interact with the GVCs framework, and what differences can be found in the history of US and EU industrial policy. Any comparative research into the resilience policies put forward by policymakers on both sides of the Atlantic has to consider how facets of industrial policy impact this process. Before analyzing the features that are specific to US and EU industrial policy, however, it important to consider how this thesis views industrial policy in the context of GVCs.

There is no singular agreed upon definition of industrial policy (Aiginger & Rodrik, 2020; Bulfone, 2022; Warwick, 2013). Defined broadly, “industrial policy is any type of intervention of government policy that attempts to improve the business environment or to alter the structure

of economic activity toward sectors, technologies, or tasks that are expected to offer better prospects for economic growth or societal welfare than would occur in the absence of such intervention" (Warwick, 2013, 16). This definition includes many components that need to be further unpacked, but based on this understanding of industrial policy, there is a clear link between the type of policy interventions that governments pursue in relation to GVC resilience, and broader debates on industrial policy (Bianchi & Labory, 2012). Actions by government to intervene in the functioning of GVCs, through coercive or incentivized means, are by this definition attempts to improve economic growth or competitiveness of firms. Altering structural designs of corporate manufacturing for the purpose of making GVCs more resilient constitutes an alteration of economic activity (Pietrobelli et al., 2021; Warwick, 2013).

2.3.1. | Literature Review

Within the literature on industrial policy, there is a broad range of topics related to the evolution of industrial policy (Aiginger & Rodrik, 2020; Bianchi & Labory, 2012). Because this thesis' is concerned with specific industrial policies that impact GVCs, there are several interesting areas within the industrial policy literature that remain unexplored. For instance, this literature overview will not explore the evolution of theoretical debates, concepts such as cluster policies, nor will it discuss structural differences between industrial policies of western and non-western economies (Warwick, 2013). Industrial policy is, and will likely remain a dynamic field of study, with new approaches and theoretical conceptualization just around the corner (Bulfone, 2022; Mazzucato, 2011; OECD, 2021b).

In addition to the debate on what constitutes industrial policy, academics have long been interested in the role that states play in the development of their economy. As Warwick (2013) and Aiginger & Rodrik (2020) note, the evolution of industry policy rationale in the postwar

period was categorized by the government's close involvement in the market. Preventing market failure, that is when a free, unregulated market, the quintessential neoliberal design, wherein supply and demand factors determine the direction of the economy, is unable to deliver goods and services efficiently (Mazzucato, 2011). To borrow an example from the lithium-ion battery industry, the innovation and growth in value of the industry has grown exponentially over the last few years. This is not necessarily because EVs are considered superior to cars with a combustion engine, but rather because governments and citizens have, more often than not, acknowledged the looming dangers of climate change (Warwick, 2013). To achieve net-zero pledges, decarbonization of the world economy, and transform existing GVC structures, financial incentives such as subsides and funding have been distributed by governments to accelerate the production and value creation of the industry (Abdelbaky et al., 2021; Bulfone, 2022; Campagnol et al., 2022).

Many argued that market failure necessitates government intervention, but in the 1980s, and with the rise of neoliberal, laissez-faire, industrial policy became less popular as a tool for intervention, and instead, was perceived as providing the "best possible environment for businesses" (Warwick, 2013, 19). The policy objectives for states shifted from protecting the local economy and corporations, to encouraging international trade without limits, integration into the global economy, and the deepening of value chains. This view of market economics, wherein government failure was worse than market failure, is often associated with the Washington Consensus, in reference to the dominance of US economic thinking in global trade (Aiginger & Rodrick, 2020; Mazzucato, 2011). In Europe, the process of integration led to a similar decline in selective industrial policies, abandoning the selective, vertically oriented policies protecting national industries, in favor the European Single Market (ESM) and its market competition policies (Bianchi & Labory, 2012; Bulfone, 2022).

However, more recent literature on industrial policy has highlighted the means through which states have remained active in the economy. Warwick (2013) and Mazzucato et al. (2015) understand the policy domain to determine what industrial policies states use. The policy domain can range from product markets to the use of labour and skills. Bulfone (2022) observes that in the EU, the actors and instruments of industrial policy changed. Investment funds and development banks have replaced the national governments, and regulatory or tax policies have become instruments of industrial policy under the constraints of the EU's restrictive competition and state aid framework (Mazzucato, 2011; Pianta et al., 2020). The shift industrial policy from targeted instruments, aimed at specific industries or companies, to broader frameworks did not constitute a full disappearance of the former, but rather, more of focus on the latter (Bulfone, 2022; Pianta et al., 2020). These types of industrial policy are useful for an analysis related to GVCs and will thus be discussed further in this chapter.

2.3.2. | Horizontal vs Selective Industrial Policies

Bianchi & Labory (2012) identify two types of industrial policy. Firstly, horizontal policies, which have also been referred to as generic, market-friendly policies, are designed to not favor specific industries or sectors (Warwick, 2013). Based on the dominant economic thinking that selective industrial policies would disrupt existing market-equilibriums, by distorting competition amongst actors in a specific industry, by "picking winners," or protecting national industries (Mazzucato et al., 2015; Thatcher, 2014). Government failure, the process whereby the intervention of a state in the market fails to create favorable economic conditions, is often touted as a reason for taking a broader horizontal approach (Bianchi & Labory, 2012; Bulfone, 2022; Pianta et al., 2020). Governments can set up and improve the framework conditions that improve the climate in which business operates. For instance, horizontal policy measures include cutting corporate taxes to boost investment, broad tax credits from R&D, or more

regulation in product markets, and less regulation on labour (Aiginger & Rodrick, 2020; Bulfone, 2020, 2022; Thatcher, 2014). Other policies that are viewed as horizontal are improving the institutional design of public-private cooperation, the flow of information, and scenario planning. Although these policies could be classified as horizontal in nature, as they are not distorting the market with investments and appear to indicate broad cooperation, they are often tailored to specific industries or companies that are viewed as critical for economic or security concerns (Warwick, 2013).

Secondly, industrial policies that target specific sectors of the economy are known as selective or vertical policies (Bianchi & Labory, 2012; Mazzucato et al., 2015). This is a kind of industrial policy that is targeted at a selective group of companies or local industries. A prominent feature of industrial policies of the 1960s and 1970s, these types of policies have been referred to as vertical, targeted, or selective in nature (Warwick, 2013). Selective policies are also linked to close public control over major industries, for instance, the banking sector, which is a critical part of any economy (Thatcher, 2014). Within selective policies, Warwick (2013) argues, the policy orientation of government intervention can be defensive or strategic in nature. Defensive policies are intended to prevent the collapse of lagging industries or manufacturing, protecting national companies against foreign competition, or economic hardship through targeted tax credits, export promotion, and other policies that can be classified as state aid (Aiginger & Rodrick, 2020; Warwick, 2013). Strategic industrial policy, on the other hand, considers how local sectors compare to international rivals, and adopts policies specifically designed to maintain a competitive advantage over other industries, or to catch-up to lead firms in the international sector. The policy orientation of selective policies is often criticized for distorting the economy, and arguing that governments do not have special knowledge that allows them to select national champions or winners to support (Warwick, 2013).

However, Mazzucato et al. (2015) have argued that the twin economic transition towards a decarbonized, digital economy, is inherently selective in nature. These policies distinguish between firms that are no longer valued, for instance, oil companies, and those that are seen as the future. Furthermore, selective policies can be better suited for supporting this process, as they can add value to specific industries that are not yet viable, but critical for future net-zero economies (Mazzucato et al., 2015). Industrial policies vary across different regions and countries. Several factors can impact the extent to which governments are intervening in the economy. For instance, the extent to which an economy is dependent on manufacturing for economic growth, determines to what extent it is viewed as an industry of importance to national security. Another factor is the competencies that are given to the policymakers at the national or supranational level. (Pelkmans, 2006; Pianta et al., 2020). As observed, there is a distinction between horizontal and selective policy interventions by states. To what extent, however, these policies have been historically adopted by the EU and the US, and what constraints are placed on policymakers, is crucial for developing the hypothesis concerning different government interventions to strengthen the resilience of GVCs.

As specified in the literature on industrial policy, a broad distinction can be made between horizontal policies, which have no favorability for specific sectors or companies, and more selective, or vertical policies, that target specific sectors, with less concerns about distorting the market (Bulfone, 2022; Warwick, 2013). If we apply this typification to the policies that can strengthen the resilience of GVCs, we can determine what instruments can be categorized as selective, and which as horizontal. Table 2 combines these two theoretical concepts, and categorizes the policies alongside the different strategies that governments may have.

Table 2

Policy domain of GVC management	Horizontal Policies	Selective/Vertical Policies
Preparation policies	Mandatory stress-testing, public-private dialogue, strategic monitoring	State aid/subsidies, risk screening, strategic national stockpiles
Reshoring policies	Conductive business environment, competition policy, regulation, tax credits	Public procurement, export restrictions, subsidies, sector specific loans
Diversification policies	Regulation, R&D tax credits, guidelines for production	Infrastructure investments, public procurement, export promotion
Innovation policies	R&D subsidies, entrepreneurship policies	Public procurement, state funding for strategic industries and R&D
International Cooperation policies	Coordination, joint procurement of strategic materials, facilitating access to markets, lowering barriers	Trade policy, export policies, safeguarding critical industries

Table 2: Framework of resilience policies and industrial policy distinctions. Adapted from OECD (2021b), Pietrobelli et al. (2021), Schneider-Petsinger (2021), Szczepański (2021), Warwick (2013).

2.3.3. | EU Industrial Policy

European industrial policy has been criticized for being ineffective, unable to move beyond the constraints of the ESM and characterized by contested policies (Pianta et al., 2020). To define and operationalize the concept of EU industrial policy, this part of the chapter presents a comprehensive overview of the different actors in EU economic policy and their respective competences in the field of industrial policy. Furthermore, it will look at the types of policy interventions that have historically characterized EU industrial policy, in addition to a more recent overview. Finally, it will determine to what extent the EU has adopted horizontal or selective policies to intervene in the economy.

The EC plays a crucial role in the development of policies related to state intervention in the economy. As the guardian of the ESM, which underpins the European economy, the EC has exclusive competences in the policy area of competition and state aid. The EC can propose laws that apply broadly to these policy areas and there is little room for individual countries to adapt those laws (European Commission, 2022a). The role of EU institutions has grown throughout the process of integration, at the expense of national governments competences (Bulfone, 2022). However, on industrial policy, the EC and other institutions have little formal authority over, and are required to facilitate discussions amongst the Member States. Finally, given the constraints that are placed on both the states and the EC, Pianta et al. (2020) observe that more recently, EU industrial policy has been lacking, both in terms of the resources made available or investments in infrastructure and R&D, and in developing a potent set industrial tools that provide demand-side incentives for companies. In terms of existing policy interventions, several academics point to an inherent focus on horizontal policies over more intrusive, and market-disrupting selective instruments. As Pelkmans (2006) also noted that the EU institutions, and mainly the EC, lack hard power or financial means to act in policy orientation, but rather depend on consultations with public and private actors.

Furthermore, the EC has failed to put forward policies that develop the broader European economy, instead, concentrating investments in certain regions that are more developed in terms of innovation institutions and infrastructure (Pianta et al., 2020). Several authors have also noted that diverging economic interests of different Member States, for instance, the desire of mostly Northern and Western European Member States to accelerate an energy transition towards renewables, and Central and Eastern nations that have thrown up roadblocks to comprehensive reforms (Bulfone, 2020; Mazzucato et al., 2015; Pianta et al., 2020). Following the pandemic and the Russian invasion of Ukraine, the EC has become more proactive on

industrial policy issues deemed crucial to the strategic autonomy and common foreign policy of the EU (European Commission, 2021a; 2022a; Dennison, 2022). The EC has also been willing to relax some of the stricter rules related to ESM management and cooperate with international partners on economic security issues (European Commission, 2021a; European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, 2022).

The EU competition and state aid regimes constrain Member States in the range of policy instruments they can employ to support selected sectors or industries (Pianta et al., 2020). The unwillingness of the EC the facilitate industrial policy interventions of a more vertical nature, for the benefit of companies operating in Member States, can be seen in the refusal to approve a merger between Siemens and Alstom, two manufacturers of trains and transport equipment (Bulfone, 2020; Pianta et al., 2020). The ECs exclusive competences in the policy areas of competition, international trade, and monetary policy, and its hawkish protection of the EU's competition and market standards have so far prevented it from implementing an effective policy response to economic challenges brought by the US and China, the other two major global economies (Pelkmans, 2006; Mazzucato et al., 2015; Pianta et al., 2020). The EC has, more recently, been open to loosening the application of its competition- and ESM-mandates, but only in rare cases, wherein it considers economic security to be under threat from, foreign investors, or during a once in a century pandemic (Bulfone, 2022).

2.3.4. | US Industrial Policy

As opposed to the EU, the US has a much less documented relationship with industrial policy. Only recently, some commentators have suggested that the US should 'develop' an industrial policy to effectively deal with the perceived threats to national security (Belton, 2021; Loayza,

2017; Mazzucato et al., 2021). The Chinese economic and military challenge to the international liberal order, the restrictive business climate for US companies abroad, the transition to a digital decarbonized economy, and the declining rate of local manufacturing have all been viewed as necessitating the development of an industrial policy. The question, as Belton (2021, para. 2) put it, is not about a possible industrial strategy, but about "which policy actions are best suited to address the challenges of the twenty-first century. Where historically, industrial policy was dismissed as in the 1980s, as neoliberal economists and policymakers sought to loosen government control of markets. Market fundamentalism and a fear of political failure have been present in political debates since that period and have had a profound impact on how government interventions have occurred (Block, 2008).

As Block (2008) has documented, US industrial policy is nothing new, it has existed for many decades, and it remains a potent avenue for the US government to respond to the serious economic challenges of this period (Aiginger & Rodrick, 2020). Government interest in selective policy interventions can be traced back to the 18th century (Cherif & Hasanov, 2019). What characterizes industrial policies in US history is based on two pillars, development programs and hiding public spending (Block, 2008; Mazzucato, 2011). The first pilar is that the government funding for industries, often those that are considered critical to national security such as military and technological manufacturing sectors, has been directed through different agencies. One example, the Advanced Research Projects Agency (ARPA), has provided funding for novel technological R&D, supporting companies that develop new technologies (Block, 2008). Several major US companies and technologies, including the internet and its search-engine behemoth Google have spawned out of the ARPA or another publicly funded program (Mazzucato, 2011). These policies were often selective, or vertical in approach, targeting specific sectors wherein the US could gain or maintain a competitive advantage over

other countries and economies (Mazzucato, 2011; Warwick, 2013). The second pilar of the US industrial policies that Block (2008) and Mazzucato (2011) have documented is the secrecy around federal spending programs, to prevent public and political backlash against government intervention in the economy. Funding often was directed through public investment funds, for purposes related to military innovation or other technological industries (Block, 2008).

More recently, US industrial policy has become much more visible. The "return of the policy that shall not be named" has occurred against the backdrop of a more confrontational US-China relationship (Cherif & Hasanov, 2019, 1). Interventionist polices have received broad bipartisan support in US politics (Aiginger & Rodrik, 2020). Contrary to EU industrial policy, US interventions have facilitated a demand-side incentive for companies. Whereas EU policies, restrained by budget and state aid regulations, have focused on the supply-side, the US has developed more efficient strategies for providing large scale (invincible) R&D funding through, for instance, public procurement initiatives (Block, 2008; Pianta et al., 2020; Warwick, 2013). The Buy American initiative, which stipulates that public funding must be directed towards products manufactured in the US, is well-known, more recent example of the federal government leveraging its financial capabilities to support industry (Belton, 2021). Another policy instrument at the disposal of the US federal government, the Defense Production Act (DPA), which grants the president the ability to directly interfere in the market and force companies to produce or work for the government for the benefit of "national defense" (Lupkin, 2021, para. 5). The law has been used by both the Trump and Biden administrations to facilitate vaccine production during the pandemic, but can be applied much broader should the president or his administration deem it necessary to fix a perceived market failure (Lupkin, 2021). The DPA's use proves that industrial policy is no longer considered an unjust solution for apparent threats to US economic and security interests.

3. | Theoretical Framework

This chapter develops a theoretical framework, based on the literature cited in the previous chapter and theoretical insights from comparative political economy and policy instrument analysis. Based on this framework, a comparative study of the two cases can determine how industrial policy and policies that enhance the resilience of GVCs interact, and how variations in industrial policy preferences impact those specifically related to the lithium-ion battery value chains. This framework provided by Bouwma et al. (2015) will be used as the primary tool of analysis for this thesis.

3.1. | Comparative Political Economy and Varieties of Capitalism

In analyzing the policy responses to support GVCs and companies in becoming more resilient, this thesis draws on methodological tools of the CPE approach, the varieties of capitalism (VoC) framework, developed by Hall & Soskice (2001) (Johnston & Regan, 2017; Schedelik et al., 2021). The literature and VoC has grown significantly in recent years, as economists and political scientists have sought to describe and understand variations in national and regional economies (Hall, 2015; Schedelik et al., 2020). To briefly summarize, CPE assumes and interrogates the different institutional designs that every country has and how this impacts all aspects of economic policy, including industrial policy. The VoC framework, perhaps the most well-known approach to comparative political economic research, distinguished between different types of capitalist systems, but has so far failed to integrate industrial policy as a crucial component of the VoC model. Because “industrial policies are decisive in helping the *adaptation* of core economic sectors to structural shifts in the international economy and in favoring the *transition* to new areas of sectoral competitiveness”, research on public policies aimed at GVCs should incorporate theoretical strands from both political economic and policy

tools analysis (Bulfone, 2022, 4). Therefore, it is important to first expand upon VoC, before linking the literature of CPE to the theoretical framework on policy instruments.

Within the VoC framework, the coordinated market economy (CME) has historically associated with Germany and other Western European countries, and the liberal market economy (LME), which resides in the United States, Ireland, and the United Kingdom, amongst others (Hall & Soskice, 2001; Schedelik et al., 2021). Academics have since expanded upon this framework to include dependent market economies (DME), often linked to the newer countries that have joined the EU, and others in non-OECD countries (see Schedelik et al., 2021). The VoC framework Hall & Soskice (2001) classify several different factors that distinguish between CMEs and LMEs, focusing on the relationship of businesses with other actors. CMEs are characterized by strong coordination and collaboration with non-market actors, incremental innovation shifts, and regulatory institutions, whilst LMEs coordinate through market indicators, favor deregulation, and enjoy more radical shifts in policy innovations (Ahrens et al., 2011; Hall & Soskice, 2001; Johnston & Regan, 2017). However, the Member States of the EU constitute a variety of systems, with CMEs (Germany, other Northwestern countries), LME (Ireland), DME (Slovakia, a.o.), and even mixed market economies in Southern Europe (Johnston & Regan, 2017). Within the EU and the ESM, there are fundamental divergences in capitalist models, and policies designed by the technocratic elites in Brussels have generally not favored the latter two regions' economic designs. In the US, on the other hand, the analysis of Hall & Soskice (2001) determines that it constitutes an LME.

3.1.1. | Industrial Policy and Comparative Political Economy

As Bulfone (2022) argues, the VoC framework, or more recently, the Growth Model (GM), have marginalized the role of state intervention through industrial policies (Ahrens et al., 2011).

However, as the literature on industrial policy has shown, the transformation of the Western economies from the 1980s onwards, state intervention continued, and, more recently, has found itself in the spotlight (Aiginger & Rodrik, 2020; Bulfone, 2022; Mazzucato et al., 2015; Peres & Primi, 2009; Warwick, 2013). The types of industrial policy relate to what kind of policies that are proposed or implemented, as they are determined by the interaction of businesses and governments within the economy, and the institutional structures that facilitate these interactions. Additionally, Ahrens et al. (2011) convincingly demonstrate that government spending is not directly related to the VoC framework, but rather, to effective governance. Therefore, the governance in a CME might not vary much from that in an LME. Johnston & Regan (2017) also note that the EU-institutions, for instance, have prioritized export-oriented policies and supply-side designs over regional demand policies as part of their drive for economic growth.

3.2. | Policy Instruments Analysis

Different governments, both national and supranational, may implement different policy instruments to tackle the same problem. Policy instruments, tools, or techniques are designed to alter the behavior of other actors within a specific policy field. These actors may be citizens, businesses, non-governmental organizations, or other governments, and the policy fields can vary broadly within existing governance frameworks (Capano & Howlett, 2020; Howlett & Ramesh, 1993; Vedung, 1998). Policy instruments are part of the larger policy design processes, wherein policymakers set out goals to attain, and develop, evaluate, and utilize certain policy instruments to achieve set goals. As the goal of this research is to determine what policy instruments are generated, or put forward, by policymakers to improve resilience in battery GVCs, a theoretical framework that categorizes different instruments is necessary to link empirical observations with existing policy instrument theory and the broader CPE debate.

Capano and Howlett (2020) note that existing policy instrument research has failed to provide a clearer, more theoretically integrated studies, and, instead, has often considered policy instruments to be fixed. Very little comparative research exists on how policy instruments may vary across sectors or governance structures. Distinctions between policy instruments have been studied, as have the questions of why, and how, policymakers decide upon a specific instrument or a mix of instruments. However, this research has failed to analyze the variations, and provide a broader theoretical framework that can be used across different governance structures and policy domains. To facilitate research into variations of policy instruments, this thesis adopts the framework provided by Bouwma et al. (2015) to explore the variations of resilience policies in GVCs governance. Although the case study relates to environmental policies, and analyzes EU policy exclusively, the categorization of policy instruments that Bouwma et al. (2015) develop, can be applied to study other policy areas, including supply-and-value chain issues (Simoes et al., 2015; Vedung, 1998). The application of this specific framework facilitates the further conceptualization of policy instruments beyond the field of environmental policies (Bouwma et al., 2015; Capano & Howlett, 2020).

3.2.1. | Instruments Framework

The framework developed by Bouwma et al. (2015) presents five distinct types of policy instruments that governments can put forward, which are expanded upon briefly in this part of the chapter. Firstly, legislative or regulatory instruments allow governments to set rules for other actors, and that can be enforced through sanctions in case of non-compliance. For example, these types of policy instruments can prohibit companies to undertake certain activities, or require corporations to make specific changes to their business activities. (Bouwma et al., 2015). Secondly, economic or fiscal instruments allow governments to alter

market mechanisms through monetary policy. Specific instruments that fit in this category are, for instance, taxation, government loans, grants, and subsidies, but also include public procurement directives. The economic or fiscal instruments are more costly for governments, and thus depend on budgetary capability. Furthermore, market intervention by governments can also disrupt competition within targeted industries (Bouwma et al., 2015). Thirdly, policy instruments in the agreement-based categorization are better if governments pursue public-private partnerships with other actors in the policy area. If governments and corporations face similar issues, voluntary cooperation through stakeholder- networks and meetings can benefit both public and private interests. Although agreement-based instruments are easier to instigate, given that they are voluntary and stakeholders are often open to working together to solve common issues. However, there is often limited capacity for enforcement with this type of instrument (Bouwma et al., 2015). Fourthly, information instruments move away from more cooperative policies by distributing information to relevant stakeholders. Governments are often the instigator of information instruments, hoping to compel other actors to change their behavior as a result of the information that government agencies share (Bouwma et al., 2015). Fifthly, and finally, knowledge or innovation instruments are based on an exchange of information between stakeholders. Through these information exchanges, governments can, on the one hand, facilitate innovation amongst other actors, who respond to information and innovation opportunities, provide by public agencies, with management changes, and, on the other hand, receive information from stakeholders that strengthens policymaking on the issue (Bouwma et al., 2015). An overview of the five policy instruments is provided in Table 3.

Table 3

Type of Instrument	**Examples of policy instruments**
Legislative/Regulatory	Regulation, export restrictions, mandatory standardization

Economic/Fiscal	Loans, tax policy, grants, public procurement
Agreement-based	Public-private dialogue, industrial alliances, international cooperation
Information	Strategic monitoring, labeling
Knowledge/Innovation	Innovation partnerships, communities of practice

Table 3: Policy Instruments Framework. Adapted from Bouwma et al. (2015).

3.2.2. | Policy Mixes

Whilst the categorization of the different policy instruments may suggest that governments are limited to a singular strategy in pursuing perceived goals, the opposite is true. In general, governments use a mix of policy instruments for any given issue (Bouwma et al., 2015). Different (supra)national governments have different preferences for designing specific mixes of policies, and policy mixes may vary across policy sectors. These variations are known as policy styles. There is, however, some research available on the determinants of variations in national policy formulations, but as this thesis is concerned with exploring possible variations in the policy instruments used by governments to strengthen the resilience of GVCs, rather than explaining them, this is beyond the scope of this research (Capano & Howlett, 2020). Instead, this thesis tests to what extent the "national tradition" of industrial policy, wherein governments tend to rely on similar instruments that have historically been used to successfully, influence the resilience policy instruments that have been designed by governments to tackle issues in GVCs (Bouwma et al., 2015; Capano & Howlett, 2020, 5).

4. | Research Design

Following up on the previous chapter's overview of literature and theory related to the concepts of GVC resilience, industrial policy, and policy instruments, this chapter moves forward with the research question and design. It presents an overview of the research set up, discusses the case selection and collection of data, before operationalizing the concepts from the previous chapter and discussing some hypothesis related to the research question. Firstly, however, this chapter will present a short summary of the previous chapters' findings.

Based on the literature and theoretical framework developed in the previous chapters, some distinction can be made between different policy approaches to GVCs. Policies related to strengthening the resilience of GVCs can be put into five broader categories: preparation, reshoring, diversification, innovation, and international cooperation. Each policy has specific policy goals that underline government rationale for pursuing them. Based on the literature on industrial policies, there are five types of policies that can be used by governments to interact with businesses on issues of resilience. Furthermore, dividing these policies in horizontal and vertical types of policies provides this thesis with a framework on which a comparative analysis can be based. Additionally, the framework based on Bouwma et al. (2015), which categorizes different types of policy instruments will provide insights based on a policy instrument analysis. This thesis will analyze the types of policies put forward in the different categories and answer the following research question:

To what extent have the European Union and the United States put forward different policies to strengthen the resilience of lithium-ion battery value chains?

4.1. | Research setup

To answer the research question, this thesis will employ a comparative case study analysis of resilience policies that have been put forward by two separate governments. By comparing the resilience policies and instruments across regions, this thesis can analyze the different types of policies and policy instruments that have been put forward by governments. The purpose of this research is exploratory and hypothesis testing, which makes it well suited for a Most Similar Systems Design (MSSD) (Toshkov, 2016). This comparative methodology can be used to analyze two case studies with similar features, or variables, but differ in a singular independent variable that can explain the difference in outcome between the two cases. For the MSSD methodology to be applied effectively, the outcome of the research is not necessarily known before conducting the analysis, as long as the dependent variable differs between the selected cases. Control variables should be present and the same across both the case studies. Before applying the MSSD framework to the research question on resilience policies in lithium-ion battery value chains, the conceptual framework, through which the cases are analyzed and the selection of the two cases need to be completed. However, before this research delves further into the methodological setup, the selection of cases is a crucial part of the research design that has to be further developed. Afterwards, some hypotheses can be put forward based on the academic literature and the theoretical framework that have been explored in the previous chapters.

4.2. | Conceptual Framework

To best be able to analyze the empirical data from two case studies, this part of the chapter develops the conceptual framework as it will be applied in the following chapters. This thesis is interested in exploring how previously developed industrial policies, or mixes of policy instruments, impact the new policies that are put forward in to strengthen resilience in the

lithium-ion battery GVCs. This policy mix of instruments, constitutes the dependent variable in this research. Based on the literature review, it can be stated that academics have been aware of the exitence of different policy styles, and that two variables are crucial in determining the preferences for certain policy instruments or a mix of policy instruments (Bouwma et al., 2015; Capano & Howlett, 2020). The independent variable that influences the dependent variable, the policy instrument mix for battery GVC resilience, is what Capano and Howlett (2020, 5) define as 'national traditions,' wherein certain regions develop preferences for certain sets or types of policy instruments that are used (Bouwma et al., 2015). The national tradition of policy instruments in the case of GVCs, an area linked to the industrial policy that governments develop, is thus closely linked to established governance structures that underpin existing policies related to economic instruments of market intervention (Aiginger & Rodrik, 2020; Capano & Howlett, 2020; Warwick, 2013). From a CPE perspective, the variations in existing national traditions can thus help us understand how industrial policies vary based on previously implemented instruments. This is relevant for both the categorization of policy instruments based on Bouwma et al. (2015) (see Table 3) and the horizontal/vertical resilience policy framework, based on the work of OECD (2021b), Pietrobelli et al. (2021), Schneider-Petsinger (2021), Szczepański (2021), and Warwick (2013) (See Table 2). To best link the findings of the policy documents analysis to existing research on policy instruments will be presented based on the framework of Bouwma et al. (2015).

Based on the literature review, as well as, the theoretical framework on policy instruments in GVCs, three hypotheses are derived for the analysis of the case studies. The main goal of this research project, based on the research question, is to determine how variation of 'national tradition' impact the selection of resilience policies in industrial policy impacts the categorization and type of policy instruments in the public management of GVCs. Specifically,

this research is focusses on the GVCs of lithium-ion batteries. The following hypothesis is stated:

Main hypothesis: *When selecting resilience policies to intervene in the management of lithium-ion battery GVCs, governments develop policy instruments based on existing governance frameworks and thus favor specific categorizations of instruments over others, with industrial policy preferences influencing the utilization of horizontal/vertical resilience measures and categories of public interventions.*

Underpinning this hypothesis is the understanding that governance structures and instruments that have been used (effectively) in the past for other policy issues in other fields related to industrial policy, will be preferred in new policy mixes for dealing with the public management of lithium-ion battery value chains. Rather than develop new policy instruments, this hypothesis expects policymakers to exhibit traditional preferences, which would result in different outcomes if two nations, regions, or jurisdictions with the same challenges have varying national traditions. To further clarify this hypothesis, two sub-hypotheses are now put forward that deal with the indicators of resilience policy instruments:

Sub-Hypothesis 1: *If governments that have a preference for implementing horizontal industrial policies as the primary feature of their policy mix, they will put forward resilience policies that are also horizontal in nature*.

The rationale behind *SH1* is that those governments or jurisdictions that have, in the, past developed and successfully implemented industrial policies of a horizontal nature, they are likely to implement those types of policies when dealing with the resilience issues in GVCs.

The preferences for these policies might stem from institutional restrictions on their policymaking, which impact the possible selection of instruments, or from a perception that existing horizontal policies are function well.

Sub-Hypothesis 2: *If governments that have prioritized certain categories of policy instruments based on the framework of Bouwma et al. (2015), they will develop a policy mix of resilience policy instruments that prioritizes the same categories.*

The rationale behind *SH2* is that policy mixes incorporate different categories of policy instruments (Capano & Howlett, 2020), but that the preference of governments to adopt certain categories of policies will lead to the same utilization of policy instruments in the case of lithium-ion battery value chain resilience policy mixes.

4.3. | Case Selection

This selection of cases for this thesis is very important, given that for the MSSD to be effectively and validly used for a comparative analysis, they have to differ on as little as possible, with all variables but the dependent variable remaining constant across cases. This is the second variable that Capano and Howlett (2020) identify as impacting the dependent variable, the policy mix of instruments, is the sectoral variation of instrument choice. For instance, regardless of a country or jurisdiction's national tradition in healthcare policy, the specific instrument mix of policy in the field of education policy differs from the healthcare sector (see Capano & Howlett, 2020, 5-6). Although, sectoral variations are still understudied in political science research, this research's focus on a singular sector, namely policy instruments targeted at lithium-ion batteries supply-and-value chains, this variable can be kept constant within the research design (Capano & Howlett, 2020). For a study of lithium-ion battery GVCs, the

theoretical framework has indicated that the sectoral variation can determine the type and category of resilience policies that are adopted. An analysis of dominant countries and regions in the lithium-ion battery value chain draws our attention to the US and the EU, both of whom have stressed the importance of the technology for their respective industrial policies, future jobs security, and as part of the transition towards a more sustainable economy (European Commission, 2021a, 2022b; White House, 2021a, 2021c).

The second control variable that has been observed to impact policies and policy instruments in relation to lithium-ion battery value chains is the 'existing position of a region within the global value chain' (Campagnol et al., 2022; Szczepański, 2021). If a region has been fully integrated within the existing GVC for lithium-ion batteries, with every step from upstream (mining), through midstream (mineral processing and cell manufacturing), to downstream (battery manufacturing and EV production), there are less incentives for governments to pursue new policies that strengthen the resilience of GVCs, and to intervene in the market, as it is already functioning well (Lund et al., 2020; Szczepański, 2021). However, if parts of the value chain are less integrated, and local manufacturers of batteries or EVs downstream experience a dependency issue, the necessity for further resilience policies that protect against disruptions become more relevant (Campagnol et al., 2022; Pietrobelli et al., 2021). Therefore, the existing position of a region with GVCs for batteries constitutes a variable in any analysis of resilience policies and policy instruments. Both the EU and the US have a strong presence in the GVCs, primarily downstream in production of EV, as well as, an expected growth in demand that will outpace the rest other economies (European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, 2019; Federal Consortium for Advanced Batteries, 2021a).

However, both lack sufficient capabilities for delving or processing in the up- and midstream sections. The EU Member States have a combined 8% of global processing of raw materials, which the US lacks, but further down in the midstream, the US possesses lithium-ion cell manufacturing capabilities which the EU does not have (European Commission, 2021a, 70). China, South Korea, and Japan account for around 86% of all battery manufacturing capabilities (European Commission, 2021a; Zhang, 2021). Figure 3 underscores this situation, as both the EU and US supply just 2% each of the raw materials used in the production of lithium-ion batteries. Furthermore, the primary supplier of raw materials, and dominant power other upstream value chain activities, China, is viewed by both the US and EU as a strategic economic security threat, which further incentivizes policy action on GVCs (Blagoeva et al., 2015; European Commission, 2021a, 2022a; White House, 2021a).

Figure 3

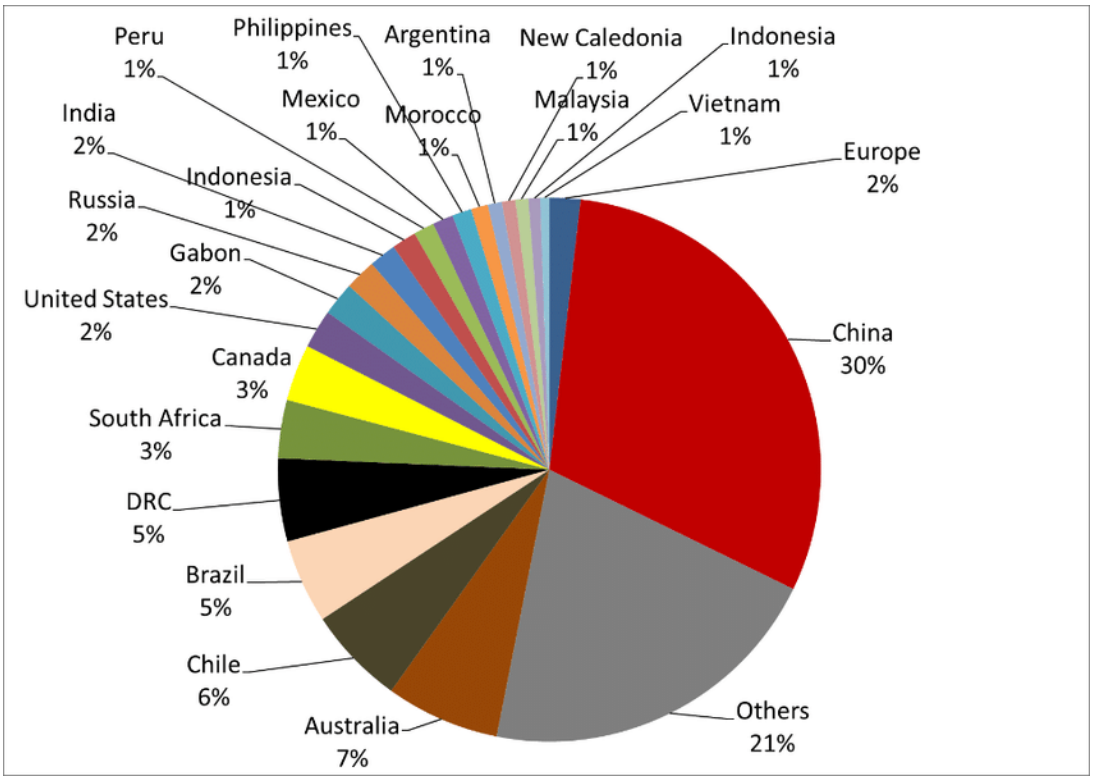

Figure 3. Source: Blagoeva et al. (2019), Outline of raw materials suppliers for lithium-ion battery value chain. https://www.researchgate.net/figure/Raw-materials-suppliers-for-Li-ion-batteries-overview_fig3_337160832.

The final variable to control for in a comparative analysis of US and EU policy has to do with the capacity and the authority of the legislator within their respective institutional frameworks (Capano & Howlett, 2020). For this comparative analysis, the observed legislative institutions are the US administration and the EC. A problem arises when studying EU policy through the EC, as it is just one of several institutions with in the union that legislate on policy issues. One might fairly critique this research design, as the EC does not hold exclusive authority in the area of industrial policy, nor does it have full competence compared to the American administration (Bouwma et al., 2015; Fontaine, 2017; Gerring, 2009; Wouters et al., 2019). Both the individual Member States, as well as, other European institutions, including the European Parliament (EP) and Council of the European Union (CEU) are involved in this process. Both institutions have to approve legislation proposed by the EC (European Commission, 2022a).

However, this thesis has opted for a comparative analysis of EU policy based on the EC policymaking for two reasons. Firstly, the EC has become an important legislator of the EU on issues of industrial and foreign policy, and continuously coordinates policies amongst Member States. Thus, it is the institution best suited for a comparative analysis of policy instruments and design (Bouwma et al., 2015; Bulfone, 2022; European Commission, 2022a). Secondly, the position of the EC vis-à-vis the Member States and the other EU institutions has largely determined how it conducts itself in policymaking. It is mandated to be sensitive to the different interests of Member States, and policies on issues over which the EC does not have full legislative authority, are designed to match this mandate (European Commission, 2022a). As the literature on industrial policy has shown, industrial policy at the European level has been heavily influenced by this institutional power dynamic. Within the VoC model, for instance, the US constitutes an LME, whereas the EU is made up of different varieties, including CMEs,

LMEs, and DMEs (Bulfone, 2022; Hall & Soskice, 2001; Johnston & Regan, 2017). This can, therefore, be considered part of the institution's 'tradition' of policy instrument design, as it impacts the considerations for the policy mix (Capano & Howlett, 2020). As this is the independent variable that is not controlled for in the research design, this distinction between US and EU policy is hypothesized to result in different resilience policies and policy instrument selection, the dependent variable in the research design. As Gerring (2009, 27) argues, within the MSSD "some flexibility is admissible on the vector of controls (X_2) that are "held constant" across the cases." This flexibility is considered to be applicable in the comparative analysis of EU and US policy.

Finally, there is other comparative research available that seeks to incorporate both US and EU perspectives, pushing the boundaries of their respective fields, whilst acknowledging the inherent challenges posed by the comparison (see Normile et al., 2004; Wouters et al., 2019). This thesis seeks to introduce a new perspective within the broader field of CPE by applying a policy instrument analysis to the policy field of industrial policy, and more specifically, the public interventions to promote resilience in lithium-ion GVCs. Therefore, based on the matching of the two cases, this thesis will analyze the US and EU as two separate case studies. The next chapters will further explore these case studies, based on the distinction in resilience policies and the Bouwma et al. (2015) framework.

4.4. | Operationalization

This part of the chapter will operationalize the conceptual framework for the purpose of analyzing the two case studies. To determine the impact of MEV, the industrial policy preferences of the US and the EU, on the resilience policies and instruments put forward to strengthen the lithium-ion battery value chains, this thesis will analyze the two cases based on

the policy instruments framework. Based on the literature, the following variables have been identified as impacting the dependent variable, the policy mix that the EU and US have put forward to strengthen resilience:

I. Industrial policy preference (MEV)
II. Sectoral variation (Constant)
III. Existing position with global value chain (Constant)
IV. Legislative authority (Constant*)

*Although the legislative authority between the EC and the US administration, the two institutional legislators that can be viewed as varying, this thesis takes an more lenient approach that this is still a valid constant variable (See Gerring, 2009).

4.5. | Data Collection

As the research is primarily concerned with what policies have been put forward, it will be based on an extensive qualitative literature analysis of policy documents, proposals, and directives, as well as, looking at a broader range of newspaper articles, analytical reports by consultants, and research papers that have been published. Within this mix of literature, the policy documents put forward by the US administration and the EC hold the most value, as they display the different types of resilience policies and instruments that have been put forward to tackle perceived issues in the lithium-ion battery GVC. An analysis of policy documents is also well suited to the qualitative type of research that this thesis pursues (Cardno, 2019). To answer the research question, this thesis will utilize a policy instrument analysis, based on the framework of Bouwma et al. (2015), which allows for an analysis of policy documents based on five policy instrument categories. Because governments are likely to develop a range of

different policies, with corresponding policy instruments, or policy mix, this thesis will seek to develop a comprehensive descriptive overview of the policy documents. Additionally, the analytical framework on resilience policies will allow this thesis to observe these different types of policies. The findings of the policy documents analysis will be presented descriptively in the next two chapters based on the policy instrument framework of Bouwma et al. (2015).

4.6. | Research Validity and Reliability

This thesis will utilize a literary study of sources from both the US and the EU to build on the central research question. For the purpose of internal validity, interviews with public policymakers, political analysts, and other stakeholders can supplement the findings of this research. This thesis, however, opts for the analysis of policy documents and other publicly available sources for two reasons. Firstly, the volatility of developments in the policy field of GVCs makes conducting interviews challenging. Policymakers involved are less likely to comment on the development process, and the available documents provide enough insight into the type of policy instruments that are being put forward. Secondly, because this thesis is not concerned with testing or predicting the effectiveness of the policy instruments, but instead intends to perform an exploratory study, conducting interviews would not directly add enough value to the findings of a policy document study. Policies, or policy instruments, that have not (yet) been put forward, where interviews might provide additional insights, are therefore less relevant for this specific research goal. However, future researchers of GVCs and industrial policy that are interested in explaining similarities, or differences, that come forward from this research, should certainly consider interviews as an added form of internal validity for their respective projects.

5. | Case Study One: European Union

Following the literature review of the research on GVC resiliency, lithium-ion battery value chains, industrial policy, and the development of an analytical framework to investigate the similarities and differences in the policy instruments that have been put forward, this chapter will provide an overview of EC policies to strengthen the lithium-ion battery value chain and make it more resilient. Firstly, it will briefly discuss the developments of these policies, followed by an analysis of recent policy documents. The policy documents are surveyed based on the categorization of the policy instrument framework of Bouwma et al. (2015). Additionally, special attention is also paid to the types of resilience policies, whether they are horizontal/vertical in nature, and to what extent they match the policy options found in resilience policy literature.

5.1. | Lithium-Ion Battery Policies in European Union

European policy on the production of lithium-ion batteries has accelerated since the introduction of the EU's ambitious Green New Deal, which was put forward in 2019 (Claeys et al., 2019; Cerai, 2022). However, policy initiatives related to the development and production of next generation batteries predates this deal. The most significant initiatives to have been developed by the EC over the past 5 years is the European Battery Alliance (EBA), the signature public-private partnership from the EU with private actors in the battery and EV industries (European Battery Alliance, n.d; Scott & Posaner, 2020). The EBA has been the primary forum for the EU's institutional stakeholders, including the EC, the European Investment Bank (EIB), knowledge institutions, and national authorities, to collaborate on policymaking related to "make Europe a global leader in sustainable battery production and use, in the context of the circular economy." (Ceral, 2022; European Commission, 2018, 2). The push for an industrial transition towards an integrated battery value chain in Europe has received the backing of the

EC, but none have been as vocal in their support for the policy initiatives as Commission Vice-President Maroš Šefčovič, leading some analysists to bestow upon him the title of "one-man cheerleading squad for Europe's battery industry" (Scott & Posaner, 2020, para. 30).

In consultation with stakeholders in the EBA, the EC introduced a roadmap for achieving its policy goals with the *European Strategic Action Plan on Batteries*, the strategic policy document for building a comprehensive, integrated, and sustainable value chain within Europe (European Commission, 2018). This action plan remains one of the primary policy documents that outlines the aims and initiatives that the EC has put forward. Some of the key policy goals that the EC specified in the *European Strategic Action Plan on Batteries* are the strengthening regional access to critical raw materials for the production of batteries (i.e., upstream), encouraging innovation with the value chain, and leveraging its position within the value chain to introduce sustainability requirements for batteries sold on the ESM (European Commission, 2018).

This strategy was further expanded with the EC's report *On the Implementation of the Strategic Action Plan on Batteries: Building a Strategic Battery Value Chain in Europe* (European Commission, 2019a). A separate plan to maintain a steady supply of raw materials, including lithium, cobalt, and (natural/synthetic) graphite, all necessary for the production of lithium-ion batteries, has also been introduced by the EC (European Commission, 2020b). With the EU taking a so-called industry-led approach, much of the funding would be directed through the individual Member States and the EIB to support the transition of the battery industry. The EC noted that it would focus on standardization, regulation, and coordination policies to complement efforts by the Member States on investments in the battery value chain (European Commission, 2018). In addition to the policies specifically related to the lithium-ion battery

value chain, the EC also set out its new industrial policy in 2020, which put forward a strategy for achieving strategic autonomy through a digital and green transformation of the EU, including in the battery value chain (European Commission, 2020a; Scott & Posaner, 2020). Because of the subsequent devastation from the pandemic, the EC recognized that the new industrial policy would have to be updated to aid the economic recovery on the continent, and published an updated version in 2021 (European Commission, 2020a, 2021b). Although battery value chains make up a relatively small part of the proposed industrial strategy, these documents are nonetheless valuable for understanding the EC's policy instrument utilization. The next part of the chapter delves deeper into the different types of policy instruments, describing how the publications by the EC indicate a certain policy mix of instruments and resilience policies (Bouwma et al., 2015; Capano & Howlett, 2020; European Commission, 2020a).

5.2. | Legislative/Regulatory Policy Instruments

The EC's *Strategic Action Plan* sets out a series of policies to strengthen the lithium-ion battery GVC and the EU's regulatory place within it. The goal of securing access to natural resources, for instance, lithium, will be pursued at the European level, through resilience policies aimed at diversification, innovation, and recycling in the value chain of raw materials (European Commission, 2018, 2020c). Rather than pursuing regulatory policies that force companies within the value chain to relocate their production, for instance, from China to the European continent, the EC set out to establish a framework of "battery sustainability 'design and use' requirements for all batteries to comply with when placed on the EU market" (European Commission, 2018, 8). By leveraging the ESM's economic position within the value chain, the EC thus puts forward several regulatory instruments through which it can alter the existing production and development rules that govern the battery value chain (Bouwma et al., 2015; Pietrobelli et al., 2021).

In *Implementation of the Strategic Action Plan*, the EC further accentuates the different regulatory policy levers that it intends to use. Firstly, by updating the EU Battery Directive, which has set standards for all batteries used on the ESM since 2006, the EC expressed the intention to require environmental sustainability, recycling, and responsible business conduct from all companies and actors involved in the battery GVC (European Commission, 2018, 2019, 2020c). The changes to the EU Battery Directive constitute a regulatory intervention in the value chain by mandating all stakeholders, both regionally and internationally, to adhere the environmental standards set in the EU, without distorting competition amongst corporations (European Commission, 2019a).

Additionally, the EC proposed further expanding the EU Battery Directive's coverage of recycling policy to increase future supply of raw materials. Although the EC expected regional mining capacity to grow, further diversifying and reshoring a stable stream of recycled materials could make a "superior contribution" to the supply of cobalt (European Commission, 2018, 13, 2020b, 2020c; Pietrobelli et al., 2021). This proposal has been reaffirmed in the EC's industrial policy, where the "New Regulatory Framework for Sustainable Batteries" (European Commission, 2020a, 10) and a "strategy of standardisation" (European Commission, 2021b, 15) are at the heart of the resilience policies pursued for the battery industry and value chain (European Commission, 2019a; Pietrobelli et al., 2021; Schneider-Petsinger, 2021).

In addition to regulatory incentives within the ESM, the EC has expressed its concern with the trade practices of bilateral trading partners, including China, Canada, and Australia (European Commission, 2021a, 2021b). To support the ongoing regulatory changes, the EC, which holds the formal authority to strike trade deals, has pursued several provisions in bilateral negotiations that would further expand the standardization of responsible mining and battery manufacturing

standards (European Commission, 2019a). This policy instrument followed an earlier EC proposal to “use all appropriate trade policy instruments (such as Free Trade Agreements) to ensure fair and sustainable access to raw materials in third countries and promote socially responsible mining” (European Commission, 2018, 3). In conclusion, framework developed by the EC, and applied to both the internal ESM and bilateral trade relations is a key regulatory policy instrument that can strengthen resilience of battery supply- and value chains, gives the EU a competitive advantage of other countries and regions, and does not have strong market-distorting effects (Council of the European Union, 2019; European Commission, 2018, 2019; Pietrobelli, 2021; Warwick, 2013).

5.3. | Financial/Economic Policy Instruments

Although much of the necessary investments for strengthening the resilience of the EU’s place in the battery GVC will be distributed by corporations and private actors, the EC has presented some policy instruments through which is intends to fund its ambitions (European Commission, 2018, 2019b, 2020a; Schneider-Petsinger, 2021; Scott & Posaner, 2020). Although state-aid restrictions within the EU legal framework have hindered broader investments in the past, the EC has developed some novel financial policy instrument to assist public and private stakeholders with investments (Bulfone, 2022; European Commission, 2019b; Pianta et al., 2020). The primary avenue for public investments has been directed through R&D projects, such as the Horizon 2020 and the European Regional Development Fund, and the European Innovation Council. These projects are also supported through the EIB, which contributes around €1 billion annually to investments in critical economic industries (European Commission, 2018, 2021b). Additionally, the EC proposed making available more public funding through new vehicles to help expand battery innovation within region. Apart from the commitment of €1 billion over a period of ten years, large financial commitments for long-term

research projects are mainly from the private sector (European Commission, 2018, 6; Scott & Posaner, 2020). Indicative of the lack of diversification in investments within the EU, Northvolt, a battery manufacturer in Sweden accounted for “around 40%” of private venture capital investments (European Commission, 2021a, 71).

The Important Projects of Common European Interest (IPCEI) allows Member States to spend public funding in the market to incentivize companies (European Commission, 2019b, 2021b). If certain conditions are met: the project has a strategic value to common European interests, there is a perceived market failure to address issues, and if public investments are a condition for further private investment, the EC has digressional authority to overrule its own restrictive state-aid policies (European Commission, 2019b). The EC proposed the IPCEI within the context of its broader new industrial policy and several Member States have successfully applied for financing up to €3.2 billion in legal state aid (European Commission, 2018, 2019b, 2021b; Scott & Posaner, 2020). Moreover, the EC has committed to working with private corporations in industrial alliances to identify and coordinate potential projects for the IPCEI framework (European Commission, 2021b).

5.4. | Agreement-based Policy Instruments

Where the EC remains restricted in the financial instruments it can deploy to boost the EU’s battery value chain resilience, its central position between corporations, Member States, and research institutions, amongst many others, boosts its influence on the evolution of GVCs. The primary policy instrument through which the EC has realized this potential is the EBA, the industrial alliance of public and private stakeholders (European Battery Alliance, n.d.; European Commission, 2018, 2019b, 2021b, 2022). The EBA is just one of several industrial alliances that the EC has launched to create a formal forum for discussions with industry

stakeholders. Other industrial alliances that the EC has set up are on hydrogen and raw materials (European Commission, 2021b). The European Raw Materials Alliance (ERMA), launched in 2020 to complement the EC's goal of strategic autonomy in the supply chain of raw materials, is closely linked to the battery value chain because of the rare earth minerals that the EU needs for its green transition (European Commission, 2020c; European Raw Materials Alliance, 2020). Within the industrial alliances set up by the EC, public and private stakeholders have an avenue for assessing value chain vulnerabilities and opportunities, developing manufacturing and research capacity, and defining goals for the future. Although the EBA is "industry-led," it frequently hosts high-level ministerial meetings with EC technocrats (European Battery Alliance, n.d.; European Commission, 2019a, 2).

Beyond the borders of the EU, the EC has progressively become more engaged with other nations and regions in strengthening the resilience of the battery value chain. For instance, although the initial *Strategic Action Plan* spend little time on the multilateral forums, such as the WTO, the *Implementation* follow-up strategy expressed a desire to cooperate more with like-minded allies on lowering trade barriers (European Commission, 2018, 2019a). Some had expressed fear that an unwillingness to cooperate with allies would lead to more trade disputes (Belton, 2021; Scott & Posaner, 2020). However, after president Biden took office in 2021, and with the Russian invasion of Ukraine disrupting the security situation on the continent, the EC has sought to strengthen international Cooperation with US and other allies. In March 2022, the EC announced that the EBA would cooperate with US stakeholders on resilience policies related to R&D, recycling, and raw material supply chains. Cooperation between the trans-Atlantic trading blocs would be help to accelerate the energy transition, with lithium-ion batteries as a central pilar. (Dennison, 2022; European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, 2022; Petsinger-Schneider, 2021).

5.5. | Information Policy Instruments

Whereas agreement-based policy instruments rely on the exchange of knowledge between two, or more stakeholders, the 'information' policy instruments function as one-way streets. The EC's central position within the EBA, and the extensive range of information avenues that it has at its disposal, both formal and informal, give it ample opportunity to distribute information about policy goals for the battery value chain (Bouwma et al., 2015; European Commission, 2021a). In addition to cooperating with industry stakeholders and Member States on (resilience) policies for the battery value chain, the EC has used public policy papers to communicate the perceived threats (European Commission, 2020c), policy strategies (European Commission, 2018, 2019a, 2020a), and to encourage action from others. Part of the communication strategy of the EC has relied on providing research and information to other stakeholders in the value chain. The EC's Joint Research Centre (JRC), which carries out scientific research on behalf of the EC, and for the purpose of informing, justifying, and evaluating policy, has provide extensive research for the policy proposals on battery GVCs (European Commission, 2019a, 2020c, 2021a). The JRC's research informs not only the EC, but it is published to inform the other stakeholders, and hopefully incentivize them to undertake action in-line with the EC's economic strategy.

To provide two examples of this policy instrument approach, the EC announced in 2018 that it had launched "a dialogue with EU Member States" to cooperate on locating regional raw material availability (European Commission, 2018, 12). Although the dialogue with Member States was based on an exchange of information, the EC had set up a policy agenda through public policy papers, press releases, and other avenues of conversation. It established a framework and information on the necessary raw materials that were required to supplement and justify its proposals for a common European approach (European Commission, 2018,

2019a). Additionally, the EC has attempted to expand funding opportunities for stakeholders in the GVC, and by providing information and communicating with Member States and private companies. The EC hopes to make these stakeholders aware of available R&D investment funds and wants to encourage more application from scientists and national governments for the financial means that underpin its own strategy (European Commission, 2018, 2021b).

5.6. | Knowledge/Innovation Policy Instruments

The final categorization of policy instruments that have been observed in the EC's public policy documents are closely linked with information-, agreement-based-, and financial/economic instruments (European Commission, 2021b). However, in addition to financing innovation projects through a range of investment funds and institutions, the EC also has put forward policies to actively engage with other stakeholders on the exchange of knowledge. In the policy papers of the EC, the EBA is put forward as the optimal forum for engaging with other knowledge- and innovation stakeholders, including research institutes, industry, and regional or national governments (European Commission, 2019a). The EC emphasized in its industrial policy vision that the exchange of knowledge should occur within industries, supported by research from the EC, and with a broad coalition. This coalition should not just include the large corporations that have a comparative advantage over small-en-medium enterprises (SME) or start-ups. Instead, for the purpose of pursing new and innovative technologies, the "broad and open platform" should "establish strategic roadmaps and efficient coordination of research, development and innovation investment plans" (European Commission, 2021b, 13).

6. | Case Study Two: United States

The second case study deals with the policies and instruments put forward by the United States on GVC resiliency of lithium-ion battery. Based on the academic literature on value chains, industrial policy, and policy instrument analysis, will provide an overview of the US policies to strengthen the lithium-ion battery value chain and make it more resilient. Firstly, it briefly discusses the historical development of these policies, followed by an analysis of recent policy documents. The policy documents are surveyed based on the categorization of the policy instrument framework of Bouwma et al. (2015). Special attention is also paid to the types of resilience policies, whether they are horizontal/vertical in nature, and to what extent they match the policy options found in resilience policy literature.

6.1. | Lithium-Ion Battery Policies in the United States

Although public policies related to the battery value chain have been put forward with increased acceleration since president Biden took office in 2021, the administration of president Trump undertook some steps that set out to review supply- and value chain vulnerabilities and develop policy solutions (White House, 2020, 2021a). As part of the ongoing trade war with China, president Trump signed Executive Order (EO) 13817, which ordered a full overview of US dependency on raw materials imported from foreign countries and required relevant agencies to identify potential opportunities to reshore the upstream (mining) and midstream (processing/refining) parts of value chains. This was the Trump administration's attempt to reduce its overreliance on foreign countries for raw materials, which it felt threatened national security (White House, 2020). The focus of this EO extended beyond the lithium-ion GVCs, including other crucial industries, such as semi-conductors and vaccine production.

Shortly after taking office, in February 2021, president Biden ordered his own federal review through EO 14017, but focused on broader concerns of supply- and value chains resilience (White House, 2021a, 2021b). The federal government's review of battery value chains, conducted by the Department of Energy, found that lacked a comprehensive and ambitious strategy compared to other large trading blocs (White House, 2021a). The review presented a few key resilience policy goals for strengthening the domestic production and procurement of raw materials and battery components. Although the report acknowledged the importance of cooperating with allies on strengthening resilience of raw materials supply, the strategic autonomy policies of the EU and China were viewed with serious reservations. A priority, according to the *Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth* report was therefore leveraging national demand for batteries, as well as, introducing federal legislations and financing to boost the local market for lithium-ion batteries and EVs (White House, 2021a). Additionally, in addition to pursuing diverse sourcing of critical raw materials for battery production, expanding sustained mining activities within the US was also considered essential for ensuring the resilience of the value chain (Federal Consortium for Advanced Batteries, 2021b; White House, 2021a, 2021b).

In addition to the Biden administration's policy on resilience in GVCs, the Department of Energy released a strategic outlook for the lithium-ion battery industry in 2021 (Federal Consortium for Advanced Batteries, 2021a, 2021b). The report, *National Blueprint for Lithium Batteries 2021-2030*, lamented a lack of national strategy that would utilize the US's strengths in the industry, "market-leading" EV manufacturers and battery companies, a broad range of universities and other knowledge institutions, and its potential access to natural resources through domestic production or via international trade, to boost resilience in the value chain (Federal Consortium for Advanced Batteries, 2021a, 16). To coordinate the industrial policy

efforts, the Department of Energy and the White House elected to set up a broad coalition of federal institutions and agencies, under the umbrella of the Federal Consortium for Advanced Batteries (FCAB). The policy instruments that the FCAB identified for implementing the policy goals included increasing federal spending through loans, grants, and public procurement (Department of Defense, 2022a; Federal Consortium for Advanced Batteries, 2021a; White House, 2021b).

Additionally, for the purpose of public-private discussions based on the Biden administration's priorities for the battery industry, the Department of Energy would coordinate with private stakeholders in roundtable discussions and in the newly created Li-Bridge alliance, a partnership between the Department of Energy, the department's research institute, the Argonne National Library, and relevant private parties in the value chain (Argonne National Library, n.d.). To further comprehend the different categories of policy instruments that have been put forward, the next part of the chapter delves deeper into the different types of policy instruments, describing how the publications by the Biden administration indicate a certain policy mix of instruments and resilience policies (Bouwma et al., 2015; Capano & Howlett, 2020; Federal Consortium for Advanced Batteries, 2021a; White House, 2021a, 2021b, 2021d).

6.2. | Legislative/Regulatory Policy Instruments

Part of the legislative instruments that the Biden administration has introduced are related to recycling and innovation as part of the resilience strategy. To ensure a stable supply from downstream battery usage, the US Department of Energy proposed expanding recycling regulatory frameworks that facilitate investments, and improve relative gains from re-using batteries (Federal Consortium for Advanced Batteries, 2021a). In addition to the recycling policies, regulation for the environmentally friendly mining of raw materials and the production

of batteries have also proposed. What stands out, however, is using federal regulatory instruments to improve "form-fit-function" standards in the battery value chain (Federal Consortium for Advanced Batteries, 2021a, 20). This process would allow companies to use specific components of the (EV) batteries to be used across different types of use, without strict regulations, thus making the broader application of these components possible and reduce costs.

To further boost the mining of raw materials and the production of batteries within the United States, president Biden invoked the DPA at the end of March, 2022 (Department of Defense, 2022b). By deploying the war-time DPA Title III as an instrument of resilience policy, the Biden administration intervened directly in the market to support certain corporations or part of the battery value chain (Department of Defense, 2022b). The invoking of the DPA focused primarily on expanding domestic capacity in the upstream part of the battery value chain, allowing the US Department of Defense to incentivize companies to adopt federal contracts for their operations, whilst also freeing financial means from the budget to make investments in expanded capacity and infrastructure (Rubio-Licht, 2022). The US Department of Defense's involvement in tackling resilience issues in the battery value chain can be traced back to the relative importance of high-capacity batteries for national defense industries and the perceived threat of Chinese technology dominance in the GVC for national security (Department of Defense, 2022b; Federal Consortium for Advanced Batteries, 2021a).

Finally, a crucial part of the federal strategy focusses on boosting demand through public procurement policies. Within the Bipartisan Infrastructure Deal that the Biden administration passed, several provisions related indirectly to the development of an integrated, domestic, value chain through public investments. For instance, through the proposal to expand federal investments in public transport, for instance, by acquiring EV busses, private corporations are

incentivized through a demand-pull to further scale-up production of batteries or components in the US (White House, 2021e). The legislation, which allocates several billions of dollars in funding to the battery value chain, further specifies that future federal investments can only be directed to domestic value chains, a policy also known as “Buy American” (Carey & Tsafos, 2021; Jenkins, 2022; White House, 2021c, 2021d, para. 8). The “Buy American” public procurement policy can be interpreted as an attempt by the federal government to distort market mechanisms in the lithium-ion battery value chain.

6.3. | Financial/Economic Policy Instruments

As has been previously shown, the Biden administration has put forward a range of financial incentive programs to support the reshoring of production of lithium-ion batteries within the US. The acquisition of public transport products, including busses and ferries, is expected to pour around $10.0 billion dollars into the value chain for batteries, driving up demand, and incentivizing more private investments to match the federal money (White House, 2021d). Similar public procurement policies are likely to be further expanded in the years to come, as the US attempts to create a full domestic battery value chain, resilient from geopolitical or climate related crises (Federal Consortium for Advanced Batteries, 2021a; Lund et al., 2020; White House, 2021c). The total “buying power” of the federal government, that is the spending on public services, is estimated to be close to $600 billion a year, the majority of which is increasingly being directed to domestic production (White House, 2021b, para. 26).

The review of the Federal Consortium for Advanced Batteries (2021a) stipulated that the federal government should also invest in value chain infrastructure, for instance, in EV charging stations, that would incentivize consumers to buy more cars, and by buying lithium-ion batteries for federal use. A further $3.2 billion has been announced by the administration in the form of

direct grants that corporate stakeholders, in the mid- and downstream part of the value chain, can apply for, if they are willing to match the funding provide by the government (Department of Energy, 2022; Jenkins, 2022). The investment programs that direct the funding, the *Battery Materials Processing and Battery Manufacturing* and the *Drive Vehicle Battery Recycling and Second Life Applications*, are in line with the recommendations in earlier policy papers distributed by the White House and FCAB, and are expected to further increase investments in value chain infrastructure, innovation, and recycling (Department of Energy, 2022; Federal Consortium for Advanced Batteries, 2021a; White House, 2021a, 2021c). Following recommendations from in the analysis of the Federal Consortium for Advanced Batteries (2021a), the U.S. Development Finance Corporation, has adopted policies that will expand its international investment portfolio to include more raw materials required for the production of lithium-ion batteries, semi-conductors, and in other critical value chains (White House, 2021c).

In addition to direct public spending on the battery value chain, the US government has also expanded funding through innovation loan programs. A separate agency within the US Department of Energy, the Loans Programs Office (LPO), has also committed to spending at least $17 billion under its Advanced Technology Vehicles Manufacturing Loan Program (AVTM) for public loans to private stakeholders to accelerate spending on reshoring or expanding battery manufacturing capacity in the US (White House, 2021b). Finally, proposals have been forward to provide additional funding for tax breaks for investments in battery- and other clean energy initiatives to incentivize private stakeholders to spend more (White House, 2021a).

6.4. | Agreement-based Policy Instruments

To coordinate investments with the private stakeholders, the FCAB and the Department of Energy have set up an industrial public-private partnership, the Li-Bridge alliance. The Li-Bridge alliances includes representatives of the industry, research, and policymaking, but has so far distributed little policy materials to analyze and does not distribute any funding (New York Battery and Energy Storage Technology Consortium, 2022). Whilst subsequent policy documents from the federal government have stipulated that coordination between public and private stakeholders will be crucial for successfully implementing the Biden administration's strategy, the primary actors in the formulation of strategy and instruments work with the FCAB framework (Argonne National Laboratory, n.d.; Federal Consortium for Advanced Batteries, 2021a; White House, 2021a, 2021c). However, in more recent months, there has been increased activity within committees established by the Li-Bridge alliance. The objective of the alliance, to "develop a strategy for the United States to build a robust and sustainable lithium-ion battery industry and supply chain in North America" further underlines the US focus on reshoring as a resilience policy tool (New York Battery and Energy Storage Technology Consortium, 2022).

The policy briefings and policies put forward by the FCAB and the White House have both acknowledged the need to work together with international partners to ensure a stable supply of raw materials in the battery value chain, but, also that policies such as the EU's "*Strategic Action Plan on Batteries*" represents a competitive challenge to the US battery industry (Federal Consortium for Advanced Batteries, 2021a, 10). Nevertheless, the Biden administration has said it is open to cooperating with like-minded Western partners to diversify and strengthen the value chain, acknowledging that the "Limited International Coordination" was one of the biggest threats to the broader supply- and value chains (White House, 2021a, 12). In the face of increased geopolitical tensions with China and the destabilizing effect of the Russian

invasion of Ukraine, the US has expanded its efforts on cooperation between the EU and US, and between the Li-Bridge alliance and the EBA, to strengthen the resilience of battery GVCs. Possible avenues that are put forward for international cooperation are the WTO and TCC, in addition to the cooperation with private corporations that are active on both sides of the Atlantic (Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, 2022; Schneider-Petsinger, 2021; White House, 2021a, 2022).

6.5. | Information Policy Instruments

Information policies, wherein the government provides relevant knowledge for the other stakeholders in the value chain, are primarily used to make corporations aware of policy initiatives. The US Department of Energy has, for instance, developed a range of publicly available materials and documents to inform corporations and researchers of funding opportunities available in the US (Department of Energy, n.d.-a; White House, 2021a). Furthermore, the Argonne National Library (n.d.) and FCAB (2021a) have published statistics and research on developments in the value chain. The White House, too, has provide private stakeholders and local/regional governments with important information about the activities of other countries or jurisdictions in the GVCs of lithium-ion batteries, with the intention of informing them about possible reactions from the federal government. Information is distributed in different forms, from press briefings and fact sheets, to long and comprehensive summary reports (White House, 2021a, 2021b, 2022).

6.6. | Knowledge/Innovation Policy Instruments

A final key component of the US strategy for reducing the vulnerabilities of battery value chains is developing new cutting-edge batteries which rely less on the rare earth minerals (Department of Energy, n.d.-b; Federal Consortium for Advanced Batteries, 2021a; White House, 2021a). In

the policy document on supply- and value chain resilience innovation environment in the US is viewed as “an unparalled innovation ecosystem with world-class universities, research centers, start-ups and incubators, attracting top talent from around the world” (White House, 2021a, 7). Because innovation is a crucial element of the Biden administration’s policy strategy, federal agencies have been encouraged to facilitate dialogues between public and private R&D institutions, wherein knowledge can be exchanged. Specifically, the review of supply- and value chains recommends creating an institute for this specific purpose (White House, 2021). The Manufacturing USA Institute would allow scientists, academics, and other actors to work together on testing new innovative technologies at scale (White House, 2021a). This would complement the activities of the National Laboratories, an agency of the US Department of Energy, where the government has funded research into new technologies for seventy years (Department of Energy, n.d.-b). Both institutions would complement further investments by the US government in innovative solutions and can be used as an avenue for the exchange of knowledge on lithium-ion batteries.

7. | Conclusion

7.1. | Hypotheses and comparison

This thesis has analyzed the resilience policies put forward by the US and the EU to strengthen their respective lithium-ion battery value chains. The main research question that this research sought to answer was: **To what extent have the European Union and the United States put forward different policies to strengthen the resilience of lithium-ion battery value chains?** Based on the literature, the following hypothesis had been stated in relation to the main research question: *When selecting resilience policies to intervene in the management of lithium-ion battery GVCs, governments develop policy instruments based on existing governance frameworks and thus favor specific categorizations of instruments over others, with industrial policy preferences influencing the utilization of horizontal/vertical resilience measures and categories of public interventions.*

A distinction was also made between the two sub-hypotheses that focused the attention of the research on 1) the type of industrial policies (horizontal vs. vertical), and 2) the policy mix of instruments. Based on the research on the case studies of the EU and US, the following conclusion are drawn in relation to the two sub-hypotheses.

Sub-Hypothesis 1: *If governments that have a preference for implementing horizontal industrial policies as the primary feature of their policy mix, they will put forward resilience policies that are also horizontal in nature*.

The literature on industrial policy had indicated that there were different preferences between the EU and the US in relation to their respective industrial policies. The EU's industrial policy is characterized by more horizontal industrial policies, aimed at strengthening regulatory

frameworks, engaging in voluntary public-private dialogues, and focusing on maintaining the integrity of the ESM. The restrictions that are imposed on the EC, the EU's primary legislative body, also impact this position. It has to consult the individual Member States for support for its policies, which results in broader, less invasive policies. The US, on the other hand, has publicly been opposed to industrial policy, but research has shown this to be not true. As Block (2008) has shown, there are several hidden financial investment levers through which the federal government has intervened in the economy. Industrial policies in the US have been primarily based on financial grants, loans, and other policies that distribute federal money to corporations and sectors that are considered critical to national security.

Within the industrial policies related to the management of these preferences were found to determine the type of resilience policies that were put forward by the respective institutions. The EU's policies were mainly horizontal in nature, focusing on a combination of regulation- and agreement-based policies to strengthen the resilience of its battery value chain. This can be seen, firstly, in the development of strict regulatory guidelines and frameworks by the EC for lithium-ion batteries that were to enter the market. The EC's ambition to go after unfair trade-practices further underscores its focus on resilience policies that utilize the strength of the ESM. There were some small instances where the EC deployed a more selective policy instrument, for instance, in the case of the IPCEI. It has also been relaxing some of the strict state-aid restrictions, which would suggest that there is room for vertical/selective policy in dealing with value chain resilience. This reflects the strategic importance that the EC and the Member States have given to developing a strong position with the value chain, primarily in the upstream and midstream. Within the resilience policy mix, there are policies that indicate a preference for reshoring some parts of the value chain through a combination of regulation, innovation, and international cooperation.

The US, conversely, has been expanding its industrial policies, focusing on vertical resilience policies of public procurement and innovation investments. In the policy field of battery value chains, it has focused primarily on fully reshoring the global value chain through financial investments, spending big on demand-driven incentivized innovation and reshoring. Compared to the EU, it has used considerably more targeted intervention in the battery industry. Using policy instruments such as the DPA and federal procurement, it has targeted corporations and parts of the domestic value chain to improve the resilience. Cooperation with international partners has picked up pace, especially in the context of rising tension with China and the war in Ukraine. The battery value chain is also approached through an economic and a defense/security lens by the US administration. Within the resilience policy mix, the investments in innovation, expanding manufacturing capacity, and the variety of loans or grants are significant, compared to the EU's resilience policies.

On the basis of this comparative analysis SH1 is found to be true, as the EU's resilience policies have been primarily horizontal, whilst the US has deployed a variety of targeted and selective industrial policies in the public management of the battery value chain.

Sub-Hypothesis 2: *If governments that have prioritized certain categories of policy instruments based on the framework of Bouwma et al. (2015), they will develop a policy mix of resilience policy instruments that prioritizes the same categories.*

Based on the policy instrument framework, there are some similarities, and differences in relation to the categories of policy instruments that the EU and US have put forward. Firstly, both have developed a policy mix that includes the five different categories from the Bouwma et al. (2015) framework. However, the policy mix priority of the EC has been to put forward

more significant instruments in the legislative/regulatory and agreement-based categories. This is concluded based on the stricter regulatory framework that the EC has introduced, and the extensive cooperation with private stakeholders in the EBA. The EBA represents a further integrated industrial alliance than the Li-Bridge alliance in the US. The main elements of the policy mix in the US, on the other hand, are based on economic/fiscal policy instruments. The substantial public (procurement) investments are significantly larger. The range of public institutions that provide some form of loan, grant, or investment is broad, and the amount of money that the federal government is willing to provide is significantly greater than that the EC can put forward.

On the basis of this comparative analysis SH2 is found to be true, as the EU's policy instrument mix has been primarily legislative/regulatory and agreement-based, whilst the US has utilized policy instruments that are more centered around economic/fiscal investment instruments.

7.2. | Final Conclusion

This part of the research will briefly answer the main research question. **To what extent have the European Union and the United States put forward different policies to strengthen the resilience of lithium-ion battery value chains?** As this research has shown, both the EU and US have developed and put forward policies related to the resilience of lithium-ion value chains, but have deployed varying policy instruments based on their preference for industrial polices. Whereas the EU relies on its ESM as leverage against foreign actors in supply- and value chains, and relies primarily on regulation- and agreement-based policies, the US's policies were found to be primarily financial in nature, with a focus on innovation and research policies as a solution to the perceived strategic risks in battery value chains. Based on the framework of Bouwma et al. (2015), both have used a mix of the five categories of policy

instruments. However, the EU has put forward more policies in the legislative/regulatory policies, whereas the US have favored the financial/economic instruments. Both the EU and the US incorporate some combination of agreement-based-, information-, and knowledge/innovation policy instruments.

8. | Discussion

The goal of this research was to explore the variations and similarities between the EU and the US in their policy instruments aimed at GVCs. The thesis sought to link theoretical and academic debates from the fields of CPE, industrial policy, and policy instrument analysis through empirical research based on the public interventions in value chains. The research has indicated that both the EU and the US have implemented similar policies that are in line with their respective, and broader, industrial policies. Therefore, the expected variations between the two regional economic blocks in policy instruments mixes is correlated to their respective policy preference. However, this thesis was intended as an exploratory study of the public policy intervention (industrial policy) as it relates to supply- and value chains, something that has not been tested with a clear link to policy instrument theory. This part of the thesis briefly expands upon the research agenda that is put forward based on the research.

Firstly, as stated by Bulfone (2022), the field of CPE does not currently incorporate enough industrial policy research, which means that there is still much to gain from performing more comparative empirical case-based analyses in the field. This research has shown the variety in industrial policies, and how it can be applied to a specific area of public policy, in this case, GVCs and resilience policies. Future research may explore different subject within industrial policy, for instance, the role of non-elected technocrats on the design and implementation of policies. Other researchers may be interested in exploring other policy area wherein the US and EU are facing similar issues, to determine if their preferences for industrial policies lead to different outcomes, or to the same. There is a great variety of related research subjects that can be derived from this specific analysis, for instance, what other types of policies related to value chains have been put forward. This research does not include policies related to labor training, as it is more closely related to upscaling policies (Pietrobelli et al., 2021), but future research

may well tackle this issue. Regardless, more research in the field of CPE should be undertaken by political scientist, economists, and even historians, to further explore the intricate workings of industrial policy and the many developments that it has gone through over the past century.

Similarly, this research should also encourage researchers to further implement the research agenda of policy instrument analysis. Capano and Howlett (2020) provide an excellent overview of the many aspects of this field that are still to be studied. Furthermore, as this research has shown, applying a policy instrument framework, in this case the excellent work of Bouwma et al. (2015), to a different sector or policy area can provide many new insights from both an individual and in-depth case analysis, to a comparative approach that incorporates similar but different cases. Future researchers can use a similar methodology to the one used in this thesis, or they might elect to pursue a different strategy. Nevertheless, if there is anything that academics interested in industrial policy and policy instrument analysis should take away from this work, it is to keep expanding the research agenda and explore the interaction between governments and corporations.

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