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How do the industrial policy instruments of the United States and the European Union compare in response to growing competition in the strategic semiconductor industry?

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Abstract

In an era marked by geopolitical tensions and the race for technological sovereignty, this study explores the divergent strategies and policy instruments employed by the United States (US) and the European Union (EU) in strengthening their semiconductor industries. Despite being economic powerhouses, the US and the EU hold only about 12 percent and 10 percent of the global semiconductor manufacturing market share, respectively. This comparative analysis delves into the nuanced policy frameworks based on the Developmental Network State (DNS) model of targeted resourcing, brokering, facilitation, and protection in shaping their semiconductor policy. This thesis aims to provide insights that extend beyond mere policy descriptions, intended to inform policymakers, industry stakeholders, and academic scholars to understand the strategic underpinnings that are influencing the global competitive semiconductor industry.

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List of Abbreviations

- AMP - Advanced Manufacturing Partnership
- ARPA-E - Advanced Research Projects Agency-Energy
- ASML - ASML Holding N.V.
- COM - European Commission Document Reference
- DIGITAL - Digital Europe Programme
- DNS - Developmental Network State
- EIB - European Investment Bank
- ERP - Economic Report of the President
- EU - European Union
- EUV - Extreme Ultraviolet
- FDI - Foreign Direct Investment
- IPCEIs - Important Projects of Common European Interest
- IoT - Internet of Things
- JU - Joint Undertaking
- KDT - Key Digital Technologies
- MFF - Multiannual Financial Framework
- MSSD - Most Similar Systems Design
- NIH - National Institutes of Health
- OECD - Organisation for Economic Co-operation and Development
- PIIE - Peterson Institute for International Economics
- PNO - PNO Consultants
- R&D - Research and Development
- SIA - Semiconductor Industry Association
- SMEs - Small and Medium-sized Enterprises
- TFEU - Treaty on the Functioning of the European Union
- TMSC - Taiwan Semiconductor Manufacturing Company
- U.S. - United States
- UNIDO - United Nations Industrial Development Organization

1 Introduction

In recent years, the strategic importance of industries such as semiconductors has increasingly influenced the formulation of industrial policies in both the European Union (EU) and the United States (US). The semiconductor industry, often referred as the chips industry, is central to technological advancement and economic growth and has emerged as a sector of strategic importance due to its widespread impact across various industries, including critical areas like national security, healthcare and communication (Brown & Linden, 2011). This industry's role in driving innovation and supporting almost all modern technologies, from consumer electronics to military equipment, underscores its significance in national and international policy agendas (Ferry, 2013). Since the 1990s, the U.S. and the EU have been offshoring much of their microchip production. These decisions were largely influenced by globalisation trends of seeking cost efficiencies, particularly driven by the disparities in labor costs. Today, the semiconductor industry is characterised by its intense global competitiveness, with the U.S. and the EU making efforts to strengthen their positions in market share manufacturing. American companies, once pioneers in global semiconductor chip production, now only represent around 12 percent of the worldwide production capacity (SIA, 2021; McKinsey, 2022). Similarly, the European Union holds approximately 10 percent share of this market, as reported by the EU Commission in 2022. Despite these efforts, the Taiwan Semiconductor Manufacturing Co (TSMC) stands as a leading producer, manufacturing over 60 percent of the world's semiconductors, including more than 90 percent of the most advanced chips (The Economist, 2023). None of these leading-edge chips (below 7 nanometres) are produced in either the EU or the U.S. (European Commission, 2022).

This comparative analysis study aims to uncover the differences and similarities of U.S. and EU policy instruments in the semiconductor industry, offering insights into the mechanisms and policy tools each employs to maintain and enhance their competitive position. Therefore, the research question of this thesis is:

"How do the industrial policy instruments of the United States and the European Union compare in response to growing competition in the strategic semiconductor industry?"

The "policy instruments" refer to the specific tools, mechanisms, and strategies that the U.S. government and the EU use to influence and guide the development of the semiconductor industry. These instruments can include, but are not limited to, subsidies, tax incentives, research and development grants, regulatory measures, and public-private partnerships, aimed at achieving desired economic and technological outcomes.

While there are multiple definitions of industrial policy in the literature, reflecting a variety of perspectives and contexts, this thesis adopts the standards definition articulated by the United Nations Industrial Development Organization (UNIDO, 2005). According to UNIDO, industrial policy is the 'the set of government decisions and actions that influence the industrial activities of a country or region,' including measures to stimulate industrial growth, increase competitiveness, and promote sustainable development. This definition closely aligns with those used by the Organisation for Economic Co-operation and Development (OECD, 2009) and the World Bank, emphasizing a comprehensive approach to government actions influencing industrial activities.

Societal relevance

The societal implications of the semiconductor industry extend far beyond its economic interest. Semiconductors are embedded in almost all modern technological advancements, ranging from automotive to manufacturing, and from data centers to communication systems. The critical components are vital for the functionality of internet infrastructure, renewable energy solutions, and the Internet of Things (IoT).

The development of the semiconductor industry has historically been closely linked with governmental support and international trade policies. For instance, the growth of the U.S. semiconductor industry in the 1960s was significantly driven by governmental demands from military and space exploration programs, illustrating the sector's deep connection with national security interests (Brown, 2020). The shift in global leadership of the semiconductor industry from American to Japanese and other Asian manufacturers, reflects broader geopolitical and economic trends, highlighting the need for strategic responses to maintain competitive advantages and secure supply chains (Macher et al., 2012).

Today, the semiconductor industry not only drives technological innovation but also plays a critical role in economic resilience and geopolitical strategy. The high costs, the cutting-edge technology, the substantial R&D investments underscore its unique position in the global economy (Johnston & Huggins, 2023). The differing positions of the U.S. and Europe in the global semiconductor landscape with the U.S. maintaining a significant market share and Europe striving to enhance its capabilities underscore the importance of tailored industrial policies (Meyers, 2022). The semiconductor industry is crucial in addressing future societal challenges. It goes beyond economic considerations, influencing aspects of global politics, security, and technological sovereignty. In addition, the industry's recent challenges, such as chip shortages after the Covid-19 pandemic, have highlighted the vulnerabilities in supply chains and global economic dependencies, thus reflecting its broad societal implications.

Theoretical relevance

To address the central research question of how U.S. and EU industrial policy instruments compare within the semiconductor industry, this thesis will employ a comparative case study approach. It will specifically examine the distinct policy interventions and strategies adopted by the U.S. and the EU, assessing their respective impacts on the development of the semiconductor industry. This study will utilize the Developmental Network State (DNS) framework, as outlined by Block (2008) and further developed by Di Carlo & Schmitz (2023), which will act as the primary tool for comparing and dissecting the diverse policy instruments employed by both the U.S. and the EU. Existing literature typically offers a broad overview of industrial policies and their impacts across various sectors. This includes work similar of Donnelly (2023), which explores the semiconductor and IT infrastructure sectors within the context of realism and liberalism theories. In contrast, this study will focus on the recent policy instruments through the lens of the DNS framework. By systematically analysing and comparing U.S. and EU approaches, this study aims to bridge a gap in the literature by and could offer valuable perspectives for those who are seeking to navigate how the regions compare in a globally competitive and technologically intensive sector.

2 Literature Review

This chapter concentrates on the existing literature concerning industrial policy within the EU and the U.S., examining its objectives, strategies and historical trajectories. The analysis of these policies will provide insights into their role in shaping the development of strategic industries, particularly in the semiconductor sector. In addition, the current global value chain of the sector will be explained in the broader context of international relations. This exploration forms the groundwork for addressing the research gap in comparative studies focusing specifically on the U.S. and EU's semiconductor industrial policies. By employing different frameworks (see chapter 3: theoretical framework) this study introduces another perspective to the industrial policy debate, particularly in the semiconductor industry.

2.1 Industrial Policy

2.1.1 Background and definitions:

To understand the concept of Industrial Policy, especially from both an European and American perspective, we first have to understand the existing definitions of it. To start with, the term Industrial Policy is a multifaceted concept and the definitions can vary depending on perspective and context. The United Nations Industrial Development Organization (UNIDO, 2005) uses an integrated approach towards industrial policy: it *"refers to the set of government decisions and actions that influence the industrial activities of a country or region. It includes measures to stimulate industrial growth, increase competitiveness, and promote sustainable development."* This definition is similar to the definitions used by the Organisation for Economic Co-operation and Development (OECD, 2009) and the World Bank (n.d.) with an emphasis on a wide range of government actions to influence industrial activities. While economic growth and competitiveness are common objectives (Roderik, 2008; OECD, 2009; Naudé, 2010a; World Bank, n.d.) the specific goals of industrial policy can differ. For example, Curzon-Price (1981) empathises that industrial policy can be used not only to promote growth and competitiveness but also to influence structural changes in the economy. This may involve interventions aimed at maintaining the stability of certain sectors. In the early 1980s, the industrial policy debate in the US and in Europe was mainly dominated by neoliberal views, arguing that current policies were "inefficient and inappropriate" and that "markets are able to operate efficiently" in both the short and long term (Pianta, 2014). Contrary to the neoclassical economics perspective, that confines the role of industrial policy to correcting failures, the reasons behind government interventions via industrial policy are more complex (Bulfone, 2022). Throughout history, the key objectives of industrial policy has changed (slightly) over time. Warwick (2013) distinguished three phases to explain the evolution of industrial policy. During the period from the 1940s to the late 1960s, industrial policies emphasized the vital role of state-driven industrialization for development, aiming to counter pervasive market failures in developing countries through measures like coordinated state intervention. From the 1970s to the 1990s, scepticism towards industrial policy grew, with a prevailing belief that government intervention often led to inefficiency. Privatisation and attracting Foreign Direct Investment (FDI) with minimum government interference became essential drivers of economic growth and industrialization. Since the 2000s, industrial policy has acknowledged both market and governmental failures, shifting focus towards the nuanced execution of policy strategies and flexible institutional frameworks. This thesis aims to contribute to existing knowledge on industrial policy, including the recent analysis by Donnelly (2023) which offered a comprehensive view on the semiconductor industry and IT infrastructure on geopolitical dynamics and theories focused on realism and liberalism. This study seeks to address a specific gap in the literature concerning comparative industrial policy analysis and focusing on the detailed application of the DNS framework. This allows for a nuanced exploration of the recent policy instruments and strategies, providing a perspective on the evolving global semiconductor landscape.

Industrial policy is often used to strategically coordinate economic activities for overall efficiency. According to Chang (1994) it can be seen as "government policy aimed at particular industries to achieve the outcomes that are perceived by the state to be efficient for the economy as a whole". Motivations for implementing industrial policy or initiating government intervention can be multifaceted, encompassing efforts to rectify market failures, instigate structural transformations in a country's industry or alter its "revenue model", as well as strategies aimed at strengthening a country's competitiveness compared to foreign countries or competitors (Bulfone, 2022). This means that industrial policy can aim to foster innovation and technological advancements and promoting national (eco)systems, for example within the strategic semiconductor industry, which has emerged as a key sector in global technological competition and plays a crucial role in the global economy, as highlighted in a recent Deloitte publication, *the semiconductor industry plays a pivotal role in today's economy* (Jiravachara, 2022). These multifaceted objectives provide a starting point for the understanding of why both U.S. and EU's industrial policies may be concerned about increasing global competition in the semiconductor industry. Semiconductors – or microchips – are everywhere, integral to industries ranging from automotive and manufacturing to data centers and communications. Taiwan emerges as the world's leading microchip manufacturing hub, with TMSC having a 58.5 percent share of the global production market (The Economist, 2023). To understand the current global dynamic landscape of the strategic semiconductor industry, it is important to distinguish the manufacturing of semiconductors (such as entities like TMSC in Taiwan) and the revenue-centric market share, often analysed by the Semiconductor Industry Association (SIA, 2021). The EU's ambitious goal, as described in the Chips Act (2022) is to elevate its global market share from 10 percent to at least 20 percent by 2030, underscores the strategic shifts and competitive positioning within this critical sector. According to the

EU Commission (2022) the current market share is “well below its (EU) economic standing”. These specific objectives within the context of the semiconductor industry, will be examined further as the literature review progresses.

Another essential aspect in understanding the meaning and approaches of industrial policy are the instruments or the specific actions that a government can use. To strengthen some specific industries a country can implement a range of different instruments such as “grants, subsidies, tax credits, low-interest loans, public guarantees, procurements, credit provisions and equity investments” (Bianchi and Labory, 2006b; Cimoli et al., 2009, as cited in Bulfone, 2022). The policy instruments used in industrial policy vary depending on the domain or the specific goals that the policy aims to achieve. Naudé (2010) provides a table in which different domains/goals are outlined with the relevant instruments that the government can use. The domains Naudé (2010; p.8) distinguishes are: "Economic Signals and Incentives," "Scientific and Technological Innovation," "Learning and Improving Technological Capabilities," "Selective Industry Support," "Selection Mechanisms," "Distribution of Information," "Improving Productivity of Firms and Entrepreneurs". For example, if a government wishes to support “Scientific and Technological Innovation” within a certain sector, then policy instruments such as R&D subsidies, tax credits, and funding for university research become important elements (Naudé, 2010). If the objective is to improve the “Productivity of companies”, or of specific SMEs, then some of the key instruments could include the promotion of public-private partnerships, support for incubators and clusters, or the establishment of venture capital funds (Naudé, 2010). For the semiconductor industry, the goals of “Scientific and Technological Innovation” and “Learning and Improving Technological Capabilities” are probably most relevant given the industry’s possible technological advancement and its foundation in complex (scientific) research. Another crucial domain can be “Improving Productivity of Firms and Entrpreneurs” especially considering the high capital intensity and competitive (international) competition in the semiconductor field.

To examine the complexities of U.S. and EU industrial policy, three distinctions will be used: goals that the industrial policy aims to achieve, the tools and instruments to realise its objectives, and the protagonists of these policies. This would provide clarity and ensures a systematic comparison between U.S. and EU industrial policy for the comparative analysis (chapter 5).

2.2 EU Industrial Policy

2.2.1 Historical evolution:

This section will outline the concept of EU industrial policy by examining predominant objectives and its distinct mechanisms and instruments to fulfil the aims of EU’s industrial policy and the protagonists (the various actors). In contrast to the more indirect approach characterized by the Developmental Network State (DNS) in the U.S., as described by Block (2008), the EU has traditionally adopted more explicit and integrated policy frameworks. Programs like Horizon 2020, the Digital Single Market Strategy, and the European Green Deal exemplify the EU's approach, where objectives and actions are clearly defined and publicly communicated, focusing on innovation, digital opportunities, and environmental sustainability.

Europe's economic recovery and growth in the aftermath of the World War II was shaped by a comprehensive industrial policy that prioritized first – in the 1960s - emerging industries such as steel, automotive and chemical industrial, and later developments in electronics, aircraft and biotechnology (Pianta, 2014). Throughout history and certainly since the 1980s, mainly France has consistently advocated that European nations should work in close cooperation to bolster the continued advancement of high technologies, including initiatives like Eureka (Pianta, 2014). Various industrial policies have been implemented across various European nations for an extended period, with an emphasis on the single European market in the 1980s and 1990s. The EU's industrial policy was primarily driven at the individual member state level, with limited coordination among member states, contrasting with the U.S. federal government's more centralized approach towards industrial policymaking within a single nation-state and unified legal framework. Only in October 2005, the European Commission introduced a significant policy framework titled 'A Policy Framework to Strengthen EU Manufacturing – Towards a More Integrated Approach for Industrial'. This comprehensive strategy aimed at strengthening EU manufacturing and promoting a more integrated approach to industrial development within the EU, reflecting a shift towards incorporating networked and collaborative aspects. It encompasses a comprehensive strategy aimed at strengthening EU manufacturing and promoting a more integrated approach to industrial development within the EU. But before this date, neoclassical views often predominated among European nations, leading to a significant reduction in industrial policies. Consequently, no integrated European industrial policy existed (European Investment Bank, 2006). According to Pianta (2014), while some EU member states implemented activist industrial policies, for example in the case of France with state owned firms such as in automotive (Renault), aerospace (Airbus) and several other industries, there was no common industrial policy strategy at the EU level. The state aid regulatory regime did not necessarily reduce the scope of state intervention by member state. Individual member states still had the flexibility to pursue their industrial policies. When the European Commission presented their first industrial policy (COM, 2005), it marked the beginning of concrete sectoral initiatives to strengthen EU manufacturing and enhance the competitiveness of the European economy. However, the financial crisis of 2008 brought the European continent into an economic stagnation and – mainly youth – unemployment rates (Pianta, 2014). Also the citizen's trust of the EU has fallen to nearly 30 percent in 2013 (Eurobarometer survey, 2013). Even policy objectives to develop a new path of growth in Europe, based on environmentally friendly activities and enhanced social justice, would face increased challenges in the absence of a more robust EU industrial framework (Pianta, 2014).

Since then, the EU has launched several specific industrial policies, each aiming to bolster its position in a distinct field. According to Di Carlo & Schmitz (2023) the Franco-German realignment on pro-EU industrial policy positions since 2016 was a significant driver for this. Targeted industrial policies included promoting sustainability (European Green Deal in 2019), advancing digitalization (Digital Single Market Strategy in 2015) and the Europe 2020 Strategy (in 2010), designed to strengthen the overall economy with a focus on job creation in the subsequent decade. These proactive initiatives by the EU were a response by global challenges and opportunities. The Europe 2020 strategy replaced the former Lisbon Strategy (Van Iersel, 2011), put forward so-called “flagship initiatives” including four that are especially relevant for making the EU’s industry more competitive. These industrial policies highlight the EU’s proactive approach as a response to global challenges and opportunities (e.g. digitalization, climate change, COVID-19, Ukraine). However, the EU is a supranational entity composed of multiple member states, each with its own legal and political systems. This requires a more collaborative and consensus driven approach to (industrial) policy making, where policies must be agreed upon by multiple sovereign nations. In its effort to promote innovation and economic growth, the European Commission has proactively undertakes numerous initiatives that are both sector- and mission-oriented across Europe (Di Carlo & Schmitz, 2023). Still, these initiatives must be implemented across diverse national member states, which sometimes can lead to variations in how policies are applied and enforced. But the notably increasing integration of policy functions at EU level, driven by the need for coordination of national policies transferred in some policy areas to the level of authority towards the EU, enhanced the competitiveness of the EU.

All the various actors and entities are crucial in shaping and implementing these industrial policies. According to Bulfone (2022), historical European Industrial policy during the post-war era was largely influenced by central governments in setting long-term industrial priorities. While managers of state-owned companies and planning officials had some autonomy in everyday market operations, it was generally accepted that governments played a pivotal role in shaping these industrial directives (Barca, 2010; Hall, 1986; Shonfield, 1965). As mentioned by Bulfone (2022), the role and influence of protagonists significantly changed with the deployment of new (industrial) policy instruments. During the trends of liberalizations and privatizations, the focus of state involvement shifted from direct intervention to a more coordinating and facilitating role. The aim became to manage the integration of specific companies, industries or strategic sectors into the (global) market. This transition marked a notable change in how state entities interacted in an evolving economic and industrial landscape. Still, within the EU, the political landscape and the dynamics between the European Commission, European Parliament, the member states, and the private sector always remain a challenge when proposing European industrial policy, especially in a field the strategic semiconductor industry.

2.2.2 Identified gaps in the existing literature

While the historical evolution of EU industrial policy is well-documented in various studies, including Bulfone (2022), Pianta (2014), Warwick (2013) and Carlo & Schmitz (2023) have extensively documented the historical evolution of EU industrial policy, their focus has largely been on the broader historical trajectories and the development of industrial strategies within the EU. However, the recent study conducted by Donnelly (2023) also delves into the analyses of the chips (including the EU Chips Act) and critical ICT infrastructure of the EU in response of the US actions, with the particular focus on the increasing importance of Waltian geopolitical security threats, which reflect a realist perspective on international relations and security. This approach underscores the strategic responses to perceived threats and the adoption of policies aimed at fostering technological sovereignty and security. This study adopting a more economically driven perspective. Specifically, it utilizes the DNS framework to examine the specific functions and policies aimed at enhancing the European semiconductor industry's market from the current 8 to 10 percent to a targeted 20 percent. This economic approach underscores the EU's ambitions to strengthen its position in a critical industry that is deeply connected with various other sectors. The existing policy instruments have not been extensively analysed through the DNS model. Also, this study tries to integrate the most recent developments concerning the semiconductor industry of both the U.S. and the EU, including recent initiatives or results. This highlights the gap between the existing literature and this comparative analysis through the lens of the DNS framework.

2.3 US Industrial Policy

2.3.1 Historical evolution:

This section will focus on the historical evolution of U.S. industrial policy, highlighting key transitions and policy shifts. The US industrial policy has traditionally been influenced by its unique political, economic and social landscapes.

In the early stages, the neoliberal approach in the U.S. advocated for a limited state role in market economies, primarily focus on regulating markets and intervening only in cases of market failures (Wade, 2012). This view predominantly rejected the idea that industrial policy should be about a state's interfering in economic management, even in strategic sectors or industries. Unlike explicit industrial policies of East Asian economies, the U.S. industrial policy has been often implicit, embedded in various government actions ranging from defense spending to public procurement, research and development subsidies, and regulatory frameworks (Mowery & Langlois, 1996). In the aftermath of the second World War, U.S. industrial policy was significantly influenced by Cold War context. The government, through defense spending and support for R&D in sectors such as aerospace, communications and pharmaceuticals, indirectly shaped industrial policy. Mann (1997) noted that there was little emphasis on industrial policy until late 1990s, partly due to the unique features of the U.S. political system, characterised by the separation of powers in the US constitution, such as the Houses of Congress, the Supreme Court, and the different states.

The shirt towards a more interventionist approach began after the World War II when the limitation of the neoliberal model became apparent, particularly in addressing the needs of developing nations (Seers, 1963). The idea arises that a state can co-create markets “the entrepreneurial state”, can take direct and indirect risk investments and does not only intervene in case of market failures (Mazzucato, 2013).

While neoliberal principles remained dominant in development economics, the U.S. transitioned from isolationism and protectionism towards a global leadership role in promoting open, market-oriented trade policies (Irwin, 2017). This transition highlighted the adaptive and strategic nature of American industrial policy in response to global challenges. Moreover, the U.S. approach, utilizing the DNS model, started to strategically support technological advancement and industry growth without the direct visibility seen in EU policies, enabling the U.S. to maintain its competitive edge in the global arena. The landscape of U.S. industrial policy is marked by a nuanced interplay between various level of governance (federal, state, and local governments) and the private sector, reflecting a complex and dynamic framework for understanding how the U.S. government interfere with the economy. Recent studies, such as those by Wade (2012), have shown that over the past thirty years, these various levels of the U.S. government have engaged in forms of industrial policy. Each level can have its own objectives, strategies, and tools, which may sometimes align or, at other times, operate independently. For instance, the federal initiatives like Manufacturing USA institutes foster innovation through public-private partnerships, while state and local governments have developed targeted economic development programs. This means that on one hand the U.S. federal government operates within a single-nation and unified legal framework reflecting a more centralized approach towards industrial policymaking, and on the other hand the U.S. allows a decentralized approach of industrial policy at the State or local levels. These layers of governance can innovate and tailor their industrial strategies to local needs and opportunities, benefiting from closer ties to their communities and regional industries.

A significant trend was that companies from emerging markets have advanced significantly in the last decade in their international operations. These companies usually have a strong sense of national identity and also receive some sort of state support (Wade, 2012). This impacted the Western companies and governments, including the US, to be more aware of the importance of both the “nationality in business” and a more open idea of state support. A real shift towards a more state intervention approach was the response of the US and Europe to the global financial crises in 2007-2008. The Economist (2010) even declared that industrial policy (in terms of promoting economic development) is ‘back in fashion’ since the financial crises. More explicit initiatives like Advanced Research Projects Agency-Energy (ARPA-E) was introduced, focusing on addressing contemporary challenges such as climate change, sustainable energy, and maintaining technological leadership. The term “conditionality” (Mazzucato, 2023) is used because governmental support is provided together with certain expectations of outcomes, such as innovation or other clear objectives. It has led to sector targeted measures in the U.S., such as increased bank lending, support for the automotive sector, and investments in specific industries like energy, life science and health and IT. The targeted measures, under the Obama administration, marks a shifts from the traditional American stance towards state intervention. Also the term ‘Buy American’ clauses illustrates a more interventionist approach. However, despite that under the Obama administration, the U.S. government considerably were more willing to use industrial policy (instruments) to address national goals, the members of Congress and the American public still were not very enthusiastic about this type of government intervention (Di Tommaso and Schweitzer, 2013). In contrast to the EU’s more explicit and integrated policy frameworks, such as Horizon 2020 (presented in 2013), the U.S. employed a more subtle and indirect approach. Block (2008) described the Developmental Network State (DNS) which is characterised by a network of state agencies, private sector partnerships, and research institutions, reflecting a 'hidden development state' where the U.S. government's role in industrial development was more ‘below the radar’. Although, the Obama administration aimed to unveil the ‘hidden’ developmental state, particularly around clean energy technologies (Block et al., 2023). Since then, the U.S. has “massively adopted selective industrial policies for promoting the growth and competitiveness of its national industries” (Di Tommaso et al., 2020). In practice, multiple agencies of the U.S. government have long practiced different types of industrial, often unnoticed by analyst (Wade, 2012). The U.S. government influences industrial development through strategic support networks or firms in selected sectors, employing targeted industrial policies without the direct visibility seen in EU policies (Wade, 2012). This included support for firms in these targeted sectors through both “hard tools” including some kind of protection, subsidies and public procurement and “soft” instruments such as seeking for collaborations between public officials, firms and universities. The U.S. government also has directly allocated funding to incentivize manufacturing domestically, for example in the cases of Tesla and Solyndra, but also with loans to both Ford and Nissan (Block et al., 2023).

From the year 2020 onwards another remarkable shift in U.S. industrial policy became notably to support domestic manufacturing. This change was influenced by many factors such as the trade conflict between the US and China, as well as the outbreak of Covid-19 (Hufbauer & Jung, 2021). During this period, the Trump administration initiated policies focused on encouraging American companies operating in China to return to the United States. In addition, there was an emphasis on providing financial support to enhance the domestic production of advanced technology products, including in the field of aerospace and semiconductors. Policy measures taken by the Trump administration included protective tariffs, trade restrictions, direct subsidies, tax credits and government procurement (Hufbauer & Jung, 2021).

The ongoing discourse in the U.S. continues to demonstrate resistance towards government intervention and the implementation of industrial policies. Di Tommaso et al. (2017) concluded earlier already that there is no doubt that the enactment of industrial policies in the American context is more difficult than in countries with well-established interventionist traditions. This complexity is further accentuated by the distinctive features of the American political system, with divergent political agendas not only between the federal and state government but also between the President and Congress. The structural configuration, as noted by Wade (2012) leads to challenges in achieving consistency and coordination in industrial policy. In addition, the relatively frequent election cycles and the media-driven focus on short-term public opinion further constrain the difficulties in formulating and executing a coherent industrial policy in the US (Di Tommaso et al., 2017).

Today, these historical influences are reflected in how the U.S. address its industrial objectives and balances market forces with strategic interventions, and determines how it responds towards global competition. In light of the evolving industrial landscape and the crucial role of the current Biden Administration's recent initiatives, the U.S. contemporary policies and strategies regarding semiconductors will be explained and analysed in the Chapter 5 (case study analyses).

2.3.2 Identified gaps in the existing literature

Similar to the EU's historical evolution, the U.S. industrial policy has been extensively studied, but a notable gap remains in comparative analysis, particularly in the context of the semiconductor industry context. While studies such as Naudé (2010), Warwick (2013), and Di Tommaso et al. (2017) provide comprehensive insights into industrial policy's nuances within the U.S. or EU, they do not offer a direct comparison between the two regions' approaches to semiconductor policies. Similarly, Bulfone (2022) and Block (2008) explore broader themes in industrial policy and the pollical economy without focusing on a comparative analysis of semiconductor industry policies between the U.S. and the EU. Berendsen (2022) and Pianta (2014) further discuss resilience and industrial strategies in other sectors, for instance on lithium-ion battery value chains between the U.S. and EU.

However, a recent study conducted by Donnelly (2023) offers insights into the semiconductor industry, mentioning both the EU Chips Act and the American CHIPS and Science Act, with a focus on the increasing importance of geopolitical security threats and thus the resulting policy responses of first the U.S. followed by the EU. While Donnelly (2023) provides a valuable perspective on the strategic motivations behind both the US and EU industrial policy, his focus remains primarily on the geopolitical and security aspects, rather than a detailed comparison of the economic strategies and the specific policy instruments employed by each region in fostering semiconductor growth and innovation.

This study seeks addresses this gap by providing a detailed comparison of the policy instruments employed by the U.S. and the EU, with a specific emphases on recent relevant industrial policies such as the EU Chips Act (2023) and the CHIPS and Science Act in the US (2022).

The comparison between these recent initiatives to foster innovation in the semiconductor industry and strengthen their current position within the global supply chain is often lacking in existing literature. While studies such as Miller (2022) has outlined how U.S. industrial policy should learn from past government efforts to shape the semiconductor industry, highlighting the critical objectives for U.S. policy towards the semiconductor industry, including promoting technological advances and guaranteeing security of semiconductor supply, there remains a scarcity of comprehensive comparative analyses with the EU. Given the rapidly evolving landscape of both the semiconductor industry itself and developments of policy initiatives foster innovation and the level of competitiveness, there is a notable gap in existing literature regarding immediate implications of these strategies. Initiatives from the Biden Administration following the CHIPS and Science Act in the U.S. underscore the challenge of keeping academic research and comparative analyses up-to-date with the current situation.

Moreover, the article from the American Enterprise Institute by Claude Barfield (2020) discussed implications of proposed U.S. legislation aiming at supporting the semiconductor industry and in light of the rising challenges with China, it's main focus are the unilateral policy developments rather than a bilateral or comparative examination of the EU and U.S. approaches.

In conclusion, the identified gaps in the literature demonstrate a need for up-to-date comparative analysis that reflect the rapidly changing landscape within the semiconductor industry including policy developments. As this sector continues to navigate through the complexities of geopolitical tensions and supply chain vulnerabilities, future research such as this study must aim to bridge this gap, offering insights that are not only reflective of the current state but also anticipate on the industry's developments. Insights of policy decisions and industries can ensure that both the U.S. and the EU can effectively respond to the (global) challenges and opportunities within the "war on chips".

3 Theoretical framework

This sections constructs a theoretical framework, based on the literature review in the previous chapter, to analyse the industrial policy instruments of the U.S. and the EU within the semiconductor industry. Central to this framework is the Developmental Network State (DNS) model. In this thesis, the DNS framework provided by Block (2008) and further developed by Di Carlo & Schmitz (2023) will serve as primary instrument for examining and assessment. The aim is to demonstrate how the policy instruments of both the U.S. and the EU compare in the competitive semiconductor industry.

3.1 DNS Framework in EU and American industrial policy

Block (2008) has provided a comprehensive analysis on how the U.S. government plays an active and significant role in economic development through the concept of “Developmental Network States” (DNS). Block refers here to the “hidden” or unseen support system that has facilitated the transition of technologies from research labs to the marketplace. Over the last fifteen years, this framework has expanded, for example by Di Carlo & Schmitz (2023) by incorporating aspects of network collaboration among various protagonists (e.g. firms, universities, public agencies) in today’s globalised economy. Additionally, in the U.S. significant legislative actions have been taken during the initial two years under the Biden administration to make more public investment possible. However, despite these developments, most of the initiatives remain largely unnoticed in political discussions beyond the federal government, remaining ‘hidden’ of the vast majority of American voters (Block et al., 2023).

The DNS model can serve as an analytical framework to better understand the objectives and the implementation of industrial policies and its tools for industrial innovation among modern states. In the expanded version of the model by Di Carlo & Schmitz (2023), they highlight the importance of collaborative advantages and the role of public officials to foster innovation. According to Di Carlo & Schmitz (2022), the European Commission is increasingly performing industrial policy tools according to the DNS concept, which seems crucial for promoting and protecting the single market in light of technological and geopolitical changes. Therefore, DNS will be used to further analyse how the EU and US shape their industrial policies, particularly regarding the semiconductor industry. There are four developmental functions performed by DNSs (see table 1). Initially the U.S. industrial policy already was extensively analysed by the work of Block (2008). However, latest development in U.S. industrial policy specifically concerning the semiconductor industry starting from the Obama, Trump, and now Biden Administration, will make it relevant to reexamine these four DNS functions in the context of recent policy shifts and initiatives. Also in the recent study by Block et al. (2023) it was concluded that even despite all the developments and increasing public spending in the development of certain technologies, most of the initiatives remain still hidden. More specifically, according to Block et al.

(2023), the Obama administration implemented several major enhancements to the DNS, yet the President did not leverage on this to publicly highlight these initiatives. Meaning that, by utilizing the DNS approach in this thesis, the re-evaluation will serve a dual purpose: it will refresh our comprehension of the U.S. strategy in response to recent government actions, and secondly it will offer a comparative examination with the EU's active measures to enhance its competitive stance within the global semiconductor industry. The four developmental functions of the DNS—targeted resourcing, brokering, facilitation, and protection—are instrumental in defining both the U.S. and the EU's approaches to industrial policy.

Targeted Resourcing: This function involves identifying and supporting sectors and actors with high potential for innovation and growth. By identifying projects with the potential for significant technological advances, public officials allocate funding to ventures that the market might overlook. This targeted support is crucial for nurturing groundbreaking ideas that require initial capital to move from concept to reality (Block, 2008; Di Carlo & Schmitz, 2023). Examples are initiatives such as *Horizon Europe*, whereas the EU commits substantial investment in R&D to maintain its competitiveness in the global economy. In the U.S, Agencies like the National Institutes of Health (NIH) exemplify this through their substantial investment in health-related R&D, highlighting the government's targeted resourcing efforts.

Brokering: In this function the state acts as a mediator by bringing together diverse stakeholders from universities, government labs, or the private sector with potential investors, across national borders and industry sectors. This networking facilitates the exchange of ideas and resources necessary for technological development (Block, 2008; Di Carlo & Schmitz, 2022).Initiatives such as the *Digital Single Market Strategy* exemplify this function, where the EU Commission promotes digital integration across member states, fostering a more unified innovative European market. In the US, The Advanced Manufacturing Partnership (AMP) illustrates this by showing the collaboration between industry leaders, academic institutions, and government entities. The AMP aims to foster innovation and reinforce the manufacturing within the United States.

Facilitation: This function explains the government's ability to adapt and adjust its regulatory framework in promoting further industrial innovation to streamline and enhance the operational environment for market participants. This can concern regulatory measures, such as redefining regulations, setting standards or simplifying administrative procedures. These actions are designed to encourage investment in new, strategic sectors by removing bureaucratic obstacles and creating a more conducive environment for business growth and innovation (Block, 2008; Di Carlo & Schmitz, 2023). In the EU, initiatives such as *EU State Aid Modernization* reflect this function, demonstrating how flexibility in a particular regulatory framework can be used to bolster innovation. In the US, regulatory sandboxes in the fintech sector demonstrates its commitment to support technological and financial innovation.

Protection: This function involves protective regulatory measures to defend domestic industries from international competition. These protective measures can be motivated by national security concerns, the need to counteract unfair competitive practices, or to support domestic sectors against more technologically advanced foreign entities. By protecting certain sectors or local businesses, the state can foster a more controlled environment for domestic growth and technological advancement (Block, 2008; Di Carlo & Schmitz, 2023). In the EU, initiatives such as the *EU Foreign Investment Screening Regulation* aim to protect critical European industrial and maintain economic security. In the U.S., the "Buy American Act" demonstrates a crucial element of its protection measure, mandating government agencies to purchase U.S. made products.

For comparative clarity, table 1 provides insights how the EU and the U.S. applied DNS functions across their different policy objectives.

Table 1: The four DNS developmental functions according to EU's and U.S.'s industrial policies

	State goals	EU examples	US examples
Targeted resourcing	Identifying and supporting sectors and actors with high potential for innovation and growth.	Horizon Europe: Substantial investment in R&D to maintain global competitiveness.	National Institutes of Health (NIH): Substantial investment in health-related R&D.
Brokering	Acting as a mediator to facilitate the exchange of ideas and resources for technological development.	Digital Single Market Strategy: Promotes digital integration across member states, fostering a unified innovative market.	Advanced Manufacturing Partnership (AMP): Collaboration between industry, academia, and government to reinforce US manufacturing.
Facilitation	Adapting and adjusting regulatory frameworks to promote industrial innovation and streamline operational environments for market participants.	EU State Aid Modernization: Demonstrates regulatory flexibility to bolster innovation.	Regulatory sandboxes in the fintech sector: Support for technological and financial innovation.
Protection	Implementing protective measures to defend domestic industries from international competition.	EU Foreign Investment Screening Regulation: Protects critical industries and maintains economic security.	Buy American Act: Mandates government agencies to purchase U.S.-made products.

Source: Di Carlo & Schmitz (p. 8, 2023)

The application of the four functions of the DNS model within the EU and U.S. industrial policy demonstrate not only the shared commitment to foster innovation and economic growth for its region, but also shows that the EU and the U.S. adapt unique policies in response to their political, economic and societal contexts. The functions reflect a comprehensive approach and demonstrates how demonstrating strategic resource allocation, stakeholder collaboration, regulatory facilitation, and protective measures intend to support and protect their key industries. In chapter 5 (case study analysis) a more detailed exploration will be given according to these four functions within the strategic semiconductor industry.

3.1.2 R&D investments

Targeted resourcing, as described by the DNS model, encompasses the allocation of resources towards sectors or projects with high potential for innovation and economic impact. Another theory, Romer's theory of Endogenous Technological Change (1990) really emphasises the importance of internal factors such as R&D investments in driving technological advancements and economic development. This internal focus shifts from the approach of seeing technological advancement as merely an external influence to recognizing that the internal factors are the core component of sustained economic developed. Both the emphasis on targeted resourcing within the DNS model and Romer's emphasis on R&D investments underscores the strategic importance of selecting sectors with high potential for innovation – particularly in industries that are important for a country's competitiveness, such as the semiconductor industry. Both public and private investments in R&D are seen as essential factors for technological advancements, and economic prosperity. Because of its specific notion on R&D investments, further exploration of R&D investments of both the EU and U.S. and their possible impact in the semiconductor industry will be given in other chapters. The semiconductor industry stands out that it invest more in R&D than all other industries. However, given the high risks and the strategic and geopolitical significance of the semiconductor industry has worldwide resulted in receiving substantial support from the public sector (EU Commission, 2022).

Multiplier effect

The concept of 'spillover effects' or multiplier has become fundamental in the study of innovation economics and the dynamics of technological advancements. Spillovers from R&D investment mean that the actual investment not only contribute directly to the growth of the specific sector but also facilitate more widespread economic benefits (Jones, 1995). These effects occur when a company benefits from another's knowledge without the originating firm having the power to manage or affect the extent of this unintentional exchange of information (which will also lead to reducing costs for these other firms). R&D investment or activities, therefore, become an important element to stimulate economic growth (Romer, 1990). However, other studies such as Wölfl (1998) suggest that R&D spillovers in strategic or competitive sectors, such as electronics, aerospace and semiconductors are more nuanced. The combination of sharing innovations and the risk of competition can either encourage or discourage firms to work together. Given the complex dynamics of R&D investments and its spillover effects within competitive sectors, this study will only focus on the direct impact of public and private R&D investments. The multifaceted nature of spillover effects, as described by Wölfl (1998) is influenced by many factors including firm size, industry competition and nature of innovations, complicates the comparative assessment.

3.4 Hypotheses

This section presents the hypotheses derived from the theoretical framework established in the previous chapters. These hypotheses are formulated to guide the subsequent comparative analysis of U.S. and EU industrial policies in the semiconductor industry. The hypotheses are based on the key concepts of the Developmental Network State (DNS) model by Block (2008) and further developed by Di Carlo & Schmitz (2023), which provides a comprehensive formulation through which the governmental strategies, structural differences, and policy implementations can be examined in relation to their impact on a critical sector like semiconductors. The three hypotheses aim to offer insights in which the U.S. federal and the EU supranational governance system influence the current development, execution and effectiveness of semiconductor policies. By focusing on governance structures (H1), targeted resourcing or funding and investments for support programs (H2), and the application of protectionist measures (H3), the case study can provide can demonstrate the complex dynamics of shaping the semiconductor industry's landscape in both the U.S. and the EU.

Hypothesis 1: Difference in governance structure: Federal versus Supranational

The first hypothesis aims to compare how the difference in governance structure – federal in the U.S. and supranational within the EU – significantly influences the centralization and effectiveness of semiconductor policy implementations, particularly in terms of financial spending of public investments and strategic investments. Specifically, the U.S. federal governance model, characterized by its greater spending capacity, is hypothesized to results in more centralized and potentially more impactful investments in the semiconductor industry compared to the more decentralized approach within the EU's supranational framework. The federal and centralized approach is expected to lead to different and higher investments and strategic initiatives within the semiconductor sector.

"The federal and more centralized governance structure of the U.S. leads to a more unified and coherent implementation of semiconductor policies, resulting in higher (public) investments in the semiconductor industry compared to the EU's supranational and decentralized approach."

Hypothesis 2: Allocation of funding and investments

Understanding the nuances of targeted funding and public investments is essential for dissecting the different strategic approaches of the U.S. and EU semiconductor policies. The U.S. federal government is likely to allocate resources directly into specific semiconductor initiatives. The EU is expected to have a more fragmented targeted spending primarily conducted by individual member states, leading to a diverse investment landscape. This analysis becomes particularly significant in light of the increasing global competition in semiconductor manufacturing and supply chain security.

"**The allocation of targeted spending in the semiconductor industry in the EU is expected to be more fragmented and driven by individual member states, reflecting diverse strategic priorities."**

Hypothesis 3: Protectionists measures

The increasing global competition (in particular from China) and geopolitical dynamics in the semiconductor industry will lead to the implementation of more protectionist measures, specifically in the U.S. due to its direct competitive stance. These measures will differ in scope and intensity compared to those adopted by the EU, reflecting variations in geopolitical strategy and economic policies as indicated in the literature.

"Due to increased global competition, the U.S. is expected to enact more rigid protectionist measures in the semiconductor industry than the EU".

4 Research Design

This chapter outlines the methodological framework to examine how U.S. and EU's industrial policy instruments compare in response to growing competition in the strategic semiconductor industry. Based on the insights gained through the theoretical exploration of the Developmental Network State (DNS) model, this research employs a comparative case study analysis to dissect and understand the nuances of policy implementation across these two geopolitical entities.

Conceptual Framework & Operationalization

This research applies the Most Similar Systems Design (MSSD) as outlined by Toshkov (2016) to facilitate an exploratory and hypothesis-testing research framework. This comparative methodology enables an in-depth analysis of U.S. and EU policies, focusing on their strategic responses to the competitive pressures within the semiconductor industry. The MSSD framework is particularly suited for this study as it allows for the examination of systems that are similar in their overarching characteristics—such as economic power, technological capabilities, and strategic ambitions in the semiconductor sector—but vary in the specific policy instruments related to the semiconductor industry. The DNS model will be used as the conceptual framework (Block, 2008; Di Carlo & Schmitz, 2023) describing four critical functions: targeted resourcing, brokering, facilitation, and protection. These functions will guide the comparative analysis, focusing on how each is implemented within the U.S. and EU semiconductor policies. To operationalize this framework, tables will be created for each of the four DNS functions with separate columns for the U.S. and the EU. This method does not strictly adhere to assigning binary values (1 or 2) as traditional MSSD might suggest but instead provides a qualitative comparison of the policy instruments in each region. This approach allows for a more nuanced exploration of the policies without necessitating a simplistic quantitative scoring system. By comparing these aspects, the research aims to identify how the different governance structures (federal vs. supranational), allocation of public investments, and protective measures reflect the DNS functions and contribute to each region's strategic positioning within the global semiconductor market.

Case selection & Data collection

To explore the comparative analysis of industrial policy instruments in the semiconductor industry, this study employs the Most Similar Systems Design (MSSD) approach. The U.S. and the EU are selected as cases due to their similar role and approach in the global semiconductor market to strengthen and foster their own semiconductor industry, with regards to their industrial policies as the EU Chips Act and the CHIPS and Science Act. In terms semiconductor manufacturing and production both the U.S. and EU are seeking to expand their respective shares in the global market share. The U.S. currently has a market share of 12 percent compared to 9 or 10 percent of the EU (Boston Consulting; SIA, 2021; McKinsey 2022). When it comes to leading-edge chips (below 7 or even 5 nanometres) actually none are produced in either the US or the EU (European Commission, 2022). Only if you look at worldwide semiconductor sales, the U.S. really stands out compared to the EU, with a market share of 48 percent compared to EU's 9 percent market share, as highlighted in figure 1 (SIA, 2023). U.S. semiconductor companies have preserved their advantage in the sector and other high-end devices, while also retain dominance in R&D, design and process innovation (SIA, 2023).

Figure 1: Worldwide semiconductor sales by global market share

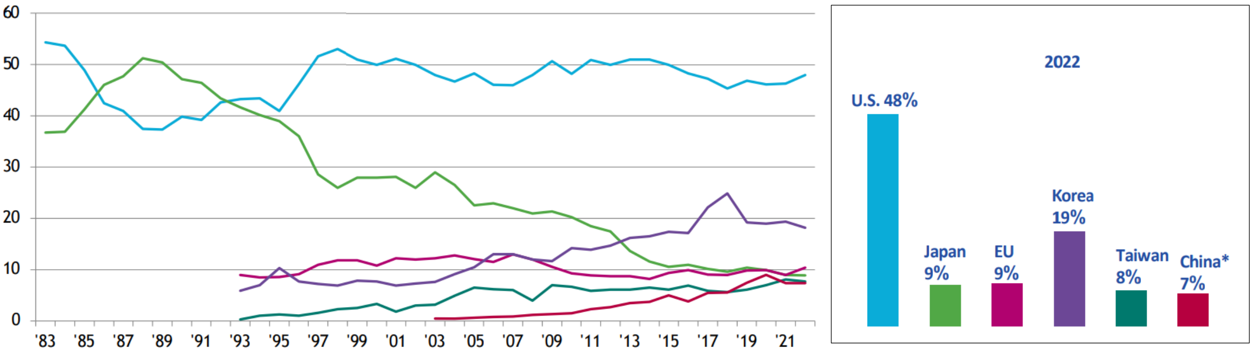


Figure 1: SIA, World Semiconductor Trade Statistics (WSTS) (2023)

Also, both the U.S. and the EU seem to respond to growing geopolitical dynamics, particularly the competition with China. The U.S. has implemented stricter export controls and security measures to safeguard its semiconductor supply chain, and the EU is focused on the security of supply and overcoming the gap in its chip supply chain.

This thesis will conduct a comprehensive qualitative analysis, focusing on the examination of policy initiatives, strategies, and guidelines. This includes an in-depth review of official documents such as from the European Commission and the Semiconductor Industry Association (SIA), strategy and consultancy papers such as from ASML, the European Investment Bank (EIB), Peterson Institute for International Economics (PIIE) and PNO Consultants, alongside a diverse array of secondary sources such as news articles like The Economist, Deutsche Welle (DW) or Reuters, and scholarly publications such as Fred Block (2008), Pianta (2014) and Mazzucato (2013). Among these, documents detailing policy measures like the U.S.'s CHIPS and Science Act and the EU's Chips for Europe Initiative (or CHIPS Act) are particularly crucial. These primary sources are crucial for understanding the varied approaches and mechanisms employed by both the U.S. and the EU to enhance their positions in the semiconductor industry, aiming to increase their technological advancement and market resilience. To address the research question effectively, this thesis will employ a policy instrument analysis framework using the DNS model as described by Block (2008). Given the complexity and diversity of governmental approaches to the semiconductor industry, this thesis aims to compile a detailed descriptive analysis of the policy landscape.

5 Case study

After conducting the literature review (chapter 2) on the history of U.S. and EU industrial policy and establishing an analytical framework based on the DNS model as introduced by Block (2008) in the theoretical framework (chapter 3), this chapter will outline a comprehensive case study analysis. The objective is to provide an analysis on the current industrial policies and strategies of both the U.S. and the EU with a focus on the semiconductor industry. Applying the DNS framework will not only facilitate an understanding of their respective approaches but can also explain the underlying reasons for the differences in these policies. The start of the analysis will provide an up-to-date overview based on recent documents provided by the EU Commission (EU Chips Act, 2022) and the US Administration (CHIPS and Science Act, 2022). This focus ensures a comprehensive understanding of the mechanisms and instruments used by the U.S. and the EU to strengthen their positions within the global semiconductor landscape, particularly against the backdrop of rising competitive pressures and the strategic dominance of Asia. The goal of this thesis is to develop a nuanced explanation of why these policies differ, moving beyond mere description to delve into the geopolitical, economic, and strategic factors that shape each region's approach to semiconductor industry policy.

5.1 U.S. Semiconductor Policy & Strategy

Amidst prevailing concerns about globalization and the relocation of American manufacturing to other parts of the world, driven by standardized production processes and low-wage opportunities for large corporations, the United States has seen a shift towards reevaluating its industrial strategies. The shift is mainly a response to challenges in maintaining “high value-added activities” (Di Tommaso et al., 2017) domestically and ensuring economic sovereignty. The significant investments in the semiconductor industry emphasizing the strategic necessity of supporting the domestic capabilities in this key technological industry.

The financial crisis of 2008 has led the American government to react and to promote policy interventions as response to the problems that occurred (Wade, 2012). One of the earliest selective interventionist measures under the Obama administration was the American Recovery and Reinvestment Act of 2009, which allocated approximately $780 billion across various sectors, represents a pivotal moment in U.S. industrial policy, reflecting a broad approach to fostering innovation and competitiveness within the domestic economy (ERP, 2010). This Act is focused on investments and tax credits across multiple sectors, including clean energy, automotive, nanotechnology, health care, and finance. Additionally, separate allocations supported advanced energy technologies and provided significant financial support to stabilize the financial sector, including a notable $80 billion for the bailouts of General Motors and Chrysler (Hartman, 2018). The overarching aim was to bolster competitiveness in advanced manufacturing and encourage the 're-shoring' of American businesses.

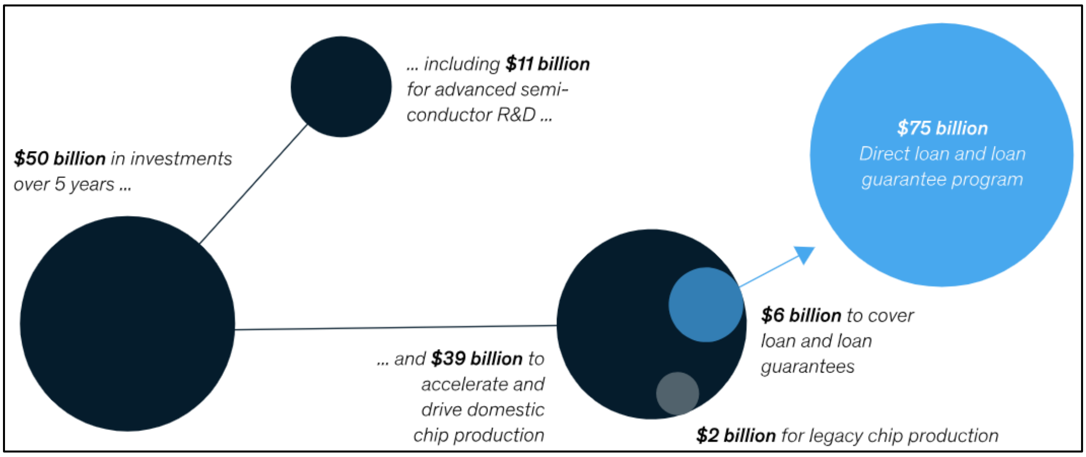
Further, the Make It In America Act represented another step towards reinforcing public-private partnerships and aligning federal activities to support the manufacturing sector. However, the broader discourse on defining 'strategic' industries within the U.S. context remains nuanced and complex. Under the Biden Administration, a renewed focus on industrial policy emphasizes supply chain resilience, targeted public investments, public procurement, climate resilience, and equity, prioritizing job creation over direct investment in strategic sectors (Atlantic Council, 2021).

In 2014, China announced it would start redoubling its efforts to design and produce its own semiconductors to become self-sufficient in technology (Mozur, 2014, The New York Times). The Chinese government has set up a number of extensive subsidy funds, allocated hundreds of billions of dollars together with state linked private equity firms aiming at enhancing the Chinese semiconductor industry. Since then, the rivalry in semiconductor between companies shifted to the world’s largest economies: the U.S. and China (Miller, 2022). In response of this growing competition of China, but also the post-pandemic effects including its risk of reliance on foreign goods, and growing concerns about the Ukraine conflict, the U.S. government is proactively seeking to domestically manufacture a broad range of products, from automobiles to household appliances (Aeppel, 2023, Reuters). In recent years, the discourse has evolved to identify and bolster strategic sectors explicitly, with a significant focus on the semiconductor industry. American firms, once at the forefront of global semiconductor production, now represent merely around 12 percent of the worldwide manufacturing capacity. The Semiconductor Industry Association (SIA) suggests that this relative decline in American semiconductor production is largely because of significant foreign government investments in their domestic semiconductor sectors, contrasting with the U.S. government support.

Therefore, on January 1st 2021, the William M. (Mac) Thornberry National Defense Authorization Act came into force. Within this act, under the title XCIX, also known as CHIPS for America programs, the U.S. Department of Commerce and other government agencies were authorized to provide financial assistance to eligible entities through competitive selection processes. The Act aimed to stimulate the semiconductor industry in the U.S. by support manufacturing and R&D activities. However, although this legislative framework provided by the U.S. government, it did not come with necessary funding appropriations, meaning the programs could not be fully implemented their intended purposes immediately (Wallwork et al., 2023). The situation highlighted the need for specific actions and ambitions to stimulate initiatives for semiconductor manufacturing. Central to the U.S. ambition in gaining a leading position in a strategic industry was the CHIPS and Science Act that came into force on Aug 9, 2022, allocating specific $280 billion for the coming ten years to support the U.S. semiconductor capacity, stimulate R&D and create high-tech hubs across the nation. It was designed to boost U.S. competitiveness, innovation and national security and to reduce dependence on production from Taiwan, South Korea and China (Block et al., 2023). The Act aims to reduce the US's reliance on foreign semiconductor companies specifically for government and military applications, as Biden underscored the sector as 'crucial to national security' (Ip, 2023, The Wall Street Journal). Compared to recent announcements by the Chinese government of $143 billion in its own semiconductor industry (Reuters, 2022) the U.S. Chips Act may looked less ambitious. However at the same time the U.S. also introduced multiple export restrictions aimed at cutting China off from accessing key technologies around semiconductors (Swanson, 2022, The New York Times). For example, in October 2023 – around one year after the CHIPS and Science Act came into force - the U.S. Commerce Department announced further restrictions on the export of advanced American-manufactured semiconductor chips to China (Toh & Tausche, 2023, CNN).

Of the total budget to boost the U.S. industry and research, around $52 billion will be invested for semiconductors alone for the next five years (see figure 1). Also, the U.S. government allocated more funding than under previous presidents to support innovation at the local level with $36 billion per year under the initiative Build to Scale (Block et al., 2023). The Act specifically allocates $39 billion to stimulate and expand domestic production of semiconductors (see figure 1). This includes fabrication, assembly facilities and testing of semiconductors through the Department of Commerce (Block et al., 2023). Around $11 billion is meant to stimulate R&D, including a National Semiconductor Technology Center, a National Advanced Packing Manufacturing Program, a Manufacturing USA Semiconductor Institute and a Microelectronics Metrology programme at the National Institutes of Standards and Technology (Donelly, 2023).

Figure 1: Budget allocation of the 50 billion investments part of the U.S. CHIPS Act



Source: McKinsey & Company (2022)

In addition to the financial allocations provided by the CHIPS and Science Act, a manufacturing investment tax credit was developed to compensate businesses for price differentials faced by American firms having domestic and overseas semiconductor production. In these cases, the recipients were prohibit from manufacturing in nations that might ‘pose a national security threat’, notably China (Donnelly, 2023). Subsequently, investments were initiated across various states.

In terms of R&D expenditure on semiconductors the American private sector significantly contributed as part of the CHIPS and science Act. As of May 2023, over $140 billion in private sector investments has been made to accelerate semiconductor research, development and manufacturing in the U.S (Cooper, 2023). Some of the given examples presented by the Biden Administration are the $4 billion investment by Applied Materials for the construction of an R&D centre in California or the $20 billion investment by IBM in October 2022. The U.S. has a worldwide market share of approximately 60 percent, compared to only 6 percent of the EU when it comes to R&D investments in the semiconductor industry (Hugging, 2023). The disparity in investment levels of the private sector between the EU and the US highlight the varying approaches each region employs in the semiconductor sector. Notable developments include major investments from leading semiconductor companies. According to SIA (2022), around 80 new semiconductor projects and $256 billion in private investments have been announced across 22 states, including new chip manufacturing facilities.

5.1.2 Conclusion

The strategic initiatives under the CHIPS and Science Act illustrate a significant shift in U.S. policy. While the U.S. approach is characterized by substantial federal funding and a clear delineation of strategic priorities, it contrasts with the EU's more distributed strategy, where significant investments are also expected from member states (chapter 5.2: EU Semiconductor Policy & Strategy). This distinction underscores the U.S. commitment in its semiconductor industry through targeted investments, emphasizing national security and economic competitiveness. The Act reflects a broader trend of strategic re-industrialization, seeking to regain leadership in critical technological fields. Moreover, the CHIPS and Science Act embodies a multifaceted approach combining investment, research, and protectionism. By allocating substantial funds (over $50 billion) directly to semiconductor research, development, and production, the U.S. aims to stimulate innovation and reduce its reliance on international supply chains, particularly those dominated by geopolitical ‘rivals’,

5.2 EU Semiconductor Policy & Strategy

The current EU Chips Act which came into force in September 2023, represents the EU’s strategic response to the US CHIPS and Science Act, aiming to secure its position within the global semiconductor landscape (Global Times, 2023). To better understand the EU’s ambition to double its global market share in semiconductor production to “at least” 20 percent by 2030 (European Commission, 2022) and its policy instruments, it is imperative to examine how the current policies are designed to address the challenges faced by the EU in the global semiconductor market. This section aims to provide a nuanced view by not only detailing the EU's policy and strategic framework but also by shedding light on Europe's current position in the global semiconductor landscape, highlighting both its competitive advantages and areas requiring attention. However, the examination of this will focus on the policy framework rather than the direct impacts.

Unlike the approach of the U.S., which emphasizes large-scale funding and domestic production incentives, the EU's approach seems to be more a combination of motivations focusing on increasing semiconductor production, and innovation support and collaboration, with subsidies of which almost all would be provided by individual member states (Donnelly, 2023). Article 173 of the Treaty on the Functioning of the European Union (TFEU) describes the general goal of EU's current industrial policy, namely: "to make European industry more competitive so that it can maintain its role as a driver of sustainable growth and employment in Europe" (European Parliament, n.d.). It is a multifaceted goal of European industrial policy driven by the need to ensure economic development, address global challenges, strengthen the EU single market, overcome network failures, ensure strategic autonomy and respond to external challenges (Di Carlo & Schmitz, 2023). These policy objectives set the stage for the EU's semiconductor strategy, which, through instruments like the European Chips Act, aims to secure the EU's position not just as a market competitor but as a leader in semiconductor innovation and supply chain resilience.

In recent years with programmes such as the Digital Europe Programme' (DIGITAL) the EU Commission already focused on enhancing EU's digital capabilities critical areas such as AI and cybersecurity, especially targeting EU's citizens and SME's, as part of the greater European Green Deal. This emphasis on digital capabilities demonstrates the strategic framework of the EU's semiconductor policy, establishing a foundation for the subsequent development of the EU Chips Act.

The Chips Act, representing an evolution in the EU's industrial policy, especially in terms of significant public investments in this sector, was formulated as a multifaceted response not just to the global semiconductor supply challenges but also as a strategic alignment with the broader objectives of EU's industrial policy (Gesley, 2022). This act encompasses both direct investment in innovation and a new regulatory framework aimed at achieving strategic autonomy in the semiconductor sector. The Act's primary objectives – addressing the microchip shortage in Europe, reducing dependency on foreign suppliers, and improving technological sovereignty – are aimed at enhancing the EU's semiconductor industry's global competitiveness and resilience. By setting an ambitious target to capture 20 percent of the global semiconductor market share by 2030, the EU is actively working to reverse the decline from its former market share, which currently stands at only 10 percent. At the same time, global semiconductor demand in 2021 exceeded that of 2019 with 17 percent, while the supply chain failed to increase correspondingly (U.S. Department of Commerce, 2022). This means that semiconductors will be of global interest competition (EU Commission, 2022). Major other economies have announced significant commitments to enhance their semiconductor sectors. For instance, Japan has dedicated $8 billion in public funds towards investments in its domestic semiconductor sector, as reported by Reuters in 2021. China is intensifying its initiatives to bridge its technological divide in the global semiconductor market. This is in alignment with the "Made in China 2025" strategy, under which it has invested an estimated $150 billion over the last ten years. Without such an adequate investment of the EU, Europe’s market share would risk to fall below 5 percent, considering the market’s doubling and the magnitude of efforts of other major economies (EU Commission, 2022). This underlines the urgency behind the EU Chips Act as a strategic policy measure, aiming to bolster Europe's semiconductor manufacturing capabilities in alignment with its broader industrial and digital strategy. The EU Commission has stated that there is no “digital” world without chips, and that the EU currently has limited chip manufacturing capabilities, of which none comes to the leading-edge chips at 7 nanometres (nm) and below. In Taiwan, semiconductor manufacturing already can take place below 5 nm today, with 3 nm in pre-production and even 2 nm under development (EU Commission, 2022). According to a CNBC article by Ten Nee Lee (2021) there are only two companies in the world (TMSC in Taiwan and Samsung in South Korea) capable of manufacturing the most advanced chips below 5 nm.

The EU's support for the semiconductor industry has traditionally been through R&D programs, exemplified by the Electronics Strategy for Europe (EU Commission, 2013), which targeted significant industry investment over 100 billion euros and aimed to double EU microchip production value. Yet, the evolving global landscape and intensified competition necessitate a broader and more aggressive strategy, as highlighted by the EU Commission (2022). The Chips Act shows a holistic approach integrating R&D investment with support for new production capacities and encouraging private-sector engagement to ensure a competitive EU presence in the semiconductor industry.

Europe's leading position in providing essential equipment and materials for the semiconductor industry, notably EUV lithography machines by ASML, underscores the strategic importance of maintaining and enhancing this industrial segment (Tarasov, 2022). The EU Chips Act aims to leverage and expand this existing strength while addressing the broader industry's structural challenges, such as the current limited manufacturing capabilities and the need for enhanced cooperation between suppliers and consumers (EU Commission, 2022).

Despite its strengths, the EU's declining global market share in semiconductor revenues from over 20 percent in the 1990s to merely 10 percent today (SIA, 2021) illustrates significant challenges. With significant public and private investment of over € 43 billion, the Chips Act seeks to reverse this trend and achieve the ambitious goal set of ‘at least 20 percent’ of cutting-edge semiconductor production.

This goal reflects the EU's strategic objective to enhance its semiconductor ecosystem, ensuring supply security and reducing external dependencies.

The establishment of the Chips Joint Undertaking (Chips JU), evolving from the Key Digital Technologies (KDT) program in 2021, represents a targeted approach to mobilise investment and fostering collaboration within the EU's semiconductor sector. It is an effort of participating member states and many relevant public and private stakeholders to mobilise up to EUR 3.5 billion of public investment until 2027. It is a tripartite effort to mobilise up to EUR 3.5 billion of public investment until 2027. It was intented to support several 'Key Enabling technologies': a group of six technologies: micro and nanoelectronics, nanotechnology, industrial biotechnology, advanced materials, photonics, and advanced manufacturing technologies. By focusing on key enabling technologies, the EU aims to reinforce its competitive edge and address the critical needs of its semiconductor industry.

It is crucial to recognize that the Chips JU operates under the broader legislative framework of the EU Chips Act, focusing specifically on R&D and capacity-building activities to support the EU's ambitions in semiconductor manufacturing. Given the substantial barriers to entry and the capital-intensive nature of the semiconductor sector, private investment in advanced facilities is only possible with considerable government support (EU Commission, 2022). However, the current State aid guidelines had to be amended in order for the EU to invest heavily in its own semiconductor industry to bolster its development. Within the 'competition policy for new challenges' (COM, 2021) it is now possible for an EU member state to cover 100 percent of a funding gap by public resources, if otherwise the facility would not have been built in Europe. For State aid the EU Commission has to approve each plan and will take into account that the new production facility is a first-of-a-kind within the EU in terms of technology, material or other product innovation. According to Di Carlo & Schmitz (2022) the primary method of targeted public investment for specific sectors has typically been the provision of funds for innovation, implemented in the EU via the budgetary allocation within the Multiannual Financial Framework (MFF). But with the Chips Act, the EU Commission represents a holistic strategy that encompasses direct investment in R&D, and support for new (greenfield) manufacturing and production facilities, including incentives to foster private sector engagement. By allocating resources with precision and foresight, the EU aims to bridge critical gaps in its semiconductor ecosystem, from foundational research to the mass production of advanced chips

While the EU Chips Act facilitates EU member states in directing public funds towards the development of semiconductor manufacturing capacities, it does not encompass the entirety of financial contributions to the sector. It is a legislative framework designed to enhance Europe's strategic autonomy in semiconductor production by encouraging both national and private investments within a coordinated EU strategy. The EU Chips Act is projected to generate EUR 43 billion in investments, combining public and private funding, with EUR 3.3 billion from the European budget to develop its own production capacity. This figure includes specific initiatives under EU programs such as Digital Europe and Horizon Europe, which contribute €3.3 billion towards this goal (see figure 2 for the further budgetary breakdown).

Since the Chips Act came into force, several initiatives has been presented. Taiwanese TMSC has announced that it will make use of the European subsidies and intends to build a €3.47 billion plant in Dresden, Germany (Deutsche Welle, 2023). Together with Bosch and two semiconductor companies Infineon (Germany) and NXP (Netherlands) the total investment will exceed 10 billion euros. According to Deutsche Welle (2023) the German government will invest 5 billion euros of public investment for the construction of the plant. Another significant investment comes from Intel (US) that is planning to build a 30-billion euro facility in Magdeburg, Germany (Euronews, 2023). The German government will cover one-third of the expenses, marking this as the most substantial foreign direct investment in the country's recent history. The initiatives seem to illustrate initial success in attracting significant capital to the EU semiconductor industry. However, according to Wennink (President of ASML) even those major investments will most likely "not be enough" for Europe to reach its goal of raising its share of the global semiconductor market to 20 percent (Sterling, 2024). Wennink reveals that the current EU's share of the global chip market might be as low as "8 percent at best". This underscores the urgency for the EU to intensify its efforts even more (Sterling, 2024).

Overall, the EU Chips Act and associated initiatives underscore the EU's strategic commitment to securing a robust position in the global semiconductor market, addressing both immediate supply chain vulnerabilities and long-term technological and industrial objectives.

5.2.2 Conclusion

The EU Chips Act and its associated strategic initiatives represent a comprehensive and multifaceted approach by the EU to address the significant challenges and opportunities within the global semiconductor market. The Act embodies the EU's determination to enhance its competitive position globally by aiming to double its semiconductor market share by 2030.

The strategic underpinnings of the EU Chips Act, from substantial R&D investments to fostering collaboration across the semiconductor value chain, illustrate the EU's commitment to building a resilient and innovative semiconductor ecosystem. This is further underscored by the establishment of the Chips Joint Undertaking, which aims to mobilize significant public and private resources towards achieving these ambitious goals. While the EU faces considerable challenges, particularly in light of the intense global competition and the current market share realities, the proactive measures outlined in the Chips Act demonstrate the EU's strategic approach to leveraging its existing strengths while addressing critical gaps. This includes enhancing manufacturing capabilities, supporting cutting-edge research and development, and ensuring a sustainable supply of essential materials and technology.

The ongoing developments and investments, as seen with initiatives by TMSC and Intel in Germany, signify a positive momentum towards achieving the EU's vision. However, the real test will lie in the effective implementation of these policies and the EU's ability to adapt to the dynamic and rapidly evolving global semiconductor landscape.

5.3 Comparative analysis between the U.S. & the EU

This section undertakes a comparative analysis of the U.S. CHIPS and Science Act and the EU Chips Act, applying the Developmental Network State (DNS) model of Block (2008; 2023) as a framework for understanding their strategic approaches. The analysis will explore the multifaceted roles of targeted resourcing, brokering, facilitation, and protection as they refer to both U.S and EU’s effort to enhance their semiconductor capabilities. By contrasting the CHIPS and Science Act and the EU Chips Act, this comparative study aims to demonstrate the distinctive paths taken by these global powers in securing technological sovereignty and economic competitiveness in the fast evolving global semiconductor market.

Table 3: DNS functions: U.S. vs. EU Semiconductor Policy Instruments Comparison

DNS Function	CHIPS and Science Act (US)	European Chips Act (EU)
Targeted Resourcing	$52 billion in public investment, with $39 billion for manufacturing and $13 billion for R&D. Includes incentives like a 25% investment tax credit for semiconductor manufacturing.	€43 billion in investments from the EU budget, member states, and the private sector, without specific allocations for R&D or manufacturing. Focuses on a collaborative investment model across member states and the private sector.
Brokering	Facilitates partnerships between federal agencies, states, and the private sector to create innovation hubs. Emphasizes national strategy for semiconductor ecosystem development.	Promotes EU-wide collaboration through the Chips Joint Undertaking and related programs, aiming to enhance the semiconductor value chain's connectivity. Focuses on a decentralized innovation model.
Facilitation	Implements supply chain and manufacturing policy reforms, offering financial incentives for domestic manufacturing growth. Focuses on reducing barriers and operational costs for U.S. manufacturers.	Modifies State Aid rules to support semiconductor projects, making it easier for member states to provide flexible support. Encourages private and public investment in semiconductor infrastructure and R&D.
Protection	Applies export controls and screens foreign investments for national security. Utilizes international agreements to safeguard technology. Emphasizes securing critical technologies and supply chains.	Coordinates with international partners to protect technological sovereignty. Implements screening of foreign investments in strategic sectors, balancing security with market openness.

5.3.1 Targeted Resourcing

The function of targeted resourcing emerges as a crucial strategy to enhance both the U.S. and the EU's semiconductor industry, yet their approaches and scales of investment differ significantly. For the U.S., the CHIPS and Science Act represents a significant federal commitment, with a total allocation surpassing $280 billion, of which $52 billion is specifically earmarked for semiconductors, addressing both manufacturing ($39 billion) and research and development ($11 billion) aspects. The €39 billion aims to encourage investments in production facilities, covering fabrication ,assembly, testing or packing at various technology levels.

In contrast, the EU's approach under the Chips Act illustrates a more diversified strategy. The EU has set aside a total of €43 billion, which is expected to be sourced from both public and private investments. However, unlike the U.S., the EU does not specify a clear division between R&D and manufacturing within this total investment. Instead, the EU's investment is more fragmented, relying significantly on contributions from member states and private entities to achieve its semiconductor goals. This funding mechanism aligns with the EU's strategy of leveraging diversified investments to enhance its technological sovereignty and competitive edge on a global scale. This difference in funding strategies reflects the underlying structural and policy distinctions between the U.S. and the EU approaches to boosting their semiconductor sectors. The EU's targeted resourcing encompasses direct R&D investments and support for new manufacturing facilities, incentivizing private sector involvement alongside public investments. Notably, the EU's total investment is structured through both the EU budget and member states' contributions, underscoring a collaborative approach to achieving semiconductor advancements. The German government's investment in the Dresden TMSC production facility exemplifies how individual member states can significantly augment the industry's growth within the broader EU framework. The EU itself allocates €4.175 billion for its semiconductor industry, through the Chips for Europe initiative (€3.3 billion) and another €1.3 billion from the EU budget for the KDT JU. Meaning that despite high ambitions of the EU Commission and its ambition to enhance the European semiconductor industry by doubling its global market share to 20 percent worldwide, almost all of the funding has to be provided by the member states (Donnelly, 2023). This EU strategy, although less centralized than the U.S., still emphasizes its balanced distribution of funding, aiming at covering essential areas from foundational research to advanced chip production and stimulate significant sectoral growth and technological advancements.

The U.S. prioritizes immediate, large-scale federal investments to quickly bolster domestic capacities, especially in manufacturing and R&D crucial for maintaining technological leadership and security. Beyond the $52 billion specifically for semiconductors, the Act's broader fiscal landscape incorporates additional funds aimed at fostering a comprehensive ecosystem for innovation. This includes investments in education, workforce development, and infrastructure to support the semiconductor sector's long-term growth. The U.S. structure in stimulating semiconductor manufacturing also differs significantly. Besides the direct public investments, the U.S. government also provides 25 percent investment tax credit for semiconductor manufacturing, aimed at reducing the cost disparities between the U.S. and other countries. This is part of a larger strategy to stimulate the relocation of production facilities (back) to U.S. The costs associated with building or expanding a semiconductor facility can easily exceed $1 billion, meaning that a 25 percent tax credit could have a significant impact on the project (Wallwork et al., 2023).

Precise EU public investments complex to determine

In addressing the challenge of determining the exact public investments by the EU and its member states under the Chips Act, it's important to note the inherent complexities involved. The EU Chips Act represents a strategic initiative aimed at significantly enhancing Europe's semiconductor manufacturing capabilities and reducing dependency on external sources. However, quantifying the total public investment directed towards this initiative introduces several challenges. Of the total expected investments of € 43 billion by 2030 including contributions from the EU budget, member states and the private sector, only the EU budget's contribution is clearly defined at € 4.175 billion. The broader figure encompasses anticipated investments across a diverse landscape of national and regional initiative within the EU. One of the main complexities lies in the decentralized nature of the EU, where each member state has the autonomy to launch its own supportive measures and investments in alignment with the Chips Act's objectives. For instance, the investment by the German government for the TMSC plant in Dresden is one of the national efforts that are crucial to achieving the collective goal of the Chips Act but also introduce variability and challenges in aggregating the precise total of public investment across the EU. Additionally, the dynamic nature of these investments, influenced by ongoing economic, technological, and political developments, means that the total public investment figure is not static but subject to change over time. New initiatives can be introduced, and existing plans can be scaled up or adjusted, further complicating the task of providing an exact figure. The nuanced approach of the total € 43 billion investment is important for the comparative analysis and methodology of total public investments in the semiconductor industry between the EU and the US.

5.3.2 Brokering

The DNS function of brokering emphasizes how the U.S. and the EU demonstrate their commitment in strengthening or supporting connections between various stakeholders in the semiconductor industry, including research institutions, government bodies and the private sector. Brokering is about creating a collaborative ecosystem where innovation can thrive through shared knowledge, resources, and technological expertise (Block, 2008; Di Carlo & Schmitz, 2023). Within both the CHIPS and Science Act and the EU CHIPS act, both regions adopt distinctive strategies to foster these industry connections and innovation ecosystems, reflecting their individual policy framework and strategic priorities.

Within the CHIPS and Science Act, the U.S. government facilitates partnerships between federal agencies, states, and the private sector, aiming at creating robust innovation hubs and ecosystems. This Act specifically prioritizes the development of regional technology hubs and collaborative platforms, such as the Directorate for Technology, Innovation and Partnerships (TIP) by bringing together researchers, practitioners and users or the NSF's Regional Innovation Engines, a multi-sector partnership involving the semiconductor industry, academia and the local government to drive R&D innovation and supporting regional growth. This is led by the National Science Foundation (NSF). Additionally, the CHIPS and Science Act encompasses further initiatives beyond the semiconductor industry. It includes explicit support for early-stage research, transcending semiconductors to encompass investments in research infrastructure, advanced computing, and international collaborations. Alongside, the Act extends funding opportunities specifically designed to stimulate avant-garde semiconductor R&D. With these concerted funding initiatives, the U.S. government, particularly through programs administered by the National Science Foundation, emphasizes the vital importance of merging scientific inquiry with practical industrial applications.

In the EU, the brokering efforts are prominently showcased through the Chips Joint Undertaking (JU) and as part of the Chips Act. This framework enhances collaboration across the semiconductor value chain, from research institutions to private enterprises and government bodies. Unlike the U.S., which emphasizes a cohesive national strategy, the EU’s approach underlines a more decentralized model, encouraging member states to create synergies and partnerships at both the national and EU levels. The Chips Act initiatives, such as Innovative Chips Pilot Lines and a cloud-based design platform aim at facilitating collaborative efforts and sharing of technological advancements among member states.

The Innovative Chips Pilot Lines calls for innovative pilot lines with a substantial allocation of €1.16 billion in EU funding. These pilot lines are intended to provide industry players with state-of-the-art facilities for testing and validating new semiconductor technologies. The pilot lines are part of the Horizon Europe programme and the EU funding covers up to 100 percent of the total project costs (PNO Consultants, 2024). This initiative encompasses a collaborative foundation, bridging research, innovation and production. One of the goals is to develop advanced technologies for semiconductors smaller than 2 nanometres. This could potentially position Europe at the forefront of semiconductor innovation (EU Commission, 2022).

The Cloud-based Design platform enables semiconductor design companies across the EU to access advanced tools and collaborate more effectively. It is a virtual environment integrating a wide range of design facilities, where various design resources and tools will be provided in an accessible way. It aims to foster extensive collaboration among users and principal stakeholders within the ecosystem, thereby bolstering Europe's capabilities in semiconductor design.

In addition to the two initiatives, the EU Chips Act also sets an overall framework to encourage collaboration between different stakeholders in the semiconductor industry. An example is the Memorandum of Understanding (MoU) signed between NXP Semiconductors and the Eindhoven University of Technology (TU Eindhoven), as part of the EuroTech Universities Alliance. This collaboration involves the sponsorship of PhD research projects focused on cutting-edge semiconductor applications, part-time professorships from industry experts to enhance academic curriculum, and shared laboratories and design rooms that promote hands-on, practical learning and innovation (EuroTech Universities Alliance, n.d.). Although this particular partnership may not have been initiated directly by EU legislative actions, it aligns with the overarching goals of the EU Chips Act which encourages synergy between the educational and industrial sectors.

5.3.3 Facilitation

Also in terms of facilitating the growth of the semiconductor industry, both the U.S. and the EU have adopted distinct yet complementary approaches aimed at reinforcing their respective semiconductor ecosystems.

For the U.S., the CHIPS and Science Act has instigated significant reforms in supply chain and manufacturing policies to stimulate growth within the semiconductor sector. These reforms are part of a broader strategy to stimulate domestic manufacturing capabilities, with the Act providing financial incentives, such as grants and loans, designed to encourage the construction and expansion of semiconductor manufacturing facilities. Furthermore, the U.S. administration has launched initiatives to strengthen supply chain resilience, ensuring the availability and security of critical semiconductor components. Specifically, as part of the Act, the Biden Administration has adopted the following measures in order to stimulate its semiconductor industry:

- **Establishment of 31 Regional Innovation and Technology hubs:** These hubs serve as centers for innovation, drawing together industry leaders, researchers, and government agencies to foster collaboration and accelerate technological development. These hubs act as catalysts for regional economic growth and technological advancement to help communities all over the U.S. to work on innovations in critical sectors. Four out of the 31 Tech Hubs will be designated for the semiconductor industry, such as Texoma Semiconductor Tech Hub, Corvallis Microfluidics Tech Hub, NY SMART I-Corridor Tech Hub and Advancing Gallium Nitride (GaN) Tech Hub (The White House, 2023).
- **Supply Chain Reforms:** The U.S. has implemented reforms to strengthen and secure the semiconductor supply chain. These efforts are aimed at reducing dependencies on foreign sources, particularly in critical areas affected by geopolitical tensions. By enhancing domestic

supply chains, the U.S. aims to ensure a more reliable and secure provision of semiconductor components.

- **Manufacturing Policy Changes:** Changes have been made to policies to support the semiconductor manufacturing sector, encouraging the establishment of new facilities and the expansion of existing ones (with $39 billion of public investment). This includes providing financial incentives such as tax credits and grants, aimed at lowering the barriers to entry and operational costs for semiconductor manufacturers.
- **Competitive Application Processes**: Through the Department of Commerce and other government agencies, the U.S. provides financial assistance to eligible entities in the semiconductor sector. This competitive process ensures that funds are allocated to projects that are most likely to advance U.S. technological leadership and national security interests.

The EU has also made strategic adjustments by adapting several regulatory frameworks to create a supportive environment for significant public and private investments within the semiconductor industry. A prime example of the facilitation action is the modification of State Aid rules, a strategic approach by the EU Commission (2022) to make it possible for individual member states to support the semiconductor industry effectively. The State Aid regulations for significant public investments in high tech facilities had to be adjusted since these type of investments do not fall under existing guidelines (EU Commission, 2022). Under the competition policy fit for new challenges (No. 54), it may be justified to cover expenses with public resources up to 100 percent if high tech facilities would otherwise not exist in Europe. These instances will be directly evaluated by the Commission under Article 107(3)(c)m which allows the Commission to deem aid acceptable if it support specific economic activities or areas without significantly distorting trade or competition. The facilitation of such a conducive environment is essential for Europe's ambitions to secure its supply chains and enhance its technological sovereignty. Additionally, the EU has embraced collaborative efforts similar to the US's regional tech hubs through the launch of Important Projects of Common European Interest (IPCEIs).

- **IPCEIs:** This allows the EU Commission to permit Member States to develop and carry out domestic investments aimed at addressing significant market deficiencies or societal issues that would otherwise remain unaddressed. In June 2023, the EU Commission has approved the IPCEI for microelectronics and communication technologies, involving 14 member states to provide €8.1 billion in public funding (with an expectation of another €13.7 billion of private investments). The investments from the IPCEI are an addition of the total public and private investments (of €43 billion) and contribute to specific projects that contributes to the objectives of the Chips Act.

5.3.4 Protection

The approach of protecting the semiconductor industry in both the U.S. and the EU reflects a number of domestic and international policies and cooperation aimed at securing critical technologies while balancing global security concerns. This multifaceted strategy is crucial in the increasingly competitive and security conscious global landscape of semiconductor technology.

The US government has undertaken several concrete action to protect and enhance its semiconductor industry, reflecting a significant shift from earlier approaches of liberal interdependence and reliance on global supply chains. These actions demonstrate a strategic approach towards strengthening domestic capabilities and addressing national security concerns related to technology transfers and foreign dependencies (Donnelly, 2023):

- **Section 301 Tarrifs**: In 2018, under the Trump administration, the U.S. imposed 25 percent tariffs on a range of imports, including Chinese semiconductors, citing 'national security reasons' (Donnelly, 2023). Although framed as national security measure, these tariffs primarily addressed economic concerns regarding Chinese subsidized goods into the US market.
- **Export Restrictions**: The US government imposed export restrictions on semiconductor chips meant for Chinese companies, notably Huawei, in 2019. This approach was justified by national security concerns regarding the potential use of these chips in spyware surveillance equipment, particularly in smartphones and 5G telecommunications. In 2023, the Biden administration has further tightened restrictions against China's Huawei by withdrawing licenses for some U.S. companies to export items to Huawei (Reuters, 2023).
- **Expanded Export Controls**: In October 2022, the US government, responding to heightened national security concerns, especially regarding the situation in Taiwan, issued an executive order expanding export controls. This order restricted not only the export and development of advanced semiconductor chips to China but also applied to lower-tech chips, marking a comprehensive effort to curb China's semiconductor capabilities.
- **International Export Control Agreements**: The US has reached agreements with key allies, such as the Netherlands and Japan, to implement export controls on the most advanced chips and semiconductor production equipment. This approach aims to collectively limit China's advancement in the semiconductor field, showcasing a coordinated international effort to address the balance of technological power.

The EU's approach to protecting its semiconductor industry showcase some differences and strategies compared to the U.S., but also align in terms of security concerns and technological sovereignty.

- **Supply Chain Diversification**: In response to previous dependency on imported chips, particularly from regions like Taiwan, the EU Chips Act promotes diversification of semiconductor sources. This strategic shift aims to mitigate risks associated with geopolitical tensions, regional disruptions, or logistical challenges, thereby reducing dependency on a single source or region for critical components. To implement this supplier diversification, the EU is encouraging the development of new partnerships and alliances, both within the EU and with other countries that share similar security and economic values. This could involve creating incentives for EU companies to source semiconductors from multiple suppliers and investing in alternative sources outside the traditional suppliers in Taiwan or China (Moore, 2023).

- **Regulatory Framework and Foreign Investment Screening:** The EU has been developing a comprehensive framework for screening foreign direct investments (FDI) in strategic sectors, including semiconductors established under Regulation (EU) 2019/452. While the US has focused on tightening export controls and restricting foreign technology transfers, the EU's approach under the Chips Act is more oriented towards protecting its internal market and technology base from potentially harmful foreign investments. This framework facilitates a coordinated approach among member states and the European Commission to assess, and if necessary, restrict foreign investments (European Court of Auditors (2023).

In contrast to the U.S., where export controls are explicitly defined actions within semiconductor protection measures, the European Union's Chips Act does not specifically mandate export controls as part of its strategy. However, individual EU Member States retain the authority to enact their own controls. An illustrative example of this is the Dutch government's prohibition on the export of advanced photolithography machines by ASML to China. This decision, while made independently, was conducted in direct consultation with the United States, highlighting a case where national security interests have led to unilateral action by an EU Member State (Zhang et al., 2023).

While both the EU and US aim to secure and strengthen their semiconductor industries, their approaches reflect their respective political structures, economic policies, and strategic priorities. The US tends to adopt more unilateral and domestically focused measures, while the EU emphasizes collaboration, market integration, and balanced international engagement under its Chips Act framework.

5.3.5 Conclusion

The comparative analysis between the U.S. and EU in addressing semiconductor industry challenges through the lens of targeted resourcing, brokering, facilitation, and protection, reveals both distinct and overlapping strategies. While the U.S. adopts a more centralized and direct investment approach, the EU favours a collaborative and diversified strategy, leveraging on member states' autonomy. the U.S. also strategically fosters partnerships across federal agencies, states, and the private sector, leading to the formation of innovation hubs and ecosystems under their CHIPS and Science Act. This contrasts with the EU's approach under the Chips Act, which encourages a decentralized model of innovation through the Chips Joint Undertaking and other collaborative frameworks. Although different in execution, both regions aim to stimulate innovation in the semiconductor industry, but the U.S. focuses on a national level while the EU emphasizes cross-border cooperation among member states. On facilitation, the U.S. implements significant supply chain and manufacturing policy reforms through the CHIPS and Science Act, with significant public investment. The EU adapts regulatory frameworks, exemplified by the modification of State Aid rules, to make public investment in the manufacturing of (cutting-edge) semiconductor production possible, up to 100 percent of a funding gap by resources, if otherwise the facility would not have been built in Europe. Both strategies highlight the critical importance of regulatory and financial mechanisms in stimulating industry growth. Regarding protection, the U.S. demonstrates robust action through measures like Section 301 Tariffs, expanded export controls, and international agreements aimed at safeguarding semiconductor technologies. The EU Chips Act does not explicitly mandate export controls, however, individual EU Member States, such as the Netherlands, retain the authority to implement such measures, as seen in the restriction of ASML's photolithography machine exports to China. This indicates a more nuanced approach within the EU, balancing between member state sovereignty and collective security interests. Despite differences in its approaches, both the U.S. and the EU converge on the ultimate goal of enhancing semiconductor competitiveness and security, reflecting a shared recognition of the sector's critical importance.

6 Conclusion

This thesis analysed the industrial policy instruments of the U.S. and the EU within the strategic semiconductor industry, a key sector to technological advancement and economic resilience. Through a detailed comparative analysis based on the Developmental Network State (DNS) framework, this study explains the contrasting yet complementary strategies of the U.S. and EU in navigating the global competitive landscape of semiconductor manufacturing.

The central research question of this thesis was "How do the industrial policy instruments of the United States and the European Union compare in response to growing competition in the strategic semiconductor industry?". It has been explored through a lens that highlights the dynamic interplay between governance structure, investment strategies and protective measures. The U.S. approach, characterized by substantial public investment and direct government intervention, contrasts with the EU's more distributed collaborative strategy, which leverages the strengths of its member states and the private sector.

Hypotheses Revisited

H1: Difference in Governance Structure

The comparative analysis confirms that the governance structure significantly impacts policy implementation and investment in the semiconductor industry. The U.S., with its federal system, demonstrates a more centralized approach, leading to substantial, direct investments in semiconductor manufacturing and R&D. The EU's supranational governance model fosters a more diversified investment strategy, indicate of its collaborative approach and autonomy of member states.

H2: Allocation of Funding and Investments

The findings in this analysis support the hypothesis that the EU experiences a more fragmented allocation of funding, with significant reliance on member states and the private sector for investment in semiconductor initiatives. This contrasts with the U.S. strategy of leveraging federal funding to foster innovation and manufacturing capabilities directly.

H3: Protectionist Measures

The analysis has demonstrated that while both the U.S. and the EU have implemented measures to protect their semiconductor industries, the U.S. has more rigid protectionist strategies including export restrictions and foreign direct investment (FDI) screening. This is in alignment with its direct competitive stance towards countries that can pose a 'national security threat' (Donnelly, 2023), notably China. The EU, through its member states – exemplified by the Dutch government's restriction on the export of ASML's advanced photolithography machines to China – demonstrates its commitment to technology protection aligned with the U.S. broader security and economic interests. Additionally, the EU's framework for screening FDI in strategic sectors, such as semiconductors, also shows a sophisticated, yet more decentralized, approach to protecting its technological and industrial base. Both the U.S. and the EU have their own respective mechanisms to navigate with the challenges posed by global competition and security concerns in the semiconductor industry.

General conclusion

This thesis aimed to explore the strategic responses of the U.S. and the EU in the semiconductor industry through their industrial policies: the CHIPS and Science Act and the European Chips Act, respectively. In addressing the research question, "How do the industrial policy instruments of the United States and the European Union compare in response to growing competition in the strategic semiconductor industry?", we have observed similarities and differences in their distinct governance models.

Looking forward, the ultimate success of these industrial policies, particularly the EU's ambitious goal to double its market share to 20 percent, remains an open question. The evolving global semiconductor landscape, characterized by rapid technological advancements and shifting geopolitical interest, presents both challenges and opportunities for both the U.S. and the EU. As they continue to navigate this complex environment, effectiveness of the CHIPS and Science Act and the European Chips Act in achieving their overreaching goals will not only depend on the policies themselves but also on the adaptability and resilience of the U.S. and the EU in responding to unforeseen developments in this critical industry.

7 Discussion

The main objective of this thesis was to compare the industrial policy instruments deployed by the United States and the European Union within the rapidly evolving semiconductor industry, focusing on the distinct governance frameworks and how they shape respective policy strategies.

It is important to note that while this study outlines the mechanisms and approaches of the CHIPS and Science Act and the EU Chips Act, it does not delve into the direct impact of these policies on the semiconductor landscape. Instead, the analysis provided a descriptive account of the policy instruments, setting a foundation for understanding rather than assessing their effectiveness.

Furthermore, this research does not claim to cover the total list of policy measures implemented by both the U.S. and the EU in support of their semiconductor industries. For instance, the EU's Horizon initiatives encompass a broad range of specific actions with significant depth also with regards to the semiconductor industry, making a direct comparison with U.S. policies complex. Similarly, the dynamic nature of the U.S. policy and industry initiatives also presents its challenges for comparison.

The role of member states within the EU also introduces variability in the implementation of the Chips Act. This study has not extensively explored these variations among different EU member states, which could significantly influence the overall impact of the EU's semiconductor strategy.

Additionally, the timing and geopolitical context significantly influence the semiconductor industry, from tensions in Taiwan to other global disputes. The policies and instruments analysed should be viewed as snapshots within a larger, shifting geopolitical and economic landscape. Changes in these instruments may occur, particularly in response to industry's feedback or emerging geopolitical events.

Lastly, it is important to acknowledge the limitation of the Developmental Network State (DNS) framework used in this analysis. While providing a valuable lens for understanding the policy instruments, the DNS framework may not capture every nuance of a state's action within the semiconductor industry. Future research could benefit from integrating additional theoretical perspectives or methodologies to gain a more comprehensive understanding of industrial policies and their implications.

In essence, this thesis serves as a preliminary exploration of the distinct semiconductor policy instruments of the U.S. and the EU. It lays groundwork for further research, highlighting areas for deeper investigation, emphasizing the importance of continuous monitoring and adaption of policy instruments in the global competitive semiconductor context.

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