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Review

The Review Article on Technonationalism

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Abstract: This review article aims at improving understanding of the theoretical discussion on technonationalism. Reviewing conventional works of the literature proposes protectionist, innovationist, and strategic industrial approaches toward high-tech industries. The findings show that technonationalism is a concept linking technology and national security, seeking geoeconomic interests in the integrated global market to exert state power for economic statecraft. The nature of industry highly relies on the global value chain, and technological innovation in the high-tech sectors occurs mainly in the private sector; thus, this article points out the issue of embracing business interests into the state's strategic addenda as a critical criterion of technonationalism. Also, technonationalism is a narrowly defined concept with state actors involved in national security affairs and high-tech business actors.

Keywords: technonationalism; high-tech industry; semiconductor; Northeast Asia; global value chain; state-business relations; economic statecraft; geoeconomics

1. Introduction

Over the last few decades, China has emerged as a great power achieving remarkable economic and military growth. In 2008, China became the highest military budget spender after the United States. In 2010, it became the world's second-largest economy surpassing Japan by nominal gross domestic product, according to the Japanese Cabinet Office [1][1]. It has been the biggest trade partner for around 120 countries, including the United States, the European Union, South Korea, Japan, Taiwan, and most ASEAN countries. Based on impressive-technological catch-up, China could achieve successful industrialization, and now it is home to many prominent tech companies closing technological caps with the most economies. Withholding a tight grip on access to critical raw materials, China is leading high-tech sectors, including electronic vehicles (EV), telecommunication, batteries, and house appliances. Such growth in China's high-tech industries made the country the biggest consumer of semiconductors, which are powering modern electronics. Thus, Chinese President Xi Jinping launched the "Made in China 2025" project aiming at technological sufficiency and becoming a global leader in semiconductors to achieve the initiative [2].

The tremendous growth of the Chinese high-tech sector under the Chinese Communist Party's support has brought consequent friction with the United States. Policymakers in Washington see China's ambition for the semiconductor industry as a "national security" threat. Thus, managing the chip industry's global value chain (GVC) became a key policy. Moving on national security grounds to block China's investments and acquisition in the semiconductor sector, the U.S. federal agencies have imposed export controls on Chinese companies starting with ZTE and Huawei in 2018. The Trump administration placed Huawei and its affiliates on the Entity List to cut the firm off from American technologies in the semiconductor industry from May 2019 (Fuller 2020). The Biden administration, inaugurated in January 2021, has strengthened measurements to block China's technological upgrading just like his predecessor. The U.S. technological supremacy allows it to control the most strategic nodes in the GVC of the semiconductor industries

[1] Japan's nominal GDP for the second quarter of the fiscal year 2010 totaled $1.2883 trillion, and China's GDP was aggregated at $1.3369 trillion.

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with Intellectual Property (IP), design tools, software, and manufacturing equipment. So-called 'decoupling' Chinese firms from the GVC of the semiconductor industry involves Washington's allies, namely South Korea, Japan, and Taiwan, who are committed to the containment of China's geopolitical ambitions and the policy coordination with the United States calling out their domestic companies. As China is defined as a "national threat" by both Republican and Democratic presidents of the United States, measurements taken by the U.S. government have resulted in geopolitical competition. Washington's stance on its commerce with Beijing involves its military allies and partners, and its political economy is difficult to distinguish to what extent domestic or international political domain, and whether it is security or commerce matters. The growing trade tensions and increasing technology rivalry between Washington and Beijing are seen as the resurgence of technonationalism policy. [3-6]

This is a comprehensive review article on the existing discussions on technonationalism and suggests its framework to analyze within the context of economic statecraft. The first section of this article reviews the conventional understanding of technonationalism in the sense of nation-building through promoting the defense industry, expecting both technological ripple effects throughout the overall economy and gaining technological autonomy in the military sector. The second section discusses how technonationalism has been conceptualized in different contexts and how the tendency has been shifted from a single-state focus to a multi-state focus by examining existing works on the application of technonationalism. The third section more closely examines the concept of technonationalism within the context of economic statecraft and geoeconomics to provide a working definition for case studies. In the fourth section, the author establishes an analytic framework by suggesting three criteria of technonationalism in order to analyze Northeast Asia's semiconductor industry. The fifth part shows the overview of Northeast Asia's semiconductor industry and how they are closely interdepending on each other. The concluding section summarizes the discussions on the theoretical implications of technonationalism and the recent movement in the Northeast Asian semiconductor industry regarding the hegemonic competition between the United States and China.

2. The Conventional Understanding of Technonationalism

Technonationalism was used first time by an American economist, Robert Reich, in 1987 to describe the Reagan administration's intervention in the deal between a Japanese giant electronics company, Fujitsu, and an American chipmaker Fairchild. The intense pressure from the U.S. government made Fairchild call off the sale of a technology subsidiary to Fujitsu. Then Defense Secretary Caspar Weinberger, Commerce Secretary Malcolm Baldrige, and the Central Intelligence Agency intervened and asked the White House to block Fujitsu from buying Fairchild. The primary reason for objection to the sale was "national security" concerns. The Fujitsu-Fairchild deal raised tensions among government officials and industry executives because Japan seemed to invest in strategically essential high technologies. Fairchild was an essential military contractor supplying some advanced components applied in military equipment and computer systems, including communication systems used to control nuclear missiles and supercomputers. Defense Department and CIA officials expressed worry about depending on Japanese manufacturers' semiconductors [7]. As the case of the Fujitsu-Fairchild deal shows, technonationalism is characterized as strategies and policy orientations advocating a nation's innovative capacity and technological autonomy [8]. The terminology reflects the American policymakers' perception that Japan was overtaking U.S. technology primacy, which worked as a disadvantage to American industries.

The conventional understanding of technonationalism reflects the linkage between the technological sphere and national security. After Reich used the term, technonationalism was conceptualized as how technological prowess is linked to a state's military capability. Japan is portrayed as a typical case of technonationalism of commercializing military technologies. Scholars apply the concept of technonationalism in the defense

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industry to explain how technological autonomy in the sector was important for Japan in terms of national security and economic development. Richard Samuels is the first scholar to conceptualize technonationalism by explaining that contemporary Japanese technological ideology evolved from the 19th century's mercantilism and the 20th century's militarism. Technonationalism is defined as a belief that technology signifies a fundamental element in national security; thus, technologies must be indigenized, diffused, and nurtured to make the state prosperous and strong [9]. Based on such a belief, technology has been understood as a strategic asset throughout Japanese history from the Tokugawa era (1603-1867), the Meiji Restoration, and pre-war Imperial Japan to postwar Japan. Its role has ideologically played in creating industrial wealth and national security. Under the slogan of *fukoku kyohei* (rich nation and strong army), Japanese political elites pursued technological advancement as a means of national defense and economic prosperity. Military production stimulated and transformed civilian manufacturing in Japan even before the Tokugawa period until Japan's defeat in the Second World War in 1945.

In the post-war period, Japan concentrates its national capacity on economic development without increasing the defense budget under the *Yoshida doctrine*[2]. During this period, Japan's national technology policy had three elements: (1) the indigenization of foreign technologies to stimulate the development of domestic manufacturing, (2) technology diffusion throughout society, and (3) the nurturance of innovation and manufacturing capacity. Postwar Japanese leaders who inherited the pre-war paradigm added the developmental creed to technonationalism. Defense sectors have a ripple effect throughout industrial development, a so-called spin-off; military contractors supply equipment and components and their sub-contractors. Embedding military production within large civilian firms accompanies the indigenization (*kokusanka*) effort. Thus, Japan could successfully reestablish its defense industry and other related manufacturing sectors requiring high technologies in the postwar era. As a result, Japanese corporates have become global leaders in designing and manufacturing materials, components, and subsystems despite the limited production of final products and large-scale weapon platforms despite its small domestic defense market.

Also, technonationalism has played an essential role in establishing the Yoshida Doctrine and Japan's hedging strategy [10]. During the pre-war and post-war, Japan aimed to transfer advanced technologies from the defense industry to civilian industries. However, the post-war period of technonationalism is to leverage vis-à-vis the United States diplomatically with its enhanced military production with the expectation of the ripple effect to the overall manufacturing sectors to revive its economy for the war-torn nation. Then-Prime Minister Shigeru Yoshida's choice was for nation-building in the post-war as an economic superpower [11]. As an overall grand strategy to maximize military technological autonomy, Japanese political leaders employ technonationalism to maximize national strategic autonomy [12]. In order to hedge against the classic dilemma of abandonment by allies, Japan maintained a self-defense force and military production capacity not to rely on the alliance of the United States overly. Japan's technonationalistic policy for the defense industry has inspired other Asian neighbors [13]. Asian countries deploy the self-reliance strategy of arms production and sustain the individual effort for the domestic defense industry in the everchanging technology dynamic. The defense industry stimulates other relative manufacturing sectors, especially high-tech industries because technological innovation in these sectors is critical to advancing the overall military technology capacity.

Through the conventional narratives on technonationalism in the defense industry, technonationalism combined with developmentalism fosters defense sectors and stimulates the development of overall domestic manufacturing capacity. The two core and

[2] The post-war Japanese foreign policy is based on the Yoshida Doctrine referring to the diplomatic strategy initiated by former Prime Minister Shigeru Yoshida in 1951: focusing on economic recovery and growth while relying its security on the U.S.-Japan military alliance and maintaining limited defense force.

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intrinsic attributes of these studies provide insights that technonationalism sees spin-off technology as a key to achieving national economic prosperity and establishing strong military forces. Second, technonationalism empathizes with technological autonomy to accomplish those purposes. However, these works do not clearly point out which industries are strategically important in accordance with the logic of technonationalism.

3. Expanded Application of Technonationalism

The origin of technonationalism is based on the linkage between critical technologies and national security. With this idea, scholars applied the concept of technonationalism limitedly to the defense industry, explaining how the ripple effect of spin-off technologies can affect economic development. From this idea, the following strands of scholarly works have widened the application of technonationalism. The works include studies on the state's intervention in the domestic market and technological innovation. The author names these three approaches, the protectionist approach, the innovationist approach, and the strategic industry approach. The first two approaches empathize with the state's leading role as a protector of the domestic market and a facilitator of the domestic technological innovation environment. The third approach highlights the state's engagement in high-tech industries with coordinated industrial policies.

3.1. Protectionist Approach to Technonationalism

The first approach is the most straightforward view of technonationalism, named the protectionist approach, that the state should intervene in the domestic market directly to protect its domestic firms. This approach is mainly applied to international trade and implementation regulations and standard implications. States take the role of regulator of foreign actors' direct market entry, investment, and M&A of domestic companies. In this approach, states demonstrate protectionism against foreign goods and protect their domestic industries, and such protections occur in trade conflicts with other states. Laura D'Andrea Tyson (1993) applies the concept of technonationalism to a cautious activist policy toward industries with technological advances creating beneficial spillovers for other economic activities and barriers to entry, generating market structures for first-mover advantages and strategic behaviors [14]. Thus, the U.S. government should utilize selective policies, negotiate with foreign counterparts, and build industry-specific strategies. Sylvia Ostry and Richard Nelson (1995) use the framework of technonationalism to explain states' protectionist behavior in international trade and policymaking [15]. Industrialized states such as the United States, France, Japan, and Germany have experienced conflicts in trade and public policy areas because they promote policies favoring and protecting their domestic firms in order to give them an advantage in the high-tech sectors where technological supremacy can create the gap in the market power. These governments are inclined to provide direct and indirect support to their domestic high-tech sectors through various protectionist policies.

As the term's origin indicates, techno "nationalism" excludes foreign participation in the domestic high-tech sectors using trade safeguards and ceases cross-border technology diffusion or transfer. One example is the trade conflict between the United States and Japan from the 1970s to the 1990s surrounding electric consumables, cars, and semiconductors. Washington accused Tokyo of unfair trade practices in these sectors. In 1985, the United States put a 100 percent tariff on Japanese semiconductor products and successfully manipulated the exchange rate by depreciating the U.S. dollar to the Japanese yen with the Plaza Accord. The U.S.-Japan Semiconductor Arrangement made in 1986 was about expanding American share in the Japanese semiconductor market and banning the dumping of Japanese firms in the American market[3]. Toshiba was prohibited from

[3] The Arrangement consisted of two parts. The first part is to boost the sales of foreign semiconductors in the Japanese market: the Japanese government's encourage its chip users to purchase more foreign chips; the gradual and steady improvement in market access; establishing an

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conducting business in the American market for the next three years in 1987 for selling submarine propellers to the Soviet Union. In 1989, Japan was forced to share semiconductor technologies with the United States by opening its patents. In 1991, both countries renewed the 1986 arrangement, and Japan agreed to double the American share in the Japanese semiconductor market by up to 20 percent. These measures resulted in the United States taking the lead in the global chip industry from Japan.

Another example is the landing ban on Concorde flights in New Jersey and New York in 1976. Air France and British Airways filed a lawsuit that the measurement was discriminatory and detrimental. On the surface, it was an environmental issue, but it was to protect the domestic American aircraft industry [16]. Tyroler-Cooper and Peet (2011) argue that technonationalistic practices based on technonationalism are manifested in regulating foreign investment in the domestic high-tech sectors, imposing standard implementation on specific technologies based on domestic regulations, and practicing protectionist trade policies pursuing the envelopment of indigenous capability for self-reliance and autonomy [17]. In the case of the Chinese aviation industry, the Chinese Communist Party (CCP) aims to foster domestic innovation in the development of a military airlifter and not depend on foreign technologies for security reasons.

Studies on the protectionist approach provide a clear idea of which industries should be objective of technonationalism: high-tech sectors such as electronics, semiconductors, and aircraft industries. Technologies applied to these sectors are knowledge-intensive and innovation-driven, requiring intense research and development (R&D) capability. A state's science, technology, engineering, and mathematics prowess is directly related to the sector's development. Also, high-tech industries usually trigger progress in other related sectors. However, the protectionist approach is yet to facilitate a comprehensive understanding of how the protection of domestic high-tech industries by regulating trade and foreign investment implies national security. In other words, technonationalism based on the protectionist approach has less security impulse; rather, technonationalism simply means policies launched by governments to give their national firms a particular edge in the changing technological environment [18-19]. Policy agendas should be possible to promote competitiveness in high-tech sectors and strengthen the regulations on high-tech trade. Then, technonationalism loses its core argument of national security interests; instead, the discussions of the protectionist approach obscure the distinction from mercantilism.

3.2. Innovationist Approach to Technonationalism

The second approach is the innovationist approach which puts emphasis on the state's role as a facilitator of an innovative environment for technologies than the protectionist one. This view argues that state actors should engage more actively in the technology sector to provide the necessary surroundings for research institutions, universities, and firms to lead technological innovation. Also, the second approach advocates a limited open-door policy element in technonationalism through hosting multi-national business actors in domestic markets. Policymakers who adopt the innovationist approach of technonationalism see that the protection of domestic firms does not occur in technological advancement.

The state-driven technological innovation is to achieve indigenizing core technologies for "critical" high-tech sectors. Whereas the protectionist approach emphasizes excluding foreign participation in the market through regulating trade and foreign investment, the innovationist approach underlines the indigenization of foreign technologies, which means the capability of changing, modifying, and improving foreign-adopted technologies [4]. Thus, the government's policy should attain a competitive advantage vis-à-vis foreign competitors. In order to do so, the level of technology a state currently has

organization to promote foreign producers' sale increase in Japan; the voluntary control to prevent excessive production capacity. The second part is to suspension dumping of Japanese chip manufacturers (Yoshimatsu, 1998).

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should move from imitating or mimicking foreign technologies to advancing to a higher level, which is producing its own domestic technologies [20]. Such technology catch-up effort by developing countries is an extension of achieving both technological independence and economic sovereignty from technologically advanced countries' economic aggression [21]. Thus, technological advancement became a crucial economic resource to increase industrial productivity and create exports; states put efforts into retaining innovation capacity in the globally integrated market [22]. Therefore, states take a leading role in technological innovation with the allocation of the government budget, such as R&D subsidies, fiscal policies, tax benefits, and the encouragement of establishing an innovation culture throughout society.

However, the innovationist approach allows some level of open-door policies to foreign players. Presuming a globally integrated market, developing countries welcomed multi-national corporates (MNCs) in their domestic market with the condition of technology transfer. Governments in emerging economies realized the importance of indigenous innovation capabilities but opened to foreign investment in the domestic market in the 1990s. A combination of technonationalism and technoglobalism, advocating technology transfer across borders [15], was a keynote of policies in the era of globalization. Yamada (2000), Luo (2002), and Meyer (2004) assess that such a trend in technonationalistic policies resulted in strengthening technological requirements from foreign players and local manufacturing capacity [22-24]. Government policies under the innovationist technonationalism are designed to require technology transfer to foreign investors. One example is China. The CCP has pursued technological development to support national economic and security interests by promoting openness and globalization initiative (Capri 2020). China is a unique case among other cases requiring technology transfer because the Chinese government supports its domestic firms to engage in anticompetitive activities with legal measurements prioritizing technology transfer from foreign companies. Chinese companies use a variety of methods to acquire core technologies, IP, and industrial know-how from foreign firms: FDI, venture capital investments, joint ventures, licensing agreements, talent acquisitions, and cyber espionage [25]. Along with the massive scale of state-funded programs such as Made in China 2025, China Standards 2035, and the Digital Belt and Road Initiatives, China hitches on the tide of globalization with limited and conditioned open-door policies.

The innovationist approach debates over the state as a technological innovation unit to create significant gaps in the state's prowess in promoting innovation. The rapid technological innovation and maturity in the high-tech sectors manifest the erosion of the state's capability. In other words, the state's innovative ability is directly connected to its industrial prowess. Such a tendency is distinctively visible in high-tech industries where innovation occurs mainly in the private business sector nowadays in most industrialized economies. The role and influence of bureaucrats in Japan's development in high-tech sectors (overall economic development) in the post-war era have been studied over decades. The conventional wisdom derived from Chalmers Johns (1982) is that state-dominant—more precisely, bureaucratic-dominant in Japan—witnesses the innovationist approach of technonationalism [26]. However, the Ministry of International Trade and Industry's (MITI) policy regime collapsed as the Japanese economy was transformed from a catch-up follower of the Western industrialized economies to a caught-up economic superpower for other Asian industrializing countries [27]. The cooperation paradigm among MITI, private firms, and other bureaucratic and political actors was replaced by market competition among business actors. The innovationist approach of technonationalism remains questions about how the policymaking process should be inclusive when states promote technonationalistic policies. Also, the innovationist approach assumes that limited and conditioned open-door policies stimulate domestic technological innovation and development. China's authoritarian technonationalism does not distinctively address such issues, but still, studies on the innovationist approach do not discuss how to balance business actors and technonationalistic impulses in policies.

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3.3. Strategic Industry Approach to Technonationalism

The third approach is labeled as the strategic industry approach, which has arisen since 2018 when the U.S.-China trade conflict as a tit-for-tat over tariffs escalated into a protracted technology war surrounding key technologies instigating a new cold war of sorts. Delisting Chinese tech firms in the U.S. market with coordinated efforts by its Western allies aims at stopping China from acquiring advanced military-related technologies to strengthen China's defense forces. While the previous approaches focus on defensive measurements, such as restricting foreign participation in the domestic high-tech sectors and access to industrial know-how, the third approach remarks on more offensive strategies to foster domestic high-tech industries' competitive edges and proactively ally with other states [28]. Alex Capri (2019) refers to technonationalism as a new strain of mercantilist thinking that links technological innovation and capabilities directly to a nation's national security, economic prosperity, and social stability [3]. Thus, this approach advocates strong state intervention against opportunistic or hostile state and non-state actors, and policymakers seek to attain geopolitical gains with domestic industrial prowess [23]. From this view, a state's technological capacity is a strategic asset to maximize its influence over other states and minimize negative externalities.

Technonationalists leverage their countries' domestic industrial capability in international politics. In other words, high-tech sectors are not only for economic growth but also for foreign policy tools to assert state power over foreign counterparts. It is possible because of the nature of the high-tech industry relying on the global production network. In the GVC[4], where the production system is fragmented globally based on the comparative advantage of geographical regions building a complex network of multinational corporates, an imbalance of dependence consequently occurs. The globally integrated production system was to chase the efficiency and profits of MNCs, but the networks have security consequences due to increasing interdependence among states [29] (p. 25). The third approach of technonationalism entails inclusive domestic industrial policies targeting the international political economy. In order to outgrow the strategic fragility of its domestic industries, the state aims at achieving technological self-sufficiency and fostering national champions through industrial policies [30]. Such a practice of state intervention in trade and technological affairs gives their domestic leading tech firms an advantageous position over their foreign rivals and indispensably accompanies friction with other countries. The GVC, originally a venue for international cooperation, became a place for competition among states. The existence of GVC and its increasing importance in the high-tech industries intertwines technological advancement, industrial prowess, and national security issues. Thus, states unfold both domestic industrial and foreign policy strategies for national interests.

With the re-defined state's role as a tactician of national interests encompassing economy, social welfare to defense affairs, the strategic industry approach of technonationalism seeks to seize the state's strategic position in the GVC. Such a perspective sees that the distinction between economic advantage, military capability, and technological and scientific capacity are blurred, and these factors all fall into "national interests" [5]. Under strategic considerations for national interests, high-tech firms have strong state support to strengthen domestic industrial capabilities and create a balance of dependence with other states. Thus, a more coordinated approach is forecasted among like-minded nations in core-high-tech sectors [31]. As the GVC is a changing variable of international political dynamics, the strategic industry approach to technonationalism proposes the state's diplomacy as a distinctive feature. Thus, technonationalism in the strategic industry

[4] Gary Gereffi and other scholars have developed a framework of 'global commodity chains' since the 1990s to analyze the shifted paradigm in the globalization of commerce. Similar terms, such as global production network and global supply chains, describe the production system relying on the geographical division of labor. However, the 'global value chain' is widely used in international business literature because it is a more inclusive concept encompassing both primary and support activities offshored and outsourced.

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approach aims beyond the state's involvement to maintain a domestic technological edge, which is the value-chain governance allying with other states to counter hostile state actors or business actors to its national security.

3.4. Summary of Existing Works on Technonationalism

The idea of technonationalism started from the government's intervention in the high-tech sectors to cease foreign companies' access to critical technologies for "national security." Later, this term became widely applied to various state involvement in technology affairs. The usage of the term in the protectionist and innovationist approaches developed the discourse in technonationalism out of the defense industry and expanded to other high-tech industries but left the concept vague that swings between economic interests and national security issues.

The strategic industry approach came into the academic debate in the late 2010s with the visualization of the US-China rivalry in international commerce, military sectors, and values each side supports, such as authoritarianism, democracy, state-led industrial plans, and laissez-fair economic practices. Such a shifted paradigm in technonationalism from a single-state focus to multi-state focus witnesses that the balance of dependence is perceived as a security risk amid intensifying hegemonic competition between Washington and Beijing. While the GVC resilience became a critical political agenda, conceptualizing technonationalism involves a total-dimensional policy consideration from domestic industries to foreign policy issues integrating business actors into national security boundaries.

To sum up, the changing paradigm in the works of literature studying the expanded application of technonationalism shows that (1) the state's interests have changed according to the changing nature of international commerce, (2) the source of national power comes from the industrial prowess of high-tech sectors, (3) geopolitical ends can be achieved by a state's grip on the GVC of high-tech industries.

4. Defining Technonationalism in the Economic State and Geoeconomic Context

From reviewing previous studies, it is possible to figure out that technonationalism is a narrowly applied idea to high-tech industries, which are closely related to national security affairs. State actors lead technology sectors for a variety of national interests, from economic ones to security ones. With the rise of the GVC as a new international commerce environment, technonationalism provides states an ideological base to seek geopolitical interests by leveraging its domestic high-tech industries. The way promoting technonationalistic initiatives has shifted from one state to multiple states in the alliance because of such a global scale of the division of labor. Nonetheless, the existing works show the shifted paradigm in technonationalism, those studies still do not provide a comprehensive conceptualization of technonationalism. Its interest areas and source of power to deploy technonationalistic imperatives should be analyzed within the context of economic statecraft (ES) and geoeconomics. This section is to make technonationalism a more concrete and distinctive notion of maneuvering strategic competition with other states within the context of economic statecraft and geoeconomics.

Economic statecraft is the study of the economic aspects of grand strategy connecting economics and national security. State actors intervene in commercial markets through economic sanctions, export control, trade barriers, and economic aid. Utilizing such measurements, states intentionally manipulate economic interaction to capitalize, reinforce, or reduce the associated strategic externalities through economic statecraft [32] (pp. 13-14). In short, ES is basically state actors' use of economic resources to conduct diplomacy to achieve multiple state objectives, including national security, economic prosperity, and political prestige and influence [33] (p.826). Technonationalism consists of a part of economic statecraft that states leverage against other states with domestic high-tech industries for national security.

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With the rise of economic statecraft, geoeconomics is also highlighted. Nonetheless, there is no agreed definition, geoeconomics refers to the use of economic instruments to promote and defend national interests and to produce beneficial geopolitical results; and the effects of other nations' economic actions on a country's geopolitical goal [34]. Based on the traditional understanding of how domestic economic strength promotes a state's power projection, geoeconomics is about how a state builds and exercises power by reference to economic factors. Geoeconomics essentially combines with the logic of geopolitics, the use of military power as a method of foreign policy in terms of given geographical variables, in order to achieve national interests by using economic tools. In other words, geoeconomics shows that the methods of commerce replaced military methods in international politics [35]. Within a big framework of economic statecraft, geoeconomics consists of a part of it, and technonationalism provides such a linkage between national security and technologies. Technonationalism answers the question of how states use economic means in which military means would have been used, emphasizing the effect of the domestic high-tech industrial arrangement on the international political economy.

The rise of technonationalism brings in the convergence of economic issues and national security matters in which power politics has shifted its pattern of state competition from geopolitics to geoeconomics, as "state power" is derived from the control of global markets with the widespread GVC than military hardware or control of territories. However, global economic networks have security consequences when major industrial states engage in disputes. Such a network, the GVC, became a competing hub in international politics. One of the conditions of successful economic statecraft is interdependence on the supply chain [36]. In technonationalism, interdependence can be deployed as a tool to exert state power over others [29]. The weaponized interdependence addresses the asymmetric balance of states' technological capabilities. Whereas economic interdependence has been theorized as constraining the likelihood of violent conflicts in liberal theories [37-41], it is embossed as a strategic weakness for economic statecraft. Thus, the new feature of technonationalism engages in diplomatic efforts for the GVC resilience to wield state power. Therefore, technonationalism can be defined as a state's utilization of its domestic high-tech firms' influence on the GVC for geoeconomic interests. State actors proactively engage in high-tech sectors to support their domestic firms to have or maintain a dominant position on the chain and use a tool of diplomatic power projection. Based on this working definition, this study aims to explain the features of technonationalism in Northeast Asia's high-tech industry.

5. Analytic Framework of Technonationalism

From reviewing previous studies, it is possible to figure out that technonationalism is an inclusive approach that links technological prowess to national security by employing domestic high-tech industry as a foreign policy tool. It is an exclusive state's policy direction for the high-tech industry in which national security matters are intertwined. Under this notion, this research suggests three criteria of technonationalism to analyze Northeast Asian countries' technonationalism amid the rising tension amid global power competition in the case study: (1) integration of business interests into the state's strategic agenda, and (2) national security-oriented high-tech strategies, and (3) the dual dynamics of cooperation and competition in the region.

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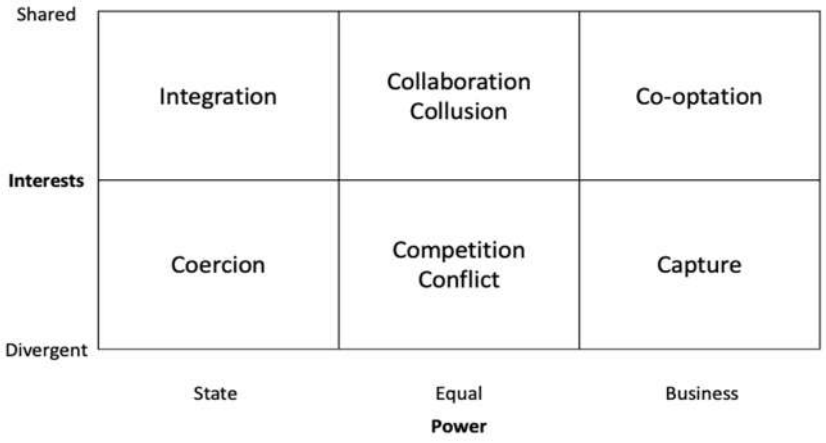

Figure 1. State-Business Relations based on power and shared interests (Source: Author's own).

First, state actors should be able to integrate business interests into the state's strategic agenda. Technonationalism hypnotizes state actors to have the upper hand in power relations vis-à-vis business actors or at least equal. To examine how technonationalism is manifested in the state actors' intervention in the high-tech sectors, the analytic framework is built based on the "state-business relations" (SBRs) model [42]. Their work focuses on the relations based on the relative power and shared interests between state actors and business actors in the developmental state narrative. Amsden (1989) and Peter Evans (1989) have argued that the positive collaborative interaction between the state and the business actors can enhance a country's economic development [43-44]. Considering such a power balance between state and business actors and their interactions is important to figure out the impacts on structural power in the evolving political economy context. Thus, applying such a pattern of interaction (formal and institutionalized, regular coordination, or informal ad hoc scoping from the whole economy or industry-specific) to economic statecraft with technonationalism. To better understand domestic power dynamics and goals in industries, this research proposes a six-squared table as Figure 1 to indicate where state and business power are asymmetric (right and left columns), and their power is equal (middle column). If the state-business interaction falls into the right column, the state engagement is clearly based on technonationalistic imperatives regardless of diverged or converged of their interests. However, when their power is symmetric, it is hard to define whether the state involvement in the sector is based on technonationalism. The transformation of the relations between state and business in the high-tech sectors makes it hard to anticipate that states are the upper hand vis-à-vis business actors.

The top middle part shows that state and business actors are in relatively equal power relations with shared interests. Along with globalization, developmental bureaucratic states, namely Japan, South Korea, and Taiwan, have made a turn to developmental network states associated with industrialization and democratization [45] These countries' industrial policies are less state-directed and more co-governed by the state and business actors [46]. Thus, technonationalism in SBRs can be narrowed to either collaboration or collusion types in the case of Northeast Asia's high-tech industries. The collusive interaction refers to the situation when these two conditions meet: (1) business actors use state agencies to seek particularistic benefits rather than a collective benefit for the overall economy, (2) influential bureaucratic or political elites control state agencies or manipulate business sectors for sectional or rent-seeking interests. In this case, the state-business interaction aims at neither a state's strategic agenda in the GVC nor geoeconomic interests, the "collusion" pattern of interaction cannot be classified as technonationalism. In contrast, collaborative interaction between state and business actors can synergize their strengths for broader societal benefits [47]. Societal interests can differ in different contexts, but they can be translated into state's geoeconomic interests and seizing strategic position in the GVC of the high-tech industry in the technonationalism context. Thus, to

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clarify whether the interaction is for technonationalistic agenda, the ripple effect of the state's intervention in the sector and the inclusiveness of upstream and downstream industries can be considered.

Second, government policies driven by technonationalistic initiatives are oriented on security implications. Technonationalism from the late 2010s tends to empathize with economic security. Conventionally, technonationalism has hired the Schumpeterian perspective that domestic economic success through innovative technology contributes to strengthening national security. However, the strategic industry approach of technonationalism contains more aggressive methods and intends to incapacitate the targeting state's industrial competitiveness. The expression of "economic security" itself connotes contradictions. Whereas 'economy' is a market-oriented concept, 'security' is a state-centered concept. While 'economy' aims at a win-win game where all participants gain by maximizing efficiency through the international division of labor, 'security' anticipates a zero-sum game in which division of labor and economic interdependence can be a threat, and one must always be superior to that of its rivals. Technonationalism in the 21st century is employed for geoeconomic interests shifting the engagement of military methods to economic means. Hence, the consideration in technonationalism should be involved in when and how countries engage in economic statecraft using high-tech capabilities rather than military power.

Third, technonationalism became a multi-state focus paradigm. In other words, the dual dynamics of cooperation and competition in the region results in the issue of coordinating competition among like-minded at the international political. As reviewed in the previous works, the paradigm of technonationalism is shifted from a single-state focus to a multi-state focus, in which the employing state gets involved in multilateral collaborations with other states. High-tech sectors, especially the semiconductor industry, are so the knowledge and technology-intensive fields that it is hard to achieve technological autonomy. Without cooperation with other states, a more feasible strategy vis-à-vis the target state would be impossible to deploy, as the high-tech industries rely on the global level of supply networks. In Northeast Asia, such a coordinated movement is already emerging based on the formal alliance and informal partnership with the United States. Washington is pondering taking leadership in such a movement from the single-state focused toward the multi-state focused technonationalism due to the complexity of the supply chains and the rise of prospective rivals in high-tech sectors, which is closely related to national security and the economy overall. Seungjoo Lee (2022) points out the dual dynamics of cooperation and competition among South Korea, Japan, and Taiwan in the high-tech sectors in a selective manner. Northeast Asian actors indirectly establish formal and informal cooperation mechanisms via the United States. Thus, the mitigation of competition is required for a stable regional order.

6. Overview of Northeast Asia's Semiconductor Industry

Semiconductors are one of the key contributing factors to the United States' victory against the Soviet Union during the Cold War. Called the transistor, invented in the Bell Labs in 1947, miniaturized chips rapidly replaced vacuum tubes in electronics and led to commercial success, increasing industrial efficiency. American economic supremacy remained unchallengeable until the early 1980s when the Japanese and European economies advanced based on the automobile and electronic industries. Semiconductors took the center of such impressive economic growth in the post-war Japanese economy, boosted since the 1970s, and South Korea and Taiwan since the 1980s. Northeast Asia became the center of semiconductor production. Rising China absorbed a significant amount of chip demand and became the biggest semiconductor consumer in the global market.

Until the 1970s, the top semiconductor firms were from the United States, namely Texas Instrument, Motorola, and Fairchild. However, under the Japanese government's support, Fujitsu, NEC, Mitsubishi, and Toshiba launched a joint VLSI Technology Research Association in 1975, and Japan became the biggest supplier of memory chips in the

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global market a decade later. Checked by Washington, Japanese chips were imposed on tariffs, and the US-Japan Semiconductor Agreement ended Japanese chip supremacy. With this effect, South Korean and Taiwanese manufacturers joined the global chip market, and the United States regained its competitiveness by moving to the memory chip sector. The early 1990s' Windows PC boom greatly contributed to a 30% per annum market growth. After the recovery from the Asian Financial Crisis, the fabless-foundry business model (separation of chip design and chip fabrication) became a new trend in the industry since the 2000s. Broadcom and Qualcomm started outsourcing their chip production to TSMC[5] and UMC[6]. Such collaboration between American and Taiwanese firms overwhelmed Japanese chip companies both in terms of technologies and production costs. The 2010s is a critical time for the semiconductor industry for the technological advancement in the communication sectors from 3G to 4G and even to 5G networks. With the widespread use of smartphones and internet services such as e-commerce, social media, and streaming services, EVs have become ingrained in our daily lives. Artificial Intelligence (AI), big data, and cloud servers increase demand for more technologically enhanced semiconductors.

South Korea is home to two leading memory chip manufacturers. Its combined global memory chip market share is around 58.4%, and in terms of total semiconductor sales, its market share was about 19.3% in 2022 [50]. As a significant driver of the Korean economy, semiconductors are the country's largest export item, recording 20% of total export [51]. Since 2013, Korea's chip sector has maintained second place in the global market. Significantly, South Korean firms are outstanding in the memory chip sector. As seen in the charts below, the memory chip market is in an oligopolistic situation with several prominent firms from Korea, Japan, and the United States. Due to the features of the DRAM market, which are highly cyclical and heavily dependent on R&D investment, only a few big corporates with a large production capacity and the ability to undergo loss during the down cycle of memory chips can remain who adopt the integrated device manufacturer (IDMs) business model.

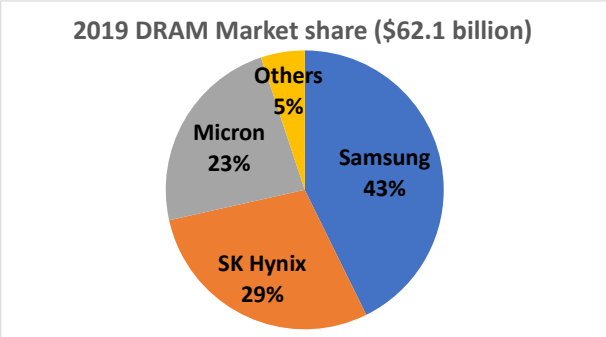

Figure 2. 2019 DRAM market share (Source: Author's own).

[5] Taiwanese Semiconductor Manufacturing Company (TSMC) is a Taiwanese foundry company established in 1987.

[6] United Microelectronics Corporation (UMC) is a Taiwanese company in 1980 as a spin-off company of the Taiwanese government-sponsored Industrial Technology Research Institution.

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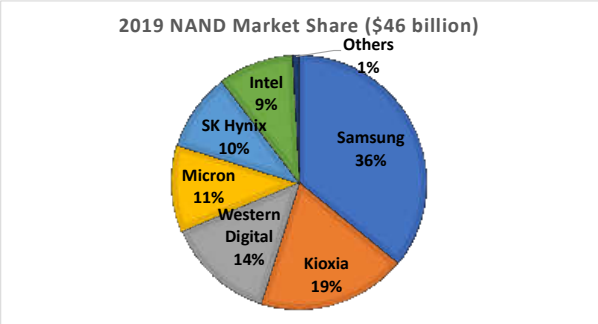

Figure 3. 2019 NAND Flash market share (Source: Author's own).

Samsung is the most crucial player in the Korean semiconductor industry. Started chip business in 1974 by acquiring Hankook Semiconductor; Samsung continually succeeded in developing bigger capacity DRAMs[7] and became the first developer of more advanced memory chips in the 1990s [52]. Samsung runs lines in Korea, the United States, and China. In 1998, the company established foundry lines in Austin, Texas producing power management integrated circuits (PMIC), communication chips, and automatic driving chips for Tesla. At the fabs in Xian, China, the firm has fabricated NAND Flash[8] since 2014. The company announced its $17 billion investment to build new foundry lines in Austin, Texas, on top of existing facilities. Both the federal and state government level of subsidies are given to Samsung's $200 billion investment plan. Also, U.S. President Joe Biden's visiting Samsung's Pyongtaek line in May 2022 signifies Samsung is a critical factor not only for the Korean economy but also for America's chip strategy for its grand strategy toward intensifying the US-China tech war. SK Hynix is another big memory chip maker. Hynix underwent a significant investment in Wuxi, China, even its workout time as its mother group, Hyundai, was broken into 35 affiliated companies in 2000. SK Group acquired Hynix in 2012 and continued investment in the semiconductor business. With the strong support from the Group, SK Hynix could grow into one of the major memory chip makers in the global market. In 2017, SK Hynix purchased 15% of Kioxia's (formerly Toshiba Memory) voting shares. As of January 2022, the company completed the first phase of Intel's NAND and SSD business acquisition [53] to increase its global market share.

Taiwan takes a critical position in the GVC of the semiconductor industry due to its prominent foundry player, TSMC. Producing semiconductors involves many different processes, such as design, fabrication, assembly, testing, and packaging. This section is to provide an overview of the chip production business models, which are based on the specialization of certain activities. IDMs conduct all processes that fabless, foundry, outsourced service assembly and testing, and packaging (OSATs) do separately. TSMC is the first pure foundry player in the global semiconductor industry. Before its establishment in 1987, semiconductor products were produced by IDMs. In the early days, when the semiconductor industry started, IC technologies were not too complicated. However, after TSMC launched a dedicated foundry business model, the specialization of labor in the industry had been accelerated. Thus, more complex designed chips and more advanced fabrication technologies can be applied. With the growth of fabless models in the United States, TSMC has been the biggest foundry company in the global semiconductor market. The foundry sector has shown strong revenue growth for the growing demands for smartphones, PCs, tablets, game consoles, and 5G communication equipment. In addition, the demand for EVs is increasing rapidly. By adopting automation, machine learning, and analytics, foundry companies optimize the production process and increase yield without compromising the quality while lowering the production cost.

[7] DRAMs are one of two main types of memory chips, which is used to store data temporarily.

[8] NAND Flash is another widely used type of memory chip for longer-term data storage.

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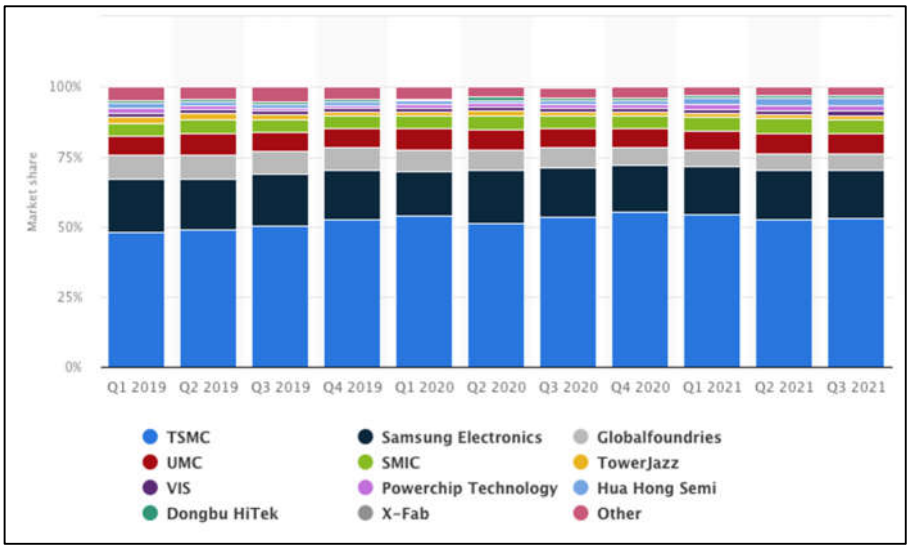

Figure 4. Major global foundry firms' revenue share 2019-2021 (Source: Statista) [54].

Due to the capital and knowledge-intensive nature, there are only a few players in the foundry business in the global market. TSMC takes up the highest share in the global foundry market (around 50% as of Q3 2021). Samsung is the second largest foundry player after TSMC. Global Foundries and UMC, other Taiwanese companies, are the third and fourth largest foundry players. The Chinese firm Semiconductor Manufacturing International Corporation (SMIC) has been growing at a fast pace under the robust support of the Chinese government. The partially state-owned Chinese firm is developing its domestic IC industry and plans to produce chips domestically. However, only two foundry firms, namely TSMC and Samsung,[9] can produce chips using the 5nm process node, which is the most advanced technology available for mass production. The technological advancement of a fab can be roughly measured by the minimum feature size of transistors the fab's production nodes can fabricate. As of April 2021, TSMC and Samsung are competing to commercialize 3nm technology to manufacture chips with increased transistor density, faster data processing speed, and reduced power consumption [55]. It is highly unlikely that the landscape of global foundry business is significantly changed in the next 5 to 10 years unless other foundry firms can catch up with TSMC and Samsung's technologies.

Contrary to South Korea and Taiwan, whose domestic firms concentrate their chip fabrication activity, most Japanese firms left the memory sector and the chip fabrication activity since the semiconductor dispute with the United States in 1987. Despite its decline in the memory market, Japanese companies still hold a strong grip in downstream sectors, such as equipment and materials. The chip fabrication sector relies on specialized material suppliers for both front and back-end steps. Producing highly specialized materials requires large plants, which is a high investment in capital as well. Leading global suppliers of materials spend between 13 to 20 percent of annual revenue on capital expenditure. The front-end materials are usually applied to make wafers, print patterns on wafers, and clean the processed wafers. As Figure 5 shows, Japanese companies, such as Shin-Etsu and Sumco, are leading wafer suppliers to the global market.

[9] Samsung is the only IDM with a substantial foundry business in the global market.

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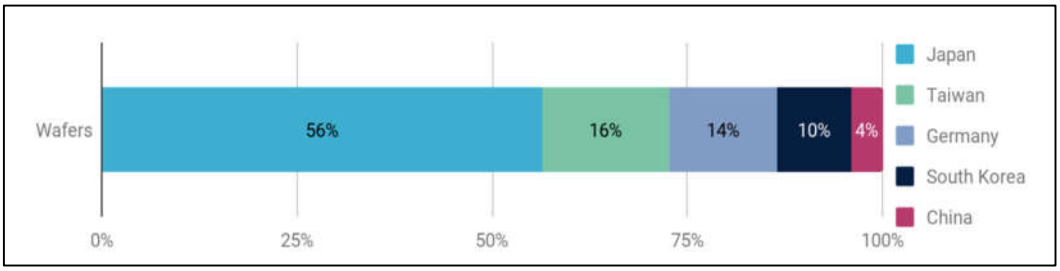

Figure 5. Wafer country share by firm headquarters (Source: Khan et al. 2021) [56] (p. 27).

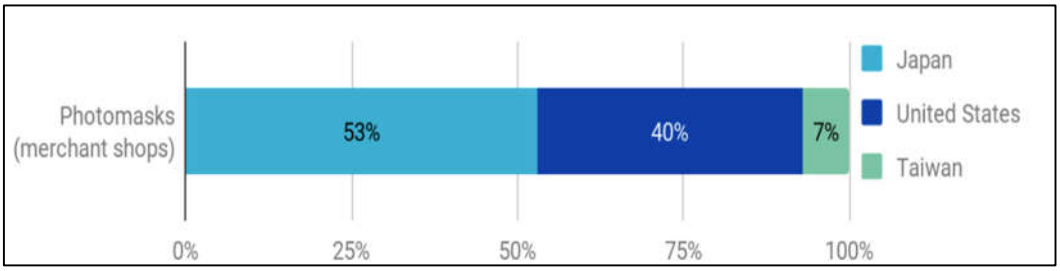

Figure 6. Photomask country share by firm headquarters (Source: Khan et al. 2021) [56] (p. 59).

Photomask is a plate covered with patterns for the lithography process. Mainly Japanese and American firms produce cutting-edge photomasks. The photoresist is a special chemical used for chemical reduction upon exposure to light. Wafers covered with a photoresist layer are imprinted with the patterns contained in the photomask during the lithography process. The Japanese government restricted this material's export to South Korea along with two other materials. From June 2018 to June 2019, South Korea imported 86.8% of photoresist, 42.9% of hydrogen fluoride, and 94.2% of polyimide from Japan. The trade disputed triggered by historical issues resulted in South Korea's withdrawal from the General Security of Military Information Agreement (GSOMIA) in August 2019. The regional security affairs had never put barriers to trade and economic ties in Seoul and Tokyo, but the dispute has shifted such a tendency.

Although the Netherlands' ASML produces the most advanced lithography equipment, key equipment at the front-end step, Japanese companies such as Canon and Nikon also have some shares in high-end scanners and steppers. Another Japanese company, Tokyo Electron (TEL), is a major vendor in the deposition equipment area. Especially spin coating and tube diffusion and deposition equipment are mostly produced by Japanese firms. Etch and clean equipment are mainly produced by American firms such as AMAT and Lam Research and Japanese companies such as Hitachi and TEL. While South Korean and Chinese firms capture little market share, their equipment is not used in the finest features. Also, in the test equipment sector, Japanese companies' market share is distinctive. In the case of systems-on-a-chip test equipment, Japanese firms take around 57% of the global market share.

7. Conclusion

Technonationalism shows that power politics has shifted its pattern of state competition or conflicts from geopolitics to geoeconomics, as "state power" is derived from the control of global markets with the widespread of the GVC than military hardware or control over territories. The zero-sum game-based idea changes the focus of economy and industry from absolute economic gains to relative economic gains determining the strategic position of states vis-à-vis each other. Such a realist view on the international economy urges the securitization of economic policy and the economization of security policy.

Regarding the three criteria of technonationalism framed above, the first criterion (integration of business interests into the state's strategic agenda) is manifested in each Northeast Asian government's policy, in which the state-business relations have

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promoted their technological comparative advantage in the GVC. The features of global commerce in the GVC and their high-tech industrial strategies are a matter of question whether state actors integrate business interests into the geoeconomic state agenda or whether the policy outcomes are results of business manipulation. The second criterion (national security-oriented high-tech strategies) can be seen in especially in the Taiwanese case, Taiwan Semiconductor Manufacturing Company (TSMC) has the global dominance of the most advanced chip fabrication. Against China's aggression, the so-called "Silicon Shield" is to maneuver its national security for Taiwan. The third criterion (a multi-state focus paradigm) can be seen in recent years. Before the US-China tech war was getting intensified, each Northeast Asian government did not plot policy coordination or cooperation in the high-tech sectors. One example is Elpida Memory, a Japanese memory chip maker that filed for bankruptcy in 2013 despite ¥30 billion of the Japanese government's public fund investment. Another case is TSMC's investment in Kumamoto Prefecture, Japan. This case shows regional cooperation in a selective manner between Japan and Taiwan. The case of Kioxia, formerly Toshiba Memory, represents a dual dynamic of competition and cooperation among Northeast Asian countries that the Japanese government engaged in its acquisition deal by the Pangea consortium (a Japan-Korea-American consortium) and cooperation between two Washington's security allies at the corporation level but confrontation at the state level. On the other hand, the Japan-Korea trade dispute over chemical materials for chip fabrication in 2019 signifies the competition involving weaponized interdependence. Those cases explaining the third criterion eventually are concluded the fundamental question for the first and second criteria.

In the liberal economic order with a high degree of interdependence, Northeast Asian states adhere to their technonationalistic drives in the intensifying US-China technology race. Washington's strategy in the Asia-Pacific has shifted to Indo-Pacific by launching the Indo-Pacific Economic Framework for Prosperity (IPEF) in May 2022. Through IPEF, the trilateral cooperation among the United States, Japan, and South Korea will increase their ties against China. Although Taiwan is excluded from IPEF, it is joining Chip 4 Alliance is expected to enhance their cooperation, particularly in the exclusion of China from the GVC of the semiconductor sector. As their cooperation is a key driving factor of the US-China technology war, the multi-state focus on technonationalism is now questioning how to mitigate competition among involved actors.

This review article proposes some areas of further research. The accumulation of those case studies suggests a basis for a more comparative study of the Northeast Asian semiconductor industry's technonationalism before and after intensifying confrontational situation between Washington and Beijing, looking across the state actors' integration of business interests into its strategic agenda within economic statecrafts and geoeconomic context. The strategic aspects of Northeast Asia's technonationalism in the upcoming phase of hegemonic competition should be further explored. The author has noted above that seemingly enhancing strategic leverage via the semiconductor industry in the region can be seen as a rational choice to protect domestic high-tech firms from Beijing's economic aggression (security aggression as well, in the case of Taiwan) and to serve their national security issues from Washington's abandonment.

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