RIETI Policy Discussion Paper Series 25-P-005

Reconsidering Supply Chains and Industrial Policy from the Economic Security Perspective

TODO, Yasuyuki
RIETI

The Research Institute of Economy, Trade and Industry
https://www.rieti.go.jp/en/

RIETI Policy Discussion Paper Series 25-P-005
February 2025

Reconsidering Supply Chains and Industrial Policy from the Economic Security Perspective*

Yasuyuki TODO
Research Institute of Economy, Trade and Industry and Waseda University

Abstract

With the rise of geopolitical risk around the world, there is a growing need to build supply chains that take economic security into account, and as a result, large-scale industrial policies have been implemented in various countries to foster domestic industries. In order to respond to this reality, policy and managerial advice based on international economics are also necessarily changing from the previous focus on free trade and competition. This paper discusses policies for building resilient supply chains and strengthening economic security, based on recent theoretical and empirical research outcomes.

Keywords: supply chain, resilience, economic security, industrial policy, economic coercion
JEL classification: F13, F51

* This study was conducted as a part of the project entitled "Research on Relationships between Economic Networks and National Security" undertaken at the Research Institute of Economy, Trade and Industry (RIETI). The authors thank Mitsuyo Ando, Kyoji Fukao, Shinichi Fukuda, Fukunari Kimura, Eiichi Tomiura, and participants at the RIETI DP seminar for the paper and the Annual Conference of the Japan Society of International Economics for their helpful comments. Yasuyuki Todo is grateful for the financial support of JSPS Kakenhi Grant No. JP23H00823. The opinions expressed and arguments employed in this paper are the sole responsibility of the authors and do not necessarily reflect those of the RIETI, Waseda University, or any institution with which the authors are affiliated.

1. Introduction

In recent years, as the confrontation between the U.S. and China has grown more serious, policies have been implemented to reduce economic ties between Western countries and China and started to affect various business activities. First, Japan, the United States (US), and European countries are strengthening controls on exports to China of advanced products, including semiconductors and equipment for their manufacturing, as well as on inward and outward direct investment and technology transfers to China. China is also imposing various restrictions in response. Second, there is a growing risk of disruptions in global supply chains, especially those with China, for political and security reasons. In response to this risk, onshoring or friend-shoring is underway, whereby essential goods such as electronics and pharmaceuticals, as well as their materials and components, are transferred to the home country or to other friendly countries in order to strengthen supply chain resilience and avoid dependence on China. industrial policies are implemented more actively in countries around the world to attract domestic and foreign investment into their own countries and foster their industries.

Because of this growing difficulty in separating the economic and national security issues in the real world, economists have been interested in "economic security" which integrates the two issues. However, economic security is a new concept and defined differently. For example, Bown (2024) defines economic security as "at a minimum, it involves a country getting the goods and services it needs when it needs them, at a reasonable price." This concept overlaps with national security, which Murphy and Topel (2013) define as as "the set of public policies that protect the safety or welfare of a nation's citizens from substantial threats." In Japan, the Liberal Democratic Party (2020) defines it as "ensuring the independence, survival and prosperity of our country from an economic perspective."

Whichever definition is relied upon, one central issue in economic security is how to respond to the risk of supply chain disruptions due to security-induced policies (e.g., trade restrictions) or conflicts. This is particularly true because firms in pursuit of production efficiency have distributed their production activities across countries, and these networks of firms are intricately interconnected, creating large global supply chains, or international production networks (Baldwin, 2016, Ando and Kimura, 2010).

In order to ensure economic security and strengthen supply chain resilience, governments believe that more policy involvement in business activities is needed than ever before. For example, in Japan, a Cabinet Decision in 2022 states, "With regard to economic security, it is necessary for the government not to rely too much on the market force and competition in the relationship between the public and private sectors and to be more involved in both public supports to and regulations" (Cabinet Office 2022). In conjunction with this, the Economic Security Promotion Act was enacted to provide subsidies to private companies in exchange for requiring them to report on procurement and inventory of critical products. In addition, large

subsidies have been provided to the semiconductor industry. In the US, the CHIPS and Science Act and the Inflation Reduction Act provide subsidies for domestic production and research and development (R&D) of essential products such as semiconductors, renewable energy, and electric vehicles (EV). Europe has also enacted a similar European Chips Act.

Economics is also rapidly responding to these realities. Theoretically, supply chain transactions are viewed as different from market transactions, and necessary policies are being considered based on various market failures. Empirically, the factors that make supply chains resilient and the effectiveness of industrial policies have been analyzed . Based on the results of these recent studies, this paper discusses the policies for building supply chain resilience and ensuring economic security and related industrial policies.

2. Supply Chain Resilience

2.1 Theoretical Studies

First, we would like to highlight some theoretical studies on supply chain resilience. Most of them assume non-market transactions in supply chains, leading to a conclusion that the market equilibrium is not socially optimal.

For example, Acemoglu and Tahbaz-Salehi (2024) analyze the equilibrium in a model that assume non-market transactions between final goods producing firms and suppliers. It is further assumed that creating a supply chain relationship is costly and that the relationship specificity leads to productivity gains, as observed in typical supply chain relationships among Japanese firms, known as *keiretsu* (Aoki, 1988). As a result, in the equilibrium, the relationship between suppliers and final goods firms is constructed at a sub-optimal level, because the benefits from creating supply chain ties are not fully internalized. In other words, the firm pays a cost of creating a supply chain tie, which benefits other firms directly and indirectly connected to the focal firm through supply chains, but the other firms do not return the benefits to the focal firm. Acemoglu and Tahbaz-Salehi (2024) also find that supply chains in the equilibrium shrink as the cost of building supply chain ties increases, but at some point they shrink discontinuously. This result is interpreted as supply chains being vulnerable to changing conditions.

Grossman et al. (2023b) also assume that firms bear costs of creating their supply chains, and prices are determined through negotiations between suppliers and customer firms. In addition, there is a risk of supply chain disruption, but each firm can invest to mitigate that risk and strengthen supply chain resilience. In the equilibrium of their model, the volume of transactions in supply chains is smaller than the socially optimal level because prices are not competitively determined. Also, because firms do not consider the social returns of their own investment for resilience, their investment and the number of suppliers (the degree of diversification) tend to be smaller than at the social optimum. The social optimum further depends on the bargaining power of suppliers and customers.

In another related paper by Capponi et al. (2024), monopolistic suppliers are assumed to invest in productive capacity to prepare for demand and supply shocks. It is predicted that suppliers do not invest in productive capacity to the socially optimal level because the suppliers hold market power after the shock even if they do not increase their productive capacity sufficiently. Also, when a large shock occurs, suppliers cannot supply enough due to lack of investment. That is, as in Acemoglu and Tahbaz-Salehi (2024), supply chains are inefficient and vulnerable in the equilibrium of this model. Capponi et al. (2024) find that subsidies for investment, provision of incentives for ordering in advance, supplier substitutability, and competition can mitigate supply chain inefficiencies and vulnerabilities.

To summarize, many of these theoretical models view transactions between suppliers and customer firms as different from market transactions and assume that creating relationships is costly. Under this assumption, creation of supply chain relationships by each firm benefits the economy as a whole through supply chains, but the benefits are not internalized by each firm, and thus, supply chains are not created at the optimal level. Similarly, firms tend to underinvest to prepare for supply chain disruptions (in reality, enacting Business Continuity Plans [BCPs], developing flexible production technologies, etc.).

In addition, while these papers assume demand and supply shocks, supply chain disruptions related to economic security can also be considered as one such shock. We can conclude that the risk of supply chain disruptions related to economic security is currently increasing, which in turn theoretically requires more extensive policies.

It should be noted, however, that these papers develop their theory as if the risk of supply chain disruption is completely predictable. In reality, the risk of supply chain disruptions, particularly those related to national security, such as politically motivated trade restrictions or reduction of bilateral economic relations due to conflicts, are difficult for private firms to accurately predict. This is in contrast to supply chain disruption risks stemming from natural disasters such as earthquakes and floods, which can be predicted to some extent based on scientific knowledge and past experience.

If it is costly to gather information to predict them while that information spills over to other firms, firms are not willing to pay that cost to obtain the information. In this case, there is a market failure other than the one contemplated in the above studies. Therefore, policy support is also needed for the government to collect such information on security risks and make it available to the private sector. This is similar to how information support to firms for exports can be justified because of search costs (Srhoj et al., 2023) .

Furthermore, with private firms not well informed, the risk of supply chain disruptions may be underestimated due to myopia of managers (Ridge et al., 2014) and status quo bias (Kahneman et al., 1991) . In such cases, there will be a larger difference in supply chain resilience between the socially optimal equilibrium based on correct risk assessment and the market equilibrium achieved under an underestimated risk on top of market failures. Therefore, more

extensive policies may be justified in the current situation where the risk of supply chain disruptions related to national security is rising. These points have not yet been sufficiently formalized in theoretical considerations, and further progress is expected.

2.2 Empirical Studies

There is also thick literature on empirical studies on supply chain resilience. Some studies were stimulated by the 2011 Great East Japan Earthquake (GEJE) that disrupted supply chains connected to the disaster areas and affected production activities not only in other areas of Japan but also overseas, drawing attention to the propagation effect of economic shocks through supply chains.

A seminal econometric paper by Carvalho et al. (2021) using firm-level data analyze shock propagation of the economic shock by the GEJE within Japan, whereas Boehm et al. (2019) examine its propagation to foreign subsidiaries in Japan. Barrot and Sauvagnat (2016) investigate propagation of shocks from various natural disasters in the US. In addition, Kashiwagi et al. (2021) use global supply chain data to analyze the international propagation of shocks from a disaster in the US. These papers confirm that economic shocks propagate through supply chains and that their impact is substantial.

Inoue and Todo (2019) simulate an agent-based model (ABM) using large-scale firm-level data in Japan to reproduce the economic damage due to the GEJE propagating to various regions of Japan. As a result, they estimate that the production loss caused by the GEJE through supply chain disruptions is about 100 times larger than the direct production loss in the affected areas, indicating that the ripple effects through the supply chain are enormous.

In addition, the global pandemic of COVID-19 in 2020-22 caused a reduction in economic activities due to "lockdowns" in various countries and regions, and the impact of this reduction spread to other countries around the world through global supply chains. Many studies have examined this issue (Todo, 2022). For example, a strand of the literature employs computational general equilibrium (CGE) models or ABM-based simulations to estimate the effect of COVID-19 on production (Guan et al., 2020, Inoue and Todo, 2020, McKibbin and Fernando, 2020, Bonadio et al. 2020, McCann and Myers, 2020), while another takes econometric approaches to estimate the effect of the COVID-19 on international trade (Hayakawa and Mukunoki , 2021b, Liu et al., 2021, Hayakawa and Mukunoki, 2021a, Hayakawa and Mukunoki, 2020, Ando and Hayakawa, 2021).

It should be emphasized that many of the above papers also analyze how the propagation of economic shocks through supply chains is amplified or mitigated, finding that substitutability and diversity of supply chain partners are particularly important. For example, Barrot and Sauvagnat (2016) use the definition in Rauch (1999) to show that propagation is larger in industries where input goods are specific, a result also supported in Kashiwagi et al. (2021).

Furthermore, Kashiwagi et al. (2021) find that firms outside the US are not indirectly

affected by the disaster in the US even if they are connected with firms in the affected region. Firms in the US connected with firms in the affected region have a smaller impact if they are connected with overseas firms. This implies that internationalized firms have a wide variety of supply chain partners and can relatively easily find substitutes even if the production of one of their partners is reduced. In addition, according to ABM-based simulations in Inoue and Todo (2019), the more stringent the conditions under which intermediate goods can be substituted, the larger the spillover effect.

Similar results are found in studies on the COVID-19 (Todo, 2022). Ando and Hayakawa (2021) and Todo et al. (2023) both find that sourcing intermediate goods from more diverse countries mitigated the impact of supply chain disruptions during the pandemic period of the COVID-19. These results indicate that diversifying and internationalizing transaction partners and strengthening their substitutability can help build supply chains that are resilient to supply and demand disruptions.

2.3 Empirical Studies on Security-Related Supply Chain Disruptions

Recently, many studies use CGE models and ABMs to estimate the impact of supply chain disruptions, particularly those related to national security, which can be estimated using the same framework as the impact of disruptions caused by natural disasters or COVID-19.

For example, Baqaee et al. (2024) estimated the impact of a trade disruption between the G7 and China on the German economy using a CGE model of multi-country and multi-industry with production networks developed by Baqaee and Farhi (2024). The results show that a sudden disruption would reduce Germany's gross national expenditure (GNE) by 4% in one year, while a gradual disruption over three years would reduce the decline to about 2% by restructuring supply chains. Note that the model in Baqaee and Farhi (2024) has also been used to estimate other economic security cases, such as simulating the impact of Russia's shutting off natural gas supplies to Germany in the wake of the Russian-Ukrainian war (Bachmann et al., 2022, Moll et al., 2023).

Inoue and Todo (2023) simulate the impact of trade disruptions, using an ABM of Inoue and Todo (2019) that focuses on the propagation of shocks through supply chains in Japan. This examination is possible by merging firm-level trade data from the Basic Survey of Business Activities of the Ministry of Economy, Trade and Industry and firm-level supply chain data from Tokyo Shoko Research. The results show that if 80% of imports from China were disrupted for four weeks and two months, Japan's value-added production (GDP) during that period would decrease by about 8% and 40%, respectively. The benchmark simulations in Inoue and Todo (2023) only allow for substitution from existing suppliers in the event of a disruption in the supply of intermediate goods and do not assume supply from new suppliers, including overseas. Furthermore, no substitution of input goods in production is assumed. Therefore, the simulation results of Inoue and Todo (2023) should be viewed as short-term predictions, and medium-term

predictions of two months may overestimate the impact of disruptions. In other words, in reality, the impact will be smaller than this prediction because of substitution of inputs and suppliers in the medium to long term. The easier it is to substitute suppliers, the smaller the impact will be.

Indeed, Inoue and Todo (2023) simulate a model that, in addition to the benchmark model, allows for more flexible substitution of suppliers, demonstrating the importance of substitutability. For example, simply allowing substitution with another supplier indirectly connected in the existing supply chain when supply from one supplier is disrupted can considerably mitigate the impact of the disruption on GDP in the short run.

Furthermore, Moll et al. (2023) analyze the impact of the disruption of natural gas supply disruption from Russia to Germany in 2022, using a mode of Baqaee and Farhi (2024). They show that a small difference in the elasticity of substitution of intermediate goods in their model significantly affect the impact of the disruption. Thereby, they conclude that the reason why the German economy was not significantly affected (German GDP growth in 2022 was close to 2%) despite the actual disruption of natural gas supply from Russia in Germany was largely due to the fact that natural gas imports from Russia could be substituted for imports from the rest of the world.

2.4 Policy implications

These theoretical and empirical studies suggest that input substitution is important for supply chain resilience and that one way to do so is to diversify suppliers in light of the risk of disruption. In particular, supply chain disruptions related to national security often result in supply and demand disruptions at the country level, such as the ban on exports of natural gas to Europe by Russia in 2022 and on rare earths to Japan by China in 2010, and the ban on imports of marine products from Japan by China in 2023. Therefore, to cope with this, it is necessary to diversify procurement and sales partners across countries.

However, there are various initial costs involved in supply chain diversification, such as those of gathering information and building non-market relationships. Eaton et al. (2021) utilize detailed data on exports from Colombia to the US and demonstrate that the search costs of finding suitable sales partners and learning about the market are very high. Although Eaton et al. (2021) analyze the costs associated with exporting, one would expect that the costs of searching for suppliers would be similar. However, even if firms pay such costs to diversify their supply chains, the benefits will spill over to other firms through their supply chains. As a result, supply chain diversification will not reach the socially optimal level (Acemoglu and Tahbaz-Salehi, 2024).

Therefore, policy interventions, such as information and business matching support for supply chain diversification, can be justified. There is also much evidence, albeit with large heterogeneity, that policies, such as information support and subsidies for export promotion,

are effective in practice (Srhoj et al., 2023). It can thus be concluded that the same policy support is effective for their search, whether for suppliers or customers.

Of course, supply chain resilience is not achieved only by diversifying suppliers. The specificity of the non-market relationship between suppliers and customer firms makes it difficult to substitute for partners and creates supply chain vulnerability (Acemoglu and Tahbaz-Salehi, 2024). Therefore, firms should modularize parts and procure them in markets that are not dependent on relationship-specific supply chains, unless the parts are specific and of high quality that can only be developed and produced through long-term relationships with trust, as is the case with Japanese *keiretsu*. In fact, even in supply chains of the Japanese automotive industry, which have been typically characterized by *keiretsu*, modularization of parts and their procurement in markets including overseas markets are increasing recently (Matous and Todo, 2015).

Other supply chain practices suggested to improve resilience include the creation of a database of direct and indirect suppliers by each company, as Toyota Motor Corporation did after the GEJE (Toyota Motor Corporation, 2016; Fujimoto et al., 2016). With the database in hand, in the event of a supply disruption from a supplier, a substitute supplier can be found quickly for resilience. By utilizing this database, Toyota Motor Corporation is said to have been able to reduce the duration of supply chain disruptions due to subsequent disasters, including the COVID-19 (Nikkan Kogyo Shimbun, 2020). It has also been empirically shown that formulating a business continuity plan (BCP) and deciding in advance how to respond to disruptions also contributes to supply chain resilience (Azadegan et al., 2020, Hamaguchi, 2013). These are one example of investments in resilience that are validated in the theory of Grossman et al. (2023b).

In addition, as discussed in Section 2.1, the risk of supply chain disruptions related to national security is often not well known to private firms, which makes the gap between the market equilibrium and the social optimum large. If the risk is clear to firms, they can use the risk information to determine how much to diversify their supply chains, at least to maximize their own long-term profits. Although it may still be unclear how much policy is needed to move from that market equilibrium to the social optimum, the gap between the market equilibrium and the social optimum should be smaller than in a situation where firms are unaware of the national security risks. Therefore, in addition to standard support for internationalization of firms, the government should make efforts to collect information on national security risks and disclose this information to the private sector.

3. Dealing with Economic Coercion

Next, I would like to examine one major issue related to economic security in recent years: economic coercion. Economic coercion refers to a country's attempts to use its own economic

resources, trade, investment, and other economic means to exert pressure on other countries and to influence their policy decisions. For example, China banned the export of rare earths to Japan in 2010 in response to the collision of Chinese fishing boats off the Senkaku Islands; in 2023, it banned the import of marine products from Japan in protest against the release of Advanced Liquid Processing System (ALPS) treated water by Japan. There have been many examples of such economic coercion by China in recent years, such as the restriction of imports of wine, barley, and other products from Australia in 2020 after it requested China to investigate the origin of COVID-19 (OECD, 2024, Zhang, 2024, Adachi et al., 2022) .

Section 2 argued that in the event of a supply chain disruption, the impact can be mitigated by diversifying trading partners in advance to make it easier to substitute suppliers. However, unlike natural disasters, economic coercion is an attempt to restrict trade with a particular country for national security or other political intentions, and is not exogenously determined as assumed in many of the theoretical models of supply chains presented in Section 2. It would be necessary, then, to discuss trade and supply chain structures that are less prone to economic coercion. In this section, as an attempt to do so, I would like to discuss whether the exercise of economic coercion can be curbed by diversifying supply chains.

A strand of literature related to this research question examines whether close trade relations reduce conflict between two countries using country-pair level trade data (Schultz, 2015, Hegre et al., 2010). However, less research has been conducted on the impact of trade relations on the use of economic sanctions or economic coercion between the two countries. In particular, the number of exercises of economic coercion by China has increased rapidly only recently and thus is not sufficient to conduct quantitative empirical analysis (30 cases since 2000 according to Zhang (2024)). Accordingly, existing empirical studies on China's economic coercion are limited to analysis of individual case studies. For example, Adachi et al. (2022) observe that South Korea's Samsung Electronics did not necessarily suffer economic coercion from the Chinese government even when it treated Taiwan and Hong Kong as countries on its website in 2019. From this observation, Adachi et al. (2022) claim that technological sophistication is a major factor that can curb economic coercion. However, this or any other existing study does not consider whether dependence and diversity in supply chains can deter economic coercion.

Therefore, here I will take up three cases of economic coercion by China: the 2010 ban on rare earth exports to Japan, the 2023 ban on seafood imports from Japan, and the 2020 restrictions on wine and barley imports from Australia. Then, I examine what products are more likely to be targeted by economic coercion of China by looking at the trade value of each product and its reliance on China in trade of Australia and Japan.

Table 1 shows, in each of these three cases, the previous year's trade value of the products subject to the trade restrictions, China's share in total trade of the products for Japan or Australia, and the share of Japan or Australis in total trade for China. In addition, Table 1 shows the

corresponding trade values and shares for the first and second largest products in terms of the value in the bilateral trade at the time (at the 4-digit HS code level) for comparison purposes.

First, let us look at Panel (A), the rare earth ban against Japan. China's exports of rare earths to Japan accounted for more than 80% of its bilateral trade value, both for Japan and for China itself. In other words, Japan was highly dependent on Chinese rare earths, but China was also highly dependent on Japan for its sales. Nevertheless, when political issues arose for China, it cut off its large customers.

This is also true for Panel (B), the ban on imports of marine products from Japan. Among fishery products, China was dependent on Japan for 97% of its imports of frozen scallops, a product with particularly large trade value, but even so, it has decided to ban imports. Japan's dependence on China for scallop exports was 56%, which is smaller than the 97%, or China's dependence ratio, but still considerably large. These experiences show that China will target even products on which China itself is heavily dependent for economic coercion in order to achieve its political goals. Furthermore, if the partner country is heavily dependent on China for its trade, the product tends to be targeted for the loss of the partner country.

In particular, rare earth metals seem to have been a target of economic coercion because they are used in the production of ICT (information and communication technologies) equipment as essential material and thus the impact on the Japanese economy as a whole would be significant if their supply were halted. Indeed, simulations by Inoue and Todo (2023) show that the greater the import disruption to upstream products in supply chains, the greater the impact on the domestic economy. This is because when imports to more upstream firms are disrupted, many downstream firms directly and indirectly linked to those firms are also affected.

However, it is also emphasized that China is not indifferent to the loss of profits and consumer welfare due to its own economic coercion. In both cases of rare earth metals and marine products, China has limited the scope of its restrictions to products with relatively small trade values and has not imposed restrictions on electrical and electronic equipment, semiconductors, or semiconductor manufacturing equipment, which have large trade values (while rows in Panels (A) and (B) of Table 1).

The restrictions on China's imports from Australia shown in Panel (C) are similar to those in the Japanese cases. Wine and barley, for which Australia and China depended on each other but have relatively small trade values, were targeted, while iron ore and coal, which have large trade values, were not, despite Australia's heavy dependence on China as an export destination.

China's use of economic coercion with minimal impact on its own country is consistent with the conclusion by Adachi et al. (2022) that China does not use economic coercion against firms with state-of-the-art technology. Also Zhang (2024) reveals that China sometimes explicitly stated that it would use economic coercion against the US, but rarely actually did so. This evidence is another indication that China chooses its targets of economic coercion carefully.

Table 1: Trade Dependence in the Case of Economic Intimidation

(A) Rare earth export ban to Japan in 2010

Products	Trade volume	China's Share of Japanese Imports	Japan's Share of China's Exports
Rare earths(280530)	65 million U.S. dollars	83.5%	88.9%
Rare earth compounds (2846)	89 million U.S. dollars ($330 million)*	58.7% (%) (83.5%)*	32.3% (58.1%)*
Automatic Data Processing Machinery (8471)	7.6 billion U.S. dollars	67.0%	5.7%
Cellular phone (8517)	5.4 billion U.S. dollars	52.3%	3.2%

(B) Marine products import ban from Japan in 2023

list of articles	trade volume	China's Share of Japanese Exports	Japan's Share of Chinese Imports
Marine Products (03)	550 million U.S. dollars	27.9%	2.7%
Frozen Scallops (030722)	350 million U.S. dollars	56.0%	97.4%
Semiconductor Equipment (8486)	9.7 billion U.S. dollars	31.5%	30.9%
Integrated circuits (8542)	7.9 billion dollars	23.3%	4.8%

(C) Import restrictions on wine, barley, coal, etc. from Australia in 2020

list of articles	trade volume	China's Share of Australian Exports	Australia's Share of China's Imports
Wine (2204)	790 million U.S. dollars	38.5%	35.5%
Barley (1003)	410 million U.S. dollars	56.7%	42.4%
Coal (2701)	9.5 billion U.S. dollars	21.5%	49.3%
Iron Ore (2601)	54.9 billion U.S. dollars	82.2%	61.2%

Source: UN Comtrade.

Note: In each case, the value and share of trade in the previous year are shown. Gray cells indicate commodities that were subject to economic intimidation, and the other cells indicate commodities that were the first and second largest in bilateral trade at the time (none of which were subject to economic intimidation). The numbers in parentheses in the commodities indicate the HS code. For rare-earth compounds, figures for the two previous years are shown in parentheses, as the previous year's trade value was extremely lower than the earlier trend.

In conclusion, these cases and considerations suggest that a strategy of diversifying trade partners and reducing dependence on China can to some extent curb the use of economic coercion, but more critical is to become an important trade partner for the partner country in terms of size and technology, not market share. However, this conclusion is based on only three cases and thus needed to examine further.

4. industrial policy

In addition to international diversification of trading partners, another possible way to strengthen supply chains is to bring production sites and suppliers back to the domestic economy. Countries, including Japan, are implementing industrial policies targeting specific industries to bring supply chains for semiconductors and other advanced products into the domestic (or, in the case of Europe, intra-regional) economy as much as possible. This subsection evaluates these industrial policies based on theoretical and empirical findings.

4.1 Theoretical implications

It is theoretically clear that such industrial policies are effective for industrial development under certain conditions. Suppose that an industry has economies of scale, and that the larger the scale of production, the higher the production efficiency and productivity. If that industry in a particular country were not sufficiently large and were to trade freely, it would lose out to imports from other countries due to lack of international competitiveness. As a result, the industry in that country would not survive. In that case, if the government supports that domestic industry and foster it to a certain size by restricting imports, growth in productivity due to increasing returns to scale enables the industry to become internationally competitive and contribute to the country's economic growth (Juhász et al., 2023) .

This logic can be applied to the development of regional economies. It is well recognized that if firms in a specific industry are concentrated in a certain region, information and technology will be locally shared and spread among those firms. Moreover, human resources specific to that industry will be attracted to the region. Accordingly, such agglomeration of firms improves the production efficiency and productivity of that region (Marshall, 1890). Therefore, it is possible to develop specific industries by attracting core firms in a certain region on a certain scale.

It has also been shown theoretically by Grossman et al. (2023a) that a policy of onshoring (relocation of production sites to the domestic economy) may also be effective in strengthening supply chains. Grossman et al. (2023a) showed that when price elasticity increases with prices, policies that discourage diversification of supply chain partners and promote onshoring enhance social welfare because of excessive diversification of supply chains in the market equilibrium.

However, while these conclusions are predicted in theory, they do not always work in

reality. Governments do not always have the ability to select industries with economies of scale appropriately, and political pressure can lead to the policy selection of the wrong industries, firms, or regions, resulting in government failures where policies do not work effectively. It is also possible that policy support may stifle corporate ingenuity and make domestic business activities rather inefficient, resulting in a failure of industry development.

4.2 Results of Empirical Analysis

Empirically, policies that promote specific industries and regions are found not to be always effective. For example, policies to attract large factories in the US are found to have had spillover effects that increased the productivity of firms in the surrounding area (Greenstone et al., 2010) . However, Okubo and Tomiura (2012) demonstrated that the subsidy policies implemented in Japan in the 1980s and 1990s to attract high-tech firms to regional economies, such as Technopolis and Zuno-ricchi, attracted rather low productivity firms and had no effect on technology spillovers and regional development.

One of the reasons for the recent upsurge in industrial policy in the US, Europe, and Japan is the awareness of policy makers that they cannot compete with China without countering its massive subsidies for domestic high-tech industries. In practice, however, industrial policy in China has not always been successful. For example, a study using firm-level data covering large and medium-sized Chinese firms from 1998 to 2007 shows that subsidies to firms were effective in increasing productivity in industries where competition among firms was maintained (Aghion et al., 2015). A more recent study using data on Chinese listed firms from 2007-2018 shows that subsidies are granted to rather less productive firms and have a positive effect on employment but a negative effect on productivity (Branstetter et al., 2022).

More recently, however, there is a growing body of evidence that industrial policies have been effective (Juhász et al., 2023, Lane, 2020) as a result of the use of advanced econometric methods that can more accurately identify causal relationships. For example, Lane (2022) shows through difference-in-differences (DID) estimations that industrial policies targeting the heavy and chemical industry in South Korea in the 1970s significantly increased the output, productivity, and exports of the targeted industries, and that the effects extended to downstream industries through supply chains. Kalouptsidi (2018) demonstrates through structural estimation that China's shipbuilding industry overtook Japan and gained the top share of the global market due to subsidies granted in the late 2000s. Furthermore, Juhász (2018) uses the Napoleonic wars during the period 1803-1815 that disrupted trade with Britain in parts of France as a natural experiment. Juhász (2018) finds that the cotton spinning and weaving industry grew significantly because the trade disruption acted as infant industry protection, increasing the production capacity of cotton spinning and weaving machines. Moreover, this growth is found to have been sustained over the long term.

This stream of empirical research, as well as the political trend to use industrial policy for

supply chain resilience, has led to a reevaluation of industrial policy both in academia and in the policymaking arena. However, such reevaluation should be done with caution. One of the leading papers reassessing the effectiveness of industrial policy, Aiginger and Rodrik (2020), advocates a contemporary conception and practice of industrial policy that establish "a sustained collaboration between the public and private sectors around issues of productivity and social goals," rather than traditional industrial policy characterized by "top-down policymaking, targeting pre-selected sectors, and employing a standard list of subsidies and incentives." Therefore, we need to be careful about the tendency to overvalue industrial policy in the policymaking arena.

Furthermore, it should be noted that many of the new empirical studies that have found the effectiveness of industrial policy deal with historical industrial policies more than a few decades old. According to the endogenous economic growth theory of Young (1991) and Baldwin and Forslid (2000), when knowledge spills over across countries through trade, high productivity growth can be achieved by free trade even in the presence of economies of scale, and hence infant industry protection is not necessary. Because knowledge spillovers from trade have become more active over time, industrial policies that were effective in the past may not necessarily be so today. It will be necessary to interpret new empirical studies of industrial policy while also taking into account such external validity with respect to different periods and conditions.

4.3 Evaluation of Current Japanese Industrial Policy and Challenges

Now, from the above perspectives, I would like to evaluate the Japanese government's ongoing industrial policy toward the semiconductor industry and consider future challenges.

One notable policy is that the Japanese government has lured a production plant of TSMC of Taiwan, the largest and most advanced semiconductor foundry in the world, to Kumamoto of the Kyushu island located in the western part of Japan with a subsidy of 476 billion yen in 2022. This policy differs from previous Japanese regional development policies, such as the Technopolis and Zuno-ricchi policies mentioned above, in the following ways and has the potential to succeed.

First, the attracted firm is a foreign firm with state-of-the-art technology. Empirical literature has found that high technologies of foreign-owned firms often spill over to and improve productivity of domestically-owned firms in many countries, including Japan, the US, and Europe (Todo, 2006, Keller and Yeaple , 2009, Haskel et al., 2007). However, despite of the fact that the amount of foreign direct investment (FDI) inflows to Japan relative to GDP has been the lowest among OECD countries (OECD Data Explorer), policies of Japan have failed to promote FDI with advanced technological capabilities.

Second, the Kyushu region, including Kumamoto, has already been a industrial cluster of the electrical and electronics equipment and automobile industries. Because TSMC's Kumamoto

plant was established in such a clustered area, it has further attracted more new investments of semiconductor-related materials, manufacturing equipment, and user firms in the region (Nihon Keizai Shimbun, 2023). The reason why previous policies such as Technopolis and Zuno-ricchi did not work was that they tried to attract high-productivity firms to regions without such an existing industrial cluster. In this respect, the attraction of TSMC to Kumamoto has been able to make good use of the economies of scale that the region originally possessed. As the agglomeration of firms increases and supply chains develop in Kyushu, it can be expected that the productivity of local firms will increase through technology and knowledge spillovers through the regional supply chains. (Javorcik, 2004, Todo et al., 2016).

Third, the policy of attracting TSMC's plant to Kyushu has been accompanied by another policy to attract its research and development (R&D) center to Tsukuba near Tokyo where R&D centers and universities are clustered. As a result, joint research is being conducted not only between TSMC and Japanese firms and universities, but also with foreign companies such as Intel, IBM, and Samsung, based on the Advanced Semiconductor Manufacturing Technology Consortium at the National Institute of Advanced Industrial Science and Technology (AIST). Empirical studies using firm-level data for various countries show that productivity spillovers from FDI to local firms are particularly large when foreign firms conduct R&D in the host country (Todo, 2006, Todo et al., 2011). It has also been demonstrated that international research collaboration improves firms' innovation capacity through technology and knowledge sharing (Iino et al., 2021). Therefore, the effect of TSMC on Japanese firms through joint R&D in Tsukuba is expected to be significant.

Therefore, I conclude that industrial policy toward TSMC has had a certain effect and appears to be expected to continue to do so in the future. To further increase the effectiveness of the policy, it is suggested to strengthen business and industry-university collaboration through policy measures by establishing regional platforms, and to encourage productivity growth through regional spillovers. In this regard, some lessons can be learnt from the evidence on the "Industrial Cluster Policy" implemented by the Ministry of Economy, Trade and Industry (METI) in the 2000s as a successor to the Technopolis and Zuno-ricchi policies. The Industrial Cluster Policy emphasized the formation of industry-university-government networks, and actively promoted business matching through industry-university joint research and support for business meetings and technology exhibitions, rather than simply attracting firms through subsidies as before. As a result, the industrial cluster policy was implemented in the region. As a result, some empirical studies demonstrate that the policy had a notable effect on sales and technological capabilities of local firms. (Nishimura and Okamuro, 2011b, Nishimura and Okamuro, 2011a). Such evidence-based network support should definitely be provided to the current semiconductor industry.

Another major industrial policy being implemented to promote the semiconductor industry in Japan is the support, including a subsidy of about 1 trillion yen (until FY2024), for

Rapidus, which aims to manufacture next-generation semiconductors of 2nm (nanometer) or smaller. In addition, a new research organization for the development of these next-generation semiconductors, the Leading-Edge Semiconductor Technology Center (LSTC) was established by the government support.

One disadvantage of Lapidus compared with TSMC's Kumamoto plant is that its headquarter and production plant are located in Chitose of Hokkaido, a northern part of Japan, where there is no sufficient agglomeration of both production and R&D facilities. Accordingly, it is not easy for the region to establish an industrial cluster or achieve industrial development in the absence of existing agglomeration.

However, the R&D center, LSTC, is not necessarily based in Chitose and is planned to collaborate with NSTC (National Semiconductor Technology Center) in the US, IBM, IMEC (Interuniversity Microelectronics Centre) in Belgium, and Leti (Laboratoire d'électronique des technologies de l'information) in France, and other leading overseas research institutions and firms. As mentioned earlier, it has been evidenced that international research collaboration improves firms' innovation capabilities (Iino et al., 2021). Therefore, LSTC and Rapidus have a possibility of the development of next-generation semiconductors.

Nevertheless, international research collaboration is not easy. Lin et al. (2023) showed that remote research collaboration is unlikely to generate break-through innovations. Therefore, even in such policy-oriented international research collaboration, it is necessary to devise ways to promote face-to-face joint research by having foreign researchers stay in Japan for long periods of time.

5. Conclusion

In response to the growing interest of business persons and policymakers in economic security, this paper discusses the implications of theoretical and empirical research findings in economics for policies related to economic security, including those on supply chain resilience, economic coercion, and industrial policies. In particular, we emphasized the need for supply chain resilience through diversification and internationalization of partners and the effectiveness of industrial policies.

6. References

Acemoglu D. and Tahbaz-Salehi A. (2024), 'The macroeconomics of supply chain disruptions', Review of Economic Studies, forthcoming.

Adachi A., Brown A. and Zenglein M. J. (2022), 'Fasten Your Seatbelt: How to manage China's economic coercion', MERICS China Monitor, No. M I. f. C. Studies.

Aghion P., Cai J., Dewatripont M., Du L., Harrison A. and Legros P. (2015), 'Industrial policy and competition', American Economic Journal. Macroeconomics, 7,4, 1-32.

Aiginger K. and Rodrik D. (2020), 'Rebirth of industrial policy and an agenda for the twenty-first century', Journal of Industry, Competition and Trade, 20,2, 189-207.

Ando M. and Hayakawa K. (2021), 'Does the import diversity of inputs mitigate the negative impact of COVID-19 on global value chains?', The Journal of International Trade & Economic Development, 31,2, 1-22.

Ando M. and Kimura F. (2010), 'The spatial patterns of production and distribution networks in East Asia', in P.-c. Athukorala (ed.), The Rise of Asia Routledge), 83-110.

Aoki M. (1988), Information, incentives and bargaining in the Japanese economy: a microtheory of the Japanese Economy, (Cambridge University Press, Cambridge). Cambridge).

Azadegan A., Mellat Parast M., Lucianetti L., Nishant R. and Blackhurst J. (2020), 'Supply chain disruptions and business continuity: An empirical assessment', Decision Sciences, 51,1, 38-73.

Bachmann R., Baqaee D., Bayer C., Kuhn M., Löschel A., Moll B., Peichl A., Pittel K. and Schularick M. (2022), 'What if? The economic effects for Germany of a stop of energy imports from Russia', ECONtribute Policy Brief, No. 028.

Baldwin R. (2016), The Great Convergence: Information Technology and the New Globalization, (Harvard University Press, Boston).

Baldwin R. E. and Forslid R. (2000), 'Trade Liberalization and Endogenous Growth A q-theory approach'Journal of International Economics 50, 497-517.

Baqaee D., Hinz J., Moll B., Schularick M., Teti F. A., Wanner J. and Yang S. (2024), 'What if? The effects of a hard decoupling from China on the German economy', in J. Pisani-Ferry, B. Weder di Mauto and J. Zettelmeyer (eds.), Europe's Economic Security, Centre for Economic Policy Research).

Baqaee D. R. and Farhi E. (2024), 'Networks, barriers, and trade', Econometrica, 92,2, 505-41.

Barrot J.-N. and Sauvagnat J. (2016), 'Input Specificity and the Propagation of Idiosyncratic Shocks in Production Networks', The Quarterly Journal of Economics, 131,3, 1543-92.

Boehm C. E., Flaaen A. and Pandalai-Nayar N. (2019), 'Input linkages and the transmission of shocks: firm-level evidence from the 2011 Tōhoku earthquake ', Review of Economics and Statistics, 101,1, 60-75.

Bonadio B., Huo Z., Levchenko A. A. and Pandalai-Nayar N. (2020), 'Global supply chains in the pandemic', National Bureau of Economic Research).

Bown C. P. (2024), 'Trade policy, industrial policy, and the economic security of the European Union', Peterson Institute for International Economics Working Paper, No. 24-2.

Branstetter L., Li G. and Ren M. (2022), 'Picking Winners? Government Subsidies and Firm Productivity in China', NBER Working Paper, No. 30699, National Bureau of Economic Research.

Capponi A., Du C. and Stiglitz J. E. (2024), 'Are supply networks efficiently resilient?', NBER Working Paper, No. 32221, National Bureau of Economic Research.

Carvalho V. M., Nirei M., Saito Y. U. and Tahbaz-Salehi A. (2021), 'Supply chain disruptions: Evidence from the Great East Japan earthquake', Quarterly Journal of Economics, 136,2, 1255-321.

Eaton J., Eslava M., Jinkins D., Krizan C. J. and Tybout J. R. (2021), 'A search and learning model of export dynamics', NBER Working Paper, No. 29100 National Bureau of Economic Research.

Greenstone M., Hornbeck R. and Moretti E. (2010), 'Identifying agglomeration spillovers: evidence from winners and losers of large plant openings',. Journal of Political Economy, 118,3, 536-98.

Grossman G. M., Helpman E. and Lhuillier H. (2023a), 'Supply chain resilience: should policy promote international diversification or reshoring?' Journal of Political Economy, 131,12, 3462-96.

Grossman G. M., Helpman E. and Sabal A. (2023b), 'Resilience in vertical supply chains', NBER Working Paper, No. 31739, National Bureau of Economic Research.

Guan D., Wang D., Hallegatte S., Davis S. J., Huo J., Li S., Bai Y., Lei T., Xue Q. and Coffman D. M. (2020), 'Global supply-chain effects of COVID-19 control measures', Nature Human Behaviour4, 577-87.

Hamaguchi N. (2013), 'Impact of the Great East Japan Earthquake on Local Industries: Synthesis and Analysis from a Survey', RIETI Policy Discussion Paper, No. 13-P-001, Research Institute of Economy, Trade and Industry.

Haskel J. E., Pereira S. C. and Slaughter M. J. (2007), 'Does Inward Foreign Direct Investment Boost the Productivity of Domestic Firms?', Review of Economics and Statistics, 89,3, 482-96.

Hayakawa K. and Mukunoki H. (2020), 'Impacts of covid-19 on international trade: evidence from the first quarter of 2020', IDE Discussion Paper, No. 791, Institute of Developing Economies, JETRO.

Hayakawa K. and Mukunoki H. (2021a), 'The impact of COVID-19 on international trade: Evidence from the first shock', Journal of the Japanese and International Economies, 60, 101135.

Hayakawa K. and Mukunoki H. (2021b), 'Impacts of COVID-19 on global value chains', The Developing Economies, 59,2, 154-77.

Hegre H., Oneal J. R. and Russett B. (2010), 'Trade does promote peace: new simultaneous estimates of the reciprocal effects of trade and conflict', Journal of Peace Research, 47,6, 763-74.

Iino T., Inoue H., Saito Y. U. and Todo Y. (2021), 'How Does the Global Network of Research Collaboration Affect the Quality of Innovation? Economic Review72, 5-48.

Inoue H. and Todo Y. (2019), 'Firm-level propagation of shocks through supply-chain networks', Nature Sustainability2, 841-47.

Inoue H. and Todo Y. (2020), 'The propagation of the economic impact through supply chains: the case of a mega-city lockdown against the spread of COVID-19 ', PLOS ONE, 15,9, e0239251.

Inoue H. and Todo Y. (2023), 'Disruption of international trade and its propagation through firm-level domestic supply chains: A case of Japan', PLOS ONE, 18,11, e0294574.

Javorcik B. S. (2004), 'Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers Through Backward Linkages ', American Economic Review, 94,3, 605-27.

Juhász R. (2018), 'Temporary protection and technology adoption: evidence from the Napoleonic blockade', American Economic Review, 108,11, 3339-76.

Juhász R., Lane N. and Rodrik D. (2023), 'The new economics of industrial policy', Annual Review of Economics, .16

Kahneman D., Knetsch J. L. and Thaler R. H. (1991), 'Anomalies: the endowment effect, loss aversion, and status quo bias', Journal of Economic Perspectives, 5,1, 193-206.

Kalouptsidi M. (2018), 'Detection and impact of industrial subsidies: The case of Chinese shipbuilding', The Review of Economic Studies, 85,2, 1111-58.

Kashiwagi Y., Todo Y. and Matous P. (2021), 'Propagation of economic shocks through global supply chains: Evidence from Hurricane Sandy', Review of International Economics, 29,5, 1186-220.

Keller W. and Yeaple S. (2009), 'Multinational Enterprises, International Trade, and Productivity Growth: Firm-Level Evidence from the United States ', Review of Economics and Statistics, 91,4, 821-31.

Lane N. (2020), 'The new empirics of industrial policy', Journal of Industry, Competition and Trade, 20,2, 209-34.

Lane N. (2022), 'Manufacturing revolutions: Industrial policy and industrialization in South Korea', SSRN Working Paper, No. 3890311, Social Science Research Network.

Lin Y., Frey C. B. and Wu L. (2023), 'Remote collaboration fuses fewer breakthrough ideas', Nature, 623,7989, 987-91.

Liu X., Ornelas E. and Shi H. (2021), 'The Trade Impact of the Covid-19 Pandemic', CESifo

Working Paper, No. 9109, Center of Economic Studies.
Marshall, Alfred. 1890. The Principles of Economics. London: Macmillan.
Matous P. and Todo Y. (2015). "Dissolve the Keiretsu, or Die": A longitudinal study of disintermediation in the Japanese automobile manufacturing supply networks. Discussion Paper, No. 15-E-039.
McCann F. and Myers S. (2020), 'COVID-19 and the transmission of shocks through domestic supply chains', Financial Stability Notes, No. 2020-3, C. B. o. Ireland.
McKibbin W. J. and Fernando R. (2020), 'The global macroeconomic impacts of COVID-19: Seven scenarios', CAMA Working Paper, No. 19/2020, Crawford School of Public Policy, Australian National University.
Moll B., Schularick M. and Zachmann G. (2023), 'The power of substitution: The great German gas debate in retrospect', Brookings Papers on Economic Activity, No. 27, 2023.
Murphy K. M. and Topel R. H. (2013), 'Some basic economics of national security', American Economic Review, 103,3, 508-11.
Nishimura J. and Okamuro H. (2011a), 'R&D productivity and the organization of cluster policy: An empirical evaluation of the Industrial Cluster Project in Japan', Journal of Technology Transfer, 36,2, 117-44.
Nishimura J. and Okamuro H. (2011b), 'Subsidy and networking: The effects of direct and indirect support programs of the cluster policy', Research Policy, 40,5, 714-27.
OECD (2024), 'Trade impacts of economic coercion', OECD Trade Policy Paper, No. 281, Organisation for Economic Co-operation and Development.
Okubo T. and Tomiura E. (2012), 'Industrial relocation policy, productivity and heterogeneous plants: Evidence from Japan', Regional Science and Urban Economics, 42,1, 230-39.
Rauch J. E. (1999), 'Networks versus markets in international trade', Journal of International Economics, 48,1, 7-35.
Schultz K. A. (2015), 'Borders, conflict, and trade', Annual Review of Political Science, 18,1, 125-45.
Srhoj S., Vitezić V. and Wagner J. (2023), 'Export boosting policies and firm performance: review of empirical evidence around the world', Jahrbücher für Nationalökonomie und Statistik, 243,1, 45-92.
Todo Y. (2006), 'Knowledge Spillovers from Foreign Direct Investment in R&D: Evidence from Japanese Firm-Level Data', Journal of Asian Economics, 17,6, 996-1013.
Todo Y., Matous P. and Inoue H. (2016), 'The Strength of Long Ties and the Weakness of Strong Ties: Knowledge Diffusion through Supply Chain Networks', Research Policy, 45,9, 1890-906.
Todo Y., Oikawa K., Ambashi M., Kimura F. and Urata S. (2023), 'Robustness and Resilience of Supply Chains During the COVID-19 Pandemic', World Economy, 46,6. 1843-1872.
Todo Y., Zhang W. and Zhou L.-A. (2011), 'Intra-Industry Knowledge Spillovers from Foreign

Direct Investment in R&D: Evidence from a Chinese Science Park', Review of Development Economics, 15,3, 569-85.

W. Ridge J., Kern D. and A. White M. (2014), 'The influence of managerial myopia on firm strategy', Management Decision, 52,3, 602-23.

Young A. (1991), 'Learning by Doing and the Dynamic Effects of International Trade', Quarterly Journal of Economics, 106,2, 369-405.

Zhang K. V. (2024), 'Just Do It: Explaining the Characteristics and Rationale of Chinese Economic Sanctions', Texas National Security Review, 7,3.

In Japanese

Liberal Democratic Party (2020). "Proposal: Toward the Formulation of an Economic and Security Strategy," Liberal Democratic Party Political Research Committee, New International Order Creation Strategy Headquarters, https://storage2.jimin.jp/pdf/news/policy/201021_1.pdf (viewed September 6, 2024).

Toyota Motor Corporation (2016). Sustainable Management Report 2016. https://www.toyota.co.jp/pages/contents/jpn/investors/library/annual/pdf/2016/smr16_4.pdf (viewed September 6, 2024).

Todo, Y. (2022). The Impact of Covid-19 on the Economy through the Global Supply Chain: A Survey of Studies during the Period of Infection Spread," International Economics, 73, 99-124. International Economics, 73, 99-124.

Cabinet Office (2022). Basic Policy on the Promotion of Security Assurance through Integrated Economic Measures, https://www.cao.go.jp/keizai_anzen_hosho/suishinhou/kihonhoshin.html (viewed September 6, 2024).

Nikkan Kogyo Shimbun (2020). Toyota's persistence in identifying even "Tier 3" issues and the strength of its supply chain that is unfazed by Coronation". Reprinted in Newswitch. https://newswitch.jp/p/23329 (viewed September 6, 2024).

Nihon Keizai Shimbun (2023). "Semiconductor Industry to Concentrate in Kyushu; Tokyo Electron and EBARA Both Invest," October 4, 2023. https://www.nikkei.com/article/DGXZQOUC2219D0S3A920C2000000/ (viewed September 6, 2024).

Fujimoto, T., Kato, K., and Iwao, T. (2016). The Toyota Way of Procurement and Efforts to Strengthen Supply Chain Management - A Record of Postscript by Hiroaki Yoshida, Procurement Planning and TNGA Promotion Department, Procurement Division, Toyota Motor Corporation, MMRC Discussion Paper, No. 487, Monozukuri Management Research Center, The University of Tokyo.