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Containing China versus Choking the Asian Economy

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Abstract

Purpose – Although many existing studies on the US-China hegemonic conflict and decoupling have been published, most of them are qualitative and use descriptive analysis methods. Papers that quantitatively analyzed decoupling mainly estimate the effect of a tariff increase. However, this paper quantitatively analyzed the ripple effect by focusing on decoupling technology spillover between the United States and China. And, for the first time, it was suggested that the blocking of technology spillover could give a fatal blow to the East Asian economy as well as China.

Design/methodology – The United States is pursuing decoupling with China, primarily in goods trade and blocking technology transfer. This paper sets up various scenarios and uses three computational general equilibrium (CGE) models to analyze the overall ripple effects of decoupling. A paper using the three CGE models for decoupling ripple effect analysis has not yet been published.

Findings – Decoupling will hit the economies of regions with close economic ties to China more than others. According to simulation results of this study, the Chinese economy may suffer severe damage that is difficult to recover from, and the economies of Asian countries are predicted to deteriorate to the point of being choked.

Originality/value – Existing papers that assessed the effect of decoupling mostly focus on estimating the effect itself through tariff hikes. This paper is meaningful in that it comprehensively analyzed decoupling by adding the effect of technology spillover blockade. In addition, another meaning can be found in that it quantified for the first time that it will deal a huge blow to the extent of choking the East Asian economy as well as China.

Keywords: China containment, Computational general equilibrium (CGE) model, Decoupling, Technology spillover, Trade war
JEL Classifications: F13, F14, F51

1. Introduction

The United States has been pursuing China containment and decoupling policies through multifaceted means, such as tariffs, more rigorous assessment of investments, and restrictions on exports and exchange of people.[1] The US-China trade war and US decoupling policies have largely reduced foreign investment and technology transfers to China. There is a strong possibility that there will be problems securing the necessary capital and technology essential for China's continuous economic growth. The possibility of a shortage of capital and technology needed to sustain China's economic growth is

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increasing. Decoupling and blocking between the US and China could be a fatal blow to the Asian economy beyond the problems for both countries, since the Asian economy is closely linked with the Chinese economy. US containment of China could suffocate the global economy (Gachúz et al, 2022).

The aggressive US approaches towards China will inevitably have an immense influence on the global value chain (GVC) and the structure of global trade. In the last few years, China has largely expanded its trade with countries in Asia. During this process, numerous multinational companies (MNCs) have relocated their manufacturing to other countries or have been contemplating such a move. However, it is difficult for those MNCs to find a country as suitable as China in terms of GVC conditions (Wall Street Journal, 2022). Thus, the possibility of choking the business environments of high-tech companies is increasing (Hmaidi and Arcesati, 2022).

Although there has been a lot of research on decoupling, most studies carried out a descriptive analysis (Johnson & Gramer, 2020; U.S. Chamber of Commerce, 2021; Bain and Company, 2022), leaving a lack of empirical analysis. Furthermore, those empirical studies on the topic of decoupling have mostly focused on the trade war (Fusacchia, 2020; Cheong & Cho, 2021; Cerdeiro et al., 2021). Among those studies, IMF researchers Cerdeiro et al. (2021) analyzed the impact of technological decoupling using a dynamic macroeconomic model. However, this paper will be the first study to comprehensively estimate the ramifications of decoupling between the US and China using the computational general equilibrium (CGE) model with modified mechanisms. Moreover, apart from the imposition of tariffs, this paper endeavors to assess the potential consequences of diminished investment inflows to China and limitations on technology transfers by using a technology spillover-absorption mechanism integrated within a conventional CGE model.

This study is different from the conventional treatment of trade policies using CGE models. Existing studies try to calculate the impact of decoupling in the manipulation of tariff shocks. As trade between China and the United States shrinks due to reciprocal tariff charges, this negatively affects the economies of South Korea (Korea, in short), Japan, and other East Asian countries that export intermediate goods to China. Instead of this approach, this paper focuses on the significance of technology spill-over as the primary driver of decoupling, as seen recently in the policies of the United States. In this case, the effects of decoupling are likely to happen in the medium to long term, because it involves the adjustment of supply chain due to blocking the technology transfer embedded in intermediate goods. Consequently, the negative effects are expected to intensify. Building upon a series of scenarios for this experiment and a relevant Computational general equilibrium (CGE) model, authors try to figure out the impacts on major countries in the world, focusing on East Asian Countries.

2. Literature Review of the Impact from US-China Decoupling

2.1. Representative studies on decoupling

Per the US Chamber of Commerce (2021), the notion of all-encompassing decoupling being unachievable is acknowledged, yet the materialization of decoupling has transitioned

[1] "…the share of nonimmigrant visas issued by the US to Chinese citizens dropped from 16% in 2018 to 4% in 2021. Student exchange is off sharply too" (Bain and Company, 2022).

from an abstract concept to concrete reality. “The separation of the world’s two largest economies is growing faster, wider, and deeper than predicted” (Bain and Company, 2022). Using the Caliendo & Parro (2015) model, Kim et al. (2019) analyzed how tariff hikes between the US and China would increase the welfare of the US to some extent while the welfare of China would decrease. This is explained by the difference in changes in the terms of trade between the US and China as the tariff war allows the US to pass on some of its tariffs to Chinese exporters. On the other hand, Gao (2022) suggests that if the West (including the US), accelerates China's exclusion from global supply chains, China may establish an alternative value-based organization such as the Cold War-era Conference on Mutual Economic Assistance (COMECON), which would further economically decoupling.

Lim, et al. (2021) used the Value-Added CGE (VA CGE) model of Antimiani et al. (2018) to estimate the impact of US-China decoupling (supply chain exclusion) and the US strengthening of export controls on China in the GVC and value-added distributions (by country) selected in the study. Multiple scenarios were set up and analyzed according to the degree of the US-China trade war and decoupling. Gachúz et al. (2022) suggested that the US-China trade war would provide Latin American commodity exporters with an opportunity to replace exports to China previously handled by the US, while Brazil and Mexico instead of China are expected to enjoy opportunities to expand exports to the United States.

Góes and Bekkers (2022) implemented full decoupling as an iceberg trade cost increase. It has been estimated that if technology decoupling intensifies, welfare in some parts of the world could decrease by up to 12%. In a complete separation scenario, trade between Western and Eastern countries would virtually cease, resulting in a 98% drop in imports and exports.

2.2. Decoupling research methodology on technology spillover

Alvarez et al. (2013) combined the stochastic process of knowledge growth (Kortum, 1997) with the Ricardian trade model (Eaton & Kortum, 2002) to examine the impact of trade liberalization on productivity and technology spillovers beyond the effects of resource reallocation effects. Their theoretical proposition implies that countries excluded from trade would encounter significant and dynamic economic hardships. Halpern and Szeidl (2015) suggested that imported intermediate inputs would play an important role in global value chains and economic growth.

A mechanism was established by Buera and Oberfeld (2020) to illustrate how trade facilitates the dissemination of technology across borders. Domestic innovators can access sources of new ideas through imported intermediate goods. Their study is in line with Alvarez et al. (2013), and in their model, the level of innovation is related to the productivity and spillover speed (parameter) of countries and sectors exporting intermediate goods. Research shows that growth through trade is possible because trade provides a selection effect that brings domestic producers into contact with the most efficient producers. Sforza and Steininger (2020) and Eppinger et al. (2021) used models similar to Alvarez et al. (2013) to estimate the effects of COVID-19 shock and decoupling through technology diffusion. Both of these investigations quantified how the economic toll caused by decoupling has the potential to exceed the losses experienced during the COVID-19 pandemic lockdown.

Bonadio et al. (2021) quantitatively analyzed re-nationalization policy based on the impact propagation model designed by Huo et al. (2020) and labor activity information created by the COVID-19 pandemic. The OECD Inter-Country Input-Output (ICIO) table was used to analyze 64 countries, suggesting that re-nationalization could exacerbate economic losses in a situation where the labor supply contracted due to the COVID-19 pandemic. To achieve this objective, a sequence of calculations was performed. First, they calculated the percentage of GDP contraction due to COVID-19. Second, it was found that 23.3% of the average GDP contraction in 64 countries was caused by overseas shocks, not domestic shocks. And third, they found that GVC participation worsened pandemic-induced labor markets. To figure out these issues, they compared the GDP reduction estimated by a baseline model with GDP reduction due to the pandemic in a world where intermediate goods are only supplied domestically (a re-nationalization scenario). In all cases, it was assumed that re-nationalization of supply chains would result in greater losses.

In the trade model set by Góes and Bekkers (2022), similar to models by Alvarez et al. (2013) and Buera and Obereld (2020), imported intermediate goods were modeled as providing the driving force for technological innovation. The authors characterized the US-China conflict as a split in the global technology system, and examined the adverse consequences of this division by categorizing it into two approaches: complete decoupling and tariff decoupling. In other words, existing studies placed emphasis on the effect of technological innovation, which allows advanced technologies introduced through imported intermediate goods to create new ideas and products through learning effects.

2.3. Evaluation of existing studies and originality of this paper

The US is reducing investment in China through various measures, such as domestic supply chain expansion, reshoring, friend shoring, imposing investment regulations, and strengthening economic security regulations, while also regulating Chinese companies' investments in the US. The ongoing decoupling between the US and China is expected to continue unless there is a change in China's authoritarian political system. In this regard, in the National Security Strategy report published in October 2022, US President Joe Biden mentioned the policy of containment against China, and said the next 10 years would be the time to reshape the world order (White House, 2022).

Considering high inflation pressure and decoupling costs, the US can adjust the decoupling speed. However, as seen in export controls for semiconductors that were triggered in October 2022, complete decoupling for high-tech industries and reduced dependence on China for general-purpose goods are being implemented to avoid China’s weaponization of such dependence.

As existing studies point out, the GVC today is a key means of industrial development and economic growth. Imported intermediate goods go beyond their roles as simple parts of the production, and function to bring technology spillover and innovation. The acceptance of geopolitical risk and decoupling, although difficult to acknowledge, appears to be necessary. However, studies on the comprehensive effects of decoupling have been conducted to an extremely limited extent.

The United States is pursuing decoupling by mobilizing various means and measures. Analysis of the effects of Trump-style tariffs is possible by applying existing analysis methods, but analysis of the effects of investment or technology spillover requires a new approach. Depending on the extent of decoupling and its speed, the effect can be quite different. It is not an easy research topic, but decoupling will change the world economic order as a whole, so various approaches and analyses will be needed.

This study could be distinguished from previous research in two points. Firstly, this study incorporates consideration of capital market closure, where two different closures are analyzed: the Keynesian closure and the neoclassical closure. The former endogenizes capital inflows and exogenizes the real exchange rate, whereas the latter endogenizes investment through savings and the real exchange rate. Previous research by Guha (2011) suggested that estimates generated from Keynesian closures are generally larger than those generated from neoclassical closures. However, it remains to be determined whether these differences in estimates are statistically significant, as noted by Zhou and Chen (2021). Secondly, authors aim to analyze the effects of decoupling on technology spill-over. Taking into consideration that decoupling between the United States and China primarily occurs through restrictions on intermediate goods trade, it is assumed that the reduction in intermediate goods trade also leads to a decrease in the speed of technology diffusion from the United States to China and other Asian countries. To achieve this analysis, authors adapt the Meijl and Tongeren (1999) technology spill-over model into a more up-to-date version that can utilize the current Global Trade Analysis Project (GTAP) database. By using the latest GTAP database, they could analyze the trade dynamics between the United States, China, and other global nations in a more realistic manner.

3. Simulation Models and Decoupling Shocks

3.1. CGE simulation models

A CGE model is a type of economic analysis method that uses real economic data to estimate how the economy will respond to changes in policy, technology, or other external factors. The CGE model consists of equations linking the model variables and a database matching these constructed economic equations. The equations are based on neoclassical economic principles, and the system is structured so that behavioral optimization of economic activity within the model is achieved. Most CGE models assume perfect competition and static conditions, but some allow imperfect competition and economies of scale. Rich documentation on CGE models can be found in Burfisher (2011), Dixon et al. (1992), Dixon and Jorgenson (2013), Hertel (1999), Kehoe and Prescott (1995), Lanz and Rutherford (2016), Reinert and Francois (1997), and Zhou & Chen (2021).

In contrast to the gravity model, CGE models offer various advantages in several areas. However, when focusing on specific research topics, CGE models that rely on the neoclassical general equilibrium theory may face issues of underestimation. As Francois et al. (1996a) pointed out, 2 that is because the various conditions to achieve general equilibrium within the model reduce the ripple effects of policy changes.

Maintaining general equilibrium in estimations increases the consistency of economic theory, but it is common for estimation outcomes derived from the CGE model to underestimate actual economic phenomena observable in the real economy. It should be understood that this is not an error in CGE theory, but an incorrect application of the CGE model. In such cases, CGE researchers need to adjust the closure or add a mechanism that reasonably reflects the shock in the model and estimate the economic results accurately.

3.2. Modeling technology spillover

Meijl and Tongeren (1999) incorporated endogenous international technology spillover

[2] Francois et al. (1996b) analyzed estimates of the impact of the Uruguay Round by several economists, such as Brown et al. (1995), Francois et al. (1995), and Harrison et al. (1995), and concluded that most of the studies underestimated the impact too much. In particular, CGE models based on the general theory of general equilibrium of the neoclassical school had a more serious downward estimation problem.

into the standard GTAP model (Hertel, 1999) in the form of Hicks-neutral technology. The spillover of technology from Country r to Country s through trade depends on the characteristics of the importing country and the characteristics of the technology in question. The former characteristics refer to the ability to absorb knowledge, and the latter refer to the structural similarity of the countries. The former is affected by the intellectual level of human capital, the knowledge infrastructure, innovation capabilities, and other factors, whereas the latter is dependent on the characteristics of the countries and the technology.

Authors can explain how technology spreads through trade using a simple Figure. Imagine a situation where country r has made progress in technology, and another country s is learning from it. In Figure, the vertical line represents the level of technology that spreads, and the horizontal line shows the amount of knowledge traded between the two countries. If they assume that there are no barriers to learning or differences in the countries' industries, then the level of technology that spreads is directly proportional to the amount of knowledge. In this scenario, for example, if the amount of shared knowledge is ${E^0}_{rs}$, then the level of technology transferred is represented by $\gamma(E_{rs})^0$.

$$\gamma(E_{rs}) = E_{rs} \tag{1}$$

However, the ability of the country s' learning the technology to understand and use that knowledge affects how much it benefits. If country s is good at absorbing knowledge, even a small amount of shared knowledge can lead to significant progress in its technology. Authors can show this on the Figure by shifting the curve upward. With a better ability to absorb knowledge (represented by H_{rs}), the curve moves upward, indicating greater progress for country s.

$$\gamma(E_{rs}) = E_{rs}^{1-H_{rs}} \tag{2}$$

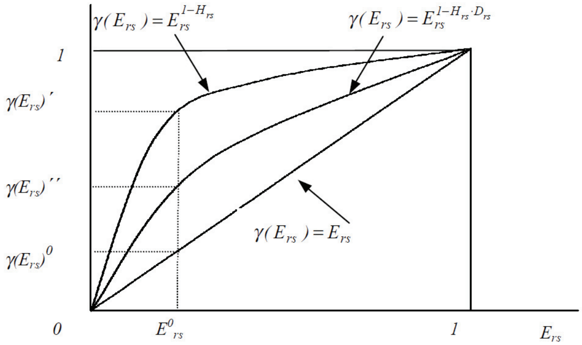
There's also another factor to consider—structural similarity between the countries. Some knowledge created in country r might not be as useful or applicable in country s due to differences in their industries or circumstances. This means that the curve shifts downward, showing that the benefit country s gets from the shared knowledge decreases when there's more structural similarity (represented by D_{rs}).

$$\gamma(E_{rs}) = E_{rs}^{1-H_{rs}D_{rs}} \tag{3}$$

So, in summary, the Fig. 1 helps us understand how technology spreads through trade. The amount of shared knowledge, the ability to absorb it, and the structural similarity between countries all affect how much technology is transferred and its impact on progress in the receiving country.

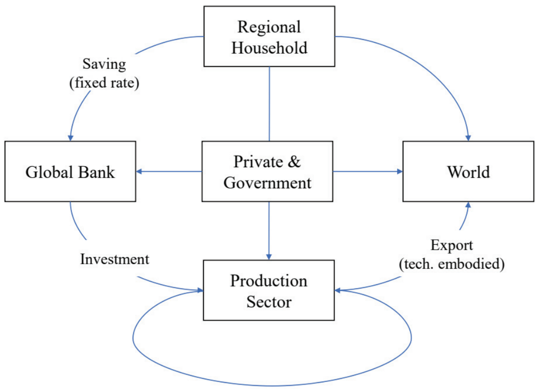
As shown in Fig. 1, Meijl and Tongeren (1999) proposed a method to add to the standard GTAP CGE model a technology spillover-absorption mechanism via trade. Description on detailed equations are not given in this paper for the limitation of pages, but structural equations of standard CGE models can be found in Burfisher (2011). However, their revised GTAP - Spillover model cannot be used as is with the current GTAP database (DB), since the data assembly system has changed in the meantime. Simulations are possible using the current GTAP DB by modifying GTAP - Spillover, especially the sets system and several of the equations. In Fig. 1, the neutralizing technology spillover mechanism in the GTAP - Spillover model converts it to the standard GTAP model.

Fig. 1. The Value of the Spillover Coefficient



Source: Meijl and Tongeren (1999).

Fig. 2. GTAP technology spillover model



Source: Author.

Fig. 2 illustrates the overall flow of the modified GTAP model in this study. Unlike the standard GTAP model, the spillover model in this study differs in two main aspects. Firstly, it assumes a fixed savings rate, and secondly, it applies country-specific technology spillover values in exports. In particular, by endogenizing the technology variable, the level of cross-country technology transfer inherent in trade between China and East Asia is disconnected from external effects, ultimately highlighting the decoupling effect.

3.3. Data and designing decoupling shocks

A balanced database is a prerequisite for the CGE model, and the present investigation utilizes GTAP version 10, with details on regional and industrial classifications featured in Table 1. The global economy is categorized into seven regions, with each region's economy segmented into 10 industrial sectors. Because the Asian regional economy is closely linked to China, this study subdivides Asia into Japan, Korea, and other Asian countries (OAsia) in addition to China.

Table 1. Classification of Regions and Industries

Regions		Industries	
Classification	**Explanation**	**Classification**	**Explanation**
US	United States	Agriculture	Agriculture, forestry, fishery
ChinaHK	China + Hong Kong	PFood	Processed food
Korea	Korea	RSect	Resource
Japan	Japan	Chem	Petro-chemicals
OAsia	Other Asian countries	Metal	Metal, steel
Europe	27 EU members	ElEquip	Electric, electrical sectors
ROW	Rest of the world	MaEqp	Machine, equipment
		TrnsEq	Transportation
		OtherMfg	Other manufacturing
		Svc	Services

Alvarez et al. (2013), Buera and Obereld (2020), and Góes and Bekkers (2022) emphasized the technological innovation effect of imported intermediate goods in the analysis of the decoupling effect. Antràs and Chor (2018) separated the role of GVCs in delivering shocks by distinguishing trade costs for intermediate inputs and final goods. The impact of external shocks on the economy is greatly influenced by the degree of labor mobility. Lagakos and Waugh (2013) developed a model that considers imperfect mobility of labor between sectors, accounting for instances where reallocation between sectors may not be seamless. This approach enables a more advanced examination of the effects of various shocks.

Economic models based on the traditional neoclassical trade theory have a problem in that they downwardly estimate the ripple effects of shocks. The shock to the CGE model can take several forms. In many trade models, a shock is a change in an exogenous tariff variable. However, shocks to the model can be applied in various ways, such as productivity, behavioral patterns, labor, and capital stock, and the shocks must be closely linked to the model's closure.

Productivity shock is a method widely used in policy research. In general, total factor productivity describes the effect of increases in combined inputs (labor, capital, and land inputs) on total output. (Dixon et al., 2011). It measures the efficiency of resource use under a given technology. Productivity shocks can also be embodied as shocks to production itself rather than value-added or final demand (Chen et al., 2018; Koike et al., 2015). CGE researchers regard productivity shocks as TFP shocks (Zhou & Chen, 2021).

Behavioral shock is a change in the behavior of economic actors in the model, such as households, firms, and governments. Behavioral shock can be driven with policy changes, changes in the condition of sectoral production such as natural disaster, changes in aggregate demand, and others. Here one of modeling issues is how to design those shocks in the model. CGE modelers often use the model closure method. The closure starts from the fact that simultaneous equations can be solved only when the number of endogenous variables is equal to the number of equations in the CGE model. In estimations using the CGE model, short-term closure and long-term closure lead to different behavioral effects (Prager et al. 2017).

Nicita, Olarreaga, and Silva (2018) increased inter-bloc tariffs by an average of 32 percentage points to simulate decoupling in their model. Sforza and Steininger (2020) estimated the COVID-19 impact in a less integrated global scenario by increasing the cost of trade for each country and sector by 100 percentage points. Eppinger et al. (2021) modeled the COVID-19 impact as decoupling between countries, and they gradually increased trade barriers for intermediate goods between all countries by 10%, 50%, 100%, and 200% to analyze the effect of mitigating COVID-19 in this situation. Góes and Bekkers (2022) implemented decoupling in their model by increasing the iceberg trade costs to 160 percentage points. Assuming full separation and tariff separation, Nicita et al. (2018) estimated the impact of decoupling on a bloc-by-bloc, whole-industry, and specific-industry basis.

3.4. Analysis scenarios

Decoupling can be analyzed through the use of iceberg-style trade barriers and Trump-style tariff hikes, and can be categorized as complete blocking or strategic (partial) decoupling, as noted in previous studies. Given the multitude of possible scenarios, researchers are required to consider multiple scenarios while referring to existing studies like those by the IMF and others. The impact of decoupling between the US and China will result in reduced trade, investment, and technology transfers between the blocs.

In this paper, long-term effects are estimated through manipulation of model closures, while short-term effects could be estimated immediately. Unlike the impact on trade, for which there are few previous studies, it is not easy to set scenarios for investment and technology. As previously mentioned, this paper aims to comprehensively estimate the ripple effects of decoupling between the US and China. Given the complexity of the issue, it is necessary to make assumptions based on optimal judgments in order to estimate the impact. Since the simulation model and research methodology have already been established, other scenarios that better reflect geo-economic realities can be used for further estimation.

Table 2. Summary of Simulation Scenarios

Shocks on trade (a)		GTAP Models (b)		Spillovers (c)	Total
Tariff rates	Three scenarios: 25% 50% 100%	GTAP Models	Two models: Standard model Inefficiency model (Fixed saving)	Two scenarios: -10% -20%	a * b * c Scenarios Combination

For our paper, authors conducted 18 simulations using two sets of scenarios, including three tariff scenarios, two technology spillovers scenarios, using three CGE simulation models: a standard model, a model with inefficiency, and a technology spillover model. Previous studies such as Góes and Bekkers (2022) estimated the decoupling effect by imposing tariffs only between the US and China. The CGE models in our study incorporate tariff imposition across three scenarios: 25%, 50%, and 100%. When decoupling is realized, cross-border investment will decrease and capital movement will be constrained. This will result in various economic losses, such as lowering the rate of return on capital. In the standard CGE model, households calculate the utility between current consumption and future consumption to determine the optimal savings rate, and the model is set up so the rate of return on investment is the same worldwide as capital moves according to the rate of return on investment by industry and country. Fixed savings closure overrides these optimal economic activities and is expected to occur in decoupling situations. Determining how much the technology spillover through trade will be reduced is a difficult matter and is beyond the scope of this study. Authors set up a scenario for this. For convenience, the reduction in technology spillover through trade was also set at -10% and -20% with a rigorous assessment for the spilldelta(s,r) parameter.3

4. Simulation results and interpretations

4.1. Decoupling and inefficiency

Simulation results are in Table 3. First, as in previous studies, the results of estimating the impact of decoupling on China from tariff impositions are presented on the left side of Table 3. These are estimated using a standard GTAP CGE model. The right side of Table 3 is a set of estimates using a CGE model with inefficiency closure to capture the impact of tariffs and the occurrence of inefficiencies in the world economy. As described above, three levels of decoupling based on tariff rates were set (25%, 50%, and 100%). Excluding China from the global economy would result in numerous losses for that country. With the worsening prospects of global economic growth, there is the likelihood of a decline in cross-border investment and domestic investment, which could result in a reduction in returns on capital worldwide. As previously discussed, it is challenging to model this issue within a static CGE model. Therefore, in this study, authors use the capital stock (fixed savings) of each region as a closure to address this limitation. The ripple effect estimated by applying fixed savings closure under the assumption of three tariff increases was found to be much larger than the value estimated by a standard CGE model.

Table 3. Simulation Results: Decoupling and Inefficiency

	Standard CGE model			Inefficiency closure		
	25%	**50%**	**100%**	**25%**	**50%**	**100%**
US	-0.14	-0.29	-0.37	-0.38	-0.91	-1.47
ChinaHK	-4.18	-7.01	-9.01	-9.71	-14.83	-18.84
Korea	-0.75	-1.28	-1.52	-3.01	-5.21	-7.10
Japan	-0.33	-0.60	-0.73	-1.80	-3.70	-5.65
OAsia	-0.62	-1.19	-1.47	-3.34	-5.99	-8.34
Europe	-0.18	-0.33	-0.40	-0.64	-1.92	-3.44
ROW	-0.24	-0.46	-0.57	-1.71	-3.36	-5.02

Estimating from a standard CGE model, if decoupling becomes a reality, the impact will be concentrated on China, but other countries will also suffer significant damage. If decoupling is viewed simply as a reduction or suspension of trade in goods, the impact will depend primarily on the share of trade with China in total trade volume. For China, the GDP loss is estimated at -4.18% when a 25% tariff is applied, but if the tariff is raised to 100%, the damage is expected to increase to -9.01%. East Asian countries with deep economic ties to China are

[3] For this study, spilldelta(s,r) can be calculated with information on the capacity of foreign technology absorption by country (Hrs) and the similarity of countries (Drs), Although there is a study on a specific country, studies that match the CGE model used in this study have not yet been done.

expected to suffer greater losses than other regions.

One can logically infer that Korea, being one of the countries with the deepest supply chain links to China, is expected to experience greater losses compared to other countries. OAsia, which includes the ASEAN countries, India, and Taiwan, is also expected to suffer significant losses, but less than Korea. Japan, which has pursued the China+1 policy since the physical conflict over the Senkaku Islands in 2010, is expected to suffer much less damage from decoupling than other Asian countries. This is because China's share of Japan's total trade has decreased. GDP in the US, Europe, and ROW is also expected to decline, but the decline is expected to be smaller than in Asian countries.

Economic inefficiency due to decoupling is expected to have a far greater ripple effect than trade contraction (or suspension). For China, the maximum impact of the inefficiency was found to be roughly double that of a trade contraction in goods (-9.01 → -18.84), but losses to the ROW could be up to 8.8 times greater than losses under trade suspension. When the decoupling level is set with a 100% tariff, the ROW GDP loss due to trade suspension is 0.57%, but becomes -5.02% in the inefficiency model. Korea's loss would be -3.01% to 7.1% depending on the scenario. Under the trade contraction scenario, OAsia was shown to have a smaller loss than Korea, but is expected to suffer a rather large loss under the inefficiency model. The interpretation is that these results are derived because OAsia is absorbing more foreign direct investment than Korea.

4.2. Technology Spillover Effects

A simulation employing a standard CGE model tends to converge to a new equilibrium even when subjected to a tariff shock of up to 100%. The accuracy of simulation estimates is also highly evaluated. However, if a high tariff shock and a technology spillover shock are simultaneously applied to the technology CGE model, the simulation process becomes unstable and the CGE model sometimes fails to reach a new equilibrium. Due to these technical difficulties, tables 4 and 5 were prepared for this paper by adding the estimated values of the effects of technology spillover shock for each scenario separate from the estimated values in Table 3.

Assuming a technology spillover loss of 10%, depending on the level of decoupling and closure, China's GDP loss will go up to -20.27%, and other regions around the world are also expected to experience significant GDP declines. China is expected to experience the most significant loss from decoupling, which is not surprising given its current situation. In equilibrium, countries that enjoyed economic growth benefits from trade with China, which has a high technology-acquisition capacity, will experience GDP losses as these benefits diminish after decoupling. This can be seen from the fact that the absolute value of an estimate presented in Table 4 is larger than in Table 3.

Table 4 presents estimates that are structurally similar to those in Table 3, but with a notable difference in the impact on OAsia. The standard CGE model in Table 3 (left side) estimated Korea to have the second-greatest loss after China; in Table 4, OAsia is estimated to have the largest loss. This implies that OAsia may experience the greatest loss in technology spillovers resulting from decoupling, because intermediate goods imported from China have a greater impact on production activities and value-added creation in OAsia (i.e., a backward linkage effect) compared to other regions. In contrast, Korea, the US, and Europe primarily suffer losses from the forward linkage effect, given their positions as technology product exporters to China. The forward linkage effect is expected to be relatively moderate.

Table 4. Simulation Results: 10% Spillover Losses

	Standard CGE model			Inefficiency closure		
	25%	50%	100%	25%	50%	100%
US	-0.79	-0.94	-1.02	-1.03	-1.56	-2.12
ChinaHK	-5.61	-8.44	-10.44	-11.14	-16.26	-20.27
Korea	-0.94	-1.47	-1.71	-3.20	-5.40	-7.29
Japan	-0.46	-0.73	-0.86	-1.93	-3.83	-5.78
OAsia	-1.17	-1.74	-2.02	-3.89	-6.54	-8.89
Europe	-0.34	-0.49	-0.56	-0.8	-2.08	-3.60
ROW	-0.47	-0.69	-0.80	-1.94	-3.59	-5.25

The present study predicts that a 20% increase in technology spillover shock would lead to GDP losses across all the regions considered, with the magnitude of the impact varying in each region. Comparing the estimates in Table 5 with those in Table 4, the increase in losses for China is expected to be relatively large, while losses in other regions are expected to increase moderately. As seen in Table 4, the loss increase for OAsia was found to be high. Based on the technology CGE model, it is estimated that OAsia's loss resulting from the spillover scenario would range between 36% and 44% of China's loss. This is possibly the reason India and the ASEAN countries were reluctant to participate in the Indo-Pacific Economic Framework (IPEF), which the US is promoting for the purpose of containing China. Even now, these countries are demanding that the IPEF not have anti-China elements.

Table 5. Simulation Results: 20% Spillover Losses

	Standard CGE model			Inefficiency closure		
	25%	50%	100%	25%	50%	100%
US	-1.48	-1.63	-1.71	-1.72	-2.25	-2.81
ChinaHK	-7.21	-10.04	-12.04	-12.74	-17.86	-21.87
Korea	-1.21	-1.74	-1.98	-3.47	-5.67	-7.56
Japan	-0.63	-0.90	-1.03	-2.10	-4.00	-5.95
OAsia	-1.93	-2.50	-2.78	-4.65	-7.30	-9.65
Europe	-0.53	-0.68	-0.75	-0.99	-2.27	-3.79
ROW	-0.74	-0.96	-1.07	-2.21	-3.86	-5.52

In the CGE model with inefficiency closure and if the level of decoupling is high and technology spillover is serious, China's GDP decrease might be -22%. These GDP shocks that the CGE model estimates do not occur in one year only; decoupling will proceed over several years, and the model used in this study calculates long-term simulation results. The estimated effect represents the difference between equilibrium before decoupling and equilibrium after decoupling (that is, the steady state difference), and the impact over a period of several years is calculated as a cumulative value. Due to the nature of a static CGE model, it is difficult to be certain how many years it will take to move from the previous equilibrium to the new equilibrium, and this is expressed as a long-term period in economics.

5. Conclusions

The US-China hegemonic competition and decoupling are likely to continue. In the US midterm elections in November 2022, the Republican Party won a majority in the House of Representatives, but shares a position similar to President Biden when it comes to the US policy on China. Republican Kevin McCarthy, who took office as Speaker of the House, launched the Select Committee on the Chinese Communist Party. In 2022, the Biden administration excluded China from the supply chain for semiconductors, electric vehicles, and batteries by enacting domestic laws. In February 2023, the United States stipulated the use of American-made building materials in infrastructure projects conducted under the Infrastructure Investment and Jobs Act. Although these regulations are based on the so-called America First initiative, these laws and regulations are largely related to China's containment. In the future, the US will expand the scope of application to other items.

It is difficult to predict at what level and on what schedule decoupling will be promoted, but according to this study, it is estimated that the Chinese economy will deteriorate to an irreversible situation, and the entire world economy will be negatively affected. In the event of a worst-case scenario, the economies of OAsia, Korea, and Japan are anticipated to suffer a significant blow, potentially leading to the collapse of Factory Asia, which was established around China. Through decoupling, the US wants to defend against China's challenge for hegemony, but the economies of Asian countries will deteriorate to the point of being choked.

According to this study that analyzed the ripple effects of decoupling using the CGE model, Korea and Japan are the countries that could suffer the most damage from the US policy against China. Japan is closely linked with Korea's high-tech industry and procurement of advanced materials (intermediate goods). The two countries share common interests in decoupling. Through mutual cross-visit summits in the first half of 2023, the two countries normalized relations between the two countries getting out of the worst relationship of years. The Indo-Pacific Strategy announced by the Korean Ministry of Foreign Affairs in December 2022 only presented a general position on the relations with Japan and did not mention specific details of cooperation about the US policy. The two countries should work together to initiate trade and diplomatic efforts to ease America's unilateralist policy in order to avoid the damage from the United States' policy.

Moreover, at the G7 summit held in Hiroshima, Japan last May, de-risking was adopted instead of decoupling as the policy stance toward China. The United States has decided to pursue a 'High Fence, Small Yard' policy that focuses regulation on China only in certain sectors, such as high-end semiconductors, that are directly related to the competition for hegemony between the United States and China, and relaxes regulations for other products. Based on the simulation results of this paper, de-risking is good for the parties and the global economy. Korea must seek industrial and trade policies appropriate for the de-risking era. Korea must participate in the U.S.-led alliance, but must not unnecessarily provoke China. The relationship between the two countries will need to be managed to facilitate smooth trade of items and products not regulated by the United States. Lastly, the Hiroshima G7 Summit promised to contribute to the normalization of the World Trade Organization (WTO) multilateral trade system. Broadly speaking, de-risking policy could mean normalizing the WTO. Korea, one of the biggest beneficiaries of the multilateral trade system, should make efforts to normalize the WTO in order to minimize the losses from decoupling/de-risking.

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