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Impact of Technological Decoupling between the United States and China on Trade and Welfare[1]

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Abstract

We quantify the impact of trade and technology transfer restrictions between the United States (US) and China, technology protection policies in China, and export control laws in both countries through the US-China technological decoupling. To achieve this, we develop a dynamic quantitative general equilibrium trade model that considers foreign direct investment involving technology transfer. Our model comprises the final and intermediate goods sectors and assumes that only the latter utilizes technology capital. Our counterfactual analysis is based on data from 89 countries in 2016. We find that the US, China, and the world as a whole experience welfare losses owing to the US-China decoupling. We further observe that China's technology protection policy affects not only countries with significant technology transfers from China but also those that rely heavily on technology capital. Countries with larger import shares from the US and China experience more substantial declines in the import of intermediate goods owing to the US and Chinese export control laws.

Keywords: technological decoupling; foreign direct investment; quantitative trade model
JEL classification: F13; F21; O34; O38

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1 Introduction

In the late 2010s, the United States (US) and China initiated a process of decoupling within global supply chains for political and security considerations, not only between themselves but also with other countries. This phenomenon is commonly referred to as the "US–China decoupling." One of the prominent issues associated with this decoupling pertains to the safeguarding of their respective technological assets to prevent their unauthorized dissemination to foreign entities, a matter known as "technological decoupling."

Within the context of decoupling, export control laws assume a pivotal role in both the US and China. In the US, the Export Control Reform Act (ECRA) was enacted in 2018 to regulate the export of technologies that possessed dual-use characteristics, that is, those applicable for both civilian and military purposes, thus raising security concerns. ECRA primarily focuses on technologies within high-tech industries, including artificial intelligence and quantum information technology. Similarly, China imposes restrictions on the export of such technologies through the Foreign Trade Law and Export Control Law. China has also introduced a set of rigorous technology protection policies, notably, the Cyber Security Law and the Data Security Law. These policies are specifically designed to curb the extrication of data from the country by firms operating within China, thereby preventing technology leakage.

These legislations in both the US and China have not only curtailed technology transfer between the two countries but also cast a ripple effect on many other countries. This study aims to investigate the impact of the technological decoupling process between the US and China, coupled with the technology protection policies implemented in both countries, on exports within sectors subject to export control laws, technology transfers, and the welfare of the US, China, and other countries.

To quantify the impact on technology transfers, we use a model constructed based on the dynamic quantitative general equilibrium model of international trade developed by Anderson et al. (2019). The model developed by Anderson et al. (2019) accounts for foreign direct investment (FDI) in the form of technology and intellectual property transfers, allowing for a comprehensive analysis of technology transfer restrictions. While the model presented by Anderson et al. (2019) is well-suited for analyzing technology transfer restrictions, it cannot assess the ramifications of policies targeting specific industries, such as the export control laws in the US and China, owing to its single-sector nature. To overcome this limitation, we extend the Anderson et al. (2019) model by introducing a segmentation of goods into the final and intermediate categories, with technology confined to the intermediate goods sector, while the final goods sector procures intermediate goods. This approach is based on the assumption that only the intermediate goods sector utilizes technology capital, aligning with the characteristics of high-tech industries often situated in the intermediate goods sector, as exemplified by the semiconductor industry, which frequently falls within the purview of export control laws.

Employing this modified model, we conduct a counterfactual analysis to quantify the impact of trade and technology transfer restrictions between the US and China, technology protection policies within China, and the export control laws in both countries. We update the dataset used in Anderson et al. (2019), which covers the data on trade, FDI, and other variables for 89 countries from 2011 to 2016.

Our findings indicate that the US, China, and the world as a whole incur welfare losses when bilateral decoupling between the US and China, accompanied by related policies, curtails both trade and technology transfer in the target sectors. Moreover, China's technology protection policy affects not only countries with substantial inward technology transfers from China but also those that rely heavily on technology capital in their production. Finally, countries with greater import shares from the US and China experience more pronounced reductions in their imports owing to the export control laws of both countries. However, it is important to note that these declines in the imports of intermediate goods do not necessarily lead to welfare losses.

Focusing on the impact of the US–China technological decoupling on Japan, we find that Japan may not necessarily lose from the decoupling. In most counterfactual scenarios, Japan's welfare improves slightly, although the imports of intermediate goods in the target sectors are likely to decline. This is because, as the share of inward FDI from China is relatively small in Japan and the technology capital intensity in production is low, the impact of China's technology protection policy on Japan is small. Moreover, although Japan's imports have decreased due to the export control law in China, welfare is still slightly improved because the increase in the domestic production of intermediate goods compensates for the decline in imports.

This study is closely related to the literature on geopolitical fragmentation. Kumagai et al. (2023) analyze the impact of trade decoupling, arising from the US–China trade war and the war between Russia and Ukraine, between the Chinese-Russian (Eastern), Western, and neutral blocs. They use a multi-region and multi-industry computable general equilibrium (CGE) model and find that the decoupling of Russia does not significantly impact the global economy in almost all industries, while it will be stronger if China joins the Russian bloc.

Campos et al. (2023), similar to Kumagai et al. (2023), quantify the impact of decoupling between the Eastern and Western blocs. They use a new measure of aggregate trade restrictions (MATR) by country and estimate how well MATR works as a measure of trade costs using a structural gravity estimation technique. In their counterfactual analysis, they use these estimates to calibrate the rate of increase in trade costs when decoupling occurs between the Eastern and Western blocs and show that trade flows are reduced by 22–57% between these blocs. This study complements Kumagai et al. (2023) and Campos et al. (2023) by considering technology transfer, which is an important issue in decoupling.

Some studies also consider technological decoupling in this field. Garcia-Macia and Goyal (2020) analyze the conditions under which a country can strategically restrict imports or exports in high-tech industries. They construct a two-country dynamic general-equilibrium model of international trade wherein the exports of high-tech industries facilitate the transfer of technology from the exporting to the importing countries through learning, while also increasing the risk of disruptive cyberattacks and hindering production in the importing country. Garcia-Macia and Goyal (2020) conduct a numerical analysis and demonstrate that the restriction of not only imports but also exports can be optimal for each country because it can prevent technology diffusion to opposing countries. However, they also show that the optimal choice for the global economy is not strict restriction but rather cooperation between both countries.

Cerdeiro et al. (2021) employ a multi-country dynamic general equilibrium model to analyze three channels through which decoupling affects the global economy: the reduction in global trade volumes, sectoral misallocation, and diminished knowledge diffusion. They also consider coalitions of countries that initiate the decoupling and find that such coalitions tend to lose in most cases.

Nevertheless, the models in these studies are unable to capture technology and knowledge flows across countries and, therefore, cannot thoroughly analyze the restriction of technology transfer resulting from the US–China decoupling. This study contributes to the literature by constructing a model based on the dynamic quantitative general equilibrium model of trade developed by Anderson et al. (2019) and addressing this limitation.

Furthermore, the structure of our model is relatively simple, unlike large-scale CGE models, as used by Cerdeiro et al. (2021) and Kumagai et al. (2023). Our model enables us to track down the causes of counterfactual results by incorporating only the settings necessary for the analysis.

Similar to this study, Góes and Bekkers (2022) construct a model that explicitly considers technology transfer. Góes and Bekkers (2022) analyze the impact of decoupling between the East and West camps using a dynamic general equilibrium model of trade that accounts for knowledge diffusion among countries. In the model, it is assumed that technology diffuses from foreign countries to the home country through the import of intermediate goods, giving domestic inventors access to new sources of ideas. Using this model, Góes and Bekkers (2022) quantify the impact of rising trade costs between the East and West camps. They show that the welfare losses of the global economy are drastic, as large as 12%, while they would be small when they exclude the assumption of knowledge diffusion.

This study differs from Góes and Bekkers (2022) in that our model can analyze not only export control but also the technology protection policy. Our model introduces an exogenous parameter that controls the openness of technology transfer, which enables us to quantify the impacts of policies that target technology transfer itself rather than trade in the counterfactual analysis. Therefore, this study can cover a broader range of policies vis-à-vis the decoupling issue.

The remainder of this paper proceeds as follows: Section 2 provides an overview of the technology protection policies implemented in the US and China. Section 3 delineates the theoretical model, which is an extension of that presented by Anderson et al. (2019). In Section 4, we elucidate the methods used for calibrating the model parameters and detail the data sources employed. Section 5 presents a counterfactual analysis to assess the impact of technological decoupling between the US and China, the export control laws in both countries, and the technology protection policies in China. Finally, Section 6 presents the concluding remarks of the paper.

2 Technological decoupling between the United States and China

Through the US–China decoupling process, both countries safeguard their technology to prevent its unauthorized transfer to other countries by implementing technology protection policies and export control laws.

In the US, ECRA was enacted in 2018 with the primary objective of regulating the export of technologies suitable for both civilian and military applications, commonly referred to as dual-use goods. However, these technologies raise security concerns. Upon the enactment of ECRA, the Bureau of Industry and Security (BIS) within the US Department of Commerce introduced a list of potential target technologies, which included 14 "emerging and foundational technologies," such as artificial intelligence and machine learning.[1] Subsequently, the list of target technologies has undergone multiple revisions. The current catalog of dual-use technologies can be found in the Commerce Control List (CCL), as published by BIS. This list categorizes goods into a combination of ten technology categories (e.g., sensors and lasers) and five product groups (e.g., test, inspection, and production equipment).[2]

Similar to the US, China imposes restrictions on the export of goods deemed crucial from a security perspective. In the context of the decoupling issue, two pivotal policies emerge: the Foreign Trade Law and the Export Control Law. The Foreign Trade Law

[1] The full list is displayed in Table A.1 in Appendix A.1.

[2] The full list is illustrated in Table A.2 in Appendix A.1. Military goods are enumerated in the US Munitions List (USML) provided by the Directorate of Defense Trade Controls of the US Department of State. See Table A.3 in Appendix A.1 for the comprehensive USML listing.

predates the emergence of the decoupling issue. Under this legislation, restricted goods are itemized in the Export Prohibited and Restricted Technology Catalogue (EPRTC), encompassing a broad spectrum of manufactured goods. Subsequent to the onset of the decoupling issue, numerous advanced technologies were incorporated into this list in August 2020[3]. Furthermore, a draft was unveiled in December 2022, proposing amendments to the items in the catalog. This draft introduces new bans or restrictions on the export of biotechnology and space-related technology.[4] Conversely, the Export Control Law was freshly enacted in October 2020,[5] which primarily governs the export of dual-use and military goods, raising security concerns.[6]

In addition to export controls, China has enacted two crucial laws designed to safeguard technology transfer. One of these is the Cyber Security Law, enacted in 2017, which imposes regulations on managers of information infrastructures regarding the protection and transfer of data, thereby preventing unauthorized technology transfer to other countries. The other is the Data Security Law, enacted in 2021, which aims to restrict companies operating in China from exporting data outside the country. These laws are highly restrictive and can affect economic activities in China across various industries. Although these laws primarily target the regulation of technology transfer between the US and China, their repercussions can be extended to all other countries. Therefore, it is imperative to analyze the impact of these laws, as they have the potential to significantly influence the global economy.

Based on the preceding discussion, we have three objectives to analyze: First, we examine the scenario in which the US and China mutually restrict trade and technology transfer in sectors that raise security concerns, reflecting the recent trend of technological decoupling between these two countries. One notable example of this bilateral decoupling is the US' inclusion of Chinese firms on its "entity list," which lists the firms, organiza-

[3]The full list is presented in Table A.4 in Appendix A.1

[4]Ministry of Commerce, People's Republic of China. "Notice of public consultation on the revision of the Export Prohibited and Restricted Technology Catalogue." (http://fms.mofcom.gov.cn/article/tongjiziliao/202212/20221203376696.shtml).

[5]Ministry of Commerce, People's Republic of China. "The president of the People's Republic of China announcement No. 58: The Export Control Law." (http://www.mofcom.gov.cn/article/b/fwzl/202010/20201003008907.shtml).

[6]The complete list of target technologies under the Export Control Law of China has not been publicly disclosed as of now.

tions, and individuals that are subject to license requirements for export.[7] The second objective is the restriction of exports from the US and China to the rest of the world, which is indicative of the export control laws in both countries. The third objective is the limitations on technology transfer from China to the rest of the world, which align with the provisions of the Cyber Security Law and Data Security Law in China.

3 Theoretical model

In this section, we describe the model that we use for the counterfactual analysis of the impact of restricting technology transfer. Our model is constructed based on that of Anderson et al. (2019), which is a dynamic quantitative general equilibrium model of trade that considers FDI. Their model assumes that non-rival technology capital in a country is transferred (or spilled) to all countries and that those countries pay for that technology capital, following McGrattan and Prescott (2009). This setup is designed with the technology transfer associated with FDI and an arms-length license in mind.[8] Therefore, their model is suitable for analyzing the impact of restricting technology transfer.

However, the impact of policies that target only specific industries, such as the export control laws in the US and China, cannot be analyzed using the model of Anderson et al. (2019) because of their one-sector setting. To address this issue, we extend their model by assuming that goods are divided into final and intermediate goods and that only the intermediate goods sector uses technology capital, while the final goods sector procures intermediate goods. It is reasonable to assume that only the intermediate goods sector uses technology capital because high-tech industries, which are the main targets of export control laws, are often in the intermediate goods sector, such as the semiconductor industry.

This section first describes the model settings, whereafter it derives the general equilibrium conditions under the steady state.

[7] https://www.bis.doc.gov/index.php/policy-guidance/lists-of-parties-of-concern/entity-list

[8] FDI does not take the form of a physical capital flow in this model.

3.1 Basic settings

In this model, the world comprises N countries. Within each country, there exists a non-tradable final goods sector denoted by f, alongside a tradable intermediate goods sector, denoted by m. Intermediate goods are distinguished by their place of origin, and the final goods sector within each country procures intermediate goods from various sources. These final goods serve multiple purposes, including final consumption, domestic investment in physical capital, and investment in non-rival technology capital.

3.2 Production

The total nominal output of the intermediate goods sector in country j at time t is defined as follows:

$$Y_{j,t}^{m} \equiv p_{j,t}^{m} A_{j,t}^{m} K_{j,t}^{1-\phi_j} \mathcal{M}_{j,t}^{\phi_j}, \tag{1}$$

where $p_{j,t}^{m}$ represents the factory-gate price of intermediate goods, $A_{j,t}^{m}$ denotes the local productivity of the intermediate goods sector, $K_{j,t}$ stands for the input of physical capital, ϕ_j is the parameter determining technology capital intensity satisfying $\phi_j \in (0,1)$, and $\mathcal{M}_{j,t}$ is a measure of global technology capital applied in country j, defined as follows:

$$\mathcal{M}_{j,t} \equiv \prod_{i=1}^{N} \left(\max\left\{1, FDI_{ij,t}\right\}\right)^{\eta_i}, \tag{2}$$

where $\sum_{i=1}^{N} \eta_i = 1$ and $FDI_{ij,t}$ represents the technology transfer from country i to country j at time t defined as follows:

$$FDI_{ij,t} \equiv \omega_{ij,t} M_{i,t}, \tag{3}$$

where $M_{i,t}$ denotes the technology capital stock in country i at time t, and $\omega_{ij,t}$ signifies the degree of openness to foreign technology of country i in country j at time t. We can interpret that $\omega_{ij,t}$ represents the extent to which the technological knowledge in country i is employed for production in country j through FDI. When $\omega_{ij,t} = 0$, it can be interpreted that no technology from country i can be utilized in country j, while $\omega_{ij,t} = 1$ indicates that country j can fully access and benefit from the technology of country i.

The functional form of Eq. (2) ensures our ability to account for zero bilateral FDI flows between countries, as often observed in the data.

The production function of the final goods sector in country j at time t is defined as follows:[9]

$$Y_{j,t}^f \equiv A_{j,t}^f L_{j,t}^{1-\mu_j} Q_{j,t}^{\mu_j}, \tag{4}$$

where $A_{j,t}^f$ represents the productivity of the final goods sector, $L_{j,t}^f$ stands for the input of labor, μ_j is the parameter defining intermediate goods intensity satisfying $\mu_j \in (0,1)$, and $Q_{j,t}$ represents the input of composite intermediate goods in country j, as defined below:

$$Q_{j,t} \equiv \left(\sum_{i=1}^{N} \gamma_i^{\frac{1-\sigma}{\sigma}} q_{ij,t}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, \tag{5}$$

where $q_{ij,t}$ represents the input of intermediate goods from country i, γ_i is the positive distribution parameter, and σ is the elasticity of substitution across goods originating from different countries. For simplicity, we assume that physical capital and labor are exclusively used by the intermediate and final goods sectors, respectively.

The final goods sector determines the volume of intermediate goods procured from each country to minimize the input cost of intermediate goods:

$$\min_{q_{ij,t}} \sum_{i=1}^{N} p_{ij,t}^m q_{ij,t} \quad \text{subject to:} \quad Y_{j,t}^f = A_{j,t}^f L_{j,t}^{f\ 1-\mu_j} \left(\sum_{i=1}^{N} \gamma_i^{\frac{1-\sigma}{\sigma}} q_{ij,t}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\mu_j \sigma}{\sigma-1}}. \tag{6}$$

By solving this problem, we can derive the demand for intermediate goods:

$$q_{ij,t} = \gamma_i^{1-\sigma} p_{ij,t}^{m\ -\sigma} P_{j,t}^{m\sigma-1} E_{j,t}^m, \tag{7}$$

where $P_{j,t}^m$ is the price index of intermediate goods and $E_{j,t}^m$ represents the total expenditure on intermediate goods, defined as follows:

$$P_{j,t}^m \equiv \left(\sum_{i=1}^{N} \gamma_i^{1-\sigma} p_{ij,t}^{m\ 1-\sigma} \right)^{\frac{1}{1-\sigma}}; \tag{8}$$

[9] We assume that final goods are numeraires and thus the price equals 1.

$$E^m_{j,t} \equiv \sum_{i=1}^{N} p^m_{ij,t} q_{ij,t} = P^m_{j,t} Q_{j,t}. \tag{9}$$

3.3 Consumer's problem

The disposable income of a representative consumer in country j is given as follows:

$$E_{j,t} = Y^m_{j,t} + Y^f_{j,t} - P^m_{j,t} Q_{j,t} + \sum_{i \neq j} \frac{\partial Y^m_{i,t}}{\partial M_{j,t}} \times M_{j,t} - \sum_{i \neq j} \frac{\partial Y^m_{j,t}}{\partial M_{i,t}} \times M_{i,t}. \tag{10}$$

In Eq. (10), the first term represents the income from the production of intermediate goods, the second and third terms represent the income from the production of final goods, the fourth term represents the rents obtained from investments of technology capital from the home country to foreign countries, and the fifth term represents the rents paid for investments of technology capital from foreign countries to the home country.

Referring to Eq. (A4) in Anderson et al. (2019), we obtain

$$\begin{aligned} \frac{\partial Y^m_{i,t}}{\partial M_{j,t}} &= \frac{\eta_j \phi_i Y^m_{i,t}}{\max\{1, \omega_{ji,t} M_{j,t}\}} \left(1 - \frac{1 - \omega_{ji,t} M_{j,t}}{|1 - \omega_{ji,t} M_{j,t}|}\right) \frac{\omega_{ji,t}}{2} \\ &= \begin{cases} \eta_j \phi_i Y^m_{i,t} / M_{j,t} & (\omega_{ji,t} M_{j,t} > 1) \\ 0 & (\omega_{ji,t} M_{j,t} \leq 1) \end{cases}. \end{aligned} \tag{11}$$

Therefore, Eq. (10) can be represented as

$$E_{j,t} = Y^f_{j,t} - P^m_{j,t} Q_{j,t} + \left(1 - \phi_j \sum_{i \in \mathbb{N}^{in}_{j,t}} \eta_i \right) Y^m_{j,t} + \eta_j \sum_{i \in \mathbb{N}^{out}_{j,t}} \phi_i Y^m_{i,t}, \tag{12}$$

where $\mathbb{N}^{in}_{j,t} \equiv \{i | i \neq j, \omega_{ij,t} M_{i,t} > 1\}$ is the set of countries that transfer technology to country j, and $\mathbb{N}^{out}_{j,t} \equiv \{i | i \neq j, \omega_{ji,t} M_{j,t} > 1\}$ is the set of countries that receive technology from country j. The disposable income is used for final consumption, domestic investment in physical capital, and investment in technology capital:

$$E_{j,t} = C_{j,t} + \Omega_{j,t} + \chi_{j,t}, \tag{13}$$

where $\Omega_{j,t}$ and $\chi_{j,t}$ represent investments in physical and technology capital in country j. The stocks of physical and technology capital accumulate as follows:

$$K_{j,t+1} = (1-\delta_{j,K})K_{j,t} + \Omega_{j,t}; \tag{14}$$

$$M_{j,t+1} = (1-\delta_{j,M})M_{j,t} + \chi_{j,t}, \tag{15}$$

where $\delta_{j,K}$ and $\delta_{j,M}$ are the depreciation rates of physical and technology capital, respectively.

Consumer preferences are assumed to be identical across countries and are represented as follows:

$$U_{j,t} \equiv \sum_{t=0}^{\infty} \beta^t \ln C_{j,t}, \tag{16}$$

where $\beta < 1$ represents the subjective discount factor, and $C_{j,t}$ is the consumption in country j. At each time period t, a representative consumer in country j selects consumption $C_{j,t}$, physical capital stock $K_{j,t}$, technology capital stock $M_{j,t}$, and intermediate goods input $Q_{j,t}$ to maximize the present discounted value of lifetime utility, subject to Eq. (1), (4), (12), (13), (14), and (15), where $K_{j,0}$ and $M_{j,0}$ are given, and $L_{j,t}$ is exogenous for a representative consumer. By solving the consumer's problem, we can derive the following three equations:

$$P^m_{j,t} Q_{j,t} = \mu_j Y^f_{j,t}; \tag{17}$$

$$\beta \left(1 - \phi_j \sum_{i \in \mathbb{N}^{in}_{j,t+1}} \eta_i \right) \frac{(1-\phi_j) Y^m_{j,t+1}}{K_{j,t+1}} + \beta(1-\delta_{j,K}) = \frac{C_{j,t+1}}{C_{j,t}}; \tag{18}$$

$$\beta \left(1 - \phi_j \sum_{i \in \mathbb{N}^{in}_{j,t+1}} \eta_i \right) \frac{\eta_j \phi_j Y^m_{j,t+1}}{M_{j,t+1}} + \beta \eta_j \sum_{i \in \mathbb{N}^{out}_{j,t+1}} \frac{\eta_j \phi_i^2 Y^m_{i,t+1}}{M_{j,t+1}} + \beta(1-\delta_{j,M}) = \frac{C_{j,t+1}}{C_{j,t}}. \tag{19}$$

3.4 Gravity equations

In this section, we derive the gravity equations of trade, also referred to as the "lower-level equilibrium" in Anderson et al. (2019).

We define $X^m_{ij,t} \equiv p^m_{ij,t} q_{ij,t}$ and $p^m_{ij,t} \equiv \tau_{ij,t} p^m_{i,t}$ where $\tau_{ij,t} > 1$ represents the iceberg trade cost and $p^m_{i,t}$ is the factory-gate price of intermediate goods. Using Eq. (7), we can derive

$$X^m_{ij,t} = \gamma_i^{1-\sigma} \tau_{ij,t}^{1-\sigma} p^{m\,1-\sigma}_{i,t} P^{m\,\sigma-1}_{j,t} E^m_{j,t}. \tag{20}$$

From $Y^m_{i,t} = \sum_{j=1}^N X^m_{ij,t}$, we can also obtain

$$Y^m_{i,t} = \gamma_i^{1-\sigma} p^{m\,1-\sigma}_{i,t} \sum_{j=1}^N \tau_{ij,t}^{1-\sigma} P^{m\,\sigma-1}_{j,t} E^m_{j,t}. \tag{21}$$

Combining Eq. (20) and (21), we can derive

$$\frac{X^m_{ij,t}}{Y^m_{i,t}} = \frac{\tau_{ij,t}^{1-\sigma} P^{m\,\sigma-1}_{j,t} E^m_{j,t}}{\sum_{j=1}^N \tau_{ij,t}^{1-\sigma} P^{m\,\sigma-1}_{j,t} E^m_{j,t}}. \tag{22}$$

By defining

$$Y^m_t \equiv \sum_{i=1}^N Y^m_{i,t}; \tag{23}$$

$$\Pi^{m\,1-\sigma}_{i,t} \equiv \sum_{j=1}^N \left(\frac{\tau_{ij,t}}{P^m_{j,t}} \right)^{1-\sigma} \frac{E^m_{j,t}}{Y^m_t}, \tag{24}$$

Eq. (22) can be represented as follows:

$$X^m_{ij,t} = \frac{Y^m_{i,t} E^m_{j,t}}{Y^m_t} \left(\frac{\tau_{ij,t}}{\Pi^m_{i,t} P^m_{j,t}} \right)^{1-\sigma}. \tag{25}$$

From $E^m_{j,t} = \sum_{i=1}^N X^m_{ij,t}$, we can obtain

$$P^{m\,1-\sigma}_{j,t} = \sum_{i=1}^N \left(\frac{\tau_{ij,t}}{\Pi^m_{i,t}} \right)^{1-\sigma} \frac{Y^m_{i,t}}{Y^m_t}. \tag{26}$$

Eq. (25), (24), and (26) represent the conditions of "lower-level equilibrium" (Anderson et al., 2019) in intermediate goods trade.[10]

<u>**Lower-level equilibrium**</u>: The lower-level equilibrium is achieved by the trade flow $X^m_{ij,t}$, outward multilateral resistance (OMR) $\Pi^m_{i,t}$, and inward multilateral resistance (IMR) $P^m_{j,t}$ that satisfy Eq. (24), (25), and (26) with trade cost $\tau_{ij,t}$, elasticity of substitution σ, and number of countries N as given.

3.5 Steady state equilibrium

Next, we derive the steady state equilibrium. From Eq. (21) and (24), we can derive

$$p^m_{i,t} = \frac{(Y^m_{i,t}/Y^m_t)^{\frac{1}{1-\sigma}}}{\gamma_i \Pi^m_{i,t}}. \tag{27}$$

From Eq. (9) and (17), we obtain

$$E^m_{j,t} = \mu_j Y^f_{j,t}. \tag{28}$$

In the steady state, Eq. (14) and (15) can be expressed as follows:

$$\Omega_j = \delta_{j,K} K_j; \tag{29}$$

$$\chi_j = \delta_{j,M} M_j. \tag{30}$$

Therefore, we can rewrite Eq. (13) as follows:

$$E_j = C_j + \delta_{j,K} K_j + \delta_{j,M} M_j. \tag{31}$$

Under the steady state, Eq. (18) and (19) can be expressed as follows, respectively:

$$K_j = \beta \left(1 - \phi_j \sum_{i \in \mathbb{N}^{in}_j} \eta_i \right) \frac{(1-\phi_j) Y^m_j}{1 - \beta + \beta \delta_{j,K}}; \tag{32}$$

[10]The lower-level equilibrium is included in the general equilibrium, which is called "upper-level equilibrium" by Anderson et al. (2019).

$$M_j = \frac{\beta\eta_j}{1-\beta+\beta\delta_{j,M}} \left(\left(1 - \phi_j \sum_{i\in\mathbb{N}_j^{in}} \eta_i \right) \phi_j Y_j^m + \sum_{i\in\mathbb{N}_j^{out}} \eta_j \phi_i^2 Y_i^m \right). \tag{33}$$

Then, we can derive the steady state equilibrium conditions.

Steady state equilibrium: The general equilibrium under the steady state is achieved by the consumption C_j, production of intermediate and final goods Y_j^m, Y_j^f, disposable income E_j, OMR Π_i^m, IMR P_j^m, physical capital stock K_j, and technology capital stock M_j that satisfy Eq. (1), (4), (12), (24), (26), (31), (32), and (33) with the trade cost τ_{ij}, openness for foreign technology ω_{ij}, share of technology capital of a country to all destinations as a share from total world technology capital η_i, FDI share of intermediate goods production ϕ_j, distribution parameter γ_j, intermediate goods share of final goods production μ_j, productivity of intermediate and final goods sector A_j^m, A_j^f, adjustment cost for physical capital $\delta_{j,K}$, adjustment cost for technology capital $\delta_{j,M}$, elasticity of substitution σ, discount factor β, labor endowment $L_{j,t}$, and number of countries N as given, where Eq. (17), (23), (27), and (28) hold.

4 Calibration method and data

In this section, we elucidate our procedure for calibrating the variables and parameters in our model and introduce the data sources for these variables. We utilize data from 89 countries[11] for the year 2016.

Data on the bilateral trade flow of intermediate goods, $X_{ij,t}^m$, are acquired from the United Nations Statistical Division (UNSD) Commodity Trade Statistics Database (COMTRADE). We aggregate the trade data for sectors subject to export control regulations in the US and China to quantify the effects of these regulations. For this study, we select the industries listed in Table 1 in accordance with the export control laws. The trade value of these industries represents 43.2% of the total trade value in our sample.

Table 2 reveals the changes in the export values of China and the US for the industries listed in Table 1 from 2016 to 2022. Table 2 shows that exports from China to the

[11] Refer to Table A.6 in Appendix A.1 for the list of countries. The countries included in our sample correspond to those used by Anderson et al. (2019).

Table 1: The list of industries that constitute the intermediate goods sector.

HS code	Industry	Trade share (%)
28	Inorganic chemicals; organic and inorganic compounds of precious metals; of rare earth metals, of radioactive elements and of isotopes	1.3
29	Organic chemicals	4.9
30	Pharmaceutical products	7.0
36	Explosives; pyrotechnic products; matches; pyrophoric alloys; certain combustible preparations	0.1
84	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	26.0
85	Electrical machinery and equipment and parts thereof; sound recorders and reproducers; television image and sound recorders and reproducers, parts and accessories of such articles	30.8
86	Railway, tramway locomotives, rolling-stock and parts thereof; railway or tramway track fixtures and fittings and parts thereof; mechanical (including electro-mechanical) traffic signaling equipment of all kinds	0.4
87	Vehicles; other than railway or tramway rolling stock, and parts and accessories thereof	18.3
88	Aircraft, spacecraft and parts thereof	3.3
89	Ships, boats and floating structures	0.7
90	Optical, photographic, cinematographic, measuring, checking, medical or surgical instruments and apparatus; parts and accessories	7.0
93	Arms and ammunition; parts and accessories thereof	0.1

Note: The industry classification is based on Harmonized Commodity Description and Coding System 2012 (HS 2012). "Trade share" is calculated as the share of trade value of each industry in the total trade value of target sectors.
Source: World Customs Organization "HS Nomenclature 2012 Edition" (https://www.wcoomd.org/en/faq/~/link.aspx?_id=3F9BB5F791484D45810FE0A5B9782E4C&_z=z) and the United Nations Statistical Division (UNSD) Commodity Trade Statistics Database (COMTRADE)

US have increased in all industries but have been relatively restrained compared to the increase in exports to the world as a whole. Furthermore, exports from the US to China have declined in several industries. The total exports of all industries increase. However, it is small compared with the total exports to the world. From these results, we can assume that trade between the US and China is restrained in many industries selected in

Table 2: Change in export value of each industry from 2016 to 2022 (%).

	From China			From the U.S.		
HScode	(1) To the U.S.	(2) To the world	(1) – (2)	(3) To China	(4) To the world	(3) – (4)
28	68.2952	233.1137	-164.8186	105.9778	53.5762	52.4016
29	103.7415	141.4648	-37.7233	53.4630	51.6487	1.8143
30	81.9364	98.6480	-16.7117	364.6707	76.1438	288.5270
36	89.7142	50.3952	39.3190	-41.5064	-11.1104	-30.3959
84	38.4302	58.4026	-19.9724	30.9846	19.5462	11.4384
85	53.5019	71.0816	-17.5798	29.2985	17.8666	11.4318
86	83.2807	164.3419	-81.0612	-33.4195	2.4395	-35.8591
87	41.4089	153.8778	-112.4689	-34.0384	6.3732	-40.4116
88	37.2539	60.3550	-23.1011	-62.0777	-22.6002	-39.4775
89	6.0504	18.7780	-12.7277	-17.8537	23.5057	-41.3594
90	28.1002	3.1704	24.9298	32.2299	19.4578	12.7722
93	76.2117	95.1574	-18.9458	31.7357	15.8723	15.8634
Total	47.4988	71.5559	-24.0571	10.1456	15.4710	-5.3253

Note: Columns (1) and (2) show the changes in China's export values to the US and the world, respectively. The column labeled "(1) – (2)" shows the difference between the former two columns. Columns (3) and (4) show the changes in US export values to China and the world, respectively. The column labeled "(3) – (4)" shows the difference between the former two columns.
Source: The United Nations Statistical Division (UNSD) Commodity Trade Statistics Database (COMTRADE).

this study.

We calculate internal trade using the same method employed by Anderson et al. (2019). This method constructs a multiplier by calculating the ratio between the aggregate manufacturing gross value (obtained from the United Nations IndStat database) and the total exports of manufacturing goods. Subsequently, we apply this multiplier, along with data on aggregate exports, to project the values of internal trade. The total output of intermediate goods $Y^m_{i,t}$ is calculated as $Y^m_{i,t} = \sum_{j=1}^{N} X^m_{ij,t}$ and the total expenditure on intermediate goods $E^m_{j,t}$ is calculated as $E^m_{j,t} = \sum_{i=1}^{N} X^m_{ij,t}$.

For data on labor endowment $L_{j,t}$, physical capital stock $K_{j,t}$, and consumption $C_{j,t}$, we rely on the "Number of persons engaged (millions)," "Capital stock at current PPPs (in mil. 2017US$)," and "Real consumption of households and government, at current PPPs (in mil. 2017US$)" in Penn World Table 10.0, respectively. We use the data of "Real domestic absorption, (real consumption plus investment), at current PPPs (in mil. 2017US$)" in Penn World Table 10.0 as the source for output of final goods $Y^f_{j,t}$ and disposable income $E_{j,t}$.

The elasticity of substitution σ is set to 6 in accordance with Head and Mayer (2014), while the discount factor β is set to 0.98, following Yao et al. (2012). Data for the depreciation rates of physical capital $\delta_{j,K}$ and technology capital $\delta_{j,M}$ are obtained from "Average depreciation rate of the capital stock" in Penn World Table 10.0. The intermediate goods intensity μ_j is calculated as $\mu_j = E^m_{j,t}/Y^f_{j,t}$, following Eq. (28). The values for bilateral trade costs $\tau_{ij,t}$, IMR $P_{j,t}$, and OMR $\Pi_{j,t}$ are derived by solving Eq. (24) and (26). The share of the technology capital of a country to all destinations η_i is calibrated as follows:

$$\eta_i = \frac{\sum_{j=1}^{N} FDI^{value}_{ij,\bar{t}}}{\sum_{i=1}^{N}\sum_{j=1}^{N} FDI^{value}_{ij,\bar{t}}}, \tag{34}$$

where $\bar{t}$ represents the baseline year, which is 2016 in this study.[12] $FDI^{value}_{ij,t} \equiv FDI_{ij,t} \times \partial Y_{j,t}/\partial M_{i,t}$ is defined as the earnings of country j from technology transfer from country i and sourced from the International Direct Investment Statistics database of the Organization for Economic Co-operation and Development (OECD). In addition to the OECD data, we incorporate FDI flow data from Eurostat and statistics officially published by each country's government.[13] While the OECD database serves as the primary source, others are considered alternative sources to compensate for missing data in the OECD.

The technology capital intensity in intermediate goods production (ϕ_j) is calibrated as follows:

$$\phi_j = \frac{FDI^{in}_{j,\bar{t}}/K_{j,\bar{t}}}{1 + FDI^{in}_{j,\bar{t}}/K_{j,\bar{t}}}, \tag{35}$$

where $FDI^{in}_{j,t}$ is defined as $FDI^{in}_{j,t} \equiv \sum_{i=1}^{N} FDI^{value}_{ij,t}$. The technology parameters $A^m_{j,t}/\gamma_j$ and $A^f_{j,t}$ are derived by solving the steady state equilibrium conditions with $Y^m_{j,t}$ and $E^f_{j,t}$ as given. The technology capital stock $M_{j,t}$ is calibrated using Eq. (33). The openness for foreign technology ω_{ij} is calibrated using the following equation that is transformed from

[12] The calibration results of μ_j, $\delta_{j,K}$, $\delta_{j,M}$, and η_i are shown in Table A.7 in Appendix A.1.

[13] We obtain the FDI flow data in China (CEIC China Premium Database, outward FDI only), Kazakhstan (National Bank of Kazakhstan), Russia (Bank of Russia), and Ukraine (National Bank of Ukraine).

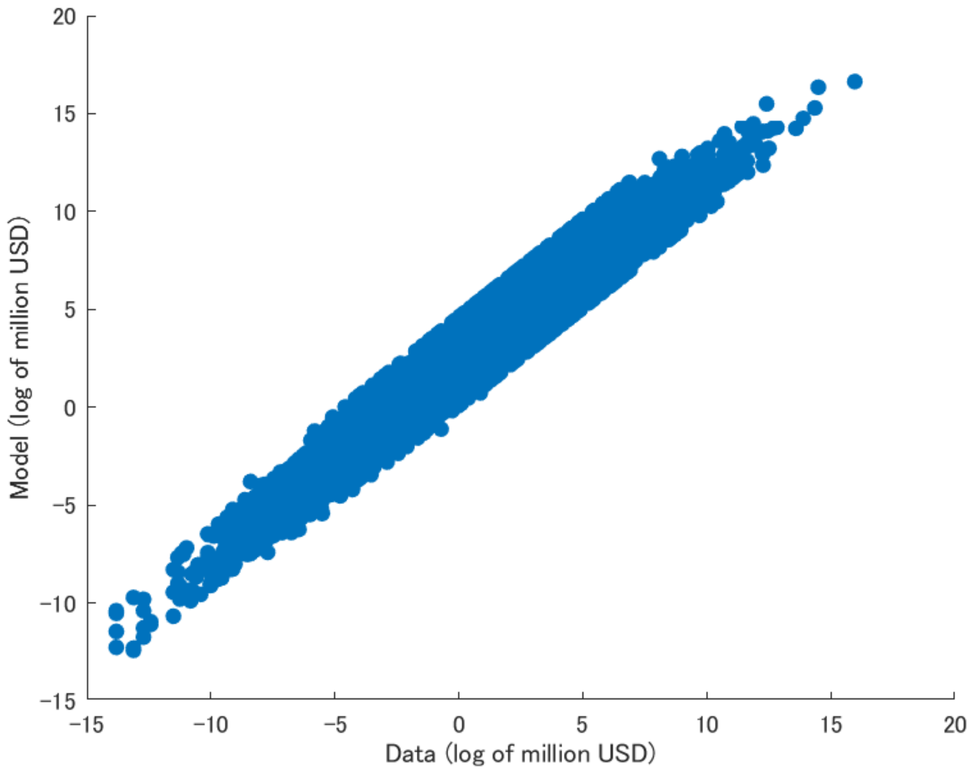

Figure 1: Comparing the trade values obtained from the data and the model.

Note: The horizontal axis shows the trade values of target sectors in export control regulations in the US and China obtained from the data, sourced from the United Nations Statistical Division (UNSD) Commodity Trade Statistics Database (COMTRADE). The vertical axis represents the trade values in the steady state equilibrium calculated in our model.

the definition of $FDI_{ij,t}^{value}$:

$$FDI_{ij,\bar{t}}^{value} \equiv FDI_{ij,\bar{t}} \times \frac{\partial Y_{j,\bar{t}}}{\partial M_{i,\bar{t}}}$$
$$= \frac{\omega_{ij}\beta\eta_i^2}{1-\beta+\beta\delta_{i,M}} \left(\left(1 - \phi_i \sum_{k\in\mathbb{N}_i^{in}} \eta_k \right) \phi_i Y_{i,\bar{t}}^m + \sum_{k\in\mathbb{N}_i^{out}} \eta_i \phi_k^2 Y_{k,\bar{t}}^m \right) \frac{\phi_j Y_{j,\bar{t}}^m}{M_{i,\bar{t}}}. \quad (36)$$

At the end of this section, we examine how well the model fits the data by comparing the trade values of intermediate goods obtained from the data with those calculated from the model using the parameters calibrated above.

Figure 1 shows the trade values obtained from the data and the model. We can find that the trade value of intermediate goods calculated from our model is strongly correlated with the data, suggesting that the model fits the data well.[14]

5 Counterfactual analysis on the US–China technological decoupling

In this section, we conduct a counterfactual analysis of the impact of bilateral decoupling between the US and China (hereinafter referred to as US–China bilateral decoupling), technology protection policies in China, and export control laws in both countries. First, we define the counterfactual scenarios in Section 5.1. Second, we predict the results of counterfactual analyses by examining the FDI flows and trade flows in the target sectors affected by the export control laws in each country in Section 5.2. Third, we evaluate the outcomes of the counterfactual analyses in Section 5.3. We further analyze the reasons behind the results obtained in the previous sections in Section 5.4. Finally, we summarize the results in Section 5.6.

5.1 Defining counterfactual cases

In this study, we assume that restrictions on technology transfer owing to the US–China bilateral decoupling and technology protection policies correspond to a decrease in the parameter of technology openness $\omega_{ij,t}$, and that export restrictions in target sectors owing to the US–China bilateral decoupling and export control laws correspond to an increase in trade costs $\tau_{ij,t}$. We quantify the impact of the US–China bilateral decoupling, technology protection policies, and export control laws by comparing the baseline equilibrium with the counterfactual equilibrium, wherein $\omega_{ij,t}$ and $\tau_{ij,t}$ change.

We analyze the following seven scenarios. First, we analyze the impact of the US–China bilateral decoupling by considering the following three scenarios:

(1) Technology transfer between the US and China is restricted, resulting in reductions of $\omega_{CN,US,t}$ and $\omega_{US,CN,t}$.

(2) Export in target sectors between the US and China is restricted, resulting in increases in $\tau_{CN,US,t}$ and $\tau_{US,CN,t}$.

[14] The correlation coefficient between the trade value obtained from the data and the model is 0.8878.

(3) Both technology transfer and export in target sectors between the US and China are restricted, resulting in reductions of $\omega_{CN,US,t}$ and $\omega_{US,CN,t}$ and increase in $\tau_{CN,US,t}$ and $\tau_{US,CN,t}$.

These scenarios assume restrictions only between the US and China, such as the US including Chinese firms on its entity list. Second, we consider the restriction of technology transfer from China to the rest of the world, reflecting the Cyber Security Law and Data Security Law in China.

(4) Technology transfer from China to all countries is restricted, resulting in a reduction of $\omega_{CN,j,t}$ $\forall j$.

We also consider the export restrictions in target sectors from China or the US to the rest of the world, reflecting the export control laws in these countries.

(5) Export in target sectors from China to all countries is restricted, resulting in an increase in $\tau_{CN,j,t}$ $\forall j$.

(6) Export in target sectors from the US to all countries is restricted, resulting in an increase in $\tau_{US,j,t}$ $\forall j$.

Finally, we consider the aggregate impact of the technology protection policies and export control laws.

(7) Technology transfer from China and export in target sectors from China and the US to all countries is restricted, resulting in a reduction of $\omega_{CN,j,t}$ $\forall j$ and increases in $\tau_{CN,j,t}, \tau_{US,j,t}$ $\forall j$.

Notably, it is difficult to quantify the extent to which the US–China bilateral decoupling and related policies correspond to changes in $\omega_{ij,t}$ and $\tau_{ij,t}$. Therefore, we consider two types of restrictions, namely, a soft restriction that results in a 20% decrease in $\omega_{ij,t}$ and 5% increase in $\tau_{ij,t}$, and a hard restriction that results in an 80% decrease in $\omega_{ij,t}$ and 20% increase in $\tau_{ij,t}$, to estimate the range of possible impacts of the US–China bilateral decoupling and related policies. Although we mainly show the results of a hard restriction here, we also show those of a soft restriction in Appendix A.2.[15]

From Eq. (25), an $x\%$ change in $\tau_{ij,t}$ approximately corresponds to an $x^{1-\sigma}\%$ change in trade flow $X^m_{ij,t}$. Given that σ is set to 6, a 5% increase in $\tau_{ij,t}$ results in a 21.65% decrease $X^m_{ij,t}$, while a 20% increase in $\tau_{ij,t}$ results in a 59.81% decrease $X^m_{ij,t}$. These changes are close to the results of Campos et al. (2023), which show 22–57% decreases in trade flow owing to the trade decoupling. Kumagai et al. (2023) notably argued that the US–China trade war increased tariff rates by 16.2% on average across all industries, which is between our soft and hard cases. Therefore, our setting for the rate of change in trade costs is reasonable.

5.2 Pre-analysis: hypothesis of counterfactual analysis

In this section, we aim to provide a concise prediction of the countries that would experience significant impacts in the counterfactual scenario described in Section 5.1. To achieve this, we examine the trade and FDI trends between the US and China, along with imports and inward FDI originating from the US and China in other countries.

We initially explore Scenarios 1 to 3, where trade and technology transfer between the US and China are mutually restricted. Table 3 displays the proportions of inward FDI flow (representing payment to technology transfer FDI^{value}_{ij} in the model) and import of the target sectors from the US to China as well as the proportions of outward FDI flow (representing earnings from technology transfer FDI^{value}_{ij} in the model) and exports of the target sectors to the US from China. Similarly, Table 4 presents the proportions of inward FDI flow and imports from China to the US, as well as the proportions of outward FDI flows and exports to China from the US.

Comparing Columns (1) and (3) in Tables 3 and 4, we find that China receives a relatively substantial portion of inward FDI from the US, whereas the US contributes a relatively significant portion of outward FDI to China. Consequently, we hypothesize in Scenarios 1 and 3 that China will encounter considerable declines in total inward FDI (representing payment for inward technology transfer $FDI^{in}_{j,t} = \sum_{i=1}^{N} FDI^{value}_{ij,t}$), while

[15] In Appendix A.2, we also analyze a scenario wherein export in target sectors and technology transfer from the US to China is unilaterally restricted, resulting in a 20% increase in $\tau_{US,CN,t}$ and an 80% reduction in $\omega_{US,CH,t}$, as well as a scenario wherein those from China to the US is unilaterally restricted, resulting in a 20% increase in $\tau_{CN,US,t}$ and an 80% reduction of $\omega_{CN,US,t}$.

Table 3: Inward FDI and import shares in China (%).

(1) Inward FDI share from the U.S.	(2) Import share from the U.S.	(3) Outward FDI share to the U.S.	(4) Export share to the U.S.
19.48	9.47	3.08	19.88

Note: Each variable is calculated as the share of the inward FDI flow, import, outward FDI flow, or export from or to the US in the total inward FDI flow, import, outward FDI flow, or export in China, respectively.
Source: FDI data are from the International Direct Investment Statistics database (OECD), CEIC China Premium Database, Direct Investments according to the directional principle (National Bank of Kazakhstan), External Sector Statistics (Bank of Russia), and External Sector Statistics (National Bank of Ukraine). Trade data are from the COMTRADE database (UNSD).

Table 4: Inward FDI and import shares in the US (%).

(1) Inward FDI share from China	(2) Import share from China	(3) Outward FDI share to China	(4) Export share to China
0.73	18.37	2.04	8.44

Note: Each variable is calculated as the share of the inward FDI flow, import, outward FDI flow, or export from or to China in the total inward FDI flow, import, outward FDI flow, or export in the US, respectively.
Source: FDI data are from the International Direct Investment Statistics database (OECD), CEIC China Premium Database, Direct Investments according to the directional principle (National Bank of Kazakhstan), External Sector Statistics (Bank of Russia), and External Sector Statistics (National Bank of Ukraine). Trade data are from the COMTRADE database (UNSD).

the US will experience notable reductions in total outward FDI (representing earning from outward technology transfer $FDI_{j,t}^{out} = \sum_{i=1}^{N} FDI_{ji,t}^{value}$).

In contrast to the fact above, Columns (2) and (4) in Tables 3 and 4 reveal that China is a net exporter of goods in the target sector, while the US predominantly acts as an importer. Consequently, we can hypothesize in Scenarios 2 and 3 that China will encounter significant declines in total exports, whereas the US will experience substantial reductions in total imports.

Next, we turn our attention to Scenarios 4 and 7, in which technology transfer from China to all countries is unilaterally restricted owing to technology protection policies. Column (1) in Table 5 presents the share of inward FDI from China for each country. Similar to Scenarios 1 and 3, we can anticipate that the impact of technology transfer restrictions on inward FDI (representing payments for inward technology transfer) will be

Table 5: Share of inward FDI from China and import from the US and China.

Country	(1) Inward FDI share from China	(2) Import share from China	(3) Import share from the U.S.
Belgium	0.0000	0.0350	0.1281
Belaris	0.0773	0.1343	0.0276
Canada	0.0142	0.0529	0.6909
Switzerland	0.0004	0.0231	0.0860
Germany	0.0048	0.0754	0.0713
The Dominican Republic	0.0001	0.1147	0.4694
Finland	0.0000	0.0540	0.0299
Hong Kong	0.7348	0.6078	0.0451
Ireland	0.0005	0.0482	0.2121
Japan	0.0031	0.3119	0.1659
Mexico	0.0020	0.1058	0.6067
North Macedonia	0.0014	0.0405	0.0157
Malta	0.0036	0.2020	0.0200
Netherlands	0.0062	0.1809	0.1155
Pakistan	0.3939	0.4641	0.0507
Sudan	0.7369	0.3493	0.0032
Singapore	0.0597	0.2040	0.1439
Slovak Republic	0.0006	0.0710	0.0047
Slovenia	0.0009	0.0795	0.0118
Tunisia	0.0038	0.0922	0.0206
Tanzania	0.2319	0.4202	0.0212
Zimbabwe	0.8706	0.2071	0.0161
World	0.0375	0.1547	0.1107

Note: We list countries that appear in Tables 6 through 10, except for the US and China. "World" calculates the share of total inward FDI from China in total inward FDI in the world, the share of total imports from China in total imports in the world, and the share of total imports from the US in total imports in the world. The results for the other countries are shown in Table A.8 in Appendix A.1.
Source: FDI data are from the International Direct Investment Statistics database (OECD), CEIC China Premium Database, Direct Investments according to the directional principle (National Bank of Kazakhstan), External Sector Statistics (Bank of Russia), and External Sector Statistics (National Bank of Ukraine). Trade data are from the COMTRADE database (UNSD).

more pronounced for countries with a higher share of inward FDI from China, such as Hong Kong, Sudan, and Zimbabwe.

We can employ the same rationale for Scenarios 5 to 7, where exports from the US and China are restricted owing to export control laws. Columns (2) and (3) in Table 5 show the share of goods imports in the target sectors from China and the US, respectively. As in the previous scenarios, we predict that the impact of the export control laws in China on imports will be more significant for countries with a larger share of imports from China, such as Hong Kong, Pakistan, and Tanzania, while the impact on the US will be more pronounced for countries with a larger share of imports from the US, such as Canada, Mexico, and the Dominican Republic.

Table 6: The impacts of technology and trade restrictions between the US and China (%).

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
A. Technology restriction							
China	-0.1326	-0.3239	0.5549	-0.0771	-0.2332	-0.1471	-0.0771
US	-0.3318	3.5195	-5.241	-3.3264	0.3616	-0.1677	-3.3264
World	-0.0732	0.2787	0.2787	-0.2095	-0.2095	-0.0788	-0.1218
B. Trade restriction							
China	-0.2657	-5.8674	-10.1219	-0.9457	0.5253	-0.0795	-0.9457
US	-0.0756	-7.1085	-1.7326	1.4064	0.2636	-0.1619	1.4064
World	-0.0395	-1.3589	-1.3589	0.4633	0.4633	-0.0435	-0.0505
C. Both restrictions							
China	-0.4071	-5.8970	-9.8808	-1.0842	0.3342	-0.2208	-1.0842
US	-0.4076	-3.6266	-6.8908	-1.8099	0.6478	-0.3363	-1.8099
World	-0.1127	-1.0752	-1.0752	0.2929	0.2929	-0.1225	-0.1709

Note: We calculate the change in variables when the economy moves from the counterfactual steady state equilibrium wherein the openness for foreign technology $\omega_{ij,t}$ decreases by 80% (in the panel labeled "Technology restriction"), trade costs $\tau_{ij,t}$ increase by 20% (in the panel labeled "Trade restriction"), and both of them occur (in the panel labeled "Both restrictions") between the US and China to the baseline steady state equilibrium. "Inward FDI" is the change in total payment for inward technology transfer from other countries, while "Outward" is that of total earning from outward technology transfer to other countries.

5.3 Results from counterfactual analyses

5.3.1 The US–China bilateral decoupling

We begin by examining the outcomes of Scenarios 1 to 3, wherein technology transfer and export in the target sectors between the US and China are mutually constrained. The results for Scenarios 1 to 3 are presented in Table 6. Interestingly, in contrast to the initial hypothesis, the US experiences significant reductions in total inward FDI (technology) flow, as shown in Column (4) of Panel A, whereas China undergoes substantial declines in total outward FDI (technology) flow when technology transfer is restricted, as shown in Column (5). We will delve into the reasons behind this outcome in the subsequent section. Table 6 also indicates that exports from China and imports to the US decrease significantly when trade is restricted, as shown in Columns (2) and (3) of Panel B, aligning with our initial expectations. It is important to note that the US, China, and the global economy all undergo negative but relatively minor changes in welfare, as shown in Column (1).

Table 7: The impacts of the technology protection policy in China (%).

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
China	-0.0326	-8.4189	4.5205	-0.0283	-7.3452	-0.1685	0.8669
US	-0.4159	1.1229	-2.9190	-1.6545	-7.4741	-0.2939	-1.6545
A. Largest FDI share							
Zimbabwe	-0.0272	-0.0294	0.5406	0.4601	-13.1309	-0.0223	0.4601
Sudan	-0.0139	-0.0448	1.3232	3.7507	-13.7998	-0.0091	3.7507
Hong Kong	-12.2694	-12.5242	-13.6634	-15.0522	-5.2227	-6.9028	-15.0522
B. Worst welfare loss (except for Hong Kong)							
Singapore	-8.7543	-5.2225	-12.4342	-12.2268	-4.4313	-4.8581	-12.2268
Ireland	-5.6541	5.8892	-19.8209	-14.5358	-6.2404	-2.5812	-14.5358
Switzerland	-4.6192	1.6116	-15.7642	-12.2096	-6.1634	-2.1317	-12.2096
World	-0.4036	-1.0710	-1.0710	-6.6877	-6.6877	-0.3171	-0.5172

Note: We calculate the change in variables when the economy moves from the counterfactual steady state equilibrium wherein the openness for foreign technology $\omega_{ij,t}$ decreases by 80% from China to all countries to the baseline steady state equilibrium. Zimbabwe, Sudan, and Hong Kong are listed because they have the largest share of inward FDI from China in the sample countries. Singapore, Ireland, and Switzerland are listed because the welfare losses are the worst except for Hong Kong. "Inward FDI" is the change in total payment for inward technology transfer from other countries, while "Outward" is that of total earning from outward technology transfer to other countries.

5.3.2 Technology protection policy in China

We now proceed to analyze the outcomes of Scenario 4, wherein technology transfer from China to all countries is unilaterally restricted because of China's technology protection policy. The results of Scenario 4 are presented in Table 7. As expected, Column (4) of Panel A shows that the inward FDI (technology) flow experiences a significant decline in Hong Kong, in line with our earlier hypothesis. However, for other countries with a larger share of inward FDI from China, such as Zimbabwe and Sudan, the declines are relatively smaller compared with the global average. Surprisingly, as shown in Panel B, the impact is more pronounced in countries that do not receive as much FDI from China, such as Singapore, Ireland, and Switzerland. We will delve into the reasons behind this outcome in the subsequent section. It is worth noting that in comparison to the bilateral restrictions between the US and China, the restriction of technology transfer in China has a relatively substantial impact on global welfare and FDI (technology) flow, as shown in Column (1).

Table 8: The impacts of the export control law in China (%).

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
China	-1.4045	-3.5763	-55.4453	-6.5259	1.9377	0.0446	-6.5259
US	0.0230	-6.8254	5.1940	3.3068	1.1536	-0.1710	3.3068
A. Largest import share							
Hong Kong	-18.1899	-14.9552	5.5800	0.3204	2.3478	-56.6815	0.3204
Pakistan	-0.0860	-6.4896	14.8782	24.9214	2.1128	-0.1172	24.9214
Tanzania	-0.1510	-0.7572	19.3724	23.4696	2.2628	-0.1603	23.4696
B. Worst welfare loss							
(except for Hong Kong)							
Singapore	-1.2218	-7.3048	8.5812	0.0915	2.4552	-2.8592	0.0915
Malta	-1.2079	-2.3230	2.9579	1.3648	2.4634	-1.5667	1.3648
Netherlands	-0.4283	-3.3573	3.5979	2.2874	1.3901	-1.1190	2.2874
C. Largest welfare gain							
Germany	0.2830	-2.6185	5.2122	2.0561	1.4545	-0.2444	1.9125
Belgium	0.2135	-0.2269	5.6058	2.0462	1.0837	-0.2906	2.0462
Switzerland	0.1998	-0.1125	5.1791	1.2090	1.5019	-0.1606	1.2090
World	-0.2708	-4.9263	-4.9263	1.6789	1.6789	-0.3474	-0.9947

Note: We calculate the change in variables when the economy moves from the counterfactual steady state equilibrium wherein the trade costs $\tau_{ij,t}$ increase by 20% from China to all countries to the baseline steady state equilibrium. Hong Kong, Pakistan, and Tanzania are listed because they have the largest share of import in target sectors from China in the sample countries. Singapore, Malta, and the Netherlands are listed because the welfare losses are the worst except for Hong Kong, while Germany, Belgium, and Switzerland are listed because the welfare gains are the largest. "Inward FDI" is the change in total payment for inward technology transfer from other countries, while "Outward" is that of total earning from outward technology transfer to other countries.

5.3.3 Export control laws in the United States and China

We now proceed to examine the outcomes of Scenarios 5 and 6, wherein exports in target sectors from China and the US to all countries are restricted owing to the export control laws in China and the US, respectively. The results of Scenario 5, which pertains to the export control laws in China, are presented in Table 8. Column (3) of Table 8 shows that the export from China decreases by 55%, which is close to our expectation from the results of Campos et al. (2023).

As anticipated, countries with larger import shares from China, such as Hong Kong and Pakistan, experience more significant declines in their imports, except for Tanzania, as shown in Panel A. Notably, the decrease in welfare in Pakistan is relatively small despite

Table 9: The impacts of the export control law in the US (%).

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
China	0.0077	-5.5823	2.8360	0.4507	-1.0890	-0.1027	0.4507
US	-0.6099	-4.9845	-52.7684	-13.1606	1.3037	0.0850	-13.1606
A. Largest import share							
Canada	-0.5509	-19.4582	-6.3500	10.7126	-1.3194	-1.4638	10.7126
Mexico	-0.1171	-22.2304	-2.1071	7.9588	-2.5002	-0.8371	7.9588
Dominican Republic	0.0137	-16.6907	-2.3821	9.9914	0.9445	-0.1946	9.9914
B. Worst welfare loss (except for Canada and the US)							
Hong Kong	-1.9275	-1.4981	1.2609	-0.1961	-2.2166	-5.4371	-0.1961
Singapore	-0.9789	-4.1902	0.5048	0.2911	-2.0306	-2.4204	0.2911
Netherlands	-0.5332	-1.9194	0.6274	0.7456	-1.1163	-0.8082	0.7456
C. Largest welfare gain							
Germany	0.1524	-2.6738	2.6642	1.7869	-1.1013	-0.2822	1.6437
Slovak Republic	0.1317	0.2497	2.4043	0.9603	-2.4011	-0.1390	0.9603
Slovenia	0.1103	-0.0827	2.3073	1.2278	6.7902	-0.0996	1.2278
World	-0.1332	-3.8858	-3.8858	-0.9473	-0.9473	-0.1488	-0.2706

Note: We calculate the change in variables when the economy moves from the counterfactual steady state equilibrium wherein the trade costs $\tau_{ij,t}$ increase by 20% from the US to all countries to the baseline steady state equilibrium. Canada, Mexico, and the Dominican Republic are listed because they have the largest share of import in target sectors from the US in the sample countries. Hong Kong, Singapore, and the Netherlands are listed because the welfare losses are the worst except for Canada and the US, while Germany, Slovak Republic, and Slovenia are listed because the welfare gains are the largest. "Inward FDI" is the change in total payment for inward technology transfer from other countries, while "Outward" is that of total earning from outward technology transfer to other countries.

the substantial reduction in imports. This outcome can be explained by an increase in domestic production of intermediate goods, which offsets the decrease in imports. This increase in domestic production of intermediate goods leads to an increase in disposable income, as implied by Eq. (12), resulting in a mitigated welfare loss. Following this rationale, it becomes evident that some countries may benefit from the restriction by struggling to compensate for the reduction in imports through increased domestic production, while others experience substantial welfare losses.

Table 9 presents the results of Scenario 6, which focuses on the export control laws in the US. This table shows results similar to those in Table 8 and supports our initial hypothesis. It is important to acknowledge that the impact of China's export control laws

Table 10: The impacts of the technology protection policy in China and export control laws in the US and China (%).

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
China	-1.4900	-16.8367	-51.7488	-6.3650	-6.2870	-0.2161	-5.5266
US	-0.9941	-10.9167	-51.4637	-11.1379	-4.8613	-0.3927	-11.1379
A. Worst welfare loss							
Hong Kong	-30.7196	-27.3931	-7.0995	-14.7516	-4.8650	-64.2621	-14.7516
Singapore	-10.8762	-16.0620	-4.3212	-11.4876	-3.7720	-10.3862	-11.4876
Ireland	-5.9739	-3.2738	-18.6238	-12.6527	-5.4074	-3.6411	-12.7658
Netherlands	-5.4835	-5.2991	-13.8470	-12.9712	-4.9828	-3.7749	-12.9712
Switzerland	-4.7079	-0.6094	-10.3893	-10.5122	-5.4878	-2.8164	-10.5122
B. Largest welfare gain							
Finland	0.1578	-5.8445	13.8317	7.4245	-4.7109	-0.5275	7.4245
North Macedonia	0.0731	-3.7218	11.1941	7.0197	-7.6040	-0.1260	7.0197
Tunisia	0.0713	-7.8751	12.2147	4.9608	-6.2101	-0.2304	4.9608
Belarus	0.0709	-6.6757	15.9869	10.2359	-9.5893	-0.1532	10.2359
Japan	0.0707	-29.4886	14.2947	3.9701	-6.1352	-0.6866	3.9701
World	-0.8013	-10.2082	-10.2082	-5.7742	-5.7742	-0.8028	-1.7190

Note: We calculate the change in variables when the economy moves from the counterfactual steady state equilibrium wherein the openness for foreign technology $\omega_{ij,t}$ decreases by 80% from China to all countries and trade costs $\tau_{ij,t}$ increase by 20% from the US and China to all countries to the baseline steady state equilibrium. Hong Kong, Singapore, Ireland, the Netherlands, and Switzerland are listed because the welfare losses are the worst, while Finland, North Macedonia, Tunisia, Belarus, and Japan are listed because the welfare gains are the largest. "Inward FDI" is the change in total payment for inward technology transfer from other countries, while "Outward" is that of total earning from outward technology transfer to other countries.

on welfare and trade in the US, China, and the world is more substantial than that of the US.

5.3.4 All policies

We conclude by examining the outcomes of Scenario 7, wherein technology transfer from China and exports from both China and the US are restricted owing to China's technology protection policy and the export control laws in both China and the US. The results of Scenario 7 are presented in Table 10. The outcomes in Table 10 appear to be the cumulative effects of the results in Tables 7 through 9. The US (-0.9941%), China (-1.4900%), and the global economy (-0.8013%) incur losses owing to these policies, as shown in Column (1). However, as observed in Scenarios 5 and 6, some countries experience minor gains.

5.4 Post-analysis

The results presented in Table 7 demonstrate that, even in the case of a country with a substantial share of FDI from China, the restriction of technology transfer owing to China's technology protection policy may not necessarily have a significant impact on that country. In this section, we explore another determinant of the impact of technology transfer restrictions.

Eq. (36) makes it abundantly evident that not only the openness for foreign technology $\omega_{ij,t}$ but also the output of intermediate goods $Y_{j,t}^m$ in the host country affect inward FDI (technology) flow, as it is also subject to change owing to technology transfer restrictions. As the output of intermediate goods $Y_{j,t}^m$ is the sole endogenous variable pertaining to the host country in Eq. (36), we can infer that the effect of technology transfer restrictions on the total inward FDI (technology) flow varies among host countries because of disparities in the impact on the output of intermediate goods $Y_{j,t}^m$.

By drawing insights from Eq. (3)–(2), we identify that technology capital intensity in production ϕ_j serves as the sole determinant for the host country that governs the impact of technology transfer restrictions on the output of intermediate goods $Y_{j,t}^m$. A larger value of ϕ_j for the host country corresponds to a more substantial negative impact on the output of the intermediate goods $Y_{j,t}^m$. Thus, even if technology transfer restrictions solely apply to China and the share of inward FDI from China is not particularly extensive, the production of intermediate goods $Y_{j,t}^m$ can experience a significant reduction owing to the constraints on technology transfer from China when the technology capital intensity ϕ_j is high. This, in turn, can result in a substantial decrease in FDI (technology) flow from all other countries. Consequently, the total inward FDI (technology) flow can experience a noteworthy decline in these countries.

Table 11 reveals that the value of ϕ_j is either equal to or lower than the world average in countries such as Sudan (SDN) and Zimbabwe (ZWE), resulting in relatively minor impacts despite the substantial share of inward FDI from China. In contrast, Switzerland (CHE), Ireland (IRL), and Singapore (SGP) exhibit significantly larger values of ϕ_j, where the total inward FDI (technology) flow experiences a substantial decrease owing to technology transfer restrictions from China, even though the share of FDI from China is

Table 11: ϕ_j in sample countries.

Country	ϕ_j	Country	ϕ_j	Country	ϕ_j	Country	ϕ_j
AGO	0.0267	EST	0.0599	KWT	0.0048	ROM	0.0345
ARG	0.0229	ETH	0.0064	LBN	0.0055	RUS	0.0218
AUS	0.0837	FIN	0.0689	LKA	0.0029	SAU	0.0071
AUT	0.0637	FRA	0.0404	LTU	0.0357	SDN	0.0063
AZE	0.0108	GBR	0.1723	LUX	0.9058	SER	0.0207
BEL	0.1584	GHA	0.0136	LVA	0.0248	SGP	0.2188
BGD	0.0009	GRC	0.0105	MAR	0.0118	SVK	0.0555
BGR	0.0438	GTM	0.0107	MEX	0.0274	SVN	0.0253
BLR	0.0106	HKG	0.2989	MKD	0.0097	SWE	0.1038
BRA	0.0382	HRV	0.0319	MLT	0.4427	SYR	0.0013
CAN	0.0857	HUN	0.1359	MYS	0.0207	THA	0.0201
CHE	0.2991	IDN	0.0069	NGA	0.0169	TKM	0.0015
CHL	0.0605	IND	0.0052	NLD	0.4019	TUN	0.0110
CHN	0.0062	IRL	0.4492	NOR	0.0807	TUR	0.0137
COL	0.0220	IRN	0.0010	NZL	0.1104	TZA	0.0146
CYP	0.4729	IRQ	0.0123	OMN	0.0066	UKR	0.0066
CZE	0.0475	ISR	0.0418	PAK	0.0075	USA	0.0622
DEU	0.0391	ITA	0.0227	PER	0.0357	UZB	0.0047
DNK	0.0783	JPN	0.0098	PHL	0.0173	VEN	0.0462
DOM	0.0110	KAZ	0.0989	POL	0.0572	VNM	0.0268
ECU	0.0099	KEN	0.0112	PRT	0.0360	ZAF	0.0335
EGY	0.0232	KOR	0.0160	QAT	0.0146	ZWE	0.0315
ESP	0.0461						

Source: The country code in this study conforms to the ISO 3166 country code, which is available in the Online Browsing Platform of International Organization for Standardization (https://www.iso.org/obp/ui/).

modest.

To investigate the relationship between technology capital intensity ϕ_j and the impact of the technology protection policy in China on the total inward FDI (technology) flow in host countries, we conduct a simple regression analysis. The dependent variable is the rate of change in the total inward FDI (technology) flow in each country in the steady state equilibrium, resulting from an 80% restriction on technology transfer from China. The independent variables include the technology capital intensity ϕ_j, the share of FDI from China FDI_share_CHN, and an interaction term between these variables for each country in the baseline equilibrium. It is worth noting that both variables have been

Table 12: Estimation results.

	(1)
Independent variables	Coefficients
ϕ_j	-0.343^{***}
	(0.019)
FDI_share_CHN	-0.780^{***}
	(0.016)
$\phi_j \times FDI\_share\_CHN$	-1.885^{**}
	(0.819)
N	88
R^2	0.980

Note: The dependent variable is the change rate of inward FDI as a result of the reduction of $\omega_{CHN,j,t}$ in 80%;
The constant is included in the estimated model;
Standard errors in parentheses;
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 13: Changes in inward FDI in the US and China (%).

	(1)	(2)	(3)
Country	From the US	From China	From other
China	-80.0154		-0.0771
US		-80.6653	-3.3264

Note: We calculate the change in inward FDI when the economy moves from the counterfactual steady state equilibrium wherein the openness for foreign technology $\omega_{ij,t}$ decreases by 80% between the US and China to the baseline steady state equilibrium.

standardized, with a mean of zero and variance of one. We use ordinary least squares as our estimation method. It is essential to mention that we exclude China from our sample.

The estimation results are displayed in Table 12, indicating that all independent variables exert negative influences on the change rate of the total inward FDI (technology) flow. This suggests that the impact of restricting technology transfer from China is contingent not only on the share of inward FDI from China but also on the technology capital intensity within the host country.

The aforementioned discussion also explains the seemingly paradoxical situation in

Table 14: The results for Japan (%).

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
Restriction between the U.S. and China							
1. Technology restriction	0.0497	-1.1264	1.6629	0.4017	-0.2258	-0.0242	0.4017
2. Trade restriction	0.0495	0.0439	1.3497	0.2363	0.4470	-0.0005	0.2363
3. Both restriction	0.1033	-1.0772	3.1265	0.6571	0.2579	-0.0246	0.6571
Policies							
4. Technology protection in China	-0.1637	-3.9002	3.8867	0.8315	-6.7940	-0.2578	0.8315
5. Export control law in China	0.1410	-16.5567	6.8689	1.8783	1.4680	-0.2770	1.8783
6. Export control law in the U.S.	0.0600	-8.7063	2.3728	1.1131	-0.9973	-0.1564	1.1131
7. All policies	0.0707	-29.4886	14.2947	3.9701	-6.1352	-0.6866	3.9701

Note: We calculate the change in variables when the economy moves from the counterfactual steady state equilibrium wherein (1) the openness for foreign technology $\omega_{ij,t}$ decreases by 80%, (2) trade costs $\tau_{ij,t}$ increase by 20%, and (3) both of them occur between the US and China to the baseline steady state equilibrium. We also calculate it when the economy moves from the counterfactual steady state equilibrium wherein (4) the openness for foreign technology $\omega_{ij,t}$ decreases by 80% from China to all countries, (5) trade costs $\tau_{ij,t}$ increase by 20% from the US to all countries, (6) trade costs $\tau_{ij,t}$ increase by 20% from China to all countries, and (7) all of them occur to the baseline steady state equilibrium. "Inward FDI" is the change in total payment for inward technology transfer from other countries, whereas "Outward" is that of total earning from outward technology transfer to other countries.

Scenario 1, where, in contrast to the initial hypothesis, the US experiences considerable declines in total inward FDI (technology) flow, while China undergoes substantial reductions in total outward FDI (technology) flow. The changes in inward FDI from the opponent country and the rest of the world owing to the bilateral restriction of technology transfer between the US and China are presented in Table 13. Notably, Column (3) shows that the US encounters a noteworthy decrease in inward FDI from countries other than China, which is consistent with the observation that the value of ϕ_j in the US is larger than that in China, as depicted in Table 11.

5.5 Results for Japan

In this section, we focus on the results for Japan. We extract the results for Japan for each counterfactual scenario and show them in Table 14. First, welfare improves slightly when technology transfer, trade, or both are restricted between the US and China, as shown in Table 14 (0.0497%, 0.0495%, and 0.1033%, respectively).

We also find that welfare loss is small in Japan (-0.1637%) when technology transfer from China is restricted owing to China's technology protection policy. This result can be attributed to the fact that the share of inward FDI from China is relatively small in

Japan, as shown in Table 5, and that ϕ_j is small in Japan, as shown in Table 11.

Table 14 shows that total imports largely decrease in Japan (-16.5567%) when exports from China are restricted owing to the export control law in China because the import shares from China are large for Japan, as shown in Table 5. However, Japan gains from the export control laws (0.1410%) because the increase in domestic production of intermediate goods compensates for the decrease in imports, which leads to an increase in disposable income in Japan. We can find similar results for the export control laws in the US.

Finally, we find that welfare slightly improves in Japan (0.0707%) when the impacts of the technology protection policy in China and the export control laws in both China and the US are added together. This result implies that the improvement in welfare owing to increased domestic production through export restrictions outweighs the welfare loss owing to restrictions on technology transfer.

5.6 Summary of the results

In the concluding part of this section, we provide a brief summary of the results. First, contrary to our initial hypothesis, the US experiences significant declines in total inward FDI (technology) flow, while China undergoes substantial reductions in total outward FDI (technology) flow when technology transfer between the US and China is bilaterally restricted. There is a significant reduction in exports from China and imports into the US, in alignment with our hypothesis.

Second, again, in contrast to our initial expectations, the technology protection policy in China does not necessarily significantly impact countries with substantial shares of inward FDI from China. We attribute this result to the production of intermediate goods that can significantly decrease in a host country with a high level of technology capital intensity in production, even if the share of inward FDI from China is not particularly extensive. This, in turn, leads to a significant reduction in FDI (technology) flows from all other countries, resulting in substantial losses for such countries.

Third, countries with larger import shares from both the US and China experience more substantial declines in their imports owing to the export control laws imposed by both countries. However, these import declines do not necessarily translate into welfare losses. Some countries offset the reduction in imports by increasing domestic production in target sectors, thereby boosting disposable income.

Lastly, and notably, when the US–China bilateral decoupling and related policies restrict both trade and technology transfer, the US, China, and the global economy all experience welfare losses.

6 Conclusion

In this study, we quantify the impact of trade and technology transfer restrictions between the US and China, technology protection policies in China, and export control laws in both countries through the US–China technological decoupling. To achieve this, we develop a dynamic quantitative general equilibrium model of trade that considers FDI involving the transfer of technology and intellectual property, allowing us to analyze the restrictions on technology transfer. Our model comprises the final and intermediate goods sectors and assumes that only the intermediate goods sector utilizes technology capital. This assumption is reasonable because high-tech industries, which are the main targets of export control laws, are often found in the intermediate goods sector.

Using this model, we conduct a counterfactual analysis of trade and technology transfer restrictions. Our analysis is based on data from 89 countries for 2016. We find that the US, China, and the world as a whole experience welfare losses when US–China bilateral decoupling and related policies restrict both trade and technology transfer in the target sectors. We further observe that China's technology protection policy affects not only countries with significant technology transfer from China but also those that heavily rely on technology capital in their production. Countries with larger import shares from the US and China experience more substantial declines in imports of intermediate goods, owing to the US and Chinese export control laws. However, these import declines do not necessarily result in welfare losses.

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A Appendix

A.1 Additional tables

Table A.1: “Emerging and foundational technologies” in the ECRA.

	Technology		Technology
1	Biotechnology	8	Logistics technology
2	Artificial intelligence and machine learning technology	9	Additive manufacturing
3	Position, Navigation, and Timing technology	10	Robotics
4	Microprocessor technology	11	Brain-computer interfaces
5	Advanced computing technology	12	Hypersonics
6	Data analytics technology	13	Advanced Materials
7	Quantum information and sensing technology	14	Advanced surveillance technologies

Source: Bureau of Industry and Security. 2018. “Review of controls for certain emerging technologies.” 83 FR 58201 (https://www.federalregister.gov/documents/2018/11/19/2018-25221/review-of-controls-for-certain-emerging-technologies).

Table A.2: Technology categories and product groups in the CCL.

	Technology category		Product group
1	Nuclear materials facilities and equipment (and miscellaneous items)	1	End items, equipment, accessories, attachments, parts, components, and systems
2	Materials, chemicals, microorganisms, and toxins	2	Test, inspection and production equipment
3	Materials processing	3	Materials
4	Electronics	4	Software
5	Computers	5	Technology
6	Telecommunications and information security		
7	Sensors and lasers		
8	Navigation and avionics		
9	Marine		
10	Aerospace and propulsion		

Source: Bureau of Industry and Security. "Commerce Control List." (https://www.bis.doc.gov/index.php/regulations/commerce-control-list-ccl).

Table A.3: Product groups in the USML.

	Product group		Product group
1	Firearms and related articles	12	Fire control, laser, imaging, and guidance equipment
2	Guns and armament	13	Materials and miscellaneous articles
3	Ammunition and ordnance	14	Toxicological agents, including chemical agents, biological agents, and associated equipment
4	Launch vehicles, guided missiles, ballistic missiles, rockets, torpedoes, bombs, and mines	15	Spacecraft and related articles
5	Explosives and energetic materials, propellants, incendiary agents, and their constituents	16	Nuclear weapons related articles
6	Surface vessels of war and special naval equipment	17	Classified articles, technical data, and defense services not otherwise enumerated
7	Ground vehicles	18	Directed energy weapons
8	Aircraft and related articles	19	Gas turbine engines and associated equipment
9	Military training equipment and training	20	Submersible vessels and related articles
10	Personal protective equipment	21	Articles, technical data, and defense services not otherwise enumerated
11	Military electronics		

Source: The Directorate of Defense Trade Controls. "The US Munitions List." (https://www.ecfr.gov/current/title-22/chapter-I/subchapter-M/part-121).

Table A.4: Technologies added to the EPRTC of China in 2020

	Technology		Technology
1	Artificial breeding technology of agricultural wild plants	13	Offshore island reef utilization and safety assurance equipment technology
2	Genetic engineering (genes and vectors)	14	Aerospace bearing technology
3	Cashmere goat breeding technology	15	Unmanned aerial vehicle technology
4	Cashmere goat breed nurturing technology	16	Laser technology
5	3D printing technology	17	Large-scale power equipment design technology
6	Application technology of construction machinery	18	Password security technology
7	Basic common technology of machine tool industry	19	Efficient detection technology
8	Large-scale high-speed wind tunnel design and construction technology	20	Information defense technology
9	Large-scale vibration platform design and construction technology	21	Information countermeasure technology
10	Petroleum equipment core component design and manufacturing technology	22	Basic software security enhancement technology
11	Large-scale petrochemical equipment basic process technology	23	Space remote sensing image acquisition technology
12	Heavy machinery industry strategic new product design technology		

Source: Ministry of Commerce, People's Republic of China. "Ministry of Commerce and Ministry of Science and Technology announcement No. 38 of 2020: Announcement on the adjustment and publication of the Export Prohibited and Restricted Technology Catalogue." (http://www.mofcom.gov.cn/article/b/c/202008/20200802996641.shtml).

Table A.5: Descriptive statistics.

	Mean	Variance	IQR	Min	Max
X_{ij}	3.1784	10620.8466	0.1602	0.0000	8626.2760
K_j	5521.8855	143950878.5000	3120.5754	57.4551	80571.5440
M_j	9.4002	2168.3029	1.2465	0.0000	394.9041
Y_j^m	282.8753	1197983.2200	178.4857	0.0315	9671.7042
E_j	1224.0968	8770244.0040	838.0252	15.9273	19767.3400
L_j	32.7462	9843.9358	20.0664	0.1960	798.5303
$\tau_{ij}^{1-\sigma}$	0.0061	0.0011	0.0008	0.0000	1.0000
ω_{ij}	0.0155	0.0122	0.0000	0.0000	1.0000
$\delta_{j,K}$	0.0451	0.0001	0.0135	0.0249	0.0787
$\delta_{j,M}$	0.0451	0.0001	0.0135	0.0249	0.0787
η_j	0.0112	0.0006	0.0082	0.0001	0.1572
ϕ_j	0.0700	0.0180	0.0494	0.0009	0.9058
μ_j	0.1736	0.0303	0.1904	0.0101	0.9076

Note: "IQR" stands for the interquartile range, "Min" for the minimum, and "Max" for the maximum. The number of labors L_i is in millions. The export value X_{ij}, physical capital stock K_j, technology capital stock M_j, output of intermediate goods Y_j^m, and expenditure of final goods E_j are in billions of current USD.

Table A.6: List of 89 sample countries.

Country	ISO code	Country	ISO code	Country	ISO code
Angola	AGO	Hungary	HUN	Poland	POL
Argentina	ARG	India	IND	Portugal	PRT
Australia	AUS	Indonesia	IDN	Qatar	QAT
Austria	AUT	Iran	IRN	Romania	ROM
Azerbaijan	AZE	Iraq	IRQ	Russia	RUS
Belgium	BEL	Ireland	IRL	Saudi Arabia	SAU
Bangladesh	BGD	Israel	ISR	Serbia	SER
Belarus	BLR	Italy	ITA	Singapore	SGP
Brazil	BRA	Japan	JPN	Slovak Republic	SVK
Bulgaria	BGR	Kazakhstan	KAZ	Slovenia	SVN
Canada	CAN	Kenya	KEN	South Africa	ZAF
Chile	CHL	Korea, Republic of	KOR	Spain	ESP
China	CHN	Kuwait	KWT	Sri Lanka	LKA
Colombia	COL	Lebanon	LBN	Sudan	SDN
Croatia	HRV	Lithuania	LTU	Sweden	SWE
Czech Republic	CZE	Latvia	LVA	Switzerland	CHE
Cyprus	CYP	Luxembourg	LUX	Syria	SYR
Denmark	DNK	North Macedonia	MKD	Tanzania	TZA
Dominican Republic	DOM	Malaysia	MYS	Thailand	THA
Ecuador	ECU	Malta	MLT	Tunisia	TUN
Egypt	EGY	Mexico	MEX	Turkey	TUR
Estonia	EST	Morocco	MAR	Turkmenistan	TKM
Ethiopia	ETH	Netherlands	NLD	Ukraine	UKR
Finland	FIN	New Zealand	NZL	United Kingdom	GBR
France	FRA	Nigeria	NGA	United States	USA
Germany	DEU	Norway	NOR	Uzbekistan	UZB
Ghana	GHA	Oman	OMN	Venezuela	VEN
Greece	GRC	Pakistan	PAK	Vietnam	VNM
Guatemala	GTM	Peru	PER	Zimbabwe	ZWE
Hong Kong	HKG	Philippines	PHL		

Source: The ISO code in this study conforms to ISO 3166 country code, which is available in Online Browsing Platform of International Organization for Standardization (https://www.iso.org/obp/ui/).

Table A.7: Calibration results of parameters.

Country	(1) μ_j	(2) $\delta_{j,K}$, $\delta_{j,M}$	(3) η_j	Country	(1) μ_j	(2) $\delta_{j,K}$, $\delta_{j,M}$	(3) η_j
AGO	0.0276	0.0457	0.0022	KWT	0.0908	0.0563	0.0014
ARG	0.0582	0.0354	0.0061	LBN	0.0468	0.0350	0.0010
AUS	0.0926	0.0330	0.0121	LKA	0.0276	0.0653	0.0014
AUT	0.3118	0.0412	0.0058	LTU	0.1539	0.0398	0.0007
AZE	0.0259	0.0565	0.0005	LUX	0.2298	0.0436	0.0090
BEL	0.4354	0.0412	0.0078	LVA	0.1456	0.0303	0.0009
BGD	0.0203	0.0406	0.0042	MAR	0.1444	0.0507	0.0027
BGR	0.1270	0.0530	0.0008	MEX	0.1918	0.0384	0.0202
BLR	0.0789	0.0429	0.0012	MKD	0.0831	0.0360	0.0003
BRA	0.0743	0.0495	0.0261	MLT	0.3993	0.0584	0.0002
CAN	0.1992	0.0351	0.0177	MYS	0.4854	0.0519	0.0061
CHE	0.3878	0.0487	0.0082	NGA	0.0101	0.0357	0.0059
CHL	0.0705	0.0420	0.0036	NLD	0.3988	0.0429	0.0182
CHN	0.5130	0.0541	0.1572	NOR	0.1601	0.0376	0.0036
COL	0.0334	0.0382	0.0040	NZL	0.0969	0.0364	0.0013
CYP	0.1424	0.0316	0.0008	OMN	0.0925	0.0468	0.0013
CZE	0.4517	0.0478	0.0046	PAK	0.0221	0.0718	0.0031
DEU	0.4224	0.0362	0.0416	PER	0.0402	0.0435	0.0025
DNK	0.2315	0.0418	0.0033	PHL	0.1265	0.0447	0.0044
DOM	0.0663	0.0325	0.0012	POL	0.1851	0.0491	0.0057
ECU	0.0327	0.0408	0.0020	PRT	0.1376	0.0317	0.0058
EGY	0.0267	0.0545	0.0033	QAT	0.0686	0.0787	0.0025
ESP	0.1639	0.0364	0.0231	ROM	0.1419	0.0628	0.0031
EST	0.2646	0.0439	0.0004	RUS	0.0386	0.0340	0.0363
ETH	0.0225	0.0509	0.0008	SAU	0.0735	0.0583	0.0125
FIN	0.2265	0.0381	0.0027	SDN	0.0140	0.0478	0.0005
FRA	0.2090	0.0352	0.0351	SER	0.1180	0.0387	0.0012
GBR	0.1592	0.0371	0.0308	SGP	0.6961	0.0533	0.0043
GHA	0.0322	0.0463	0.0010	SVK	0.4952	0.0465	0.0014
GRC	0.0674	0.0298	0.0050	SVN	0.3730	0.0409	0.0009
GTM	0.0309	0.0386	0.0008	SWE	0.2501	0.0402	0.0057
HKG	0.9076	0.0338	0.0051	SYR	0.0141	0.0509	0.0008
HRV	0.1116	0.0429	0.0011	THA	0.2405	0.0621	0.0104
HUN	0.4262	0.0450	0.0030	TKM	0.0368	0.0417	0.0011
IDN	0.0548	0.0424	0.0290	TUN	0.1730	0.0438	0.0007
IND	0.0457	0.0545	0.0577	TUR	0.0968	0.0516	0.0180
IRL	0.3627	0.0567	0.0044	TZA	0.0273	0.0438	0.0007
IRN	0.0415	0.0414	0.0124	UKR	0.0407	0.0249	0.0111
IRQ	0.0304	0.0528	0.0014	USA	0.1575	0.0441	0.1363
ISR	0.1937	0.0430	0.0024	UZB	0.0188	0.0469	0.0016
ITA	0.2297	0.0357	0.0381	VEN	0.1054	0.0429	0.0012
JPN	0.3940	0.0418	0.0542	VNM	0.4746	0.0550	0.0030
KAZ	0.0354	0.0524	0.0020	ZAF	0.1086	0.0520	0.0054
KEN	0.0342	0.0585	0.0008	ZWE	0.0243	0.0535	0.0001
KOR	0.5236	0.0510	0.0197				

Note: The intermediate goods intensity μ_j is calculated as $\mu_j = E^m_{j,t}/Y^f_{j,t}$, following Eq. (28). Data for the depreciation rates of physical capital $\delta_{j,K}$ and technology capital $\delta_{j,M}$ are obtained from "Average depreciation rate of the capital stock" in Penn World Tables 10.0. The share of technology capital of a country to all destinations η_i is calibrated as $\eta_i = \frac{\sum_{j=1}^{N} FDI^{value}_{ij,\bar{t}}}{\sum_{i=1}^{N}\sum_{j=1}^{N} FDI^{value}_{ij,\bar{t}}}$, where $\bar{t}$ represents the baseline year, which is 2016 in this study.

Table A.8: The share of inward FDI from China and import from the United States and China (all countries).

Country	(1) Inward FDI share from China	(2) Import share from China	(3) Import share from the U.S.	Country	(1) Inward FDI share from China	(2) Import share from China	(3) Import share from the U.S.
AGO	0.0518	0.1331	0.2324	KWT	0.1672	0.0898	0.2087
ARG	0.0261	0.1508	0.1669	LBN	0.0010	0.1382	0.1102
AUS	0.0510	0.1763	0.1626	LKA	0.3569	0.2374	0.0211
AUT	0.0028	0.0211	0.0414	LTU	0.0003	0.0686	0.0348
AZE	0.0115	0.0467	0.1184	LUX	0.0029	0.1349	0.0984
BEL	0.0000	0.0350	0.1281	LVA	0.0061	0.0705	0.0241
BGD	0.1188	0.3667	0.0164	MAR	0.0096	0.0843	0.0577
BGR	0.0088	0.0552	0.0180	MEX	0.0020	0.1058	0.6067
BLR	0.0773	0.1343	0.0276	MKD	0.0014	0.0405	0.0157
BRA	0.0055	0.1747	0.2402	MLT	0.0036	0.2020	0.0200
CAN	0.0142	0.0529	0.6909	MYS	0.0551	0.2003	0.1118
CHE	0.0004	0.0231	0.0860	NGA	0.0482	0.3308	0.0958
CHL	0.0030	0.1710	0.2666	NLD	0.0062	0.1809	0.1155
CHN	0.0000	0.0000	0.0947	NOR	0.0179	0.0293	0.0831
COL	0.0039	0.1825	0.2806	NZL	0.0256	0.1119	0.1464
CYP	0.0006	0.0651	0.0376	OMN	0.0189	0.0892	0.1345
CZE	0.0057	0.0999	0.0196	PAK	0.3939	0.4641	0.0507
DEU	0.0048	0.0754	0.0713	PER	0.0162	0.1938	0.2246
DNK	0.0024	0.0691	0.0369	PHL	0.0178	0.2068	0.0967
DOM	0.0001	0.1147	0.4694	POL	0.0010	0.0952	0.0269
ECU	0.1142	0.2026	0.2018	PRT	0.0168	0.0975	0.0195
EGY	0.0218	0.1898	0.0692	QAT	0.0553	0.0366	0.2853
ESP	0.0017	0.0614	0.0447	ROM	0.0069	0.0611	0.0145
EST	0.0009	0.0767	0.0222	RUS	0.0311	0.1919	0.0520
ETH	0.7271	0.3217	0.1177	SAU	0.0564	0.0992	0.2392
FIN	0.0000	0.0540	0.0299	SDN	0.7369	0.3493	0.0032
FRA	0.0038	0.0438	0.0849	SER	0.0064	0.0402	0.0143
GBR	0.0006	0.0804	0.1141	SGP	0.0597	0.2040	0.1439
GHA	0.2775	0.3119	0.1021	SVK	0.0006	0.0710	0.0047
GRC	0.0004	0.1160	0.0245	SVN	0.0009	0.0795	0.0118
GTM	0.0002	0.1523	0.3380	SWE	0.0117	0.0420	0.0394
HKG	0.7348	0.6078	0.0451	SYR	0.0203	0.2480	0.0002
HRV	0.0006	0.0475	0.0135	THA	0.0408	0.2368	0.0759
HUN	0.0008	0.0913	0.0292	TKM	0.2939	0.0680	0.0313
IDN	0.0911	0.2569	0.0336	TUN	0.0038	0.0922	0.0206
IND	0.0200	0.3417	0.0685	TUR	0.0037	0.1273	0.0700
IRL	0.0005	0.0482	0.2121	TZA	0.2319	0.4202	0.0212
IRN	0.5004	0.4188	0.0014	UKR	0.0017	0.1188	0.0386
IRQ	0.0602	0.2610	0.0949	USA	0.0073	0.1837	0.0000
ISR	0.0073	0.1044	0.2018	UZB	0.2712	0.2240	0.0638
ITA	0.0001	0.0781	0.0643	VEN	0.0910	0.2458	0.3178
JPN	0.0031	0.3119	0.1659	VNM	0.1160	0.2869	0.0532
KAZ	0.0477	0.2151	0.0812	ZAF	0.0677	0.1650	0.0797
KEN	0.2218	0.3562	0.0412	ZWE	0.8706	0.2071	0.0161
KOR	0.0345	0.3175	0.1492	World	0.0375	0.1547	0.1107

Note: "World" calculates the share of total inward FDI from China in total inward FDI in the world, the share of total imports from China in total imports in the world, and the share of total imports from the United States in total imports in the world.
Source: FDI data are from the International Direct Investment Statistics database (OECD), CEIC China Premium Database, Direct Investments according to the directional principle (National Bank of Kazakhstan), External Sector Statistics (Bank of Russia), and External Sector Statistics (National Bank of Ukraine). Trade data are from the COMTRADE database (UNSD). The country code conforms to ISO 3166 country code, which is available in Online Browsing Platform of International Organization for Standardization (https://www.iso.org/obp/ui/).

A.2 Additional counterfactual analysis

Table A.9: The impacts of “soft” technology and trade restrictions between the United States and China (%).

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
A. Technology restriction							
China	-0.0184	-0.0470	0.0779	-0.0106	-0.0325	-0.0204	-0.0106
United States	-0.0464	0.4863	-0.7420	-0.4648	0.0506	-0.0235	-0.4648
World	-0.0103	0.0375	0.0375	-0.0306	-0.0306	-0.0110	-0.0170
B. Trade restriction							
China	-0.0937	-2.1229	-3.5616	-0.3305	0.1826	-0.0289	-0.3305
United States	-0.0279	-2.5059	-0.6253	0.4835	0.0925	-0.0577	0.4835
World	-0.0142	-0.4807	-0.4807	0.1610	0.1610	-0.0156	-0.0182
C. Both restrictions							
China	-0.1125	-2.1547	-3.4984	-0.3441	0.1522	-0.0490	-0.3441
United States	-0.0743	-2.0213	-1.3630	0.0242	0.1443	-0.0815	0.0242
World	-0.0244	-0.4429	-0.4429	0.1322	0.1322	-0.0266	-0.0352

Note: We calculate the change in variables when the economy moves from the counterfactual steady state equilibrium wherein the openness for foreign technology $\omega_{ij,t}$ decreases in 20% (in the panel labeled “Technology restriction”), trade costs $\tau_{ij,t}$ increase in 5% (in the panel labeled “Trade restriction”), and both of them occur (in the panel labeled “Both restrictions”) between the United States and China to the baseline steady state equilibrium. “Inward FDI” is the change in total payment for inward technology transfer from other countries, while “Outward” is that of total earning from outward technology transfer to other countries.

Table A.10: The impacts of the "soft" technology protection policy in China (%).

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
China	-0.0058	-1.2431	0.6270	0.1233	-1.0799	-0.0248	0.1233
United States	-0.0585	0.1390	-0.4030	-0.2238	-1.1033	-0.0415	-0.2238
A. Largest FDI share							
Zimbabwe	-0.0039	-0.0045	0.0899	0.0762	-1.9606	-0.0032	0.0762
Sudan	-0.0020	-0.0066	0.1871	0.5339	-2.0611	-0.0013	0.5339
Hong Kong	-1.8305	-1.8586	-2.0131	-2.2424	-0.7695	-1.0369	-2.2424
B. Worst welfare loss							
(in Table 7)							
Singapore	-1.2820	-0.7448	-1.8232	-1.7952	-0.6466	-0.7061	-1.7952
Ireland	-0.8297	0.8058	-3.0169	-2.1568	-0.9177	-0.3706	-2.1568
Switzerland	-0.6719	0.2176	-2.3522	-1.7882	-0.9074	-0.3059	-1.7882
World	-0.0582	-0.1641	-0.1641	-0.9869	-0.9869	-0.0455	-0.0749

Note: We calculate the change in variables when the economy moves from the counterfactual steady state equilibrium wherein the openness for foreign technology $\omega_{ij,t}$ decreases in 20% from China to all countries to the baseline steady state equilibrium. Zimbabwe, Sudan, and Hong Kong are listed because they have the largest share of inward FDI from China in the sample countries. Singapore, Ireland, and Switzerland are listed because the welfare losses are the worst except for Hong Kong in Table 7. "Inward FDI" is the change in total payment for inward technology transfer from other countries, while "Outward" is that of total earning from outward technology transfer to other countries.

Table A.11: The impacts of the "soft" export control law in China (%).

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
China	-0.5189	-1.3177	-18.9189	-2.4067	0.6719	0.0160	-2.4067
United States	0.0069	-2.3916	1.7403	1.1562	0.3894	-0.0609	1.1562
A. Largest import share							
Hong Kong	-7.4469	-5.8793	1.8166	0.0961	0.8189	-23.1284	0.0961
Pakistan	-0.0293	-1.9803	4.7405	7.6168	0.7374	-0.0389	7.6168
Tanzania	-0.0499	-0.2318	6.1464	7.1429	0.7814	-0.0528	7.1429
B. Worst welfare loss							
(in Table 8)							
Singapore	-0.4498	-2.5737	2.7864	0.0066	0.8564	-1.0197	0.0066
Malta	-0.4240	-0.8032	1.0118	0.4573	0.8589	-0.5472	0.4573
Netherlands	-0.1548	-1.1599	1.1995	0.7879	0.4742	-0.3945	0.7879
C. Largest welfare gain							
(in Table 8)							
Germany	0.0974	-0.9351	1.7676	0.8133	0.4957	-0.0881	0.6715
Belgium	0.0724	-0.0866	1.8729	0.7160	0.3641	-0.1043	0.7160
Switzerland	0.0672	-0.0469	1.7317	0.4179	0.5128	-0.0579	0.4179
World	-0.1040	-1.7190	-1.7190	0.5905	0.5905	-0.1346	-0.3973

Note: We calculate the change in variables when the economy moves from the counterfactual steady state equilibrium wherein the trade costs $\tau_{ij,t}$ increases in 5% from China to all countries to the baseline steady state equilibrium. Hong Kong, Pakistan, and Tanzania are listed because they have the largest share of import in target sectors from China in the sample countries. Singapore, Malta, and the Netherlands are listed because the welfare losses are the worst except for Hong Kong, while Germany, Belgium, and Switzerland are listed because the welfare gains are the largest in Table 8. "Inward FDI" is the change in total payment for inward technology transfer from other countries, while "Outward" is that of total earning from outward technology transfer to other countries.

Table A.12: The impacts of the "soft" export control law in the United States (%).

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
China	0.0021	-1.9560	0.9382	0.1537	-0.3687	-0.0358	0.1537
United States	-0.2062	-1.6431	-17.4914	-4.4181	0.4350	0.0270	-4.4181
A. Largest import share							
Canada	-0.1984	-5.7399	-2.0165	3.1313	-0.4355	-0.4681	3.1313
Mexico	-0.0522	-6.9849	-0.7352	2.5016	-0.8501	-0.2796	2.5016
Dominican Republic	0.0017	-5.3956	-0.8055	3.2365	0.3334	-0.0659	3.2365
B. Worst welfare loss (in Table 9)							
Hong Kong	-0.6733	-0.5205	0.4329	-0.0541	-0.7518	-1.9294	-0.0541
Singapore	-0.3338	-1.4418	0.1852	0.1122	-0.6898	-0.8404	0.1122
Netherlands	-0.1810	-0.6641	0.2213	0.2695	-0.3795	-0.2781	0.2695
C. Largest welfare gain (in Table 9)							
Germany	0.0507	-0.9313	0.8866	0.7007	-0.3726	-0.0975	0.5590
Slovak Republic	0.0463	0.0833	0.8159	0.3290	-0.7971	-0.0463	0.3290
Slovenia	0.0376	-0.0309	0.7827	0.4183	-0.3675	-0.0340	0.4183
World	-0.0459	-1.2862	-1.2862	-0.3160	-0.3160	-0.0513	-0.0941

Note: We calculate the change in variables when the economy moves from the counterfactual steady state equilibrium wherein the trade costs $\tau_{ij,t}$ increases in 5% from the United States to all countries to the baseline steady state equilibrium. Canada, Mexico, and Dominican Republic are listed because they have the largest share of import in target sectors from the United States in the sample countries. Hong Kong, Singapore, and the Netherlands are listed because the welfare losses are the worst except for Canada and the United States, while Germany, Slovak Republic, and Slovenia are listed because the welfare gains are the largest in Table 9. "Inward FDI" is the change in total payment for inward technology transfer from other countries, while "Outward" is that of total earning from outward technology transfer to other countries.

Table A.13: The impacts of unilateral restrictions between the United States and China (%).

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
A. China to the United States							
China	-0.2494	-1.4280	-9.3434	-1.1245	0.5301	-0.0054	-1.1245
United States	-0.3548	-3.2452	-5.7166	-0.7143	0.6591	-0.3421	-0.7143
World	-0.0737	-0.8391	-0.8391	0.4795	0.4795	-0.0828	-0.0772
B. The United States to China							
China	-0.1602	-4.8746	-0.6305	0.0515	-0.2074	-0.2217	0.0515
United States	-0.0570	-0.4519	-1.2670	-1.1638	-0.0108	0.0052	-1.1638
World	-0.0401	-0.2590	-0.2590	-0.1973	-0.1973	-0.0409	-0.0962

Note: We calculate the change in variables when the economy moves from the counterfactual steady state equilibrium wherein the openness for foreign technology $\omega_{ij,t}$ decreases in 80% and trade costs $\tau_{ij,t}$ increase in 20% from China to the United States (in the panel labeled "China to the U.S.") and from the United States to China (in the panel labeled "The U.S. to China") to the baseline steady state equilibrium. "Inward FDI" is the change in total payment for inward technology transfer from other countries, while "Outward" is that of total earning from outward technology transfer to other countries.

Table A.14: Full results of technology restriction between the United States and China.

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
AGO	-0.0048	-1.7811	0.8048	0.1152	-1.2247	0.0000	0.1152
ARG	-0.0019	-0.5276	1.0889	0.8126	-0.9025	-0.0102	0.8126
AUS	-0.0137	-0.1899	1.0777	0.8630	-0.3391	-0.0242	0.8630
AUT	0.0191	-0.0560	0.7904	0.3655	-0.4074	-0.0311	0.3655
AZE	-0.0048	-0.0215	0.3608	0.6102	0.1798	-0.0052	0.6102
BEL	-0.0287	-0.1983	0.5638	0.3902	0.3253	-0.1473	0.3902
BGD	-0.0012	-0.0385	0.6073	0.4556	0.2084	-0.0018	0.4556
BGR	-0.0005	-0.0828	0.4212	0.2471	-0.4137	-0.0075	0.2471
BLR	-0.0002	-0.1694	0.4382	0.2843	-1.6009	-0.0034	0.2843
BRA	0.0003	-1.0826	1.3732	0.7849	-1.1037	-0.0120	0.7849
CAN	0.0242	-1.3213	2.3041	2.3443	-0.3019	-0.1617	2.3443
CHE	-0.0251	-0.0238	0.5887	0.2293	-0.2383	-0.1013	0.2293
CHL	-0.0212	-0.2472	1.1025	1.2053	-0.5077	-0.0272	1.2053
CHN	-0.1326	-0.3239	0.5549	-0.0771	-0.2332	-0.1471	-0.0771
COL	-0.0080	-0.4139	1.6051	1.6406	-0.4191	-0.0120	1.6406
CYP	-0.0246	-0.0101	0.0392	-0.0133	-0.4753	-0.0148	-0.0133
CZE	0.0182	-0.0611	0.5344	0.2372	-0.3549	-0.0372	0.2372
DEU	0.0676	-0.2613	0.9341	0.6042	-0.2526	-0.0478	0.4627
DNK	0.0167	-0.0560	0.8021	0.4422	-0.2082	-0.0242	0.4422
DOM	0.0192	-1.6761	3.4479	2.0025	0.2036	-0.0222	2.0025
ECU	-0.0064	-0.1524	1.2587	1.6017	0.2224	-0.0100	1.6017
EGY	-0.0017	-0.1246	0.6662	0.5419	0.4377	-0.0034	0.5419
ESP	0.0082	-0.1917	0.7373	0.3658	-0.2544	-0.0125	0.3658
EST	0.0058	-0.0360	0.4254	0.2950	-0.2141	-0.0232	0.2950
ETH	-0.0046	-0.0448	0.7533	0.9699	0.1617	-0.0050	0.9699
FIN	0.0130	-0.0916	0.7260	0.3672	-0.3193	-0.0193	0.3672
FRA	0.0168	-0.3161	0.8250	0.4658	-0.2196	-0.0228	0.4658
GBR	-0.0017	-0.1636	0.8087	0.4925	-0.2558	-0.0314	0.4925
GHA	-0.0091	-0.0636	1.2549	0.9811	-1.6834	-0.0066	0.9811
GRC	-0.0071	-0.0700	0.6277	0.4376	-0.4838	-0.0052	0.4376
GTM	-0.0132	-0.2644	2.0878	2.2023	-0.9607	-0.0143	2.2023
HKG	-0.3980	-0.2456	0.4209	0.1525	-0.5611	-1.5111	0.1525
HRV	0.0028	-0.0335	0.8372	0.4396	-0.7711	-0.0059	0.4396
HUN	0.0026	-0.0398	0.4712	0.1907	-0.2652	-0.0494	0.1907
IDN	-0.0033	-0.3249	0.9731	0.3235	-1.2189	-0.0026	0.3235
IND	0.0000	-0.5485	1.0184	0.4676	-0.5929	-0.0025	0.4676
IRL	-0.0403	-0.2981	0.8822	0.3178	-0.3488	-0.1582	0.3178
IRN	-0.0047	-0.1982	0.5860	0.2320	-0.9017	-0.0016	0.2320
IRQ	-0.0053	-0.0059	0.4206	0.4611	0.3016	-0.0058	0.4611
ISR	0.0320	-0.6067	1.5641	1.0137	-0.2363	-0.0425	1.0137
ITA	0.0259	-0.3551	0.9339	0.4344	-0.2127	-0.0155	0.4344
JPN	0.0497	-1.1264	1.6629	0.4017	-0.2258	-0.0242	0.4017
KAZ	-0.0021	-0.0811	0.2966	0.4607	0.2248	-0.0052	0.4607
KEN	-0.0025	-0.0959	0.5423	0.4929	0.2905	-0.0038	0.4929
KOR	0.0553	-0.8585	1.2575	0.4099	-0.2186	-0.0592	0.4099
KWT	-0.0118	-0.5072	0.5126	0.8935	-0.7928	-0.0211	0.8935

(continued)

Table A.14: Full results of technology restriction between the United States and China (continued).

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
LBN	-0.0088	-0.1544	0.6336	0.7900	-0.7737	-0.0085	0.7900
LKA	-0.0032	-0.0895	0.5793	0.4378	-1.2684	-0.0018	0.4378
LTU	0.0015	-0.0887	0.3850	0.3183	-0.4641	-0.0122	0.3183
LUX	-0.0925	-0.1047	0.0760	-0.0409	-0.2058	-0.0581	-0.0409
LVA	-0.0009	-0.0581	0.4428	0.3561	-0.5962	-0.0114	0.3561
MAR	0.0042	-0.3360	0.4935	0.2586	0.3139	-0.0080	0.2586
MEX	0.1215	-1.7302	3.1857	2.5838	-0.6472	-0.0977	2.5838
MKD	0.0041	-0.0980	0.4385	0.2353	0.1917	-0.0032	0.2353
MLT	-0.0400	0.0682	0.9967	0.2984	-0.7211	-0.0753	0.2984
MYS	0.0318	-0.6144	1.2476	0.3670	-0.6110	-0.0552	0.3670
NGA	-0.0043	-0.0182	0.5869	0.7267	-1.0794	-0.0020	0.7267
NLD	-0.0807	-0.2090	0.2390	0.1305	-0.2449	-0.1238	0.1305
NOR	-0.0109	-0.1020	0.5144	0.4654	-0.2072	-0.0265	0.4654
NZL	-0.0158	-0.0944	1.0447	0.8146	-0.3780	-0.0252	0.8146
OMN	-0.0082	-0.2126	0.7839	0.7285	0.2760	-0.0175	0.7285
PAK	-0.0017	-0.1318	0.8031	0.6744	0.4635	-0.0028	0.6744
PER	-0.0141	-0.1336	1.4500	1.4438	-1.1960	-0.0138	1.4438
PHL	0.0072	-0.4289	1.5482	0.5155	-0.7797	-0.0124	0.5155
POL	0.0044	-0.1327	0.5488	0.2702	-0.3097	-0.0125	0.2702
PRT	0.0024	-0.0957	0.4480	0.3239	-0.3410	-0.0085	0.3239
QAT	-0.0275	-0.1855	0.5358	1.0178	-1.1007	-0.0284	1.0178
ROM	0.0042	-0.0916	0.5015	0.2279	0.4204	-0.0066	0.2279
RUS	-0.0028	-0.1867	0.4583	0.4089	-0.2379	-0.0035	0.4089
SAU	-0.0023	-0.8384	0.6935	0.8920	0.3438	-0.0154	0.8920
SDN	-0.0009	-0.0055	0.3473	0.4295	0.1675	-0.0010	0.4295
SER	-0.0015	-0.0986	0.5089	0.2210	-2.5020	-0.0046	0.2210
SGP	-0.1063	-0.3892	0.4751	0.1430	-0.5311	-0.3824	0.1430
SVK	0.0267	0.0418	0.5434	0.2181	-0.6226	-0.0350	0.2181
SVN	0.0231	-0.0192	0.4857	0.2657	-0.2587	-0.0223	0.2657
SWE	0.0143	-0.0358	0.7235	0.3700	-0.2165	-0.0276	0.3700
SYR	-0.0003	-0.0048	0.5979	0.3193	0.2043	-0.0007	0.3193
THA	0.0151	-0.3764	1.0834	0.4947	-0.6492	-0.0200	0.4947
TKM	-0.0004	-0.0708	0.4454	0.3094	0.3397	-0.0020	0.3094
TUN	0.0060	-0.2017	0.5245	0.1742	0.2889	-0.0052	0.1742
TUR	0.0003	-0.3868	0.6821	0.3665	-0.2680	-0.0065	0.3665
TZA	-0.0026	-0.0116	0.7960	0.6005	0.1936	-0.0030	0.6005
UKR	-0.0091	-0.1448	0.4655	0.3674	-0.7972	-0.0029	0.3674
USA	-0.3318	3.5195	-5.2410	-3.3264	0.3616	-0.1677	-3.3264
UZB	-0.0005	-0.1845	0.6586	0.5049	0.2765	-0.0018	0.5049
VEN	-0.0297	-0.4588	1.4832	1.5160	20.2603	-0.0458	1.5160
VNM	0.0276	-0.2889	1.1806	0.3319	-1.4917	-0.0442	0.3319
ZAF	0.0001	-0.3582	0.8356	0.4727	-0.6096	-0.0102	0.4727
ZWE	-0.0017	-0.0068	0.4763	0.3028	0.1695	-0.0018	0.3028
World	-0.0732	0.2787	0.2787	-0.2095	-0.2095	-0.0788	-0.1218

Note: We calculate the change in variables when the economy moves from the counterfactual steady state equilibrium wherein the openness for foreign technology $\omega_{ij,t}$ decreases in 80% between the United States and China to the baseline steady state equilibrium. "Inward FDI" is the change in total payment for inward technology transfer from other countries, while "Outward" is that of total earning from outward technology transfer to other countries.

Table A.15: Full results of trade restriction between the United States and China.

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
AGO	0.0036	-0.0660	0.5170	0.1146	0.7664	0.0000	0.1146
ARG	0.0041	-0.0228	0.3120	0.1481	0.7554	-0.0004	0.1481
AUS	0.0091	0.0136	0.8760	0.3973	0.4643	-0.0013	0.3973
AUT	0.0365	0.0665	0.5637	0.2136	0.5706	-0.0004	0.2136
AZE	0.0000	-0.0006	0.0380	0.0789	0.2564	-0.0002	0.0789
BEL	0.0645	0.0812	0.6272	0.3224	0.2387	-0.0076	0.3224
BGD	0.0003	0.0003	0.1386	0.0475	0.2526	0.0000	0.0475
BGR	0.0058	-0.0006	0.1595	0.0773	0.5345	0.0005	0.0773
BLR	0.0021	0.0105	0.0072	0.0021	0.8413	0.0001	0.0021
BRA	0.0078	-0.0349	0.7701	0.2589	0.8075	-0.0005	0.2589
CAN	0.0959	0.3068	3.1616	1.4169	0.4271	-0.0166	1.4169
CHE	0.0751	0.1872	0.7675	0.3239	0.4476	-0.0152	0.3239
CHL	0.0049	-0.0031	0.4823	0.3227	0.6525	-0.0013	0.3227
CHN	-0.2657	-5.8674	-10.1219	-0.9457	0.5253	-0.0795	-0.9457
COL	0.0031	-0.0187	0.4441	0.3065	0.4668	-0.0006	0.3065
CYP	0.0181	0.0176	0.1999	0.1880	0.5822	0.0000	0.1880
CZE	0.0310	0.0339	0.2370	0.0889	0.4458	0.0049	0.0889
DEU	0.0646	0.0956	0.6276	0.2464	0.4529	0.0005	0.2464
DNK	0.0325	0.0524	0.5748	0.2692	0.4400	0.0005	0.2692
DOM	0.0179	-0.0203	3.7954	0.9306	0.2649	-0.0013	0.9306
ECU	0.0009	-0.0033	0.4051	0.4575	0.2499	-0.0004	0.4575
EGY	0.0004	-0.0061	0.0544	0.0350	0.3954	-0.0001	0.0350
ESP	0.0158	-0.0035	0.3307	0.1321	0.4623	0.0006	0.1321
EST	0.0181	0.0199	0.1885	0.1177	0.4431	0.0019	0.1177
ETH	0.0000	-0.0010	0.1224	0.1095	0.2722	-0.0001	0.1095
FIN	0.0279	0.0301	0.4973	0.2295	0.5670	0.0011	0.2295
FRA	0.0242	0.0147	0.4810	0.1984	0.4444	0.0002	0.1984
GBR	0.0279	0.0662	0.8833	0.4008	0.4423	-0.0019	0.4008
GHA	0.0016	-0.0001	0.6946	0.1467	0.8742	-0.0002	0.1467
GRC	0.0079	0.0071	0.1738	0.0861	0.4323	0.0000	0.0861
GTM	0.0020	-0.0093	1.1915	0.4948	0.6819	-0.0008	0.4948
HKG	0.2237	0.2613	0.3334	0.3302	0.6141	-0.0084	0.3302
HRV	0.0113	0.0302	0.5179	0.2298	0.6135	0.0001	0.2298
HUN	0.0511	0.0437	0.3819	0.1727	0.4604	0.0058	0.1727
IDN	0.0047	-0.0042	0.5005	0.0949	0.7339	0.0000	0.0949
IND	0.0049	-0.0081	0.4835	0.1803	0.6327	-0.0001	0.1803
IRL	0.0914	0.4065	1.5009	0.4444	0.5637	-0.0389	0.4444
IRN	0.0041	0.0140	0.0078	0.0146	0.6615	0.0001	0.0146
IRQ	0.0003	0.0003	0.0180	0.0239	0.3071	-0.0002	0.0239
ISR	0.0433	0.1006	1.4763	0.5927	0.4512	-0.0038	0.5927
ITA	0.0290	0.0310	0.5318	0.1952	0.4421	0.0002	0.1952
JPN	0.0495	0.0439	1.3497	0.2363	0.4470	-0.0005	0.2363
KAZ	0.0019	0.0003	0.1929	0.2515	0.1915	0.0000	0.2515
KEN	0.0003	-0.0025	0.0175	0.0155	0.3083	0.0000	0.0155
KOR	0.0661	0.0893	0.8719	0.2319	0.4435	-0.0003	0.2319
KWT	0.0025	-0.0202	0.0273	0.0555	0.7118	-0.0009	0.0555

(continued)

Table A.15: Full results of trade restriction between the United States and China (continued).

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
LBN	0.0027	-0.0043	0.0324	0.0473	0.6174	-0.0004	0.0473
LKA	0.0018	0.0008	0.2276	0.1217	0.7819	0.0000	0.1217
LTU	0.0076	0.0055	0.0921	0.0801	0.4664	0.0006	0.0801
LUX	0.1098	0.1069	0.3511	0.2400	0.4400	-0.0013	0.2400
LVA	0.0109	0.0108	0.1184	0.0935	0.6059	0.0002	0.0935
MAR	0.0020	-0.0044	0.0953	0.0249	0.2918	0.0002	0.0249
MEX	0.1370	0.3412	3.5567	1.7133	0.6500	-0.0095	1.7133
MKD	0.0008	0.0036	0.0898	0.0108	0.2372	0.0002	0.0108
MLT	0.0500	0.1552	1.4971	0.5345	0.5953	-0.0161	0.5345
MYS	0.0451	0.0572	0.9859	0.1905	0.5892	-0.0015	0.1905
NGA	0.0021	0.0015	0.1382	0.0761	0.8783	-0.0001	0.0761
NLD	0.0640	0.0361	0.4536	0.2815	0.4577	0.0000	0.2815
NOR	0.0137	0.0161	0.3198	0.2146	0.4401	-0.0006	0.2146
NZL	0.0082	0.0235	0.8240	0.4513	0.4578	-0.0016	0.4513
OMN	0.0009	-0.0074	0.0997	0.0920	0.2600	-0.0007	0.0920
PAK	0.0003	-0.0008	0.3732	0.1275	0.2965	0.0000	0.1275
PER	0.0020	-0.0024	0.4743	0.3387	0.7545	-0.0007	0.3387
PHL	0.0127	0.0160	1.3634	0.2689	0.6887	-0.0006	0.2689
POL	0.0111	-0.0072	0.2795	0.1090	0.4578	0.0014	0.1090
PRT	0.0150	0.0135	0.2343	0.1102	0.5845	0.0004	0.1102
QAT	0.0025	-0.0035	0.1500	0.1906	0.7214	-0.0014	0.1906
ROM	0.0036	0.0020	0.1598	0.0525	0.3291	0.0006	0.0525
RUS	0.0057	-0.0051	0.0867	0.0771	0.4491	0.0000	0.0771
SAU	0.0017	-0.0385	0.2064	0.1124	0.2674	-0.0007	0.1124
SDN	0.0001	0.0003	0.0334	-0.0037	0.2749	0.0000	-0.0037
SER	0.0050	0.0090	0.2086	0.0565	1.1304	0.0003	0.0565
SGP	0.1406	0.1887	0.5224	0.2680	0.6035	-0.0215	0.2680
SVK	0.0346	0.0537	0.2642	0.1002	0.4512	0.0054	0.1002
SVN	0.0215	0.0293	0.1673	0.0757	0.4422	0.0015	0.0757
SWE	0.0346	0.0620	0.5374	0.2515	0.4435	0.0001	0.2515
SYR	0.0004	0.0007	0.0160	-0.0056	0.2621	0.0000	-0.0056
THA	0.0233	0.0472	0.6502	0.2473	0.6429	-0.0007	0.2473
TKM	0.0006	0.0009	0.0068	0.0050	0.3956	0.0000	0.0050
TUN	0.0021	0.0009	0.1410	0.0218	0.2813	0.0003	0.0218
TUR	0.0063	-0.0061	0.2129	0.0770	0.4330	0.0001	0.0770
TZA	0.0003	0.0002	0.0750	0.0858	0.2651	0.0000	0.0858
UKR	0.0066	0.0073	0.0479	0.0318	0.4864	0.0001	0.0318
USA	-0.0756	-7.1085	-1.7326	1.4064	0.2636	-0.1619	1.4064
UZB	0.0004	-0.0012	0.1798	0.0806	0.2539	0.0000	0.0806
VEN	0.0079	0.0020	1.1020	0.3697	0.9140	-0.0022	0.3697
VNM	0.0382	0.0678	0.8373	0.1809	0.8039	-0.0003	0.1809
ZAF	0.0083	-0.0006	0.5055	0.1861	0.6633	-0.0002	0.1861
ZWE	0.0001	-0.0001	0.0527	0.0296	0.2603	0.0000	0.0296
World	-0.0395	-1.3589	-1.3589	0.4633	0.4633	-0.0435	-0.0505

Note: We calculate the change in variables when the economy moves from the counterfactual steady state equilibrium wherein the trade costs $\tau_{ij,t}$ increase in 20% between the United States and China to the baseline steady state equilibrium. "Inward FDI" is the change in total payment for inward technology transfer from other countries, while "Outward" is that of total earning from outward technology transfer to other countries.

Table A.16: Full results of technology and trade restrictions between the United States and China.

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
AGO	-0.0009	-1.8485	1.3656	0.2404	-0.3967	0.0000	0.2404
ARG	0.0025	-0.5514	1.4271	0.9725	-0.0863	-0.0106	0.9725
AUS	-0.0038	-0.1753	2.0263	1.2933	0.1630	-0.0256	1.2933
AUT	0.0588	0.0164	1.4017	0.5970	0.2096	-0.0313	0.5970
AZE	-0.0048	-0.0221	0.4008	0.6933	0.4588	-0.0054	0.6933
BEL	0.0418	-0.1097	1.2436	0.7399	0.5845	-0.1549	0.7399
BGD	-0.0009	-0.0381	0.7555	0.5046	0.4832	-0.0018	0.5046
BGR	0.0058	-0.0829	0.5939	0.3303	0.1634	-0.0069	0.3303
BLR	0.0021	-0.1574	0.4444	0.2855	-0.6926	-0.0032	0.2855
BRA	0.0087	-1.1192	2.2087	1.0656	-0.2324	-0.0125	1.0656
CAN	0.1281	-1.0002	5.7062	3.8775	0.1601	-0.1794	3.8775
CHE	0.0572	0.1780	1.4201	0.5818	0.2459	-0.1170	0.5818
CHL	-0.0159	-0.2507	1.6250	1.5549	0.1979	-0.0285	1.5549
CHN	-0.4071	-5.8970	-9.8808	-1.0842	0.3342	-0.2208	-1.0842
COL	-0.0046	-0.4340	2.0871	1.9733	0.0861	-0.0126	1.9733
CYP	-0.0049	0.0087	0.2589	0.1932	0.1541	-0.0148	0.1932
CZE	0.0520	-0.0241	0.7911	0.3331	0.1276	-0.0317	0.3331
DEU	0.1376	-0.1571	1.6142	0.8707	0.2375	-0.0470	0.7288
DNK	0.0520	0.0010	1.4255	0.7338	0.2679	-0.0235	0.7338
DOM	0.0387	-1.6985	7.5681	3.0146	0.4918	-0.0236	3.0146
ECU	-0.0054	-0.1558	1.6981	2.0984	0.4944	-0.0104	2.0984
EGY	-0.0013	-0.1310	0.7244	0.5787	0.8667	-0.0034	0.5787
ESP	0.0254	-0.1947	1.0960	0.5085	0.2455	-0.0118	0.5085
EST	0.0255	-0.0143	0.6299	0.4222	0.2653	-0.0210	0.4222
ETH	-0.0046	-0.0458	0.8829	1.0839	0.4584	-0.0052	1.0839
FIN	0.0433	-0.0584	1.2651	0.6153	0.2938	-0.0180	0.6153
FRA	0.0431	-0.2993	1.3464	0.6801	0.2613	-0.0225	0.6801
GBR	0.0287	-0.0924	1.7655	0.9275	0.2227	-0.0333	0.9275
GHA	-0.0074	-0.0636	2.0078	1.1388	-0.7396	-0.0068	1.1388
GRC	0.0014	-0.0619	0.8151	0.5297	-0.0162	-0.0052	0.5297
GTM	-0.0109	-0.2745	3.3818	2.7406	-0.2240	-0.0151	2.7406
HKG	-0.1599	0.0311	0.7864	0.5019	0.1025	-1.5162	0.5019
HRV	0.0152	-0.0004	1.3988	0.6890	-0.1079	-0.0057	0.6890
HUN	0.0584	0.0078	0.8862	0.3785	0.2339	-0.0427	0.3785
IDN	0.0017	-0.3280	1.5152	0.4255	-0.4264	-0.0026	0.4255
IND	0.0053	-0.5552	1.5423	0.6627	0.0908	-0.0026	0.6627
IRL	0.0598	0.1356	2.4961	0.7999	0.2597	-0.1991	0.7999
IRN	-0.0003	-0.1828	0.5903	0.2442	-0.1871	-0.0015	0.2442
IRQ	-0.0050	-0.0056	0.4395	0.4861	0.6349	-0.0059	0.4861
ISR	0.0791	-0.4977	3.1634	1.6557	0.2519	-0.0465	1.6557
ITA	0.0573	-0.3201	1.5103	0.7450	0.2657	-0.0151	0.6456
JPN	0.1033	-1.0772	3.1265	0.6571	0.2579	-0.0246	0.6571
KAZ	0.0000	-0.0813	0.5072	0.7299	0.4330	-0.0052	0.7299
KEN	-0.0022	-0.0984	0.5600	0.5085	0.6257	-0.0038	0.5085
KOR	0.1265	-0.7626	2.2000	0.6585	0.2614	-0.0593	0.6585
KWT	-0.0091	-0.5285	0.5403	0.9507	-0.0238	-0.0220	0.9507

(continued)

Table A.16: Full results of technology and trade restrictions between the United States and China (continued).

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
LBN	-0.0059	-0.1588	0.6675	0.8394	-0.1067	-0.0089	0.8394
LKA	-0.0013	-0.0883	0.8251	0.5685	-0.4238	-0.0018	0.5685
LTU	0.0097	-0.0823	0.4843	0.4045	0.0414	-0.0115	0.4045
LUX	0.0265	0.0111	0.4596	0.2225	0.2703	-0.0593	0.2225
LVA	0.0109	-0.0460	0.5704	0.4565	2.1072	-0.0112	0.4565
MAR	0.0063	-0.3396	0.5957	0.2848	0.6309	-0.0078	0.2848
MEX	0.2705	-1.3715	7.0368	4.4449	0.0552	-0.1078	4.4449
MKD	0.0049	-0.0935	0.5343	0.2457	0.4500	-0.0030	0.2457
MLT	0.0148	0.2352	2.6005	0.8776	-0.0779	-0.0920	0.8776
MYS	0.0806	-0.5513	2.3157	0.5724	0.0258	-0.0566	0.5724
NGA	-0.0021	-0.0166	0.7359	0.8078	-0.1309	-0.0021	0.8078
NLD	-0.0106	-0.1698	0.7327	0.4376	0.2501	-0.1232	0.4376
NOR	0.0040	-0.0846	0.8615	0.6966	0.2690	-0.0270	0.6966
NZL	-0.0069	-0.0690	1.9363	1.3039	0.1171	-0.0268	1.3039
OMN	-0.0073	-0.2204	0.8872	0.8221	0.5583	-0.0182	0.8221
PAK	-0.0014	-0.1324	1.2073	0.8119	0.7844	-0.0028	0.8119
PER	-0.0119	-0.1361	1.9641	1.8111	-0.3808	-0.0146	1.8111
PHL	0.0209	-0.4105	3.0258	0.8056	-0.0355	-0.0130	0.8056
POL	0.0165	-0.1400	0.8519	0.3882	0.1856	-0.0109	0.3882
PRT	0.0187	-0.0806	0.7020	0.4428	0.2912	-0.0080	0.4428
QAT	-0.0247	-0.1893	0.6973	1.2219	-0.3214	-0.0299	1.2219
ROM	0.0081	-0.0889	0.6742	0.2841	0.7777	-0.0059	0.2841
RUS	0.0034	-0.1918	0.5512	0.4902	0.2480	-0.0034	0.4902
SAU	-0.0005	-0.8790	0.9146	1.0106	0.6340	-0.0161	1.0106
SDN	-0.0008	-0.0052	0.3827	0.4240	0.4668	-0.0010	0.4240
SER	0.0040	-0.0883	0.7344	0.2817	-1.2832	-0.0042	0.2817
SGP	0.0471	-0.1860	1.0421	0.4336	0.1210	-0.4037	0.4336
SVK	0.0645	0.1001	0.8297	0.3266	-0.1335	-0.0288	0.3266
SVN	0.0464	0.0128	0.6664	0.3470	0.2197	-0.0205	0.3470
SWE	0.0520	0.0313	1.3066	0.6426	0.2634	-0.0272	0.6426
SYR	0.0001	-0.0040	0.6136	0.3121	0.4895	-0.0006	0.3121
THA	0.0403	-0.3243	1.7879	0.7618	0.0455	-0.0207	0.7618
TKM	0.0002	-0.0695	0.4509	0.3134	0.7688	-0.0020	0.3134
TUN	0.0082	-0.1996	0.6763	0.1972	0.5948	-0.0048	0.1972
TUR	0.0072	-0.3923	0.9121	0.4492	0.2004	-0.0064	0.4492
TZA	-0.0023	-0.0114	0.8757	0.6927	0.4821	-0.0030	0.6927
UKR	-0.0019	-0.1363	0.5159	0.4003	-0.2700	-0.0028	0.4003
USA	-0.4076	-3.6266	-6.8908	-1.8099	0.6478	-0.3363	-1.8099
UZB	0.0000	-0.1854	0.8467	0.5868	0.5522	-0.0018	0.5868
VEN	-0.0211	-0.4569	2.6761	1.9170	21.3048	-0.0481	1.9170
VNM	0.0690	-0.2147	2.0880	0.5273	-0.6236	-0.0443	0.5273
ZAF	0.0091	-0.3579	1.3840	0.6744	0.1074	-0.0103	0.6744
ZWE	-0.0015	-0.0069	0.5328	0.3344	0.4532	-0.0018	0.3344
World	-0.1127	-1.0752	-1.0752	0.2929	0.2929	-0.1225	-0.1709

Note: We calculate the change in variables when the economy moves from the counterfactual steady state equilibrium wherein the openness for foreign technology $\omega_{ij,t}$ decreases in 80% and trade costs $\tau_{ij,t}$ increase in 20% between the United States and China to the baseline steady state equilibrium. "Inward FDI" is the change in total payment for inward technology transfer from other countries, while "Outward" is that of total earning from outward technology transfer to other countries.

Table A.17: Full results of the technology protection policy in China.

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
AGO	-0.0381	-6.7678	2.1296	-2.2474	-6.9143	0.0000	-2.2474
ARG	-0.0550	-1.1297	2.3761	1.6617	-5.7677	-0.0599	1.6617
AUS	-0.2627	0.4511	-4.5162	-3.7819	-5.8613	-0.1544	-3.7819
AUT	-0.9031	-0.6969	-2.3455	-1.3719	-6.3375	-0.7459	-1.3719
AZE	-0.0409	-0.1328	2.2538	3.8536	-12.3820	-0.0361	3.8536
BEL	-0.6358	-2.4383	1.8288	2.7915	-7.9920	-1.3862	2.7915
BGD	-0.0260	-0.3541	4.0494	3.9479	-10.9981	-0.0161	3.9479
BGR	-0.2190	-0.7638	-0.6319	0.3859	-7.1063	-0.2066	0.3859
BLR	-0.0116	-1.5876	3.3953	2.4435	-6.3432	-0.0558	2.4435
BRA	-0.0895	-0.6821	0.0037	0.2743	-1.1856	-0.0931	0.2743
CAN	-0.7281	0.3284	-4.1077	-3.0850	-6.2876	-0.4642	-3.0850
CHE	-4.6192	1.6116	-15.7642	-12.2096	-6.1634	-2.1317	-12.2096
CHL	-0.1421	0.1211	-2.3311	-1.8883	-5.8205	-0.0956	-1.8883
CHN	-0.0326	-8.4189	4.5205	-0.0283	-7.3452	-0.1685	0.8669
COL	-0.0728	-0.6208	2.0208	2.1360	-8.1379	-0.0380	2.1360
CYP	-0.8328	0.4373	-16.9711	-16.0650	-5.4043	-0.2344	-16.0650
CZE	-1.0978	-1.3219	-0.4046	-0.3555	-6.9012	-1.1851	-0.3555
DEU	-0.7582	-2.7564	0.4022	0.3569	-7.0823	-1.0141	0.4904
DNK	-0.8520	-0.3940	-3.9830	-2.4036	-6.5972	-0.5888	-2.4036
DOM	-0.0041	-2.5814	5.5807	3.0902	-11.8493	-0.0550	3.0902
ECU	-0.0484	-0.4305	3.2747	3.8607	-10.8593	-0.0348	3.8607
EGY	-0.0351	-0.5162	1.4259	2.1898	-10.1997	-0.0302	2.1898
ESP	-0.3327	-0.9282	-0.4582	0.2388	-5.5588	-0.2902	0.2388
EST	-0.7304	-0.6327	-2.5026	-1.3042	-6.6823	-0.5899	-1.3042
ETH	-0.0286	-0.1792	3.6573	3.6857	-14.0920	-0.0226	3.6857
FIN	-0.0236	-3.3049	3.5834	3.5390	-5.8368	-0.3198	3.5390
FRA	-0.3945	-1.5508	-0.2164	0.5266	-6.7330	-0.3771	0.5266
GBR	-1.0152	2.6898	-11.3340	-8.3566	-6.4622	-0.4614	-8.3566
GHA	-0.0495	-0.2632	4.1969	3.8299	-6.6237	-0.0377	3.8299
GRC	-0.1417	-1.0073	4.3077	4.7376	-14.1171	-0.0883	4.7376
GTM	-0.0461	-0.4896	3.9468	3.8742	-5.7099	-0.0341	3.8742
HKG	-12.2694	-12.5242	-13.6634	-15.0522	-5.2227	-6.9028	-15.0522
HRV	-0.1469	-0.9205	1.3052	1.8047	-19.8899	-0.1602	1.8047
HUN	-2.8675	0.0637	-8.1794	-6.7779	-5.8338	-1.6165	-6.7779
IDN	-0.0234	-3.1264	3.4769	2.2599	-4.9036	-0.0350	2.2599
IND	-0.0172	-3.0906	4.2593	2.1290	-4.4638	-0.0209	2.1290
IRL	-5.6541	5.8892	-19.8209	-14.5358	-6.2404	-2.5812	-14.5358
IRN	-0.0360	-1.7014	3.3727	1.6152	-5.3250	-0.0146	1.6152
IRQ	-0.0420	-0.0438	1.0226	2.1649	-8.4669	-0.0292	2.1649
ISR	-0.3291	-1.5806	0.3232	0.6595	-6.8966	-0.3431	0.6595
ITA	-0.2066	-3.1343	2.3870	1.8765	-6.6798	-0.2961	1.8765
JPN	-0.1637	-3.9002	3.8867	0.8315	-6.7940	-0.2578	0.8315
KAZ	-0.1084	1.0485	-6.7126	-6.1934	-8.9879	-0.0443	-6.1934
KEN	-0.0334	-0.4265	2.0953	2.0739	-10.9113	-0.0266	2.0739
KOR	-0.5414	-2.7297	2.1931	0.2202	-6.7046	-0.6466	0.2202
KWT	-0.0563	-1.7189	2.7804	3.2185	-5.4407	-0.0829	3.2185

(continued)

Table A.17: Full results of the technology protection policy in China (continued).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Country	Welfare	Import	Export	Inward FDI	Outward FDI	Output of final goods	Output of intermediate goods
LBN	-0.0644	-0.9664	3.3470	4.8751	-4.7511	-0.0585	4.8751
LKA	-0.0247	-0.7838	3.1817	3.3804	-6.8951	-0.0176	3.3804
LTU	-0.2090	-0.6693	-0.1115	0.9334	-5.0160	-0.2367	0.9334
LUX	-2.4416	-1.5091	-20.4629	-19.9415	-6.5338	-0.4552	-19.9415
LVA	-0.1568	-0.8348	1.5760	2.6623	-5.8661	-0.2303	2.6623
MAR	-0.0304	-3.0017	3.5724	2.4592	-8.1307	-0.1209	2.4592
MEX	-0.0866	-1.4439	2.9758	2.1380	-4.9092	-0.2597	2.1380
MKD	0.0204	-2.0525	4.9995	3.8597	-10.8424	-0.0798	3.8597
MLT	-2.6097	-1.4868	-15.6460	-15.8066	-4.8718	-0.9374	-15.8066
MYS	-0.5223	-3.4734	1.3396	0.4984	-6.0086	-0.7499	0.4984
NGA	-0.0343	-0.0827	0.8584	2.2931	-5.4043	-0.0116	2.2931
NLD	-4.3689	0.0209	-17.4565	-15.9389	-5.4751	-1.6606	-15.9389
NOR	-0.5383	-0.3808	-5.1805	-2.6018	-6.5991	-0.3655	-2.6018
NZL	-0.2966	0.3229	-5.9171	-5.3967	-7.2327	-0.1738	-5.3967
OMN	-0.0758	-0.9327	2.8537	2.8280	-8.3076	-0.0893	2.8280
PAK	-0.0132	-0.4740	3.4391	2.4494	-2.8936	-0.0144	2.4494
PER	-0.0649	-0.0976	0.5615	0.5497	-6.7729	-0.0463	0.5497
PHL	-0.0769	-1.4916	1.7262	0.9599	-5.6910	-0.1045	0.9599
POL	-0.4287	-0.1910	-1.8347	-0.8578	-6.6202	-0.3601	-0.8578
PRT	-0.2342	-0.9831	-0.4499	1.2666	-6.2291	-0.2108	1.2666
QAT	-0.1242	-0.5603	1.4668	3.2681	-6.3458	-0.1076	3.2681
ROM	-0.1642	-1.3244	0.9238	1.2889	-6.9543	-0.2085	1.2889
RUS	-0.1057	-0.9185	0.8927	1.4783	-6.9557	-0.0407	1.4783
SAU	-0.0481	-2.9752	3.0162	3.1371	-6.3597	-0.0684	3.1371
SDN	-0.0139	-0.0448	1.3232	3.7507	-13.7998	-0.0091	3.7507
SER	-0.0429	-1.8699	2.7468	2.3932	-1.1921	-0.1386	2.3932
SGP	-8.7543	-5.2225	-12.4342	-12.2268	-4.4313	-4.8581	-12.2268
SVK	-1.3626	-0.9712	-0.9424	-1.0275	-5.5065	-1.4318	-1.0275
SVN	-0.3183	-0.9398	2.1128	1.8507	-6.0757	-0.6230	1.8507
SWE	-1.1972	0.5834	-6.2626	-4.3443	-6.6562	-0.7046	-4.3443
SYR	-0.0248	-0.0745	4.5119	3.1825	-11.6715	-0.0077	3.1825
THA	-0.1838	-1.5637	1.8557	0.9121	-5.0451	-0.2372	0.9121
TKM	-0.0236	-0.8031	4.8458	3.3849	-9.1163	-0.0237	3.3849
TUN	-0.0051	-2.9027	4.4466	2.1566	-9.7241	-0.1271	2.1566
TUR	-0.0878	-2.6902	3.3196	2.4851	-6.9349	-0.0856	2.4851
TZA	-0.0303	-0.0587	2.9544	2.2635	-12.2184	-0.0206	2.2635
UKR	-0.0813	-1.7017	3.8312	4.3154	-6.2877	-0.0418	4.3154
USA	-0.4159	1.1229	-2.9190	-1.6545	-7.4741	-0.2939	-1.6545
UZB	-0.0161	-1.0177	4.3123	2.4787	-8.0504	-0.0122	2.4787
VEN	-0.1665	-0.0067	-0.1810	-0.3863	-6.4809	-0.1350	-0.3863
VNM	-0.6101	-0.9168	1.4063	-0.1610	-6.2493	-0.7051	-0.1610
ZAF	-0.1431	-0.8567	0.1224	0.6835	-6.5454	-0.1338	0.6835
ZWE	-0.0272	-0.0294	0.5406	0.4601	-13.1309	-0.0223	0.4601
World	-0.4036	-1.0710	-1.0710	-6.6877	-6.6877	-0.3171	-0.5172

Note: We calculate the change in variables when the economy moves from the counterfactual steady state equilibrium wherein the openness for foreign technology $\omega_{ij,t}$ decreases in 80% from China to all countries to the baseline steady state equilibrium. "Inward FDI" is the change in total payment for inward technology transfer from other countries, while "Outward" is that of total earning from outward technology transfer to other countries.

Table A.18: Full results of the export control law in China.

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
AGO	0.0132	-8.3850	6.7269	0.6205	2.6446	0.0000	0.6205
ARG	0.0082	-3.9762	5.6002	5.0412	2.6323	-0.0703	5.0412
AUS	-0.0970	-2.0961	5.1196	4.9216	1.4791	-0.1902	4.9216
AUT	0.1502	-0.2678	5.0600	1.4099	2.2161	-0.0862	1.4099
AZE	-0.0141	-0.0658	5.0144	3.7908	2.3124	-0.0170	3.7908
BEL	0.2135	-0.2269	5.6058	2.0462	1.0837	-0.2906	2.0462
BGD	-0.0758	-2.2594	9.3633	19.3234	2.2968	-0.0935	19.3234
BGR	0.0227	-1.1894	5.3225	2.7900	1.9868	-0.0688	2.2106
BLR	0.0646	-3.9320	8.7843	5.6124	2.8084	-0.0769	5.6124
BRA	0.0214	-6.9375	6.5390	3.6769	2.5897	-0.0651	3.6769
CAN	0.1013	-0.9626	4.7704	2.6099	1.4724	-0.1217	2.6099
CHE	0.1998	-0.1125	5.1791	1.2090	1.5019	-0.1606	1.2090
CHL	-0.0868	-1.4776	6.5809	6.1850	2.3826	-0.1469	6.1850
CHN	-1.4045	-3.5763	-55.4453	-6.5259	1.9377	0.0446	-6.5259
COL	-0.0262	-2.4212	9.6463	8.4346	1.2801	-0.0653	8.4346
CYP	-0.0351	-0.1755	5.8179	1.4383	2.3424	-0.1361	1.4383
CZE	0.1353	-2.7608	4.3953	2.1372	1.4850	-0.4786	2.1372
DEU	0.2830	-2.6185	5.2122	2.0561	1.4545	-0.2444	1.9125
DNK	0.0978	-1.4682	5.2696	2.3990	1.4788	-0.1685	2.3990
DOM	0.0263	-3.8897	5.2330	3.5213	2.2792	-0.0489	3.5213
ECU	-0.0560	-1.3485	14.7146	10.6810	2.2348	-0.0812	10.6810
EGY	-0.0343	-2.3078	11.9142	8.3386	2.0132	-0.0549	8.3386
ESP	0.0829	-1.8343	4.9491	2.1026	1.3778	-0.0783	2.1026
EST	0.0444	-1.1836	5.1870	2.6584	1.4661	-0.2576	2.6584
ETH	-0.0884	-0.9326	18.0636	17.8911	2.2610	-0.0958	17.8911
FIN	0.1272	-1.5091	6.6130	2.1880	2.1983	-0.1072	2.1880
FRA	0.1143	-1.3436	6.2972	1.8129	1.4771	-0.0738	1.8129
GBR	0.0319	-1.7702	5.6774	2.1876	1.4329	-0.1283	2.1876
GHA	-0.1118	-1.3338	14.0045	18.5771	2.7989	-0.1312	18.5771
GRC	-0.0120	-1.2704	6.6470	4.4748	1.3744	-0.0898	4.4748
GTM	-0.0352	-1.0787	7.5052	7.7897	2.5564	-0.0562	7.7897
HKG	-18.1899	-14.9552	5.5800	0.3204	2.3478	-56.6815	0.3204
HRV	0.0307	-0.8559	5.1649	2.2173	2.2468	-0.0554	2.2173
HUN	0.0997	-2.1701	3.8944	1.8549	1.5669	-0.4647	1.8549
IDN	0.0227	-9.7855	8.4101	5.5418	2.6347	-0.0715	5.5418
IND	0.0220	-14.9290	13.5034	6.4325	2.4938	-0.0631	6.4325
IRL	0.1725	-1.1998	3.4393	1.3385	2.0497	-0.2171	1.2073
IRN	0.0150	-14.7388	12.5684	12.2831	2.5360	-0.1113	12.2831
IRQ	-0.1042	-0.1157	19.7664	13.0659	1.9329	-0.1078	13.0659
ISR	0.0612	-3.1303	5.0666	2.7120	1.4479	-0.1604	2.7120
ITA	0.1492	-3.0992	6.7472	2.1098	1.4787	-0.0956	2.0090
JPN	0.1410	-16.5567	6.8689	1.8783	1.4680	-0.2770	1.8783
KAZ	-0.0556	-2.3211	5.2136	5.5179	0.6962	-0.0869	5.5179
KEN	-0.0977	-4.0400	26.6356	20.9683	2.2174	-0.1421	20.9683
KOR	-0.0473	-15.6760	6.7012	1.8945	1.4732	-0.7513	1.8945
KWT	-0.0075	-1.8283	10.3684	4.4393	2.6866	-0.0775	4.4393

(continued)

Table A.18: Full results of the export control law in China (continued).

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
LBN	-0.0312	-1.3634	15.6541	7.9542	2.4954	-0.0746	7.9542
LKA	-0.0386	-3.5533	9.8381	9.9112	2.7020	-0.0667	9.9112
LTU	0.0829	-1.0073	6.9776	3.6396	1.6274	-0.1169	3.6396
LUX	0.0158	-0.3341	4.4350	1.2416	1.4849	-0.5029	1.2416
LVA	0.0605	-0.7766	6.4052	3.3572	4.4457	-0.1264	3.3572
MAR	0.0326	-3.1809	7.9339	2.1789	2.1524	-0.0679	2.1789
MEX	0.1524	-3.1453	4.9106	3.3497	2.4927	-0.1526	3.3497
MKD	0.0219	-1.0660	3.2805	1.5818	2.2544	-0.0287	1.5818
MLT	-1.2079	-2.3230	2.9579	1.3648	2.4634	-1.5667	1.3648
MYS	-0.0204	-8.8399	7.2598	1.7743	2.3148	-0.5484	1.7743
NGA	-0.0363	-0.3812	19.0749	15.6866	2.4879	-0.0446	15.6866
NLD	-0.4283	-3.3573	3.5979	2.2874	1.3901	-1.1190	2.2874
NOR	0.0267	-0.2577	5.6256	1.9125	1.4813	-0.0690	1.9125
NZL	-0.0766	-0.8070	5.7581	3.7666	1.3506	-0.1431	3.7666
OMN	-0.0466	-1.1764	6.8371	3.4364	2.1011	-0.0923	3.4364
PAK	-0.0860	-6.4896	14.8782	24.9214	2.1128	-0.1172	24.9214
PER	-0.0730	-1.0333	7.9606	8.8992	2.8222	-0.0979	8.8992
PHL	-0.0577	-7.2782	5.8555	2.1544	2.5615	-0.1622	2.1544
POL	0.0400	-2.8072	4.5013	2.4500	1.4522	-0.1390	2.4500
PRT	0.0510	-2.2671	2.5361	2.6566	2.2643	-0.1221	2.6566
QAT	-0.0088	-0.1756	6.7256	3.1657	2.6297	-0.0358	3.1657
ROM	0.0218	-1.7006	4.9264	2.0100	2.2311	-0.0701	2.0100
RUS	0.0056	-4.0075	7.9523	6.8289	1.4351	-0.0668	6.8289
SAU	-0.0014	-2.9862	10.3872	3.3800	2.1600	-0.0536	3.3800
SDN	-0.0637	-0.4101	2.2139	20.0579	2.2354	-0.0661	20.0579
SER	0.0355	-1.1382	5.0734	1.7178	3.0593	-0.0395	1.7178
SGP	-1.2218	-7.3048	8.5812	0.0915	2.4552	-2.8592	0.0915
SVK	0.1941	-1.6249	4.3837	1.8530	1.6048	-0.4298	1.8530
SVN	0.1408	-1.5967	4.8543	2.3421	9.4010	-0.3414	2.3421
SWE	0.1282	-0.8748	5.8460	1.8435	1.4665	-0.1137	1.8435
SYR	-0.0403	-0.3767	15.5009	14.7587	2.2888	-0.0453	14.7587
THA	-0.0193	-9.2068	7.3619	3.2996	2.5057	-0.3202	3.2996
TKM	-0.0064	-0.9192	8.7453	4.5769	1.5713	-0.0261	4.5769
TUN	0.0364	-3.7671	4.3570	1.7465	2.1999	-0.0762	1.7465
TUR	0.0297	-4.6656	8.7023	3.2657	1.4001	-0.0697	3.2657
TZA	-0.1510	-0.7572	19.3724	23.4696	2.2628	-0.1603	23.4696
UKR	0.0302	-2.2398	8.5427	5.3503	1.5182	-0.0458	5.3503
USA	0.0230	-6.8254	5.1940	3.3068	1.1536	-0.1710	3.3068
UZB	-0.0176	-4.2824	6.5725	8.9317	2.1849	-0.0394	8.9317
VEN	-0.1515	-3.4207	4.4583	8.9908	24.7825	-0.3017	8.9908
VNM	-0.1135	-11.8356	6.0629	3.2023	2.7559	-0.9590	3.2023
ZAF	0.0112	-5.4192	10.6010	4.1659	2.3635	-0.1193	4.1659
ZWE	-0.0634	-0.3185	9.6050	8.9322	2.2739	-0.0669	8.9322
World	-0.2708	-4.9263	-4.9263	1.6789	1.6789	-0.3474	-0.9947

Note: We calculate the change in variables when the economy moves from the counterfactual steady state equilibrium wherein the trade costs $\tau_{ij,t}$ increases in 20% from China to all countries to the baseline steady state equilibrium. "Inward FDI" is the change in total payment for inward technology transfer from other countries, while "Outward" is that of total earning from outward technology transfer to other countries.

Table A.19: Full results of the export control law in the United States.

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
AGO	-0.0199	-14.1294	2.0496	0.1531	-4.8084	0.0000	0.1531
ARG	-0.0104	-4.3325	7.1790	5.7533	-3.4549	-0.0788	5.7533
AUS	-0.1196	-1.8105	2.7273	4.4839	-1.3860	-0.1792	4.4839
AUT	0.0110	-0.9465	2.2660	1.3269	-1.6543	-0.1791	1.3269
AZE	-0.0386	-0.1771	2.0510	3.9890	0.8793	-0.0409	3.9890
BEL	-0.4059	-2.4277	0.9941	1.7024	1.1816	-0.9989	1.7024
BGD	-0.0029	-0.1089	3.0452	1.5026	0.9725	-0.0051	1.5026
BGR	-0.0020	-0.4683	2.0777	1.4343	-1.7899	-0.0381	1.2263
BLR	0.0053	-0.9169	2.5536	1.5731	-6.2589	-0.0183	1.5731
BRA	-0.0097	-9.3309	6.0124	4.6452	-4.3081	-0.0913	4.6452
CAN	-0.5509	-19.4582	-6.3500	10.7126	-1.3194	-1.4638	10.7126
CHE	-0.2741	-2.1703	0.6821	0.5053	-1.0291	-0.5047	0.5053
CHL	-0.1760	-2.3558	6.2213	8.6187	-2.0187	-0.2286	8.6187
CHN	0.0077	-5.5823	2.8360	0.4507	-1.0890	-0.1027	0.4507
COL	-0.0617	-3.7695	11.1087	12.7334	-1.8201	-0.1004	12.7334
CYP	-0.1251	-0.1408	0.3293	0.0231	-1.8372	-0.0912	0.0231
CZE	0.0940	-0.3401	2.5124	1.1568	-1.5398	-0.1791	1.1568
DEU	0.1524	-2.6738	2.6642	1.7869	-1.1013	-0.2822	1.6437
DNK	0.0229	-0.7500	2.5999	1.6255	-0.9315	-0.1292	1.6255
DOM	0.0137	-16.6907	-2.3821	9.9914	0.9445	-0.1946	9.9914
ECU	-0.0583	-1.3264	7.2445	9.9724	1.1342	-0.0800	9.9724
EGY	-0.0113	-0.8097	4.7329	3.6920	1.7158	-0.0213	3.6920
ESP	0.0378	-1.3456	3.7560	1.9236	-1.1620	-0.0748	1.9236
EST	0.0286	-0.2437	2.1699	1.4994	-0.9566	-0.1202	1.4994
ETH	-0.0313	-0.3103	3.5905	5.9328	0.8452	-0.0338	5.9328
FIN	0.0171	-0.8776	2.4973	1.2959	-1.3146	-0.0980	1.2959
FRA	0.0384	-2.7149	3.0357	2.1984	-0.9864	-0.1541	2.1984
GBR	-0.0899	-2.3852	1.1276	1.7467	-1.1115	-0.1992	1.7467
GHA	-0.0508	-0.4157	3.9655	5.7331	-6.5963	-0.0425	5.7331
GRC	-0.0307	-0.3528	3.2679	2.1757	-2.0162	-0.0263	2.1757
GTM	-0.1071	-2.5738	8.9020	17.1376	-3.8006	-0.1261	17.1376
HKG	-1.9275	-1.4981	1.2609	-0.1961	-2.2166	-5.4371	-0.1961
HRV	-0.0058	-0.2958	2.7026	1.3595	-3.1591	-0.0278	1.3595
HUN	-0.0227	-0.4980	1.7013	0.7830	-1.0933	-0.2470	0.7830
IDN	-0.0150	-1.4840	3.5311	1.2193	-4.7568	-0.0117	1.2193
IND	-0.0049	-3.0340	3.6613	1.6957	-2.2720	-0.0136	1.6957
IRL	-0.4416	-7.6207	-1.9676	0.6390	-1.4650	-0.7506	0.5087
IRN	-0.0180	-0.2340	3.4950	0.4673	-3.5555	-0.0019	0.4673
IRQ	-0.0366	-0.0407	1.9022	2.7100	1.0596	-0.0383	2.7100
ISR	-0.0474	-6.3933	1.0694	3.3710	-1.0569	-0.3061	3.3710
ITA	0.0700	-2.7523	3.2286	1.8084	-0.9502	-0.0944	1.7079
JPN	0.0600	-8.7063	2.3728	1.1131	-0.9973	-0.1564	1.1131
KAZ	-0.0201	-0.7112	1.4056	2.1306	0.6960	-0.0335	2.1306
KEN	-0.0116	-0.4399	2.3538	2.2653	1.1812	-0.0173	2.2653
KOR	0.0210	-7.0061	2.7683	1.2601	-0.9706	-0.3784	1.2601
KWT	-0.0855	-4.4140	3.2505	7.3928	-2.9552	-0.1757	7.3928

(continued)

Table A.19: Full results of the export control law in the United States (continued).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Country	Welfare	Import	Export	Inward FDI	Outward FDI	Output of final goods	Output of intermediate goods
LBN	-0.0518	-1.1381	3.9253	5.7567	-3.0257	-0.0613	5.7567
LKA	-0.0131	-0.3566	2.0722	1.4691	-4.9958	-0.0071	1.4691
LTU	0.0038	-0.6235	2.1244	1.6674	-1.7410	-0.0727	1.6674
LUX	-0.5145	-0.6945	0.1783	-0.0422	-0.9225	-0.4013	-0.0422
LVA	-0.0072	-0.3539	2.2594	1.6790	-0.3444	-0.0619	1.6790
MAR	0.0211	-2.3342	2.5775	1.6049	1.3337	-0.0527	1.6049
MEX	-0.1171	-22.2304	-2.1071	7.9588	-2.5002	-0.8371	7.9588
MKD	0.0246	-0.5263	2.2753	1.3501	0.9432	-0.0170	1.3501
MLT	-0.3046	-0.3680	-1.2347	-0.4462	-2.8194	-0.2613	-0.4462
MYS	-0.0125	-4.9396	1.8424	1.2721	-2.4997	-0.3458	1.2721
NGA	-0.0220	-0.1105	2.5065	4.5181	-4.3885	-0.0126	4.5181
NLD	-0.5332	-1.9194	0.6274	0.7456	-1.1163	-0.8082	0.7456
NOR	-0.1022	-0.9862	2.1616	2.3925	-0.9292	-0.1870	2.3925
NZL	-0.1432	-1.0844	3.0590	3.7407	-1.5671	-0.1888	3.7407
OMN	-0.0732	-1.7706	5.2585	5.2844	1.1231	-0.1385	5.2844
PAK	-0.0084	-0.6009	2.4811	2.5820	1.6597	-0.0124	2.5820
PER	-0.1049	-1.1915	9.5393	10.2949	-4.6954	-0.1129	10.2949
PHL	-0.0103	-3.2270	1.3979	1.8136	-2.9776	-0.0801	1.8136
POL	0.0204	-0.7727	2.5361	1.3339	-1.2813	-0.0643	1.3339
PRT	0.0104	-0.5101	1.9815	1.4702	-1.4289	-0.0412	1.4702
QAT	-0.2303	-1.7969	2.8211	7.6666	-4.3042	-0.2526	7.6666
ROM	0.0224	-0.4619	2.6650	1.1803	1.6177	-0.0320	1.1803
RUS	-0.0143	-1.1204	2.6546	2.1594	-1.0631	-0.0201	2.1594
SAU	-0.0303	-7.2477	3.1934	6.8285	1.3836	-0.1264	6.8285
SDN	-0.0012	-0.0083	2.6840	1.6415	0.8137	-0.0016	1.6415
SER	-0.0068	-0.5522	2.0365	0.9718	-9.9105	-0.0233	0.9718
SGP	-0.9789	-4.1902	0.5048	0.2911	-2.0306	-2.4204	0.2911
SVK	0.1317	0.2497	2.4043	0.9603	-2.4011	-0.1390	0.9603
SVN	0.1103	-0.0827	2.3073	1.2278	6.7902	-0.0996	1.2278
SWE	0.0126	-0.8159	2.4217	1.3775	-0.9635	-0.1466	1.3775
SYR	0.0007	-0.0045	3.5299	1.2088	0.9490	-0.0008	1.2088
THA	0.0109	-2.7635	3.5236	1.7410	-2.4838	-0.1151	1.7410
TKM	-0.0046	-0.4615	2.5862	1.8899	0.8970	-0.0130	1.8899
TUN	0.0321	-1.0438	2.6598	0.9163	1.2416	-0.0263	0.9163
TUR	-0.0010	-2.6680	3.3748	2.0337	-1.1637	-0.0426	2.0337
TZA	-0.0078	-0.0344	4.7750	2.5376	0.9072	-0.0093	2.5376
UKR	-0.0353	-0.8552	2.6200	1.9955	-3.0983	-0.0172	1.9955
USA	-0.6099	-4.9845	-52.7684	-13.1606	1.3037	0.0850	-13.1606
UZB	-0.0046	-1.1712	2.5637	2.5575	1.1411	-0.0113	2.5575
VEN	-0.2460	-4.4291	4.0885	11.0224	16.5100	-0.3862	11.0224
VNM	0.0141	-1.9612	2.8688	0.9937	-5.8403	-0.2139	0.9937
ZAF	-0.0162	-2.6287	2.4569	2.0907	-2.4369	-0.0639	2.0907
ZWE	-0.0062	-0.0244	3.0577	1.5606	0.8800	-0.0070	1.5606
World	-0.1332	-3.8858	-3.8858	-0.9473	-0.9473	-0.1488	-0.2706

Note: We calculate the change in variables when the economy moves from the counterfactual steady state equilibrium wherein the trade costs $\tau_{ij,t}$ increases in 20% from the United States to all countries to the baseline steady state equilibrium. “Inward FDI” is the change in total payment for inward technology transfer from other countries, while “Outward” is that of total earning from outward technology transfer to other countries.

Table A.20: Full results of the technology protection policy in China and export control laws in the United States and China.

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
AGO	-0.0436	-27.9751	11.8667	-1.3557	-8.8927	0.0000	-1.3557
ARG	-0.0481	-10.1064	16.8177	13.4105	-6.3615	-0.2138	13.4105
AUS	-0.4929	-3.8150	3.4638	6.5552	-5.5619	-0.5543	6.5552
AUT	-0.7206	-1.8904	5.4016	1.5120	-5.5839	-1.0129	1.5120
AZE	-0.0946	-0.3957	9.8907	12.4420	-9.1814	-0.0954	12.4420
BEL	-0.7445	-5.2720	9.2225	6.9904	-5.5900	-2.6902	6.9904
BGD	-0.1078	-2.9791	17.9878	27.1822	-7.6889	-0.1197	27.1822
BGR	-0.1920	-2.5154	7.2321	4.0802	-6.6916	-0.3175	4.0802
BLR	0.0709	-6.6757	15.9869	10.2359	-9.5893	-0.1532	10.2359
BRA	-0.0699	-17.9161	13.8882	9.1443	-2.5848	-0.2539	9.1443
CAN	-1.1786	-20.7660	-5.6253	10.7551	-5.9396	-2.0957	10.7551
CHE	-4.7079	-0.6094	-10.3893	-10.5122	-5.4878	-2.8164	-10.5122
CHL	-0.4192	-4.1585	11.6611	14.6055	-5.2496	-0.4991	14.6055
CHN	-1.4900	-16.8367	-51.7488	-6.3650	-6.2870	-0.2161	-5.5266
COL	-0.1583	-7.7689	26.1081	26.5526	-8.5226	-0.2145	26.5526
CYP	-0.9973	0.1433	-11.5506	-14.6462	-4.6891	-0.4695	-14.6462
CZE	-0.8289	-4.6159	7.0135	3.1856	-6.7989	-1.8662	3.1856
DEU	-0.2556	-8.2921	8.9904	4.4894	-6.5482	-1.5464	4.3424
DNK	-0.7152	-2.7463	4.2337	1.9169	-5.8618	-0.9028	1.9169
DOM	0.0515	-24.0568	9.0885	17.2642	-8.6030	-0.2963	17.2642
ECU	-0.1671	-3.6000	28.1831	28.2791	-7.4426	-0.2079	28.2791
EGY	-0.0822	-3.9881	19.5719	15.5395	-6.3691	-0.1109	15.5395
ESP	-0.1939	-4.2678	8.9857	4.5569	-5.1263	-0.4476	4.5569
EST	-0.6490	-2.1665	5.1510	3.0897	-5.9869	-0.9861	3.0897
ETH	-0.1582	-1.6708	29.0081	32.5155	-11.0147	-0.1639	32.5155
FIN	0.1578	-5.8445	13.8317	7.4245	-4.7109	-0.5275	7.4245
FRA	-0.2165	-5.7360	9.9576	4.8139	-6.0557	-0.6068	4.8139
GBR	-1.0852	-1.5951	-4.7919	-4.2940	-5.9488	-0.8126	-4.2940
GHA	-0.2243	-2.3436	25.6622	33.0188	-10.2226	-0.2277	33.0188
GRC	-0.1776	-2.8023	15.5677	12.2128	-14.1489	-0.2100	12.2128
GTM	-0.1911	-4.7671	22.8832	33.1392	-6.7482	-0.2272	33.1392
HKG	-30.7196	-27.3931	-7.0995	-14.7516	-4.8650	-64.2621	-14.7516
HRV	-0.1131	-2.1291	9.8342	5.7232	-8.0387	-0.2461	5.7232
HUN	-2.8014	-2.6698	-2.6239	-4.0643	-5.1750	-2.3693	-4.0643
IDN	-0.0098	-15.0847	16.9823	9.5220	-6.8013	-0.1206	9.5220
IND	0.0056	-21.8683	23.9790	10.7829	-4.0036	-0.0989	10.7829
IRL	-5.9739	-3.2738	-18.6238	-12.6527	-5.4074	-3.6411	-12.7658
IRN	-0.0344	-17.1954	21.7762	14.9262	-6.1347	-0.1295	14.9262
IRQ	-0.1932	-0.2133	24.5143	19.6165	-5.3476	-0.1860	19.6165
ISR	-0.2886	-11.7374	7.0799	7.2592	-6.3243	-0.8230	7.2592
ITA	0.0449	-9.1847	13.4812	5.9834	-5.9640	-0.4867	5.8788
JPN	0.0707	-29.4886	14.2947	3.9701	-6.1352	-0.6866	3.9701
KAZ	-0.1906	-2.1271	-0.2325	1.7466	-7.4847	-0.1732	1.7466
KEN	-0.1462	-5.3676	34.3229	27.7427	-7.4672	-0.1945	27.7427
KOR	-0.5116	-26.1249	12.6557	3.5868	-6.0148	-1.7768	3.5868
KWT	-0.1378	-8.3737	17.7606	15.8877	-5.7241	-0.3365	15.8877

(continued)

Table A.20: Full results of the technology protection policy in China and export control laws in the United States and China (continued).

Country	(1) Welfare	(2) Import	(3) Export	(4) Inward FDI	(5) Outward FDI	(6) Output of final goods	(7) Output of intermediate goods
LBN	-0.1455	-3.8280	25.6417	20.5552	-5.0556	-0.2014	20.5552
LKA	-0.0762	-4.9928	16.3852	15.7443	-8.9993	-0.0940	15.7443
LTU	-0.1067	-2.4004	9.6772	6.6613	-4.9661	-0.4331	6.6613
LUX	-2.9420	-2.4819	-16.4300	-18.7913	-5.7822	-1.4207	-18.7913
LVA	-0.0862	-2.0604	10.9798	8.1993	-3.5605	-0.4266	8.1993
MAR	0.0324	-8.6994	15.1640	6.4573	-4.5268	-0.2415	6.4573
MEX	0.0015	-28.1758	6.3398	14.0754	-4.6950	-1.2500	14.0754
MKD	0.0731	-3.7218	11.1941	7.0197	-7.6040	-0.1260	7.0197
MLT	-4.2104	-4.1266	-14.2014	-14.8017	-5.0095	-2.8786	-14.8017
MYS	-0.5043	-17.8651	11.3324	3.8073	-5.9944	-1.6541	3.8073
NGA	-0.0973	-0.6663	24.3583	27.0910	-7.0496	-0.0745	27.0910
NLD	-5.4835	-5.2991	-13.8470	-12.9712	-4.9828	-3.7749	-12.9712
NOR	-0.6084	-1.6496	3.2322	1.9866	-5.8590	-0.6297	1.9866
NZL	-0.5308	-1.6697	3.3780	2.6043	-7.2706	-0.5289	2.6043
OMN	-0.1899	-4.0999	16.0852	12.2867	-4.9877	-0.3233	12.2867
PAK	-0.1107	-8.3430	22.7326	33.0114	1.1078	-0.1510	33.0114
PER	-0.2530	-2.6508	20.4300	22.6525	-8.6003	-0.2735	22.6525
PHL	-0.1297	-12.5876	9.5312	5.4257	-5.8967	-0.3532	5.4257
POL	-0.3587	-4.0070	5.6204	3.1976	-6.2593	-0.5735	3.1976
PRT	-0.1588	-3.9612	4.5609	5.7614	-5.1980	-0.3817	5.7614
QAT	-0.3609	-2.6802	11.7494	15.0519	-7.8247	-0.3992	15.0519
ROM	-0.1129	-3.6171	9.1498	4.7203	-2.9526	-0.3139	4.7203
RUS	-0.1098	-6.5004	12.5404	11.3130	-6.4072	-0.1318	11.3130
SAU	-0.0707	-13.8186	17.9633	13.9939	-2.6689	-0.2483	13.9939
SDN	-0.0812	-0.4911	7.1801	27.5384	-10.7794	-0.0795	27.5384
SER	-0.0066	-3.6351	10.6017	5.2855	-7.6968	-0.2023	5.2855
SGP	-10.8762	-16.0620	-4.3212	-11.4876	-3.7720	-10.3862	-11.4876
SVK	-0.9953	-2.3951	6.3099	1.9944	-6.1593	-2.0214	1.9944
SVN	-0.0243	-2.7084	9.9569	5.7159	1.3424	-1.0757	5.7159
SWE	-1.0468	-1.1523	2.2106	-0.9813	-5.9653	-0.9751	-0.9813
SYR	-0.0656	-0.4772	25.7657	20.3162	-8.4091	-0.0551	20.3162
THA	-0.1628	-14.1716	13.9446	6.4519	-4.8001	-0.6844	6.4519
TKM	-0.0328	-2.2512	17.6357	10.3847	-6.4657	-0.0631	10.3847
TUN	0.0713	-7.8751	12.2147	4.9608	-6.2101	-0.2304	4.9608
TUR	-0.0490	-10.3808	16.7868	8.1706	-6.5245	-0.1995	8.1706
TZA	-0.1973	-0.9170	31.4677	31.0392	-9.0394	-0.1993	31.0392
UKR	-0.0787	-5.0838	16.3187	12.4530	-7.7533	-0.1071	12.4530
USA	-0.9941	-10.9167	-51.4637	-11.1379	-4.8613	-0.3927	-11.1379
UZB	-0.0377	-6.9459	14.7434	14.9936	-4.6175	-0.0646	14.9936
VEN	-0.5778	-9.1538	9.1463	22.9500	13.6268	-0.8854	22.9500
VNM	-0.6722	-15.3161	11.2572	4.3382	-9.1364	-1.9084	4.3382
ZAF	-0.1409	-9.4383	14.6336	7.4171	-6.4172	-0.3241	7.4171
ZWE	-0.1004	-0.3941	15.0549	11.7310	-9.9840	-0.0999	11.7310
World	-0.8013	-10.2082	-10.2082	-5.7742	-5.7742	-0.8028	-1.7190

Note: We calculate the change in variables when the economy moves from the counterfactual steady state equilibrium wherein the openness for foreign technology $\omega_{ij,t}$ decreases in 80% from China to all countries and trade costs $\tau_{ij,t}$ increases in 20% from the United States and China to all countries to the baseline steady state equilibrium. "Inward FDI" is the change in total payment for inward technology transfer from other countries, while "Outward" is that of total earning from outward technology transfer to other countries.