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Export Controls Game: Rethinking Global Integration

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I. Introduction

One of the factors contributing to recent adjustment of global supply chains is the use of trade policies by governments to protect their national interests. This is aptly described by the term "geoeconomic fragmentation," which refers to the policy-driven reversal of global integration often guided by strategic considerations (Aiyar et al., 2023). During the rapid wave of globalization in the past, liberalization policies were often regarded as the virtue of an open economy. While the impact of globalization on the labor market and the resulting deepening of inequality were concerns for governments worldwide, the prevailing view was to develop complementary 'domestic' measures rather than to doubt the benefits of globalization.

However, the situation has changed significantly. With geopolitical interests becoming more pronounced among the various elements that constitute national interests, the countless connections that form the fabric of international relationships are being reevaluated. Trade and investment relationships are no exception. The emerging perspective is that to maximize national interests in areas such as security and strategic autonomy, it is necessary to sacrifice some aspects of global integration. In this regard, adjustments to globalization are seen to be inevitable.

If that is the case, what analytical framework can we employ to discuss trade policies based on national interests? A government's objective function should reflect the geopolitical interests closely tied to the choice of trade policy instrument as well as gains from global integration. Before embodying this idea, let us consider a well-known anecdotal example first.

In October 2023, the United States strengthened its existing semiconductor export control measures against China, originally imple-

mented on October 7, 2022. The export controls imposed in October 2022 were aimed at preventing the export of advanced semiconductor manufacturing-related items and advanced computing-related semiconductor items to China. Advanced semiconductors, although produced for commercial purposes, can be used for military technology development and are therefore considered dual-use items. In a speech, Jake Sullivan, the National Security Advisor of the Biden administration, explained that these measures were "focused on technology that could tilt the military balance [between the United States and China]." He argued that these actions were taken to "[be] ensuring that U.S. and allied technology is not used against us" and that they did not intend to "[be] cutting off trade [with China]."[1] This stance of the U.S. is also summarized by the expression "small yard, high fence," meaning that the high-intensity export control measures are implemented only for a narrow range of items related to technologies that threaten U.S. security.

However, one of the challenges the United States faces in trying to block China's acquisition and production of advanced semiconductors through export controls on semiconductor manufacturing-related items is the fact that China holds a position in the semiconductor supply chain beyond merely consuming the semiconductors produced. China is a major producer of raw materials such as gallium and germanium, which are used in the semiconductor production process, and is also home to production facilities of major multinational semiconductor companies. As signs of an expansion in U.S. export control measures loomed, China began fortifying export control measures on gallium and germanium from August 2023. Less possibly, if China's export control measures develop into a complete ban on exports of gallium and germanium, there is concern that disruptions in the semiconductor supply chain and production setbacks will be inevitable in the short term.

Rivalry between two countries will burden the global semiconductor supply chains with inefficient allocations of resources after all. Despite the social welfare losses resulting from the distortion of resource allocation, the governments of both countries prioritize export control measures because they acknowledge the distinct non-economic benefits and detriments associated with the maintenance of existing production relationships. Under this perspective, this article aims to rationalize two countries' export controls measures via a simple game-theoretic model based on Yea et al. (2024).

[1] The White House. April 27, 2023. "Remarks by National Security Advisor Jake Sullivan on Renewing American Economic Leadership at the Brookings Institution." https://www.whitehouse.gov/briefing-room/speeches-remarks/2023/04/27/remarks-by-national-security-advisor-jake-sullivan-on-renewing-american-economic-leadership-at-the-brookings-institution/ (accessed July 12, 2024)

II. Model and Results

1. Model description

The model examines the issue of a multinational corporation with advanced technology established in one country (let's call it 'A') producing advanced goods (hereafter referred to as 'high-tech goods') using raw materials sourced from another country (let's call it 'B'). The multinational corporation can decide to set up production facilities either in country A or in country B. If the latter occurs, the production of high-tech goods in country B results in fixed-sized opposing externalities for both countries. For instance, consider the case of advanced semiconductors. If these are produced in a factory in China (country B in our model), there could be technology spillovers that enhance the technological capabilities of other Chinese companies supplying advanced semiconductors for military purposes. Assuming a military competition exists between the U.S. and China, China's advancement in military technology poses a security threat to the U.S., leading to opposing externalities from the production of advanced semiconductors in China.

Assuming the sum of security benefits and economic benefits is defined as social welfare (national interests) of a country, the multinational corporation's decision-making could result in an excessively high level of high-tech goods production in country B from the perspective of country A's government, which maximizes social welfare. Conversely, low level of high-tech goods production in country B would be unsatisfactory for the perspective of country B's social welfare once the production of high-tech goods occurs mainly in country A. Therefore, each government has an incentive to use trade policies as tools to influence the multinational corporation's production location choice in a way that favors their social welfare. The government of country A can employ punitive "security taxes" on the transfer of production facilities or technology to country B by prohibitively increasing the production costs in country B when the multinational corporation's production in country B decreases country A's social welfare. In this model, export control policies by country A can be understood as an extreme form of "security tax" that significantly raises the cost of foreign investment for the multinational corporation.

Conversely, the government of country B has an incentive to actively encourage the establishment of production facilities within its borders by the multinational corporation to gain security benefits. Again, assuming the multinational corporation's choice is between the actions of "foreign investment in country B" or "domestic production in country A," the government of country B has an incentive to implement export restriction policies on raw materials produced in country B as a means to prevent "domestic production in country A." By banning the export of raw materials produced within its borders, the multinational corporation is compelled to establish produc-

tion facilities in country B to secure the necessary production inputs. By analyzing the simultaneous strategic choice of export control policies by the governments of country A and country B, this study shows the emergence and effects of export control policies based on the multinational corporation's sourcing structure and the magnitude of externalities.

To determine the sourcing structure of multinational corporations, this study considers the incomplete contracts arising in production relationship as discussed in Antràs and Helpman (2004). Antràs and Helpman (2004) applies the argument by Grossman and Hart (1986) that in the presence of incomplete contracts, the party contributing more to production should have greater ownership rights over the output to mitigate inefficiencies from the holdup problem. Antràs and Helpman (2004) applies this insight to the multinational corporations' global sourcing decisions. In capital-intensive industries, the firm supplying capital will merge with the firm supplying labor to enhance production efficiency, while in labor-intensive industries, the firm supplying capital will outsource labor from another firm supplying labor. As a result, in capital-intensive industries, intra-firm trade occurs, while in labor-intensive industries, international sourcing patterns emerge. A U.S. multinational semiconductor manufacturing firm would have an incentive to set up a merged firm with production facilities in China to mitigate the holdup problem arising from incomplete contracts, given that U.S.-made manufacturing equipment contributes significantly to the production of advanced semiconductors. Otherwise, the multinational corporation would rationally decide to set up advanced semiconductor production facilities in the U.S.

The sequence of the game is as follows:

1. Countries A and B simultaneously determine the levels of export taxes.
2. The multinational corporation from country A decides on its global sourcing structure. It can either import raw materials from country B to produce high-tech goods domestically or establish a joint venture with a firm in country B to procure raw materials and produce high-tech goods within country B.
3. Given the chosen production mode, firms from countries A and B sign contracts.
4. Production takes place, and profits are distributed according to the resulting output.

The solution to the game is the subgame perfect Nash equilibrium. By using backward induction, the study aims to find the optimal strategies for each country and the multinational corporation, considering the externalities present in the mode of global production. This approach helps predict the potential emergence of export control policies based on the strategic interactions between countries and firms.

2. Main results

In the benchmark model, we assume that there are no externalities directly affecting social welfare in countries A and B in the context of international sourcing. In this case, the problem of maximizing social welfare aligns with the problem of maximizing the firm's profits. Consequently, both countries would refrain from intervening in the production mode to ensure efficient production. This means that no effective export taxes would be imposed on the movement of production facilities or raw materials necessary for production. One interesting finding is that the larger the equity stake of country A's multinational corporation in the joint venture established in country B, the less incentive there is to establish the joint venture in country B. The reason is that as country A's multinational corporation's residual control rights increase, the partner firm in country B has less incentive to invest sufficient labor, leading to suboptimal production.

Now, let us assume that the investment and production of high-tech goods by country A's multinational corporation in country B result in externalities in opposite directions for countries A and B. Specifically, there are negative externalities for country A and positive externalities for country B. In this case, examining the optimal response functions of the two countries reveals that multiple equilibria can exist. By categorizing the multiple equilibria, the following results can be identified based on the relative magnitudes of the externalities:

If the negative externalities for country A are large and the positive externalities for country B are not very large, the equilibrium will result in country A's government implementing export control measures to ensure that the multinational corporation from country A produces high-tech goods domestically. In this scenario, the government of country B will not actively implement export restrictions on raw materials. However, if the positive externalities for country B from the production of high-tech goods are very large, the government of country B may also implement strong export control measures, potentially leading to a complete severance of production relationships between the two countries.

It turns out that a necessary condition for the equilibrium to involve export control policies by country A is that the externalities resulting from the investment in country B are sufficiently large. The negative externalities from the investment in country B must be significant enough to justify the costs associated with the inefficiencies in production caused by constraining the firm's efficient global sourcing structure. Conversely, for country B, if the positive externalities from the investment itself, regardless of the actual production volume, are very large, the government of country B may strongly implement export control measures proportional to those of country A to secure the investment by the multinational corporation from country A. However, if the positive externalities are not very large, country B will not implement export control

measures that hinder its firms from participating in the global supply chains by exporting raw materials.

In our model, whether the external effects resulting from investments by firms from country A into country B have a positive or negative impact on the social welfare of each country is closely related to the geopolitical interests between two countries. This theoretically supports the use of export control policies as major instruments in semiconductor supply chains against the backdrop of intensifying geopolitical tensions between the U.S and China.

III. Policy Implications

We examined how the security interests justify the export control policies of governments in the context of multinational corporations with advanced technology deciding on their overseas production sites. How would the results differ if both countries could gain positive external effects from the multinational corporation's investing in country B?

In brief, the government of country A would not use effective export control measures that may influence the company's investment decisions. In contrast, the government of country B might use export control measures on raw materials to attract the multinational's investments if the positive externalities are large enough. This explains why countries like Indonesia implement export ban policies restricting the outflow of nickel ore. Additionally, it implies that when considering alternative production sites to China, the U.S. would prioritize like-minded countries that would not harm its national security interests.

Developing trade policies based on national interests necessitates accurately capturing the changes in inter-country relations that affect the security interests of each nation. KIEP

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