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Supply Chain Stability and Strategic Investment Subsidies

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I. Introduction

Since the COVID-19 pandemic, industrial policies adopted by major advanced economies, including the United States, the European Union, and Japan, have brought about significant changes in the global trade environment. Guided by policy objectives such as digital and green transitions, the acquisition of advanced industrial technologies, economic security, and supply chain resilience, these economies have expanded support measures to promote domestic investment in selected industries. These measures include R&D subsidies, production subsidies, and tax incentives, and they apply not only to domestic firms but also to foreign investors.

As a result, such policies exert a direct influence on multinational corporations' overseas investment decisions by altering firms' cost structures and locational incentives. This has encouraged the geographic reallocation of R&D activities and production facilities, particularly in advanced technology-intensive and strategically important sectors such as semiconductors and batteries. These developments have emerged as a key structural driver reshaping global supply chains around newly favored investment locations.

Against this background, this article draws on Yea et al. (2024)[1] to briefly examine how subsidies for investment in so-called strategic industries, which governments deploy to achieve industrial policy objectives, affect multinational enterprises' foreign direct investment decisions. Yea et al. (2024) theoretically investigate how supply chain stability and uncertainty surrounding the technological capabilities of investing firms interact with the design of government subsidies aimed at attracting multinational investment, using a styl-

[1] Yea, Sangjun, Hyuk-Hwang Kim, Jun-Hyun Eom, Euncheol Shin, and Jinhyuk Lee. 2024. "Implications of Subsidies for Strategic Industries on Foreign Direct Investment and Global Supply Chain). KIEP Policy Analysis 24-23 (in Korean), Available at SSRN: https://ssrn.com/abstract=5890085 or http://dx.doi.org/10.2139/ssrn.5890085

ized model of firm decision-making. The following section provides a concise overview of the theoretical framework developed by Yea et al. (2024) and the key implications derived from the model.

II. Model and Implications

Consider a multinational enterprise that owns Firm A and Firm B, and suppose that Firm A produces goods in country j and exports them to Firm B in country i, where they are sold as intermediate inputs for production in country i.

In a world with perfectly stable supply chains, when a quantity q_{ij} is produced in country j, the same quantity q_{ij} is exported to country i and sold there. In reality, however, risks such as natural disasters or pandemics disrupt supply chains and constrain the cross-border movement of goods. To capture supply chain fragility, we assume that only a fraction $\left(1-\theta f(s_i,s_j)\right)q_{ij}$ of the goods produced in country j is successfully exported to country i. Here, $\theta \in [0,1]$ is a parameter that represents the severity of supply chain risk, with lower values indicating more stable supply chains. The variable $s_i \in [0,1]$ denotes the level of government support provided by country i to enhance supply chain stability, while $s_j \in [0,1]$ denotes the corresponding level of government support in country j. The variables s_i and s_j can be interpreted as the levels of investment in infrastructure or public services that each government provide in preparation for supply chain disruptions.

The function $f(s_i,s_j)$ captures the outcome determined by the support levels of the two governments and takes values between zero and one. We assume that $f(s_i,s_j)$ is twice continuously differentiable and weakly decreasing in both s_i and s_j. In addition, the function satisfies $f(0,0)=1$ and $f(1,1)=0$, and its partial derivatives satisfy $f_{s_i}>0$ and $f_{s_j}>0$ at interior points of the domain.

The term $\theta f(s_i,s_j)q_{ij}$ represents the quantity of goods that is lost due to supply chain fragility, even though q_{ij} units are produced in country j. The magnitude of $\theta f(s_i,s_j)q_{ij}$ depends on the extent to which the governments of the two countries exert effort to mitigate sources of supply chain instability between them. When neither government undertakes any effort, that is, when $(s_i,s_j)=(0,0)$, supply chain fragility is maximized, and only $(1-\theta)q_{ij}$ units of goods are exported to country i. By contrast, when both s_i and s_j take the value of one, $f(s_i,s_j)=0$, and the entire quantity q_{ij} is delivered along the supply chain without loss. If the cross-partial derivative satisfies $\frac{\partial^2 f(s_i,s_j)}{\partial s_i \partial s_j} \leq 0 \quad (i \neq j)$, then each country's effort to stabilize the supply chain is either independent of, or positively affected by, the effort exerted by the other country. In this case, a higher level of stabilization effort by one country enhances the effectiveness of the other country's supply chain policy, generating policy complementarities.

Governments choose the levels of s_i and s_j subject to fiscal constraints and policy priorities. Suppose that when a government provides support at level s_k $(k \in \{i,j\})$, for supply chain stability, it incurs a policy cost given by $\phi_k g(s_k)$. Here, $\phi_k (>0)$ is a parameter that captures the cost efficiency of country k's supply chain policy, with a lower value indicating higher policy efficiency. The function $g(s_k)$ represents the cost function and satisfies $g'(s_k) > 0$ and $g''(s_k) > 0$, with $\lim_{s\to 0} g'(s) = 0$. These assumptions imply that fiscal expenditures increase with the level of support and that the marginal fiscal cost of raising the support level increases as s_k becomes larger.

We assume that demand for the firm's output takes the standard form associated with monopolistic competition. The production function exhibits constant returns to scale with respect to production factors, and the supply of each factor is perfectly competitive. Under these assumptions, the firm's cost function is linear in output and characterized by a constant marginal cost c. For brevity, we use the notation $\mu_{ij} \equiv 1 - \theta f(s_i, s_j)$.

Given the policy choices s_i and s_j determined by the governments of countries i and j, respectively, the multinational enterprise solves the following profit maximization problem:

$$\max_p \pi(p) = p\mu_{ij} D(p) - cD(p),$$

where demand is given by $D(p) \equiv Ap^{-\sigma} P^{\sigma-1} E$.

In this expression, $D(p)$ denotes the inverse demand function, $A > 0$ is a parameter capturing market size or the intensity of intermediate input use, p is the transaction price set by the multinational enterprise, and $\sigma(>2)$ represents the elasticity of substitution. The variable P denotes the price index, while E represents the level of consumption in country i or, alternatively, the aggregate production cost of downstream intermediate-good users.

Solving the firm's profit maximization problem yields the optimal price $p^*(\mu_{ij}) = \frac{\sigma}{\sigma-1}\frac{c}{\mu_{ij}}$, and the corresponding level of demand $D\left(p^*(\mu_{ij})\right) = A\left(\frac{\sigma}{\sigma-1}\frac{c}{\mu_{ij}}\right)^{-\sigma} P^{\sigma-1}E$. As supply chains become more fragile, that is, as μ_{ij} decreases, the transaction price increases while the traded quantity declines.

We now consider the multinational enterprise's investment decision when global supply chains are unstable, taking into account both investment costs and supply chain stability. Specifically, suppose that the multinational enterprise has already established a production facility in country j as above and faces the need to build a new production line to manufacture next-generation products for sale in country i. The new production line can be introduced either by expanding the existing plant in country j or by establishing a new plant in country i. In the former case, the firm incurs a fixed cost F_j, while in the latter case it incurs a fixed cost F_i. We assume that establishing a new plant involves a higher fixed

cost than expanding an existing production line, so that $F_j < F_i$.

If the headquarters of the multinational enterprise is located in country i, the establishment of a production facility in country i for next-generation products can be interpreted as a form of reshoring.

Suppose that when the multinational enterprise produces q_{ik} units of output in country $k \in \{i, j\}$, its cost function is given by $C_k(q_{ik}) = F_k + \frac{w_k}{z} q_{ik}$, where w_k denotes the wage level in country k, and z is a productivity parameter that captures the firm's technological capability, such as its efficiency in producing next-generation products. Under this specification, the marginal cost of production is given by $c_k \equiv \frac{w_k}{z}$.

The net profit obtained by the multinational enterprise from expanding its production line in country j can then be expressed as

$$\pi(\mu_{ij}) = \sigma^{-1} A \left(\frac{\sigma}{\sigma - 1} c_j\right)^{1-\sigma} \mu_{ij}^{\sigma} E P^{\sigma-1} - F_j,$$

which can be rewritten as

$$\pi(\mu_{ij}) = B_i \left(\frac{z}{w_j}\right)^{\sigma-1} \mu_{ij}^{\sigma} - F_j,$$

where $B_i \equiv A_i E_i P_i^{\sigma-1} \sigma^{-1} \left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}$.

This expression shows that the parameter μ_{ij}, which captures the stability of the supply chain between countries i and j, affects the multinational enterprise's profit in the same manner as productivity z. A higher level of supply chain stability therefore raises the effective productivity of the firm when operating along the corresponding supply chain.

In an analogous manner, the net profit obtained by the multinational enterprise from establishing a new production facility in country i can be expressed as

$$\pi(\mu_{ii}) = \sigma^{-1} A \left(\frac{\sigma}{\sigma - 1} c_i\right)^{1-\sigma} \mu_{ii}^{\sigma} E P^{\sigma-1} - F_i,$$

which can be rewritten as

$$\pi(\mu_{ii}) = B_i \left(\frac{z}{w_i}\right)^{\sigma-1} \mu_{ii}^{\sigma} - F_i,$$

where $B_i \equiv A_i E_i P_i^{\sigma-1} \sigma^{-1} \left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}$.

The multinational enterprise chooses the structure of its supply chain by comparing the levels of net profit associated with the two investment options. The key determinants of this choice are the wage level w, fixed costs F, and the degree of supply chain stability captured by μ. Since it is reasonable to assume that wages are lower in the country where production facilities are initially located, we assume that $w_j < w_i$.[2] As previously assumed, fixed costs satisfy $F_i > F_j$.

For analytical convenience, suppose that the supply chain stability function is $f(s_i, s_j) =$

[2] Strictly speaking, when trade costs τ_{ij} are taken into account, the unit production cost incurred when expanding production facilities in country j is given by $w_j \tau_{ij}$, while the unit production cost associated with establishing a production facility in country i is given by $w_i \tau_{ii}$. For simplicity, however, here we assume that trade costs are fully embedded in wages and therefore do not appear explicitly in the cost expressions.

$1 - s_i^{0.5} s_j^{0.5}$. Under this assumption, it is straightforward to verify that

$$\mu_{ij} < \mu_{ii} \quad \Leftrightarrow \quad s_j < s_i.$$

This result implies that when the effort exerted by the government of country j to keep the supply chain stable is lower than that of country i, establishing a new production facility in country i is more attractive for the multinational enterprise holding all other conditions constant. As a result, a higher level of supply chain stability supported by the government of country i increases the probability of the multinational enterprise to invest within country i.

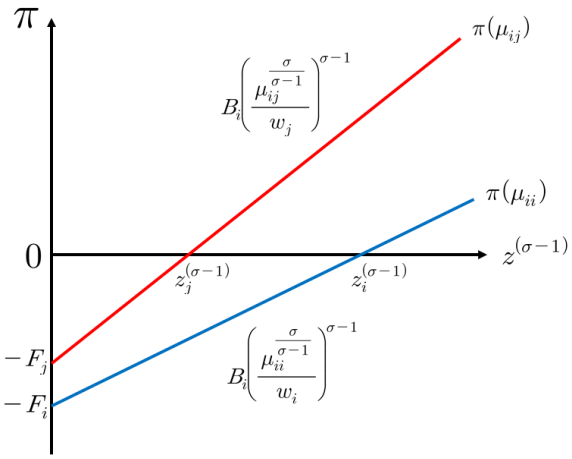
In what follows, we examine the economic implications of strategic investment subsidy policies implemented by the government of country i. To this end, we compare two extreme cases $s_j = 0$ and $s_j = 1$ regarding the level of effort exerted by the country j's government to keep the supply chain stable. The level of effort exerted by the country i's government s_i, is assumed to lie in the open interval $(0,1)$. Given the relationship $\mu_{ij} < \mu_{ii}$ if and only if $s_j < s_i$, it follows that when $s_j = 0$, we have $\mu_{ij} < \mu_{ii}$, whereas when $s_j = 1$, the opposite inequality $\mu_{ij} > \mu_{ii}$ holds.

We further assume that the productivity of the new production line, z, which the multinational enterprise establishes to manufacture next-generation products, is not observable by both governments of countries i and j. This assumption reflects the realistic uncertainty surrounding the profitability of new production lines when firms undertake new investments to produce technologically advanced products. On the other hand, we assume that the firm can perfectly observe z, given its access to proprietary information.

1. Stable Supply Chain: $s_j = 1$

As the analysis below repeatedly refers to graphical representations similar to those shown in Figure 1, we begin by explaining the structure of this figure. In Figure 1, the horizontal axis represents the multinational enterprise's productivity level, expressed as $z^{\sigma-1}$, while the vertical axis measures the level of net profit earned by the firm. The red line

Figure 1.



Source: Yea et al. 2024.

depicts the net profit obtained when the multinational enterprise invests in country j at each productivity level, whereas the blue line represents the net profit associated with investment in country i. Since the firm earns positive profits only when the curve lies above zero on the vertical axis, investment in country

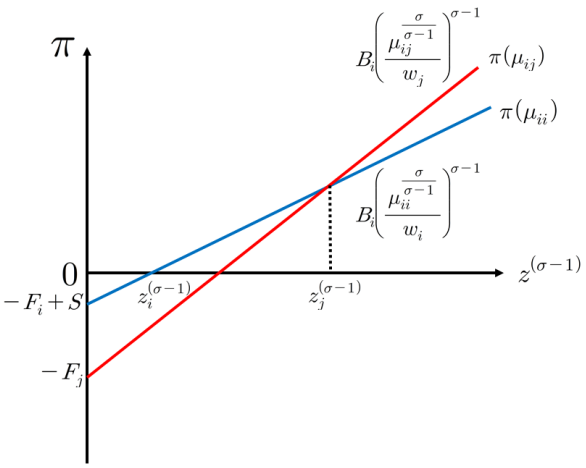
j is feasible only for productivity levels exceeding z_j, and investment in country i is feasible only for productivity levels exceeding z_i.

When the red line lies above the blue line for all values of z, investing in country j yields higher net profits than investing in country i at every productivity level. In this case, firms with productivity levels above z_j choose to invest in country j, while firms with productivity below this threshold do not undertake investment.

Put differently, establishing a production facility in country j is inferior to establishing a new facility in country i in terms of supply chain stability. At the same time, since wages in country j are lower than those in country i, country j enjoys a cost advantage from the production cost perspective. As a result, firms that earn positive investment returns choose to invest exclusively in country j.

Consider now a policy in which the government of country i provides a subsidy S that covers part of the fixed cost associated with establishing a production facility by multinational enterprises. Since the government of country i cannot observe firm-level productivity, all firms are eligible for the subsidy. Figure 2 illustrates this situation. Unlike the case without subsidies, multinational enterprises with productivity levels within a certain range now earn positive profits and are induced to invest in country i.

Figure 2.



Source: Yea et al. 2024.

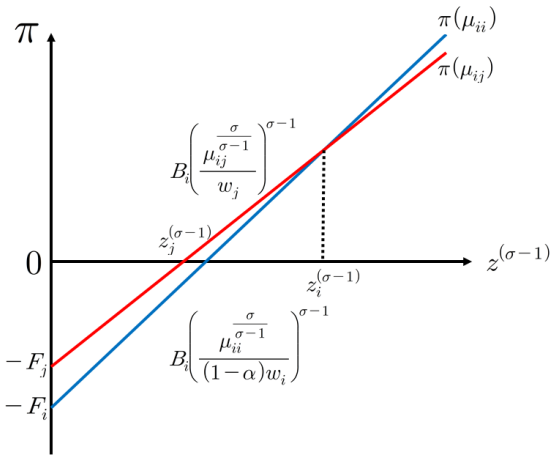
However, the productivity of these firms lies above z_j but below z_i. That is, firms with very high productivity have no incentive to invest in country i, while firms that would not have invested in the absence of subsidies are now induced to invest in country i. This generates a reversal effect in which firms that would otherwise not have invested choose to do so solely because of the subsidy.

From the perspective of country i, although such a subsidy policy succeeds in attracting investment, it fails to attract high-quality firms when viewed through the lens of international competition in strategic industries. Consequently, subsidies targeted at fixed costs do not constitute an effective investment promotion policy.

We now consider an alternative policy in which the government of country i offers production-cost subsidies α as an incentive for multinational investment. Here, production-cost subsidies refer broadly to policies

that reduce unit production costs. These include direct measures such as income tax relief or tax credits for workers employed at the production facility, as well as indirect measures such as R&D support that enhances firm productivity. Figure 3 illustrates the case in which production-cost subsidies are provided instead of fixed-cost subsidies.

Figure 3.

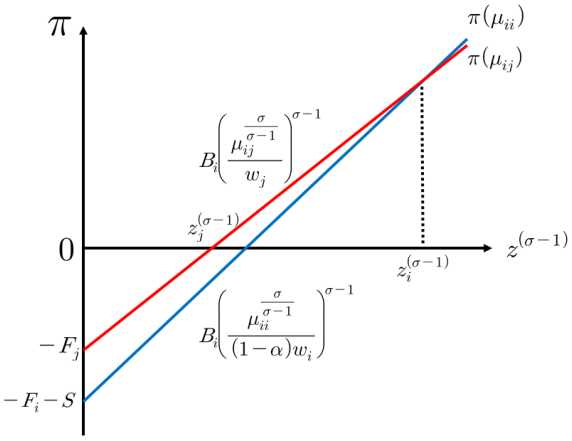


Source: Yea et al. 2024.

Under a production-cost subsidy regime, multinational enterprises with productivity levels above z_i choose to invest in country i, while those with productivity between z_j and z_i invest in country j. Firms with productivity levels below z_j do not undertake investment. This pattern reflects the fact that more productive firms are less sensitive to fixed investment costs but respond more strongly to changes in unit production costs.

An important implication of this result is that, from the perspective of country i, subsidizing production costs alone is dominated by a policy that combines production-cost subsidies with higher fixed investment costs, as such a policy is more effective in selectively attracting highly productive firms. As illustrated by the comparison between Figures 3 and 4, an increase in fixed investment costs associated with investing in country i discourages firms with marginal productivity levels from investing in country i. As this selection effect becomes stronger, investment in country i is increasingly concentrated among highly productive firms.

Figure 4.



Source: Yea et al. 2024.

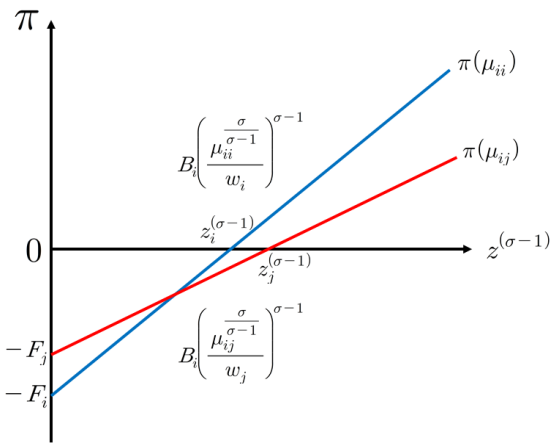
Accordingly, a policy mix that subsidizes production costs while simultaneously increasing the fixed costs associated with investment can enable country i to secure a robust cost advantage relative to country j and attract high-quality multinational investment. In practice, requirements attached to subsidy programs, such as mandatory provision of childcare services or the use of domestically produced construction materials, can raise fixed investment costs. For example, under the U.S. CHIPS and Science Act, firms receiving subsidies above a specified threshold are required

to provide childcare services or comply with domestic content requirements, which effectively increase fixed investment costs. From a theoretical perspective, such requirements function as a screening mechanism that selectively attracts highly productive firms when production subsidies are provided.

2. Unstable Supply Chain: $s_j = 0$

We now examine the effectiveness of strategic investment subsidy policies implemented by the government of country i when the level of supply chain stabilization effort in country j is low, that is, when $s_j = 0$. Figure 5 illustrates the investment patterns of multinational enterprises in the absence of strategic investment subsidies by the government of country i. When $s_j = 0$ we have $\mu_{ij} > \mu_{ii}$, implying that, as long as wage differentials are not excessively large, the slope of the profit schedule with respect to firm productivity takes the form depicted in Figure 5. If, by contrast, the wage gap between w_i and w_j becomes sufficiently large, the analysis corresponding to the case shown in Figure 1 applies.

Figure 5.



Source: Yea et al. 2024.

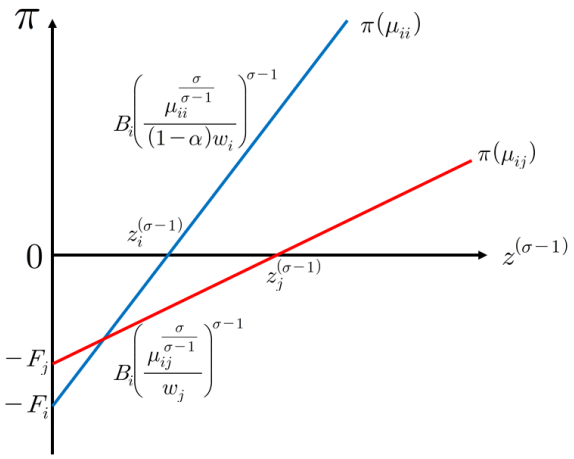
As shown in Figure 5, when the supply chain linking country j to country i is highly unstable, multinational enterprises with productivity levels exceeding z_i generally prefer to establish production facilities in country i rather than expand production in country j. In other words, even in the absence of investment subsidies, firms consider relocating production facilities to country i when supply chains originating from country j are sufficiently fragile.

This observation suggests that policy instruments aimed at deliberately increasing supply chain instability across countries can function as strategic tools to attract multinational investment. Measures such as technology export controls, which can artificially raise the degree of supply chain instability associated with specific countries, indicate that strategic investment promotion policies are not confined to direct financial incentives alone.

Figure 6 shows that when the government of country j exerts a low level of effort to keep supply chains stable, production-cost subsidy policies implemented by the government of country i may reduce the average productivity of firms investing in country i. When production-cost subsidies are provided to firms investing in country i, marginal firms with relatively low productivity become less sensi-

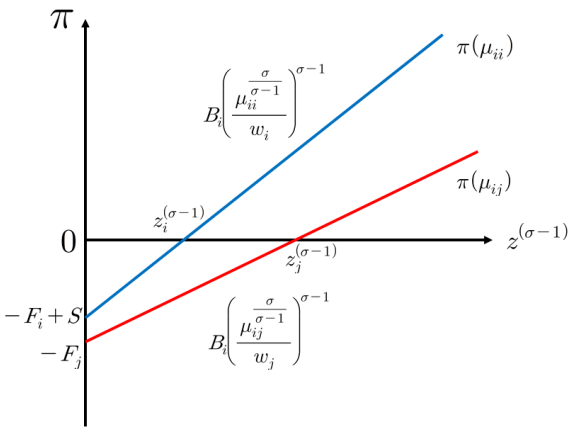
tive to fixed investment costs, thereby undertaking investment in country i. As a result, firms that would have postponed investment in the absence of subsidies now choose to invest, generating an adverse selection effect. Fixed-cost subsidy policies exhibit a similar pattern, as illustrated in Figure 7, by also inducing investment from relatively low-productivity firms.

Figure 6.



Source: Yea et al. 2024.

Figure 7.



Source: Yea et al. 2024.

Taken together, the preceding analysis suggests that investment subsidy policies that subsidize fixed costs, regardless of the level of supply chain stability, are not well suited to attracting highly productive firms' investment. Rather, policies that increase fixed investment costs can serve as a screening device that filters out low-productivity firms, provided that production costs in country i are sufficiently competitive. Surely, governments that prioritize job creation may still find fixed-cost subsidy policies effective in attracting a large number of foreign firms. However, in technology-intensive strategic industries where firm-level technological capabilities are uncertain, the design of investment subsidy policies aimed at attracting multinational enterprises requires a more cautious and targeted approach.

III. Conclusion

This article presents a theoretical framework that examines the use of strategic investment subsidies by a government seeking to retain multinational investment within its own borders, taking into account the mobility of corporate investment decisions under conditions of supply chain instability. By incorporating the level of supply chain stability, which is influenced by governments' stabilization efforts, into firms' investment decision problems, the analysis explores how governments can selectively attract firms with high technological capabilities in advanced strategic industries.

In technology-intensive sectors, uncertainty regarding firms' underlying technological capabilities requires governments to adopt more targeted and precise investment promotion strategies. While the analysis focuses on a setting in which a single country designs investment subsidies in isolation, real-world investment competition often involves two or more countries competing to attract the same multinational firm's most advanced production facilities.

This study considers investment subsidy schemes in a static framework. In practice, however, governments frequently adopt dynamic subsidy schemes, and firms commonly make investment decisions through sequential negotiations with multiple governments. Extending the analysis to dynamic policy environments and multi-country investment competition therefore represents an important avenue for future research. KIEP