RIETI Discussion Paper Series 24-E-024

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https://www.rieti.go.jp/en/

RIETI Discussion Paper Series 24-E-024
February 2024

Keep Your Friends Close and Your Enemies Closer: Network externality and tax competition*

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Abstract

This study investigates the effects of network externality on the policy competition between two countries regarding their attempts to attract a multinational enterprise (MNE). The two countries have different numbers of consumers and endogenously set a tax/subsidy on the MNE. The larger country has a local firm with a large market. Network externality makes the larger country with the local firm more attractive to the MNE because the resulting larger supply amplifies the network size. The MNE's location in the larger country can also benefit the local firm despite fiercer competition with the MNE while also benefiting consumers in all countries. Fiscal competition increases the likelihood of a larger country hosting the MNE when the network externality is large, but it promotes the MNE's location in a small country when the network externality is small. A location change from a smaller to a larger country, induced by fiscal competition, improves both countries' welfare or their joint welfare when the network externality is significant.

Keywords: Network externality; Fiscal competition; Foreign direct investment; Digitalization
JEL classification: F13, F23, H25, L13

*This study is conducted as a part of the project "Economic Policy Issues in the Global Economy" undertaken at the Research Institute of Economy, Trade and Industry (RIETI). The draft of this paper was presented at a DP seminar of the Research Institute of Economy, Trade and Industry (RIETI). We would like to thank Arpita Chatterjee, John Gilbert, Andreas Haufler, Keisaku Higashida, Naoto Jinji, Satoshi Kasamatsu, Daiki Kishishita, Tidiane Ly, Mohammed Mardan, Masayuki Morikawa, Gregory Ponthière, Martin Richardson, Dirk Schindler, Emmanuelle Taugourdeau, Eiichi Tomiura, Halis Yildiz, Dennis De Widt, and the seminar participants at RIETI, Erasmus University Rotterdam, Fukuoka University, Kyoto University, Musashi University, Toronto Metropolitan University, ATW 2023, IIPF 2023, KVS New Paper Sessions and SOPE 2023. The usual disclaimer applies.

1 Introduction

Many factors influence firms' foreign direct investments (FDIs), and digitalization of the world economy has been one of the important changes affecting their FDI location choices. According to the International Telecommunications Union, the share of internet users worldwide increased from 16% (1 billion users) in 2005 to 66% (5 billion users) in 2022, and almost three-quarters of the world population in 2022 owned a mobile phone, which is the most common gateway to the internet.[1] Considerable attention has been paid to the impacts of the progress of digitalization, and its effect on firms' location choices is one of them. For instance, Baldwin and Freeman (2022) pointed out that the development of information and communication technology (ICT) enables firms to offshore some tasks across countries. Ko (2007) empirically showed that the internet plays a core role in attracting FDIs. Exploring firms' decisions under digitalization is critical to understand how ICT changes the shape of global production.[2]

In addition to digitalization, there are other factors affecting firms' location choices. Among them, fiscal policies such as the provision of tax incentives and that of subsidization are a main tool for attracting FDI.[3] Many countries have offered tax incentives to attract FDI in high-tech products, such as semiconductors. As the Organisation for Economic Co-operation and Development (OECD) pointed out, however, one country's change in fiscal policies can trigger other countries to modify their policies, which may lead to "harmful tax competition"(OECD, 1998). Fierce fiscal competition results in host countries collecting less tax revenue and then providing reduced public goods. It may also induce inefficient location choices among multinational enterprises (MNEs) and worsen host countries' welfare. This concern about the harmful tax competition has been an important policy topic in the global economy. However, whether digitalization promotes or prevents harmful tax competition has been an open question.

Among several features of digitalization, this study focuses on consumption network ex-

[1] See `https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx` and `https://www.itu.int/itu-d/reports/statistics/2022/11/24/ff22-mobile-phone-ownership/`, accessed on July 7, 2023.

[2] For instance, Chiappini and Gaglio (2024) empirically showed that sectoral digital intensity is associated with sectoral exports. Stallkamp et al. (2023) empirically showed that even if firms are able to distribute their products remotely via digital channels such as apps, they may still establish a physical presence to sell those products by undertaking FDIs.

[3] The host governments offer these policies to gain benefits from inward FDIs, such as transfer of superior technology, higher wages, or greater consumer surpluses. See Navaretti and Venables (2020) for a survey of benefits from inward FDI.

ternality. Because users and suppliers are connected online, their behaviors affect others' utilities and profits. For instance, consumers' gains from purchasing network goods, such as mobile phones, personal computers, and game consoles, increase as users of the same network good increase because they can interact more with other consumers (resulting in a direct network effect). Moreover, consumers' benefits also increase as online service providers become more willing to develop new services (resulting in an indirect network effect). Although consumers are able to interact with other consumers and online service providers through the internet, consumers still need to physically purchase network goods. Therefore, MNEs need to have a plant to produce network goods, and they are subject to fiscal competition for FDI. However, how network externality affects fiscal competition has not been explored.

Some countries provide tax incentives to attract FDI from firms producing network goods. For example, after Samsung announced its plan to establish a new mobile phone plant in 2007, it was granted a large tax exemption from Vietnam, and the company established plants to produce its smartphones in 2008.[4] Similarly, Apple Inc. plans to produce laptop personal computers in Vietnam, and it has also announced its smartphone production in India[5], which introduced production-linked incentive scheme in 2020 to grant firms in several key sectors, such as electronic manufacturing and ICT hardware, financial incentives based on their domestic investments, production, and sales.[6] The chairman of India Cellular and Electronics Association, Pankaj Mohindroo, stated "I just hope that India Inc. acts together so that we provide the right space for them (Apple), because we lost Samsung completely to Vietnam." His statement indicates that there is fiscal competition between the two countries to attract firms producing network goods.[7]

These trends in and anecdotes from the world economy raise important questions. How does network externality influence MNEs' location choices? How does it affect countries' fiscal competition to attract MNEs? Does fiscal competition result in harmful tax competition?

[4]See https://www.reuters.com/article/samsung-vietnam-idUSSEO33711720080321, accessed on June 5, 2023. Vietnam also applies preferential tax rates or other tax exemptions to firms in certain sectors, including high-tech sectors that produce digital and IT products. See https://fia.mpi.gov.vn/en/Single/MenuID/30ed8984-6d18-48b5-af2a-757cc6c65d90, accessed on February 19, 2023.

[5]https://asia.nikkei.com/Spotlight/Supply-Chain/Apple-to-start-making-MacBooks-in-Vietnam-by-mid-2023, accessed on February 19, 2023.

[6]https://www.investindia.gov.in/production-linked-incentives-schemes-india, accessed on February 19, 2023. Some smartphone producers such as Samsung, Vivo, Xiaomi, and Oppo have set up manufacturing units in India. See https://www.kearney.com/technology/article/-/insights/are-companies-considering-india-for-electronics-vs-sticking-with-malaysia-vietnam-etc, accessed on April 26, 2023.

[7]https://economictimes.indiatimes.com/industry/cons-products/electronics/we-must-not-lose-apple-the-way-we-lost-samsung-to-vietnam-says-icea-chairman/articleshow/97251963.cms, accessed on July 8, 2023.

To address these questions, we explore the fiscal competition between two countries in a situation where the consumption of goods generates network externality and there are local competitors.[8] Specifically, we consider a situation where two countries in the same region have different market sizes, and there is a local incumbent firm in the larger country. Due to the fixed costs of FDI, an MNE chooses to locate itself in either country in a region, where they serve both markets. The local firm also sells its products to both markets, and the firms' exports incur trade costs. The consumption of goods generates network externality, and demand for goods increases as the total sales across the two countries increase. Given this situation, we analyze the countries' endogenous determinations of taxes/subsidies to maximize their welfare.

Without network externality, the MNE faces a trade-off between the market size and competition effects. In other words, the MNE can sell goods without trade costs to many consumers ("friends"), but also faces fiercer competition with the local firm ("enemy"). If the market size difference is small and trade costs are high, the MNE chooses a smaller country to avoid the rival firm provided that the two countries have similar taxes/subsidies. The network externality provides additional benefits due to the MNE's location in a large country. Because a larger market size and competition with the local firm increase the product's total worldwide sales, being located in a large country with a local firm amplifies the network effect and benefits the MNE. Furthermore, such strong network effects due to being located in a large country also benefit consumers in both countries and the local firm in the large country because of the direct network effect and the expansion of demand. Therefore, the network externality incentivizes the MNE "to keep its friends close and its enemies closer"compared with a case without the network externality, where the MNE's choice is between "keeping its friends close or keeping its enemies far."

Our model also shows that network externality can change the winner of fiscal competition among countries. Without network externality, as Bjorvatn and Eckel (2006) pointed out, the local firm's loss of profit makes the larger country less willing to welcome the MNE, and as a result of the fiscal competition, a small country can host the MNE. Given the small network effect, the large country will be less aggressive in fiscal competition because of the local firm's presence, whereas a small country is more aggressive to increase its consumer

[8]In India, MNEs producing smartphones compete with local smartphone producers, such as Micromax Mobile, Lava International, and Karbonn Mobiles.

surplus. Consequently, the fiscal competition changes the MNE's location from a large country to a small country, which is the same result as a case without network externality. When the network externality is large, positive network effects on consumers in both countries and on local firms are higher when the MNE is located in a larger country. Therefore, the larger country becomes more aggressive, and the smaller country becomes less aggressive in the fiscal competition. Consequently, in contrast to the previous two cases, the larger country is more likely to host the MNE when the network externality is large.[9]

We also investigate whether fiscal competition is harmful in terms of welfare. In line with the previous papers, fiscal competition always leads to MNEs' efficient location and attains the largest total welfare. This is because the country that benefits the most from an MNE's location offers the most generous fiscal policy and wins the fiscal competition. Since the governments' taxes/subsidies are purely transferred to MNEs, fiscal competition maximizes total welfare. The efficient location of MNEs that fiscal competition accomplishes, however, does not necessarily benefit the countries engaged in the competition. When the winning country offers MNE an investment subsidy, the MNE captures some of the efficiency gains, and the fiscal competition may hurt the competing countries. Our model predicts that fiscal competition benefits the winning country when the competition changes the location of the MNE or when the equilibrium fiscal policy is a tax.

Even if the fiscal competition changes the location of an MNE, the country that loses the fiscal competition and the MNE may both still benefit from the relocation. If the losing country is the large country, the relocation occurs under small network externality and large trade costs. In this case, the local firm in the large country benefits from the relocation, and this effect dominates the consumer loss. If the losing country is the small country, the relocation occurs when the network externality is large. If the network externality is sufficiently large, the relocation benefits the consumers in the small country due to the network effect. Additionally, even if the losing country suffers welfare loss, the fiscal competition could improve the joint welfare of the two countries in the region.

These results suggest that "harmful tax competition" is less likely to occur when network externality is sufficiently large, and the location of MNEs in the larger and more competitive countries not only benefits consumers in those countries but also benefits domestic firms in

[9] Amerighi and De Feo (2017) also showed a case where fiscal competition changes an MNE's location from a smaller to a larger country, despite a local firm's presence in the larger country. In their study, the distinction between private and public firms is the key. In contrast, this study focuses on the role of network externality.

those countries and consumers in other countries. The promotion of digitalization is important not only for facilitating online transactions but also for weakening the harmful effects of tax competition on attracting MNEs.

1.1 Related Literature

This study relates to two strands of the literature. First, many studies have investigated fiscal competition for FDI. One seminal study was conducted by Haufler and Wooton (1999), who demonstrated that the market size difference is an important determinant of the location choice of a monopolistic MNE. They showed that a larger country wins the tax competition. Some other studies have added new elements to the market size difference. Barros and Cabral (2000) considered an unemployment problem in a smaller country and highlighted a case where the smaller country wins the tax competition. Bjorvatn and Eckel (2006) demonstrated that competition with other firms also affects tax competition winners, and a smaller country without local firms is more likely to win the tax competition.

Some recent research has extended these seminal studies by including new elements. Amerighi and De Feo (2017) considered a situation where the local firm is a public firm that maximizes domestic welfare. They demonstrated that a larger country with a public firm always benefits from attracting FDI. Ma and Wooton (2020) analyzed the role of product differentiation and demonstrated that fiscal competition only has a redistribution effect and does not affect new entrants' location choices. Ferrett and Gravino (2021) considered technological spillover from an MNE to a local firm and demonstrated that MNEs prefer away from local firms to limit technology spillover, but fiscal competition induces MNEs to locate themselves close to local firms, improving world welfare. Our study is distinct in the following ways: It examines the effects of network externality and provides new policy implications for fiscal competition amid the digitalization of the economy.[10]

Second, this study contributes to the literature on international trade and network externality. For instance, Klimenko and Saggi (2007) investigated entrant firms' choice between greenfield FDI and mergers and acquisitions (M&A) in the presence of network externality and demonstrated that stronger network externality reinforces M&A because it increases

[10]These papers considered a single MNE, but some papers, such as Ferrett and Wooton (2010), Haufler and Wooton (2010) and Ferrett and Wooton (2021), considered tax competition when there are more than two MNEs. Other studies considered fiscal competition among more than three countries/regions, as in Haufler and Wooton (2006), Darby et al. (2014), and Janeba and Schulz (2020).

monopoly profit and lowers the acquisition price. Kao and Mukunoki (2021) investigated the effects of permitting parallel imports of platform products that generate two-way network externality and demonstrated that parallel imports benefit platform producers and consumers in all countries when the network externality is large. Klimenko and Qu (2023) compared a foreign platform firm's entry through greenfield FDI and the acquisition of the incumbent platform and demonstrated that the degrees of technology transfer, network externality, and product differentiation determine the two modes' private and social desirability. However, none of these studies investigated the impact of network externality on tax competition.

The remainder of this paper is organized as follows. Section 2 presents the model and derives the market outcomes. Section 3 discusses MNEs' location choices and investigates how fiscal competition changes the equilibrium location. Section 4 explores the welfare effects of fiscal competition to identify whether fiscal competition is harmful. Section 5 further discusses the model and the results. Section 6 concludes.

2 Model

This section provides a formal model and explores the outcomes of the product market competition. Section 2.1 sets up an international fiscal competition model. Section 2.2 derives the equilibrium in the product markets and examines how MNE location and the degree of network externality affects market outcomes.

2.1 Setup

We consider a region comprising two countries (countries A and B) and two industries. The industry X is under imperfect competition, which is this study's main focus. The other industry is under perfect competition and produces numéraire goods.

An MNE, firm M, has headquarters in a foreign country outside the two countries. Firm M must establish a plant in these countries to sell its products in both countries, possibly because of the high trade costs associated with exporting from outside the region. We assume that firm M establishes its plant in only one country in the region because of the high fixed costs associated with plant establishment.[11] The two countries are heterogeneous in two

[11]The same assumption has been employed in the literature on fiscal competition, such as in Bjorvatn and Eckel (2006).

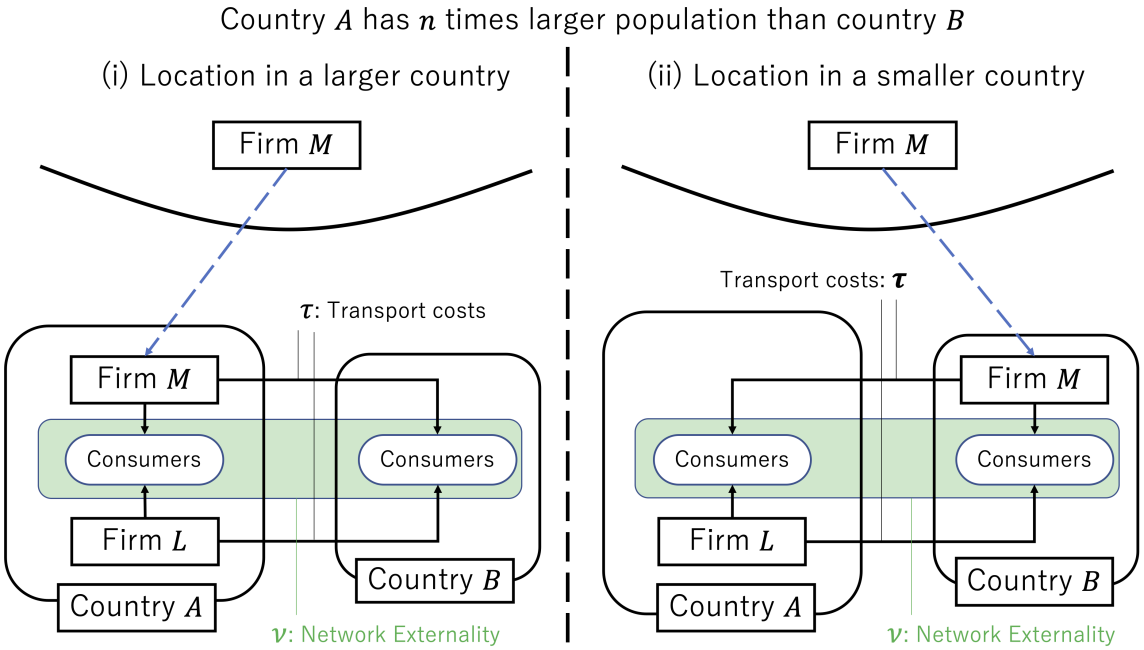

Figure 1: Model

respects. First, country A's population is n times larger than country B's. Let n_i be the population of country i. For simplicity, we normalize the market size in the smaller country B to unity, and hence, $n_A = n > 1 = n_B$ holds. Second, a local incumbent firm exists, firm L in the larger country, A. Figure 1 describes the model's structure.

2.1.1 Consumers

Each individual's utility from consuming network goods and numéraire goods are additively separable. Each consumer decides to buy one unit of the network good. Each consumer's net utility from consuming the network good in country i is given by:

$$u_i = \theta + \nu Y - p_i, \tag{1}$$

where p_i is the price of network goods in country i, and θ is consumers' willingness to pay for the network good. Consumers have different θ, and this is uniformly distributed on $\theta \in (-\infty, \alpha]$ in both countries. We consider consumption network externality: Y is the expected network size, which is equal to the total consumption of network goods in the two countries. Each consumer's utility increases as Y increases. The parameter ν captures the degree of network externality. There is no externality when $\nu = 0$.

Consumers in country i buy network goods if and only if $u_i \geq 0$ holds. Let $\overline{\theta}_i$ be the willingness to pay for the network good, such that $u_i = 0$ holds: $\overline{\theta}_i = p_i - \nu Y$. Then, the aggregate demand of the network good becomes $n_i \int_{\overline{\theta}_i}^{\alpha} 1 d\theta = n_i(\alpha - \overline{\theta}_i)$, and we assume that the two markets are segmented such that the market clears in each market. The market-clearing condition requires $n_i(\alpha - \overline{\theta}_i) = X_{Mi} + X_{Li}$, where X_{Mi} is firm M's supply and X_{Li} is the local firm's supply of the network good in country i. By combining this equation with $u_i \geq 0$, we obtain the aggregate inverse demand function in country i as:

$$p_i = \alpha + \nu Y - \frac{X_{Mi} + X_{Li}}{n_i}. \tag{2}$$

The corresponding consumer surplus in country i becomes:

$$CS_i = n_i \int_{\overline{\theta}_i}^{\alpha} (\theta + \nu Y - p_i) d\theta = \frac{(X_{Mi} + X_{Li})^2}{2n_i}. \tag{3}$$

2.1.2 Firms

Firms M and L produce a homogeneous network good and engage in Cournot competition. Both firms produce network goods using the same production technology, and their marginal production costs are given by c. Both firms supply their products in both markets, implying that they are both exporters. They incur a per unit trade cost τ.

Henceforth, let the superscript letter indicate the country where firm M is located. Given that firm M is in country j, firm L's profit is given by

$$\Pi_L^j = (p_A^j - c) X_{LA}^j + (p_B^j - c - \tau) X_{LB}^j \tag{4}$$

where $j \in \{A, B\}$. Firm M's profit is given by

$$\Pi_M^j = (p_j^j - c) X_{Mj}^j + (p_k^j - c - \tau) X_{Mk}^j - t_j, \tag{5}$$

where $k \neq j$ and t_i represents a fiscal policy set by country j. We will explain t_i below.

2.1.3 Governments

Because of the heterogeneity between the two countries and the presence of trade costs, firm M's location affects the welfare of countries A and B. Here, we consider a fiscal policy that

affects firm M's investment: Government i imposes lump-sum investment tax t_i on firm M's investment in country i. If $t_i < 0$, then the government offers an investment subsidy.[12]

Country A's welfare comprises the consumer surplus, firm L's profit, and the possible tax revenues/subsidy payments. Country B's welfare comprises the consumer surplus and tax revenues/subsidy payments. Given firm M's location in country j, we have

$$W_A^j = CS_A^j + \Pi_L^j + \lambda_A^j t_A, \qquad \text{and} \qquad W_B^j = CS_B^j + \lambda_B^j t_B, \tag{6}$$

where λ_i^j ($i = \{A, B\}$) is a binary parameter that takes unity if country i hosts firm M ($\lambda_i^j = 1$ where $i = j$) and zero otherwise.

2.1.4 Timing of the game

We solve the following four-stage game. At Stage 1, the two countries simultaneously determine their fiscal policies t_i to maximize their own welfare. In Stage 2, firm M chooses its subsidiary production location. At Stage 3, consumers form their network size expectations. Following Katz and Shapiro (1985) and Wu et al. (2022), we do not examine how expectations are formed and rather suppose that consumers' expectation would be fulfilled in prpoportion to the actual network size (i.e., total consumption of the network good) in equilibrium. At Stage 4, firms engage in a Cournot competition in each market.

2.2 Product Market Competition and Network Externality

This subsection derives the equilibrium of subgames at Stage 3 and Stage 4, given firm M's location and the govenrments' fiscal policies. It also examines how firm M's location and the presence of the network externality affects consumers in each country as well as the local firm in Country A. For notational brevity, we use $a = \alpha - c$ hereafter.

2.2.1 Market Outcomes

At Stage 4, given firm M's location in country j, firms M and L set their supplies in each market to maximize their respective profits. Although each firm's supply affects total consumption and consumers' willingness to pay through the network effect, firms do not control

[12] In the case of subsidization, $t_i < 0$, one may wonder how the governments finance the subsidy. Although we do not explicitly incorporate the source of finance, following Haufler and Wooton (1999), introducing a head tax from consumers is an option.

for the expected network size and take Y as given.[13] At Stage 3, consumers predict the size of the network, and those expectations coincide with the actual size $Y^j = X^j_{Mj} + X^j_{Lj} + X^j_{Mk} + X^j_{Lk}$. Combining this equation with the first-order conditions of profit maximization at Stage 4, the equilibrium output when firm M is located in country A becomes

$$\widehat{X}^A_{MA} = \widehat{X}^A_{LA} = \frac{n}{3}\left[a + \frac{2\{(1+n)a - \tau\}\nu}{3 - 2(1+n)\nu}\right], \tag{7}$$

$$\widehat{X}^A_{MB} = \widehat{X}^A_{LB} = \frac{1}{3}\left[a - \tau + \frac{2\{(1+n)a - \tau\}\nu}{3 - 2(1+n)\nu}\right]. \tag{8}$$

Throughout the analysis, we focus on the case where both firms supply finite amounts of their products in both markets. This restricts the range of ν and τ to $0 \leq \nu < \frac{3}{2(1+n)} \equiv \nu^{max}$ and $0 \leq \tau < \frac{a}{2-(1+n)\nu} \equiv \tau^{max}$, respectively. Therefore, $3 - 2(1+n)\nu > 0$ in these equations. The second terms in parentheses in these equations represent the network effect. When firm M is located in country B, the outputs are

$$\widehat{X}^B_{MA} = \frac{n}{3}\left[a - 2\tau + \frac{(1+n)(2a-\tau)\nu}{3 - 2(1+n)\nu}\right],\ \widehat{X}^B_{LA} = \frac{n}{3}\left[a + \tau + \frac{(1+n)(2a-\tau)\nu}{3 - 2(1+n)\nu}\right] \tag{9}$$

$$\widehat{X}^B_{MB} = \frac{\widehat{X}^B_{LA}}{n},\ \widehat{X}^B_{LB} = \frac{X^B_{MA}}{n}. \tag{10}$$

By substituting these outputs into the profit function, we obtain the equilibrium profits when firm M is in country j, denoted by $\widehat{\Pi}^j_M$ and $\widehat{\Pi}^j_L$.

2.2.2 Effects of MNE location on consumers and the local firm

Before exploring firm M's location choices and the two governments' fiscal competition, we examine how firm M's location affects consumers in each country and the local firm's profit. Given that the network size affects consumers' willingness to pay, let us first compare how firm M's location affects the equilibrium network size, which coincides with the total equilibrium sales of a network good in the region. We can confirm that the equilibrium network size $\widehat{Y}^j$ is always larger when firm M is located in country A:

$$\widehat{Y}^A - \widehat{Y}^B = \frac{(n-1)\tau}{3 - 2(1+n)\nu} > 0. \tag{11}$$

[13] As mentioned in the Introduction, the network externality implicitly represents both the direct and indirect network effects. It should be difficult for firms to accurately predict how their individual supplies will affect the number and the quality of online services.

This is because, by locating in country A, firm M supplies free of trade cost in a country with a larger market and a local firm. Consequently, the equilibrium sales are always larger than in the case where firm M is located in country B and bears the trade cost of supplying in country A. The network size difference increases as the degree of network externality ν grows because a larger ν magnifies the network effect on consumers' willingness to pay and further incentivizes firms to supply network goods.

The difference in the equilibrium network sizes affects governments' incentive to attract firm M by changing the effects of the MNE's location on consumer surplus and the local firm's profits. By Eq.(3), each country's consumer surplus improves if total sales in the country increase. In country A, we have

$$(\widehat{X}^A_{MA} + \widehat{X}^A_{LA}) - (\widehat{X}^B_{MA} + \widehat{X}^B_{LA}) = \frac{n(3-4\nu)\tau}{3\{3-2(1+n)\nu\}} = \frac{n\tau}{3} + \frac{2n\tau\nu(n-1)}{3\{3-2(1+n)\nu\}} > 0. \tag{12}$$

$\nu < \nu^{max}$ ensures that the denominator is positive. The equation's second term represents the network effect and is positive, implying that network externality magnifies the consumers' gains from hosting the MNE and thereby strengthens government A's desire to attract FDI.

In country B, we have

$$\begin{aligned}(\widehat{X}^B_{MB} + \widehat{X}^B_{LB}) - (\widehat{X}^A_{MB} + \widehat{X}^A_{LB}) = \frac{(3-4n\nu)\tau}{3\{3-2(1+n)\nu\}} = \frac{\tau}{3} - \frac{2(n-1)\tau\nu}{3\{3-(1+n)\nu\}} \gtreqless 0 \\ \iff \nu \lesseqgtr \nu^{CS} \equiv \frac{3}{4n}.\end{aligned} \tag{13}$$

This implies that the total sales in country B are *larger* when firm M locates in country A if the degree of the network externality and country A's market size is sufficiently large to satisfy $\nu^{CS} (\in (0, \nu^{\max}))$. In this case, consumers in country B will oppose attracting FDI.

Without network externality, hosting the MNE always increases consumer surplus in country B, because the MNE supplies goods without trade costs. However, the overall network size is larger when firm M locates in country A, where the market size is larger and the market competition is more intense. If the degree of network externality is sufficiently large, the latter effect dominates the former, and consumers in country B will prefer not to attract Firm M domestically. We have the following proposition:

Proposition 1. *The consumer surplus in country A is greater when firm M is located in country A rather than country B. There exists a threshold level of network externality, ν^{CS}, such that the*

consumer surplus in country B is greater when firm M is located in country A if $\nu > \nu^{CS}$. *The consumer surplus in country B is greater when firm M is located in country B otherwise.*

The network effect also changes the effects of hosting the MNE on the local firm. Because of the network effect, firm L may benefit from having firm M in the same country. On the one hand, having firm M in the same country intensifies market competition and harms firm L. On the other hand, having a rival in a larger market increases the overall network size, increasing consumers' willingness to pay in both countries and thus increasing both firms' profits. If the latter effect dominates the former effect, the local firm's profit will be larger given the inward FDI. Specifically, we have

$$\widehat{\Pi}_L^A - \widehat{\Pi}_L^B = -\frac{\{2a(n-1)+(n+3)\tau\}\tau}{9} - \frac{(n-1)\Gamma_L \tau \nu}{9\{3-2(1+n)\nu\}^2}, \tag{14}$$

where $\Gamma_L \equiv 6\{(n+1)a - n\tau\} - (n+1)\{8(n+1)a - (5n+3)\tau\}\nu$. With a sufficiently large ν, Γ_L is negative, and the second term becomes positive. If the positive second term dominates the (always negative) first term, firm M's location in country A will benefit firm L. There exists a threshold of ν, $\nu^L \in (0, \nu^{max})$, such that $\Pi_L^A > \Pi_L^B$ holds for $\nu^L < \nu < \nu^{max}$, and $\Pi_L^A \leq \Pi_L^B$ holds otherwise.[14] The following proposition summarizes the results.

Proposition 2. *There exists a threshold level of network externality,* ν^L, *such that the local firm's profit in country A is greater when firm M locates in country A rather than in country B if* $\nu > \nu^L$. *The local firm's profit is greater when firm M is located in country B otherwise*

Propositions 1 and 2 suggest the important role of network externality in fiscal competition. Traditionally, attracting FDI is beneficial for consumers but harmful for local firms. However, our results suggest that having MNE in a large country rather than in a small country benefits the local firms in the larger country and the consumers in all countries if the degree of network externality is sufficiently large. Therefore, network externality critically affects governments' incentive to attract FDI, which we will discuss in Section 3.2.

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[14]The order of the two thresholds, ν^{CS} and ν^L, depends on parameter values. If the market size difference and trade costs are sufficiently large, $\nu^{CS} < \nu^L$ holds, and firm M's location in country A benefits consumers in country B but hurts the local firm in country A when $\nu^{CS} < \nu < \nu^L$. Otherwise, $\nu^L < \nu^{CS}$ holds and firm M's location in country A benefits the local firm in country A but decreases consumer surplus in country B when $\nu^L < \nu < \nu^{CS}$.

3 Location Choice and Fiscal Competition

This section explores which country the MNE chooses for its production location and how the two countries' fiscal competition affects the equilibrium location. As a benchmark, we first examine firm M's choices without policy competition; that is, when the two countries employ common fiscal policies. We then examine MNE's location choice with policy competition. Comparing these two cases allows us to determine how policy competition changes equilibrium location. We demonstrate that the effects of policy competition critically depend on the degree of network externality.

3.1 Exogenous policy

To examine the impact of fiscal competition on firm M's location, we first consider firm M's location choice without government fiscal competition. Suppose that $t_A = t_B = t$ holds, such that the investment taxes/subsidies do not affect firm M's location choice between the two countries. By comparing firm M's profit when located in country A with its profit when it is located in country B, we have

$$\left(\Pi_M^A - \Pi_M^B\right)\Big|_{t_A=t_B=t} = \underbrace{\frac{4\{(n-1)a - n\tau\}\tau}{9}}_{+/-:\text{ Market size/Competition effect}} + \underbrace{\frac{(n-1)\Gamma_M \tau \nu}{9\{3-2(1+n)\nu\}^2}}_{+:\text{ Network effect}} \equiv \Omega, \qquad (15)$$

where $\Gamma_M \equiv 6\{5(n+1)a - \tau(3+2n)\} - (n+1)\{16(n+1)a - (9+7n)\tau\}\nu > 0$ due to $\nu < \nu^{\max}$. The first term captures the difference between the sum of the market size and the competition effect between the two markets, which can be positive or negative. Firm M faces a trade-off between larger and fiercer market competition when locating country A. It is positive if n is sufficiently large and τ is sufficiently small. This trade-off is Bjorvatn and Eckel (2006)'s main point.

In addition to the market size and the competition effect, the second term captures the positive network effect. As Eq.(11) suggests, the network size is larger when firm M is located in country A. A greater network effect increases consumers' willingness to pay and enhances the demand in both countries, which increases firm M's profits.

The sum of these two terms, Ω, represents country A's fundamental location advantage over country B. Without policy competition between the two countries, the sign of Ω determines firm M's location. From Eq.(15), we derive the cutoff level of τ under no fiscal

competition, $\overline{\tau}^{nfc}$, below which firm M will prefer to locate in country A and above which it will prefer to be located in B. Specifically, we have

$$\Omega \gtreqless 0 \iff \tau \lesseqgtr \overline{\tau}^{nfc} \equiv \frac{18\,(n-1)\,\{2-(n+1)\,\nu\}a}{36n-\{6(3+7n+6n^2)-(n+1)(9+14n+9n^2)\nu\}\nu} \tag{16}$$

Since the network effect always enhances county A's attractiveness as a production place, an increase in the degree of network externality ν will induce firm M to locate in country A and will also increase $\bar{\tau}^{nfc}$. The following lemma summarizes the MNE location choice without policy competition.

Lemma 1. *Suppose there is no fiscal competition to attract FDI. If $\tau \leq \overline{\tau}^{nfc}$ holds, firm M chooses the larger country, where local firms are also located, as its production location. Otherwise, firm M selects the smaller country without local firms. Firm M is more likely to choose a larger country as network externality strengthens.*

Figure 2 shows a numerical example of firm M's location choice in the ν-τ plane, where the solid upward curve represents $\overline{\tau}^{nfc}$.[15] Given the small network externality, firm M chooses country B if τ is high but selects country A if it is low. As the network externality increases, country A becomes more likely to host firm M. When ν is sufficiently high, $\bar{\tau}^{nfc} > \tau^{\max}$ holds, and country A always hosts firm M. This figure also depicts ν^{CS} and ν^{L}. If ν is sufficiently high so as to exceed these thresholds, firm M's location in country A rather benefits the local firm in country A and consumers in country B.

3.2 Endogenous policy

We now turn to the case where each government sets respective fiscal policies, t_i. At Stage 2, firm M chooses its location to maximize its profit given t_A and t_B. As $\Pi_M^A - \Pi_M^B = \Omega - (t_A - t_B)$, the fiscal competition can change firm M's location. Specifically, if $\Omega > 0$ and $t_B < t_A - \Omega$ hold, country B will attract firm A, which, without fiscal competition, would have chosen country A. Similarly, if $\Omega < 0$ and $t_A < t_B + \Omega$ hold, country A attracts firm M that would choose country B without fiscal competition.

At Stage 1, governments design their fiscal policies to maximize their own welfare. As the governments compete for the MNE outside the two countries, and firm M will only establish one plant, fiscal competition becomes an auction between the two countries. Before deriving

[15] The parameters are set to $a = 1$ and $n = 1.1$. With these parameter values, $\nu^{\max} = 5/7 \approx 0.71429$.

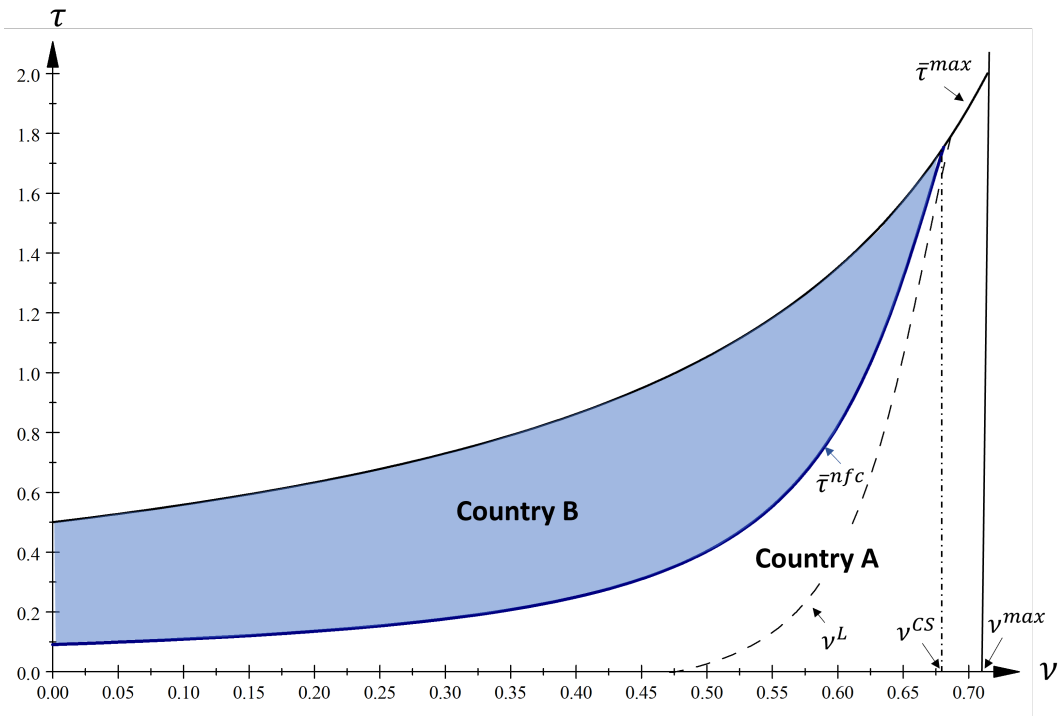

Figure 2: MNE location choice without policy competition

the equilibrium, we first consider the two countries' most generous fiscal policies, $\underline{t_i}$, below which country i has no intention to attract firm M.

By comparing Country A's welfare with and without Firm M's presence, $\underline{t_A}$ is given by

$$W_A^A \geq W_A^B \iff t_A \geq \underline{t_A} \equiv \underbrace{-\frac{\{4a-3(2+n)\tau\}\tau}{18}}_{+/-} \underbrace{-\frac{\xi_A \tau \nu}{9\{3-2(1+n)\nu\}^2}}_{-} \tag{17}$$

where $\xi_A \equiv 6\{(1+3n^2)\,a-2\tau n\}-\{8(1+n)^2 a-(3+15n+n^2-3n^3)\,\tau\}\nu > 0$ due to $\nu < \nu^{max}$. The level of $\underline{t_A}$ is divided into two components. The first term captures the effects of hosting firm M, which exists without network externality. In the absence of network externality, hosting the MNE increases consumer surplus, but simultaneously reduces firm L's profit. Therefore, the sign of the first term can be either positive or negative. If the market size effect dominates the competition effect, the first term is negative, and country A is willing to offer an investment subsidy $t_A < 0$ even without the network effect.

The second term reflects the network-externality-enhancing effect of hosting the MNE. Because hosting firm M saves trade costs and increases national supply, country A becomes more eager to attract firm M domestically in the presence of network externality. Additionally, the overall network size is always larger when country A hosts firm M. Owing to these effects,

the second term is negative, and the network externality reduces the lowest t_A that country A is willing to offer.

For country B, $\underline{t_B}$ is calculated as

$$W_B^B \geq W_B^A \iff t_B \geq \underline{t_B} \equiv \underbrace{-\frac{\tau\,(4a-3\tau)}{18}}_{-} \underbrace{-\frac{2\nu\tau\xi_B}{9\{3-2(1+n)\nu\}^2}}_{+/-} \tag{18}$$

where $\xi_B \equiv 3\{4a-\tau\,(3-n)\}-\nu\{4(n+1)^2a-\left(3+6n-n^2\right)\tau\}$. The first term captures consumer gains from hosting firm M without network externality, which reduces the lowest t_B that country B can offer. The second term captures the network effect, and its sign depends on the degree of network externality. On the one hand, the network externality increases the MNE's supply and country B's consumer gains from hosting firm M domestically by saving trade costs. This effect reduces $\underline{t_B}$. However, the overall network size decreases if country B is the host, diminishing the network effect. If ν is small, the former effect dominates the latter, and the second term is negative. However, if v is large, then the latter effect dominates the former, and the second term becomes positive. As $\underline{t_B}=0$ at $\nu=\nu^{CS}$ and $\underline{t_B}>0$ for $v>v^{CS}$, country B offers an investment tax whenever hosting firm M reduces consumer surplus.

Given the most generous fiscal policies, we can identify the conditions under which a country would succeed in attracting firm M. Note that the most generous fiscal policies determine the winner of the fiscal competition, but the winning country's equilibrium fiscal policy differs from $\underline{t_j}$. See Section 4.1 for details. By substituting $\underline{t_j}$ for Π_M^j, we obtain

$$\Pi_M^A(\underline{t_A}) \gtreqless \Pi_M^B(\underline{t_B}) \iff \tau \lesseqgtr \overline{\tau}^{fc} \equiv \frac{72(n-1)a}{9(3+11n)-4\nu\{3-(1+n)\nu\}(9+10n+9n^2)}. \tag{19}$$

Country A attracts firm M when trade cost is less than $\bar{\tau}^{fc}$, but country B attracts firm M when the trade cost is greater than $\overline{\tau}^{fc}$. As in the case without fiscal competition, firm M prefers to be located in the smaller country, B, when τ is large because of the absence of local firms coupled with the protection country B offers Firm M from high trade costs. When τ is small, firm M will choose country A because a larger market size is more important than avoiding fiercer competition with local firms. $\overline{\tau}^{fc}$ is increasing in ν, implying that stronger network externality increases country A's attractiveness because the overall network size is larger if firm M is located there. Subsequently, we have the following lemma.

Lemma 2. *In the presence of fiscal competition, firm M chooses a larger country with a local firm if*

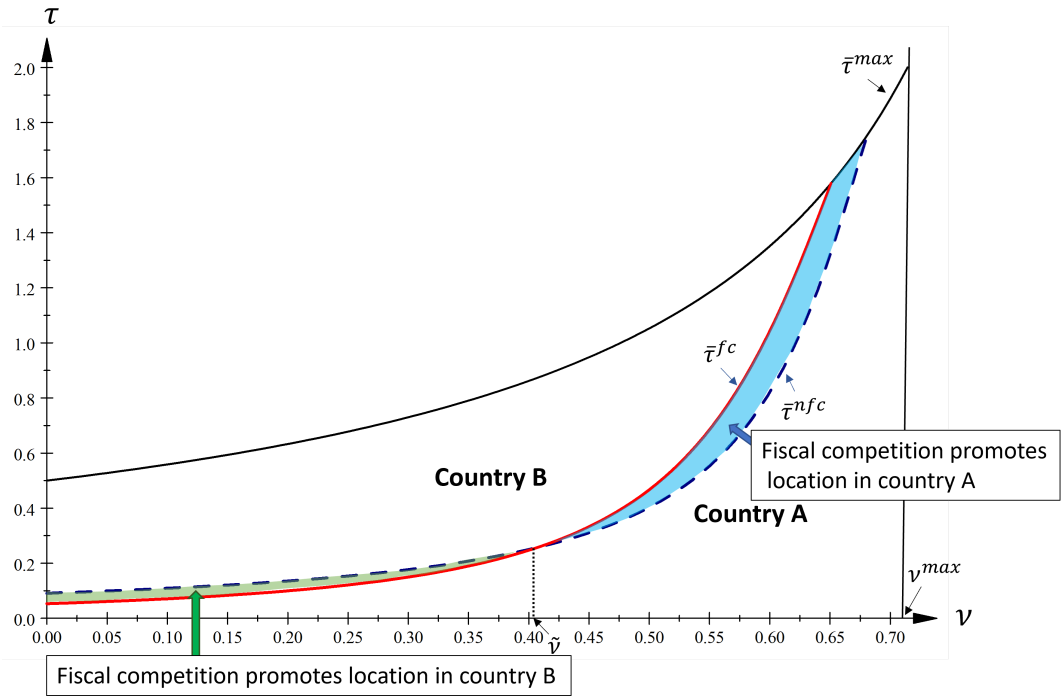

Figure 3: Location choice with policy competition

$\tau \leq \bar{\tau}^{fc}$ *holds. Otherwise, firm M chooses a smaller country without local firms. Firm M is more likely to choose a larger country as the network externality strengthens.*

Figure 3 shows a numerical example of firm M's location choice with endogenous taxes or subsidies, where the solid upward curve represents $\bar{\tau}^{fc}$.[16] The dotted line indicates the threshold level without policy competition, $\bar{\tau}^{nfc}$. As before, network externality increases the likelihood of country A hosting firm M, and country A always hosts firm M if ν is sufficiently high. Figure 3 also indicates that whether fiscal competition induces firm M's relocation to country A or B depends on the degree of network externality. Subsequently, we have the following lemma (see Appendix A.1 for proof).

Lemma 3. *There exists a network externality cut-off level, $\tilde{\nu}$, such that fiscal competition decreases the threshold level of trade costs, below which firm M locates in a larger country for $\nu \in [0, \tilde{\nu})$, and increases the threshold level for $\nu \in (\tilde{\nu}, \nu^{\max})$.*

When the network externality is insignificant, country A cares more about the local firm's profit loss than consumer gains. However, consumers' gains from hosting an MNE are large in country B. Therefore, country A is less aggressive, whereas country B is more aggressive

[16] The same parameters are set as those in Figure 2.

in attracting firm M. Consequently, the fiscal competition expands the range of τ, in which firm M chooses country B. By contrast, when the network externality is significant, hosting firm M in country A hurts the local firm less (or even benefits it), while benefiting consumers more. Meanwhile, consumers' gains from hosting firm M are relatively small in country B. This is because firm M's location in country A expands the overall network size, thereby enhancing demand in all countries. Therefore, the fiscal competition expands the range of τ, in which firm M chooses country A.[17] The following proposition describes how fiscal competition changes the equilibrium location.

Proposition 3. *Fiscal competition changes the MNE's location from a larger country to a smaller country if* $\nu \in [0, \widetilde{\nu})$ *and* $\bar{\tau}^{fc} < \tau \leq \min[\overline{\tau}^{nfc}, \overline{\tau}^{\max}]$ *hold. It changes the MNE's location from a smaller country to a larger country if* $\nu \in (\widetilde{\nu}, \nu^{\max})$ *and* $\bar{\tau}^{nfc} < \tau \leq \min[\overline{\tau}^{fc}, \overline{\tau}^{\max}]$ *hold. Otherwise, fiscal competition does not affect the equilibrium location.*

The results provide new insight into the link between network externality and locations of MNEs. Usually, countries with large markets have a larger number of local firms that generate trade-offs between consumer gains and local firms' profit losses when hosting MNEs. Small countries are eager to host MNEs because they care more about consumer gains and are more likely to win the fiscal competition. Bjorvatn and Eckel (2006) have pointed out this result. Network externality affects these countries' eagerness to attract MNEs. When the degree of network externality is high, larger countries are more likely to host MNEs despite the presence of local rival firms. This implies that countries with larger markets, such as the United States and India, tend to successfully attract MNEs in industries where a strong network externality prevails. By contrast, smaller countries are more likely to attract MNEs in industries that do not generate much network externality. A country's fiscal competition amplifies the magnitude of the network effects on MNEs' location choices.

4 Welfare analysis

We have shown that the effects of fiscal competition on an MNE's location depend on the degree of network externality. This section explores the welfare effects of fiscal competition to determine whether fiscal competition is harmful.

[17] In the numerical example illustrated in Figure 3, we have $\widetilde{\nu} = (24\,275 - 5\sqrt{1775041})/43\,246 \approx 0.40729$.

If we consider the total welfare, which is the sum of the welfare of countries A and B and the MNE's profits, the equilibrium location with fiscal competition is always efficient and always achieves the largest total welfare. Since the country that benefits more from hosting the MNE wins the policy competition by offering a more generous fiscal policy, the equilibrium location with fiscal competition always generates efficient outcomes (See Appendix A.2 for a detailed calculation).[18] This indicates that, irrespective of the direction of the MNE's location change, firm M's location changes induced by fiscal competition always improve the total welfare. Therefore, fiscal competition cannot be harmful in terms of total welfare.

An efficient outcome of fiscal competition does not necessarily mean that countries in the region will benefit from it. To simplify the analysis, we set $t_A = t_B = t = 0$ such that the two host countries set no investment tax/subsidy without fiscal competition.[19] If the equilibrium fiscal policy is an investment subsidy, some of the host country's gains are transferred to the MNE. Therefore, there is a case where fiscal competition worsens the winning country's welfare. If fiscal competition causes the relocation of the MNE, the fiscal competition loser's welfare may be reduced. Therefore, fiscal competition can be harmful to the countries engaging in it.

4.1 The equilibrium fiscal policy

We need to derive the equilibrium fiscal policy to derive the conditions under which fiscal competition improves the competing countries' welfare. Note that countries' most generous fiscal policies determine which country wins the policy competition, but these differ from the equilibrium fiscal policies.

When $\Pi_M^A(\underline{t_A}) > \Pi_M^B(\underline{t_B})$ holds and country A wins fiscal competition to attract firm M, country B sets $\underline{t_B}$ and country A sets t_A^* in equilibrium such that it satisfies $\Pi_M^A(t_A^*) = \Pi_M^B(\underline{t_B})$. Similarly, when $\Pi_M^B(\underline{t_B}) > \Pi_M^A(\underline{t_A})$ holds, country A sets t_A but country B sets t_B^* such that it satisfies $\Pi_M^B(t_B^*) = \Pi_M^A(\underline{t_A})$. We have

$$t_A^* = \underline{t_B} + \Omega, \quad \text{and} \quad t_B^* = \underline{t_A} - \Omega. \tag{20}$$

[18] This result is consistent with those of previous studies such as Barros and Cabral (2000), Fumagalli (2003), Bjorvatn and Eckel (2006), and Ferrett and Gravino (2021).

[19] The effect of fiscal competition on each country's welfare depends on the level of the two countries' uniform tax/subsidy without competition, $t_A = t_B = t$. Fiscal competition is more likely to worsen the welfare of competing countries in the region as t becomes higher.

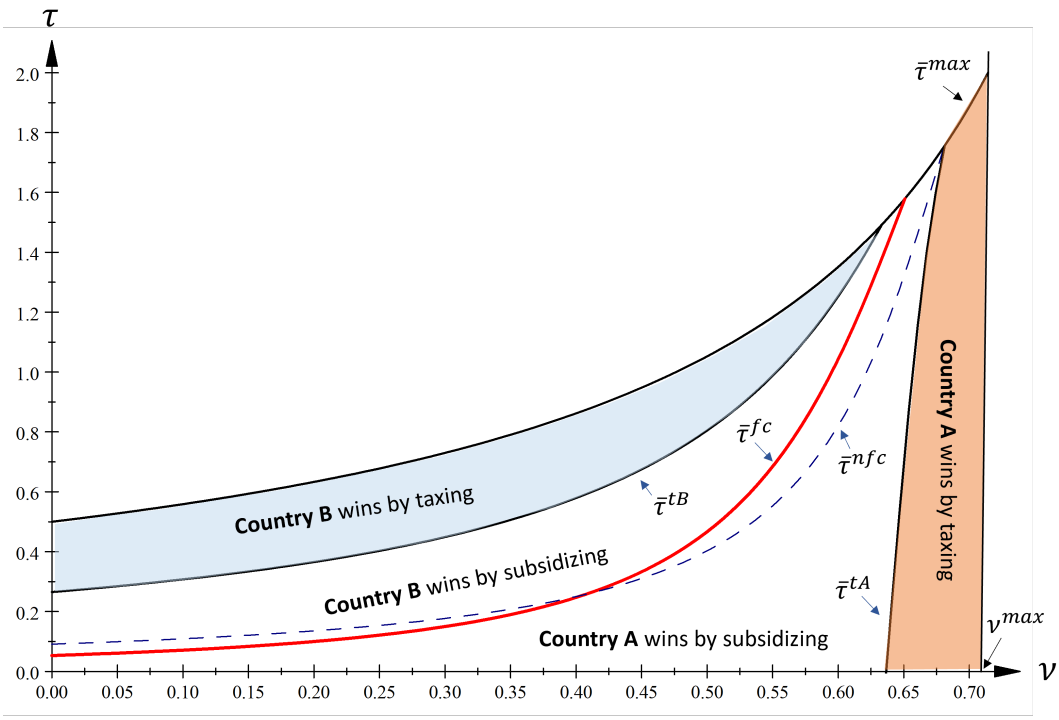

Figure 4: Equilibrium fiscal policies

As explained in Section 3.1, Ω is country A's fundamental location advantage over country B. The winning country's equilibrium fiscal policy tends to be a tax when the losing government is less eager to attract firm M and firm M's incentive to locate in the winning country is strong.

Figure 4 presents a numerical example of equilibrium fiscal policies.[20] $\overline{\tau}^{tA}$ is the threshold level of τ, below which $t_A^* > 0$ holds. The figure also shows the threshold level $\overline{\tau}^{tB}$, above which $t_B^* > 0$ holds.[21] The large country (country A) wins the competition and sets a positive investment tax if the network externality is sufficiently large. Strong network externality discourages country B from attracting firm M because the MNE's location in country A would hurt consumers in country B less or may even benefit them. The strong network externality also increases country A's fundamental location advantage. The small country (country B) wins the fiscal competition with a positive investment tax when the network externality is weak and trade costs are high. This is because higher trade costs decrease the larger country's location advantage and increase the lowest tax (largest subsidy) the larger country is willing to offer.

In the following subsections, we examine how fiscal competition changes the joint welfare

[20] The same parameters are set as those in Figure 2.

[21] With $a = 1$ and $n = 1.1$, $\overline{\tau}^{tA} = 60(377\nu - 240)/(64\,429\nu^2 - 81\,360\nu + 26\,100)$ and $\overline{\tau}^{tB} = 1200(9 - 11\nu)\left(69\,709\nu^2 - 105\,870\nu + 40\,725\right)$.

of the two countries in the region and how it changes each country's welfare in the region.

4.2 The countries' joint welfare in the region

Let us consider the joint welfare of the countries in the region, which we will hereafter refer to as the regional welfare. The regional welfare is defined as the sum of two countries' individual welfare. If fiscal competition reduces the regional welfare, it should be regarded as harmful tax competition in the sense that any transfers between the countries cannot lead to improved welfare in both countries.

Fiscal competition improves the regional welfare if the winning country offers an investment tax. Since fiscal competition always achieves the highest total welfare, it improves the regional welfare if the winning country acquires a portion of the MNE's profits via the collection of an investment tax. Conversely, if the winning country offers an investment subsidy and fiscal competition does not change the MNE's location, the fiscal competition worsens the regional welfare by failing to generate efficiency gains.

If fiscal competition changes the MNE's location, the region reaps efficiency gains from the MNE's relocation. In this case, fiscal competition can improve the regional welfare even if the winning country offers an investment subsidy. First, suppose a case of weak network externality, $\nu \in (0, \widetilde{\nu})$ and $\bar{\tau}^{fc} < \tau \leq \min[\overline{\tau}^{nfc}, \overline{\tau}^{\max}]$, where fiscal competition changes the MNE's location from country A to B. Since we assume $t_A = 0$ without fiscal competition, we have

$$
\begin{aligned}
& W_A^B + W_B^B \gtreqless W_A^A\Big|_{t_A=0} + W_B^A \\
\iff & \tau \gtreqless \overline{\tau}_{AB}^{JW} \equiv \frac{12\{3(2n-1) - (4n+3)\nu + 3n^2\nu\}a}{9(14n+9) - 12(12n^2+17n+15)\nu + 2(27n^3+61n^2+53n+27)\nu^2}. \quad (21)
\end{aligned}
$$

Hence, the fiscal competition responsible for inducing the MNE's relocation from Country A to B increases the regional welfare if $\tau > \overline{\tau}_{AB}^{JW}$.

Second, suppose a case of strong network externality, $\nu \in (\widetilde{\nu}, \nu^{\max})$ and $\bar{\tau}^{nfc} < \tau \leq \overline{\tau}^{fc}$, where fiscal competition changes the MNE's location from country B to A. Since we assume

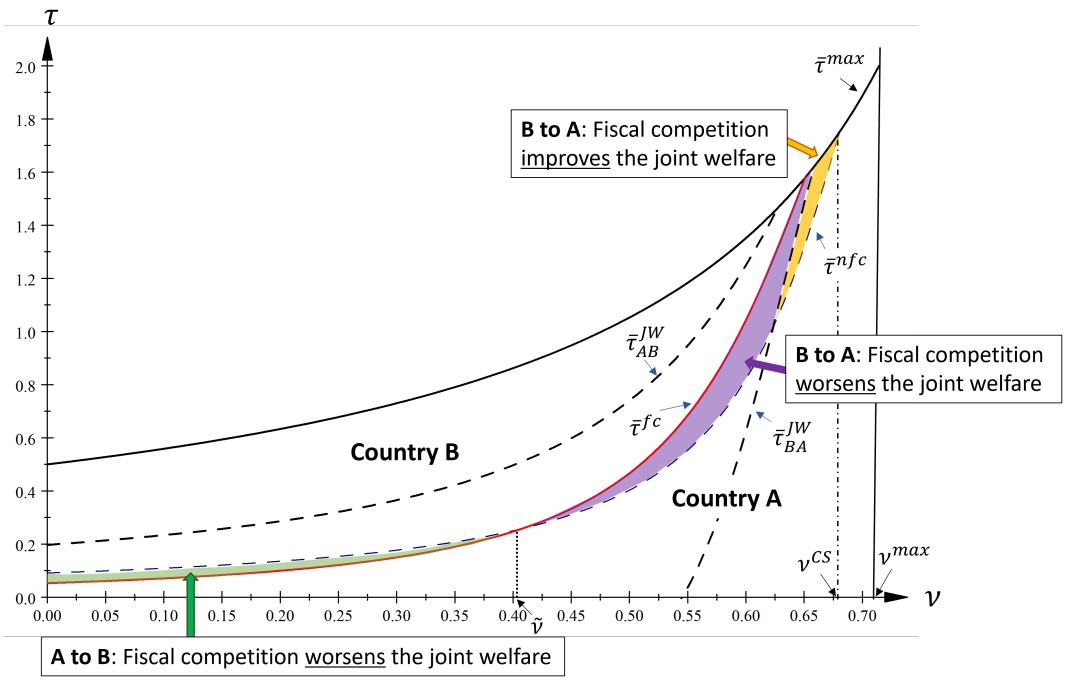

Figure 5: Policy-induced MNE location changes and joint welfare ($n = 1.1$)

$t_B = 0$ without fiscal competition, we have

$$W_A^A + W_B^A \gtreqless W_A^B + W_B^B\Big|_{t_B=0}$$
$$\iff \tau \gtreqless \overline{\tau}_{BA}^{JW} \equiv \frac{12\{3(2n-3)+4n\nu\}a}{99n - 36(3n^2+2n+3)\nu + 4(9n^3+15n^2+19n+9)\nu^2}. \tag{22}$$

Unlike the previous relocation pattern, the fiscal competition responsible for inducing the MNE's location changes from country B to A increases the regional welfare if the trade costs are small $\tau < \overline{\tau}_{BA}^{JW}$.

Figure 5 presents a numerical example of how the fiscal competition-induced MNE location change affects the regional welfare, when the two countries set no tax/subsidy in the absence of policy competition. It employs the same parameters as the previous figures, where the market size difference is not so large ($n = 1.1$). In this case, $\overline{\tau}_{AB}^{JW}$ is always larger than $\overline{\tau}^{nfc}$, and the policy-induced location change of the MNE from country B to A necessarily worsens the regional welfare.[22] By contrast, $\overline{\tau}_{BA}^{JW}$ is larger than $\overline{\tau}^{nfc}$ when the extent of the network externality is sufficiently large. Therefore, the policy-induced MNE location change from Country B to A improves the regional welfare if $\overline{\tau}^{nfc} < \tau < \overline{\tau}_{BA}^{JW}$ holds. As the extent of the network externality increases, $\overline{\tau}_{BA}^{JW}$ becomes larger. This is because a larger network exter-

[22] Appendix A.4 provides another numerical example and shows the case where $\overline{\tau}_{BA}^{JW} < \overline{\tau}^{nfc}$ holds.

nality enhances both the two countries' efficiency gains and the MNE's gains from choosing a larger country.

As discussed, if fiscal competition does not change the MNE's location, the fiscal competition never affects firms' supplies, and thus, a tax (subsidy) always improves (hurts) regional welfare. If $\tau < \min[\overline{\tau}^{fc}, \overline{\tau}^{tA}]$ holds, country A wins the fiscal competition with a positive investment tax, and the regional welfare improves because there is no change in country B's welfare. If $\max[\overline{\tau}^{fc}, \overline{\tau}^{tB}] < \tau < \tau^{\max}$ holds, country B wins the fiscal competition with a positive investment tax, and the regional welfare improves. Proposition 4 summarizes the effects of fiscal competition on regional welfare.

Proposition 4. *Suppose there are no investment taxes or subsidies without fiscal competition. Fiscal competition improves the regional welfare if an investment tax is imposed on the MNE. If an investment subsidy is imposed, fiscal competition improves the regional welfare if the subsidy leads to the MNE's relocation, and either* $\tau > \overline{\tau}^{JW}_{AB}$ *or* $\tau < \overline{\tau}^{JW}_{BA}$ *holds. Otherwise, fiscal competition worsens regional welfare.*

These results suggest that whether we observe "harmful tax competition" among (potential) host countries depends not only on the market size difference and the trade costs but also on the extent of the network externality. If the network externality is significant enough, fiscal competition leads to MNE location change from a small to a large country, improving the countries' joint welfare even though the host country offers the subsidy.

Figures 5 and 8 in Appendix A.4 illustrate the role of trade liberalization in avoiding "harmful tax competition." When there is a high degree of network externality and $\overline{\tau}^{nfc} < \overline{\tau}^{JW}_{BA} < \min[\overline{\tau}^{fc}, \overline{\tau}^{\max}]$ holds, a reduction in trade costs from $\tau_0 \in (\overline{\tau}^{JW}_{BA}, \min[\overline{\tau}^{fc}, \overline{\tau}^{\max}])$ to $\tau_1 \in (\overline{\tau}^{nfc}, \overline{\tau}^{JW}_{BA})$ transforms the fiscal competition form a factor that worsens the regional welfare into one that improves it. When there is a lower degree of network externality and $\overline{\tau}^{fc} < \overline{\tau}^{JW}_{AB} < \min[\overline{\tau}^{nfc}, \overline{\tau}^{\max}]$ holds, a reduction in trade costs from $\tau_0 \in (\overline{\tau}^{JW}_{AB}, \min[\overline{\tau}^{nfc}, \overline{\tau}^{\max}])$ to $\tau_1 \in (\overline{\tau}^{fc}, \overline{\tau}^{JW}_{AB})$ transforms the fiscal competition from increasing regional welfare to decreasing it.

4.3 The individual countries' welfare

Lastly, we explore how fiscal competition affects the welfare of each country in the region. Fiscal competition can be harmful to a winning country in some conditions, and it can be beneficial to a losing country in some other conditions.

Let us start with the winning country. If fiscal competition changes the firm M's location, it will always improve the winning country's welfare (see Appendix A.3 for the detailed calculation). This is because the winning country's efficiency gains from the relocation always dominate the government's loss arising from granting an investment subsidy. If the fiscal competition does not change the firm M's location, no efficiency gains are generated. Therefore, fiscal competition benefits the winning country if an investment tax is imposed on the MNE and hurts it if an investment subsidy is granted to the MNE. As Figure 4 shows, the large country as the competition's winner imposes an investment tax when the network externality is strong. As the competition's winner, the smaller country imposes an investment tax if the trade costs are high.

Proposition 5 summarizes the welfare effects of fiscal competition on the winning country.

Proposition 5. *Suppose there are no investment taxes or subsidies without fiscal competition. Fiscal competition increases the winning country's welfare if the equilibrium fiscal policy is an investment tax or fiscal competition leads to relocation of the MNE. Otherwise, fiscal competition reduces the winning country's welfare.*

Let us turn to the losing country. If the fiscal competition does not change the MNE's location, it will not change the losing country's welfare because the country is not hosting the MNE. If the fiscal competition changes the MNE's location, however, whether the fiscal competition benefits or hurts the losing country will depend on the amount of trade costs and the degree of network externality. First, suppose a case involving a strong network effect, $\nu \in (\widetilde{\nu}, \nu^{\max})$, where $\bar{\tau}^{nfc} < \tau \leq \overline{\tau}^{fc}$ holds and fiscal competition changes the MNE's location from country B to A. In this case, consumer gains due to the large network externality are a driver of welfare changes, and the MNE's relocation benefits the losing country, B, if and only if the extent of the network externality is sufficiently large to satisfy $\nu > \nu^{CS}$.[23]

Second, suppose a case of $\nu \in (0, \widetilde{\nu})$ and $\bar{\tau}^{fc} < \tau \leq \min[\overline{\tau}^{nfc}, \overline{\tau}^{\max}]$, where fiscal competition changes the MNE's location from country A to B. We have

$$\begin{aligned} & W_A^B \gtreqless W_A^A\Big|_{t_A=0} \\ & \iff \tau \gtreqless \overline{\tau}_{AB}^{AW} \equiv \frac{12\{3-(4n+3)\,\nu+3n^2\nu\}a}{27\,(n+2)-12\,(3n^2+7n+6)\,\nu+2\,(9n^3+23n^2+15n+9)\,\nu^2}. \end{aligned} \tag{23}$$

If $\overline{\tau}_{AB}^{AW} < \tau \leq \min[\overline{\tau}^{nfc}, \overline{\tau}^{\max}]$ holds, the fiscal competition leading to the MNE's relocation

[23] This case is possible only if the market size difference is sufficiently small to satisfy $1 < n < 27/25 = 1.08$.

from country A to B will benefit country A. Such a case only happens if the market size difference, n, is sufficiently large. When the market size is sufficiently larger in country A, and trade costs are high, the MNE relocation's positive effect on local firms' profits outweighs the negative effect on consumers.

Proposition 6 summarizes the welfare effects of fiscal competition on the losing country.

Proposition 6. *Suppose there are no investment taxes or subsidies without fiscal competition. Fiscal competition has no effect on the losing country's welfare if it does not change the MNE's location. Fiscal competition benefits the losing country if it leads to the MNE's relocation from a smaller to a larger country and the network externality is sufficiently strong to satisfy $v > v^{CS}$, or if it leads to the MNE's relocation from a larger to a smaller country and the trade costs are sufficiently high to satisfy $\tau > \overline{\tau}_{AB}^{AW}$. Otherwise, fiscal competition reduces the losing country's welfare.*

Propositions 5 and 6 suggest that the degree of network externality and MNE relocation critically determine whether fiscal competition is harmful to each country.[24] When the network externality is small, fiscal competition that induces the MNE's relocation is harmful to the losing country unless the trade costs are sufficiently high. Fiscal competition may even be harmful to the winning country if the competition does not change the MNE's location unless the trade costs are sufficiently high. This implies that trade liberalization increases the likelihood of harmful tax competition for competing countries.

When the network externality is large, however, the larger country tends to be the winner, and fiscal competition is more likely to benefit both the winning and losing countries. This is because hosting the MNE benefits both the local firm in the larger country and consumers in the losing country. The same property applies to the effect on regional welfare. Therefore, our results provide a strong policy implication, suggesting that strengthening network externality plays a role in transforming harmful tax competition into beneficial competition. This point is further discussed in Section 5.3.

5 Discussion

We have demonstrated the connection between network externality and fiscal competition regarding attract FDI. This section discusses additional results pertaining to the equilibrium

[24] Table 1 in Appendix 6 summarizes the welfare effects of fiscal competition.

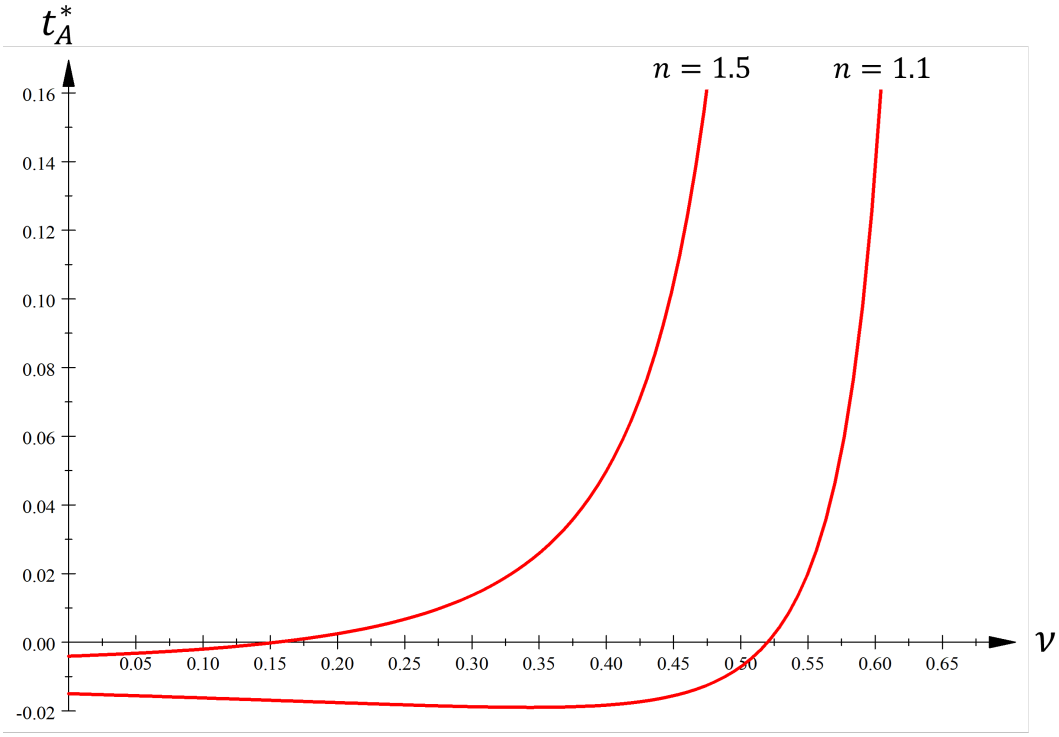

Figure 6: Country A's equilibrium tax

fiscal policy, how the range of the network externality changes the main results, and implications for digital policies.

5.1 The marginal effect of network externality on the equilibrium fiscal policy

Figure 4 shows that stronger network externality enables a large country to impose investment tax in equilibrium, but requires a small country to offer an investment subsidy to win the competition. It is less clear, however, how an increase in the network externality changes the level of equilibrium fiscal policies.

For country B, stronger network externality always decreases t_B^*. A higher ν decreases $\underline{t_A}$ because it increases government A's gains from attracting an MNE. It also decreases country B's location advantage and decreases $-\Omega$. For country A, an increase in network externality can either increase or decrease t_A^*. Network externality increases consumers' gains from attracting firm M to country B, thereby decreasing $\underline{t_B}$ when ν is small, but increases $\underline{t_B}$ when ν is large because the smaller network size associated with the MNE being located a smaller country diminishes consumer gains. Additionally, a higher ν increases Ω because it enhances country A's relative location advantage.

Figure 6 illustrates a numerical example of how ν changes t_A^*.[25] When the market size difference is relatively small ($n = 1.1$), the higher degree of network externality first decreases t_A^* and then increases it. When it is relatively large ($n = 1.5$), a higher ν value always increases t_A^*.[26] Therefore, an increase in network externality decreases the larger country's equilibrium tax when the market difference and degree of the network externality are small. Otherwise, it increases the equilibrium tax on the larger country.

When both ν and n are small, a marginal increase in ν raises country B's gains from hosting the MNE because the network externality increases the amount of consumption in country B and thereby amplifies country B's consumers' gains from saving trade costs. Consequently, a larger network externality intensifies fiscal competition and induces country A to set a lower t_A^*. When ν is sufficiently large, however, a further increase in ν will reduce country B's incentive to host the MNE because country A's hosting of the MNE would hurt the consumers in country B less or may even benefit them due to the network effect. These results suggest that we need to promote digitalization and ensure that ν is sufficiently large to avoid harmful tax competition.

5.2 Country-specific network externality

In the main analysis, we assumed that consumption network externality arises at the international level. However, some factors, such as the physical and cultural distances between countries, language differences, and regulation differences, may limit cross-border extensions of network externality.

This section considers the other extreme case, where network externality only works within each country. The modified utility function in country i is given by $u_i = \theta + \nu Y_i - p_i$. and the corresponding inverse demand function becomes $p_i = a + \nu Y_i - \frac{X_{Mi}+X_{Li}}{n_i}$. The equilibrium outcomes based on this modified setting are provided in Appendix A.5.

Let $\widehat{Y}_i^j (= X_{Mi}^j + X_{Li}^j)$ denote the total consumption of the network goods. We have

$$\widehat{Y}_A^A - \widehat{Y}_A^B = \frac{n\tau}{3-2n\nu} > 0, \quad \text{and} \quad \widehat{Y}_B^B - \widehat{Y}_B^A = \frac{\tau}{3-2\nu} > 0. \tag{24}$$

[25] The parameters are set at $a = 1$ and $\tau = 0.05$ such that country A wins the fiscal competition for any $\nu \in [0, \nu^{\max})$. $\nu^{\max} = 5/7 \approx 0.71429$ for $n = 1.1$ and $\nu^{\max} = 0.6$ for $n = 1.5$.

[26] We have $\left.\frac{\partial t_A^*}{\partial \nu}\right|_{\nu=0} = \frac{3[(5a-2\tau)n^2-2\tau n-3(3a-2\tau)]}{2(n+1)(3n^2-4n-3)a+\{3+11n-3n^2+3n^3\}\tau}$, where the denominator is positive only if $n < \frac{2+\sqrt{13}}{3} \approx 1.8685$ and $\tau < \min\left\{-\frac{2(n+1)(3n^2-4n-3)a}{3n^3-3n^2+11n+3}, \frac{a}{2}\right\}$ hold. If these conditions are met, we obtain $\left.\frac{\partial t_A^*}{\partial \nu}\right|_{\nu=0} \gtreqless 0 \iff n \gtreqless \frac{\tau+\sqrt{45a^2-48a\tau+13\tau^2}}{5a-2\tau}$.

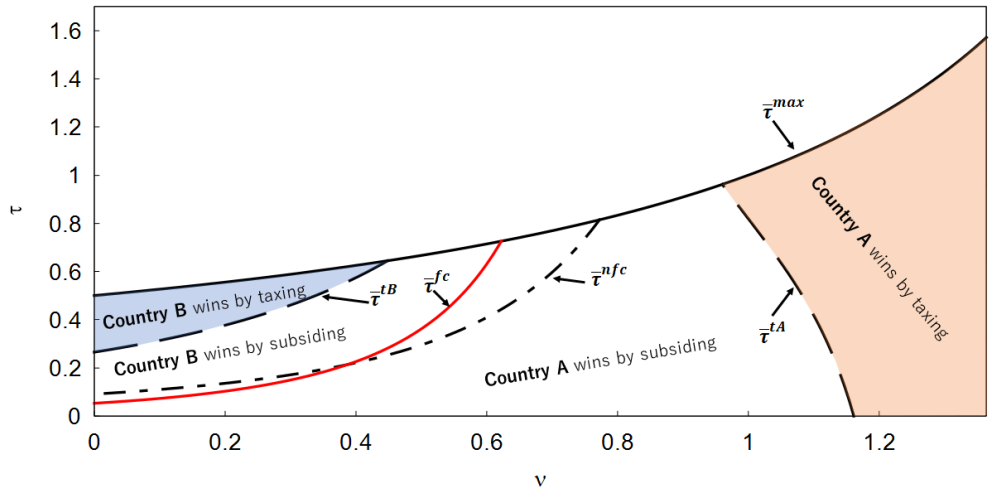

Figure 7: Equilibrium location under country-specific network externality

The network size of country i is larger when country i hosts the MNE. Therefore, the increased network externality always intensifies fiscal competition because it increases each country's consumers' gains from attracting FDI. This property deviates from the benchmark model, in which the MNE's location in the larger country always realizes the largest network size. Therefore, the MNE's location in country A never benefits consumers in country B, although it can still benefit the local firm in country A.

As shown in Figure 7, however, we can obtain results that are qualitatively identical to those of the baseline model regarding the equilibrium fiscal policy and the fiscal competition winner: Country A imposes a tax when the network externality is very strong, whereas country B imposes a tax when the network externality is weak, and trade costs are high. The fiscal competition induces the MNE's relocation from country A to B when the network externality is weak, but it induces relocation from country B to A when the network externality is strong.

One departure from the benchmark analysis is the effect of trade liberalization on country A's equilibrium fiscal policy. Here, $\overline{\tau}^{tA}$ is decreasing in ν, whereas in the benchmark model, it is increasing in ν. Therefore, trade liberalization from $\tau_0(> \overline{\tau}^{tA})$ to $\tau_1(< \overline{\tau}^{tA})$ changes the country A's equilibrium fiscal policy from a tax to a subsidy, whereas it changes country B's equilibrium policy from a subsidy to a tax. Under cross-border network externality in the benchmark analysis, country A loses its location advantage, Ω, under sufficiently high trade costs. This is because the MNE is able to weaken the competition with the local firm by locating itself in country B under high trade costs. Therefore, country A imposes a tax in

equilibrium with the low trade costs.

Under country-specific network externality, however, the MNE significantly loses its gains from the network effects by locating itself in country B under high trade costs. This effect magnifies country A's location advantage, and there is a case where country A imposes a tax under high trade costs. However, as in the benchmark analysis, country A always imposes a tax irrespective of the trade costs if the network externality is sufficiently strong.

5.3 Implications for digitalization

We have argued that network externality changes the nature of tax competition for FDI. Although many studies have explored factors affecting fiscal competition, little discussion has addressed its relation to the recent development of digitalization and digital policies.

A feature of the recent digitalization is the development of two-sided markets, where users and service providers are connected through platforms. Game consoles, mobile phones, and personal computers are examples of these platform products, which consumers use to enjoy online services such as games, apps, and online communication tools. In two-sided markets, an increase in the number of a platform's users benefits service providers, stimulating their entry into the platform, which, in turn, benefits the users and increases their demands. The progress of digitalization magnifies this indirect network effect.

Our model considers the direct network externality. However, as is briefly mentioned in the Introduction, ν can implicitly represent the degree of indirect network externality: ν captures the extent to which an increase in the platform product consumption improves users' utility by expanding the variety or quality of online services.

Certain digital policies would affect ν. Restrictions on cross-border data flows, such as China's local storage requirements, increase the cost of providing services and decrease ν. Hence, facilitating data flows is an important policy agenda. For instance, OECD (2022) has discussed the policy challenges of pursuing cross-border data flows with trust. There are other factors limiting network externality. Due to high commissions, many mobile device app providers only supply their services on a single platform (i.e., single-homing).[27] Several countries' antitrust authorities in several countries, such as Japan and Korea, have questioned the high commission rates Apple and Google impose on developers and now require these

[27] Hyrynsalmi et al. (2016) investigated the developers of mobile apps available in Apple's App Store, the Google Play Store, and the Windows Phone Store and showed that about 95% of developers are single-homing.

platforms to refrain from forcing customers to use their native payment systems.[28] Indeed, the Digital Market Act passed in the European Union aims to prevent large platforms from engaging in unfair practices.[29]

These policies will contribute to increasing ν, which implies that they are important not only for amplifying network externality but also for avoiding the harmful effects of fiscal competition.

6 Conclusion

The policy debate on "harmful tax competition" is essential in international taxation. The question of how progress in digitalization affects the winner and welfare effects of fiscal competition aimed at attracting MNEs is important, but analyses of digitalization are scarce. This study investigated the consequences of fiscal competition for FDI in the presence of network externality as network goods are traded and consumed globally. The findings are useful for considering optimal fiscal policies in a digitalized world.

The results demonstrate that network externality increases larger countries' probability of attracting more MNEs. With strong network externality, MNEs in larger countries may benefit local firms and consumers in smaller countries. Fiscal competition decreases the likelihood of a larger country hosting an MNE when the network externality is small, but notably, this increases the likelihood when the network externality is large. When the network externality is significant, a larger country always wins the fiscal competition by imposing a positive investment tax. A location change induced by fiscal competition improves the total welfare, but it may worsen the losing country's welfare and the joint welfare of potential host countries. If the network externality is significant, an MNE location change from a smaller to a larger country will improve the joint welfare, and there is a case where it improves both countries' welfare. If the network externality and trade costs are relatively small, the MNE's location change from a larger to a smaller country will worsen the losing country's welfare as well as the two countries' joint welfare.

This study sheds new light on policy debates regarding tax competition in a digitalized world. There have been concerns that tax competition distorts FDI patterns and erodes the

[28] See https://asia.nikkei.com/Business/Technology/Apple-and-Google-warned-on-app-stores-by-Japan-antitrust-watchdog.

[29] See https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/digital-markets-act-ensuring-fair-and-open-digital-markets_en.

national tax basis. Our results suggest that "harmful tax competition" is less likely when the network externality is large; that is, with sufficiently large network externality, tax competition promotes MNEs' location choice of larger and more competitive countries, enlarges the overall network size, benefits consumers in those larger countries, and improves competing countries' overall welfare. Further, MNEs' location in these larger countries can benefit local firms and consumers in smaller countries. The larger country that wins the tax competition can set a positive investment tax and earn tax revenue when the network externality is sufficiently large. These results suggest that promoting digitalization to enhance network externality is important for avoiding the harmful effects of tax competition.

This study's novelty lies in its status as the first to consider the effect of digitalization on fiscal competition for FDI, but there remain some elements that have not been considered. For instance, it would be intriguing to explicitly consider two-sided markets and explore how platforms' commissions charged to service providers affect fiscal competition. Introducing product differentiation and product-specific network externality can provide additional insights. Estimating network externality is a tall order, but our study provides empirically testable results regarding how digitalization affects MNEs' location choices and the outcomes of tax competition. We leave these points for future research.

Appendix

A.1 Proof of Lemma 3

From Eqs.(16) and (19), we have

$$\overline{\tau}^{nfc} - \overline{\tau}^{fc} = \frac{\{3 - 2(n+1)\nu\}\Psi_1(\nu)}{72(n-1)\{2-(n+1)\nu\}a}\overline{\tau}^{nfc}\overline{\tau}^{fc},$$

where $\Psi_1(\nu) = 18(n+1) - \{3\left(15+14n+15n^2\right) - 2(n+1)\left(9+10n+9n^2\right)\nu\}\nu$. We have $\left(\overline{\tau}^{nfc} - \overline{\tau}^{fc}\right)\Big|_{\nu=0} = 54a(n^2-1)/\{(3+11n)(7n-3)\} > 0$ and $\left(\overline{\tau}^{nfc} - \overline{\tau}^{fc}\right)\Big|_{\nu=v^{\max}} = 0$. As $\Psi(\nu)$ is U-shaped in ν, $\Psi'(0) = -3\left(15+14n+15n^2\right) < 0$, and $\Psi'(v^{\max}) = 9(n+1)^2 > 0$, there always exists a cut-off level of v, $\widetilde{v}$ ($\in (0, v^{\max})$), such that $\overline{\tau}^{nfc} > \overline{\tau}^{fc}$ holds for $v \in (0, \widetilde{v})$, $\overline{\tau}^{nfc} = \overline{\tau}^{fc}$ at $v = \widetilde{v}$, and $\overline{\tau}^{nfc} < \overline{\tau}^{fc}$ for $v \in (\widetilde{v}, v^{\max})$.

A.2 The effect of fiscal competition on total welfare

Let $TW^j = W_A^j + W_B^j + \Pi_M^j$ be the total welfare, which comprises the welfare of the two countries in the region and the MNE's profits, when firm M is in country j. By comparing the total welfare when firm M locates in country A to that when firm M locates in country B, we have

$$\begin{aligned} TW^A - TW^B &= W_A^A + W_B^A + \Pi_M^A - \left(W_A^B + W_B^B + \Pi_M^B\right) \\ &= \Pi_M^A - \left(W_A^B - W_A^A\right) - \{\Pi_M^B - (W_B^A - W_B^B)\} \\ &= \Pi_M^A - \underline{t_A} - (\Pi_M^B - \underline{t_B}) \\ &= \Pi_M^A(\underline{t_A}) - \Pi_M^B(\underline{t_B}). \end{aligned}$$

We have $TW^A \gtreqless TW^B \iff \Pi_M^A(\underline{t_A}) \gtreqless \Pi_M^B(\underline{t_B})$. By (19),

$$TW^A \gtreqless TW^B \iff \tau \lesseqgtr \overline{\tau}^{fc}.$$

Therefore, the equilibrium locations with policy competition always maximize the total welfare.

A.3 Proof of Proposition 5

When fiscal competition does not change the MNE's equilibrium location, it is straightforward that the winning country's welfare increases if it imposes a tax and decreases if it grants a subsidy in equilibrium. When fiscal competition leads to the MNE's relocation from country A to B, we have

$$\begin{aligned} W_B^B - W_B^A &= CS_B^B + \underline{t}_A - (\Pi_M^A - \Pi_M^B) - CS_A^B \\ &= CS_A^B + CS_B^B + \Pi_M^B + \Pi_L^B - (CS_A^A + CS_B^A + \Pi_M^A + \Pi_L^A) \\ &= TW^B - TW^A > 0. \end{aligned}$$

Note that $\underline{t}_A = CS_A^B + \Pi_L^B - (CS_A^A + \Pi_L^A)$. Since MNE relocation always improves the total welfare ($TW^B > TW^A$), $W_B^B > W_B^A$ holds. Similarly, by using $\underline{t}_B = CS_B^A - CS_B^B$, we have a welfare change in country A when fiscal competition leads to the MNE's relocation from country B to A:

$$\begin{aligned} W_A^A - W_A^B &= CS_A^A + \Pi_L^A + \underline{t}_B + (\Pi_M^A - \Pi_M^B) - (CS_A^B + \Pi_L^B) \\ &= CS_A^A + CS_B^A + \Pi_M^A + \Pi_L^A - (CS_A^B + CS_B^B + \Pi_M^B + \Pi_L^B) \\ &= TW^A - TW^B > 0. \end{aligned}$$

Since $TW^A > TW^B$ holds with this relocation, $W_A^A > W_A^B$ holds.

A.4 The case for $\overline{\tau}_{BA}^{JW} < \bar{\tau}^{nfc}$ with weak network externality.

In the example depicted in Figure 5, the MNE's location change from country B to A never improves the joint welfare. When the market size difference is small, the regional welfare gains from the MNE's relocation to a smaller country are small, and country A's subsidy payments dominate those gains.

Figure 8 illustrates another example with a relatively large market-size difference ($n = 1.5$). In this case, the MNE's relocation to a smaller country generates larger welfare gains and also requires a smaller subsidy payment to attract the MNE. In this case, the MNE's policy-induced relocation from a larger to a smaller country improves the regional welfare if the trade costs are sufficiently high to satisfy $\tau > \overline{\tau}_{AB}^{JW}$; however, the relocation also improves country A's welfare because $\bar{\tau}^{nfc} < \overline{\tau}_{AB}^{AW}$ holds. Even with a large market size difference, we

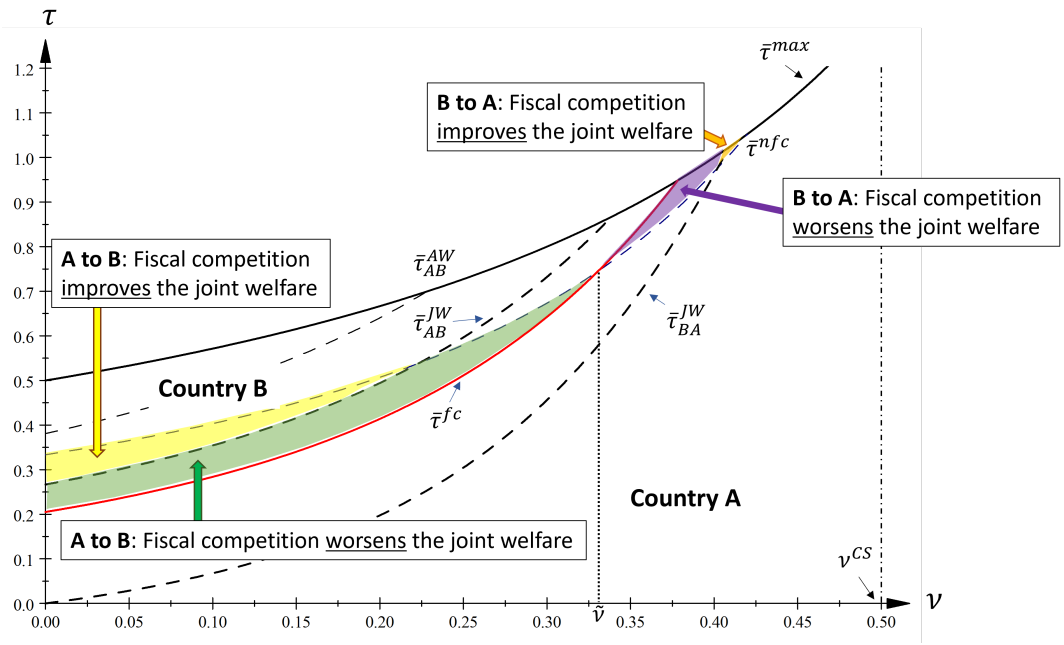

Figure 8: Policy-induced location changes and joint welfare ($n = 1.5$)

still have the range of ν and τ where the MNE's policy-induced relocation from a smaller to a larger country improves the two countries' joint welfare.

Table 1 shows all cases of the welfare effects of fiscal competition.

A.5 Country-specific network effects

In the modified model, firms' equilibrium supplies become[30]

$$\widehat{X}^A_{MA} = \widehat{X}^A_{LA} = \frac{an}{3-2n\nu}, \qquad \widehat{X}^A_{MB} = \widehat{X}^A_{LB} = \frac{a-\tau}{3-2\nu},$$
$$\widehat{X}^B_{MA} = \frac{n(a-2\tau+n\nu\tau)}{3-2n\nu}, \qquad \widehat{X}^B_{LA} = \frac{n(a+\tau-n\nu\tau)}{3-2n\nu},$$
$$\widehat{X}^B_{MB} = \frac{a+\tau-\nu\tau}{3-2\nu}, \qquad \widehat{X}^B_{LB} = \frac{a-2\tau+\nu\tau}{3-2\nu}.$$

These supplies lead to (24).

Concerning the effect of MNE location on the local firm in country A, we have

$$\widehat{\Pi}^A_L - \widehat{\Pi}^B_L = -\frac{\{2(n-1)a+(n+3)\tau\}}{9} + \frac{n\nu\Gamma_L}{9(3-2\nu)^2(3-2n\nu)^2}$$

where $\Gamma_L = -54\{(n^2-1)a-n^2\tau\} + 9(n+1)\{8(n^2-1)a-(5n^2+3n-3)\tau\}\nu - 12n(n+$

[30] In the modified model, we redefine the upper-bounds of ν and τ as $\nu^{max} = \frac{3}{2n}$ and $\tau^{max} = \frac{a}{2-\nu}$, respectively, to secure positive supplies of all firms in all markets.

	Welfare Effect	Winner	Policy	Relocation	Other Conditions
Total	Always beneficial				
Region	Beneficial	Large/Small	Tax	Yes/No	
		Large	Subsidy	Yes	Large ν & small τ
		Small*			Small ν & large τ
	Harmful	Large/Small		No	
		Large		Yes	Small ν & large τ
		Small			Large ν & small τ
Large Country	Beneficial	Large	Tax	Yes/No	
			Subsidy	Yes	
		Small*	Tax/Subsidy		Small ν & large τ
	Harmful	Large	Subsidy	No	
		Small	Tax/Subsidy	Yes	Large ν & small τ
	No effect			No	
Small Country	Beneficial	Small	Tax	Yes/No	
			Subsidy	Yes	
		Large	Tax/Subsidy		Large ν
	Harmful	Small	Subsidy	No	
		Large	Tax/Subsidy	Yes	Small ν
	No effect			No	

*These cases only happen if the market-size difference (n) is sufficiently large.

Table 1: Summary of the welfare effects of fiscal competition

$1)\{8(n-1)a-(5n-3)\tau\}\nu^2+4n^2\{8(n-1)a-(5n-3)\tau\}\nu^3$ and $\Gamma_L|_{\nu=\nu^{max}}=\{9(n-1)^2(4a-3\tau\}/(4n)>0$. Therefore, the local firm benefits from the MNE's location choice of a large country with a very strong network externality.

Without fiscal competition, we calculate country A's fundamental location advantage over country B as

$$\Omega=\left.(\Pi_M^A-\Pi_M^B)\right|_{t_A=t_B=t}=\frac{4\{(n-1)a-n\tau\}\tau}{9}+\frac{\tau\nu\Gamma_M}{9(3-2\nu)^2(3-2n\nu)^2},$$

where $\Gamma_M=54\{5(n^2-1)a-(2n^2-3)\tau\}-9\{8(n-1)(2n^2+7n+2)a-(7n^3+16n^2-24n-9)\tau\}\nu+12n(n+1)\{16(n-1)a-(7n-9)\tau\}\nu^2-4n^2\{16(n-1)a-(7n-9)\tau\}\nu^3$. The threshold level of location choice without fiscal competition, $\overline{\tau}^{nfc}$, is given by

$$\Omega\gtreqless 0\iff\tau\lesseqgtr\overline{\tau}^{nfc}\equiv\frac{2a(n-1)(18-9(1+n)\nu-4n\nu^2)}{\zeta^{nfc}}$$

where $\zeta^{nfc}\equiv 36n-6(6n^2+8n+3)\nu+(9n^3+48n^2+40n+9)\nu^2-12n(n+1)^2+4n^2(n+1)$.

The most generous fiscal policy of country A becomes

$$W_A^A \geq W_A^B \iff t_A \geq \underline{t}_A \equiv -\frac{\{4a-3(n+2)\tau\}\tau}{18} - \frac{\nu\tau\xi_A}{9(3-2\nu)^2(3-2n\nu)^2},$$

where $\xi_A \equiv 54(3n^2+1)a - 9\{8(1+n+3n^2)a - 3(n^3-1)\tau\}\nu + 12n(1+n)\{8a+3(n-1)\tau\}\nu^2 - 4n^2\{8a+3(n-1)\tau\}\nu^3$. The most generous fiscal policy of country B becomes

$$W_B^B \geq W_B^A \iff t_B \geq \underline{t}_B \equiv -\frac{(4a-3\tau)\tau}{18} - \frac{2\nu\tau(3-\nu)(4a-3\tau)}{9(3-2\nu)^2}.$$

Given the most generous fiscal policies, we obtain,

$$\Pi_M^A(\underline{t}_A) \gtreqless \Pi_M^B(\underline{t}_B) \iff \tau \lesseqgtr \overline{\tau}^{fc} \equiv \frac{8(n-1)(9-4n\nu^2)a}{\zeta^{fc}},$$

where $\zeta^{fc} \equiv 9(11n+3) - 12(9n^2+14n+9)\nu + 4(9n^3+39n^2+47n+9)\nu^2 - 48n(n+1)^2\nu^3 + 16n^2(n+1)\nu^4$.

As shown in Figure 7, the modified model demonstrates a similar pattern of firm M's location choice and of the equilibrium fiscal policies.

References

Amerighi, O., De Feo, G., 2017. Tax competition for foreign direct investments and the nature of the incumbent firm. Journal of Public Economic Theory 19, 811–826.

Baldwin, R., Freeman, R., 2022. Risks and global supply chains: What we know and what we need to know. Annual Review of Economics 14, 153–180.

Barros, P.P., Cabral, L., 2000. Competing for foreign direct investment. Review of International Economics 8, 360–371.

Bjorvatn, K., Eckel, C., 2006. Policy competition for foreign direct investment between asymmetric countries. European Economic Review 50, 1891–1907.

Chiappini, R., Gaglio, C., 2024. Digital intensity, trade costs and exports' quality upgrading. The World Economy 47, 709–747.

Darby, J., Ferrett, B., Wooton, I., 2014. Regional centrality and tax competition for FDI. Regional Science and Urban Economics 49, 84–92.

Ferrett, B., Gravino, D., 2021. Fiscal competition for foreign direct investment with knowledge spillovers and trade costs. The World Economy 44, 2821–2837.

Ferrett, B., Wooton, I., 2010. Competing for a duopoly: International trade and tax competition. Canadian Journal of Economics 43, 776–794.

Ferrett, B., Wooton, I., 2021. Targeting FDI. International Tax and Public Finance 28, 366–385.

Fumagalli, C., 2003. On the welfare effects of competition for foreign direct investments. European Economic Review 47, 360–371.

Haufler, A., Wooton, I., 1999. Country size and tax competition for foreign direct investment. Journal of Public Economics 71, 121–139.

Haufler, A., Wooton, I., 2006. The effects of regional tax and subsidy coordination on foreign direct investment. European Economic Review 50, 285–305.

Haufler, A., Wooton, I., 2010. Competition for firms in an oligopolistic industry: The impact of economic integration. Journal of International Economics 80, 239–248.

Hyrynsalmi, S., Suominen, A., Mäntymäki, M., 2016. The influence of developer multi-homing on competition between software ecosystems. Journal of Systems and Software 111, 119–127.

Janeba, E., Schulz, K., 2020. A theory of economic disintegration. CESifo Working Paper No. 8706 .

Kao, K.F., Mukunoki, H., 2021. The effects of parallel trade in two-sided markets. Economics Letters 199, 109721.

Katz, M.L., Shapiro, C., 1985. Network externalities, competition, and compatibility. The American Economic Review 75, 424–440.

Klimenko, M., Qu, J., 2023. Global digital platforms, technology transfer and foreign direct investment policies in two-sided markets. Economic Inquiry 61, 584–604.

Klimenko, M., Saggi, K., 2007. Technical compatibility and the mode of foreign entry with network externalities. Canadian Journal of Economics 40, 176–206.

Ko, K.W., 2007. Internet externalities and location of foreign direct investment: A comparison between developed and developing countries. Information Economics and Policy 19, 1–23.

Ma, J., Wooton, I., 2020. Market size, product differentiation and bidding for new varieties. International Tax and Public Finance 27, 257–279.

Navaretti, G.B., Venables, A.J., 2020. Multinational firms in the world economy. Princeton University Press.

OECD, 1998. Harmful tax competition: An emerging global issue. volume 235. Organisation for Economic Co-operation and Development.

OECD, 2022. Fostering cross-border data flows with trust. OECD Digital Economy Papers No.343 .

Stallkamp, M., Chen, L., Li, S., 2023. Boots on the ground: Foreign direct investment by born digital firms. Global Strategy Journal 13, 805–829.

Wu, T.C., Yen, C.T., Chang, H.W., 2022. Network externalities, trade costs, and the choice of commodity taxation principle. International Tax and Public Finance , 1–22.