Economic Integration and Agglomeration of Multinational Production with Transfer Pricing

Kato, Hayato and Okoshi, Hirofumi

9 January 2022

Economic Integration and Agglomeration of Multinational Production with Transfer Pricing*

Hayato Kato[†] Hirofumi Okoshi[‡]

January 9, 2022

Abstract

Do low corporate taxes always favor multinational production over economic integration? We propose a two-country model in which multinationals choose the locations of production plants and foreign distribution affiliates and shift profits between them through transfer prices. With high trade costs, plants are concentrated in the low-tax country; surprisingly, this pattern reverses with low trade costs. Indeed, economic integration has a non-monotonic impact: falling trade costs first decreases and then increases the plant share in the high-tax country, which we empirically confirm. Moreover, allowing for transfer pricing makes tax competition tougher and international coordination on transfer-pricing regulation can be beneficial.

Keywords: Profit shifting; Multinational firms; Intra-firm trade; Trade costs; Foreign direct investment (FDI); Tax competition; Economic geography; Transfer-pricing regulation
JEL classification: F12; F23; H25; H26.

*We wish to thank Co-Editor, Masaki Aoyagi, and three anonymous referees for valuable comments and suggestions. This paper is a much revised version of Chapter 2 of Okoshi's Ph.D. thesis submitted to the University of Munich (Okoshi, 2020). Helpful comments from the committee members, Carsten Eckel, Andreas Haufler and Dominika Langenmayr are greatly appreciated. We are grateful to Cristina Angelico, Makoto Hasegawa, Tsung-Yu Ho, Yukio Karasawa-Ohtashiro and Dirk Schindler for extensive discussions. Thanks also to participants of seminars and conferences at Kagawa U, Kochi U, U of Munich, IIPF (U of Tampere), 2019 Symposium of Public Economics (Osaka U), APTS (U of Tokyo), Osaka U (ISER and OSIPP), U of Tokyo, ERSA (U of Lyon), MYEM Conference (U of Munich), Chulalongkorn U, Kobe U and Hanyang U for comments. Financial supports from the Japan Society for the Promotion of Science (Grant Numbers: JP16J01228; JP17K03789; JP18H00866; JP19K13693; JP99K13693; JP20K22122), the German Research Foundation through GRK1928, the Nomura Foundation, and the Obayashi Foundation are gratefully acknowledged.

[†]Corresponding author. Graduate School of Economics, Osaka University, 1-7 Machikaneyama, Toyonaka, Osaka, 560-0043, Japan. *E-mail address:* hayato.kato@econ.osaka-u.ac.jp

[‡]Faculty of Economics, Okayama University, 3-1-1 Tsushima, Kita-ku, Okayama, 700-8530, Japan. *E-mail address:* hirofumi.okoshi1@gmail.com

1 Introduction

Progressive economic integration in the last few decades has increased the international mobility of multinational enterprises (MNEs), allowing them to diversify activities across subsidiaries in different countries. Considering the complexity of multinational activities, governments today need to carefully design policies to attract MNEs. Among many factors, corporate taxation is one of the essential determinants of foreign direct investment (FDI) (Navaretti and Venables, 2004, Chapter 6; Blonigen and Piger, 2014).[1] One naturally expects that countries with a low corporate tax rate would succeed in hosting more FDI inflows than those with a high tax rate. Earlier empirical studies confirmed this using data on FDI in *all sectors* (e.g., Bénassy-Quéré et al., 2005; Egger et al., 2009).

However, the type of activities of multinationals that operate in such low-tax countries is not obvious. Governments reduce taxes to attract production plants, which contribute to local employment and tax revenues.[2] Contrary to host governments' expectations, MNEs may establish affiliates in low-tax countries just to save taxes and may not engage in production (Horner and Aoyama, 2009).[3] As economic integration has dismantled barriers to goods' and factors' mobility in recent years, MNEs may put more emphasis on other barriers such as high taxes when choosing a location.

Figure 1 illustrates this point and shows that countries with lower taxes do not necessarily attract more multinational production. In Figure 1(a), we take 23 Organisation for Economic Co-operation and Development (OECD) countries and draw the relationship between each country's average corporate tax rate from 2008 to 2016 and the average number of foreign affiliates in all sectors coming from the other OECD countries in the same period.[4] To control for the host country's size, the average number of affiliates is divided by the host country's average GDP during the sample period. The fitted line with a clear downward slope tells us

[1] As for other determinants of MNEs' location decision, recent studies highlight agglomeration economies arising from affiliates (Mayer et al., 2010) and financial development in the host country (Bilir et al., 2019).

[2] The Irish government, for example, has explicitly stated its commitment to the low corporate tax rate to attract FDI. See the 2013 Financial Statement by the Minister for Finance: `http://www.budget.gov.ie/Budgets/2013/FinancialStatement.aspx`, accessed on November 25, 2020.

[3] Horner and Aoyama (2009) provide a list of Ireland-based MNEs' relocations. There are several examples where some MNEs moved production from Ireland abroad while maintaining non-production activities, such as service centers and marketing, in Ireland.

[4] The sample countries do not include four European countries identified as tax havens by Zucman (2014), i.e., Ireland, Luxembourg, the Netherlands, and Switzerland. The patterns laid out in Figure 1 remain unchanged even after including these four countries.

that countries with a lower tax rate tend to attract more MNEs. Figure 1(b) shows the type of MNEs' activities by plotting the share of affiliates in manufacturing sectors out of those in all sectors. The fitted line has little explanatory power, with R-squared being 0.088, and its slope has little statistical significance. This suggests that whether tax rates are high or low does not contribute much to the share of foreign manufacturing affiliates.

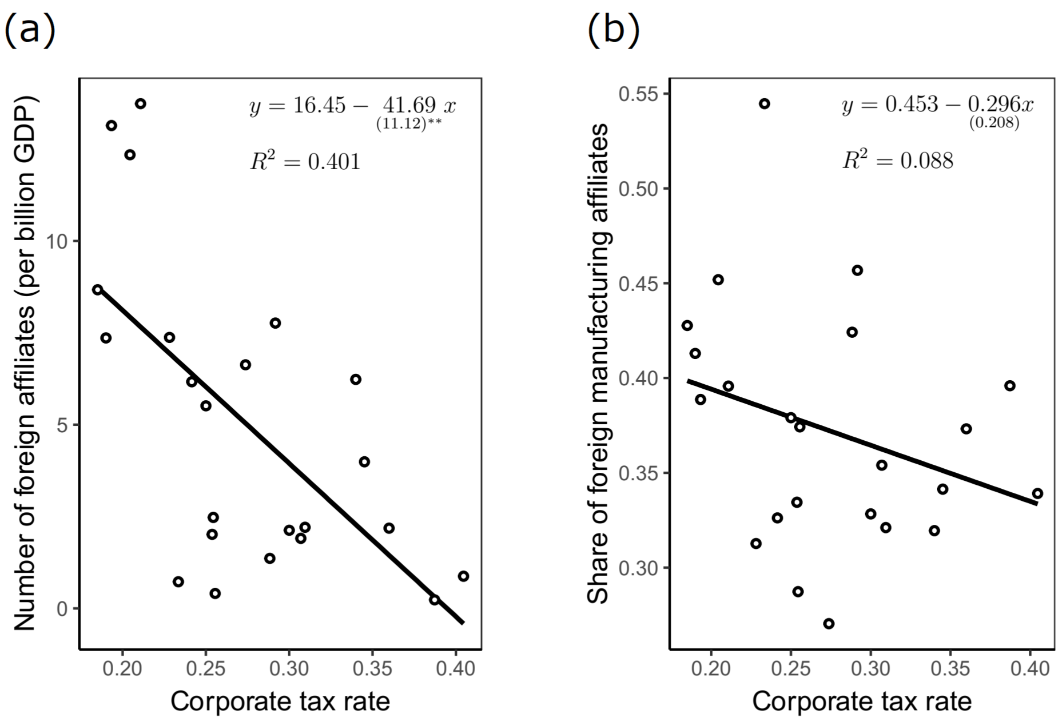

Figure 1. Corporate tax rates and foreign affiliates in 2008 to 2016

Sources: Centre for Business Taxation Tax Database 2017 (Habu, 2017); Corporate Outward activity of multinationals by country of location–ISIC Rev 4. In OECD Statistics: `https://stats.oecd.org/`
Notes: The horizontal axis is the average statutory corporate tax rate of a country in 2008 to 2016. In panel (a), the vertical axis is the average number of foreign affiliates in all sectors (per USD 1 billion GDP of the host country) coming from the other sample countries in 2008 to 2016. In panel (b), it is the average share of foreign manufacturing affiliates out of those in all sectors. Foreign affiliates in 2008 to 2016. Numbers in parentheses below the fitted equation are standard errors, where ** indicates significance at the 5% level. See Appendix 2 for details on data.

This lack of a clear relationship between taxes and the manufacturing affiliate share can be explained by profit shifting by MNEs. MNEs allocate their activities between low- and high-tax countries, and transfer profits by controlling prices for intra-firm trade, known as *transfer prices*.[5] For example, headquarters in high-tax countries make profits by selling

[5] Many studies provide empirical evidence on transfer pricing. See Swenson (2001); Bartelsman and

goods to affiliates in low-tax countries by setting low transfer prices to inflate the affiliates' profits. This profit shifting through intra-firm trade has been made easier by the recent proliferation of trade liberalization and transportation technology advancements.

When profits are transferable between countries with different tax rates, it is unclear where MNEs optimally set up their plants and affiliates. To answer the question, we extend a two-country spatial model developed by Martin and Rogers (1995); and Pflüger (2004) to incorporate MNEs with profit-shifting motives.

Specifically, we investigate in which country—the low-tax or high-tax one—multinational production is agglomerated and how the location pattern changes as trade costs fall. There is a fixed mass of monopolistically competitive MNEs in the world, with each locating a plant (or headquarters) for production in one country and an affiliate for distribution in the other. The MNE engages in intra-firm trade by exporting the output produced in the home country to the affiliate in a foreign country. It can use the transfer price of the output for profit shifting. However, due to trade costs, shipping goods from one country to another will be costly. Trade costs change the volume of intra-firm trade, and thus, affect the effectiveness of profit shifting, which in turn affects the choice of MNEs' location.

Based on this setting, we obtain the following results. With a low level of economic integration marked by high trade costs, the low-tax country attracts a higher share of multinational production than the high-tax country does. When high trade costs hamper intra-firm trade, thereby limiting the profit-shifting opportunity, MNEs can sell little to their foreign affiliates. As most of the profits are made in the country where goods are produced, they simply prefer to locate production in the low-tax country.

However, with a high level of economic integration marked by low trade costs, this location pattern reverses: production plants agglomerate in the high-tax country. This result seems surprising, but is indeed consistent with MNEs' optimal location choice. The MNE with production in the high-tax country *lowers* the transfer price to shift its home plant's profits to its foreign affiliate in the low-tax country. The lowered transfer price reduces the affiliate's marginal cost, which allows it to lower the price of goods and gain competitiveness against local plants. Conversely, the MNE with production in the low-tax country *raises* the transfer price to shift profits from its foreign affiliate in the high-tax country back to its home plant. Due to the high transfer price, the affiliate sells goods at a high price and loses competitiveness against local plants. Thus, transfer pricing favors the MNE with production in the high-tax country such that it makes them competitive in both home and foreign markets. When

Beetsma (2003); Clausing (2003); Bernard et al. (2006); Cristea and Nguyen (2016); Gumpert et al. (2016); Guvenen et al. (2017); Bruner et al. (2018); and Davies et al. (2018).

trade costs are so low that this effect is significant, all MNEs strategically choose to locate production in the high-tax country.

Moreover, the location pattern of multinational production is indeed non-monotonic. That is, a fall in trade costs first decreases and then increases the share of production plants in the high-tax country. A simple intuition that production is agglomerated in the low-tax country to save both taxes and trade costs holds under high trade costs; however, it does not apply under low trade costs, as transfer pricing affects the strategic location choice of MNEs that seek price competitiveness.

These results may explain why taxes do not have a strong explanatory power for the share of manufacturing affiliates, as Figure 1 suggests. In addition, Overesch (2009) provides empirical evidence that MNEs in high-tax Germany increase real investments as the cross-country corporate tax difference between their home country and Germany is larger. Our own empirical exercise using the same data as those in Figure 1 also confirms the non-monotonic impact of economic integration on the distribution of multinational production.

As a result of transfer pricing, the high-tax country attracts more multinational production but does not enjoy greater tax revenues than it would without transfer pricing. The opposite is true for the low-tax country. In fact, allowing for transfer pricing lowers global tax revenues. Amid growing concerns about tax base erosion, the OECD recently reported that the estimated revenue losses from MNEs' tax avoidance are about 10% of global corporate income tax revenues.[6] Our finding may justify the concern about low-tax countries attracting affiliates that receive shifted profits from high-tax countries.

The basic model is further extended to consider tax competition between two countries that differ in tax-administration efficiency. The main result still holds: transfer pricing leads to production agglomeration in the high-tax country with more efficient tax administration. Contrary to existing studies telling that agglomeration generates taxable rents (Baldwin and Krugman, 2004), agglomeration in our model leads to tax base erosion. A larger tax difference brings more opportunities to manipulate transfer prices, triggering greater tax base erosion. To prevent this, the high-tax country is forced to lower its tax rate. In addition, transfer

[6]See `http://www.oecd.org/ctp/oecd-presents-outputs-of-oecd-g20-beps-project-for-discussion-at-g20-fi` `htm`, accessed on November 25, 2020. To tackle this issue, the OECD set up a project called "Base Erosion and Profit Shifting" (BEPS), involving over 80 countries. See `http://www.oecd.org/tax/beps`, accessed on February 20, 2019. Recent empirical studies estimate the magnitude of revenues losses from BEPS (e.g., Dharmapala, 2014; Janskỳ and Palanskỳ, 2019; Beer et al., 2020; Tørsløv et al., 2018), among which Blouin and Robinson (2020) caution against the possibility of overestimation due to double counting of foreign income. The estimated magnitude of revenue losses depends on how pre-tax profits respond to corporate taxes. Heckemeyer and Overesch (2017) suggest that a dominant channel of profit shifting is transfer pricing, which our model highlights.

pricing makes tax competition tougher and the two countries worse off by narrowing the equilibrium tax difference. Although the governments have difficulty coordinating their tax rates, they agree on tightening transfer-pricing regulation to achieve a Pareto improvement.

Relation to the literature. Our main contribution to the literature on transfer pricing pioneered by Copithorne (1971) and Horst (1971) is to examine the impact of economic integration on the location choice of MNEs using transfer pricing. Earlier studies point out that transfer prices are used to make affiliates competitive and to shift profits (Elitzur and Mintz, 1996; Schjelderup and Sørgard, 1997; Zhao, 2000; Nielsen et al., 2003).[7] The former is called a strategic effect and the latter a tax manipulation effect. These studies assume the fixed location of affiliates, unlike ours. In our monopolistically competitive model à la Dixit and Stiglitz (1977), optimal transfer prices themselves are not chosen strategically in the sense that they do not depend on the number of rival firms as a result of the constant elasticity of substitution between varieties. However, our model shares the strategic aspect of transfer pricing in the sense that MNEs choose their location of plants/affiliates to make them competitive in their markets. We allow for the flexible location of affiliates and show that it is in fact chosen strategically due to transfer pricing.

Although many studies have examined the production location choice of MNEs with profit-shifting motives, they focus on symmetric tax rates (e.g., Haufler and Schjelderup, 2000; Kind et al., 2005; Slemrod and Wilson, 2009). Some studies highlight asymmetric tax rates resulting from tax competition between symmetric/asymmetric countries (Stöwhase, 2005, 2013; Johannesen, 2010).[8,9] Stöwhase (2013) studies tax competition between two unequal-sized countries and finds that the large country sets a higher tax rate while attracting a plant. By contrast, Stöwhase (2005) and Johannesen (2010) obtain the opposite result that low-tax countries attract more plants (or a higher capital-labor ratio) than high-tax countries. These studies, however, do not consider trade costs, which is our primary interest. Trade

[7] For subsequent developments, see Nielsen et al. (2008); Choe and Matsushima (2013); and Yao (2013).

[8] In many studies dealing with asymmetric tax rates, country asymmetry results from differences in market size (Stöwhase, 2005, 2013). In other tax competition models without profit-shifting MNEs, countries are assumed to be asymmetric due to inequality in public infrastructure (Han et al., 2018), the hub-and-spoke structure of jurisdictions (Janeba and Osterloh, 2013; Darby et al., 2014), and heterogeneous efficiency in tax administration (Han et al., 2014) as in our study.

[9] Some studies introduce a low-tax country with no production and/or no consumption, calling it a *tax haven* country (Slemrod and Wilson, 2009; Johannesen, 2010; Krautheim and Schmidt-Eisenlohr, 2011; Langenmayr et al., 2015; Hauck, 2019). Underlying channels through which profits are shifted to tax havens include royalty payments for intangible assets (Juranek et al., 2018; Choi et al., 2019) and the financial choice between debt and equity (Fuest et al., 2005; Haufler and Runkel, 2012). However, we do not consider tax havens because our main focus is on the MNEs' production location.

costs are important for profit-shifting patterns among MNEs because they significantly affect intra-firm trade, one of the main channels of profit shifting (Heckemeyer and Overesch, 2017).

The location choice of MNEs' production plants is sometimes associated with the choice of their organizational form (Bauer and Langenmayr, 2013; Egger and Seidel, 2013; Keuschnigg and Devereux, 2013).[10] Specifically, firms choose whether they should undertake FDI to manufacture inputs within their firms (i.e., vertical integration), or source inputs from independent suppliers (i.e., outsourcing), known as the *make or buy* decision.[11] This type of FDI can be considered as vertical FDI in the sense that different stages of bringing a product on to the market are organized across borders (Antràs and Helpman, 2004). To highlight MNEs' organizational choices, whether vertical integration or outsourcing, these studies fix the headquarters' location, either a high-tax or low-tax country. By contrast, we allow for MNE's location choices and examine how they are affected by economic integration, while fixing their organizational form, i.e., vertical integration only. Furthermore, we extend the basic model to incorporate a flexible choice of organizational form and confirm the robustness of our main results (see Section 4.2).

Among studies on internationally mobile MNEs with profit-shifting motives, Peralta et al. (2006); and Ma and Raimondos (2015) are the closest to ours in that they allow for both trade costs and asymmetric tax rates. In tax competition over a *single* MNE with a plant and an affiliate, Peralta et al. (2006) show the possibility that the large, high-tax country wins the MNE's plant when trade costs are *high*, which is similar to but different from our findings. Despite its higher tax rate, the large country can attract the plant by adopting a loose regulation policy, and thus, its *effective tax rate* is lower. Unlike their models, we consider a *continuum* of MNEs, who compete in the good's market. MNEs strategically locate their plants/affiliates such that transfer pricing contributes to price competitiveness as well as to tax savings. This leads to a new finding in the literature, i.e., the non-monotonic impact of economic integration on MNEs' plant share, which we empirically confirm (see Section 3.3).

We also contribute to the literature on new economic geography (NEG), which examines the impact of economic integration on firm location (Fujita et al., 1999). To our knowledge, our study is the first to introduce transfer pricing into an NEG model, the one developed by Martin and Rogers (1995); and Pflüger (2004). An important insight from NEG models is

[10] See also Amerighi and Peralta (2010); Behrens et al. (2014); Bond and Gresik (2020); and Choi et al. (2020) for related studies on organizational choice of MNEs with profit-shifting motives. As in the aforementioned studies, they only deal with a single MNE and/or do not consider trade costs, unlike our model. Our companion study investigates the location of input production within the boundaries of MNEs (Kato and Okoshi, 2019).

[11] For quantitative studies on MNEs and taxes but without transfer pricing, see Shen (2018); and Wang (2020).

that countries with large home markets hosts a greater share of firms than their market-size share for *all levels* of trade costs, except for prohibitive and zero levels. This is known as the *home-market effect* (Helpman and Krugman, 1985).[12] Our model also inherits this effect in the sense that the low-tax country offers a greater profit potential for MNEs than the high-tax country. Indeed, with high trade costs, the home-market effect dominates and the low-tax country attracts a higher plant share. By contrast, with low trade costs, the strategic and tax-saving considerations dominate the home-market effect so that the location pattern reverses (Propositions 1 and 2 in Section 3.1).

In the analysis of tax competition using NEG models, the home-market effect allows the country, where firms are agglomerated, to set a higher tax rate without losing firms (Proposition 3 in Section 5.1; Baldwin and Krugman, 2004; Borck and Pflüger, 2006).[13,14] Introducing transfer pricing does not alter this location pattern, but drastically changes the implication of agglomeration. That is, the agglomeration of production plants in the high-tax country does not bring such taxable rents, but, on the contrary, induces tax base erosion, and thus, puts downward pressure on its tax rate (Proposition 4 in Section 5.2). If the two countries can choose the stringency of transfer-pricing regulation as well as taxes, they agree on tightening regulation in the high-tax agglomerated country and are better off (Proposition 5 in Section 5.3).[15]

The rest of the paper is organized as follows. The next section develops the model. Section 3 characterizes the equilibrium plant distribution when taxes are given. It shows how allowing for transfer pricing changes the plant distribution. Section 4 discusses several extensions of the basic model. Section 5 deals with tax competition between the two countries, and examines how the results change with and without profit shifting. The final section concludes. Formal proofs and additional robustness analyses are relegated to Online Appendix.

[12] To see this, consider a large and a small country, each of which initially hosts one firm. Under a positive, but not prohibitive level of trade costs, the firm in the large country makes a greater profit by serving the larger home market without trade costs. Thus, the firm in the small country has an incentive to relocate to the large country.

[13] See also Kind et al. (2000); Ludema and Wooton (2000); Andersson and Forslid (2003); and Ottaviano and van Ypersele (2005) for earlier contributions. Recent studies in the literature allow for heterogeneity among firms (Davies and Eckel, 2010; Haufler and Stähler, 2013; Baldwin and Okubo, 2014), forward-looking behavior of governments (Han et al., 2014; Kato, 2015). See also Keen and Konrad (2013, Section 3.5.3).

[14] This result is in contrast with that of perfectly competitive models of tax competition between asymmetric countries (Bucovetsky, 1991; Wilson, 1991; Stöwhase, 2005). In these models, diminishing returns to marginal capital investment imply that smaller countries face a higher outflow of capital when raising their tax rate than larger countries, unlike NEG models. As a result, smaller countries set a lower tax rate and achieve a higher capital-labor ratio.

[15] This result is in contrast with existing studies on tax competition and profit shifting with multiple policy instruments (Peralta et al., 2006; Hauck, 2019; Hindriks and Nishimura, 2021), where governments typically fail to coordinate any policy instruments to achieve a Pareto-improving outcome.

2 Basic setting

We consider an economy with two countries (countries 1 and 2), two goods (homogeneous and differentiated goods), and two factors of production (labor and capital). Letting L be the world population, there are $L_1 = s_1 L$ of population in country 1 and $L_2 = s_2 L = (1 - s_1)L$ in country 2, where $s_1 \in (0, 1)$ is country 1's world share. Likewise, the amount K of world capital is distributed such that country 1 (or country 2) is endowed with $K_1 = s_1 K$ (or $K_2 = s_2 K = (1 - s_1)K$). An individual in each country owns one unit of labor and two units of capital, implying that $K = 2L$. To highlight corporate tax differences, we assume away the difference in market size, i.e., $s_1 = 1/2$, throughout the paper except for Section 4.3. There are two types of MNEs, one with a production plant (headquarters) in country 1 and a foreign distribution affiliate in country 2; and the other with a production plant (headquarters) in country 2 and a foreign distribution affiliate in country 1. MNEs use labor and capital supplied by individuals. The government in each country taxes the operating profits (i.e., sales minus labor/input costs) of plants and affiliates there. We interpret capital as equity and assume that capital costs are non-deductible, while labor costs are deductible. This assumption is commonly adopted in the public finance literature mentioned in Introduction and is in line with the tax codes of OECD countries.[16] In this and the next sections, we fix the tax rates of countries and assume that country 1's tax rate is higher than that of country 2, $t_1 > t_2$, without loss of generality. The key variables are listed in Appendix 1.

The timing of actions is as follows. First, each MNE chooses the respective country in which to locate a production plant and a foreign distribution affiliate, thereby endogenously determining the share of plants n_1. Second, the MNE chooses transfer prices, g_i. Third, production plants and distribution affiliates set selling prices, p_{ij}. Finally, production and consumption take place. We solve the game backward. For convenience, we refer to the results with fixed capital allocation as a *short-run equilibrium* and refer to the results in the endogenous case as a *long-run equilibrium.*

Consumers. Following Pflüger (2004), each consumer has an identical quasi-linear utility function with a constant-elasticity-of-substitution (CES) subutility. Consumers in country 1

[16] The Glossary of Tax Terms of the OECD website defines "DIVIDENDS" as follows: "A payment by a corporation to shareholders $[\cdots]$. Most corporations receive no deduction for it." See: `https://www.oecd.org/ctp/glossaryoftaxterms.htm`, accessed on December 19, 2021.

solve the following maximization problem:

$$\max_{\tilde{q}_{11}(\omega),\tilde{q}_{21}(\omega),q_1^O} \quad u_1 = \mu \ln Q_1 + q_1^O,$$
$$\text{where} \quad Q_1 \equiv \left[\sum_{i=1}^{2} \int_{\omega\in\Omega_i} \tilde{q}_{i1}(\omega)^{\frac{\sigma-1}{\sigma}} d\omega\right]^{\frac{\sigma}{\sigma-1}},$$

subject to the budget constraint:

$$\sum_{i=1}^{2} \int_{\omega\in\Omega_i} p_{i1}(\omega)\tilde{q}_{i1}(\omega)d\omega + q_1^O = w_1 + \overline{q}_1^O.$$

$\mu > 0$ captures the intensity of the preference for the differentiated goods. q_1^O and $\overline{q}_1^O$ are respectively the individual demand for the homogeneous good and its initial endowment. We assume that $\overline{q}_1^O$ is large enough for the homogeneous good to be consumed. w_1 is the wage rate. $\tilde{q}_{i1}(\omega)$ is the individual demand from consumers in country 1 for the variety $\omega \in \Omega_i$, where Ω_i is the set of varieties produced in country $i \in \{1, 2\}$. Q_1 is the CES aggregator of differentiated varieties, with $\sigma > 1$ being the elasticity of substitution over them.

Solving the foregoing problem gives the aggregate demand for the variety ω produced in country $i \in \{1, 2\}$ and consumed in country 1:

$$q_{i1}(\omega) \equiv L_1\tilde{q}_{i1}(\omega) = \left(\frac{p_{i1}(\omega)}{P_1}\right)^{-\sigma} \frac{\mu L_1}{P_1}, \tag{1}$$
$$\text{where} \quad P_1 \equiv \left[\sum_{i=1}^{2} \int_{\omega\in\Omega_i} p_{i1}(\omega)^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}}.$$

P_1 is the price index of the varieties. Although we will mainly present the results for country 1 in the following, analogous expressions hold for country 2. As firms are symmetric, we suppress the variety index ω for notational brevity.

Homogeneous good sector. The homogeneous good sector uses a constant-returns-to-scale technology. That is, one unit of labor produces one unit of the good. The technology leads to perfect competition, making the good's price equal to its production cost, or the wage rate. Letting w_i be the wage rate of country $i \in \{1, 2\}$, the costless trade of the homogeneous good equalizes the wage rates between countries, i.e., $w_1 = w_2$.[17] We choose the good as the

[17] We assume the costless trade of the homogeneous good to highlight the role of differentiated sector while eliminating the complicated general-equilibrium channel of wages. This is common in the NEG models, but

numéraire such that $w_1 = w_2 = 1$.

Differentiated goods sector. The differentiated goods sector uses an increasing-returns-to-scale technology. Each MNE needs one unit of capital for a production plant serving as the headquarters in one country and another unit for a distribution affiliate in the other country.[18] Once established, the plant needs a units of labor to produce one unit of variety. Since the total amount of capital in the world is $K = 2L$, the mass of (the headquarters of) MNEs in the world is $K/2 = L$.[19] We denote the mass of production plants located in country 1 by $N_1 = n_1 L$ and that in country 2 by $N_2 = n_2 L = (1 - n_1)L$, where $n_1 \in [0, 1]$. Each MNE owns both a plant and an affiliate. Thus, country 1 hosts a mass N_1 of plants and N_2 of affiliates, while country 2 hosts a mass N_2 of plants and N_1 of affiliates.

Consider an MNE with a production plant (i.e., headquarters) in country 1. The plant produces quantities q_{11} using aq_{11} units of labor and sells them at a price p_{11} to home consumers. In addition, it produces quantities q_{12} and exports them at a transfer price g_1 to its distribution affiliate in country 2. When exporting, due to iceberg trade costs $\tau > 1$, a $(\tau - 1)/\tau$ fraction of quantities melts away. Thus, the plant has to produce τ units to deliver one unit to the affiliate. The affiliate sells the imported goods to consumers in country 2 at a price p_{12}.

MNEs are assumed to have decentralized decision making following previous studies on transfer pricing (Zhao, 2000; Nielsen et al., 2003, 2008; Kind et al., 2005). In other words, the production plant (i.e., the headquarters) of the MNE sets the transfer price to maximize global post-tax profits, while the foreign affiliate sets the retail price to maximize its own profits. In practice, it is sensible to delegate decisions to local managers who are familiar with their local business environments. In many cases, a company's acquisition of a rival often involves the latter receiving divisional autonomy (e.g., Volkswagen's acquisition of Audi, Ford's acquisition of Volvo, and GM's acquisition of Saab).[20] We examine the case of centralized decision making in Online Appendix H and confirm the robustness of our results.

is not totally innocuous. See, for example, Fujita et al. (1999, Chapter 7) for more on this.

[18]Similar specifications in the context of transfer pricing can be found in Kind et al. (2005); and Matsui (2012), although they fix the location of plants and affiliates.

[19]All qualitative results in this study do not depend on the size of L. It matters only for the level of the equilibrium tax rate in Section 5 and the level of tax revenues in Online Appendix E.

[20]See Ziss (2007) for more on this issue.

2.1 Short-run equilibrium

Here, we derive the optimal prices given the location of plants and affiliates (see Online Appendix A for detailed derivations). The initial share of production plants is assumed to be equal to the capital endowment share, i.e., $n_1 = s_1 = 1/2$.[21] The MNE with production in country 1 makes profits from a home plant and a foreign distribution affiliate in country 2. The pre-tax operating profits of the plant, π_{11}, and those of the affiliate, π_{12}, are respectively,

$$\begin{aligned}
\pi_{11} &= \underbrace{(p_{11} - a)q_{11}}_{\text{Domestic profits}} + \underbrace{(g_1 - \tau a)q_{12}}_{\text{Shifted profits}} - \underbrace{\delta|g_1 - \tau a|q_{12}}_{\text{Concealment cost}}, \\
\pi_{12} &= \underbrace{(p_{12} - g_1)q_{12}}_{\text{Foreign profits}} \\
&= (p_{12} - \tau a)q_{12} \underbrace{-(g_1 - \tau a)q_{12}}_{\text{Shifted profits}},
\end{aligned}$$

where q_{11} is given by Eq. (1); q_{12} is defined analogously; and a is the unit labor requirement. The second term in π_{11} represents the profits from intra-firm trade subject to trade costs τ. The MNE may choose the transfer price differently than the true marginal cost: $g_i \neq \tau a$. For profits to move from high-tax country 1 to low-tax country 2, the second term must be negative: $(g_1 - \tau a)q_{12} < 0$ or $g_1 < \tau a$, which we will see shortly. This term captures profit shifting within MNEs, appearing in π_{12} with the opposite sign. The third term in π_{11} is concealment costs associated with the deviation of the transfer price from the true marginal cost (Haufler and Schjelderup, 2000; Kind et al., 2005). As the deviation is larger, it is more costly for MNEs to conceal the transfer pricing activity from tax authorities. A high δ makes profit shifting more costly, implying that δ can be interpreted as the stringency of transfer price regulation.

In the third stage of the game, the production plant and the foreign affiliate choose their prices to maximize their own profits. The optimal prices are

$$p_{11} = \frac{\sigma a}{\sigma - 1}, \quad p_{12} = \frac{\sigma g_1}{\sigma - 1}. \tag{2}$$

At the second stage, the MNE with a plant in the high-tax country 1 sets the transfer price to maximize the following global post-tax profits Π_1:

$$\Pi_1 \equiv (1 - t_1)\pi_{11} + (1 - t_2)\pi_{12} - 2R_1, \tag{3}$$

[21] As we shall see, the allocation of plants does not affect optimal selling prices (i.e., transfer prices).

where $t_i \in [0,1]$ is the tax rate of country $i \in \{1,2\}$ and R_1 is the reward to capital invested in the MNE. Again, note that labor/input costs are deductible, while capital costs are non-deductible. Suppose that the MNE with production in country 1 tries to shift profits of its home plant to its foreign affiliate in the low-tax country 2, i.e., $(g_1 - \tau a)q_{12} < 0$, where the concealment cost is given by $\delta|g_1 - \tau a|q_{12} = -\delta(g_1 - \tau a)q_{12} > 0$. It chooses the transfer price to maximize the post-tax profit (Eq. (3)):

$$g_1 = \frac{(1+\delta)\sigma\tau a}{\sigma - \Delta t_1 + \delta(\sigma - 1)}, \quad \text{where} \ \ \Delta t_1 \equiv \frac{t_2 - t_1}{1 - t_1} < 0, \tag{4-1}$$

where g_1 decreases with t_1 and increases with t_2. This implies that a greater tax difference leads to a more aggressive transfer-pricing behavior.[22] Similarly, supposing that the MNE with production in country 2 tries to shift profits from its foreign affiliate in country 1 back to its home plant, it incurs the concealment cost of $\delta|g_2 - \tau a|q_{21} = \delta(g_2 - \tau a)q_{21} > 0$. The optimal transfer price maximizing the MNE's post-tax profit is

$$g_2 = \frac{(1-\delta)\sigma\tau a}{\sigma - \Delta t_2 - \delta(\sigma - 1)}, \quad \text{where} \ \ \Delta t_2 \equiv \frac{t_1 - t_2}{1 - t_2} > 0, \tag{4-2}$$

where g_2 decreases with t_2 and increases with t_1. The optimal transfer prices g_i do not depend on the plant share n_i because of the constant elasticity of substitution σ, implying that g_is entail only tax-saving motives, not strategic ones. As will be clear in the next section, however, MNEs make a strategic location choice such that they use g_is to make their affiliates competitive.

For the optimal transfer prices to be consistent with the direction of profit shifting, the optimal transfer price from country 1 to 2 (or from country 2 to 1) must be set lower (or higher) than the true marginal cost:

$$\begin{aligned} g_1 < \tau a \ &\rightarrow \ \delta < \frac{t_1 - t_2}{1 - t_1}, \\ g_2 > \tau a \ &\rightarrow \ \delta < \frac{t_1 - t_2}{1 - t_2}. \end{aligned}$$

These conditions reduce to $\delta < (t_1 - t_2)/(1 - t_2) = \overline{\delta}$, which also satisfies the second-order condition for maximization ($\delta < 1$). Under $\delta < \overline{\delta}$, profits (net of concealment costs) shifted from country 1 to 2 are negative: $(1+\delta)(g_1 - \tau a)q_{12} < 0$. By contrast, those shifted from country 2 to 1 are positive: $(1-\delta)(g_2 - \tau a)q_{21} > 0$. If the tax difference is too large, the total

[22]The result that a larger tax difference leads to a lower export price from the high-tax to low-tax country is in line with empirical findings by Clausing (2003).

pre-tax profits of the plant in country 1 could be negative: $\pi_{11} < 0$ (see Online Appendix B for details). To exclude this possibility, we further assume $(t_2 <)t_1 < 1/2$, which is plausible considering the highest corporate tax rate being 0.4076 in 23 OECD countries in 2010 to 2016 (from 2010 to 2012 in Japan).

Using the demand function (Eq. (1)), and optimal prices (Eqs. (2) and (4)), we rearrange the post-tax profit (Eq. (3)) as

$$\begin{aligned}
\Pi_1 &= (1-t_1)\pi_{11} + (1-t_2)\pi_{12} - 2R_1 \\
&= (1-t_1)\Bigg[\underbrace{\frac{\mu L_1}{\sigma(N_1+\phi\gamma_2 N_2)}}_{\text{Domestic profits}} + \underbrace{\frac{(\sigma-1)(\Delta t_1+\delta)}{\sigma}\cdot\frac{\phi\gamma_1\mu L_2}{\sigma(\phi\gamma_1 N_1+N_2)}}_{\text{Shifted profits (net of concealment cost) }<0}\Bigg] \\
&\qquad + (1-t_2)\cdot\underbrace{\frac{\phi\gamma_1\mu L_2}{\sigma(\phi\gamma_1 N_1+N_2)}}_{\text{Foreign profits}} - 2R_1,
\end{aligned} \tag{5-1}$$

$$\begin{aligned}
\Pi_2 &= (1-t_1)\pi_{21} + (1-t_2)\pi_{22} - 2R_2 \\
&= (1-t_1)\cdot\underbrace{\frac{\phi\gamma_2\mu L_1}{\sigma(N_1+\phi\gamma_2 N_2)}}_{\text{Foreign profits}} \\
&\qquad + (1-t_2)\Bigg[\underbrace{\frac{\mu L_2}{\sigma(\phi\gamma_1 N_1+N_2)}}_{\text{Domestic profits}} + \underbrace{\frac{(\sigma-1)(\Delta t_2-\delta)}{\sigma}\cdot\frac{\phi\gamma_2\mu L_1}{\sigma(N_1+\phi\gamma_2 N_2)}}_{\text{Shifted profits (net of concealment cost) }>0}\Bigg] - 2R_2,
\end{aligned} \tag{5-2}$$

$$\text{where}\quad \phi \equiv \tau^{1-\sigma}, \qquad \Delta t_i \equiv \frac{t_j - t_i}{1-t_i}, \qquad i \neq j \in \{1,2\},$$

$$\gamma_1 \equiv \left(\frac{\sigma(1+\delta)}{\sigma - \Delta t_1 + \delta(\sigma-1)}\right)^{1-\sigma}, \qquad \gamma_2 \equiv \left(\frac{\sigma(1-\delta)}{\sigma - \Delta t_2 - \delta(\sigma-1)}\right)^{1-\sigma}.$$

The first and second terms in the square brackets in Π_1 and Π_2 are respectively the profit from the domestic market and the profit shifted through transfer pricing. $\phi = \tau^{1-\sigma} \in [0,1]$ is an inverse measure of trade costs, or the openness of trade. $\phi = 0$ (i.e., $\tau = \infty$) corresponds to a prohibitively high level of trade costs, while $\phi = 1$ (i.e., $\tau = 1$) indicates zero trade costs.

We assume, as in standard NEG models, the free entry and exit of potential MNEs (or equivalently the arbitrage behavior of capital owners), so that excess profits are driven to zero. This zero-profit condition implies that for given MNEs' locations, the return to capital, R_i, is determined at the point where $\Pi_i = 0$ holds. In the short-run equilibrium, where capital is immobile, the return to capital in general differs between countries. The capital-return differential generates a relocation incentive which guides us to analyze the long-run equilibrium, where capital is mobile.

3 Long-run equilibrium

To highlight the role of tax difference, we assume that the two countries are of equal size ($s_1 = 1/2$). When the difference in capital returns is positive, $R_1 - R_2 > 0$ (or negative, $R_1 - R_2 < 0$), capital owners invest in the MNE with production in country 1 (or in country 2). In the long-run equilibrium, the return differential is zero, with no capital owners changing their investment behavior. This also means that no MNEs are willing to change the location of their plants/affiliates. By solving the long-run equilibrium condition ($R_1 - R_2 = 0$) for the share of production plants in country 1, we obtain interior equilibria $n_1 \in (0, 1)$. If $R_1 - R_2 = 0$ does not have interior solutions, then we obtain corner equilibria in which all multinational production takes place in one country, i.e., $n_1 \in \{0, 1\}$.

3.1 Plant distribution and the non-monotonic impact of economic integration

The location incentives of MNEs depend on the ease of intra-firm trade, which is subject to trade costs. A low trade openness ϕ does not allow for much intra-firm trade, leaving little room for profit shifting.[23] As MNEs earn profits mostly from home production plants, they prefer to locate them in the low-tax country 2. The concentration of production in country 2 results from the well-known home-market effect, which is commonly observed in NEG models (Helpman and Krugman, 1985). We note that there is a small, but positive share of plants in the high-tax country 1, i.e., $n_1|_{\phi=0} \in (0, 1/2)$. Since competition in the domestic market works as a dispersion force, the corner distribution where all plants are in the low-tax country 2 cannot be an equilibrium, i.e., $n_1|_{\phi=0} \neq 0$.

By contrast, a high ϕ allows MNEs to fully engage in intra-firm trade, increasing the effectiveness of profit shifting through transfer pricing.[24] Transfer pricing does not just shift profits between home plants and foreign affiliates, but also affects the competitiveness of foreign affiliates. As we showed, MNEs with production in the high-tax country 1 set a low transfer price to shift profits to their affiliates in the low-tax country 2 (see Eq. (4-1)). Due to the low input cost, affiliates can sell at a low price and become competitive against local

[23]In Eqs. (5-1) and (5-2), the profits from intra-firm trade and those from the foreign affiliate disappear if $\phi = 0$.

[24]We can confirm that given the plant share n_1, the shifted profit increases with ϕ; that is, $\partial(|g_i - \tau a|q_{ij})/\partial\phi > 0$ for $i \neq j \in \{1, 2\}$.

plants. Conversely, MNEs with production in country 2 set a high transfer price (see Eq. (4-2)), which makes their affiliates in country 1 less competitive against local plants. MNEs with production in country 1 have a competitive advantage in both domestic and foreign markets against MNEs with production in country 2. Therefore, MNEs prefer to locate production in the high-tax country 1 so that transfer pricing makes their affiliates competitive. In fact, if ϕ is sufficiently high such that $\phi \geq \phi^S$, which we call an agglomeration threshold, all production plants are located in country 1.[25]

Assuming away transfer-pricing regulation ($\delta = 0$), we can formally prove the following proposition by applying Taylor approximations at zero tax difference.

Proposition 1 (Plant distribution). *Assume that two countries are of equal size ($s_1 = 1/2$), country 1 has a higher corporate tax rate than country 2 ($t_2 < t_1 < 1/2$), the tax difference is small enough ($t_1 - t_2 \approx 0$), and there is no transfer-pricing regulation ($\delta = 0$). There exist two threshold values of trade openness, $\phi^\dagger < \phi^S$, such that the following holds:*

(i). If $\phi \in [0, \phi^\dagger)$, the high-tax country 1 hosts a smaller share of plants than the low-tax country 2, i.e., $n_1 \in [0, 1/2)$.

(ii). If $\phi \in [\phi^\dagger, \phi^S)$, the high-tax country 1 hosts an equal or a greater share of plants but does not attract all plants, i.e., $n_1 \in [1/2, 1)$.

(iii). If $\phi \in [\phi^S, 1]$, the high-tax country 1 attracts all plants, i.e., $n_1 = 1$.

See Online Appendix C for the proof, where we also numerically check that Proposition 1 holds when the tax difference is not close to zero under a plausible range of parameter values. We do not report here the lengthy expressions of $\phi^\dagger$ and ϕ^S, which are implicitly defined as $\phi^\dagger \equiv \arg_\phi\{n_1 = 1/2\}$ and $\phi^S \equiv \min \arg_\phi\{n_1 = 1\}$, respectively.

Notably, full production agglomeration in country 1 occurs even with completely free trade ($\phi = 1$). In the case without transfer pricing, MNEs are indifferent to the location of plants at $\phi = 1$. The selling price for the foreign market is equal to that for the home market, i.e., $p_{ij} = p_{ii} = \sigma a/(\sigma - 1)$, so that MNEs make the same profits from the two markets. They

[25] The agglomeration threshold is called the sustain point in the literature in the sense that full agglomeration is sustainable when trade openness is higher than this point (Fujita et al., 1999). We can verify that ϕ^S decreases with $t_1 - t_2$ (see Online Appendix D). A larger tax difference offers more room for profit shifting, and thus, leads to more aggressive transfer pricing (very low g_1 or very high g_2). This strengthens the competitiveness of MNEs with production in country 1 against those with production in country 2 in both domestic and foreign markets. Consequently, a larger tax difference lowers ϕ^S, making more likely full production agglomeration in country 1.

cannot avoid high taxes in country 1 by changing the location of plants/affiliates, and thus, do not have a strong location preference. In the transfer-pricing case, however, the selling prices for the two markets are not equalized even at $\phi = 1$, i.e., $p_{ij} \neq p_{ii}$, because they depend on taxes (see Eqs. (4-1) and (4-2)). To fully utilize transfer pricing to save taxes and to enhance competitiveness, MNEs have a strong preference for production location even at $\phi = 1$.

The effect of trade openness on the world distribution of production is illustrated in Figure 2. Figure 2(a) shows a representative pattern of long-run equilibrium plant share for different levels of ϕ (solid curve), along with the long-run equilibrium plant share in the case without transfer pricing (dashed curve).[26] Figure 2(b) depicts an enlarged view of Figure 2(a) to highlight the threshold values. As ϕ increases from zero, the share of plants in the high-tax country 1 decreases in both cases with and without profit shifting. When low openness prevents exporting, MNEs make profits mostly from their home plants, and thus, prefer to locate them in the low-tax country 2. Along with a further increase in ϕ from $\phi^{\#}$, however, the mass of plants in the high-tax country 1 increases in the case with profit shifting, whereas it continues to decrease in the case without profit shifting. Sufficiently high openness expands intra-firm trade, and thus, increases the opportunities for profit shifting, leading to a sharp contrast in location patterns.

[26] Parameter values for all figures are also summarized in Appendix 4. We set the elasticity of substitution σ to five, which is the lower bound of the range estimated by Lai and Trefler (2002) and is close to the median estimate by Broda and Weinstein (2006). We set tax rates to $(t_1, t_2) = (0.3, 0.2)$, which seems plausible as the average tax rate is 0.274 and the average tax difference is 0.077 in our sample of 23 OECD countries from 2008 to 2016. In the special case where the tax difference is extremely large or σ is extremely low, it is possible that as openness is higher, full production agglomeration in country 2 occurs before full production agglomeration in country 1 is achieved. However, our qualitative results remain unchanged in this special case. See Online Appendix D for details.

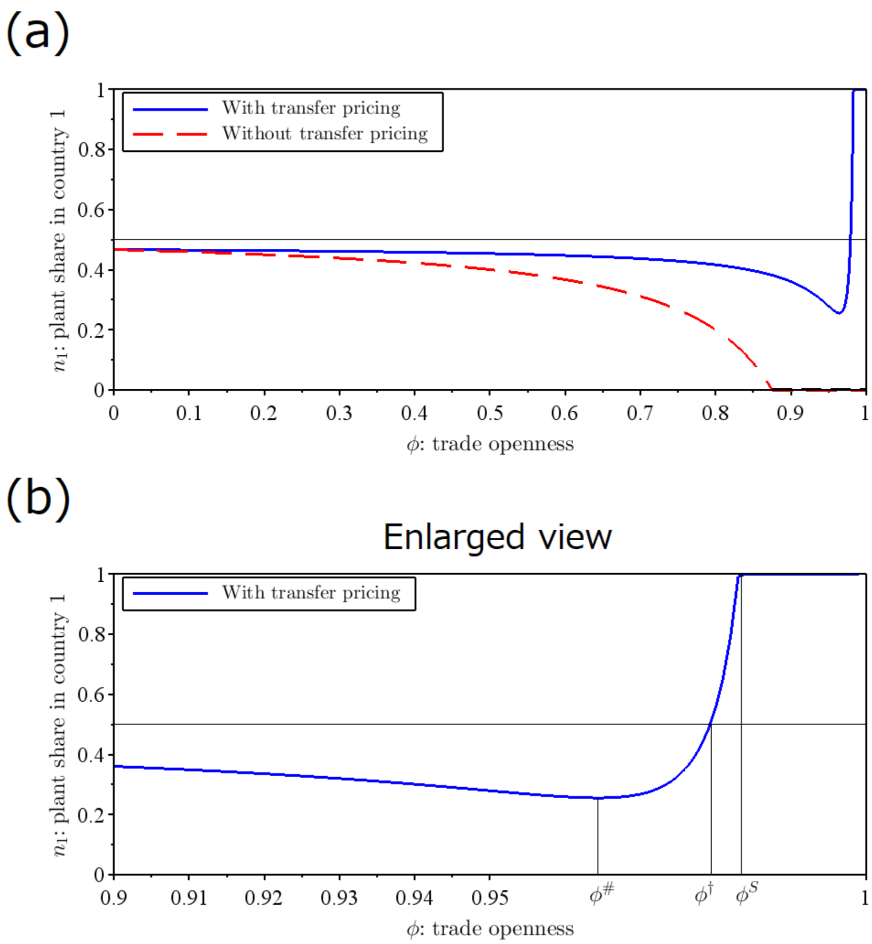

Figure 2. Share of production plants in the high-tax country 1

Notes: Parameter values are $\sigma = 5$; $t_1 = 0.3$; $t_2 = 0.2$; $\delta = 0$; $s_1 = 0.5$.

This finding is summarized in the following proposition:

Proposition 2 (Non-monotonic impact of economic integration). *Under the same assumptions as in Proposition 1, the impact of economic integration on the plant share in the high-tax country 1, n_1, is non-monotonic. That is, a rise in trade openness first decreases and then increases the plant share, i.e., $dn_1/d\phi \leq 0$ for $\phi \in [0, \phi^{\#})$ and $dn_1/d\phi \geq 0$ for $\phi \in (\phi^{\#}, 1]$.*

See Online Appendix D for the proof, where we also numerically check that Proposition 2 holds when the tax difference is not close to zero under a plausible range of parameter values.

Tax revenues. As a result of transferring profits taxable in the high-tax country 1 to the low-tax country 2, introducing transfer pricing weakly reduces (or weakly raises) tax revenues in country 1 (or country 2). We formally show this in Online Appendix E.

3.2 Empirical evidence

Proposition 2 provides the following empirical implication. Given the tax difference between two countries, there is a non-monotonic effect of bilateral trade openness on the share of manufacturing affiliates out of those in all sectors. To empirically test this prediction, we can think of the following regression:

$$(\text{Manufacturing-affiliate share})_{h,s,t} = \beta_1 \Delta TAX_{h,s,t} \cdot \phi_{h,s} + \beta_2 \Delta TAX_{h,s,t} \cdot \phi_{h,s}^2 + \boldsymbol{x}'_{\boldsymbol{h,s,t}} \boldsymbol{\beta} + \varepsilon_{h,s,t},$$

where the variables are defined as

$(\text{Manufacturing-affiliates share})_{h,s,t}$:
the share of manufacturing affiliates out of all affiliates in country h from country s in time t,
$\Delta TAX_{h,s,t} = TAX_{h,t} - TAX_{s,t}$: corporate tax rate difference between h and s in time t,
$\phi_{h,s}$: bilateral trade openness,
$\boldsymbol{x}_{h,s,t}$: vector of control variables,
$\varepsilon_{h,s,t}$: error term,

noting that with an abuse of notation, we here use t for the time subscript. Supposing that the host country h sets a higher tax rate than the source country s, i.e., $\Delta TAX_{h,s,t} > 0$, our theory predicts

$$\frac{\partial(\text{Manufacturing-affiliate share})_{h,s,t}}{\partial \phi_{h,s}} = \underbrace{\Delta TAX_{h,s,t}}_{>0} \cdot (\beta_1 + \beta_2 \underbrace{\phi_{h,s}}_{>0}) \begin{cases} < 0 & \text{if } \phi_{h,s} < -\beta_1/\beta_2 \\ > 0 & \text{if } \phi_{h,s} > -\beta_1/\beta_2 \end{cases},$$

which states that an increase in trade openness has a negative (or positive) effect on the manufacturing-affiliate share in country h coming from country s if trade openness is low (or high). The sign of the derivative flips in the case of $\Delta TAX_{h,s,t} < 0$. Because $\phi_{h,s}$ takes positive values, the theory-consistent signs are $\beta_1 < 0$ and $\beta_2 > 0$.

We test this using the same affiliate data as those used in Figure 1. To construct bilateral trade openness, $\phi_{h,s} \in (0,1)$, we take the inverse of the log of the bilateral geodesic distance constructed by Mayer and Zignago (2011). In addition to the two interaction terms of our interest, control variables ($\boldsymbol{x}_{h,s,t}$) include a simple host-source tax difference, $\Delta TAX_{h,s,t}$; a host-source difference in labor costs, $\Delta(\text{Labor costs})_{h,s,t}$; a host-source difference in productivity, $\Delta(\text{Productivity})_{h,s,t}$; a host-source difference in index capturing pro-business policies, $\Delta(\text{Pro business})_{h,s,t}$; country-year dummy; a source country-year dummy; and a year dummy, following the empirical literature on the determinants of FDI (e.g., Egger et al., 2009; Choi et al., 2021).[27] In addition to the statutory tax rate, as a robustness check, we use the effective average tax rate (Devereux and Griffith, 1999), which takes care of forward-looking behavior of firms. The sample is an unbalanced panel of 23 OECD countries, covering the period 2008–2016. We exclude observations with missing values and/or zero affiliates from the sample. See Appendix 2 for details on the descriptions and sources of variables and Table A1 for summary statistics.

One may be concerned about that corporate tax policies in a country are influenced by affiliate activities there. We address this potential endogeneity by following Da Rin et al. (2010, 2011).[28] To construct an instrumental variable (IV) for the host-source tax difference, we argue that the characteristics of a country's political system are important determinants of corporate taxation and other business-related policies, which in turn affect FDI flows. For example, a more impartial electoral process strengthens the transparency of policymaking and helps the government gain public trust, making changing (or perhaps raising) taxes easier. The impartial electoral process would not have a direct but indirect effect on FDI flows only through corporate taxation and other policies such as business laws/regulations and infrastructure investment. The difference in political processes would be a valid IV for the corporate tax difference, once pro-business policies other than corporate taxes are appropriately controlled for.

Specifically, as a measure of political processes, we use a summary index of government accountability constructed by the World Governance Indicators of the World Bank. This accountability index is the mean of 21 policy indices reported in the Institutional Profiles Database of the CEPII. The sub-indices measure the freedom of elections at the national level, the reliability of the state budget, and the freedom of association. We take the host-source difference of the index ($\Delta(\text{Accountability})_{h,s,t}$) and use it as an IV for the corporate

[27]We cannot include variables varying only in host/source country and year such as host/source country GDP because their effects are absorbed by the host/source country-year dummy.

[28]When estimating the effect of corporate tax rates on firm entry, Da Rin et al. (2010, 2011) use political measures such as the degree of political stability and election dates as IVs for corporate tax rates.

tax difference.[29] To control for other pro-business policies than corporate taxes, which affect the share of manufacturing affiliates, we include the host-source difference in pro-business policies ($\Delta(\text{Pro business})_{h,s,t}$) as a control variable. This is calculated from the "Index of Economic Freedom" published by the Heritage Foundation.

The regression results are summarized in Table 1. In columns (1) and (2), the statutory tax rates are used. In columns (3) and (4), the effective average tax rates are used. In columns (2) and (4), the tax difference and its interactions with $\phi_{h,s}$ and $\phi^2_{h,s}$ are instrumented with the difference in accountability and its interactions with $\phi_{h,s}$ and $\phi^2_{h,s}$. The high values of the first-stage Cragg-Donald F statistic in columns (2) and (4) suggest that our IVs are not weak. We can also confirm that the turning point of trade openness is actually between zero and one (e.g., in column (1): $\phi^{\#} = 0.715/(2 \cdot 2.630) \simeq 0.136$) and its equivalent geodesic distance is around 1560 km ($0.136 \simeq 1/\log(1560)$), roughly equal to the one between Germany and Spain (1479.3 km). As a further robustness check, we use a trade-cost measure calculated à la Head and Ries (2001); and Novy (2013) to construct an alternative trade-openness measure. Estimation results are unchanged: see Tables A2 and A3 in Appendix 3.

[29] One may wonder countries with large market size tend to have both high corporate taxes and accountable governments. This is not the case in our sample. Although the log of GDP is highly correlated with the corporate tax rate (0.75), it has little correlation with our accountability measure (0.047).

Table 1

Non-monotonic effect of economic integration on multinational production

Dependent variable: (foreign manufacturing affiliates)/(foreign affiliates in all sectors)

	Statutory tax rate		Effective average tax rate	
	OLS	2SLS	OLS	2SLS
	(1)	(2)	(3)	(4)
$\Delta TAX_{h,s,t} \cdot \phi_{h,s}$	−0.715***	−1.477*	−0.864***	−1.804*
	(0.218)	(0.886)	(0.232)	(1.027)
$\Delta TAX_{h,s,t} \cdot \phi^2_{h,s}$	2.630***	6.793**	3.191***	8.083**
	(0.789)	(3.254)	(0.848)	(3.857)
$\Delta TAX_{h,s,t}$	0.034	0.060	0.045	0.083
	(0.127)	(0.166)	(0.117)	(0.157)
$\Delta(\text{Labor cost})_{h,s,t}$	0.001	0.006	0.002	0.007
	(0.009)	(0.010)	(0.017)	(0.019)
$\Delta(\text{Productivity})_{h,s,t}$	0.008	0.010	0.009	0.010
	(0.015)	(0.017)	(0.014)	(0.016)
$\Delta(\text{Pro business})_{h,s,t}$	−0.004	−0.007	−0.004	−0.007
	(0.047)	(0.055)	(0.042)	(0.047)
Host country–year dummy	✓	✓	✓	✓
Source country–year dummy	✓	✓	✓	✓
Year dummy	✓	✓	✓	✓
Cragg–Donald F		20.21		25.98
Observations	1,833	1,825	1,833	1,825
R^2	0.507	0.422	0.507	0.422

Notes: The dependent variable is the share of a source country's manufacturing affiliates in a host country out of the source's affiliates in all sectors in the host in a year. Standard errors clustered at the host country-year level are in parentheses. We use the host-source difference in government accountability ($\Delta(\text{Accountability})_{h,s,t}$) as the IV for $\Delta TAX_{h,s,t}$. The interaction terms between a variable and $\Delta TAX_{h,s,t}$ are also instrumented by the interaction terms between the variable and $\Delta(\text{Accountability})_{h,s,t}$.

***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level.

Supporting evidence can also be found in Overesch (2009) and Goldbach et al. (2019). Using firm-level panel data of German inward FDI from 1996 to 2005, Overesch (2009) finds that domestic investment by foreign affiliates located in Germany increases as the corporate tax difference between Germany and their source country is higher. Goldbach et al. (2019) also employ similar data of German outward FDI and find that the complementarity between domestic and foreign investment by Germany-based MNEs is higher as the tax difference between Germany and their destination country gets wider. Important source and destination countries of German FDI are Germany's neighboring ones, such as France and Austria. Therefore, the empirical results of these studies are consistent with our prediction that the high-tax country attracts multinational production from the low-tax country when bilateral trade openness is high.[30]

4 Extensions

This section discusses four extensions of our basic model.

4.1 Transfer-pricing regulation

We established Propositions 1 and 2 under no transfer-pricing regulation, i.e., $\delta = 0$. A tighter regulation (higher δ) limits the effectiveness of profit shifting such that it reduces the deviation of the transfer price from the true marginal cost. Thus, MNEs find it less profitable to move to country 1, where there is a higher tax rate but little scope for transferring profits. In fact, we can numerically confirm in Figure 3 that a higher δ makes less likely the concentration of production in the high-tax country 1. When δ is sufficiently high such that $\delta = (t_1 - t_2)/(1 - t_1) = (0.3 - 0.2)/(1 - 0.3) = 0.143$ (dashed curve), there is no room for profit shifting ($g_i = \tau a$) so that the plant share in country 1 coincides with that in the case without transfer pricing (dashed curve in Figure 2) and never exceeds one-half.

[30] Strictly speaking, Overesch (2009) and Goldbach et al. (2019) consider a different mechanism than ours in that they consider incremental investment by a representative MNE, while we consider discrete investment by a continuum of MNEs. In the theoretical model of Overesch (2009), the amount of shifted profits is assumed to be related to that of capital invested by the affiliate. Profit shifting from an affiliate in high-tax Germany to its parent in a low-tax source country reduces the required rate of return to the affiliate, leading to an increase in investment by the affiliate. Goldbach et al. (2019) apply the same argument to the case of Germany-based parents.

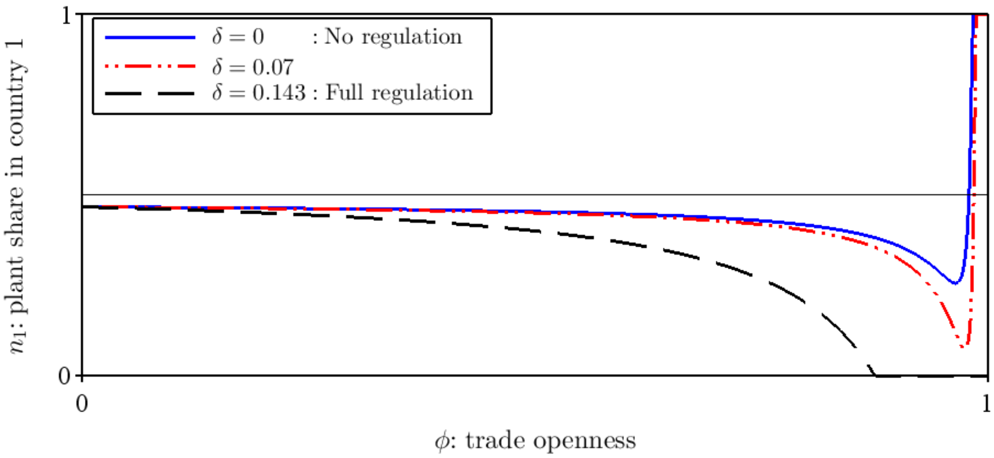

Figure 3. Impact of transfer-pricing regulation

Notes: Parameter values are $\sigma = 5$; $t_1 = 0.3$; $t_2 = 0.2$; $s_1 = 0.5$; $\delta \in \{0, 0.07, 0.143\}$.

4.2 Pure exporters

In the main analysis, we excluded the possibility of pure exporters, who export varieties without using distribution affiliates. However, one may expect that it would be profitable for production plants in the low-tax country to serve the high-tax country by exporting directly to consumers, rather than via distribution affiliates. By exporting while producing in the low-tax country, firms can save taxes and avoid setting a high selling price for the foreign market. To examine this, we endogenize whether each firm becomes an MNE or a pure exporter. The MNE uses two units of capital to establish a plant in one country and a distribution affiliate in the other, as in the basic model. The pure exporter uses $1+\kappa$ units of capital to set up two plants in the same country, one for the home market and the other for the foreign market. The benefit of becoming a pure exporter is modeled as low fixed costs, i.e., $\kappa \in [0,1]$ and $1+\kappa \leq 2$, following Helpman et al. (2004).

The timing of actions is modified as follows. Firms first decide the location of a plant for the home market and then choose their organizational form, either an MNE or a pure exporter. The choice of organizational form is equivalent to the choice of where to locate the second plant/affiliate. The subsequent actions proceed as in the basic model.

This extended model is fully analyzed in Online Appendix F, where we confirm the aforementioned reasoning: firms locating the first plant in the low-tax country 2 always become pure exporters. Given production in the low-tax country, it makes no sense to become an MNE because its distribution affiliates faces high taxes and is less competitive due to a higher transfer price of inputs. By contrast, firms locating the first plant in the high-tax country 1 may become an MNE or a pure exporter. The relative benefit of becoming an MNE instead of a pure exporter depends on the effectiveness of profit shifting, which in turn is affected by trade openness.

Considering these decisions of organizational form, firms choose the location of production location, i.e., the first plant. In summary, the organizational choice and the production location pattern crucially rest on the value of fixed cost of export plant κ. When κ is high, and thus, the benefit of becoming a pure exporter is small, as trade openness rises, the high-tax country 1 first loses and then gains multinational production, as in the basic model. By contrast, when κ is low, firms in both countries become pure exporters and move away from the high-tax country 1, as openness rises. As long as the benefit of becoming a pure exporter is not too large (κ is not too small), we maintain the conclusion of full production agglomeration in the high-tax country for high openness.

4.3 Asymmetric country size

The result of the high-tax country 1 attracting more multinational production for high trade openness, in general, does not depend on the assumption of symmetric market size. Our model inherits a common feature of NEG models that firms try to locate in large countries to save trade costs when exporting. Thus, if country 1 is larger ($s_1 > 1/2$), the larger market size strengthens the incentive of MNEs to locate production there. If country 1 is smaller ($s_1 < 1/2$), MNEs have less incentive to choose it for production. Even in this case, however, the small high-tax country 1 may achieve full production agglomeration for high openness, where the trade-cost-saving motive is weak. In Online Appendix G, we confirm that production plants are always agglomerated in the high-tax country 1 at $\phi = 1$ except in the case where country 1 is extremely large.[31]

[31]In the special case where $s_1 > \bar{s}_1 \equiv \sigma/(2\sigma - \Delta t_2)$, full production agglomeration in the large, high-tax country 1 does not occur. This is because the transferable profits, which depend on the sales of distribution affiliates in country 2, are very small. This exceptional case implies that the very small, low-tax country (roughly a tax-haven) may host a greater share of plants than its market-size share: $n_2 > s_2$.

4.4 Centralized decision making

We assumed that MNEs have decentralized decision making, where foreign affiliates choose prices to maximize their own profits. Our main result holds true even if MNEs have centralized decision making, whereby they choose all prices to maximize global profits. Note that the direction of profit shifting does not change depending on the decision making style. That is, foreign affiliates source goods from production plants by paying high (or low) transfer prices if they are in the low-tax country (or the high-tax country). By locating in the low-tax country, foreign affiliates enjoy a higher price-cost margin than those located in the high-tax country ($p_{12} - g_1 > p_{21} - g_2$) and earn larger profits. As in the decentralized decision making case, profit shifting affects the profitability of foreign affiliates asymmetrically, leading to the agglomeration of production plants in the high-tax country. See Online Appendix H for more details.

5 Tax competition

Here, we allow countries to choose their tax rate and compare the results of tax competition in the case with and without transfer pricing. Throughout this section except for Section 5.3, we cast aside transfer-pricing regulation, i.e., $\delta = 0$. The objective function of government $i \in \{1, 2\}$ takes the form of

$$\begin{aligned} G_i &= TR_i - \frac{t_i}{\alpha_i(1-t_i)}, \\ \text{where } \ TR_i &\equiv t_i \cdot TB_i, \\ TB_i &\equiv N_i\pi_{ii} + N_j\pi_{ji}, \qquad i \neq j \in \{1, 2\}. \end{aligned}$$

The tax base for government i, TB_i, consists of the profits of home production plants, $N_i\pi_{ii}$, and those of foreign distribution affiliates, $N_j\pi_{ji}$. The second term of G_i is tax administration costs, where $\alpha_i > 0$ captures its efficiency. We assume that government 1 is more efficient in tax administration than government 2: $\alpha_1 > \alpha_2$.[32] The two governments simultaneously

[32]Tax administration costs are well recognized as an important determinant of raising revenues (OECD, 2017; Profeta and Scabrosetti, 2017). OECD (2017) states that "Even small increases in compliance rates or compliance costs can have significant impacts on government revenues and the wider economy." (p.5) In addition, this objective function captures the fundamental conflicts governments face: they attempt to raise tax revenues while maintaining a low tax rate, which is deemed a reduced-form objective that either a selfish or a benevolent government adopts (Baldwin and Krugman, 2004). See also Borck and Pflüger (2006); Han et al. (2014); and Kato (2015) for similar specifications. An alternative interpretation of the

and non-cooperatively decide their tax rates before the MNEs' location decisions.

5.1 No-transfer-pricing case

As a benchmark, we derive the equilibrium tax rates when transfer pricing is not allowed. The inability to manipulate transfer prices implies that the transfer price must be equal to the true marginal cost: $g_i = \tau a$, in which case $\gamma_i = 1$ holds. This leads to zero profits from intra-firm trade: $(g_i - \tau a)q_{ij} = 0$ for $i \neq j \in \{1, 2\}$. Combining these results with π_{11} in Eq. (5-1) and π_{21} in Eq. (5-2) yields tax revenues for government 1:

$$\begin{aligned}
TR_1 &= t_1 TB_1 \\
&= t_1[N_1\pi_{11} + N_2\pi_{21}] \\
&= t_1\left[N_1 \cdot \frac{\mu L_1}{\sigma(N_1 + \phi N_2)} + N_2 \cdot \frac{\phi\mu L_1}{\sigma(N_1 + \phi N_2)}\right] \\
&= t_1 \cdot \frac{\mu L_1(N_1 + \phi N_2)}{\sigma(N_1 + \phi N_2)} \\
&= t_1 \cdot \frac{\mu L}{2\sigma},
\end{aligned}$$

where $L_1 = L_2 = L/2$. We can analogously derive tax revenues for government 2 as $TR_2 = t_2 TB_2 = t_2\mu L/(2\sigma)$. Notably, TB_i depends on neither the share of plants (n_i), trade openness (ϕ), nor taxes (t_is). Two factors explain that the tax base is independent of n_i, ϕ and t_is.[33] First, the total mass of plants and affiliates generating country 1's tax base is constant and is given by $N_1 + N_2 = n_1 L + (1 - n_1)L = L$. Second, the transferable profits of foreign affiliates depend on their sales in country 1, and thus, are limited by its residents' expenditure on manufacturing goods ($\sum_{i=1}^{2} N_i p_{i1} q_{i1} = \mu L_1$). The constant tax base then implies that governments do not benefit from the full agglomeration of plants. Put differently, the concentration of multinational production in a country does not generate taxable agglomeration rents there, which sharply contrasts with the implication of the NEG models (Baldwin and Krugman, 2004).

objective function is that the government is supported (or elected) by residents, who put a high value on public goods/services funded by tax revenues. This specification is used in Krautheim and Schmidt-Eisenlohr (2011) in the context of tax competition between a tax-haven and a non-tax-haven country.

[33]The constant tax base does not result from the quasi-linear utility function with constant expenditure on manufacturing goods: $\sum_{i=1}^{2} N_i p_{ij} q_{ij} = \mu L_j$. In Online Appendix K, we confirm that the Cobb-Douglas utility function also yields a constant tax base.

Government i thus maximizes

$$G_i = \frac{\mu L t_i}{2\sigma} - \frac{t_i}{\alpha_i(1-t_i)}.$$

Solving the first-order condition gives the equilibrium tax rate in country i:

$$\widehat{t}_i = 1 - \sqrt{\frac{2\sigma}{\alpha_i \mu L}}, \tag{7}$$

where we use $\widehat{t}_i$ to represent the equilibrium value of t_i in tax competition without transfer pricing. We can check the government payoff is positive: $G_i(t_i = \widehat{t}_i) = [\mu L/(2\sigma) - 1/\alpha_i]^2 > 0$. The equilibrium tax rate increases with α_i, reflecting the fact that a government with efficient tax administration can easily raise taxes. In fact, government 1 sets a higher tax rate than government 2, i.e., $\widehat{t}_1 > \widehat{t}_2$. Because the government objective functions depend on neither the plant share (n_i) nor trade openness (ϕ), the equilibrium tax rates given by Eq. (7) are unique for any n_i and ϕ. An excessively high (or low) α_i makes the equilibrium tax rate too high (or too low). To ensure $\widehat{t}_i \in (0, 1/2)$ that guarantees positive total pre-tax profits (see Section 2.1), we assume $\alpha_i \in (2\sigma/(\mu L), 3\sigma/(\mu L))$.

Without transfer pricing, a higher tax rate of a country simply discourages production plants from locating there. This tendency is more pronounced when trade openness is high. In particular, all plants move away from the high-tax country 1 to the low-tax country 2, when the level of openness is higher than the agglomeration threshold $\widehat{\phi}^S$:

$$\widehat{\phi}^S = \frac{1-\widehat{t}_1}{1-\widehat{t}_2} \in (0, 1), \tag{8}$$

The situation of full production agglomeration in country 2, i.e., $n_1 = 0$, is shown in Figure 4 (dashed line). At $\phi = 1$, MNEs are indifferent to the production location because, unlike the transfer-pricing case, the pre-tax profits from the home and foreign markets are the same when there are no trade costs.

These results are summarized as follows (see Online Appendix I for the proof).

Proposition 3 (tax competition without transfer pricing). *Assume that two countries are of equal size ($s_1 = 1/2$) and that government 1 has a more efficient tax administration than government 2: $\alpha_1 > \alpha_2$, where $\alpha_i \in (2\sigma/(\mu L), 3\sigma/(\mu L))$. As a result of tax competition without transfer pricing, government 1 always sets a higher tax rate and hosts a smaller share of plants than government 2, i.e., $\widehat{t}_1 > \widehat{t}_2$, given by Eq. (7). There exists a threshold value of trade openness, $\widehat{\phi}^S$, such that the following holds:*

(i). If $\phi \in [0, \widehat{\phi}^S)$, the high-tax country 1 hosts a smaller share of plants than the low-tax country 2, i.e., $n_1 \in (0, 1/2)$.

(ii). If $\phi \in [\widehat{\phi}^S, 1)$, the high-tax country 1 loses all plants, i.e., $n_1 = 0$.

(iii). If $\phi = 1$, any plant distribution can be the long-run equilibrium, i.e., $n_1 \in [0, 1]$.

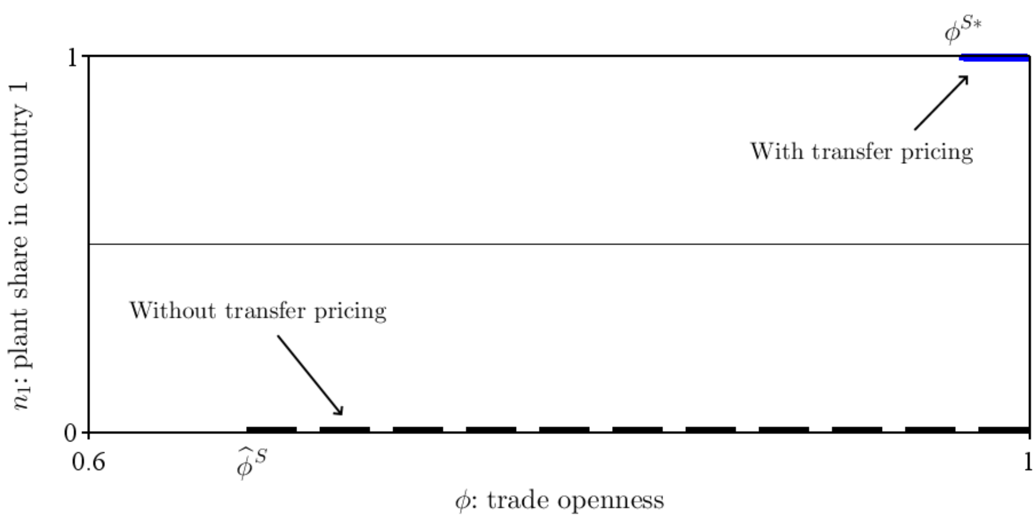

Figure 4. Plant share under tax competition

Notes: Parameter values are $\sigma = 5$; $t_1 = 0.3$; $t_2 = 0.2$; $\delta = 0$; $s_1 = 0.5$.

5.2 Transfer-pricing case

We examine how these results change if MNEs can use transfer pricing. The analysis in Section 3 tells that when trade openness is high enough such that $\phi \in [\phi^S, 1]$, all production plants are agglomerated in country 1, as long as its tax rate is higher than that of country

2 ($t_1 > t_2$). This situation is illustrated in Figure 4 (thick line).[34] Here, we focus on the range $\phi \in [\phi^S, 1]$ and derive conditions under which full production agglomeration emerges as a result of tax competition.

Supposing that all plants are in country 1 ($N_1 = n_1 L = L$), we can derive tax revenues for government 1 as

$$\begin{aligned} TR_1 &= t_1 TB_1 \\ &= t_1 \left[\frac{\mu L}{2\sigma} + N_1 \frac{(\sigma-1)\Delta t_1}{\sigma} \frac{\phi\gamma_1 \mu L}{2\sigma(\phi\gamma_1 N_1 + N_2)} \right] \\ &= t_1 \left[\frac{\mu L}{2\sigma} + \underbrace{\frac{(\sigma-1)\Delta t_1}{\sigma} \frac{\mu L}{2\sigma}}_{\text{Shifted profits of home plants } <0} \right], \end{aligned}$$

where $L_1 = L_2 = L/2$; $N_1 = n_1 L = L$; and $N_2 = (1-n_1)L = 0$. By contrast, tax revenues for government 2 remain unchanged because there are no production plants there, which transfer profits. We obtain

$$\begin{aligned} TR_2 &= t_2 TB_2 \\ &= t_2 \left[\frac{\mu L}{2\sigma} + N_2 \frac{(\sigma-1)\Delta t_2}{\sigma} \frac{\phi\gamma_2 \mu L}{2\sigma(N_1 + \phi\gamma_2 N_2)} \right] \\ &= t_2 \cdot \frac{\mu L}{2\sigma}. \end{aligned}$$

The governments' payoffs then become

$$\begin{aligned} G_1 &= \frac{\mu L t_1}{2\sigma} \left[1 + \frac{(\sigma-1)\Delta t_1}{\sigma} \right] - \frac{t_1}{\alpha_1(1-t_1)}, \\ G_2 &= \frac{\mu L t_2}{2\sigma} - \frac{t_2}{\alpha_2(1-t_2)}, \end{aligned}$$

where G_1 now involves the tax difference due to the presence of shifted profits of home plants. To prevent this tax base erosion, government 1 has a stronger incentive to lower its tax rate than it does in the no-transfer-pricing case. By contrast, as country 2 does not have any plants that receive shifted profits, G_2 is the same as in the no-transfer-pricing case.[35]

[34] We obtain the agglomeration threshold ϕ^{S*} in Figure 4 by evaluating ϕ^S at the equilibrium tax rate $\{t_i^*\}_{i=1}^2$, which will be discussed shortly.

[35] Profits that foreign affiliates transfer from/to plants are indeed included in the first term of TB_i and do not show up explicitly. See Online Appendix E for more details.

From the first-order conditions, we obtain

$$t_1^* = 1 - \sqrt{\frac{2\sigma}{\alpha_1 \mu L} + \frac{(\sigma-1)(\sqrt{2\sigma\mu L/\alpha_2} - 2\sigma/\alpha_1)}{\mu L(2\sigma - 1)}}, \tag{9-1}$$

$$t_2^* = 1 - \sqrt{\frac{2\sigma}{\alpha_2 \mu L}} \quad (= \widehat{t}_2), \tag{9-2}$$

where we use t_i^* to represent the equilibrium value of t_i in tax competition with transfer pricing. We can confirm that t_1^* and t_2^* are in $(0, 1/2)$ under our assumption that $\alpha_1 > \alpha_2$, where $\alpha_i \in (2\sigma/(\mu L), 3\sigma/(\mu L))$. To be consistent with the full agglomeration of plants in country 1, t_1^* must be higher than t_2^*. This requires a sufficiently high α_1 such that $\alpha_1 \in (\alpha^*, 3\sigma/(\mu L))$ with $\alpha^* > \alpha_2$. We can also check that t_1^* is lower than the equilibrium tax rate without transfer pricing $\widehat{t}_1$. Introducing profit shifting intensifies tax competition in the sense that the tax difference becomes narrower.[36]

Thus, our main result that profit shifting leads to production agglomeration in the high-tax country for high trade openness (Proposition 1) carries over to a tax-competition framework when countries are quite different in their efficiency in tax administration. We can formally prove the following proposition.

Proposition 4 (Tax competition with transfer pricing). *Assume that $s_1 = 1/2$, $\alpha_1 > \alpha_2$, where $\alpha_i \in (2\sigma/(\mu L), 3\sigma/(\mu L))$, as in Proposition 3. Consider tax competition with transfer pricing under sufficiently high trade openness such that $\phi \in [\phi^S, 1]$, where ϕ^S is the agglomeration threshold. Then, there exists a unique pair of equilibrium tax rates, $\{t_i^*\}_{i=1}^2$ given by Eqs. (9-1) and (9-2), which satisfy the following:*

(i). (**The tax rates of country 1 versus country 2**) *Country 1's tax rate is higher than country 2's ($t_1^* > t_2^*$) if the tax-administration efficiency of government 1 is sufficiently high: $\alpha_1 > \alpha^*$. All production plants are located in country 1 ($n_1 = 1$) for $\phi > \phi^{S*}$, where ϕ^{S*} is the agglomeration threshold evaluated at the equilibrium tax rates.*

(ii). (**Tax rates with and without transfer pricing**) *Assume $\alpha_1 > \alpha^*$ and $\phi > \phi^{S*}$. Compared to the no-transfer-pricing case, country 1's tax rate and payoff decrease ($t_1^* < \widehat{t}_1$; $G_1(t_1^*) < G_1(\widehat{t}_1)$), whereas country 2's tax rate and payoff are unchanged ($t_2^* = \widehat{t}_2$;*

[36] If instead α_1 is higher than α_2 but is low enough such that $\alpha_1 \in (\alpha_2, \alpha^*]$, t_1^* is equal to or lower than t_2^* and full production agglomeration in country 1 does not occur. In this case, government 1 chooses to mimic government 2's tax rate ($t_1^* = t_2^*$), whereas government 2 chooses the same tax rate as it does in the no-transfer-pricing case ($t_2^* = \widehat{t}_2$). This leads to a symmetric distribution of plants ($n_1 = 1/2$).

$G_2(t_2^*) = G_2(\widehat{t}_2)$). That is, introducing transfer pricing makes tax competition tougher ($0 < t_1^* - t_2^* < \widehat{t}_1 - \widehat{t}_2$) and leaves the world worse off ($G_1(t_1^*) + G_2(t_2^*) < G_1(\widehat{t}_1) + G_2(\widehat{t}_2)$).

See Online Appendix J for the proof. We note that, unlike the no-transfer-pricing case, full production agglomeration occurs even with completely free trade ($\phi = 1$). This is because MNEs can differentiate the two selling prices using transfer prices dependent on the international tax difference. In Online Appendix K, we also confirm that when the utility function takes the Cobb-Douglas form, the results remain qualitatively similar to Proposition 4.

Our conclusion that profit shifting pushes taxes downward (Proposition 4(ii)) is consistent with Haufler and Schjelderup (2000), who employ a framework of perfect competition with symmetric countries.[37] By contrast, Stöwhase (2005, 2013) obtain the opposite result: introducing profit shifting softens tax competition by increasing the equilibrium tax rates of countries.[38] In the presence of profit shifting, governments chase the shifted profits and intensify tax competition. Meanwhile, MNEs can save tax payments regardless of their locations and become less sensitive to international tax differences, thereby making tax competition less severe. In Stöwhase (2005, 2013), the latter effect dominates the former, whereas the opposite is true in our model. These differing results may come from the fact that while Stöwhase (2005, 2013) consider a representative firm or a monopoly firm, we consider a continuum of MNEs competing with each other. The competitive environment strengthens the tax-saving incentive, and thus, increases the tax base sensitivity in the high-tax country hosting full production agglomeration.

Our result that the high-tax country achieves full production agglomeration (Proposition 4(i)) resembles the one in Baldwin and Krugman (2004) and other NEG models; however, their mechanism crucially differs from ours. In Baldwin and Krugman (2004), production agglomeration generates taxable rents, which are non-monotonic in terms of trade openness ϕ. A higher ϕ may expand the rents and soften tax competition. By contrast, in our model with profit shifting, production agglomeration is harmful to a country by inducing the erosion of its tax base. One government sets a higher tax rate than the other, not because it wants to tax agglomeration rents, but because it has a more efficient tax administration.

[37] Agrawal and Wildasin (2020) also show that globalization, defined by a decline in relocation costs, leads to tougher tax competition in a linear spatial model where agglomeration is exogenously given.

[38] Becker and Riedel (2013) obtain a similar result, although MNEs in their model cannot shift profits for tax-saving purposes.

5.3 Coordination of transfer-pricing regulation

Based on Proposition 4(ii) that introducing transfer pricing leaves the world worse off, one may think that international coordination of transfer-pricing regulation would make the world better off. We show that this is indeed possible as a result of mutual agreement between the two governments. Note that international coordination of *tax rates* is difficult because both governments set the dominant-strategy equilibrium tax rate, and thus, do not have any incentive to change it.

Adding transfer-pricing regulation δ modifies the governments' payoffs as

$$G_1 = \frac{\mu L t_1}{2\sigma}\left[1 + \frac{(\sigma-1)(\Delta t_1 + \delta)}{\sigma}\right] - \frac{t_1}{\alpha_1(1-t_1)},$$
$$G_2 = \frac{\mu L t_2}{2\sigma} - \frac{t_2}{\alpha_2(1-t_2)},$$

where government 2's payoff, G_2, is unchanged since there is no plant in country 2. The associated equilibrium tax rates are

$$t_1^{**} = 1 - \sqrt{\frac{2\sigma}{\alpha_1 \mu L} + \frac{(\sigma-1)[\sqrt{2\sigma\mu L/\alpha_2} - 2\sigma(1+\delta)/\alpha_1]}{\mu L[2\sigma - 1 + \delta(\sigma-1)]}},$$
$$t_2^{**} = 1 - \sqrt{\frac{2\sigma}{\alpha_2 \mu L}} \quad (= t_2^* = \widehat{t}_2).$$

A tighter regulation (higher δ) increases t_1^{**}, and thus, raises government 1's payoff. Since δ does not enter G_2, government 2 is indifferent to the stringency of regulation.[39] These observations suggest the possibility of a Pareto improvement through the coordination of transfer-pricing regulation. Both governments agree on tightening the regulation to make transfer pricing impossible, i.e., $\Delta t_1 + \delta = 0$ or $\delta = (t_1 - t_2)/(1-t_2)$. This result is summarized as follows.

Proposition 5 (Transfer-pricing regulation). *Consider tax competition with transfer pricing, as described in Proposition 4. International coordination of regulation that prohibits transfer pricing, i.e., $\delta = (t_1 - t_2)/(1-t_2)$, makes the world better off and is possible based on mutual agreement between the two countries.*

[39] Here, we do not relate the stringency of regulation δ and the efficiency level of tax administration α_i. It is reasonable to think that δ increases with α_i because a more efficient government prevents its tax base erosion more effectively. In Online Appendix L, we check that t_1^{**} rises as the correlation of δ with α_i increases.

Studies on competition for profit-shifting multinationals typically find that setting transfer-pricing regulation leads to a prisoners' dilemma situation (e.g., Peralta et al., 2006; Hauck, 2019; Hindriks and Nishimura, 2021).[40] Namely, governments never agree on international coordination for maximizing world payoffs because unilateral deviation from the agreed level of regulation always improves the national payoff. In our model, however, government 2 is indifferent to the level of regulation, and thus, has no objection because it has no taxable profits that production plants try to shift to country 1. When trade openness is sufficiently high such that plants fully agglomerate in a country with efficient tax administration, international cooperation on regulation is possible and sustainable.

6 Conclusion

Countries with lower corporate tax rates are expected to host more multinational production. However, this simplistic view may be challenged because economic integration, marked by falling trade costs (or rising trade openness), allows for profit shifting, and thus, may change the location incentives of multinationals. To investigate this, we introduced transfer pricing into a simple two-country model of trade and geography.

With low trade openness, a low-tax country attracts more production plants than a high-tax country. With high trade openness, this pattern completely reverses and production agglomerates in the high-tax country. When high openness helps intra-firm trade expand, MNEs can use transfer pricing as both a strategic and a profit-shifting device. To shift profits, the transfer price from the high-tax to the low-tax country is set low, whereas that from the low-tax to the high-tax country is set high. This transfer-pricing strategy lowers the input cost of distribution affiliates in the low-tax country, and thus, makes them competitive. By contrast, distribution affiliates in the high-tax country become less competitive due to the high input cost. Therefore, MNEs prefer to locate production in the high-tax country and distribution in the low-tax country.

The main results carry over to a tax-competition framework where countries non-cooperatively choose their tax rates. The difference in equilibrium tax rates between countries results from the difference in the level of efficiency in tax administration. Unlike standard NEG models, the country hosting all production plants does not enjoy agglomeration rents from it; rather, it faces tax base erosion due to profit shifting. Another finding is that introducing profit

[40] Hindriks and Nishimura (2021) point out two key drivers that help governments agree on a cooperated outcome: (i) the complementarity of countries' efforts for regulation and (ii) tax leadership.

shifting makes tax competition fiercer by reducing the high-tax country's equilibrium tax rate.

We test our prediction using bilateral FDI data from 23 OECD countries from 2008 to 2016. The empirical exercise supports the non-monotonic effect of economic integration on the share of production affiliates out of affiliates in all sectors. Furthermore, supporting evidence can also be found in Overesch (2009) and Goldbach et al. (2019). For example, Overesch (2009) confirms that foreign affiliates in Germany invest more, as the cross-country tax difference between their source countries and high-tax Germany increases.

Although our model is admittedly stylized, we believe that it is versatile enough to accommodate further extensions. An interesting extension is to consider various channels of profit shifting such as licensing fees for intellectual property rights and the choice between equity and debt financing. While we solely focus on the transfer pricing of tangible goods, these alternative channels are equally important in reality. Adding these channels into our model may yield different implications for production location and tax revenues. Another extension is to examine the impact of different international tax systems, such as separate accounting and formula apportionment. Which tax system prevents profit shifting more effectively may differ depending on the degree of economic integration. We leave these avenues for future research.

Appendices

Appendix 1. List of key variables

Variable	Description
L_i	Population in country i
K_i	Capital endowment in country i
κ	Capital that pure exporters need to supply to a foreign market (Section 4.2)
s_i	Share of population and capital endowment in country i
w_i	Wage in country i
a	Unit labor requirement for the differentiated varieties
R_i	Reward to capital invested in MNEs with production in country i
μ	Intensity of the preference for the differentiated goods
σ	Elasticity of substitution over differentiated varieties
$\widetilde{q}_{ij}(\omega)$	Individual demand for the variety ω produced in country i and consumed in country j
$q_{ij}(\omega)$	Aggregate demand for the variety ω produced in country i and consumed in country j
Q_i	CES aggregator of the differentiated varieties in country i
$p_{ij}(\omega)$	Price of the variety ω produced in country i and consumed in country j
P_i	Price index of the differentiated varieties in country i
n_i	Share of production plants in country i
N_i	Mass of MNEs with production in country i $(= n_i L)$
g_i	Transfer price set by MNEs headquartered in country i
δ	Stringency of transfer pricing regulation
π_{ii}	Pre-tax operating profits of a production plant of MNEs with production in country i
π_{ij}	Pre-tax operating profits of a distribution affiliate of MNEs with production in country i
Π_i	Global post-tax profits of MNEs with production in country i
t_i	Corporate tax rate in country i
Δt_i	Weighted tax gap $(\equiv (t_j - t_i)/(1 - t_i))$
$\widehat{t}_i$	Equilibrium tax rate in country i without transfer pricing (Section 5.1)
t_i^*	Equilibrium tax rate in country i under tax competition with transfer pricing (Section 5.2)
t_i^{**}	Equilibrium tax rate in country i under tax competition with transfer price regulation (Section 5.3)
γ_i	Bundle of parameters $\left(\gamma_1 \equiv \left(\dfrac{\sigma(1+\delta)}{\sigma - \Delta t_1 + \delta(\sigma-1)}\right)^{1-\sigma}, \quad \gamma_2 \equiv \left(\dfrac{\sigma(1-\delta)}{\sigma - \Delta t_2 - \delta(\sigma-1)}\right)^{1-\sigma}\right)$
τ	Iceberg trade cost of the differentiated goods
ϕ	Trade openness $\left(\equiv \tau^{1-\sigma}\right)$
ϕ^S	Agglomeration threshold above which level of ϕ all plants are located in one country $(n_1 \in \{0, 1\})$
$\phi^\dagger$	Threshold of ϕ such that $n_1 = 1/2$ holds
$\phi^\#$	Threshold of ϕ such that $dn_1/d\phi = 0$ holds
$\widehat{\phi}^S$	Agglomeration threshold under tax competition without transfer pricing (Section 5.2)
ϕ^{S*}	Agglomeration threshold under tax competition with transfer pricing (Section 5.2)
TB_i	Tax base in country i
TR_i	Tax revenue in country i
G_i	Objective function of the government in country i
α_i	Efficiency measure of tax administration

Appendix 2. Data

Sources for the variables used in the paper and their descriptions are as follows.

Foreign affiliates. We take bilateral outward "Number of enterprises" data from Corporate Outward activity of multinationals by country of location–ISIC Rev 4. in OECD Statistics, covering the period from 2007 to 2017. Although the data is available by sector, we only use data on "TOTAL BUSINESS SECTOR" and "MANUFACTURING" because many of sector-level data are missing. The sample consists of 23 OECD counties: Australia, Austria, Belgium, Canada, Czech Republic, Germany, Finland, France, Greece, Hungary, Israel, Italy, Japan, South Korea, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom, United States. We exclude observations with missing values and/or zero affiliates from the sample, so that the sample period is reduced to the period 2008 to 2016. Note that four European countries identified as tax havens by Zucman (2014), i.e., Ireland, Luxembourg, the Netherlands, and Switzerland, are not included in the sample. In regression analysis, we define a host-source-year level "Manufacturing affiliate share" as the share of affiliates in "MANUFACTURING" out of those in "TOTAL BUSINESS SECTOR."

Corporate tax rates. Data on statutory corporate tax rates and effective average tax rates are from Centre for Business Taxation Tax Database 2017 (Habu, 2017). In regression analysis, we convert them into a percentage value and take their difference between host country h and source country s, $\Delta TAX_{h,s,t} = TAX_{h,t} - TAX_{s,t}$, where with an abuse of notation we here use t for time subscript.

Trade openness. We take the bilateral distance measure from Mayer and Zignago (2011) and define the trade openness as the inverse of the log of the bilateral geodesic distance between the main city of the two countries. As an alternative measure, we use the inverse of the log of the bilateral trade costs in manufacturing sector constructed by the ESCAP-World Bank Trade Cost Database (Arvis et al., 2016). This alternative measure is time variant and computed using data on bilateral trade flows à la Head and Ries (2001); and Novy (2013).

Pro-business index. As a measure of pro-business conditions, we use the "Index of Economic Freedom" published by the Heritage Foundation. The Index includes 12 sub-indices, each of which ranges from zero to one and captures the rule of law, government size, regulation efficiency, and market openness. Among the 12 sub-indices, we exclude the "tax burden" index and redefine a simple average of the other 11 sub-indices as the pro-business index. In regression analysis, we use the difference of this index between a host and a source country, $\Delta(\text{Pro business})_{h,s,t}$, as the IV for their corporate tax difference.

Accountability index. As a measure of political process, we use a summary index of government accountability constructed by the World Governance Indicators (WGI) of the World Bank. This accountability index is a mean of 21 policy indices reported in the Institutional Profiles Database of the CEPII. The sub-indices measure e.g., freedom of elections at national level, reliability of state budget, and freedom of association, capturing perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.[41] The original index constructed by the WGI ranges from 0 to 1, which we transform from 0 to 100. We use the difference of this index between a host and a source country, $\Delta(\text{Accountability})_{h,s,t}$, for the IV of their corporate tax difference.

Other variables. We respectively use the growth rate (%) of unit labor costs hours based as a measure of labor costs and the growth rate (%) of GDP per hour worked as a measure of productivity. In regression analysis, we take the difference of these values between a host and a source country: $\Delta(\text{Labor costs})_{h,s,t}$ and $\Delta(\text{Productivity})_{h,s,t}$. These data and real GDP used to draw Figure 1 are from OECD statistics.

Summary statistics for the variables used in regression is provided in Table A1 in Appendix.

Table A1

Summary statistics

	N	Mean	St. Dev.	Min	Max
Manufacturing affiliate share	1,833	0.345	0.167	0.022	1.000
$\Delta TAX_{h,s,t}$: statutory rate (%point)	1,833	-0.654	9.043	-21.760	23.460
$\Delta TAX_{h,s,t}$: effective average rate (%point)	1,833	-0.667	7.926	-20.191	20.028
$\phi_{h,s}$: 1/log(distance)	1,833	0.135	0.021	0.102	0.245
$\phi_{h,s,t}$: 1/log(trade costs)	1,630	0.238	0.046	0.183	1.074
$\Delta(\text{Labor cost})_{h,s,t}$ (%point)	1,833	0.330	6.729	-31.025	31.454
$\Delta(\text{Productivity})_{h,s,t}$ (%point)	1,833	0.264	1.975	-9.554	11.407
$\Delta(\text{Pro business})_{h,s,t}$ (%point)	1,833	0.392	8.398	-25.264	25.745
$\Delta(\text{Accountability})_{h,s,t}$	1,825	-0.906	7.098	-21.825	21.429

[41] The 21 sub-indices are listed under name of "IPD" in `https://info.worldbank.org/governance/wgi/Home/downLoadFile?fileName=va.pdf`, accessed on 10 August 2022. Both the accountability index (e.g., "IPD060708VA") and the sub-indices are given in `https://info.worldbank.org/governance/wgi/Home/downLoadFile?fileName=IPD.xlsx`, accessed on 10 August 2022.

Appendix 2. Robustness check for the non-monotonic effect

In the regression analysis shown in Table 1, we use the geodesic distance to construct the measure of bilateral trade openness $\phi_{h,s}$. As an alternative measure, we use the inverse of the log of trade costs reported by the ESCAP-World Bank Trade Cost Database (Arvis et al., 2016). This alternative measure is time variant. We also include the interaction terms of the control variables with trade openness and its squared, in addition to the level terms of trade openness and its squared. The regression results are provided in Table A2. As a further robustness check, we use a one-year lagged tax difference to mitigate the endogeneity concern on taxes and FDI flows. The regression results with lagged tax difference are in Table A3. In all specifications, the coefficient of $\Delta TAX_{h,s,t} \cdot \phi_{h,s,t}$ is negative and that of $\Delta TAX_{h,s,t} \cdot \phi^2_{h,s,t}$ is positive with strong statistical significance, confirming the non-monotonic effect of economic integration on multinational production.

Table A2

Robustness check for the non-monotonic effect

	Statutory tax rate	Effective average tax rate
	(1)	(2)
$\Delta TAX_{h,s,t} \cdot \phi_{h,s,t}$	-0.122***	-0.147***
	(0.047)	(0.051)
$\Delta TAX_{h,s,t} \cdot \phi^2_{h,s,t}$	0.150**	0.184***
	(0.059)	(0.067)
$\Delta TAX_{h,s,t}$	0.014	0.018
	(0.121)	(0.112)
$\phi_{h,s,t}$	-5.515***	-5.546***
	(0.567)	(0.573)
$\phi^2_{h,s,t}$	6.091***	6.146***
	(0.788)	(0.802)
Δ(Labor cost)$_{h,s,t}$	-0.051***	-0.050**
	(0.018)	(0.022)
Δ(Labor cost)$_{h,s,t} \cdot \phi_{h,s,t}$	0.405***	0.402***
	(0.104)	(0.104)
Δ(Labor cost)$_{h,s,t} \cdot \phi^2_{h,s,t}$	-0.780***	-0.776***
	(0.166)	(0.166)
Δ(Productivity)$_{h,s,t}$	0.195***	0.193***
	(0.061)	(0.061)
Δ(Productivity)$_{h,s,t} \cdot \phi_{h,s,t}$	-1.296***	-1.283***
	(0.381)	(0.382)
Δ(Productivity)$_{h,s,t} \cdot \phi^2_{h,s,t}$	2.157***	2.142***
	(0.549)	(0.550)
Δ(Pro business)$_{h,s,t}$	0.032	0.029
	(0.047)	(0.042)
Δ(Pro business)$_{h,s,t} \cdot \phi_{h,s,t}$	-0.304***	-0.286***
	(0.094)	(0.089)
Δ(Pro business)$_{h,s,t} \cdot \phi^2_{h,s,t}$	0.618***	0.591***
	(0.155)	(0.147)
Host country–year dummy	✓	✓
Source country–year dummy	✓	✓
Year dummy	✓	✓
Observations	1,630	1,630
R^2	0.597	0.597

Notes: The dependent variable is the share of a source country's manufacturing affiliates in a host country out of the source's affiliates in all sectors in the host in a year. Standard errors clustered at the host country-year level are in parentheses. Unlike Table 1, we use the inverse of the log of the Head-Ries index as a measure of trade openness $\phi_{h,s,t}$.

***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level.

Table A3

Robustness check for the non-monotonic effect: lagged tax difference

	Statutory tax rate	Effective average tax rate
	(1)	(2)
$\Delta TAX_{h,s,t-1} \cdot \phi_{h,s,t}$	-0.122***	-0.147***
	(0.047)	(0.051)
$\Delta TAX_{h,s,t-1} \cdot \phi^2_{h,s,t}$	0.150**	0.184***
	(0.059)	(0.067)
$\Delta TAX_{h,s,t-1}$	0.025*	0.030**
	(0.013)	(0.013)
$\phi_{h,s,t}$	-5.601***	-5.518***
	(0.589)	(0.567)
$\phi^2_{h,s,t}$	6.209***	6.135***
	(0.813)	(0.797)
Δ(Labor cost)$_{h,s,t}$	-0.051***	-0.050**
	(0.018)	(0.022)
Δ(Labor cost)$_{h,s,t} \cdot \phi_{h,s,t}$	0.405***	0.402***
	(0.104)	(0.104)
Δ(Labor cost)$_{h,s,t} \cdot \phi^2_{h,s,t}$	-0.780***	-0.776***
	(0.166)	(0.166)
Δ(Productivity)$_{h,s,t}$	0.195***	0.193***
	(0.061)	(0.061)
Δ(Productivity)$_{h,s,t} \cdot \phi_{h,s,t}$	-1.296***	-1.283***
	(0.381)	(0.382)
Δ(Productivity)$_{h,s,t} \cdot \phi^2_{h,s,t}$	2.157***	2.142***
	(0.549)	(0.550)
Δ(Pro business)$_{h,s,t}$	0.026*	0.022
	(0.016)	(0.015)
Δ(Pro business)$_{h,s,t} \cdot \phi_{h,s,t}$	-0.305***	-0.280***
	(0.099)	(0.091)
Δ(Pro business)$_{h,s,t} \cdot \phi^2_{h,s,t}$	0.624***	0.581***
	(0.162)	(0.149)
Host country–year dummy	✓	✓
Source country–year dummy	✓	✓
Year dummy	✓	✓
Observations	1,352	1,352
R^2	0.583	0.583

Notes: The dependent variable is the share of a source country's manufacturing affiliates in a host country out of the source's affiliates in all sectors in the host in a year. Standard errors clustered at the host country-year level are in parentheses. Unlike Table 1, we use the inverse of the log of the Head-Ries index as a measure of trade openness $\phi_{h,s,t}$.

***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level.

Appendix 4. Parameter values

The figures in the text were produced using the following parameter values:
Figure 2: $\sigma = 5$, $t_1 = 0.3$, $t_2 = 0.2$, $\delta = 0$, $s_1 = 0.5$.
Figure 3: $\sigma = 5$, $t_1 = 0.3$, $t_2 = 0.2$, $\delta \in \{0, 0.07, 0.143\}$, $s_1 = 0.5$.
Figure 4: $\sigma = 5$, $\alpha_1 = 4$, $\alpha_2 = 0.33$, $\delta = 0$, $L = 20$, $s_1 = 0.5$, $\mu = 1$.

The figures do not depend on other parameter values listed above. The choice of elasticity of substitution ($\sigma = 5$) is the lower bound of the range estimated by Lai and Trefler (2002) and is also close to 4, the median estimate by Broda and Weinstein (2006). The choice of tax rates ($t_1 = 0.3$; $t_2 = 0.2$) is in line with the average tax rate is 0.2747 for our sample of 23 OECD countries in 2008 to 2016.

References

Agrawal, D. R. and Wildasin, D. E. (2020). Technology and tax systems. *Journal of Public Economics*, 185:104082.

Amerighi, O. and Peralta, S. (2010). The proximity-concentration trade-off with profit shifting. *Journal of Urban Economics*, 68(1):90–101.

Andersson, F. and Forslid, R. (2003). Tax competition and economic geography. *Journal of Public Economic Theory*, 5(2):279–303.

Antràs, P. and Helpman, E. (2004). Global sourcing. *Journal of Political Economy*, 112(3):552–580.

Arvis, J.-F., Duval, Y., Shepherd, B., Utoktham, C., and Raj, A. (2016). Trade costs in the developing world: 1996–2010. *World Trade Review*, 15(3):451–474.

Baldwin, R. E. and Krugman, P. R. (2004). Agglomeration, integration and tax harmonisation. *European Economic Review*, 48(1):1–23.

Baldwin, R. E. and Okubo, T. (2014). Tax competition with heterogeneous firms. *Spatial Economic Analysis*, 9(3):309–326.

Bartelsman, E. J. and Beetsma, R. M. (2003). Why pay more? Corporate tax avoidance through transfer pricing in OECD countries. *Journal of Public Economics*, 87(9):2225–2252.

Bauer, C. J. and Langenmayr, D. (2013). Sorting into outsourcing: Are profits taxed at a gorilla's arm's length? *Journal of International Economics*, 90(2):326–336.

Becker, J. and Riedel, N. (2013). Multinational firms mitigate tax competition. *Economics Letters*, 118(2):404–406.

Beer, S., De Mooij, R., and Liu, L. (2020). International corporate tax avoidance: A review of the channels, magnitudes, and blind spots. *Journal of Economic Surveys*, 34(3):660–688.

Behrens, K., Peralta, S., and Picard, P. M. (2014). Transfer pricing rules, OECD guidelines, and market distortions. *Journal of Public Economic Theory*, 16(4):650–680.

Bénassy-Quéré, A., Fontagné, L., and Lahrèche-Révil, A. (2005). How does FDI react to corporate taxation? *International Tax and Public Finance*, 12(5):583–603.

Bernard, A. B., Jensen, J. B., and Schott, P. K. (2006). Transfer pricing by US-based multinational firms. NBER Working Paper, 12493.

Bilir, L. K., Chor, D., and Manova, K. (2019). Host-country financial development and multinational activity. *European Economic Review*, 115:192–220.

Blonigen, B. A. and Piger, J. (2014). Determinants of foreign direct investment. *Canadian Journal of Economics*, 47(3):775–812.

Blouin, J. L. and Robinson, L. A. (2020). Double counting accounting: How much profit of multinational enterprises is really in tax havens? mimeo.

Bond, E. W. and Gresik, T. A. (2020). Unilateral tax reform: Border adjusted taxes, cash flow taxes, and transfer pricing. *Journal of Public Economics*, 184:104160.

Borck, R. and Pflüger, M. (2006). Agglomeration and tax competition. *European Economic Review*, 50(3):647–668.

Broda, C. and Weinstein, D. E. (2006). Globalization and the gains from variety. *Quarterly Journal of Economics*, 121(2):541–585.

Bruner, J., Rassier, D. G., and Ruhl, K. J. (2018). Multinational profit shifting and measures throughout economic accounts. In *The Challenges of Globalization in the Measurement of National Accounts*. University of Chicago Press.

Bucovetsky, S. (1991). Asymmetric tax competition. *Journal of Urban Economics*, 30(2):167–181.

Choe, C. and Matsushima, N. (2013). The arm's length principle and tacit collusion. *International Journal of Industrial Organization*, 31(1):119–130.

Choi, J. P., Furusawa, T., and Ishikawa, J. (2020). Transfer pricing regulation and tax competition. *Journal of International Economics*, 127:103367.

Choi, J. P., Ishikawa, J., and Okoshi, H. (2019). Tax havens and cross-border licensing. RIETI Discussion Paper Series 19-E-105.

Choi, S., Furceri, D., and Yoon, C. (2021). Policy uncertainty and foreign direct investment. *Review of International Economics*, 29(2):195–227.

Clausing, K. A. (2003). Tax-motivated transfer pricing and US intrafirm trade prices. *Journal of Public Economics*, 87(9):2207–2223.

Copithorne, L. W. (1971). International corporate transfer prices and government policy. *Canadian Journal of Economics*, 4(3):324–341.

Cristea, A. D. and Nguyen, D. X. (2016). Transfer pricing by multinational firms: New evidence from foreign firm ownerships. *American Economic Journal: Economic Policy*, 8(3):170–202.

Da Rin, M., Di Giacomo, M., and Sembenelli, A. (2010). Corporate taxation and the size of new firms: Evidence from Europe. *Journal of the European Economic Association*, 8(2-3):606–616.

Da Rin, M., Di Giacomo, M., and Sembenelli, A. (2011). Entrepreneurship, firm entry, and the taxation of corporate income: Evidence from Europe. *Journal of Public Economics*, 95(9-10):1048–1066.

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

Davies, R. B. and Eckel, C. (2010). Tax competition for heterogeneous firms with endogenous entry. *American Economic Journal: Economic Policy*, 2(1):77–102.

Davies, R. B., Martin, J., Parenti, M., and Toubal, F. (2018). Knocking on tax haven's door: Multinational firms and transfer pricing. *Review of Economics and Statistics*, 100(1):120–134.

Devereux, M. P. and Griffith, R. (1999). The taxation of discrete investment choices. Working Paper Series No. W98/16, The Institute for Fiscal Studies.

Dharmapala, D. (2014). What do we know about base erosion and profit shifting? A review of the empirical literature. *Fiscal Studies*, 35(4):421–448.

Dixit, A. and Stiglitz, J. (1977). Monopolistic competition and optimum product diversity. *American Economic Review*, 67(3):297–308.

Egger, P., Loretz, S., Pfaffermayr, M., and Winner, H. (2009). Bilateral effective tax rates and foreign direct investment. *International Tax and Public Finance*, 16(6):822–849.

Egger, P. and Seidel, T. (2013). Corporate taxes and intra-firm trade. *European Economic Review*, 63:225–242.

Elitzur, R. and Mintz, J. (1996). Transfer pricing rules and corporate tax competition. *Journal of Public Economics*, 60(3):401–422.

Fuest, C., Huber, B., and Mintz, J. (2005). Capital mobility and tax competition. *Foundations and Trends in Microeconomics*, 1(1):1–62.

Fujita, M., Krugman, P. R., and Venables, A. J. (1999). *The Spatial Economy.* MIT Press, Cambridge, MA.

Goldbach, S., Nagengast, A. J., Steinmüller, E., and Wamser, G. (2019). The effect of investing abroad on investment at home: On the role of technology, tax savings, and internal capital markets. *Journal of International Economics*, 116:58–73.

Gumpert, A., Hines Jr, J. R., and Schnitzer, M. (2016). Multinational firms and tax havens. *Review of Economics and Statistics*, 98(4):713–727.

Guvenen, F., Mataloni Jr, R. J., Rassier, D. G., and Ruhl, K. J. (2017). Offshore profit shifting and domestic productivity measurement. NBER Working Paper, 23324.

Habu, K. (2017). Centre for business taxation tax database 2017. University of Oxford.

Han, Y., Pieretti, P., Zanaj, S., and Zou, B. (2014). Asymmetric competition among nation states: A differential game approach. *Journal of Public Economics*, 119:71–79.

Han, Y., Pieretti, P., and Zou, B. (2018). Does tax competition increase infrastructural disparity among jurisdictions? *Review of International Economics*, 26(1):20–36.

Hauck, T. (2019). Lobbying and the international fight against tax havens. *Journal of Public Economic Theory*, 21(3):537–557.

Haufler, A. and Runkel, M. (2012). Firms' financial choices and thin capitalization rules under corporate tax competition. *European Economic Review*, 56(6):1087–1103.

Haufler, A. and Schjelderup, G. (2000). Corporate tax systems and cross country profit shifting. *Oxford Economic Papers*, 52(2):306–325.

Haufler, A. and Stähler, F. (2013). Tax competition in a simple model with heterogeneous firms: How larger markets reduce profit taxes. *International Economic Review*, 54(2):665–692.

Head, K. and Ries, J. (2001). Increasing returns versus national product differentiation as an explanation for the pattern of US-Canada trade. *American Economic Review*, 91(4):858–876.

Heckemeyer, J. H. and Overesch, M. (2017). Multinationals' profit response to tax differentials: Effect size and shifting channels. *Canadian Journal of Economics*, 50(4):965–994.

Helpman, E. and Krugman, P. R. (1985). *Market Structure and Foreign Trade.* MIT Press, Cambridge, MA.

Helpman, E., Melitz, M. J., and Yeaple, S. R. (2004). Export versus FDI with heterogeneous firms. *American economic review*, 94(1):300–316.

Hindriks, J. and Nishimura, Y. (2021). Taxing multinationals: The scope for enforcement cooperation. *Journal of Public Economic Theory*, 23(3):487–509.

Horner, R. and Aoyama, Y. (2009). Limits to FDI-driven growth in Ireland: A newspaper content analysis for investment, upgrading and divestment. *Irish Geography*, 42(2):185–205.

Horst, T. (1971). The theory of the multinational firm: Optimal behavior under different tariff and tax rates. *Journal of Political Economy*, 79(5):1059–1072.

Janeba, E. and Osterloh, S. (2013). Tax and the city—A theory of local tax competition. *Journal of Public Economics*, 106:89–100.

Janskỳ, P. and Palanskỳ, M. (2019). Estimating the scale of profit shifting and tax revenue losses related to foreign direct investment. *International Tax and Public Finance*, 26(5):1048–1103.

Johannesen, N. (2010). Imperfect tax competition for profits, asymmetric equilibrium and beneficial tax havens. *Journal of International Economics*, 81(2):253–264.

Juranek, S., Schindler, D., and Schjelderup, G. (2018). Transfer pricing regulation and taxation of royalty payments. *Journal of Public Economic Theory*, 20(1):67–84.

Kato, H. (2015). The importance of government commitment in attracting firms: A dynamic analysis of tax competition in an agglomeration economy. *European Economic Review*, 74(C):57–78.

Kato, H. and Okoshi, H. (2019). Production location of multinational firms under transfer pricing: The impact of the arm's length principle. *International Tax and Public Finance*, 26(4):835–871.

Keen, M. and Konrad, K. A. (2013). The theory of international tax competition and coordination. In Auerbach, A. J., Chetty, R., Feldstein, M., and Saez, E., editors, *Handbook of Public Economics*, volume 5, pages 257–328. Elsevier, Oxford.

Keuschnigg, C. and Devereux, M. P. (2013). The arm's length principle and distortions to multinational firm organization. *Journal of International Economics*, 89(2):432–440.

Kind, H. J., Knarvik, K. H. M., and Schjelderup, G. (2000). Competing for capital in a 'lumpy' world. *Journal of Public Economics*, 78(3):253–274.

Kind, H. J., Midelfart, K. H., and Schjelderup, G. (2005). Corporate tax systems, multinational enterprises, and economic integration. *Journal of International Economics*, 65(2):507–521.

Krautheim, S. and Schmidt-Eisenlohr, T. (2011). Heterogeneous firms, profit shifting of FDI and international tax competition. *Journal of Public Economics*, 95(1):122–133.

Lai, H. and Trefler, D. (2002). The gains from trade with monopolistic competition: Specification, estimation, and mis-specification. NBER Working Paper, 24884.

Langenmayr, D., Haufler, A., and Bauer, C. J. (2015). Should tax policy favor high-or low-productivity firms? *European Economic Review*, 73:18–34.

Ludema, R. D. and Wooton, I. (2000). Economic geography and the fiscal effects of regional integration. *Journal of International Economics*, 52(2):331–357.

Ma, J. and Raimondos, P. (2015). Competition for FDI and profit shifting. CESifo Working Paper Series, 5153.

Martin, P. and Rogers, C. A. (1995). Industrial location and public infrastructure. *Journal of International Economics*, 39(3):335–351.

Matsui, K. (2012). Auditing internal transfer prices in multinationals under monopolistic competition. *International Tax and Public Finance*, 19(6):800–818.

Mayer, T., Méjean, I., and Nefussi, B. (2010). The location of domestic and foreign production affiliates by French multinational firms. *Journal of Urban Economics*, 68(2):115–128.

Mayer, T. and Zignago, S. (2011). Notes on CEPII's distances measures: The GeoDist database. CEPII Working Paper 2011-25.

Navaretti, G. B. and Venables, A. (2004). *Multinational Firms in the World Economy*. Princeton University Press, Princeton, NJ.

Nielsen, S. B., Raimondos-Møller, P., and Schjelderup, G. (2003). Formula apportionment and transfer pricing under oligopolistic competition. *Journal of Public Economic Theory*, 5(2):419–437.

Nielsen, S. B., Raimondos-Møller, P., and Schjelderup, G. (2008). Taxes and decision rights in multinationals. *Journal of Public Economic Theory*, 10(2):245–258.

Novy, D. (2013). Gravity redux: Measuring international trade costs with panel data. *Economic Inquiry*, 51(1):101–121.

OECD (2017). *Tax Administration 2017: Comparative Information on OECD and Other Advanced and Emerging Economies*. OECD, Paris.

Okoshi, H. (2020). *Transfer Pricing: Interaction with Multionationals' Location, Export and R&D Choices*. Ph.D. dissertation submitted to the University of Munich.

Ottaviano, G. I. and van Ypersele, T. (2005). Market size and tax competition. *Journal of International Economics*, 67(1):25–46.

Overesch, M. (2009). The effects of multinationals' profit shifting activities on real investments. *National Tax Journal*, 62(1):5–23.

Peralta, S., Wauthy, X., and van Ypersele, T. (2006). Should countries control international profit shifting? *Journal of International Economics*, 68(1):24–37.

Pflüger, M. (2004). A simple, analytically solvable, Chamberlinian agglomeration model. *Regional Science and Urban Economics*, 34(5):565–573.

Profeta, P. and Scabrosetti, S. (2017). The political economy of taxation in Europe. *Hacienda Pública Española*, 1(220):139–172.

Schjelderup, G. and Sørgard, L. (1997). Transfer pricing as a strategic device for decentralized multinationals. *International Tax and Public Finance*, 4(3):277–290.

Shen, Y. (2018). Corporate income taxation and multinational production. mimeo. Hanyang University.

Slemrod, J. and Wilson, J. D. (2009). Tax competition with parasitic tax havens. *Journal of Public Economics*, 93(11-12):1261–1270.

Stöwhase, S. (2005). Asymmetric capital tax competition with profit shifting. *Journal of Economics*, 85(2):175–196.

Stöwhase, S. (2013). How profit shifting may increase the tax burden of multinationals: A simple model with discrete investment choices. *Journal of Public Economic Theory*, 15(2):185–207.

Swenson, D. L. (2001). Tax reforms and evidence of transfer pricing. *National Tax Journal*, 54(1):7–25.

Tørsløv, T. R., Wier, L. S., and Zucman, G. (2018). The missing profits of nations. mimeo.

Wang, Z. (2020). Multinational production and corporate taxes: A quantitative assessment. *Journal of International Economics*, 126:103353.

Wilson, J. D. (1991). Tax competition with interregional differences in factor endowments. *Regional Science and Urban Economics*, 21(3):423–451.

Yao, J. T. (2013). The arm's length principle, transfer pricing, and location choices. *Journal of Economics and Business*, 65:1–13.

Zhao, L. (2000). Decentralization and transfer pricing under oligopoly. *Southern Economic Journal*, 67(2):414–426.

Ziss, S. (2007). Hierarchies, intra-firm competition and mergers. *International Journal of Industrial Organization*, 25(2):237–260.

Zucman, G. (2014). Taxing across borders: Tracking personal wealth and corporate profits. *Journal of Economic Perspectives*, 28(4):121–48.

Online Appendix to "Economic Integration and Agglomeration of Multinational Production with Transfer Pricing"

Hayato Kato* Hirofumi Okoshi†

January 9, 2022

Contents

*Corresponding author. Graduate School of Economics, Osaka University, 1-7 Machikaneyama, Toyonaka, Osaka, 560-0043, Japan. *E-mail address:* hayato.kato@econ.osaka-u.ac.jp

†Faculty of Economics, Okayama University, 3-1-1 Tsushima, Kita-ku, Okayama, 700-8530, Japan. *E-mail address:* hirofumi.okoshi1@gmail.com

A Derivations

A.1 Optimal transfer price

Here, we derive the optimal transfer price given the allocation of plants. As in the text, we focus on the case where profits are shifted from the high-tax country 1 to the low-tax country 2, i.e., $g_1 < \tau a$ and $g_2 > \tau a$, which is equivalent to assuming $\delta < (t_1 - t_2)/(1 - t_2)$. The post-tax profit of the MNE with a plant in country 1 is

$$
\begin{aligned}
\Pi_1 &= (1-t_1)[(p_{11}-a)q_{11} + (g_1 - \tau a)q_{12} - \delta|g_1 - \tau a|q_{12}] + (1-t_2)(p_{12}-g_1)q_{12} - 2R_1 \\
&= (1-t_1)\left[\left(\frac{p_{11}}{P_1}\right)^{1-\sigma}\frac{\mu L_1}{\sigma} + (1+\delta)(g_1-\tau a)\left(\frac{p_{12}}{P_2}\right)^{-\sigma}\frac{\mu L_2}{P_2}\right] + (1-t_2)\left(\frac{p_{12}}{P_2}\right)^{1-\sigma}\frac{\mu L_2}{\sigma} - 2R_1,
\end{aligned}
$$

$$
\text{where} \quad q_{1j} = \left(\frac{p_{1j}}{P_j}\right)^{-\sigma}\frac{\mu L_j}{P_j}, \quad p_{11} = \frac{\sigma a}{\sigma - 1}, \quad p_{12} = \frac{\sigma g_1}{\sigma - 1}, \qquad j \in \{1, 2\}.
$$

The optimal transfer price is obtained from taking the first derivative with respect to g_1:

$$
\begin{aligned}
\frac{\partial \Pi_1}{\partial g_1} &= (1-t_1)(1+\delta)\left[\left(\frac{\sigma g_1}{\sigma-1}\frac{1}{P_2}\right)^{-\sigma}\frac{\mu L_2}{P_2} - \tau a(-\sigma g_1^{-\sigma-1})\left(\frac{\sigma}{\sigma-1}\frac{1}{P_2}\right)^{-\sigma}\frac{\mu L_2}{P_2}\right] \\
&\quad + (1-t_2)(1-\sigma)g_1^{-\sigma}\left(\frac{\sigma}{\sigma-1}\frac{1}{P_2}\right)^{1-\sigma}\frac{\mu L_2}{\sigma} = 0, \\
\to g_1 &= \frac{(1+\delta)\sigma\tau a}{\sigma - \Delta t_1 + \delta(\sigma-1)}, \\
\text{where} \quad \Delta t_i &\equiv \frac{t_j - t_i}{1 - t_i},
\end{aligned}
$$

and in monopolistic competition individual firms take the price index as given: $\partial P_2/\partial g_1 = 0$. The second-order condition (SOC) for the post-tax profit maximization problem requires

$$
\begin{aligned}
\frac{\partial^2 \Pi_1}{\partial g_1^2} &= g_1^{-\sigma-2}\left(\frac{\sigma}{\sigma-1}\frac{1}{P_2}\right)^{-\sigma}\frac{\sigma\tau a(1+\delta)(1-t_1)\cdot SOC_1}{(\sigma-1)[1-t_2+(1-t_1)(\sigma-1)(1+\delta)]} < 0, \\
\text{where} \quad SOC_1 &\equiv -(1-t_1)^2(\sigma-1)^2\delta - (1-t_2)\sigma^2 + (2t_2 - 3t_1 + 1)\sigma + t_1 - t_2,
\end{aligned}
$$

This inequality holds because SOC_1 is negative, noting that $\delta > 0$; $\sigma > 1$; $t_i \in [0, 1]$; and $t_1 > t_2$.

Similarly, we can derive the optimal transfer price for the MNE with a plant in country 2. Supposing that profits are shifted from high-tax country 1 to low-tax country 2, i.e., $g_2 > \tau a$, the MNE's post-tax profit is

$$\begin{aligned}
\Pi_2 &= (1-t_2)[(p_{22}-a)q_{22} + (g_2-\tau a)q_{21} - \delta|g_2-\tau a|q_{21}] + (1-t_1)(p_{21}-g_2)q_{21} - 2R_2 \\
&= (1-t_2)\left[\left(\frac{p_{22}}{P_2}\right)^{1-\sigma}\frac{\mu L_2}{\sigma} + (1-\delta)(g_2-\tau a)\left(\frac{p_{21}}{P_1}\right)^{-\sigma}\frac{\mu L_2}{P_2}\right] + (1-t_1)\left(\frac{p_{21}}{P_1}\right)^{1-\sigma}\frac{\mu L_1}{\sigma} - 2R_2, \\
\text{where}\ \ q_{2j} &= \left(\frac{p_{2j}}{P_j}\right)^{-\sigma}\frac{\mu L_j}{P_j},\quad p_{22} = \frac{\sigma a}{\sigma-1},\quad p_{21} = \frac{\sigma g_2}{\sigma-1},\qquad j\in\{1,2\}.
\end{aligned}$$

The first-order condition (FOC) is

$$\begin{aligned}
\frac{\partial \Pi_2}{\partial g_2} &= (1-t_1)(1-\delta)\left[\left(\frac{\sigma g_2}{\sigma-1}\frac{1}{P_1}\right)^{-\sigma}\frac{\mu L_1}{P_1} - \tau a(-\sigma g_2^{-\sigma-1})\left(\frac{\sigma}{\sigma-1}\frac{1}{P_1}\right)^{-\sigma}\frac{\mu L_1}{P_1}\right] \\
&\quad + (1-t_1)(1-\sigma)g_2^{-\sigma}\left(\frac{\sigma}{\sigma-1}\frac{1}{P_1}\right)^{1-\sigma}\frac{\mu L_1}{\sigma} = 0, \\
\to g_2 &= \frac{(1-\delta)\sigma\tau a}{\sigma - \Delta t_2 - \delta(\sigma-1)}.
\end{aligned}$$

The SOC requires

$$\begin{aligned}
\frac{\partial^2 \Pi_2}{\partial g_2^2} &= -g_2^{-\sigma-2}\left(\frac{\sigma}{\sigma-1}\frac{1}{P_2}\right)^{-\sigma}\frac{\sigma\tau a(1-\delta)(1-t_1)\cdot SOC_2}{(\sigma-1)[1-t_1+(1-t_2)(\sigma-1)(1-\delta)]} < 0, \\
\text{where}\ \ SOC_2 &\equiv -(1-t_2)^2(\sigma-1)^2\delta + (1-t_1)\sigma^2 + (3t_2-2t_1-1)\sigma + t_1 - t_2.
\end{aligned}$$

The sufficient condition for this inequality is $\delta < 1$, in which case SOC_2 is positive. To be consistent with both the direction of profit shifting and the SOCs, we need to assume

$$\delta < \frac{t_1-t_2}{1-t_2}\ (<1).$$

A.2 Post-tax profit

The post-tax profit of the MNE with a plant in country 1 can be rewritten as

$$\begin{aligned}
\Pi_1 &= (1-t_1)\left[\frac{p_{11}^{1-\sigma}\mu L_1}{\sigma(N_1 p_{11}^{1-\sigma} + N_2 p_{21}^{1-\sigma})} + (1+\delta)\frac{g_1-\tau a}{p_{12}}\frac{p_{12}^{1-\sigma}\mu L_2}{N_1 p_{12}^{1-\sigma} + N_2 p_{22}^{1-\sigma}}\right] \\
&\quad + (1-t_2)\frac{p_{12}^{1-\sigma}\mu L_2}{\sigma(N_1 p_{12}^{1-\sigma} + N_2 p_{22}^{1-\sigma})} - 2R_1 \\
&= (1-t_1)\left[\frac{\mu L_1}{\sigma(N_1 + N_2(p_{21}/p_{11})^{1-\sigma})} + (1+\delta)\frac{g_1-\tau a}{p_{12}}\frac{(p_{12}/p_{22})^{1-\sigma}\mu L_2}{N_1(p_{12}/p_{22})^{1-\sigma} + N_2}\right] \\
&\quad + (1-t_2)\frac{(p_{12}/p_{22})^{1-\sigma}\mu L_2}{\sigma(N_1(p_{12}/p_{22})^{1-\sigma} + N_2)} - 2R_1,
\end{aligned}$$

noting that the price index is reduced to $P_i^{1-\sigma} = N_i p_{ii}^{1-\sigma} + N_j p_{ji}^{1-\sigma}$ because symmetric firms set the same price for each market. We use the results of optimal prices to obtain

$$
\begin{aligned}
&\frac{p_{21}}{p_{11}} = \frac{\sigma g_2}{\sigma - 1}\frac{\sigma - 1}{\sigma a} = \tau \cdot \frac{\sigma(1-\delta)}{\sigma - \Delta t_2 - \delta(\sigma - 1)}, \\
&\to \left(\frac{p_{21}}{p_{11}}\right)^{1-\sigma} = \tau^{1-\sigma} \cdot \left(\frac{\sigma(1-\delta)}{\sigma - \Delta t_2 - \delta(\sigma - 1)}\right)^{1-\sigma} = \phi \cdot \gamma_2, \\
&\frac{p_{12}}{p_{22}} = \frac{\sigma g_1}{\sigma - 1}\frac{\sigma - 1}{\sigma a} = \tau \cdot \frac{\sigma(1+\delta)}{\sigma - \Delta t_1 + \delta(\sigma - 1)}, \\
&\to \left(\frac{p_{12}}{p_{22}}\right)^{1-\sigma} = \tau^{1-\sigma} \cdot \left(\frac{\sigma(1+\delta)}{\sigma - \Delta t_1 + \delta(\sigma - 1)}\right)^{1-\sigma} = \phi \cdot \gamma_1, \\
&\frac{g_1 - \tau a}{p_{12}} = \frac{\sigma - 1}{\sigma^2}\frac{\Delta t_1 + \delta}{1 + \delta}, \\
&\text{where} \quad \phi \equiv \tau^{1-\sigma}, \quad \gamma_1 \equiv \left(\frac{\sigma(1+\delta)}{\sigma - \Delta t_1 + \delta(\sigma - 1)}\right)^{1-\sigma}, \quad \gamma_2 \equiv \left(\frac{\sigma(1-\delta)}{\sigma - \Delta t_2 - \delta(\sigma - 1)}\right)^{1-\sigma}.
\end{aligned}
$$

We substitute these results into the above to obtain

$$
\begin{aligned}
\Pi_1 =& (1 - t_1)\left[\frac{\mu L_1}{\sigma(N_1 + \phi\gamma_2 N_2)} + \frac{(\sigma - 1)(\Delta t_1 + \delta)}{\sigma}\frac{\phi\gamma_1\mu L_2}{\sigma(\phi\gamma_1 N_1 + N_2)}\right] \\
&+ (1 - t_2)\frac{\phi\gamma_1\mu L_2}{\sigma(\phi\gamma_1 N_1 + N_2)} - 2R_1,
\end{aligned}
$$

which is Eq. (5.1) in the text. The post-tax profit of the MNE with a plant in country 2 can be derived analogously.

For later reference, we provide a first-order Taylor approximation of γ_i at $\Delta t_i = 0$:

$$\gamma_i \simeq 1 - \frac{\sigma - 1}{\sigma}\Delta t_i. \tag{A1}$$

The approximations are justified when $\Delta t_i = (t_j - t_i)/(1 - t_i)$ is sufficiently small. With respect to our sample of 23 OECD countries from 2008 to 2016, this is plausible because |average tax differential| / [1−(average tax rate)] = 0.077/(1 − 0.2747) = 0.1061.

B Conditions for positive profits

Here, we derive sufficient conditions under which operating profits are positive. The operating profits are π_{11}, π_{12}, π_{21}, and π_{22}. Only π_{11} can be negative:

$$
\begin{aligned}
\pi_{11} &= \frac{\mu L_1}{\sigma(N_1 + \phi\gamma_2 N_2)} + \underbrace{\frac{(\sigma-1)(\Delta t_1 + \delta)}{\sigma}}_{<0} \frac{\phi\gamma_1 \mu L_2}{\sigma(\phi\gamma_1 N_1 + N_2)} \\
&= \frac{\mu/2}{\sigma(n_1 + \phi\gamma_2 n_2)} + \underbrace{\frac{(\sigma-1)(\Delta t_1 + \delta)}{\sigma}}_{<0} \frac{\phi\gamma_1 \mu/2}{\sigma(\phi\gamma_1 n_1 + n_2)},
\end{aligned}
$$

where $L_1 = L_2 = L/2$; $N_i = n_i L$; and $n_2 = 1 - n_1$. Note that $\Delta t_1 + \delta < 0$, or equivalently, $\delta < (t_1 - t_2)/(1 - t_1)$ because we assume $\delta < \overline{\delta} \leq (t_1 - t_2)/(1 - t_2) < (t_1 - t_2)/(1 - t_1)$. We can check that π_{11} decreases with n_1:

$$
\frac{\partial \pi_{11}}{\partial \phi} = -\frac{\mu\gamma_2 n_2}{2\sigma(n_1 + \phi\gamma_2 n_2)^2} - \frac{\mu\gamma_1 n_2(\sigma-1)[t_1 - t_2 - \delta(1-t_1)]}{2\sigma^2(1-t_1)(\phi\gamma_1 n_1 + n_2)^2} < 0,
$$

where $\sigma > 1$ and $\delta < \overline{\delta} \leq (t_1 - t_2)/(1 - t_2) < (t_1 - t_2)/(1 - t_1)$. Since π_{11} takes the minimum value at $\phi = 1$, in which case n_1 must be one according to Proposition 1, the sufficient condition for it to be positive is

$$
\begin{aligned}
\pi_{11} &\geq \min_{\phi} \pi_{11} = \pi_{11}|_{(n_1,\phi)=(1,1)} \\
&\simeq \frac{\mu[\sigma(1 + t_2 - 2t_1) + t_1 - t_2 + \delta(\sigma-1)(1-t_1)]}{2\sigma^2(1-t_1)} \\
&\geq \frac{\mu[\sigma(1 + t_2 - 2t_1) + t_1 - t_2]}{2\sigma^2(1-t_1)} > 0, \\
&\to 1 + t_2 - 2t_1 > 0,
\end{aligned}
$$

where we used the Taylor approximation (A1). The sufficient condition for this inequality is $(t_2 <)t_1 < 1/2$, which is close to 0.4076, i.e., the highest corporate tax rate in 23 OECD countries in 2010 to 2016 (from 2010 to 2012 in Japan).

C Proof of Proposition 1

C.1 Proof of Propositions 1(i) and 1(ii)

The zero-profit conditions for both type of multinationals requires

$$
\begin{aligned}
&\Pi_1 = (1-t_1)\pi_{11} + (1-t_2)\pi_{12} - 2R_1 = 0,\\
&\to R_1 = [(1-t_1)\pi_{11} + (1-t_2)\pi_{12}]/2,\\
&\Pi_2 = (1-t_1)\pi_{21} + (1-t_2)\pi_{22} - 2R_2 = 0,\\
&\to R_2 = [(1-t_1)\pi_{21} + (1-t_2)\pi_{22}]/2.
\end{aligned}
$$

The capital-return differential is

$$
\begin{aligned}
\Delta R &\equiv 2(R_1 - R_2)\\
&= \frac{\mu s_1}{\sigma^2}\cdot\frac{\sigma(1-t_1)(1-\phi\gamma_2) - \phi\gamma_2(\sigma-1)[t_1 - t_2 - \delta(1-t_2)]}{n_1 + \phi\gamma_2 n_2}\\
&\qquad - \frac{\mu s_2}{\sigma^2}\cdot\frac{\sigma(1-t_2)(1-\phi\gamma_1) - \phi\gamma_1(\sigma-1)[t_2 - t_1 + \delta(1-t_1)]}{\phi\gamma_1 n_1 + n_2}. \quad \text{(A2)}
\end{aligned}
$$

$$
\begin{aligned}
&\text{where}\quad \phi \equiv \tau^{1-\sigma},\quad \Delta t_i \equiv \frac{t_j - t_i}{1-t_i},\qquad \text{for } i \neq j \in \{1,2\},\\
&\gamma_1 \equiv \left(\frac{\sigma(1+\delta)}{\sigma - \Delta t_1 + \delta(\sigma-1)}\right)^{1-\sigma},\qquad \gamma_2 \equiv \left(\frac{\sigma(1-\delta)}{\sigma - \Delta t_2 - \delta(\sigma-1)}\right)^{1-\sigma}.
\end{aligned}
$$

We here show that there exists a level of trade openness, denoted by $\phi^\dagger$, which satisfies $\Delta R|_{n_1=1/2} = 0$ and that the long-run equilibrium becomes $n_1 < 1/2$ (or $n_1 > 1/2$) if $\phi < \phi^\dagger$ (or $\phi > \phi^\dagger$).

Assuming symmetric country size: $s_1 = 1/2$, we evaluate the capital-return differential at $n_1 = 1/2$:

$$
\Delta R|_{n_1=1/2} = \frac{\mu\cdot F(\phi)}{\sigma^2(1+\phi\gamma_1)(1+\phi\gamma_2)},
$$

where

$$
\begin{aligned}
F(\phi) \equiv\ &\gamma_1\gamma_2[(2-\sigma)(t_1-t_2) + \delta(\sigma-1)(2-t_1-t_2)]\phi^2\\
&+ [2\sigma\{\gamma_1(1-t_1) - \gamma_2(1-t_2)\} + (\gamma_1+\gamma_2)(t_1-t_2) + \delta(\sigma-1)\{\gamma_1(1-t_1) + \gamma_2(1-t_2)\}]\phi\\
&-\sigma(t_1-t_2),
\end{aligned}
$$

The sign of the capital-return differential is determined by the quadratic function of ϕ: $F(\phi)$. At the level of ϕ that satisfies $F(\phi) = 0$, the equilibrium distribution of plants becomes one-half.

We readily observe that (i)$F(\phi)$ is a quadratic function of ϕ and (ii)$F(\phi = 0) = -\sigma(t_1 - t_2) < 0$. When $\delta = 0$, we can also confirm (iii)$F(\phi = 1) > 0$:

$$F(\phi = 1) \simeq \frac{2(\sigma - 1)(t_1 - t_2)^3}{\sigma^2(1 - t_1)(1 - t_2)} > 0,$$

where we used the Taylor approximation (A1).

The above argument rests on the assumption that the tax difference is so small ($t_1 - t_2 \simeq 0$) that applying a Taylor approximation to γ_i is justified. Relying on numerical calculation, we extensively check whether $F(\phi = 1) > 0$ (when $\delta = 0$) holds in Figure A1. Each panel in Figure A1 shows the value of $F(\phi = 1)$ for different levels of $\sigma \in [1, 30]$ for the given taxes. Note that we assume $t_2 < t_1$ and $t_1 < 1/2$ to ensure positive pre-tax profits. The range of σ to be checked is broad enough to include its empirical estimates reported by Lai and Trefler (2002) and Broda and Weinstein (2006). The tax difference is greater as the panel moves from left to right. The absolute tax level is lower as the panel moves from top to bottom. All panels show $F(\phi = 1) > 0$ for $\sigma \in [1, 30]$, confirming the generality of our analytical results around $t_1 - t_2 \simeq 0$.

These three observations show that there exists $\phi^\dagger \in (0, 1)$ that satisfies $F(\phi) = 0$ (or equivalently $\Delta R|_{n_1=1/2} = 0$), as observable in Figure A2. Regardless of the sign of the coefficient of ϕ^2, $F(\phi)$ has a unique solution in $\phi \in (0, 1)$. In addition, if $\phi < \phi^\dagger$, $F(\phi) < 0$ and thus $\Delta R|_{n_1=1/2} < 0$ hold, implying that MNEs with production in country 1 have an incentive to relocate. Thus, the long-run equilibrium must be $n_1 < 1/2$. Similarly, if $\phi > \phi^\dagger$ holds, we have $F(\phi) > 0$ and thus $\Delta R|_{n_1=1/2} > 0$. The positive return differential at $n_1 = 1/2$ requires that the long-run equilibrium be $n_1 > 1/2$. These findings establish Propositions 1(i) and 1(ii).

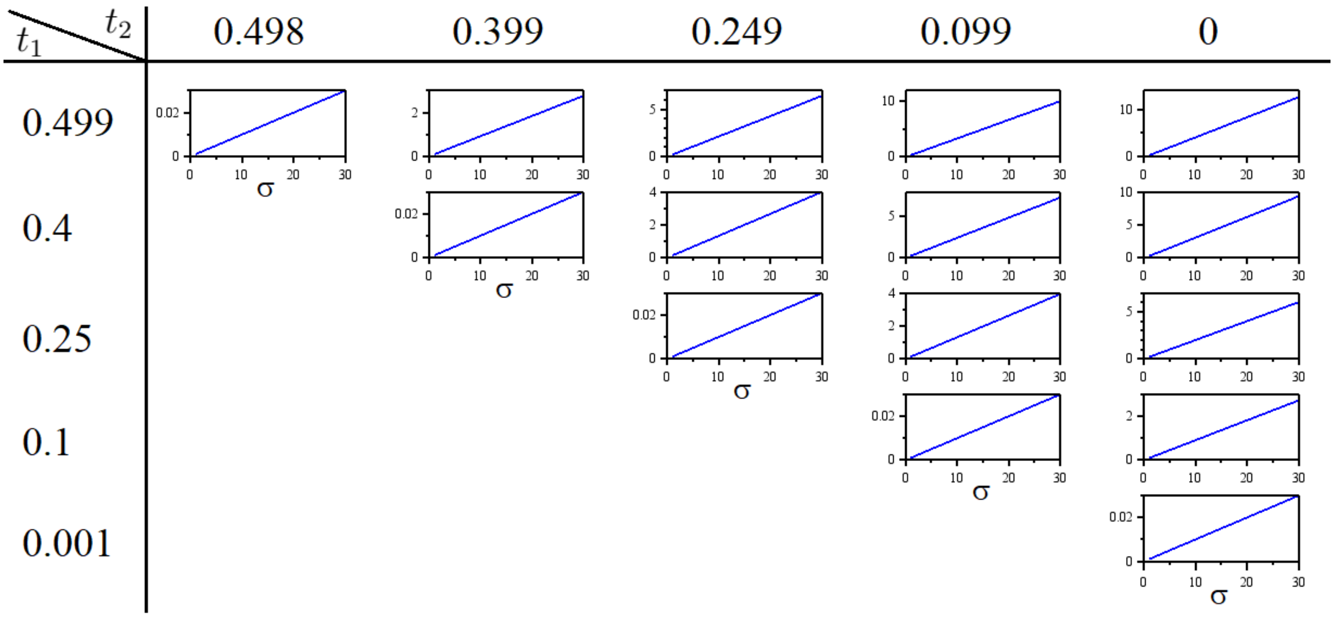

Figure A1. Function $F(\phi = 1)$ for different levels of $\sigma \in [1, 30]$

(a) (coefficient of ϕ^2) > 0 (b) (coefficient of ϕ^2) < 0

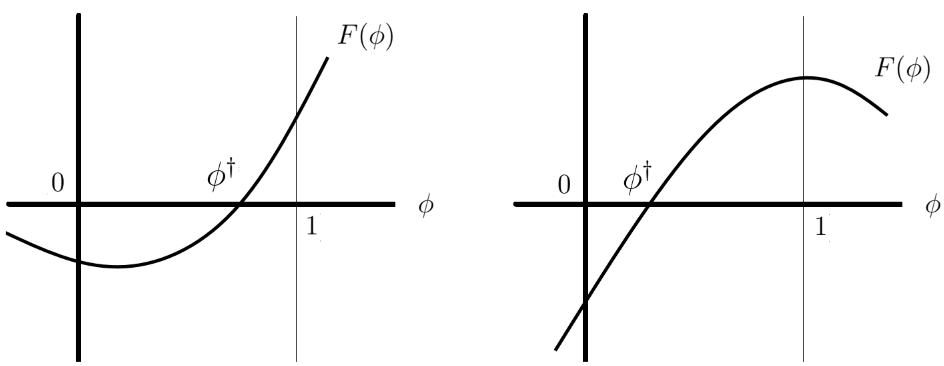

Figure A2. Existence of $\phi^\dagger$ at which $F(\phi^\dagger) = 0$

C.2 Proof of Proposition 1(iii)

The proof follows the following two steps. First, we confirm that all MNEs prefer to locate their production plant in the high-tax country 1 under completely free trade. That is, capital-return differential ΔR is positive irrespective of the plant share n_1 at $\phi = 1$. In the second step, we show that there exists a level of trade openness above which full agglomeration is achieved, which we call the agglomeration threshold ϕ^S, or also known as the sustain point.

Step I: Full agglomeration at $\phi = 1$. We set δ to zero and evaluate the capital-return differential (A2) at $\phi = 1$ to obtain

$$\Delta R|_{\phi=1} = \underbrace{\frac{\mu(t_2 - t_1)(\sigma - 1)}{2\sigma^2}}_{<0} \left(\frac{\omega_1}{\gamma_1 n_1 + n_2} + \frac{\omega_2}{n_1 + \gamma_2 n_2} \right),$$

$$\text{where } \omega_i \equiv \gamma_i + \frac{\sigma(1 - \gamma_i)}{(\sigma - 1)\Delta t_j}, \qquad \text{for } i \neq j \in \{1, 2\},$$

noting that $\Delta t_1 < 0 < \Delta t_2$ and $\gamma_2 < 1 < \gamma_1$. The capital-return differential is positive (or negative) if the big bracket term is negative (or positive). We check that the big bracket term is indeed negative. The condition for this is

$$\begin{aligned}
&\frac{\omega_1}{\gamma_1 n_1 + n_2} + \frac{\omega_2}{n_1 + \gamma_2 n_2} < 0, \\
&\to \omega_1(n_1 + \gamma_2 n_2) + \omega_2(\gamma_1 n_1 + n_2) < 0, \\
&\to n_1 \underbrace{[\omega_1(1 - \gamma_2) + \omega_2(\gamma_1 - 1)]}_{>0} + \omega_1\gamma_2 + \omega_2 < 0,
\end{aligned}$$

noting that $n_2 = 1 - n_1$ and $\gamma_2 < 1 < \gamma_1$. The inequality holds for any $n_1 \in [0, 1]$ if the following holds:

$$\begin{aligned}
&n_1[\omega_1(1 - \gamma_2) + \omega_2(\gamma_1 - 1)] + \omega_1\gamma_2 + \omega_2 \\
&\leq 1 \cdot [\omega_1(1 - \gamma_2) + \omega_2(\gamma_1 - 1)] + \omega_1\gamma_2 + \omega_2 \\
&= \omega_1 + \omega_2\gamma_1 < 0.
\end{aligned}$$

Using the Taylor approximation (A1), we can confirm that the inequality holds:

$$\omega_1 + \omega_2\gamma_1 \simeq -\frac{(t_1 - t_2)^2}{2\sigma^2(1 - t_1)(1 - t_2)} < 0.$$

The above argument rests on the assumption that the tax difference is so small ($t_1 - t_2 \simeq 0$) that applying a Taylor approximation to γ_i is justified. As shown in Figure A1, we provide an extensive numerical check for whether $\omega_1 + \omega_2\gamma_1 < 0$ holds in Figure A3. All panels show $\omega_1 + \omega_2\gamma_1 < 0$ for $\sigma \in [1, 30]$, confirming the generality of our analytical results around $t_1 - t_2 \simeq 0$.

Hence, it holds that $\Delta R|_{\phi=1} > 0$ for any $n_1 \in [0, 1]$. All MNEs are willing to establish production plants in the high-tax country 1; that is, $n_1|_{\phi=1} = 1$ is achieved in the long-run equilibrium.

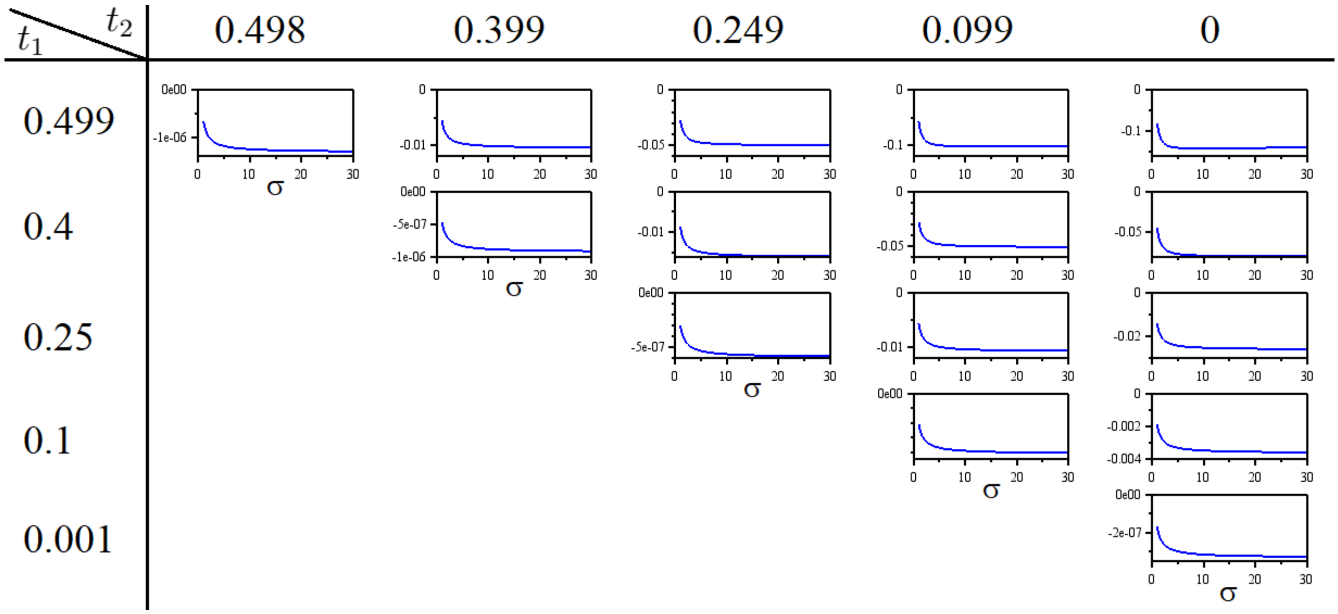

Figure A3. Function $\omega_1 + \omega_2\gamma_1$ for different levels of $\sigma \in [1, 30]$

Step II: Agglomeration threshold (or sustain point). Evaluating the capital-return differential (A2) at $n_1 = 1$ gives

$$\Delta R|_{n_1=1} = \frac{\mu \cdot I(\phi)}{2\sigma^2\phi\gamma_1},$$
$$\text{where} \quad I(\phi) \equiv -\gamma_1\gamma_2(1-t_2)(\sigma - \Delta t_2)\phi^2 + \gamma_1(1-t_1)(2\sigma - \Delta t_1)\phi - \sigma(1-t_2).$$

Since the denominator is positive, the sign of the profit differential is determined by $I(\phi)$. Solving $I(\phi) = 0$ for $\phi \in [0, 1]$ gives the agglomeration threshold ϕ^S (if any).

We observe that $I(\phi)$ is a quadratic function of ϕ. Further inspections reveal that

$$I(\phi = 0) = -\sigma(1-t_2) < 0,$$
$$I(\phi = 1) = \sigma[2\gamma_1(1-t_1) - (1+\gamma_1\gamma_2)(1-t_2)] + \gamma_1(1+\gamma_2)(t_1 - t_2) > 0,$$

noting that $2\gamma_1(1-t_1) - (1+\gamma_1\gamma_2)(1-t_2) > 2\gamma_1(1-t_1) - (1+\gamma_1)(1-t_2) = (\gamma_1 - 1)(1-t_1) > 0$ holds because $\gamma_2 < 1 < \gamma_1$.

These observations imply: (i) the agglomeration threshold $\phi^S \in (0, 1)$ always exists and is given by a root of $I(\phi) = 0$ and (ii) $I(\phi)$ or the capital-return differential is negative for $\phi \in [0, \phi^S)$ but positive for $\phi \in (\phi^S, 1]$.

D Proof of Proposition 2

Here, we show that as economic integration proceeds, the equilibrium share of production plants in country 1 first decreases and then increases. We also discuss the possibility that full production agglomeration in country 2 occurs.

By solving the capital-return differential (A2) for n_1, we obtain

$$n_1^O = \frac{\Upsilon - \phi\gamma_2\Upsilon'}{(1-\phi\gamma_1)\Upsilon + (1-\phi\gamma_2)\Upsilon'}, \tag{A3}$$
$$\text{where } \Upsilon \equiv (\sigma - \phi\gamma_2)(1-t_1) - \phi\gamma_2(1-\delta)(\sigma-1)(1-t_2),$$
$$\Upsilon' \equiv (\sigma - \phi\gamma_1)(1-t_2) - \phi\gamma_1(1+\delta)(\sigma-1)(1-t_1).$$

We differentiate this with respect to ϕ:

$$\frac{dn_1^O}{d\phi} = \frac{G(\phi)}{H(\phi)^2},$$

where

$$G(\phi) \equiv G_2\phi^2 + G_1\phi + G_0, \quad G_i\text{s are bundles of parameters of } \gamma_i,\ t_i,\ \sigma \text{ and } \delta,$$
$$\begin{aligned} H(\phi) \equiv\ & \gamma_1\gamma_2[\sigma(t_1+t_2-2) - \delta(\sigma-1)(t_1-t_2)]\phi^2 \\ & +[2\sigma\{\gamma_1(1-t_1)+\gamma_2(1-t_2)\} + (\gamma_1-\gamma_2)(t_1-t_2) + \delta(\sigma-1)\{\gamma_1(1-t_1)-\gamma_2(1-t_2)\}]\phi \\ & -\sigma(2-t_1-t_2). \end{aligned}$$

Because $H(\phi)^2 > 0$, the sign of the derivative, $dn_1/d\phi$, is determined by $G(\phi)$. Hereafter, we assume $\delta = 0$

We note that (i) the numerator is a quadratic function of ϕ and that (ii) $H(\phi) > 0$ for any $\phi \in [0,1]$. Furthermore, we can verify that (iii) the slope is negative at $\phi = 0$:

$$\begin{aligned} G(\phi = 0) = G_0 &= 2\sigma^2[\gamma_1(1-t_1)^2 - \gamma_2(1-t_2)^2] + \sigma(t_1-t_2)[\gamma_1(1-t_1)+\gamma_2(1-t_2)] \\ &\simeq -\sigma(t_1-t_2)(2-t_1-t_2) < 0, \end{aligned}$$

where we used the Taylor approximation (A1). We then solve for $\phi^{\#}$ that satisfies $dn_1/d\phi = 0$, that is, the smaller root of $G(\phi) = 0$:

$$\phi^{\#} \simeq \frac{\sigma^2}{(\sigma - \Delta t_1)(\sigma - \Delta t_2)}, \tag{A4}$$

where we used the Taylor approximation (A1). We can easily confirm that $\phi^{\#} \in (0,1)$. In addition, a close inspection of $\phi^{\#}$ reveals

$$\frac{d\phi^{\#}}{dt_1} = \frac{\sigma(\sigma-1)(1-t_2)(2-t_1-t_2)(t_2-t_1)}{[(\sigma-1)(t_1-t_2)^2+\sigma(1-t_1)(1-t_2)]^2} < 0,$$
$$\frac{d\phi^{\#}}{dt_2} = \frac{\sigma(\sigma-1)(1-t_2)(2-t_1-t_2)(t_1-t_2)}{[(\sigma-1)(t_1-t_2)^2+\sigma(1-t_1)(1-t_2)]^2} > 0.$$

implying that ϕ^S also decreases (or increases) with t_1 (or t_2). Asn_1 is continuous in ϕ, a higher $\phi^{\#}$ makes ϕ^S higher. As a greater tax difference due to an increase in t_1 (or a decrease in t_2) reduces $\phi^{\#}$, and thus, ϕ^S, multinational production is more likely to be agglomerated in the high-tax country 1.

The above argument rests on the assumption that the tax difference is so small ($t_1 - t_2 \simeq 0$) that applying a Taylor approximation to γ_i is justified. As in Figure A1 in Online Appendix C, we provide an extensive numerical check for whether $G_0 < 0$ holds in Figure A4 and whether $\phi^{\#}$ lies in $(0, 1)$ in Figure A5. All panels in Figure A4 show $G_0 < 0$ for $\sigma \in [1, 20]$ except when the tax difference is quite large: $(t_1, t_2) = (0.49, 0.099), (0.49, 0), (0.4, 0)$. Even in the exceptional cases, $G_0 < 0$ holds for the range of $\sigma \in [1, 9.5]$, which covers the representative estimates of σ reported in Lai and Trefler (2002); and Broda and Weinstein (2006). All panels in Figure A5 show $\phi^{\#} \in (0, 1)$ for $\sigma \in [1, 30]$, noting that in the diagonal panels $\phi^{\#}$ is not accurately computed due to near zero tax difference.[1] From left to right, Figure A5 shows that σ fixed, $\phi^{\#}$ decreases as the tax difference is larger. An enlarged view in Figure A6 further confirms this. These numerical results confirm the generality of our analytical results at around $t_1 - t_2 \simeq 0$.

[1] When enlarging the view of the diagonal panels, $\phi^{\#}$ decreases with σ while fluctuating a lot.

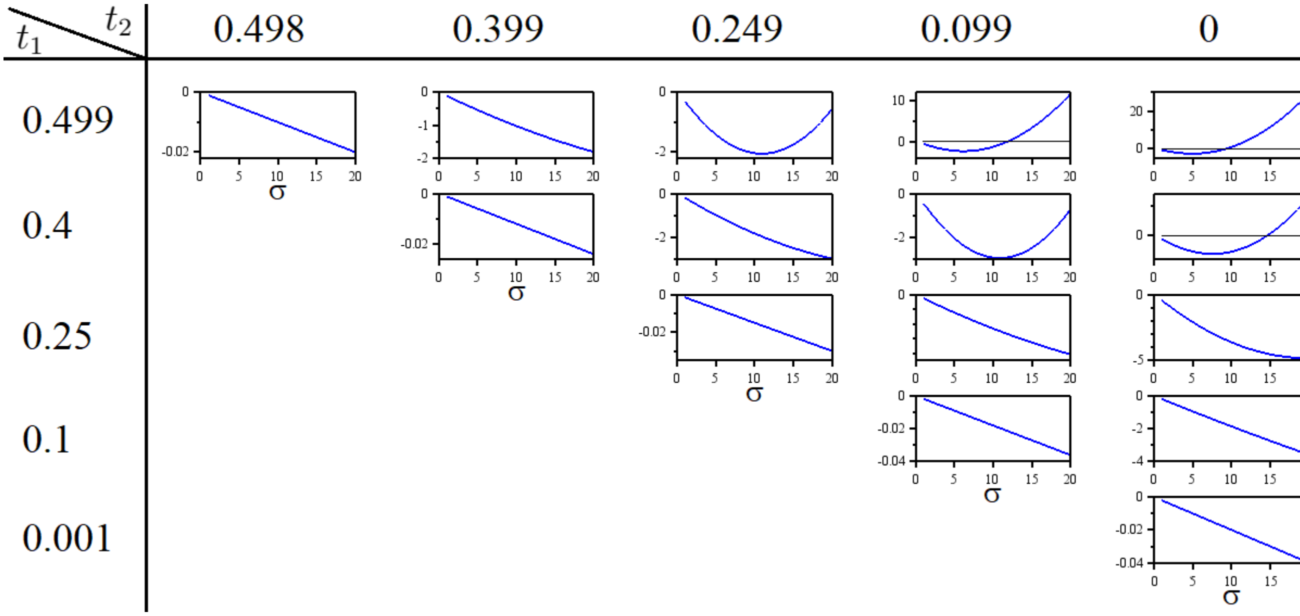

Figure A4. Function G_0 for different levels of $\sigma \in [1, 20]$

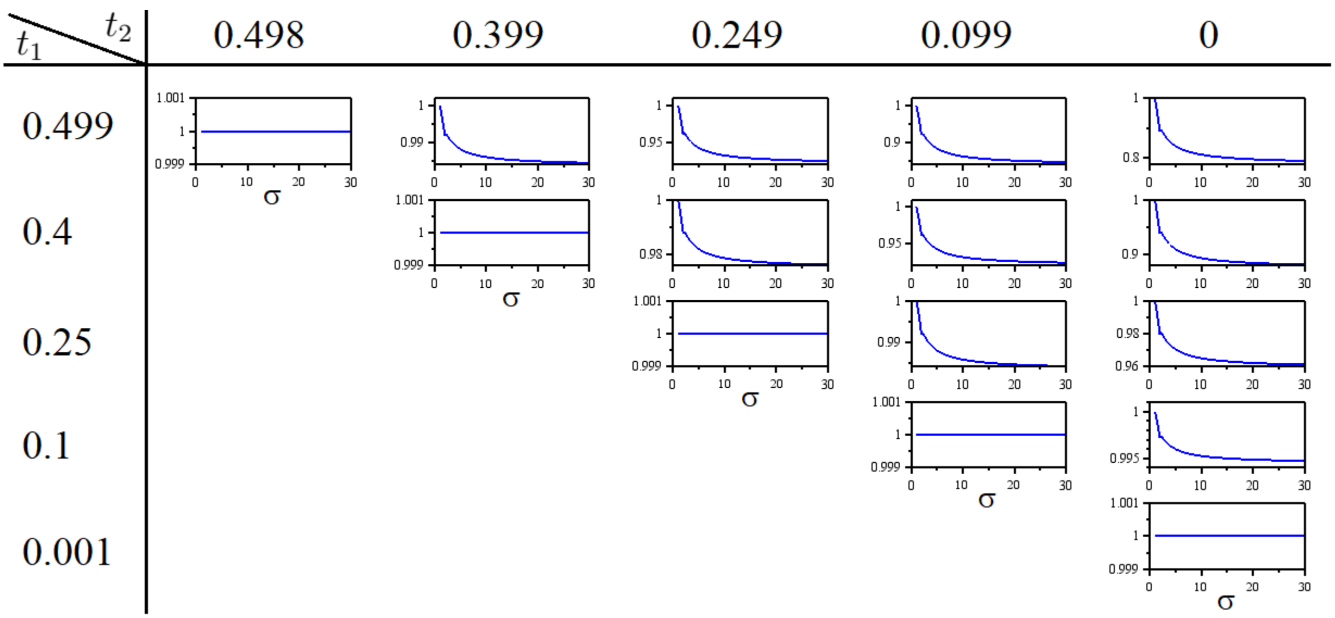

Figure A5. Turning point $\phi^{\#}$ for different levels of $\sigma \in [1, 30]$

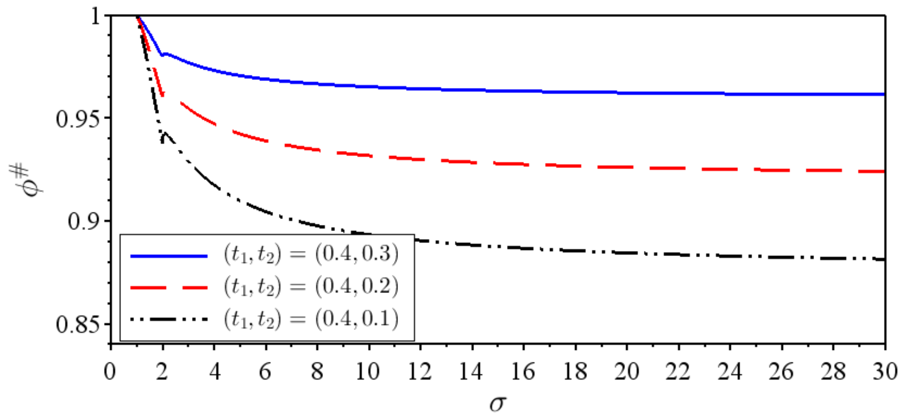

Figure A6. Effect of tax difference on turning point $\phi^{\#}$

We know from Proposition 1 that if $\delta = 0$, country 1 achieves full agglomeration with sufficiently high trade openness such that $\phi \in [\phi^S, 1]$, in which case the slope becomes zero: $dn_1/d\phi = 0$. Combining this with observations (i) to (iii) and assuming $n_1^O > 0$, we can summarize the equilibrium plant share n_1 and its derivative $dn_1/d\phi$ as follows:

$$n_1 = \begin{cases} n_1^O \in (0,1) & \text{if } \ \phi \in [0, \phi^S) \\ 1 & \text{if } \ \phi \in [\phi^S, 1] \end{cases},$$

$$\frac{dn_1}{d\phi} \begin{cases} < 0 & \text{if } \ \phi \in [0, \phi^{\#}) \\ = 0 & \text{if } \ \phi = \phi^{\#} \\ > 0 & \text{if } \ \phi \in (\phi^{\#}, \phi^S) \\ = 0 & \text{if } \ \phi \in [\phi^S, 1] \end{cases},$$

where n_1^O is defined in Eq. (A3) and ϕ^S is the agglomeration threshold.

Possibility of full agglomeration in the low-tax country 2. The plant share n_1^O defined in Eq. (A3), may take negative values, in which case the equilibrium plant share must be zero: $n_1 = 0$. Numerical calculations suggest that this is likely when the elasticity of substitution σ is low (Figure A7(a)) and the tax difference is low (Figure A7(b)). For example, as shown in Figure A7(a), a lower σ shifts n_1 downward. When $\sigma = 3$, n_1^O takes negative values for around between $\phi = 0.96$ and $\phi = 0.99$, so that n_1 becomes zero there. Even when $n_1 = 0$ occurs, our result of the non-monotonic effect of ϕ on n_1 is unchanged because the proofs of Propositions 1 and 2 do not depend on whether n_1 equals zero (see also Online Appendix C).

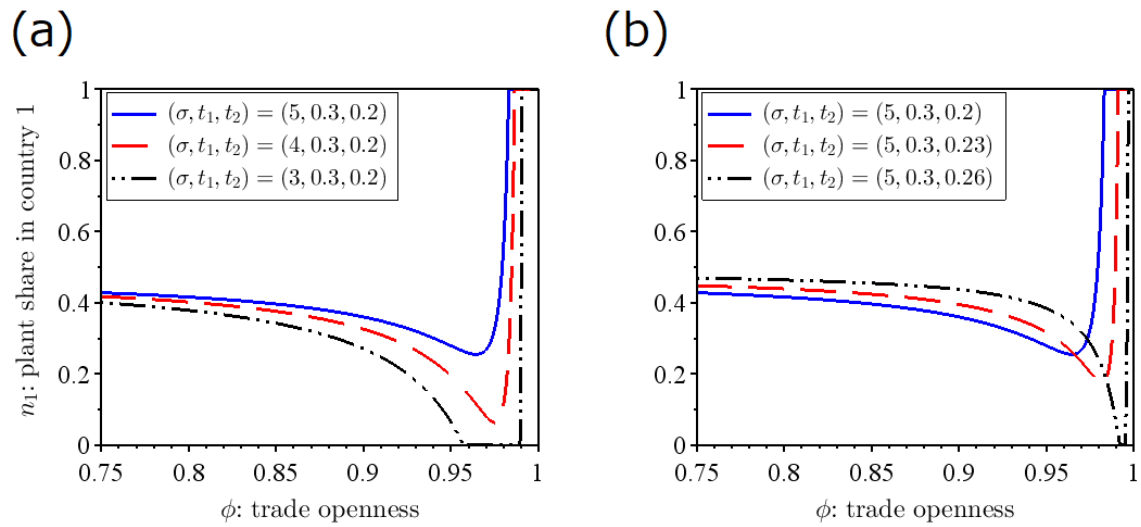

Figure A7. Possibility of full production agglomeration in country 2

Notes: Parameter values other than those in the panels are $\delta = 0$; $s_1 = 0.5$.

E Tax revenues

The tax base in country 1, denoted by TB_1, consists of the profits of both home production plants and foreign distribution affiliates. Using Eqs. (6-1) and (6-2), we can rewrite TB_1 as

$$
\begin{aligned}
TB_1 &= \underbrace{N_1\pi_{11}}_{\text{Profits of home plants}} + \underbrace{N_2\pi_{21}}_{\text{Profits of foreign affiliates}} \\
&= \Big[\underbrace{N_1(p_{11} - a)q_{11}}_{\text{Domestic profits of home plants}} + \underbrace{N_1(1+\delta)(g_1 - \tau a)q_{12}}_{\text{Shifted profits of home plants (net of concealment cost) } <0} \Big] \\
&\quad + \Big[\underbrace{N_2(p_{21} - \tau a)q_{21}}_{\text{Domestic profits of foreign affiliates}} + \underbrace{N_2(\tau a - g_2)q_{21}}_{\text{Shifted profits of foreign affiliates } <0} \Big] \\
&= \left[N_1 \frac{\mu L_1}{\sigma(N_1 + \phi\gamma_2 N_2)} + N_1 \frac{(\sigma-1)(\Delta t_1 + \delta)}{\sigma} \frac{\phi\gamma_1\mu L_2}{\sigma(\phi\gamma_1 N_1 + N_2)} \right] \\
&\quad + \left[N_2 \frac{\phi\gamma_2\mu L_1}{\sigma(N_1 + \phi\gamma_2 N_2)} \left\{ 1 + \frac{(\sigma-1)(\Delta t_2 - \delta)}{\sigma(1-\delta)} \right\} - N_2 \frac{(\sigma-1)(\Delta t_2 - \delta)}{\sigma(1-\delta)} \frac{\phi\gamma_2\mu L_1}{\sigma(N_1 + \phi\gamma_2 N_2)} \right] \\
&= \frac{\mu L}{2\sigma} + \underbrace{N_1 \frac{(\sigma-1)(\Delta t_1 + \delta)}{\sigma} \frac{\phi\gamma_1\mu L}{2\sigma(\phi\gamma_1 N_1 + N_2)}}_{\text{Shifted profits of home plants (net of concealment cost) } <0},
\end{aligned}
$$

where $L_1 = L_2 = L/2$; $\Delta t_1 + \delta < 0$; and $\Delta t_2 - \delta > 0$. Then, tax revenues are given by $TR_1 \equiv t_1 \cdot TB_1$. The first term of the last line, $\mu L/(2\sigma)$, is the total profits made in country

1 and turns out to be the tax base in the no-transfer-pricing case. The constant first term corresponds to the tax base in the case without transfer pricing (see Section 5.1 for more details). The second negative term of the last line, the shifted profits of home plants, clearly shows that introducing transfer pricing always reduces tax revenues in country 1.

As shown in the second and third lines, there are two types of shifted profits: one by the plants of MNEs headquartered in country 1 (i.e., home plants) and the other by the affiliates of MNEs headquartered in country 2 (i.e., foreign affiliates). However, the shifted profits of foreign affiliates do not explicitly appear in the last line. This is because the lost tax base is compensated by an increase in domestic profits of home plants and is implicitly included in the first term of the last line: $\mu L/(2\sigma)$. Specifically, foreign affiliates in the high-tax country 1 pay a high input/transfer price g_2 to move profits to their plants in the low-tax country 2. They pass on the high input price to the selling price p_{21}, raising the price index (higher $P_1 = (\sum_{i=1}^{2} N_i p_{i1}^{1-\sigma})^{\frac{1}{1-\sigma}}$), and thus, the demand for all varieties in country 1 (larger $q_{i1} = p_{i1}^{-\sigma} P_1^{\sigma-1} \mu L_1$). Home plants increase their domestic profits such that the loss from profit shifting is cancelled out.

Similarly, the tax base in country 2 is

$$\begin{aligned}
TB_2 = {} & \underbrace{N_2 \pi_{22}}_{\text{Profits of home plants}} + \underbrace{N_1 \pi_{12}}_{\text{Profits of foreign affiliates}} \\
= {} & \Big[\underbrace{N_2 (p_{22} - a) q_{22}}_{\text{Domestic profits of home plants}} + \underbrace{N_2 (1-\delta)(g_2 - \tau a) q_{21}}_{\text{Shifted profits of home plants (net of concealment cost) } >0} \Big] \\
& + \Big[\underbrace{N_1 (p_{12} - \tau a) q_{12}}_{\text{Domestic profits of foreign affiliates}} + \underbrace{N_1 (\tau a - g_1) q_{12}}_{\text{Shifted profits of foreign affiliates } >0} \Big] \\
= {} & \left[N_2 \frac{\mu L_2}{\sigma(\phi\gamma_1 N_1 + N_2)} + N_2 \frac{(\sigma-1)(\Delta t_2 - \delta)}{\sigma} \frac{\phi\gamma_2 \mu L_1}{\sigma(N_1 + \phi\gamma_2 N_2)} \right] \\
& + \left[N_1 \frac{\phi\gamma_1 \mu L_2}{\sigma(\phi\gamma_1 N_1 + N_2)} \left\{ 1 + \frac{(\sigma-1)(\Delta t_1 + \delta)}{\sigma(1+\delta)} \right\} - N_1 \frac{(\sigma-1)(\Delta t_1 + \delta)}{\sigma(1+\delta)} \frac{\phi\gamma_1 \mu L_2}{\sigma(\phi\gamma_1 N_1 + N_2)} \right] \\
= {} & \frac{\mu L}{2\sigma} + \underbrace{N_2 \frac{(\sigma-1)(\Delta t_2 - \delta)}{\sigma} \frac{\phi\gamma_2 \mu L}{2\sigma(N_1 + \phi\gamma_2 N_2)}}_{\text{Shifted profits of home plants (net of concealment cost) } >0},
\end{aligned}$$

noting that $\Delta t_2 - \delta > 0$. Due to the inflow of profits made in the high-tax country 1 (i.e., the second positive term of the last line), tax revenues, defined by $TR_2 \equiv t_2 \cdot TB_2$, are higher in the transfer-pricing case than in the no-transfer-pricing case, except when $\phi = 0$. As in the case of TB_1, the shifted profits of foreign affiliates do not explicitly enter the last line. By sourcing inputs at a low transfer price g_1, foreign affiliates in country 2 set a low selling price p_{12}, and thus, push the price index P_2 downward. The lowered price index reduces the domestic profits of home plants, eroding the tax base inflow brought by foreign affiliates.

These findings are summarized as follows.

Result on tax revenues. *Under the same assumptions as in Proposition 1, tax revenues in the high-tax country 1 (or the low-tax country 2) in the transfer-pricing case are always lower than or equal to (or higher than or equal to) those than in the no-transfer-pricing case.*

Figure A8(a) illustrates the total profits shifted from the high-tax country 1 to the low-tax country 2, $N_1(\tau a - g_1)q_{12} + N_2(g_2 - \tau a)q_{21}$, for different levels of trade openness ϕ. The dashed horizontal lines are the corresponding values in the no-transfer-pricing case. Naturally, more profits are transferred as trade becomes more open. Tax revenues in each country for different ϕ are drawn in Figure A8(b). Notably, both curves exhibit an inverted-U shape when ϕ is high. This can be explained from the U-shaped relationship between ϕ and the plant share n_1. As Figure 2 and Proposition 2 suggest, a rise in ϕ below $\phi^{\#}(< \phi^S)$ decreases n_1 and increases $n_2 = 1 - n_1$. This change in the plant share is likely to suppress the tax base outflow from country 1 (smaller $N_1(\tau a - g_1)q_{12}$) and encourage the tax base inflow to country 2 (larger $N_2(g_2 - \tau a)q_{21}$). Both countries may increase tax revenues, as ϕ is higher (see the highlighted circles in Figure A8(b)).[2] Conversely, a rise in ϕ above $\phi^{\#}$ increases n_1 and decreases $n_2 = 1 - n_1$, changing tax revenues in the opposite direction.

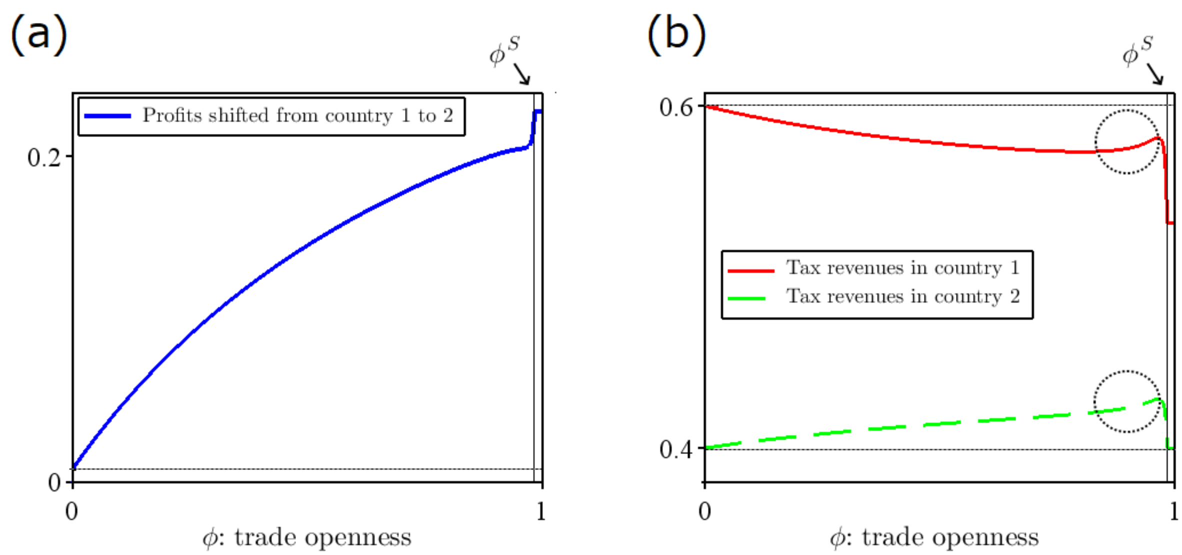

Figure A8. Shifted profits (a) and tax revenues (b)

Notes: Parameter values are $\sigma = 5$; $t_1 = 0.3$; $t_2 = 0.2$; $\delta = 0$; $s_1 = 0.5$; $\mu = 1$; $L = 20$.

[2]We can easily verify that $\partial[N_1(\tau a - g_1)q_{12}]/\partial n_1 > 0$ and $\partial[N_2(g_2 - \tau a)q_{21}]/\partial n_1 < 0$.

F Pure exporters

Here, we introduce pure exporters into the basic model, who serve foreign market through direct exporting. Relying on numerical simulations, we identify situations under which our main conclusion of production agglomeration in the high-tax country for high trade openness is likely to hold.

Pure exporters are modeled as a firm locating their plants in one country and are thus unable to engage in profit shifting. One benefit of becoming a pure exporter rather than an MNE is low fixed costs (Helpman et al., 2004). Specifically, pure exporters use one unit of capital for setting up a plant producing goods for home market and $\kappa \in [0, 1]$ units of capital for another plant producing goods for foreign market.[3] Whether a firm becomes an MNE or a pure exporter is endogenously determined. This implies that the total mass of MNEs and pure exporters in the world is endogenous, in contrast to the basic model in the text where it is fixed at $K = 2L$. For example, letting N_i^M be the mass of MNEs with production in country i and N_i^E be the mass of pure exporters in country i, it could be that all firms choose to become an MNE and we see $2N_1^M + 2N_2^M = 2L$ or $N_1^M + N_2^M = L$ or that all firms choose to become a pure exporter and we see $(1+\kappa)N_1^E + (1+\kappa)N_2^E = 2L$ or $N_1^E + N_2^E = 2L/(1+\kappa)$. As we will see below, the mass of firms is adjusted so as to internationally equalize the return to capital. Thus, all units of capital are employed and rewarded by the equalized return R.

The timing of actions is modified as follows. First, each firm chooses the location of a production plant in one country. Second, they decide whether to establish an export plant in the same country or to set up a distribution affiliate in the other country. The firm using a distribution affiliate is called an MNE and the one locating the two plants in the same country is called a pure exporter. Third, MNEs set transfer prices. Fourth, distribution affiliates and production plants of both MNEs and pure exporters set selling prices. Finally, production and consumption take place.

To summarize results in brief, the organization choice and the production location pattern crucially rest on the value of fixed cost of export plant κ. When κ is high, and thus, the benefit of becoming a pure exporter is small, as trade openness rises, the high-tax country 1 first loses and then gains multinational production, as in the basic model (Proposition 1). When κ is low, on the other hand, firms in both countries become pure exporters and move away from the high-tax country 1, as openness rises. As long as the benefit of becoming a pure exporter is not too large (κ is not too small), we maintain the main conclusions.

Fourth stage. We solve the problem from the fourth stage. The superscript M (or E)

[3] Assuming additional fixed costs for exporting, or simply called the beachhead/overhead cost, are common in studies on heterogeneous-firm trade and FDI (Helpman et al., 2004). Examples of the beachhead costs include production capacity constraints and costs of collecting information on the targeted foreign markets. The former aspect of beachhead costs is also highlighted in studies on supply-chain management (Chakravarty, 2005) and the second aspect in studies on international mergers (Qiu and Zhou, 2006).

stands for MNEs (or pure exporters). For an MNE with production in country 1, the pre-tax operating profits of a production plant and a distribution affiliate are

$$
\begin{aligned}
&\pi_{11}^M = (p_{11}^M - a)q_{11}^M + (g_1 - \tau a)q_{12}^M - \delta|g_1 - \tau a|q_{12}^M, \\
&\pi_{12}^M = (p_{12}^M - g_1)q_{12}^M, \\
&\text{where } \; q_{11}^M = \left(\frac{p_{11}^M}{P_1}\right)^{-\sigma}\frac{\mu L_1}{P_1}, \;\; q_{12}^M = \left(\frac{p_{12}^M}{P_2}\right)^{-\sigma}, \\
&\qquad\qquad P_j = \left[\sum_{i=1}^{2}\left\{N_i^M(p_{ij}^M)^{1-\sigma} + N_i^E(p_{ij}^E)^{1-\sigma}\right\}\right]^{\frac{1}{1-\sigma}}, \;\; j \in \{1,2\},
\end{aligned}
$$

and where N_i^M is the mass of MNEs with production in country i and N_i^E the mass of pure exporters in country i. We note that pure exporters in country i locate their two production plants in the same country i. The optimal prices are

$$
p_{11}^M = \frac{\sigma a}{\sigma - 1}, \quad p_{12}^M = \frac{\sigma g_1}{\sigma - 1}.
$$

For a pure exporter in country 1, the pre-tax operating profits consist of

$$
\begin{aligned}
&\pi_{11}^E = (p_{11}^E - a)q_{11}^E, \\
&\pi_{12}^E = (p_{12}^E - \tau a)q_{12}^E, \\
&\text{where } \; q_{11}^E = \left(\frac{p_{11}^E}{P_1}\right)^{-\sigma}\frac{\mu L_1}{P_1}, \;\; q_{12}^E = \left(\frac{p_{12}^E}{P_2}\right)^{-\sigma}\frac{\mu L_2}{P_2}.
\end{aligned}
$$

The optimal prices are

$$
p_{11}^E = \frac{\sigma a}{\sigma - 1}(= p_{11}^M), \quad p_{12}^E = \frac{\sigma \tau a}{\sigma - 1}.
$$

We can similarly derive optimal prices of MNEs with production in country 2 and pure exporters in country 2.

Third stage. In the third stage, MNEs with production in country 1 set transfer prices to maximize the following post-tax profits:

$$
\begin{aligned}
\Pi_1^M &= (1 - t_1)\pi_{11}^M + (1 - t_2)\pi_{12}^M - 2R_1 \\
&= (1 - t_1)[(p_{11}^M - a)q_{11}^M + (g_1 - \tau a)q_{12}^M - \delta|g_1 - \tau a|q_{12}^M] + (1 - t_2)[(p_{12}^M - a)q_{12}^M] - 2R_1.
\end{aligned}
$$

The optimal transfer price is the same as in the text:

$$g_1^M = \frac{(1+\delta)\sigma\tau a}{\sigma - \Delta t_1 + \delta(\sigma-1)}.$$

Similarly, MNEs with production in country 2 set the transfer price as

$$g_2^M = \frac{(1-\delta)\sigma\tau a}{\sigma - \Delta t_2 - \delta(\sigma-1)}.$$

We substitute these optimal prices into the post-tax profits of MNEs to obtain

$$\begin{aligned}
\Pi_1^M &= (1-t_1)\pi_{11}^M + (1-t_2)\pi_{12}^M - 2R_1 \\
&= (1-t_1)\left[\frac{\mu L_1}{\sigma(N_1 + \phi\gamma_2 N_2^M + \phi N_2^E)} + \frac{(\sigma-1)(\Delta t_1 + \delta)}{\sigma} \cdot \frac{\phi\gamma_1\mu L_2}{\sigma(\phi\gamma_1 N_1^M + \phi N_1^E + N_2)}\right] \\
&\quad + (1-t_2)\frac{\phi\gamma_1\mu L_2}{\sigma(\phi\gamma_1 N_1^M + \phi N_1^E + N_2)} - 2R_1, \\
\Pi_2^M &= (1-t_1)\pi_{21}^M + (1-t_2)\pi_{22}^M - 2R_2 \\
&= (1-t_1)\frac{\phi\gamma_2\mu L_1}{\sigma(N_1 + \phi\gamma_2 N_2^M + \phi N_2^E)} \\
&\quad + (1-t_2)\left[\frac{\mu L_2}{\sigma(\phi\gamma_1 N_1^M + \phi N_1^E + N_2)} + \frac{(\sigma-1)(\Delta t_2 - \delta)}{\sigma} \cdot \frac{\phi\gamma_2\mu L_1}{\sigma(N_1 + \phi\gamma_2 N_2^M + \phi N_2^E)}\right] \\
&\quad - 2R_2,
\end{aligned}$$

where $\phi \equiv \tau^{1-\sigma}$; and $N_i = N_i^M + N_i^E$ is the total mass of production plants in country $i \in \{1, 2\}$. Note that pure exporters in country i locate their two plants there. The above expressions are reduced to Eqs. (5-1) and (5-2) if $N_i^E = 0$. Similarly we use the optimal prices to write the post-tax profits of pure exporters as

$$\begin{aligned}
\Pi_1^E &= (1-t_1)(\pi_{11}^E + \pi_{12}^E) - (1+\kappa)R_1 \\
&= (1-t_1)\left[\frac{\mu L_1}{\sigma(N_1 + \phi\gamma_2 N_2^M + \phi N_2^E)} + \frac{\phi\mu L_2}{\sigma(\phi\gamma_1 N_1^M + \phi N_1^E + N_2)}\right] - (1+\kappa)R_1, \\
\Pi_2^E &= (1-t_2)(\pi_{21}^E + \pi_{22}^E) - (1+\kappa)R_2 \\
&= (1-t_2)\left[\frac{\phi\mu L_1}{\sigma(N_1 + \phi\gamma_2 N_2^M + \phi N_2^E)} + \frac{\mu L_2}{\sigma(\phi\gamma_1 N_1^M + \phi N_1^E + N_2)}\right] - (1+\kappa)R_2.
\end{aligned}$$

We set δ to zero in what follows.

Second stage. In the second stage, given the location of production, firms choose their way of serving the foreign market, either through distribution affiliates or through exporting. A firm with plant in country i chooses to use a distribution affiliate if $\Pi_i^M \geq \Pi_i^E$. Otherwise it chooses to locate an export plant in the same country i. It can be checked that firms with production plant in country 2 always become pure exporters:

$$\Pi_2^M - \Pi_2^E = -\frac{\phi\mu L[\sigma(1-\gamma_2)+\gamma_2^2]}{2\sigma^2(N_1+\phi\gamma_2 N_2^M+\phi N_2^E)} - (1-\kappa)R_2 < 0,$$

noting that $\gamma_2 \in (0,1)$; and $\kappa \leq 1$.

First stage. In the first stage, the free entry and exit of firms drives the post-tax profits to zero and the capital allocation is determined. The world capital-market clearing requires that the total amount of capital used to build plants/affiliates of both MNEs and pure exporters must be equal to the world capital endowment. Since firms with production in country 2 are always pure exporters, all we have to consider is the cases where firms in country 1 choose to become an MNE (or a pure exporter).[4]

In the case where firms in country 1 become MNEs and those in country 2 pure exporters, the free-entry condition implies

$$\begin{aligned}
&\Pi_1^M = \widetilde{\Pi}_1^M - 2R_1 \equiv (1-t_1)\pi_{11}^M + (1-t_2)\pi_{12}^M - 2R_1 = 0,\\
&\to 2R_1 = \widetilde{\Pi}_1^M\\
&\qquad = (1-t_1)\pi_{11}^M + (1-t_2)\pi_{12}^M,\\
&\qquad = (1-t_1)\left[\frac{\mu L}{2\sigma(N_1^M+\phi N_2^E)} + \frac{(\sigma-1)\Delta t_1}{\sigma}\cdot\frac{\phi\gamma_1\mu L}{2\sigma(\phi\gamma_1 N_1^M+N_2^E)}\right]\\
&\qquad\quad + (1-t_2)\frac{\phi\gamma_1\mu L}{2\sigma(\phi\gamma_1 N_1^M+N_2^E)},\\
&\Pi_2^E = \widetilde{\Pi}_2^E - (1+\kappa)R_2 \equiv (1-t_2)(\pi_{11}^E+\pi_{12}^E) - (1+\kappa)R_2 = 0,\\
&\to (1+\kappa)R_2 = \widetilde{\Pi}_2^E\\
&\qquad = (1-t_2)(\pi_{22}^E+\pi_{21}^E)\\
&\qquad = (1-t_2)\left[\frac{\phi\mu L}{2\sigma(N_1^M+\phi N_2^E)} + \frac{\mu L}{2\sigma(\phi\gamma_1 N_1^M+N_2^E)}\right],
\end{aligned}$$

where $\widetilde{\Pi}_i^M$ is, e.g., the gross post-tax profits of the MNE in country i. The capital-market clearing condition requires $2N_1^M + (1+\kappa)N_2^E = K = 2L$. Letting $n_1 = N_1/L \in [0,1]$, the mass of pure exporters in country 2 is then expressed as $N_2^E = 2(1-n_1)L/(1+\kappa)$. Capital owners invest in MNEs/pure exporters that guarantee higher return: $R_i > R_j$. Solving $\Delta R \equiv R_1 - R_2 = \widetilde{\Pi}_1^M/2 - \widetilde{\Pi}_2^E/(1+\kappa) = 0$ gives, if any, the interior long-run equilibrium $n_1 \in (0,1)$.

In the case where firms in both countries 1 and 2 become pure exporters, the free entry

[4] Although there may be a case where both MNEs and pure exporters coexist in country 1, we do not consider here to illustrate our main point.

condition implies

$$
\begin{aligned}
&\Pi_1^E = \widetilde{\Pi}_1^E - 2R_1 \equiv (1-t_1)(\pi_{11}^E + \pi_{12}^E) - (1+\kappa)R_1 = 0,\\
&\to (1+\kappa)R_1 = \widetilde{\Pi}_1^E\\
&\qquad\qquad = (1-t_1)(\pi_{11}^E + \pi_{12}^E),\\
&\qquad\qquad = (1-t_1)\left[\frac{\mu L}{2\sigma(N_1^E + \phi N_2^E)} + \frac{\phi\mu L}{2\sigma(\phi N_1^E + N_2^E)}\right],\\
&\Pi_2^E = \widetilde{\Pi}_2^E - \kappa R_2 \equiv (1-t_2)(\pi_{11}^E + \pi_{12}^E) - (1+\kappa)R_2 = 0,\\
&\to (1+\kappa)R_2 = \widetilde{\Pi}_2^E\\
&\qquad\qquad = (1-t_2)(\pi_{22}^E + \pi_{21}^E)\\
&\qquad\qquad = (1-t_2)\left[\frac{\phi\mu L}{2\sigma(N_1^E + \phi N_2^E)} + \frac{\mu L}{2\sigma(\phi N_1^E + N_2^E)}\right].
\end{aligned}
$$

The capital-market clearing condition requires $(1+\kappa)N_1^E + (1+\kappa)N_2^E = K = 2L$. Letting $n_1 = (1+\kappa)N_1/(2L) \in [0,1]$, the mass of pure exporters in country 2 is given by $N_2^E = 2(1-n_1)L/(1+\kappa)$. Solving $\Delta R \equiv R_1 - R_2 = \widetilde{\Pi}_1^E/(1+\kappa) - \widetilde{\Pi}_2^E/(1+\kappa) = 0$ gives, if any, the interior long-run equilibrium $n_1 \in (0,1)$.

Figure A9(a) shows the share of plants in country 1, when the fixed cost for setting up an export plant is as high as that for an distribution affiliate, i.e., $\kappa = 1$. In this case, firms in country 1 become MNEs so that $N_1 = N_1^M$. The plant share in country 1 is thus given by $N_1^M/(N_1^M + 2N_2^E)$ and has a non-monotonic relationship with trade openness ϕ, as in the basic model. We can check that this long-run equilibrium location pattern is indeed consistent with individual firm's incentive of organization choice using Figure A9(b). Namely, given the long-run equilibrium mass of firms, Figure A9(b) draws $\widetilde{\Pi}_i^M - \widetilde{\Pi}_i^E$, which captures the incentive of firms in country i to become an MNE. The fact that $\widetilde{\Pi}_1^M - \widetilde{\Pi}_1^E$ is always positive means that no firms in country 1 have an incentive to change their organization form from an MNE to a pure exporter. Conversely, the fact that $\widetilde{\Pi}_2^M - \widetilde{\Pi}_2^E$ is always negative suggests that no firms in country 2 are not willing to change their organization form from a pure exporter to an MNE.

When κ is low such that $\kappa = 0.8$, no firms become MNEs. In this case, the plant share in country 1 is given by $2N_1^E/(2N_1^E + 2N_2^E) = N_1^E/(N_1^E + N_2^E)$ and is weakly decreasing in ϕ, as shown in Figure A11(a). Since there are no profit shifting activities, higher taxes in country 1 hamper production agglomeration. Figure A11(b) shows $\widetilde{\Pi}_i^M - \widetilde{\Pi}_i^E < 0$ for any ϕ, confirming that no firms in both countries have an incentive to change their organizational form. However,we note that $\widetilde{\Pi}_1^M - \widetilde{\Pi}_1^E$ is weakly increasing in ϕ. As ϕ rises, the relative benefit of becoming a pure exporter decreases because greater intra-firm trade, due to higher trade openness, encourages profit shifting, and thus, makes becoming an MNE more profitable.

When κ is intermediate such that $\kappa = 0.95$, the organizational choice of firms in country 1 is not uniform across ϕ. When $\phi < \phi^{M*}$, firms in both countries become pure exporters, whereas when $\phi \geq \phi^{M*}$, firms in country 1 become MNEs. Namely, Figure A10(a) depicts $N_1^E/(N_1^E + N_2^E)$ for $\phi < \phi^{M*}$ and $N_1^M/(N_1^M + 2N_2^E)$ for $\phi \geq \phi^{M*}$. The resulting plant share is qualitatively similar to the one in Figure A9(a). The change in organizational form can be explained by the fact that the sign of $\widetilde{\Pi}_1^M - \widetilde{\Pi}_1^E$ changes from negative to positive at ϕ^{M*}, as shown in Figure A10(b).

As long as the benefit of becoming a pure exporter is not too large (κ is not too small), our main result holds that multinational production agglomerates in the high-tax country when trade openness is high.

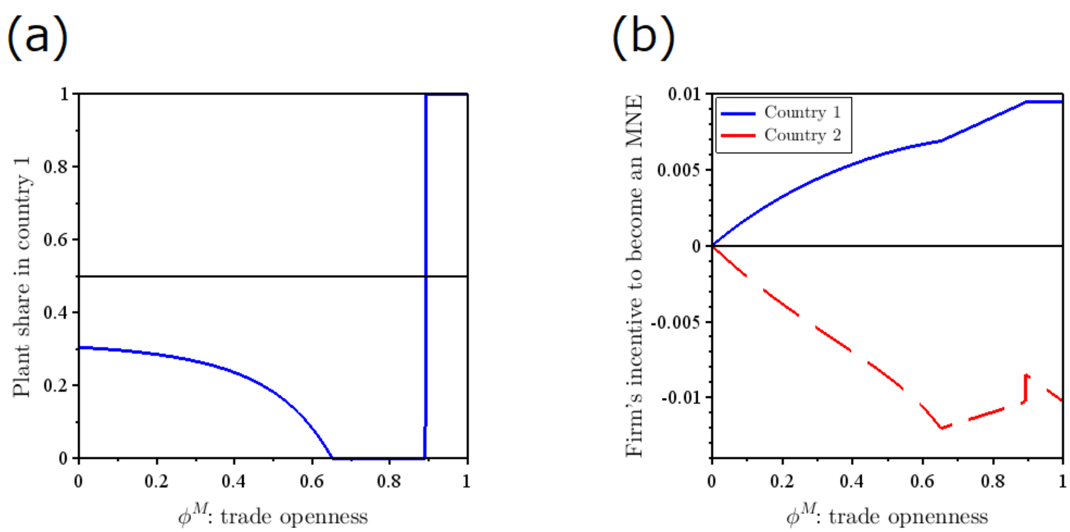

Figure A9. MNEs versus pure exporters when κ is high

Notes: Parameter values are $\sigma = 5$; $t_1 = 0.3$; $t_2 = 0.2$; $\delta = 0$; $s_1 = 0.5$; $\mu = 1$; $\kappa = 1$.

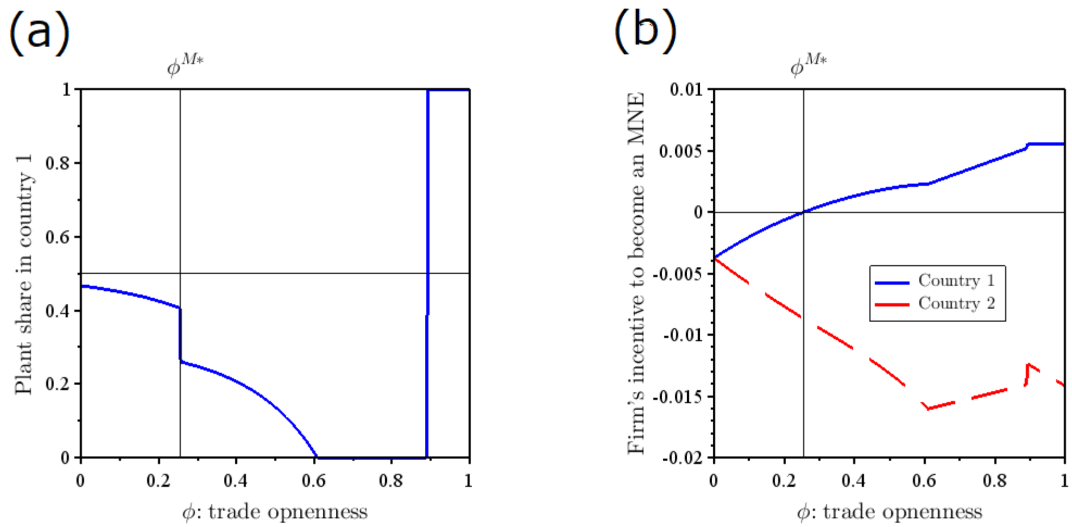

Figure A10. MNEs versus pure exporters when κ is intermediate

Notes: Parameter values are $\sigma = 5$; $t_1 = 0.3$; $t_2 = 0.2$; $\delta = 0$; $s_1 = 0.5$; $\mu = 1$; $\kappa = 0.95$.

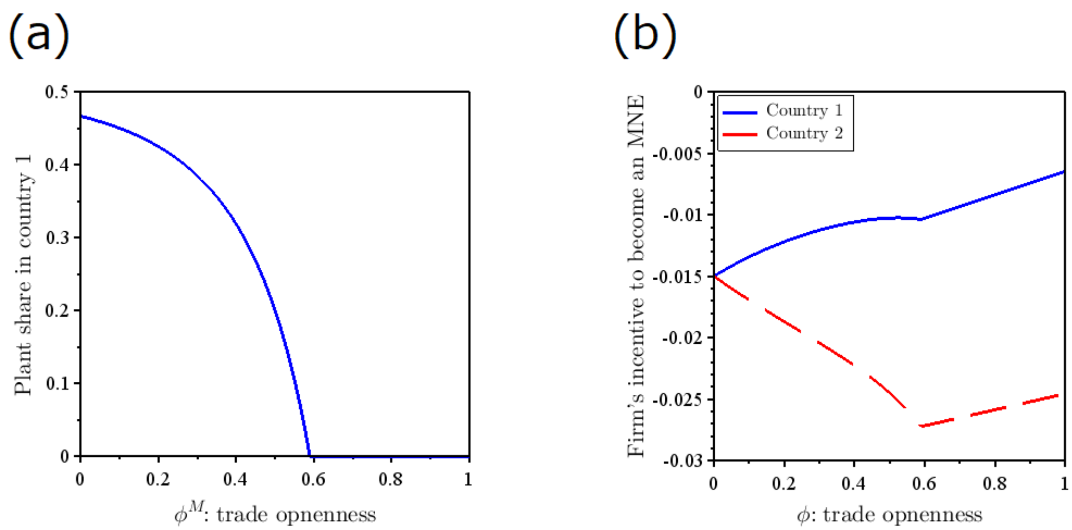

Figure A11. MNEs versus pure exporters when κ is low

Notes: Parameter values are $\sigma = 5$; $t_1 = 0.3$; $t_2 = 0.2$; $\delta = 0$; $s_1 = 0.5$; $\mu = 1$; $\kappa = 0.8$.

G Asymmetric country size

Here, we allow countries to have unequal size, i.e., $s_1 \neq 1/2$, and derive the conditions under which all production plants are agglomerated in the high-tax country 1 under completely free trade ($\phi = 1$). We set δ to zero and evaluate the capital-return differential (A2) at $\phi = 1$ to obtain

$$\Delta R|_{\phi=1} = \underbrace{\frac{\mu(t_2 - t_1)(\sigma - 1)}{\sigma^2}}_{<0} \left(\frac{s_2\omega_1}{\gamma_1 n_1 + n_2} + \frac{s_1\omega_2}{n_1 + \gamma_2 n_2} \right),$$

$$\text{where} \quad \omega_i \equiv \gamma_i + \frac{\sigma(1-\gamma_i)}{(\sigma-1)\Delta t_j}, \qquad \text{for } i \neq j \in \{1, 2\},$$

noting that $\Delta t_1 < 0 < \Delta t_2$ and $\gamma_2 < 1 < \gamma_1$. The capital-return differential is positive (or negative) if the large bracket term in the first line is negative (or positive). The condition for the big bracket term to be negative is

$$\begin{aligned}
&\frac{s_2\omega_1}{\gamma_1 n_1 + n_2} + \frac{s_1\omega_2}{n_1 + \gamma_2 n_2} < 0, \\
&\to s_2\omega_1(n_1 + \gamma_2 n_2) + s_1\omega_2(\gamma_1 n_1 + n_2) < 0, \\
&\to n_1 \underbrace{[s_2\omega_1(1-\gamma_2) + s_1\omega_2(\gamma_1 - 1)]}_{>0} + s_2\omega_1\gamma_2 + s_1\omega_2 < 0,
\end{aligned}$$

noting that $n_2 = 1 - n_1$ and $\gamma_2 < 1 < \gamma_1$. The inequality holds for any $n_1 \in [0, 1]$ if the following holds:

$$\begin{aligned}
&n_1[s_2\omega_1(1-\gamma_2) + s_1\omega_2(\gamma_1 - 1)] + s_2\omega_1\gamma_2 + s_1\omega_2 \\
&\leq 1 \cdot [s_2\omega_1(1-\gamma_2) + s_1\omega_2(\gamma_1 - 1)] + s_2\omega_1\gamma_2 + s_1\omega_2 \\
&= s_2\omega_1 + s_1\omega_2\gamma_1 \\
&\simeq \frac{(t_1 - t_2)[\sigma(2s_1 - 1)(1 - t_2) - s_1(t_1 - t_2)]}{\sigma^2(1-t_1)(1-t_2)} < 0,
\end{aligned}$$

where we used the Taylor approximation (A1) from the second to the last line. This inequality holds if the following holds:

$$\begin{aligned}
&\sigma(2s_1 - 1)(1 - t_2) - s_1(t_1 - t_2) < 0, \\
&\to s_1 < \frac{\sigma}{2\sigma - \Delta t_2} \equiv \overline{s}_1 \in \left(\frac{1}{2}, 1\right).
\end{aligned}$$

As long as the high-tax country is not too large such that $s_1 < \overline{s}_1$, the capital-return differential at $\phi = 1$ is positive for any $n_1 \in [0, 1]$. In this case, production plants are agglomerated in the high-tax country 1 in the long-run equilibrium: $n_1|_{\phi=1} = 1$.

H Centralized decision making

In the text, we consider the case of decentralized decision making, in which the foreign affiliate chooses a price to maximize its own profit. Here, using the same framework as in the text, we examine the case of centralized decision making, in which the MNE chooses all prices to maximize its total profit. As we shall see, the two different organization forms give qualitatively similar results.

An MNE with a plant in country 1 solves the following problem:

$$\begin{aligned}
&\max_{p_{11}, g_1, p_{12}} \Pi_1 = \max_{p_{11}, g_1, p_{12}} (1-t_1)\pi_{11} + (1-t_2)\pi_{12} - 2R_1, \\
&\text{where } \ \pi_{11} = (p_{11} - a)q_{11} + (g_1 - \tau a)q_{12} - C(g_1, q_{12}), \\
&\qquad\quad\ \ \pi_{12} = (p_{12} - g_1)q_{12}.
\end{aligned}$$

In contrast to decentralized decision making, p_{12} is chosen to maximize Π_1 rather than π_{12}. $C(\cdot)$ is the concealment cost specified as $C(g_i, q_{ij}) = \delta(g_i - \tau a)^2 q_{ij}$ with $\delta \geq 0$ (see Nielsen et al., 2003; Kind et al., 2005; Haufler et al., 2018 for similar specifications).

The FOCs give the following optimal prices:

$$\begin{aligned}
&p_{11} = \frac{\sigma a}{\sigma - 1}, \quad g_1 = \tau a + \frac{\Delta t_1}{2\delta}, \quad p_{12} = \frac{\sigma a}{\sigma - 1}\left(\tau + \frac{\Delta t_1 \Delta t_2}{4a\delta}\right), \\
&\text{where } \ \Delta t_i \equiv \frac{t_j - t_i}{1 - t_i}, \quad i \neq j \in \{1, 2\}.
\end{aligned}$$

Mirror expressions hold for MNEs with production in country 2:

$$p_{22} = \frac{\sigma a}{\sigma - 1}, \quad g_2 = \tau a + \frac{\Delta t_2}{2\delta}, \quad p_{21} = \frac{\sigma a}{\sigma - 1}\left(\tau + \frac{\Delta t_1 \Delta t_2}{4a\delta}\right).$$

As in the decentralized case, g_i decreases with t_i and increases with t_j. Since $p_{12} = p_{21}$ and $g_1 < g_2$ hold, we see $p_{12} - g_1 > p_{21} - g_2$. This implies a higher profitability of the affiliate in country 1 than that of the affiliate in country 2. As trade costs decline and the shifted profits are larger, more MNEs are likely to locate their affiliate in country 2 to exploit the higher price-cost margin. As a result, plants are agglomerated in country 1 for high openness. The mechanism here that transfer pricing does not just shift profits but affects profitability is very close to that in the decentralized decision case in the text.

Using the optimal prices, we can rewrite the post-tax profit as

$$\Pi_1 = \frac{(1-t_1)\mu L/2}{\sigma(N_1+\gamma N_2)} + (1-t_2)\left[\tau + \frac{(2\sigma-1)\Delta t_1 \Delta t_2 - 2(\sigma-1)(\Delta t_1+\Delta t_2)}{4a\delta}\right]\frac{\gamma^{\frac{\sigma}{\sigma-1}}\mu L/2}{\sigma(\gamma N_1+N_2)} - 2R_1,$$
$$\Pi_2 = \frac{(1-t_2)\mu L/2}{\sigma(\gamma N_1+N_2)} + (1-t_1)\left[\tau + \frac{(2\sigma-1)\Delta t_1 \Delta t_2 - 2(\sigma-1)(\Delta t_1+\Delta t_2)}{4a\delta}\right]\frac{\gamma^{\frac{\sigma}{\sigma-1}}\mu L/2}{\sigma(N_1+\gamma N_2)} - 2R_2,$$
$$\text{where } \gamma \equiv \left(\tau + \frac{\Delta t_1 \Delta t_2}{4a\delta}\right)^{1-\sigma}.$$

The free entry and exit of firms drive these post-tax profits to zero ($\Pi_i = 0$), determining the capital-return, R_i.

As in the decentralized decision case, the long-run equilibrium distribution of plants is interior if $R_1 - R_2 = 0$ has a solution for $n_1 \in (0,1)$. If $R_1 - R_2 > 0$ (or $R_1 - R_2 < 0$) for any $n_1 \in [0,1]$, then the economy reaches the corner equilibrium of $n_1 = 1$ (or $n_1 = 0$). We obtain

$$n_1 = \begin{cases} \dfrac{1}{2} + \dfrac{(\gamma+1)(t_1-t_2)}{2(\gamma-1)(2-t_1-t_2)} & \text{if } \tau \in (\tau^{S1}, \infty) \quad \text{(i)} \\ 0 & \text{if } \tau \in (\tau^{S2}, \tau^{S1}] \quad \text{(ii)} \\ [0,1] & \text{if } \tau = \tau^{S2} \quad \text{(iii)} \\ 1 & \text{if } \tau \in [1, \tau^{S2}) \quad \text{(iv)} \end{cases},$$
$$\text{where } \gamma \equiv \left(\tau + \frac{\Delta t_1 \Delta t_2}{4a\delta}\right)^{1-\sigma}, \quad \Delta t_i \equiv \frac{t_j - t_i}{1-t_i}, \quad i \neq j \in \{1,2\},$$
$$\tau^{S1} \equiv \left(\frac{1-t_1}{1-t_2}\right)^{\frac{1}{1-\sigma}} - \frac{\Delta t_1 \Delta t_2}{4a\delta}, \quad \tau^{S2} \equiv 1 - \frac{\Delta t_1 \Delta t_2}{4a\delta},$$

which is illustrated in Figure A12. The horizontal dashed line represents the share at which the equilibrium share converges as trade costs go to infinity:

$$\widehat{n}_1 \equiv \lim_{\tau\to\infty} n_1 = \frac{1}{2} + \frac{t_2 - t_1}{2(2-t_1-t_2)}.$$

If trade costs are high such that $\tau \in (\tau^{S1}, \infty)$, then the low-tax country hosts more production plants than the high-tax country does. By contrast, if trade costs are low such that $\tau \in [1, \tau^{S1})$, the high-tax country attracts all production plants. This result is qualitatively similar to that under decentralized decision making.

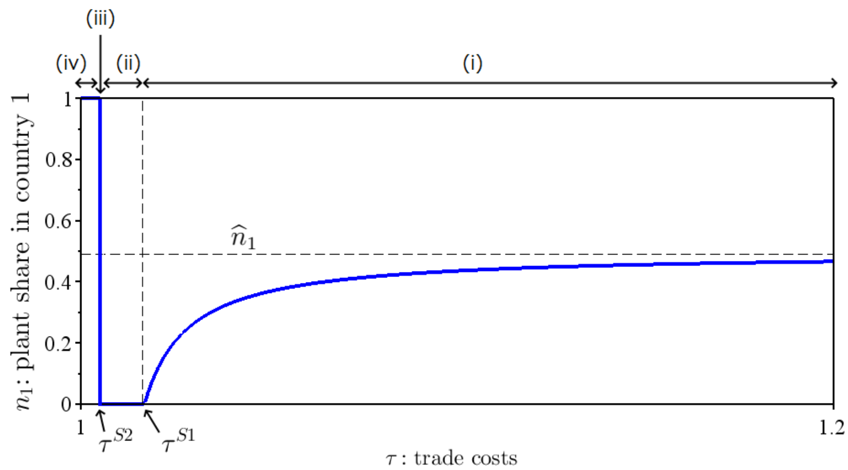

Figure A12. Plant share under centralized decision making

Notes: Parameter values are $\sigma = 5$; $t_1 = 0.3$; $t_2 = 0.267$; $\delta = 0.1$; $s_1 = 0.5$; $a = 1$.

I Proof of Proposition 3

We obtain the capital-return differential in the no-transfer-pricing case, $\Delta\widehat{R}$, by substituting $\gamma_1 = \gamma_2 = 1$, $\delta = 0$ and $s_1 = 1/2$ into Eq. (A2). The interior solution of $n_1 \in (0, 1)$ satisfying $\Delta\widehat{R} = 0$ is

$$n_1 = \frac{1}{2} - \frac{(1+\phi)(\widehat{t}_1 - \widehat{t}_2)}{2(1-\phi)(2-\widehat{t}_1 - \widehat{t}_2)},$$

which is smaller than one half and decreases with ϕ because $\widehat{t}_1 > \widehat{t}_2$.

Evaluating $\Delta\widehat{R}$ at $n_1 = 0$ yields

$$\Delta\widehat{R}|_{n_1=0} = \frac{\mu \cdot \widehat{\Theta}(\phi)}{2\sigma\phi},$$
$$\text{where} \quad \widehat{\Theta}(\phi) \equiv (1-\phi)[1 - t_1 - \phi(1-t_2)].$$

$\widehat{\Theta}(\phi) = 0$ has two solutions, $\phi = 1$ and $\phi = \widehat{\phi}^S$:

$$\widehat{\phi}^S \equiv \frac{1-\widehat{t}_1}{1-\widehat{t}_2} \in (0, 1),$$

noting $\widehat{t}_1 > \widehat{t}_2$. Clearly, $\widehat{\Theta}(\phi)$ or $\Delta\widehat{R}|_{n_1=0}$ are negative if $\phi \in (\widehat{\phi}^S, 1)$. That is, if $\phi \in (\widehat{\phi}^S, 1)$, then all production plants are located in the low-tax country 2: $n_1 = 0$.

In summary, the equilibrium plant share in country 1 is summarized as

$$n_1 = \begin{cases} \dfrac{1}{2} - \dfrac{(1+\phi)(\widehat{t}_1 - \widehat{t}_2)}{2(1-\phi)(2-\widehat{t}_1-\widehat{t}_2)} & \text{if } \phi \in [0, \widehat{\phi}^S) \\ 0 & \text{if } \phi \in [\widehat{\phi}^S, 1) \\ [0,1] & \text{if } \phi = 1 \end{cases}.$$

J Proof of Proposition 4

We first check the SOCs for the maximization problem. The SOC of government 2 is

$$\frac{\partial^2 G_2}{\partial t_2^2} = -\frac{2}{\alpha_2(1-t_2)^3} < 0.$$

Evaluating the SOC of government 1 at $t_2 = t_2^* = \widehat{t}_2$ gives

$$\left.\frac{\partial^2 G_1}{\partial t_1^2}\right|_{t_2=t_2^*} = -\frac{\sqrt{2\sigma/\alpha_2}[\sqrt{2\sigma^3/\alpha_2} + (\sigma-1)\sqrt{\mu L}]}{\sigma(1-t_1)^3} < 0.$$

We then confirm that t_i^* lies in $(0, 1/2)$ and the government payoffs are positive. From the analysis of the no-transfer-pricing case, we know that $t_2^* = \widehat{t}_2 \in (0, 1/2)$ and $G_2(t_2 = t_2^*) > 0$ hold because $\alpha_1 > \alpha_2$ and $\alpha_i \in (2\sigma/(\mu L), 3\sigma/(\mu L))$. We only have to confirm $t_1^* \in (0, 1/2)$. The condition for $t_1^* > 0$ is

$$\begin{aligned} & t_1^* = 1 - \sqrt{\frac{2\sigma^2/\alpha_1 + (\sigma-1)\sqrt{2\sigma\mu L/\alpha_2}}{\mu L(2\sigma-1)}} > 0, \\ & \to \frac{1}{\alpha_1} < \frac{\mu L(2\sigma-1) - (\sigma-1)\sqrt{2\sigma\mu L/\alpha_2}}{2\sigma^2} \equiv \frac{1}{\alpha^\dagger}. \end{aligned}$$

As we assume $\alpha_1 > \alpha_2$, it suffices to check $\alpha_2 \geq \alpha^\dagger$:

$$\begin{aligned} & \alpha_2 \geq \alpha^\dagger \equiv \frac{2\sigma^2}{\mu L(2\sigma-1) - (\sigma-1)\sqrt{2\sigma\mu L/\alpha_2}}, \\ & \to \alpha_2 \left[\mu L(2\sigma-1) - (\sigma-1)\sqrt{2\sigma\mu L/\alpha_2}\right] \geq 2\sigma^2. \end{aligned}$$

This inequality always holds because $\alpha_2 > 2\sigma/(\mu L)$:

$$\alpha_2 \left[\mu L(2\sigma - 1) - (\sigma - 1)\sqrt{2\sigma\mu L/\alpha_2}\right] > \frac{2\sigma}{\mu L} \cdot \left[\mu L(2\sigma - 1) - (\sigma - 1)\sqrt{2\sigma\mu L \cdot \frac{\mu L}{2\sigma}}\right] = 2\sigma^2.$$

The condition for $t_1^* < 1/2$ is

$$\begin{aligned}
&t_1^* = 1 - \sqrt{\frac{2\sigma^2/\alpha_1 + (\sigma - 1)\sqrt{2\sigma\mu L/\alpha_2}}{\mu L(2\sigma - 1)}} < \frac{1}{2}, \\
&\to \frac{1}{\alpha_1} > \frac{\mu L(2\sigma - 1)/4 - (\sigma - 1)\sqrt{2\sigma\mu L/\alpha_2}}{2\sigma^2} \equiv \frac{1}{\alpha^\ddagger}.
\end{aligned}$$

As we assume $\alpha_1 < 3\sigma/(\mu L)$, it suffices to check $3\sigma/(\mu L) < \alpha^\ddagger$:

$$\begin{aligned}
&\frac{3\sigma}{\mu L} < \alpha^\ddagger \equiv \frac{2\sigma^2}{\mu L(2\sigma - 1)/4 - (\sigma - 1)\sqrt{2\sigma\mu L/\alpha_2}}, \\
&\to -\mu L(2\sigma + 3) - 12(\sigma - 1)\sqrt{2\sigma\mu L/\alpha_2} < 0.
\end{aligned}$$

We can see that the government 1's payoff in equilibrium is positive:

$$\begin{aligned}
G_1(t_1 = t_1^*, t_2 = t_2^*) &= \frac{\mu L t_1^*}{2\sigma}\left[1 + \frac{(\sigma - 1)\Delta t_1^*}{\sigma}\right] - \frac{t_1^*}{\alpha_1(1 - t_1^*)} \\
&> G_1(t_1 = t_2^*, t_2 = t_2^*) = \frac{\mu L t_2^*}{2\sigma} - \frac{t_2^*}{\alpha_1(1 - t_2^*)} \\
&> G_2(t_2 = t_2^*) = \frac{\mu L t_2^*}{2\sigma} - \frac{t_2^*}{\alpha_2(1 - t_2^*)} = \left(\frac{\mu L}{2\sigma} - \frac{1}{\alpha_2}\right)^2 \\
&> 0,
\end{aligned}$$

where we used $t_2^* = \widehat{t}_2 = 1 - \sqrt{2\sigma/(\alpha_2\mu L)}$ and $\alpha_1 > \alpha_2$.

(i) The tax rates of country 1 versus country 2. We check the condition under which in the transfer-pricing case the equilibrium tax in country 1 is higher than that in country 2

$(t_1^* > t_2^*)$:

$$
\begin{aligned}
& t_1^* = 1 - \sqrt{\frac{2\sigma^2/\alpha_1 + (\sigma-1)\sqrt{2\sigma\mu L/\alpha_2}}{\mu L(2\sigma-1)}} > 1 - \sqrt{\frac{2\sigma}{\alpha_2 \mu L}} = t_2^*, \\
& \rightarrow \sqrt{\frac{2\sigma}{\alpha_2 \mu L}} > \sqrt{\frac{2\sigma^2/\alpha_1 + (\sigma-1)\sqrt{2\sigma\mu L/\alpha_2}}{\mu L(2\sigma-1)}}, \\
& \rightarrow 2\sigma(2\sigma-1)/\alpha_2 > 2\sigma^2/\alpha_1 + (\sigma-1)\sqrt{2\sigma\mu L/\alpha_2}, \\
& \rightarrow \alpha_1 > \frac{2\sigma^2}{2\sigma(2\sigma-1)/\alpha_2 - (\sigma-1)\sqrt{2\sigma\mu L/\alpha_2}} \equiv \alpha^*.
\end{aligned}
$$

Similarly, we can check that $\alpha^* \in (\alpha_2, 3\sigma/(\mu L))$ holds. When ϕ is smaller than ϕ^S, all production plants are located in the high-tax country $(n_1 = 1)$ as long as $\alpha_1 > \alpha^*$ and thus $t_1^* > t_2^*(= \widehat{t}_2)$ hold. The equilibrium is unique because neither government benefits from changes in the tax rate from the equilibrium rate.

Conversely, if $\alpha_1 \leq \alpha^*$ and thus $t_1^* \leq t_2^*$ hold, the lower tax rate of country 1 is inconsistent with the presumption that all production plants are in country 1. In this case, government 1 sets a tax rate equal to that of government 2, and the plants are equally distributed between the two countries: $n_1 = 1/2$. As both governments try to avoid tax base erosion from full agglomeration of plants, the equal equilibrium tax rate of $t_1^* = t_2^*(= \widehat{t}_2)$ is unique.

(ii) Tax rates with and without transfer pricing. Assume $\delta = 0$ and $\alpha_1 > \alpha^*$. Supposing $t_1 > t_2$, the objective function of government 1 with and without transfer pricing can be summarized as

$$
G_1 = \frac{\mu L t_1}{2\sigma} + \mathbb{1} \underbrace{\frac{\mu L t_1}{2\sigma} \frac{(\sigma-1)\Delta t_1}{\sigma}}_{<0} - \frac{t_1}{\alpha_1(1-t_1)},
$$

$$
\text{where} \quad \mathbb{1} = \begin{cases} 1 & \text{transfer-pricing case} \\ 0 & \text{no-transfer-pricing case} \end{cases},
$$

where the second negative term of the right hand side of the equation represents tax base erosion. A higher t_1 increases the tax base erosion:

$$
\frac{\partial}{\partial t_1}\left[\frac{\mu L t_1}{2\sigma}\frac{(\sigma-1)\Delta t_1}{\sigma}\right] = -\frac{\mu L(2\sigma-1)}{2\sigma^2} \cdot \frac{t_1(2-t_1) - t_2}{(1-t_1)^2} < 0.
$$

Using this, we can compare the marginal effect of tax on the objective function with and without transfer pricing:

$$
\begin{aligned}
\left.\frac{\partial G_1(\mathbb{1}=1)}{\partial t_1}\right|_{t_i=\widehat{t}_i} &= \left.\frac{\partial}{\partial t_1}\left[\frac{\mu L t_1}{2\sigma} - \frac{\alpha_1 t_1}{1-t_1}\right]\right|_{t_i=\widehat{t}_i} + \left.\frac{\partial}{\partial t_1}\left[\frac{\mu L t_1}{2\sigma}\frac{(\sigma-1)\Delta t_1}{\sigma}\right]\right|_{t_i=\widehat{t}_i} \\
&= \left.\frac{\partial G_1(\mathbb{1}=0)}{\partial t_1}\right|_{t_i=\widehat{t}_i} + \left.\frac{\partial}{\partial t_1}\left[\frac{\mu L t_1}{2\sigma}\frac{(\sigma-1)\Delta t_1}{\sigma}\right]\right|_{t_i=\widehat{t}_i} \\
&= 0 - \frac{\mu L(2\sigma-1)}{2\sigma^2}\cdot\frac{\widehat{t}_1(2-\widehat{t}_1)-\widehat{t}_2}{(1-\widehat{t}_1)^2} \\
&< 0 = \left.\frac{\partial G_1(\mathbb{1}=0)}{\partial t_1}\right|_{t_i=\widehat{t}_i},
\end{aligned}
$$

where taxes are evaluated at the equilibrium under no transfer pricing: $(t_1, t_2) = (\widehat{t}_1, \widehat{t}_2)$. Government 1 has an incentive to reduce its tax rate from $\widehat{t}_1$. Since the concave objective function has a unique maximizer, government 1 sets a lower tax rate in the transfer-pricing case than in the no-transfer-pricing case: $t_1^* < \widehat{t}_1$. Under our assumption of $\alpha_1 > \alpha^*$, $t_1^* > t_2^*$ indeed holds.

K Tax competition under the Cobb-Douglas preferences

Here, we check the robustness of our result that introducing transfer pricing narrows the tax difference under the Cobb-Douglas utility function. The basic model assumes the quasi-linear utility function such that $u_1 = \mu \ln Q_1 + q_1^O$, implying that expenditures for manufacturing varieties are fixed. To see this point first, let E_1 be the total expenditure for manufacturing varieties in country 1. Using Eq. (1), we calculate the goods-market-clearing condition as

$$
\begin{aligned}
E_1 &= \sum_{i=1}^{2}\int_{\omega\in\Omega_i} p_{i1}(\omega)q_{i1}(\omega)d\omega \\
&= \sum_{i=1}^{2}\int_{\omega\in\Omega_i}\left(\frac{p_{i1}(\omega)}{P_1}\right)^{1-\sigma}\mu L_1 d\omega \\
&= \mu L_1 P_1^{\sigma-1}\sum_{i=1}^{2}\int_{\omega\in\Omega_i} p_{i1}(\omega)^{1-\sigma}d\omega \\
&= \mu L_1 P_1^{\sigma-1}\cdot P_1^{1-\sigma} \\
&= \mu L_1,
\end{aligned}
$$

which is exogenously given.

Instead, we adopt the Cobb-Douglas utility function such that $u_1 = Q_1^{\theta}(q_1^O)^{1-\theta}$, where $\theta \in (0,1)$ is the weight attached to manufacturing goods. We also assume that tax revenues in each country are repatriated to its residents. The aggregate demand for variety ω defined in Eq.(1) is modified as

$$q_{i1}(\omega) = \left(\frac{p_{i1}(\omega)}{P_1}\right)^{-\sigma} \frac{\theta(L_1 + TR_1)}{P_1},$$

where $L_1 (= w_1 L_1)$ is labor income and TR_1 is tax revenues. The total expenditure is no longer constant:

$$\begin{aligned} E_1 &= \sum_{i=1}^{2} \int_{\omega \in \Omega_i} \left(\frac{p_{i1}(\omega)}{P_1}\right)^{1-\sigma} \theta(L_1 + TR_1) d\omega \\ &= \theta(L_1 + TR_1). \end{aligned}$$

We note that optimal prices are the same as those derived in the text. Using the results of optimal prices, we rearrange tax revenues as

$$\begin{aligned} TR_1 &= t_1 \cdot TB_1, \\ TB_1 &= N_1\pi_{11} + N_2\pi_{21} \\ &= N_1[(p_{11} - a)q_{11} + \mathbb{1}(g_1 - \tau a)q_{12}] + N_2(p_{21} - g_2)q_{21} \\ &= N_1[(p_{11} - a)q_{11} + N_2(p_{21} - g_2)q_{21}] + \mathbb{1}N_1(g_1 - \tau a)q_{12} \\ &= (N_1 p_{11} q_{11} + N_2 p_{21} q_{21})/\sigma + \mathbb{1}N_1(g_1 - \tau a)q_{12} \\ &= E_1/\sigma + \mathbb{1}N_1(g_1 - \tau a)q_{12} \\ &= \frac{\theta(L_1 + t_1 TB_1)}{\sigma} + \mathbb{1}N_1 \frac{(\sigma-1)\Delta t_1}{\sigma} \frac{\phi\gamma_1\theta(L_2 + t_2 TB_2)}{\sigma(\phi\gamma_1 N_1 + N_2)} \end{aligned} \tag{A5-1}$$

$$\text{where} \quad \mathbb{1} = \begin{cases} 1 & \text{transfer-pricing case} \\ 0 & \text{no-transfer-pricing case} \end{cases}.$$

Similarly, tax revenues in country 2 are given by

$$\begin{aligned} TR_2 &= t_2 \cdot TB_2, \\ TB_2 &= N_2\pi_{22} + N_1\pi_{12} \\ &= \frac{\theta(L_2 + t_2 TB_2)}{\sigma} + \mathbb{1}N_2 \frac{(\sigma-1)\Delta t_2}{\sigma} \frac{\phi\gamma_2\theta(L_1 + t_1 TB_1)}{\sigma(N_1 + \phi\gamma_2 N_2)}. \end{aligned} \tag{A5-2}$$

The tax bases of the two countries are obtained by solving the system of equations: (A5-1) and (A5-2). Next, we derive the Nash-equilibrium tax rates in the cases with and without transfer pricing.

No-transfer-pricing case. In the case without transfer pricing, government $i \in \{1,2\}$'s payoff becomes

$$G_i(\mathbb{1}=0) = t_i TB_i - \frac{t_i}{\alpha_i(1-t_i)}$$
$$= \frac{\theta L_i t_i}{\sigma - \theta t_i} - \frac{t_i}{\alpha_i(1-t_i)},$$

where $\alpha_1 < \alpha_2$. Solving the FOCs give the equilibrium tax rates:

$$\widehat{t_i} = 1 - \frac{(\sigma-\theta)\sqrt{2\theta/\alpha_i}}{\sqrt{\sigma L} - \sqrt{2\theta/\alpha_i}},$$

noting that the tax base does not depend on the plant distribution n_i. We assume that $\sigma > 2\theta/(\alpha_i L)$ and $\alpha_i > 2\theta/L$ to ensure positive tax rates: $\widehat{t_i} > 0$, in which case the SOCs also hold. Clearly, $\widehat{t_i}$ increases with α_i. Government 1 with a more efficient tax administration sets a higher tax rate than government 2 with a less efficient one.

Transfer-pricing case. In the case with transfer pricing and full production agglomeration in country 1, government 1's payoff becomes

$$G_1(\mathbb{1}=1) = \frac{\theta t_1}{\sigma - \theta t_1}(L_1 + X) - \frac{t_1}{\alpha_1(1-t_1)},$$
$$\text{where} \quad X \equiv \frac{(\sigma-1)\Delta t_1}{\sigma} \cdot (L_2 + t_2 TB_2)$$
$$= \frac{(\sigma-1)\Delta t_1}{\sigma} \cdot \left(L_2 + \frac{\theta L_2 t_2}{\sigma - \theta t_2}\right) < 0.$$

X is a negative term accruing from the profits that the MNEs with production in country 1 transfer to their affiliates in country 2. It increases with t_1:

$$\frac{\partial X}{\partial t_1} = -\frac{\theta L(\sigma-1)[\sigma(1-t_1) + \theta\{t_2(2t_1-1) - t_1^2\}]}{2(1-t_1)^2(\sigma-\theta t_1)^2(\sigma-\theta t_2)} < 0,$$

noting that $\sigma > 1$; $\theta \in (0,1)$; and $t_i \in [0,1]$.

Government 2's payoff is the same as that in the no-transfer-pricing case, and thus, its equilibrium tax rate, denoted by t_2^*, is unchanged: $t_2^* = \widehat{t_2}$. Using this, we can compare the marginal effect of tax on government 1's payoff with and without transfer pricing:

$$\begin{aligned}
\left.\frac{\partial G_1(\mathbb{1}=1)}{\partial t_1}\right|_{t_i=\widehat{t}_i} &= \frac{\partial}{\partial t_1}\left[\frac{\theta L_i t_i}{\sigma-\theta t_i}-\frac{\alpha_i t_i}{1-t_i}\right]\Bigg|_{t_i=\widehat{t}_i}+\frac{\partial}{\partial t_1}\left[\frac{\theta t_1}{\sigma-\theta t_1}X\right]\Bigg|_{t_i=\widehat{t}_i} \\
&= \left.\frac{\partial G_1(\mathbb{1}=0)}{\partial t_1}\right|_{t_i=\widehat{t}_i}+\frac{\partial}{\partial t_1}\left[\frac{\theta t_1}{\sigma-\theta t_1}X\right]\Bigg|_{t_i=\widehat{t}_i} \\
&= 0+\left[\frac{\sigma\theta}{(\sigma-\theta t_1)^2}X+\frac{\theta t_1}{\sigma-\theta t_1}\frac{\partial X}{\partial t_1}\right]\Bigg|_{t_i=\widehat{t}_i} \\
&< 0 = \left.\frac{\partial G_1(\mathbb{1}=0)}{\partial t_1}\right|_{t_i=\widehat{t}_i}.
\end{aligned}$$

where taxes are evaluated at the equilibrium under no transfer pricing: $t_i = \widehat{t}_i$. Government 1 has an incentive to reduce its tax rate from $\widehat{t}_1$. Since the concave objective function has a unique maximizer, government 1 sets a lower tax rate in the transfer-pricing case than in the no-transfer-pricing case: $t_1^* < \widehat{t}_1$. For consistency with full production agglomeration in country 1, we choose the range of parameters such that $t_1^* > t_2^*$ holds.

L Transfer-pricing regulation and efficiency of tax administration

We assume that the degree of transfer-pricing regulation in country i, δ_i, increases with the country's efficiency of tax administration, α_i. Specifically, we set $\delta_i = \underline{\delta} + \xi\alpha_i$, where ξ captures the extent of correlation between the two measures. In Section 5.3 of the text, we derive the equilibrium tax rate under tax competition with regulation as follows:

$$\begin{aligned}
t_1^{**} &= 1-\sqrt{Y}, \quad \text{where } Y \equiv \frac{2\sigma}{\alpha_1\mu L}+\frac{(\sigma-1)[\sqrt{2\sigma\mu L/\alpha_2}-2\sigma(1+\delta_1)/\alpha_1]}{\mu L[2\sigma-1+\delta_1(\sigma-1)]}, \\
t_2^{**} &= 1-\sqrt{\frac{2\sigma}{\alpha_2\mu L}} \quad (= t_2^* = \widehat{t}_2),
\end{aligned}$$

As δ_2 does not appear in t_2^{**}, we only focus on t_1^{**}. Differentiating t_1^{**} with respect to ξ yields

$$\frac{dt_1^{**}}{d\xi} = -\frac{1}{2\sqrt{Y}}\frac{dY}{d\xi} > 0,$$

because

$$\frac{dY}{d\xi} = -\frac{(\sigma-1)\left[2\sigma^2+\alpha_1(\sigma-1)\sqrt{2\sigma\mu L/\alpha_2}\right]}{\mu L[2\sigma-1+\delta_1(\sigma-1)]^2} < 0.$$

As tax administration in country 1 is more efficient, government 1 prevents profit shifting more effectively. It is not as afraid of tax base erosion and thus can raise its tax rate.

References

Broda, C. and Weinstein, D. E. (2006). Globalization and the gains from variety. *Quarterly Journal of Economics*, 121(2):541–585.

Chakravarty, A. K. (2005). Global plant capacity and product allocation with pricing decisions. *European Journal of Operational Research*, 165(1):157–181.

Haufler, A., Mardan, M., and Schindler, D. (2018). Double tax discrimination to attract FDI and fight profit shifting: The role of CFC rules. *Journal of International Economics*, 114:25–43.

Helpman, E., Melitz, M. J., and Yeaple, S. R. (2004). Export versus FDI with heterogeneous firms. *American economic review*, 94(1):300–316.

Kind, H. J., Midelfart, K. H., and Schjelderup, G. (2005). Corporate tax systems, multinational enterprises, and economic integration. *Journal of International Economics*, 65(2):507–521.

Lai, H. and Trefler, D. (2002). The gains from trade with monopolistic competition: Specification, estimation, and mis-specification. NBER Working Paper, 24884.

Nielsen, S. B., Raimondos-Møller, P., and Schjelderup, G. (2003). Formula apportionment and transfer pricing under oligopolistic competition. *Journal of Public Economic Theory*, 5(2):419–437.

Qiu, L. D. and Zhou, W. (2006). International mergers: Incentives and welfare. *Journal of International Economics*, 68(1):38–58.