

Economic integration and agglomeration of multinational production with transfer pricing

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Abstract

Do low corporate taxes always favor multinational production in the course of economic integration? We build a two-country spatial model with different corporate tax rates in which multinational enterprises (MNEs) can manipulate transfer prices in intra-firm trade. Using transfer pricing, MNEs can shift profits between domestic production plants and foreign distribution affiliates. In the initial stage of integration, more MNEs locate their production plants in the low-tax country, and then in the later stage, this location pattern reverses. Contrary to conventional wisdom, high taxes may favor multinational production, which does not yet necessarily bring greater tax revenues. The results have implications for empirical studies and tax competition between unequal-sized countries.

Keywords: Transfer price; Production location; Economic integration; Intra-firm trade; Economic geography.

JEL classification: F12; F23; H25; H26.

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1. Introduction

Continuing economic integration in the last few decades brought more international mobility to multinational enterprises (MNEs) and allowed 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, Ch.6). One naturally expects that countries with a low corporate tax rate will succeed in hosting more FDI inflow than those with a high tax rate.

However, the type of MNE activities that operate in such low-tax countries is not obvious. Governments lower taxes with an aim of hosting production plants, which contribute to local employment and tax revenues. Contrary to host governments' expectations, MNEs reportedly establish affiliates in low-tax countries to save taxes and do not engage in production (Horner and Aoyama, 2009).¹

We can illustrate this point by looking at the profits and manufacturing activities of U.S. affiliates in Europe. In Fig. 1, we take U.S. affiliates in twelve European countries and draw the share of their profits from two low-tax countries, Ireland and Switzerland, over the last 15 years (thick line). The profit share of low-tax countries is disproportionately large for their size and doubled from 17% in 1997 to 34% in 2012. The manufacturing employment share of low-tax countries (dotted line), on the other hand, has been less than their profit share, indicating that U.S. affiliates there rely more on non-production activities, such as distribution, than those in the other countries. Although both the profit and manufacturing employment shares increased over time, there is no clear sign of convergence between the two.

¹Horner and Aoyama (2009) provide a list of Irish company relocations, with several examples indicating that MNEs move production from Ireland—with the world's lowest corporate tax rate at the time—abroad while maintaining non-production activities such as service centers and marketing. This implies that low-tax countries do not necessarily retain multinational production.

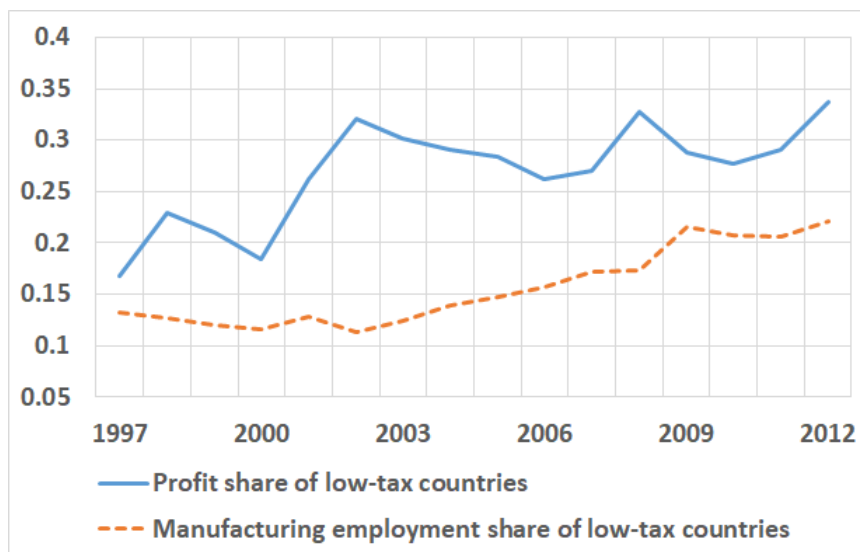


Fig. 1. Profit share and manufacturing employment share of low-tax countries in U.S. affiliates in Europe.

Sources: The U.S. Bureau of Economic Analysis (the BEA) and Zucman (2014).

Notes: Data on profit are from Zucman (2014) (“U.S. Direct Investment Abroad, Direct Investment Income Without Current-Cost Adjustment”), who compiled data originally from the BEA. Either Ireland or Switzerland had the lowest or the second lowest corporate tax rates among the sample countries for most of the period from 1997 to 2012: the average rates are 17.5% (Ireland), 23.3% (Switzerland), and 30.3% (overall) (source: OECD tax database). Data on employment are also from the BEA (“Employment of Affiliates, Country of UBO by Industry of Affiliate”). Because the BEA reports employment data for only selected countries, we take twelve countries in Europe with consistent reporting for 1997-2012: Belgium, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Spain, Sweden, Switzerland, and the U.K.

The diverging shares of profits versus manufacturing employment in low-tax countries may be explained by profit shifting of MNEs. MNEs allocate their activities between low-tax and high-tax countries and transfer profits by controlling prices for intra-firm trade, known as *transfer prices*.² For example, headquarters in high-tax countries makes profits by producing final goods and sells them to affiliates in low-tax countries by setting low transfer prices to inflate the affiliates’ profits. As expanding intra-firm trade due to economic integration made

²Empirical evidence on transfer pricing can be found in Swenson (2001); Bartelsman and Beetsma (2003); Clausing (2003); Bernard et al. (2006); Cristea and Nguyen (2016); Gumpert et al. (2016); Guvenen et al. (2017); and Davies et al. (2018).

profit shifting easy, the geographical separation of production and profits may continue to rise.

When firms can shift profits and relocate, it is no longer clear how MNEs optimally set up their firm structure in the presence of international tax differences. We examine this aspect in the present study. We extend a two-country geography model developed by Martin and Rogers (1995) and Pflüger (2004) to incorporate MNEs with profit-shifting motives. In the main analysis, the model contains two countries of equal size, but with (exogenously given) different corporate tax rates. Each MNE sets up a production plant in one country and a distribution affiliate in the other. MNEs engage in intra-firm trade; their production plants sell goods to the domestic market and export them to their foreign affiliates for distribution. Firms use the internal transaction price, or transfer pricing, for profit shifting. The effectiveness of profit shifting crucially depends on the volume of intra-firm trade, which is subject to trade costs. We investigate in which country, the low-tax or the high-tax one, multinational production is agglomerated and how the location pattern changes in response to a decline in trade costs.

Our findings are as follows. In the initial stage 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 and thus profit shifting, MNEs rely on their domestic production plant for profits. They simply prefer to locate production in the low-tax country to save taxes on their plant.

A further reduction in trade costs, however, reverses this location pattern. Especially when trade costs are sufficiently low, all multinational production is agglomerated in the high-tax country. This result seems surprising, but it is indeed consistent with MNEs' profit-shifting motive. As low trade costs expand intra-firm trade, MNEs with production plants in the high-tax country *lower* the transfer price to shift their domestic plants profits to their foreign affiliate in the low-tax country. Furthermore, the lowered transfer price reduces the marginal cost of the foreign affiliates, and thus makes them competitive in their market. On the other hand, MNEs with production plants in the low-tax country *raise* the transfer price to move profits from the foreign affiliate in the high-tax country back to the domestic plant.

The high transfer price decreases the affiliate's competitiveness. The direction of profit shifting from the high-tax to the low-tax country works such that MNEs with production in the high-tax country become competitive, resulting in production agglomeration there.

These results may explain the fact that U.S. affiliates in low-tax European countries engage disproportionately more in non-production activities than those in high-tax European countries do, as Fig. 1 shows. In addition, Overesch (2009) provides supporting empirical evidence. He finds that multinationals in high-tax Germany increase real investments because the cross-country corporate tax difference between their home country and Germany is larger.

The agglomeration of multinational production in the high-tax country, however, does not necessarily lead to greater tax revenues there, since a large portion of profits shift to the foreign affiliates in the low-tax country. Amid growing concerns about tax base erosion, the OECD recently reported that the estimated revenue losses from MNEs' tax avoidance is at most 10% of global corporate income tax revenues.³ Our finding may justify the concern about low-tax countries attracting multinationals that contribute little to the host economies.

Based on our theoretical findings, we can draw implications for empirical studies on FDI and corporate taxes. The empirical literature largely supports the positive effect of low corporate tax rates on FDI inflow but does not agree on the significance and magnitude of the effect (Navaretti and Venables, 2004, Ch.10). It is unsurprising, according to our findings, that host countries with lower corporate tax rates may not enjoy inward FDI if the host and source countries are integrated enough to make profit shifting easy.

Our results also have implications for tax competition over multinational production between unequal-sized countries. Existing studies on tax competition in agglomeration economies tell us that large countries set a higher tax rate, while keeping the agglomeration of production (Kind et al., 2000; Ludema and Wooton, 2000; Andersson and Forslid,

³See <http://www.oecd.org/ctp/oecd-presents-outputs-of-oecd-g20-beps-project-for-discussion-at-g20-htm>, accessed on 20 February 2019. To tackle this issue, the OECD set up a project called "Base Erosion and Profit Shifting" (BEPS), involving over eighty countries. See <http://www.oecd.org/tax/beps>, accessed on 20 February 2019.

2003; Baldwin and Krugman, 2004; Ottaviano and van Ypersele, 2005; Borck and Pflüger, 2006).⁴ If transfer pricing can be used, however, the large country still keeps the agglomeration, but sets a lower tax rate than it would if transfer pricing is impossible. A bigger tax difference would bring more opportunities to manipulate transfer pricing, thus triggering an erosion of taxable profits. Therefore, introducing profit shifting exerts downward pressure on the large country's tax rate and thus narrows the equilibrium tax difference.

Relation to the literature. This paper fits into the literature on transfer pricing pioneered by Copithorne (1971) and Horst (1971). The literature points out that MNEs use transfer prices to make affiliates competitive as well as for shifting profits. The former is called a strategic effect and the latter a tax manipulation effect. Earlier studies examining the strategic use of transfer pricing include those by Elitzur and Mintz (1996); Schjelderup and Sjørgard (1997); Zhao (2000); and Nielsen et al. (2003).⁵ The literature looks only at profit shifting with a fixed location of each affiliate. Our contribution is to uncover how these two effects of transfer pricing affect the MNEs' location choices.

Recent studies focus on the FDI decision of MNEs with profit-shifting motives; that is, whether MNEs should undertake FDI and manufacture inputs within their firms, or source inputs from independent suppliers, known as the *make or buy* decision (Bauer and Langenmayr, 2013; Egger and Seidel, 2013; Keuschnigg and Devereux, 2013; Choi et al., 2018).⁶ Egger and Seidel (2013), for example, theoretically predict and empirically confirm that larger tax differences are more likely to lead MNEs to engage in FDI, rather than outsourcing. Choi et al. (2018) find a possibility that MNEs do both FDI and outsourcing to avoid regulations by tax authorities. While these studies fix the supplier's location and look at MNEs' organizational choices, we fix the MNEs' organization form and allow for the

⁴Recent studies in the literature allow for heterogeneity among firms (Davies and Eckel, 2010; Haufler and Stähler, 2013; Baldwin and Okubo, 2014), forward looking behavior by governments (Han et al., 2014; Kato, 2015), and lobbying by firms (Ma, 2017; Kato, 2018).

⁵While these studies (and ours) deal exclusively with tangible assets, recent studies examine intangible assets (Juránek et al., 2018).

⁶For studies on MNEs without profit shifting motives, see Antràs and Yeaple (2014); Section 3.6 of Costinot and Rodríguez-Clare (2014).

endogenous location of production. Our companion study, Kato and Okoshi (2018), focuses on the location decision within MNEs, though accounts for neither MNEs' various activities (production and distribution), nor trade costs, unlike the present one.

Due to analytical inconvenience, only a handful of studies examine tax competition for MNEs using transfer prices (Haufler and Schjelderup, 2000; Kind et al., 2005; Stöwhase, 2005, 2013; Ma and Raimondos, 2015).⁷ In models with two unequal-sized countries, Stöwhase (2005, 2013) find that introducing profit shifting will *not* generally put downward pressure on tax rates, which is in contrast to our findings. These different results are mainly due to the strategic effect of transfer prices in our model, which strengthens profit-shifting incentives and thereby leads to tougher tax competition. In terms of setting, the closest study to ours is Ma and Raimondos (2015), who allow for both trade costs and unequal-sized countries. In a tax-competition game over a *single* MNE, they show the possibility that the large country will win the MNE while setting a higher tax rate, which is similar to our findings.⁸ However, due to the analytical inconvenience arising from the location discontinuities of a single MNE, their analysis relies heavily on numerical simulations. It is thus unclear whether or not introducing profit shifting increases the tax difference between the large and small countries. By contrast, we can obtain sharp predictions in analytical form by employing an economic geography model with a continuum of MNEs and focusing on a full agglomerated situation.

The rest of the paper is organized as follows. The next section develops the model. Section 3 examines the case where the tax rates of two equal-sized countries are exogenously given and derives the equilibrium distribution of production plants. Section 4 discusses the implications for empirical studies and tax competition between unequal-sized countries. The final section concludes.

⁷More recent studies introduce a low-tax country with no production or consumption, calling it a *tax haven* country, and consider tax competition between a home country and the tax haven (Krautheim and Schmidt-Eisenlohr, 2011; Langenmayr et al., 2015; Hauck, 2019). This setting greatly enhances analytical tractability but is not suitable to investigate the MNEs' production location.

⁸In other numerical examples, they allow for asymmetry in the leniency of tax regulations and asymmetric country sizes, in which case, the small country may win the MNE while setting a higher tax rate.

2. Basic setting

Consumers. We consider an economy with two countries, indexed by 1 and 2, and two goods, homogeneous and differentiated ones. Letting L be the world population, country 1 has a population of $L_1 = s_1L$, while country 2 has a population of $L_2 = s_2L = (1 - s_1)L$, where $s_1 \in (0, 1)$ is country 1's share of the world population. Each individual owns one unit of labor.

Following Pflüger (2004), each consumer has an identical quasi-linear utility function with a constant-elasticity-of-substitution (CES) sub utility. Consumers in country 1 solve the following maximization problem:

$$\max_{\tilde{q}_{11}(\omega), \tilde{q}_{21}(\omega), q_1^O} u_1 = \mu \ln Q_1 + q_1^O,$$

$$\text{where } Q_1 \equiv \left[\sum_{i=1}^2 \int_{\omega \in \Omega_i} \tilde{q}_{i1}(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}},$$

subject to the budget constraint:

$$\sum_{i=1}^2 \int_{\omega \in \Omega_i} p_{i1}(\omega) \tilde{q}_{i1}(\omega) d\omega + q_1^O = y_1 + \bar{q}_1^O.$$

$\mu > 0$ captures the intensity of the preference for the differentiated goods. q_1^O and \bar{q}_1^O are the individual demand for the homogeneous good and its initial endowment, respectively. We assume that \bar{q}_1^O is large enough for the homogeneous good to be consumed. $\tilde{q}_{i1}(\omega)$ 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 above problem gives the aggregate demand for the variety ω produced in

country $i \in \{1, 2\}$ and consumed in country 1:

$$q_{i1}(\omega) \equiv L_1 \tilde{q}_{i1}(\omega) = \left(\frac{p_{i1}(\omega)}{P_1} \right)^{-\sigma} \frac{\mu L_1}{P_1}. \quad (1)$$

where $P_1 \equiv \left[\sum_{i=1}^2 \int_{\omega \in \Omega_i} p_{i1}(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}}$.

P_1 is the CES 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 will 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; that is $w_1 = w_2$. We choose the good as the 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 f units of capital for a production plant in one country and another f units for a foreign affiliate in the other.⁹ Supposing the world amount of capital is $2K$, we choose f such that the world has $2K/(2f) = L$ MNEs, or $f = K/L$. The post-tax profits are repatriated to capital owners living in a third country (outside of the economy). We denote the number of production plants located in country 1 (or country 2) by $N_1 = n_1 L$ (or $N_2 = n_2 L = (1 - n_1)L$), where $n_1 \in [0, 1]$ is country 1's share of production plants. Once established, each MNE needs a units of labor to produce one unit of variety.

Consider an MNE with its production plant in country 1. The plant produces quantities q_{11} and sells them at a price p_{11} to domestic consumers. In addition, it produces quantities q_{12}

⁹Similar 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.

and exports them at a transfer price g_1 to its foreign affiliate in country 2. When exporting, due to iceberg trade costs $\tau > 1$, $1/\tau < 1$ units of quantities melt away, so 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 have decentralized decision making. In other words, the headquarters (or the production plant) 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. The idea that the headquarters lets affiliates make decisions for strategic purpose is known as the delegation principle, and is adopted by many studies in the literature.¹⁰ 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).¹¹ We examine the case of centralized decision making in Appendix 6 and confirm the robustness of our results.

The timing of actions proceeds as follows. First, each MNE chooses the country in which to locate a production plant and a foreign affiliate, endogenously determining the share of plants n_1 . The decision is based on a comparison of the post-tax profits in the two countries. Second, the MNE chooses the transfer price. Third, production plants and foreign affiliates engage in price competition in each country. Finally, production and consumption take place. We solve the game in a backward fashion. 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*. We will examine the two situations in turn.

2.1. Optimal prices in the short-run equilibrium

Let us derive the optimal prices given the distribution of plants and affiliates. The pre-tax profits of the production plant in country 1 (π_{11}) and those of the foreign affiliate in

¹⁰See, for example, Zhao (2000); Nielsen et al. (2003, 2008); and Kind et al. (2005).

¹¹See Ziss (2007) for more on this issue.

country 2 (π_{12}) are, respectively,

$$\pi_{11} = (p_{11} - a)q_{11} + \underbrace{(g_1 - \tau a)q_{12}}_{\text{Shifted profit}},$$

$$\pi_{12} = (p_{12} - g_1)q_{12},$$

where q_{11} is given by Eq. (1) and q_{12} is defined analogously. The second term in π_{11} represents the profits from intra-firm trade subject to trade costs τ . As we will see shortly, this term captures profit shifting within MNEs. At 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

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

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

$$\Pi_1 = (1 - t_1)\pi_{11} + (1 - t_2)\pi_{12},$$

where $t_i \in [0, 1]$ is the tax rate of country $i \in \{1, 2\}$. The optimal transfer price is¹²

$$g_1 = \frac{\sigma \tau a}{\sigma - \Delta t_1}, \quad \text{where } \Delta t_1 \equiv \frac{t_2 - t_1}{1 - t_1}, \quad (2)$$

which is positive because $\sigma - \Delta t_1 > 0$. We can check that g_1 decreases with t_1 and increases with t_2 . As a higher tax rate in country 1 reduces the post-tax profit of the production plant, the MNE tries to move profits from country 1 to 2 by lowering the transfer price. When the tax rate in country 2 increases, the direction of profit shifting reverses, and the MNE raises the transfer price.

¹²We can confirm that the second order condition (SOC) is satisfied at the optimal point. The SOC is $\partial^2 \Pi_1 / \partial g_1^2 < 0$, which reduces to $(1 - t_2)g_1 - (1 - t_1)[(\sigma + 1)\tau a - \sigma g_1] < 0$. This inequality holds at $g_1 = \sigma \tau a / (\sigma - \Delta t_1)$.

Similarly, the MNE with its production plant in country 2 sets the optimal transfer price as follows:

$$g_2 = \frac{\sigma\tau a}{\sigma - \Delta t_2}, \quad \text{where } \Delta t_2 \equiv \frac{t_1 - t_2}{1 - t_2}, \quad (3)$$

which is also positive because $\sigma - \Delta t_2 > 0$.

To see the direction of profit shifting, we assume $t_1 > t_2$ and have $\Delta t_1 < 0 < \Delta t_2$. Using the optimal transfer prices, we can rewrite the profit from intra-firm trade as

$$(g_1 - \tau a)q_{12} = \frac{\tau a \Delta t_1}{\sigma - \Delta t_1} q_{12} < 0 \quad \text{for the MNE with production in country 1,} \quad (4-1)$$

$$(g_2 - \tau a)q_{21} = \frac{\tau a \Delta t_2}{\sigma - \Delta t_2} q_{21} > 0 \quad \text{for the MNE with production in country 2.} \quad (4-2)$$

The MNE with production in country 1 cuts the transfer price to below the true marginal cost, making negative profits from intra-firm trade. In doing so, the plant shifts profits made in the high-tax country 1 to the foreign affiliate in the low-tax country 2. As for the MNE with production in country 2, the direction reverses: from the affiliate in the high-tax country 1 to the plant in the low-tax country 2.

We can rewrite the post-tax profit as

$$\begin{aligned}
\Pi_1 &= (1 - t_1)\pi_{11} + (1 - t_2)\pi_{12} \\
&= (1 - t_1) \left[\frac{\mu L_1}{\sigma(N_1 + \phi\gamma_2 N_2)} + \underbrace{\frac{(\sigma - 1)\Delta t_1}{\sigma} \cdot \frac{\phi\gamma_1 \mu L_2}{\sigma(\phi\gamma_1 N_1 + N_2)}}_{\text{Shifted profits}} \right] + (1 - t_2) \cdot \frac{\phi\gamma_1 \mu L_2}{\sigma(\phi\gamma_1 N_1 + N_2)},
\end{aligned} \tag{5-1}$$

$$\begin{aligned}
\Pi_2 &= (1 - t_1)\pi_{21} + (1 - t_2)\pi_{22} \\
&= (1 - t_1) \cdot \frac{\phi\gamma_2 \mu L_1}{\sigma(N_1 + \phi\gamma_2 N_2)} + (1 - t_2) \left[\frac{\mu L_2}{\sigma(\phi\gamma_1 N_1 + N_2)} + \underbrace{\frac{(\sigma - 1)\Delta t_2}{\sigma} \cdot \frac{\phi\gamma_2 \mu L_1}{\sigma(N_1 + \phi\gamma_2 N_2)}}_{\text{Shifted profits}} \right],
\end{aligned} \tag{5-2}$$

$$\text{where } \phi \equiv \tau^{1-\sigma}, \quad \gamma_i \equiv \left(\frac{\sigma}{\sigma - \Delta t_i} \right)^{1-\sigma}, \quad \Delta t_i \equiv \frac{t_j - t_i}{1 - t_i}, \quad i \neq j \in \{1, 2\}.$$

The second term in the square brackets in Π_1 and Π_2 expresses the profits shifted through transfer pricing. $\phi = \tau^{1-\sigma} \in [0, 1]$ is an inverse measure of trade costs, or the freeness 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.

If the tax difference is large, profit shifting is so excessive that taxable profits can be negative. To ensure positive profits, we assume the condition that $1 + (\sigma - 1)\Delta t_1/\sigma > 0$. This simply requires that the tax difference should not be too large. See Appendix 3 for details.

When the difference in the above post-tax profits is positive; that is, $\Delta\Pi \equiv \Pi_1 - \Pi_2 > 0$, the MNE prefers to locate its production plant in country 1, and vice versa. In the long-run equilibrium, the profit differential is zero and no MNEs are willing to change their allocation of plants.

3. Equilibrium allocation of production plants

To highlight the role of tax difference, we suppose that the tax rate is higher in country 1 ($t_1 > t_2$), but the two countries are of the same size ($s_1 = 1/2$).¹³ By solving the long-run equilibrium condition ($\Delta\Pi = 0$) for the share of production plants in country 1, we obtain interior equilibria $n_1 \in (0, 1)$. If $\Delta\Pi = 0$ does not have interior solutions, then we obtain corner equilibria in which all multinational production takes place in one country; that is, $n_1 \in \{0, 1\}$.

To see how a reduction in trade costs affects the long-run equilibrium allocation, we consider the two extreme cases: prohibitive trade costs ($\phi = 0$) and zero trade costs ($\phi = 1$).

An extremely high level of trade costs does not allow for intra-firm trade, leaving no room for profit shifting.¹⁴ As the MNEs earn profits only from the domestic sales of their production plants, they prefer to locate them in the low-tax country 2. We note that the equilibrium distribution involves a small but positive share of plants in the high-tax country 1; that is, $n_1|_{\phi=0} \in (0, 1/2)$. Since competition in the domestic market works as a dispersion force, the corner distribution where all production plants are in country 2 ($n_1|_{\phi=0} = 0$) cannot be an equilibrium.

Zero trade costs, on the other hand, allow MNEs to engage in intra-firm trade fully, making profit shifting through transfer pricing effective.¹⁵ In our model, transfer pricing does not just shift profits between domestic plants and foreign affiliates, but also affects the competitiveness of the affiliates. As we showed, MNEs with production in the high-tax country 1 set a low transfer price to shift profits to their foreign affiliates in the low-tax country 2 (see Eqs. (2) and (4-1)). Due to the low sourcing cost, the foreign affiliates can sell varieties at a low price and become competitive against local production plants. By contrast, MNEs with production in the low-tax country 2 set a high transfer price (see Eqs. (3) and (4-2)), which makes their foreign affiliates in the high-tax country 1 less competitive.

¹³The assumption of symmetric market size is for simplicity and is not crucial for our main result, which we will discuss after Proposition 1.

¹⁴In Eqs. (5-1) and (5-2), the profits from intra-firm trade and those from the foreign affiliate disappear if $\phi = 0$.

¹⁵We can confirm that the shifted profit increases with ϕ ; that is, $\partial[(g_i - \tau a)q_{ij}]/\partial\phi > 0$ for $i \neq j \in \{1, 2\}$.

They are at a disadvantage in both the domestic and foreign markets. Therefore, MNEs prefer to locate production in the high-tax country so the direction of profit shifting makes foreign affiliates competitive.

From the results of the two polar cases, it is expected that more production plants are in the low-tax country 2 if trade costs are high, whereas they are in the high-tax country 1 if trade costs are low. We can prove that this is the case and summarize the findings as follows (see Appendix 1 for a proof).

Proposition 1 (Plant distribution). *Suppose that country 1 has a higher corporate tax rate than country 2 does. The equilibrium allocation of production plants is summarized as follows:*

(i). *With high trade costs such that $\phi \in [0, \phi^*)$, the high-tax country 1 hosts a smaller share of plants than the low-tax country 2 does; that is, $n_1 < 1/2$.*

(ii). *With low trade costs such that $\phi \in (\phi^*, 1]$, the high-tax country 1 hosts a greater share of plants; that is, $n_1 > 1/2$.*

At $\phi = \phi^$, the two countries have an equal share of plants; that is, $n_1 = 1/2$.*

Fig. 2 shows a representative pattern of equilibrium plant distribution for different levels of the freeness of trade ϕ (thick curve), along with the equilibrium plant distribution under no profit shifting (dotted line).¹⁶ As ϕ increases from zero, the high-tax country 1 has a decrease in plants in both cases, with and without profit shifting. When high trade costs prevent exporting, MNEs make profits mostly from their domestic production plant and thus prefer to locate it in the low-tax country. Along with a further decrease in ϕ from $\phi^\#$, however, the high-tax country 1 increases plants in the case with profit shifting, whereas it continues to decrease plants in the case without profit shifting. Sufficiently low trade costs expand intra-firm trade and thus the opportunities for profit shifting, leading to a sharp contrast in location patterns.

¹⁶The parameter values are $\sigma = 5$, $t_1 = 0.8$, $t_2 = 0.7$, $L = 10$, $s_1 = 0.5$, $\mu = 1$, and $a = 1$.

The result that the high-tax country attracts more multinational plants for low trade costs does not depend on the assumption of a symmetric market size. If the high-tax country is larger, then its market-size advantage strengthens the agglomeration of plants (see Section 4.2). If it has a smaller size, then its market-size disadvantage may weaken the agglomeration force. Even in this case, we can numerically confirm that multinational production would be agglomerated in the high-tax country for sufficiently low trade costs.

This finding seems consistent with the fact that in the last two decades, which are marked by globalization, U.S. affiliates in Europe make a disproportionate share of profits from low-tax countries compared to manufacturing activities there, as Fig. 1 shows. Moreover, Overesch (2009) finds empirically that the cross-country tax difference between high-tax Germany and a low-tax home country increases German inbound investments.

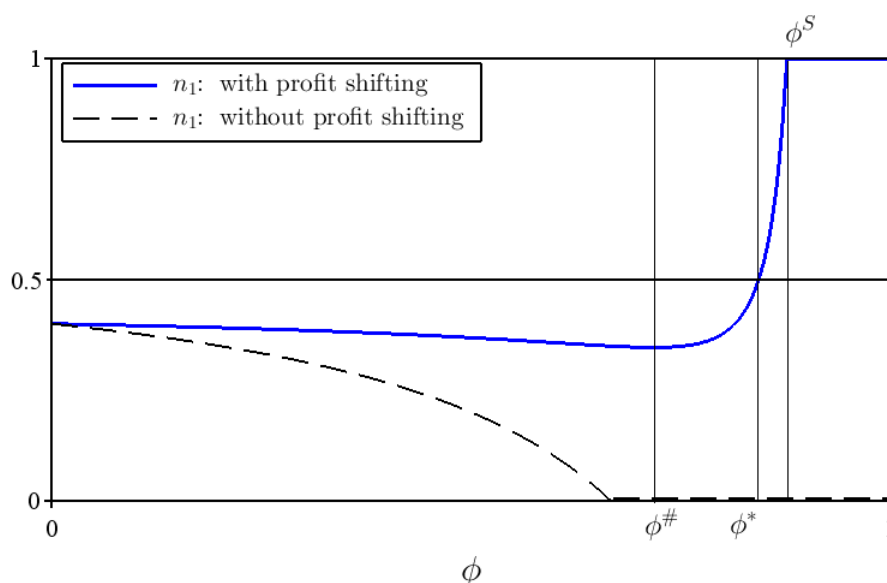


Fig. 2. Share of production plants in the high-tax country 1.

Full agglomeration. If ϕ is sufficiently high such that $\phi > \phi^S$, which is called a *sustain point*, then all production plants are located in country 1.¹⁷ It can be checked that ϕ^S

¹⁷Formally, a sustain point is the level of the freeness of trade above which full agglomeration is sustainable.

decreases with $t_1 - t_2$. 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, since they set a much lower price than their rivals in both the domestic and foreign markets (i.e., $p_{11} < p_{21}$; $p_{12} < p_{22}$). Consequently, full agglomeration in country 1 is more likely to occur since the tax difference is larger. We summarize these findings as follows (see Appendix 2 for a proof).

Proposition 2 (Full agglomeration). *With sufficiently low trade costs such that $\phi \in [\phi^S, 1]$, where $\phi^S > \phi^*$, all production plants locate in the high-tax country 1, that is, $n_1 = 1$. As the tax difference increases, the sustain point ϕ^S decreases, and thus full agglomeration is more likely to occur.*

Tax revenues. Although the high-tax country 1 may host more multinational production, this does not necessarily guarantee greater tax revenues. The tax revenues of each country are

$$TR_1 \equiv t_1(N_1\pi_{11} + N_2\pi_{21}),$$

$$TR_2 \equiv t_2(N_2\pi_{22} + N_1\pi_{12}).$$

Fig. 3 illustrates the profits and tax revenues.¹⁸ In both countries, the profit of the production plant, π_{ii} , decreases with ϕ since a fall in trade costs leads to tougher import competition (see Eqs. (5-1) and (5-2)). As a mirror image of this result, the profit of the affiliate, π_{ji} , generally increases with ϕ .

Although the profits of plant and affiliate in both countries behave similarly, π_{11} declines at a faster rate than does π_{22} , and π_{21} increases at a slower rate than does π_{12} . Lower trade costs increase profit shifting from country 1 to 2, and thus reduce π_{11} further. This in turn makes the foreign affiliates in country 2 competitive through low transfer prices, raising π_{12} more. Especially when trade costs are low, such that $\phi \in (\phi^\dagger, 1]$, these effects are so

¹⁸The parameter values are the same as those in Fig. 2.

strong that tax revenues in country 1 become smaller than those in country 2. The high tax country 1 can attract more multinational production, which nevertheless does not mean it earns greater tax revenues. Unlike the case without profit shifting, the high tax country cannot fully enforce taxes because MNEs shift some of the operating profits to the low tax country.

We summarize these findings as follows (see Appendix 5 for a proof).

Proposition 3 (Tax revenues). *With high trade costs such that $\phi \in [0, \phi^\dagger)$, the high-tax country 1 earns greater tax revenues than the low-tax country 2 does. With low trade costs, such that $\phi \in (\phi^\dagger, 1]$, this pattern reverses.*

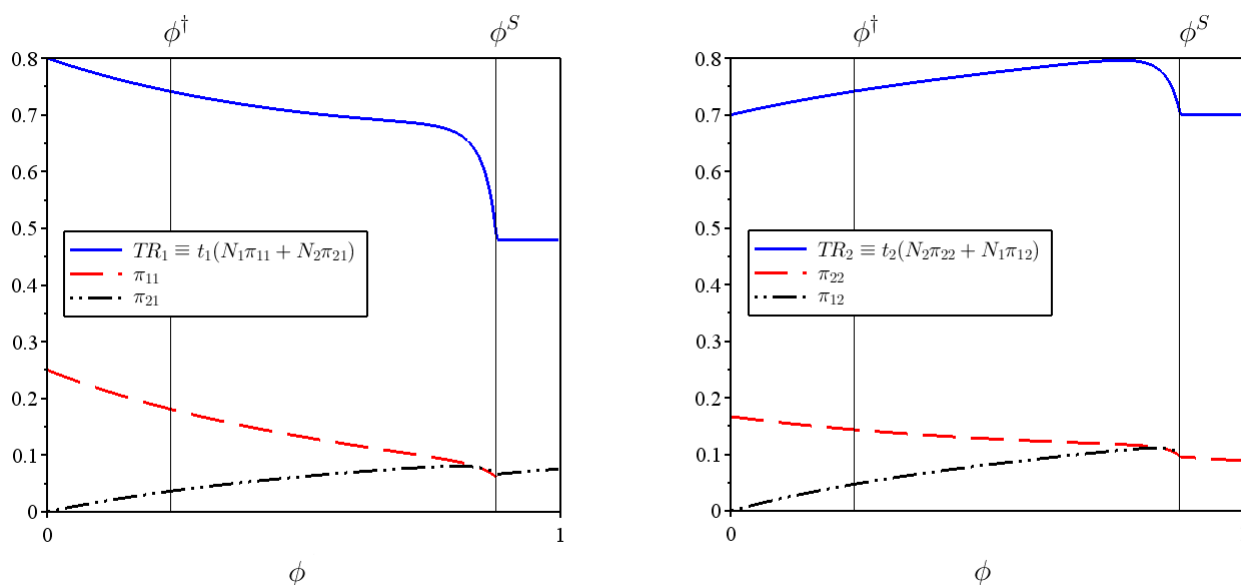


Fig. 3. Profits and tax revenues: Country 1 on the left and country 2 on the right.

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 if MNEs have centralized decision making, in which the MNE chooses 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 agglomeration of production plants in the high-tax country. See Appendix 6 for details.

4. Discussion and extensions

The main result in the previous analysis is that the high-tax country gains agglomeration of multinational production if trade costs are low. We discuss here (i) its implications for empirical studies investigating the determinants of FDI and (ii) those for tax competition between unequal-sized countries.

4.1. Implications for empirics

Our results have implications for empirical research on the relationship between FDI and the host country's taxes. By interpreting production plants in our model as FDI, we can think of the following regression:

$$FDI_{h,s} = \beta_0 + \beta_1(TAX_s - TAX_h) + \beta_2 \cdot \phi_{h,s} \cdot (TAX_s - TAX_h) + \mathbf{X}\boldsymbol{\beta} + \varepsilon_{h,s},$$

where $FDI_{h,s}$ is the inflow of FDI from source country s to host country h , TAX_i is the corporate tax rate in country $i \in \{h, s\}$, $\phi_{h,s}$ is a measure of economic integration between country h and s , \mathbf{X} is a vector of other explanatory variables, and $\varepsilon_{h,s}$ is the error term. One proxy for $\phi_{h,s}$ is an inverse of the distance between two countries.

Holding other factors fixed, it is expected that a larger tax difference encourages FDI inflow, meaning $\beta_1 > 0$. Our results indicate that the impact of the tax difference varies

according to the freeness of trade. As two countries are more integrated, a larger tax difference discourages FDI inflow, implying $\beta_2 < 0$. Empirical studies using country-level data have yet to reach a consensus on the impact of corporate tax on FDI (Navaretti and Venables, 2004, Ch.10 for a survey). Some obtain significant and large coefficients, while others find weak and small coefficients (De Mooij and Ederveen, 2003; Bellak and Leibrecht, 2009; Jensen, 2012). These mixed findings may be because these studies do not consider the degree of economic integration between the host and source countries.

4.2. Implications for tax competition

We showed that MNEs' profit-shifting motives may lead to the agglomeration of production in the high-tax country, which challenges the conventional view that countries with low-taxes attract production plants. The profit-shifting channel is also expected to affect competition between governments for multinational production. This section allows countries to choose their tax rate non-cooperatively and compare the results of tax competition with profit shifting to those without profit shifting.

We introduce country-size asymmetry and assume that country 1 is larger than country 2 is; that is, $L_1 = s_1 L > (1 - s_1)L = L_2$, or $s_1 > 1/2$. To highlight the asymmetric size, suppose for a moment that country 1's tax rate is exogenous and is higher than country 2's. If country 1's size advantage is sufficiently stronger than its tax disadvantage, MNEs prefer to locate their production plants in country 1.¹⁹

Fig. 4 illustrates a representative pattern of equilibrium plant share in country 1 in the case with and without profit shifting.²⁰ Declining trade costs accelerates the concentration of production in the large country, and eventually leads to full agglomeration, known as the *core-periphery* situation. Fig. 4 also shows that the sustain point in the case without profit shifting, $\hat{\phi}^S$, is larger than that in the case with profit shifting, ϕ^S .²¹ As the competitive

¹⁹See Appendix 5 for the condition of this case.

²⁰The parameter values are $\sigma = 5$, $t_1 = 0.8$, $t_2 = 0.75$, $L = 10$, $s_1 = 0.6$, $\mu = 1$, and $a = 1$.

²¹To avoid the abuse of notation, we use the same symbol ϕ^S as in the previous section, in which the two countries are of equal size. We formally prove $\hat{\phi}^S > \phi^S$ in Appendix 5.

effect of transfer pricing favors the high-tax country (Proposition 2), introducing profit shifting further motivates MNEs to locate production in country 1.

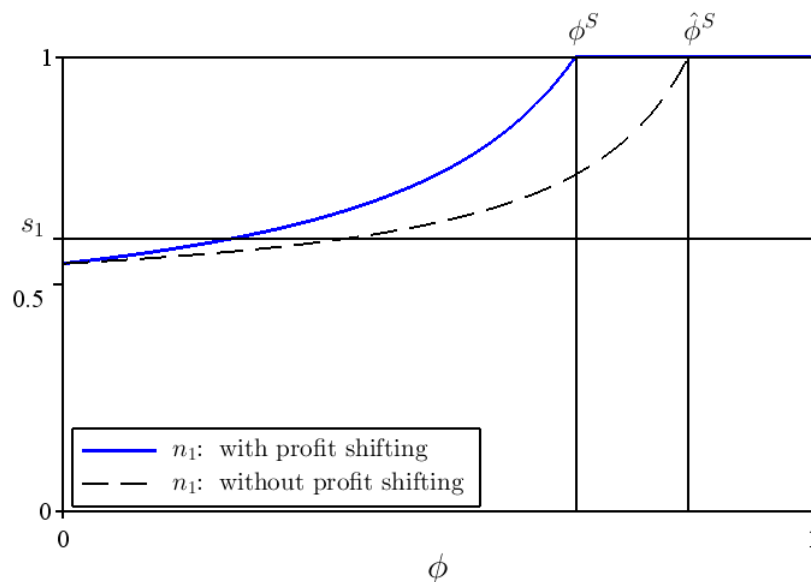


Fig. 4. Share of production plants in the large, high-tax country 1.

Following Baldwin and Krugman (2004); Borck and Pflüger (2006); and Kato (2015), the objective function of the government in each country takes the form of

$$G_i = TR_i - \frac{\beta}{1 - t_i},$$

$$\text{where } TR_i \equiv t_i(N_i\pi_{ii} + N_j\pi_{ji}), \quad i \neq j \in \{1, 2\},$$

where β is a positive constant.²² The first term represents tax revenues and the second term is the administration cost associated with collecting taxes.²³ The timing of actions proceeds

²²The objective function captures the basic conflicts governments face: they attempt to raise tax revenues while maintaining a low tax rate, which is thought of as a reduced-form objective that either selfish or benevolent governments adopt (Baldwin and Krugman, 2004).

²³Tax administration cost is 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)

as follows. First, the two governments simultaneously and non-cooperatively decide their tax rates, and then MNEs choose their plant allocations. Finally, MNEs set their prices and both domestic and foreign affiliates make sales. We solve the tax-competition game in a backward fashion.

To make our results as comparable as possible to those of prior studies (Baldwin and Krugman, 2004, in particular), we analyze tax competition in the core-periphery situation. That is, we focus on the range of the freeness of trade such that $\phi \in [\phi^S, 1]$.

No-profit-shifting case. As a benchmark, we first derive the difference in equilibrium tax rates when profit shifting is not allowed. The inability to manipulate transfer prices means $g_i = \tau a$, resulting in zero profits from intra-firm trade: $(g_i - \tau a)q_{ij} = 0$ for $i \neq j \in \{1, 2\}$. In the core-periphery situation (i.e., $n_1 = 1$), the objective functions become

$$G_i = \frac{\mu L_i t_i}{\sigma} - \frac{\beta}{1 - t_i}, \quad i \in \{1, 2\}.$$

The equilibrium tax rates are given by

$$t_i^O = 1 - \sqrt{\frac{\beta\sigma}{\mu L_i}}, \quad i \in \{1, 2\}.$$

It is easy to see that $t_1^O > t_2^O$, suggesting that the large country 1 sets a higher tax rate than the small country 2, while keeping all production plants.²⁴ This is in line with the results in the literature (Baldwin and Krugman, 2004).

Profit-shifting case. We will see how the results above change if MNEs can utilize transfer

²⁴For G_i to be positive in equilibrium, we assume that the intensity of administration costs is not too large: $\beta < \mu L_2 / (2\sigma)$. Under this assumption, t_i^O lies between $[0, 1]$.

pricing. The objective functions are modified as

$$G_1 = \frac{\mu t_1}{\sigma} \left[L_1 + \frac{(\sigma - 1)\Delta t_1}{\sigma} L_2 \right] - \frac{\beta}{1 - t_1},$$

$$G_2 = \frac{\mu L_2 t_2}{\sigma} - \frac{\beta}{1 - t_2}.$$

Country 1's payoff now involves the tax difference since plants in the high-tax country 1 move their profits to the low-tax country 2. If country 1 keeps its tax rate as high as it does in the no-profit-shifting case, then it earns less tax revenues. Thus, country 1 has an incentive to lower its tax rate to prevent the erosion of taxable profits.

The equilibrium tax rates are

$$t_1^* = 1 - \sqrt{\frac{\beta\sigma^2 + (\sigma - 1)\sqrt{\beta\sigma\mu L_2}}{\mu L(\sigma + s_1 - 1)}},$$

$$t_2^* = 1 - \sqrt{\frac{\beta\sigma}{\mu L_2}} \quad (= t_2^O).$$

It can be checked that $t_1^* > t_2^*$ and $t_1^* < t_1^O$. Although country 1 still chooses a higher tax rate and maintains all production plants, its tax rate is lower than that in the no-profit shifting case. In terms of equilibrium tax rates, profit shifting leads to more intense tax competition.

We summarize these findings as follows.

Proposition 4 (Tax competition). *Consider tax competition between unequal-sized countries in the core-periphery outcome.*

- (i) *The large country 1 sets a higher tax rate than the small country 2 does, while keeping full agglomeration of production: $t_1^* > t_2^*$; $n_1 = 1$.*
- (ii) *Compared to the no-profit-shifting case, country 1's tax rate is low, whereas country 2's tax rate is unchanged: $t_1^* < t_1^O$; $t_2^* = t_2^O$.*

That is, introducing transfer pricing makes tax competition tougher in the sense that the equilibrium tax differential is smaller.

A similar result can be found in Haufler and Schjelderup (2000), who employ a framework of perfect competition with equal-sized countries.²⁵ Our result partly extends theirs to a setting with imperfect competition and unequal-sized countries. Stöwhase (2005, 2013), by contrast, obtain the opposite result: the presence of profit shifting softens tax competition by increasing the equilibrium tax rates of both large and small countries.²⁶ Introducing profit shifting reduces MNEs' tax payments and makes them less sensitive to international tax differences; thus, tax competition becomes less severe. On the other hand, taxable profits decrease due to profit shifting, which makes tax competition for the shifted profits more severe. In Stöwhase (2005, 2013), the former effect dominates the latter, whereas the opposite is true in our model. These differing results are mainly because our imperfectly competitive framework gives rise to the strategic purpose of transfer pricing. The strategic effect strengthens profit-shifting incentives and thus increases the tax-base sensitivity, leading to tougher tax competition.

5. Conclusion

We introduced a profit shifting mechanism through transfer pricing into a simple economic geography model for MNEs. We show that in the early stage of economic integration, the low-tax country attracts more production plants than the high-tax country does. Further integration, however, completely reverses this pattern and leads to the agglomeration of production in the high-tax country. By lowering transfer prices for intra-firm transactions, MNEs compress the pre-tax profits of plants in the high-tax country and inflate those of foreign affiliates in the low-tax country. In addition, the lowered transfer prices make the affiliates competitive in their markets. Transferring profits from a high-tax to a low-tax

²⁵Agrawal and Wildasin (2019) also show that globalization (a decline in relocation costs) leads to tougher tax competition in a linear spatial model where agglomeration is exogenously given.

²⁶Becker and Riedel (2013) also obtain a similar result, although MNEs in their model cannot shift profits for tax-saving purposes.

country is more effective than transferring profits in the other way around if trade costs are low enough for intra-firm trade to expand. MNEs thus prefer to locate production in the high-tax country in the late stage of economic integration. The result sheds new light on tax competition in the core-periphery case and on the empirical relationship between the host country's corporate tax rate and its FDI inflow.

Although our model is admittedly stylized, we believe that it is versatile enough to accommodate several extensions. One interesting extension is to introduce tax haven countries. While we assume that MNEs shift profits between affiliates in two countries, MNEs may do so using non-production affiliates in a third country with almost zero taxes. The question is which non-tax haven country, the high-tax or the low-tax one, benefits from the presence of tax haven countries. Another extension is to examine the impact of different international tax systems, such as separate accounting and formula apportionment. The system that prevents profit shifting effectively may differ depending on the degree of economic integration. We leave these avenues for future research.

Appendices

Appendix 1. Equilibrium allocation of production plants

We first prove Proposition 1 by showing whether the equilibrium share of plants n_1 exceeds one-half depending on trade costs. Then, we further investigate how a marginal change in trade costs affects n_1 .

Proof of Proposition 1. Using Eqs. (5-1) and (5-2), we can write the profit differential as

$$\Delta\Pi \equiv \Pi_1 - \Pi_2 = \frac{\mu}{2\sigma} \cdot \frac{(1-t_1)(1-\phi\gamma_2) - \phi\gamma_2(t_1-t_2)(\sigma-1)/\sigma}{n_1 + \phi\gamma_2 n_2} - \frac{\mu}{2\sigma} \cdot \frac{(1-t_2)(1-\phi\gamma_1) - \phi\gamma_1(t_2-t_1)(\sigma-1)/\sigma}{\phi\gamma_1 n_1 + n_2}. \quad (\text{A1})$$

where $\gamma_i \equiv \left(\frac{\sigma - \Delta t_i}{\sigma}\right)^{\sigma-1}$, $\Delta t_i \equiv \frac{t_j - t_i}{1 - t_i}$, for $i \neq j \in \{1, 2\}$.

We evaluate this at $n_1 = 1/2$:

$$\Delta\Pi|_{n_1=1/2} = \frac{\mu(t_1 - t_2) \cdot F(\phi)}{\sigma^2(1 + \phi\gamma_1)(1 + \phi\gamma_2)},$$

where $F(\phi) \equiv \gamma_1\gamma_2(2 - \sigma)(t_1 - t_2)\phi^2$

$$+ [2\sigma\{\gamma_1(1 - t_1) - \gamma_2(1 - t_2)\} + (\gamma_1 + \gamma_2)(t_1 - t_2)]\phi - \sigma(t_1 - t_2),$$

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

We denote this value of ϕ by ϕ^* , and it is given by the larger (smaller) root of $F(\phi) = 0$ under $\sigma < 2$ ($\sigma > 2$). We can confirm that ϕ^* falls within $(0, 1)$ from the facts that (i) $F(\phi)$ is a quadratic function of ϕ , (ii) $f(0) < 0$, and (iii) $f(1) > 0$.

If $\phi < \phi^*$ or $F(\phi) < 0$, then the profit differential is negative, implying that MNEs with production in country 1 have an incentive to relocate their plants to country 2. Thus, the long-run equilibrium must be $n_1 < 1/2$. Similarly, if $\phi > \phi^*$ or $F(\phi) > 0$, then the positive profit differential at $n_1 = 1/2$ requires that the long-run equilibrium be $n_1 > 1/2$. These findings establish Proposition 1.

Equilibrium plant allocation and trade costs. Here, we show that as trade costs decline, the equilibrium share of production plants in country 1 first decreases, then increases. By solving the profit differential for n_1 , we obtain

$$n_1 = \frac{(1 - t_1)(1 + \phi^2\Gamma_1\gamma_2) - \phi(1 - t_2)(\Gamma_2 + \gamma_2)}{(1 - t_1)[1 - \phi(\Gamma_1 + \gamma_1) + \phi^2\Gamma_1\gamma_2] + (1 - t_2)[1 - \phi(\Gamma_2 + \gamma_2) + \phi^2\Gamma_2\gamma_1]}, \quad (\text{A1})$$

where $\Gamma_i \equiv \left(\frac{\sigma - \Delta t_i}{\sigma}\right)^\sigma$.

We differentiate this with respect to ϕ :

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

where

$$\begin{aligned}
G(\phi) &\equiv [\{t_1(2-t_1)-1\}\Gamma_1\gamma_2(\Gamma_1+\gamma_1) - \{t_2(2-t_2)-1\}\Gamma_2\gamma_1(\Gamma_2+\gamma_2)]\phi^2 \\
&\quad + 2(1-t_1)(1-t_2)(\Gamma_1\gamma_2 - \Gamma_2\gamma_1)\phi \\
&\quad + \{t_2(2-t_2)-1\}(\Gamma_2+\gamma_2) - \{t_1(2-t_1)-1\}(\Gamma_1+\gamma_1), \\
H(\phi) &\equiv [\{\Gamma_1\gamma_2(1-t_1) + \Gamma_2\gamma_1(1-t_2)\}\phi^2 - \{(\Gamma_1+\gamma_1)(1-t_1) + (\Gamma_2+\gamma_2)(1-t_2)\}\phi \dots \\
&\quad \dots + 2-t_1-t_2]^2 > 0.
\end{aligned}$$

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 $\phi = 0$:

$$\left. \frac{dn_1}{d\phi} \right|_{\phi=0} \simeq \frac{t_2 - t_1}{\sigma(2 - t_1 - t_2)} < 0,$$

where we use a Taylor approximation such that $\Gamma_i \simeq 1 - \Delta t_i + [(\sigma - 1)/\sigma](\Delta t_i)^2$ and $\gamma_i \simeq 1 - [(\sigma - 1)/\sigma]\Delta t_i + [(\sigma - 1)(\sigma - 2)/\sigma^2](\Delta t_i)^2$.

We then find $\phi \in [0, 1]$, where $dn_1/d\phi = 0$. From (ii), it suffices to solve $G(\phi) = 0$, whose solution, denoted by $\phi^\#$, is

$$\phi^\# \simeq \frac{\sigma}{\sigma - (\sigma - 1)\Delta t_1 \Delta t_2}, \tag{A2}$$

where the approximation was used as before. We can confirm that $\phi^\#$ is within $(0, 1)$. From (i) and (iii), we observe that $dn_1/d\phi$ changes its sign at $\phi^\#$ from negative to positive. In summary,

$$\left. \frac{dn_1}{d\phi} \right\} \begin{cases} < 0 & \text{if } \phi \in [0, \phi^\#) \\ = 0 & \text{if } \phi = \phi^\# \\ > 0 & \text{if } \phi \in (\phi^\#, \phi^S) \\ = 0 & \text{if } \phi \in [\phi^S, 1] \end{cases}. \tag{A3}$$

Appendix 2. Proof of Proposition 2

We first confirm that the high-tax country 1 hosts all production plants when the trade costs are zero. Then, we derive the level of the freeness of trade above which the full agglomeration is realized; that is, the sustain point ϕ^S . Finally, we show that ϕ^S decreases with t_1 , but increases with t_2

Full agglomeration at zero trade costs. Evaluating the profit differential (A1) at $\phi = 1$ yields

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

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

noting that $\Delta t_1 < 0 < \Delta t_2$ and $\gamma_1 > 1 > \gamma_2$. The profit differential is positive (negative) if the big bracket term is negative (positive). We will check that the big bracket term is indeed negative, the condition for which is

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

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

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

Using a Taylor approximation such that $\gamma_i \equiv (1 - \Delta t_i/\sigma)^{\sigma-1} \simeq 1 - [(\sigma - 1)/\sigma]\Delta t_i$, we can

confirm that the inequality holds:

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

Hence, the profit differential at $\phi = 1$ is positive for any $n_1 \in [0, 1]$. All MNEs are willing to establish production plants in the high-tax country 1, that is, $n_1|_{\phi=1} = 1$.

Sustain point. Evaluating the profit differential (A1) at $n_1 = 1$ gives

$$\Delta\Pi|_{n_1=1} = \frac{\mu \cdot I(\phi)}{2\sigma^2\phi\gamma_1},$$

$$\text{where } I(\phi) \equiv -\gamma_1\gamma_2(1 - t_2)(\sigma - \Delta t_2)\phi^2 + \gamma_1(1 - t_1)(2\sigma - \Delta t_1)\phi - \sigma(1 - t_2).$$

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 sustain point ϕ^S (if any).

We observe that $I(\phi)$ is a quadratic function of ϕ with a negative coefficient of ϕ^2 . A further inspection reveals that

$$I(0) = -\sigma(1 - t_2) < 0,$$

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

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 $\gamma_1 > 1 > \gamma_2$.

These observations imply that (i) the sustain point $\phi^S \in (0, 1)$ always exists and is given by the smaller root of $I(\phi)$ and that (ii) $I(\phi)$ or the profit differential is negative for $\phi \in [0, \phi^S)$ but positive for $\phi \in (\phi^S, 1]$.

Sustain point and taxes. As Fig. 2 and (A3) in Appendix 1 clearly show, a higher (lower) $\phi^\#$ (see Eq. (A2)) makes the sustain point ϕ^S higher (lower). A close inspection of $\phi^\#$

reveals that

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

implying that ϕ^S also decreases (increases) with t_1 (t_2). That is, multinational production is more likely to be agglomerated in the high-tax country 1 because the tax difference is larger.

Appendix 3. Conditions for positive profits

The taxable profits are π_{11} , π_{12} , π_{21} , and π_{22} , but only π_{11} can be negative:

$$\pi_{11} = \frac{\mu}{2\sigma} \left[\frac{1}{n_1 + \phi\gamma_2 n_2} + \underbrace{\frac{(\sigma-1)\Delta t_1}{\sigma}}_{<0} \frac{\phi\gamma_1}{\phi\gamma_1 n_1 + n_2} \right],$$

because $\Delta t_1 < 0$. Note also that $\pi_{11} > 0$ at $\phi = 0$. We check whether π_{11} remains positive if the following assumption holds:

$$1 + \frac{(\sigma-1)\Delta t_1}{\sigma} > 0. \tag{A4}$$

Differentiating this with respect to ϕ yields

$$\frac{d\pi_{11}}{d\phi} \simeq \frac{(1-\phi)(2-t_1-t_2)[\phi(-\Delta t_1)(\sigma-1)(\sigma-\Delta t_2) - \sigma^2]}{2(1-t_1)[\phi^2(\sigma-\Delta t_1)(\sigma-\Delta t_2) - \sigma^2]},$$

where we use Eq. (A1) and a Taylor approximation such that $\gamma_i \simeq 1 - [(\sigma-1)/\sigma]\Delta t_i$. The numerator is always negative:

$$\begin{aligned}\phi(-\Delta t_1)(\sigma-1)(\sigma-\Delta t_2) - \sigma^2 &\leq 1 \cdot (-\Delta t_1)(\sigma-1)(\sigma-\Delta t_2) - \sigma^2 \\ &= -(1+\Delta t_1)\sigma^2 + \Delta t_1(1+\Delta t_2)\sigma - \Delta t_1\Delta t_2 < 0,\end{aligned}$$

because $-(1 + \Delta t_1) < 0$ (from Ineq. (A4)) and $\sigma > 1$.

The sign of the derivative is determined by the square bracket term in the denominator.

We can see that

$$\frac{d\pi_{11}}{d\phi} \begin{cases} > 0 & \text{if } \phi \in [0, \phi^\dagger) \\ = 0 & \text{if } \phi = \phi^\dagger \\ < 0 & \text{if } \phi \in (\phi^\dagger, 1] \end{cases},$$

where $\phi^\dagger \equiv \frac{\sigma}{\sqrt{(\sigma - \Delta t_1)(\sigma - \Delta t_2)}} \in (0, 1)$. (A5)

This result and $\pi_{11}|_{\phi=0} > 0$ imply that π_{11} takes the minimum value at $\phi = 1$:

$$\pi_{11}|_{\phi=1} = \frac{\mu}{2\sigma} \left[1 + \frac{(\sigma - 1)\Delta t_1}{\sigma} \right],$$

noting that $n_1 = 1$ at $\phi = 1$. The condition for $\pi_{11}|_{\phi=1} > 0$ is equivalent to Ineq. (A3).

Appendix 4. Proof of Proposition 3

The tax revenues in the two countries are

$$TR_1 = \frac{\mu L t_1}{2\sigma} \left[1 + \frac{(\sigma - 1)\Delta t_1}{\sigma} \frac{\phi \gamma_1 n_1}{\phi \gamma_1 n_1 + n_2} \right],$$

$$TR_2 = \frac{\mu L t_2}{2\sigma} \left[1 + \frac{(\sigma - 1)\Delta t_2}{\sigma} \frac{\phi \gamma_2 n_2}{n_1 + \phi \gamma_2 n_2} \right].$$

Taking the difference yields

$$\Delta TR \equiv TR_1 - TR_2 = \frac{\mu L}{2\sigma} \left[t_1 - t_2 + \phi \left(\frac{\sigma - 1}{\sigma} \right) \left(\frac{t_1 \gamma_1 n_1 \Delta t_1}{\phi \gamma_1 n_1 + n_2} - \frac{t_2 \gamma_2 n_2 \Delta t_2}{n_1 + \phi \gamma_2 n_2} \right) \right].$$

Using Eq. (A1) and a Taylor approximation such that $\gamma_i \simeq 1 - [(\sigma - 1)/\sigma]\Delta t_i$, we can

express this as

$$\Delta TR \simeq \frac{\mu L(t_1 - t_2) \cdot J(\phi)}{2\sigma^2(1 - t_1)(1 - t_2)[\sigma^2 - \phi^2(\sigma - \Delta t_1)(\sigma - \Delta t_2)]},$$

$$\begin{aligned} \text{where } J(\phi) \equiv & -(\sigma - \Delta t_1)(\sigma - \Delta t_2)[\sigma\{3t_1t_2 - 2(t_1 + t_2) + 1\} - 2t_1t_2 + t_1 + t_2]\phi^2 \\ & + \sigma(\sigma - 1)[\sigma(2t_1t_2 - t_1 - t_2) + (t_1 - t_2)^2]\phi \\ & + \sigma^3(1 - t_1)^2(1 - t_2)^2. \end{aligned}$$

We note that

$$\begin{aligned} \text{the sign of the coefficient of } \phi^2 : & -[\sigma\{3t_1t_2 - 2(t_1 + t_2) + 1\} - 2t_1t_2 + t_1 + t_2] < 0, \\ J(0) = & \sigma^3(1 - t_1)^2(1 - t_2)^2 > 0, \\ J'(0) = & \sigma(\sigma - 1)[\sigma(2t_1t_2 - t_1 - t_2) + (t_1 - t_2)^2] < 0, \\ J(1) = & (\sigma - 1)^2(t_1 - t_2)^2(t_1 + t_2 - 2t_1t_2) > 0, \end{aligned}$$

where the inequality in the first line holds due to (A4). This implies that $J(\phi) > 0$ for $\phi \in [0, 1]$.

The sign of ΔTR is determined by the square bracket term in the denominator. Thus, we have

$$\Delta TR \begin{cases} > 0 & \text{if } \phi \in [0, \phi^\dagger) \\ = 0 & \text{if } \phi = \phi^\dagger \\ < 0 & \text{if } \phi \in (\phi^\dagger, 1] \end{cases},$$

where ϕ^\dagger is defined in Eq. (A5). This establishes Proposition 3.

Appendix 5. Sustain points in the case of asymmetric country size

In the case without profit shifting, the profit differential at $n_1 = 1$ is

$$\Delta\hat{\Pi}|_{n_1=1} = \frac{\mu \cdot \hat{\Theta}(\phi)}{\sigma\phi},$$

$$\text{where } \hat{\Theta}(\phi) \equiv -s_1(1-t_1)\phi^2 + [s_1(1-t_1) + (1-s_1)(1-t_2)]\phi - (1-s_1)(1-t_2),$$

Clearly, the sign of the profit differential is determined by $\hat{\Theta}(\phi)$, which is a quadratic function of ϕ . We note that

$$\text{the sign of the coefficient of } \phi^2 : -s_1(1-t_1) < 0,$$

$$\hat{\Theta}(0) = -(1-s_1)(1-t_2) < 0,$$

$$\hat{\Theta}'(0) = s_1(1-t_1) + (1-s_1)(1-t_2) > 0,$$

$$\hat{\Theta}(1) = 0.$$

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

$$\hat{\phi}^S \equiv \frac{1-s_1}{s_1} \cdot \frac{1-t_2}{1-t_1}.$$

Assume that $\hat{\phi}^S$ is in $[0, 1]$, or, equivalently,

$$s_1 > \frac{1-t_2}{2-t_1-t_2} \left(> \frac{1}{2} \right). \tag{A6}$$

Under this condition, $\hat{\Theta}(\phi)$, and thus the profit differential is greater than zero if the freeness of trade is larger than the sustain point $\hat{\phi}^S$. That is, if $\phi \in [\hat{\phi}^S, 1]$, then all multinational production takes place in the large, high-tax country 1.

In the case with profit shifting, the profit differential at $n_1 = 1$ is

$$\Delta\Pi|_{n_1=1} = \frac{\mu \cdot \Theta(\phi)}{\sigma\phi},$$

$$\begin{aligned} \text{where } \Theta(\phi) \equiv & -\gamma_2 s_1 (1 - t_2) [(\sigma - \Delta t_2)/\sigma] \phi^2 \\ & + (1 - t_1) [\{\sigma - (1 - s_1)\Delta t_1\}/\sigma] \phi - (1 - s_1)(1 - t_2)/\gamma_1. \end{aligned}$$

The sign of the differential is determined by $\Theta(\phi)$, which is a quadratic function of ϕ . As in the previous case, we note that

$$\text{the sign of the coefficient of } \phi^2 : -\gamma_2 s_1 (1 - t_2) [(\sigma - \Delta t_2)/\sigma] < 0,$$

$$\Theta(0) = -(1 - s_1)(1 - t_2)/\gamma_1 < 0,$$

$$\Theta'(0) = (1 - t_1) [\{\sigma - (1 - s_1)\Delta t_1\}/\sigma] > 0,$$

$$\Theta'(1) \simeq -\frac{(2s_1 - 1)(1 - t_1)(1 - t_2)\sigma^2 - (t_1 - t_2)[s_1(3t_2 - 2t_1 - 1) + 1 - t_2]\sigma - 2s_1(t_1 - t_2)^2}{\sigma^2(1 - t_2)} < 0,$$

$$\Theta(\hat{\phi}^S) \simeq \frac{(\sigma - 1)(t_1 - t_2)[\sigma^2(1 - t_1)\{s_1(2 - t_1 - t_2) - (1 - t_2)\} + (\sigma - 1)(1 - s_1)(t_1 - t_2)^2]}{s_1\sigma^2(1 - t_1)(\sigma - \Delta t_2)} > 0,$$

where the inequalities in the fourth and fifth lines hold due to the Taylor approximation such that $\gamma_i \simeq 1 - [(\sigma - 1)/\sigma]\Delta t_i$ and Ineq. (A6).

From these observations, we can illustrate $\hat{\Theta}(\phi)$ and $\Theta(\phi)$ as in Fig. A1. We can thus conclude that the sustain point in the case with profit shifting, ϕ^S , is lower than that in the case without profit shifting, $\hat{\phi}^S$.

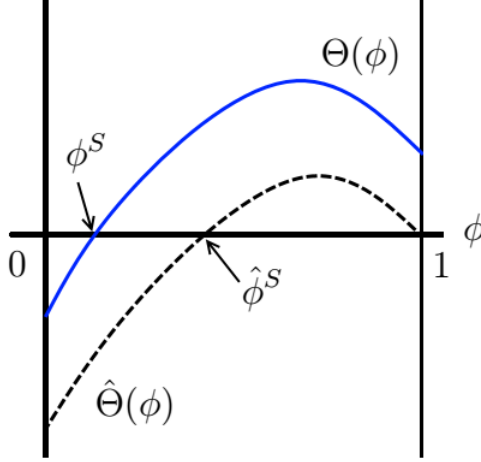


Fig. A1. Sustain points in the case of unequal-sized countries.

Appendix 6. Centralized decision making

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

An MNE with production in country 1 solves the following problem:

$$\max_{p_{11}, g_1, p_{12}} \Pi_1 = \max_{p_{11}, g_1, p_{12}} (1 - t_1)\pi_{11} + (1 - t_2)\pi_{12},$$

where $\pi_{11} = (p_{11} - a)q_{11} + (g_1 - \tau a)q_{12} - C(g_1, q_{12})$,

$$\pi_{12} = (p_{12} - g_1)q_{12}.$$

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 first order conditions give the following optimal prices:

$$p_{11} = \frac{\sigma a}{\sigma - 1}, \quad g_1 = \tau a + \frac{\Delta t_1}{2\delta}, \quad p_{12} = \frac{\sigma a}{\sigma - 1} \left(\tau + \frac{\Delta t_1 \Delta t_2}{4a\delta} \right),$$

where $\Delta t_i \equiv \frac{t_j - t_i}{1 - t_i}$, $i \neq j \in \{1, 2\}$.

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 , while it increases with t_j . Since $p_{12} = p_{21}$ and $g_1 < g_2$ hold, the affiliate of the MNE with production in the high-tax country 1 has a higher price-cost margin than the affiliate of the MNE with production in the low-tax country 2 does; that is, $p_{12} - g_1 > p_{21} - g_2$. Transfer pricing does not just shift profits, but also affects the profitability of affiliates. The direction of the profit shifting from the high-tax to the low-tax country allows affiliates to source goods at a lower cost, and thus earn more profits. The mechanism here is very close to the one in the decentralized-decision case we show in the text.

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

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

The equilibrium distribution of plants is interior if $\Pi_1 - \Pi_2 = 0$ has a solution for $n_1 \in (0, 1)$. If $\Pi_1 - \Pi_2 > 0$ ($\Pi_1 - \Pi_2 < 0$), then the economy reaches the corner equilibrium

of $n_1 = 1$ ($n_1 = 0$). We obtain

$$n_1 = \begin{cases} \frac{1}{2} + \frac{(\gamma + 1)(t_1 - t_2)}{2(\gamma - 1)(2 - t_1 - t_2)} & \text{if } \tau \in (\tau^{S1}, \infty) \quad \text{(i)} \\ 0 & \text{if } \tau \in (\tau^{S2}, \tau^{S1}] \quad \text{(ii)} \\ [0, 1] & \text{if } \tau = \tau^{S2} \quad \text{(iii)} \\ 1 & \text{if } \tau \in [1, \tau^{S2}) \quad \text{(iv)} \end{cases},$$

$$\text{where } \gamma \equiv \left(\tau + \frac{\Delta t_1 \Delta t_2}{4a\delta} \right)^{1-\sigma}, \quad \Delta t_i \equiv \frac{t_j - t_i}{1 - t_i}, \quad i \neq j \in \{1, 2\},$$

$$\tau^{S1} \equiv \left(\frac{1 - t_1}{1 - t_2} \right)^{\frac{1}{1-\sigma}} - \frac{\Delta t_1 \Delta t_2}{4a\delta}, \quad \tau^{S2} \equiv 1 - \frac{\Delta t_1 \Delta t_2}{4a\delta},$$

which is illustrated in Fig. A1. The horizontal dotted line represents the share at which the equilibrium share converges as trade costs go to infinity:

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

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. If trade costs are low, such that $\tau \in [1, \tau^{S1})$, on the other hand, then the high-tax country attracts all production plants. The result is qualitatively the same as that under decentralized decision making.

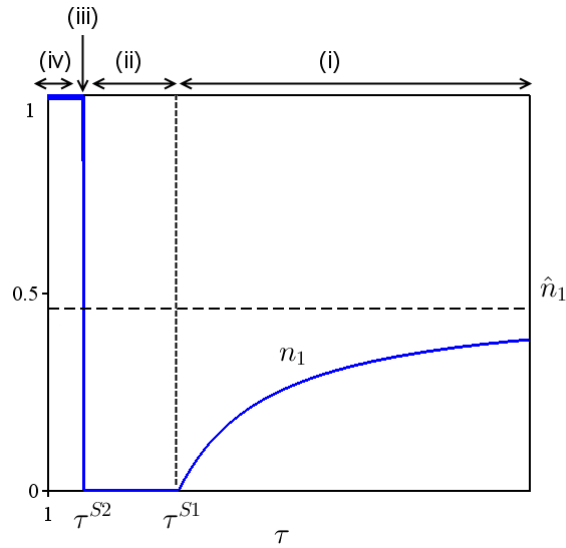


Fig. A2. Equilibrium distribution of production plants under centralized decision making.

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