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

Hayato Kato* Hirofumi Okoshi†

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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

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

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

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

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

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

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

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

The first-order condition (FOC) is

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

The SOC requires

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

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

$$\Pi_1 = (1-t_1)\left[\frac{p_{11}^{1-\sigma}\mu L_1}{\sigma(N_1p_{11}^{1-\sigma}+N_2p_{21}^{1-\sigma})} + (1+\delta)\frac{g_1-\tau a}{p_{12}}\frac{p_{12}^{1-\sigma}\mu L_2}{N_1p_{12}^{1-\sigma}+N_2p_{22}^{1-\sigma}}\right]$$
$$+ (1-t_2)\frac{p_{12}^{1-\sigma}\mu L_2}{\sigma(N_1p_{12}^{1-\sigma}+N_2p_{22}^{1-\sigma})} - 2R_1$$
$$= (1-t_1)\left[\frac{\mu L_1}{\sigma(N_1+N_2(p_{21}/p_{11})^{1-\sigma})} + (1+\delta)\frac{g_1-\tau a}{p_{12}}\frac{(p_{12}/p_{22})^{1-\sigma}\mu L_2}{N_1(p_{12}/p_{22})^{1-\sigma}+N_2}\right]$$
$$+ (1-t_2)\frac{(p_{12}/p_{22})^{1-\sigma}\mu L_2}{\sigma(N_1(p_{12}/p_{22})^{1-\sigma}+N_2)} - 2R_1,$$

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

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

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

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

The capital-return differential is

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

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

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

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).

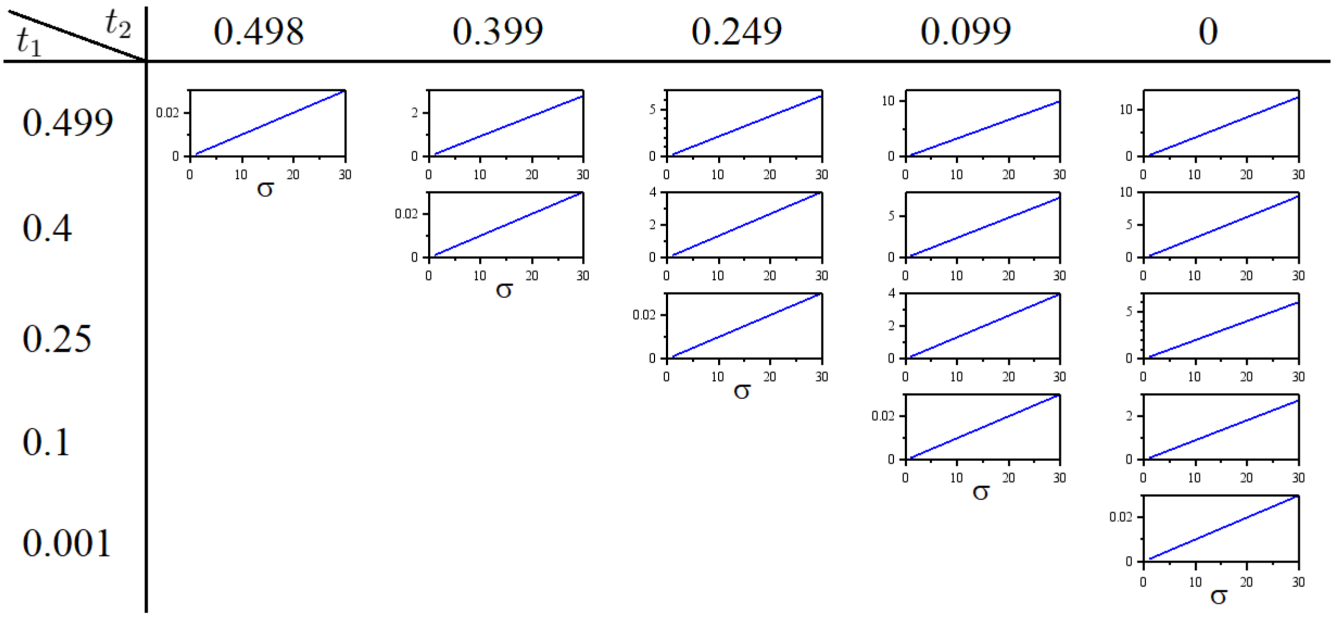

Figure A1. Function $F(\phi = 1)$ for different levels of $\sigma \in [1, 30]$

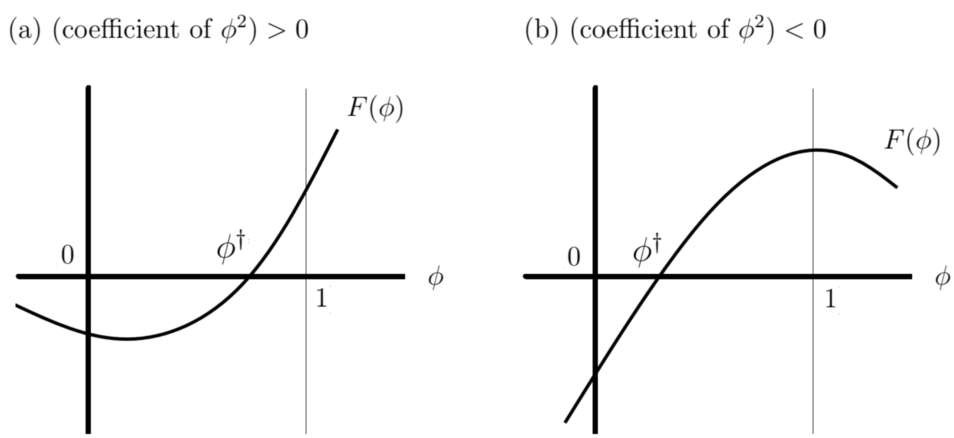

Figure A2. Existence of $\phi^\dagger$ at which $F(\phi^\dagger) = 0$

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

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

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

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.

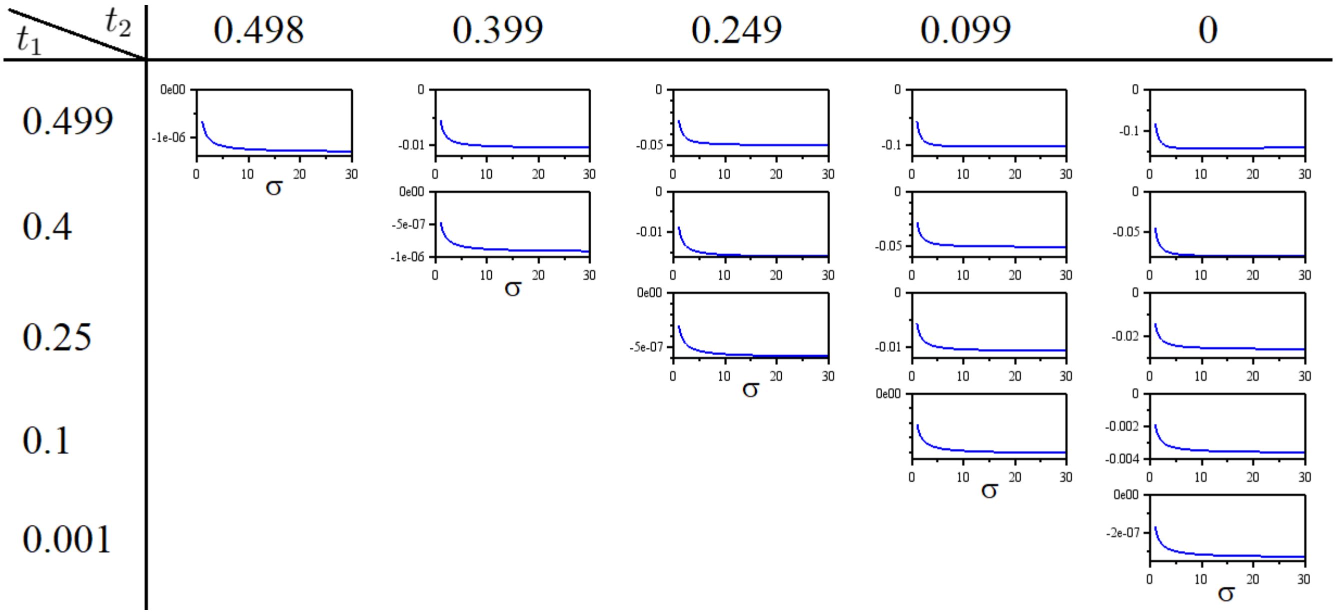

Figure A3. Function $\omega_1 + \omega_2\gamma_1$ for different levels of $\sigma \in [1, 30]$

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

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

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 $\phi = 0$:

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

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.

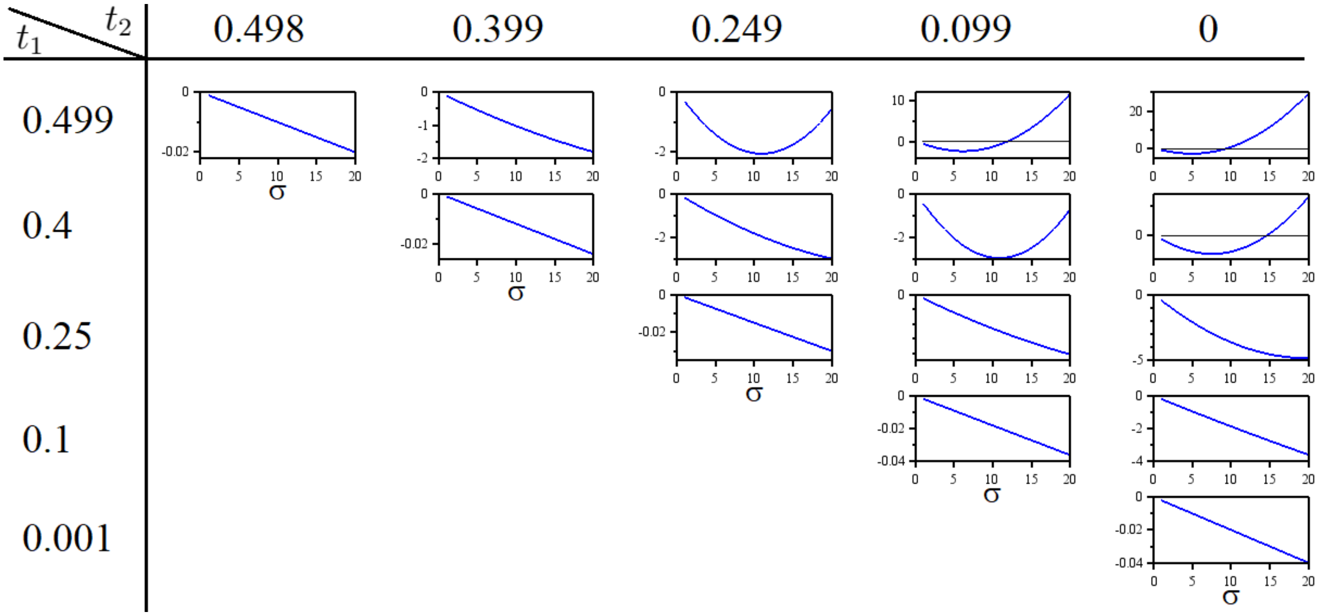

Figure A4. Function G_0 for different levels of $\sigma \in [1, 20]$

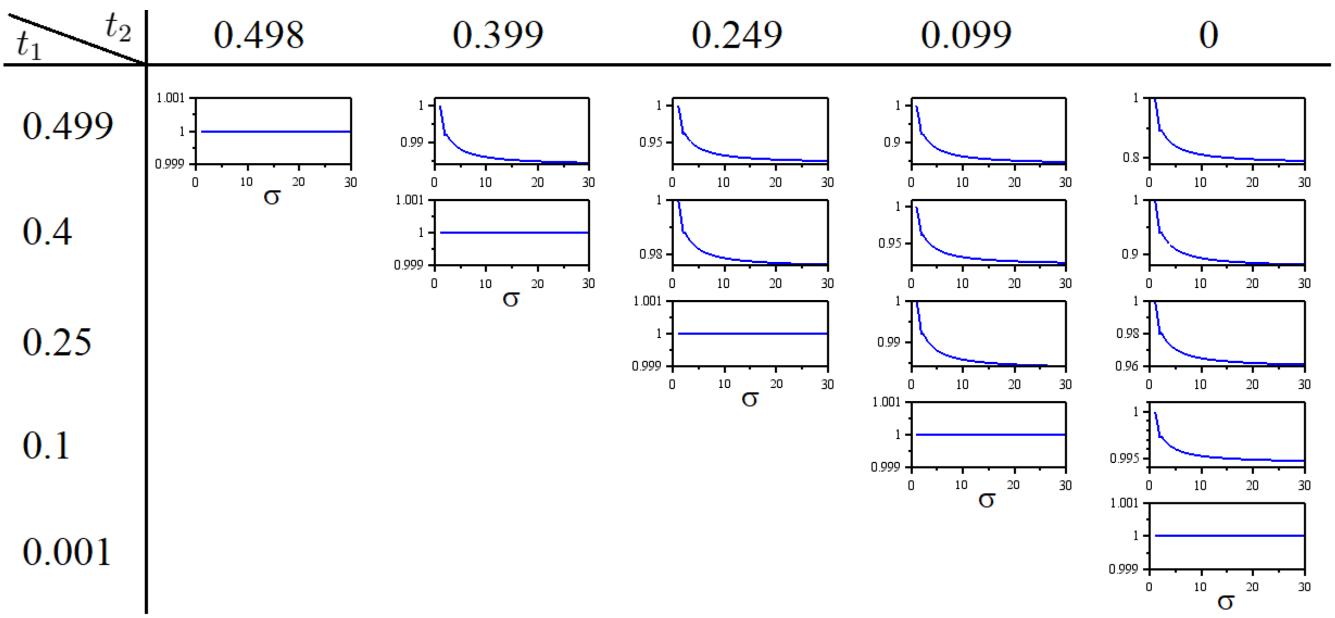

Figure A5. Turning point $\phi^{\#}$ for different levels of $\sigma \in [1, 30]$

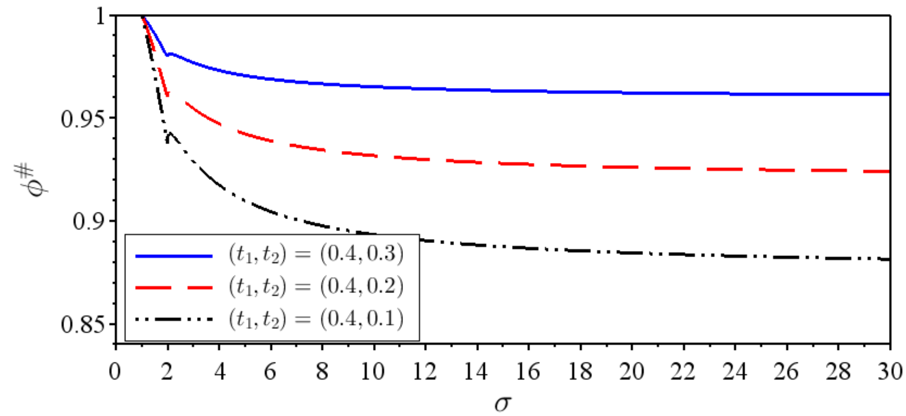

Figure A6. Effect of tax difference on turning point $\phi^{\#}$

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).

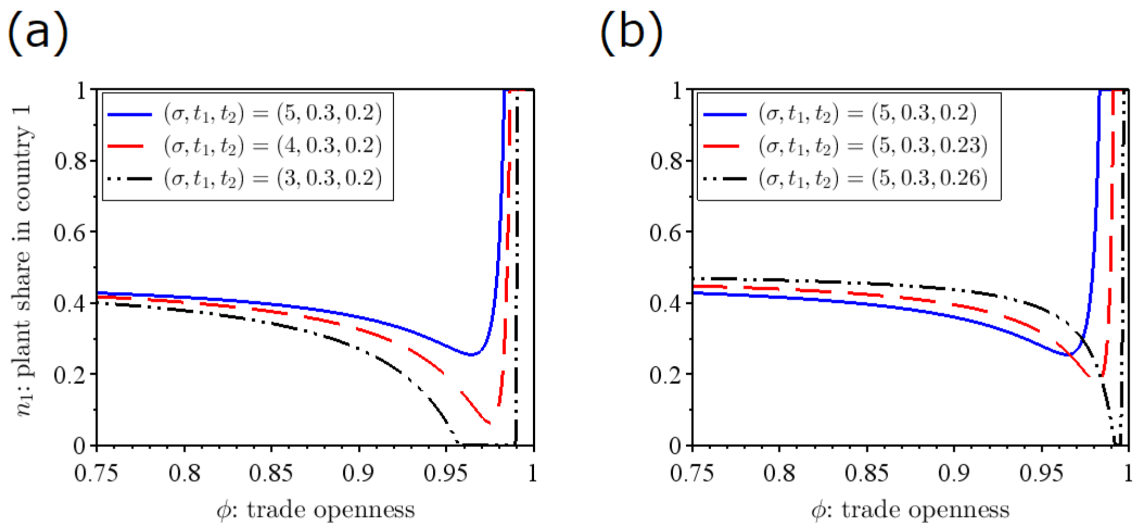

Figure A7. Possibility of full production agglomeration in country 2

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

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

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.

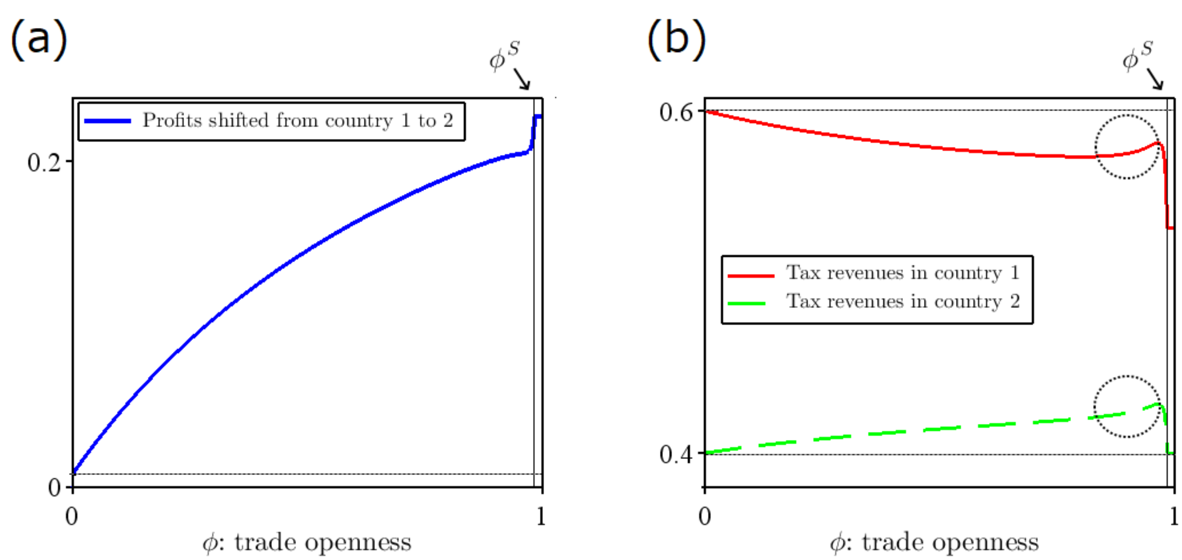

Figure A8. Shifted profits (a) and tax revenues (b)

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

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

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

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

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

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

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.

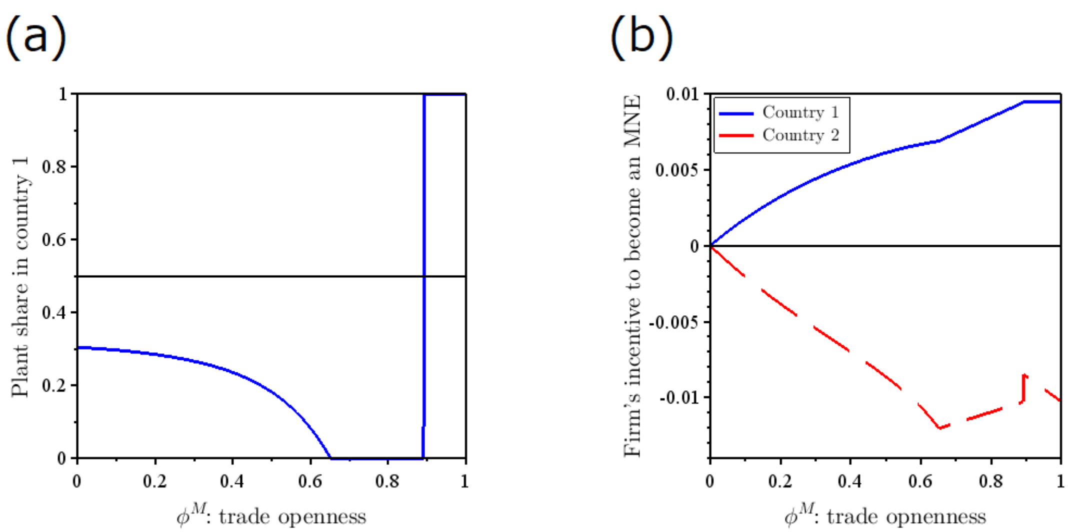

Figure A9. MNEs versus pure exporters when κ is high

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

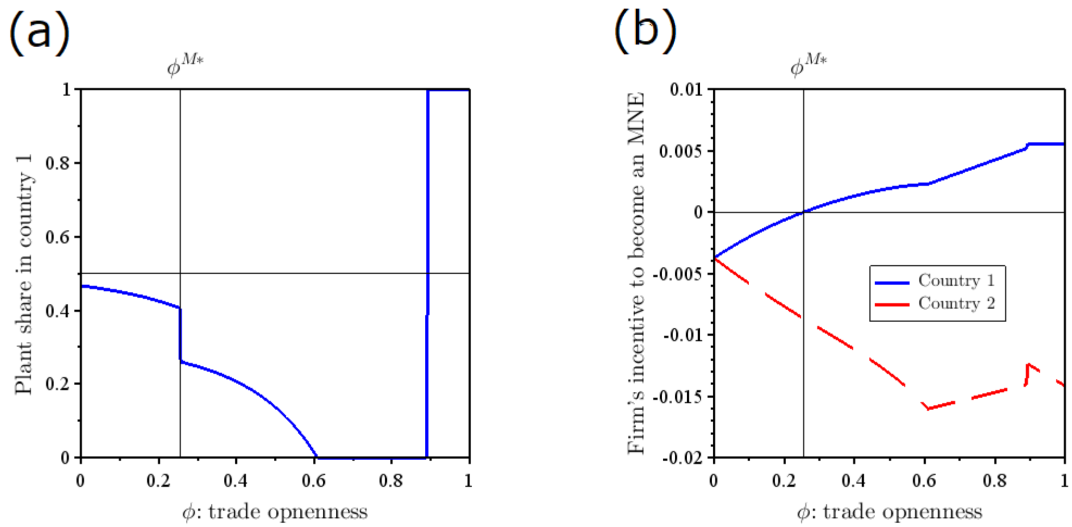

Figure A10. MNEs versus pure exporters when κ is intermediate

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

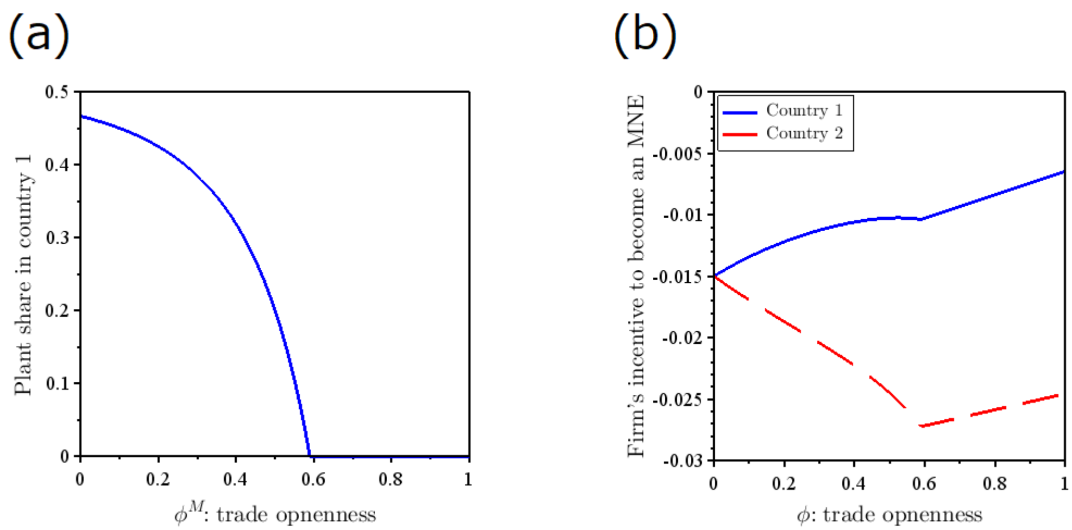

Figure A11. MNEs versus pure exporters when κ is low

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

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

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

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

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

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

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

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.

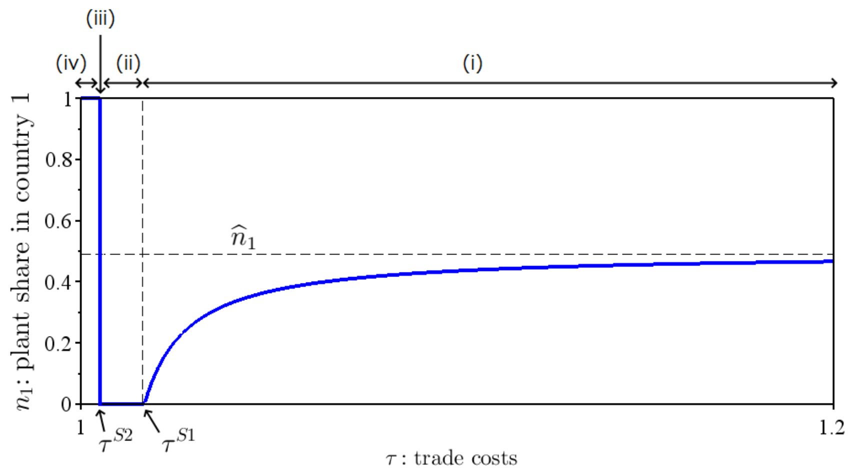

Figure A12. Plant share under centralized decision making

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:

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

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

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

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

Similarly, tax revenues in country 2 are given by

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

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

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

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

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

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.

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