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EFFECTS OF EXPORT TAXES IN AN ENDOGENOUS GROWTH MODEL WITH INDUSTRIAL LOCATION

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Abstract

This paper examines the impact of export taxes on the global growth rate and the welfare of individual countries within an endogenous growth model that incorporates industrial location and local knowledge spillovers. We demonstrate that when the elasticity of substitution between differentiated goods is large, the transport cost is high, consumption spending on differentiated goods is low, and the export tax rate of the agglomeration (non-agglomeration) country is low, an agglomerated country's increase in export taxes decreases the world growth rate. Conversely, an increase in export taxes by a non-agglomerated country enhances the global growth rate under the same conditions. Furthermore, welfare analysis results show that an export tax increase in an agglomeration country diminishes the welfare of agglomeration and non-agglomeration countries if the labor endowment is substantial and R&D sector productivity is high. However, an export tax increase in a non-agglomeration country improves the welfare of both countries under the same conditions.

Keywords: Growth, Export Taxes, Welfare, Local Spillover of Knowledge, Industrial Location
JEL Classification: F12, F13, F43, O31.

1. Introduction

The cross-border movement of companies transfers technological knowledge to the host country and contributes to global growth through the knowledge spillover effect caused by industrial agglomerations in the host country. Empirical evidence suggests that increased globalization and

relaxed regulations on foreign firm entry led to strong growth (e.g., Darku and Yeboach 2018; D'Costa, Garcilazo and Martins 2019; Haini and Loon 2022; Kinfack and Bonga-Bonga 2023). This paper examines the impact of one country's export taxes on the world growth rate and welfare using a two-country endogenous growth model. In this model, firms can relocate internationally, and research and development (R&D) knowledge depends positively on the number of firms in a given location, which is considered a local public good.

The utilization of import tariffs in the United States, which has been the focus of global attention in recent years, has been an intermittent phenomenon that can be traced back to the Civil War era. These tariffs have been employed as a means of generating tax revenue and safeguarding domestic industries against economic challenges (Irwin, 2017). Conversely, the origins of export taxes are less clear, at least in the United States. However, there is a documented instance in which Britain attempted to impose an export tax on the American colony during the period of American independence, known as the Boston Tea Party of 1773. The historical context of the Boston Tea Party is deeply intertwined with the deteriorating financial state of Britain, which was precipitated by its involvement in the Seven Years' War (1756–1763). This military conflict emerged as a result of the confrontation between the Kingdom of Prussia and Austria. In an effort to address its financial woes, Britain sought to impose a tea tax on America, a measure that would ultimately contribute to the tension that led to the Boston Tea Party. Ultimately, the Boston Tea Party was sparked by deep resentment in the colonies over Britain's imposition of the Tea Tax, a type of export tax on America. Liefert and Westcott (2016) posit that the primary objectives of export taxes are threefold: to augment revenue, to enhance the terms of trade, and to ensure a cost advantage for domestic companies by reducing the domestic price of intermediate goods for export. For instance, Indonesia imposes export taxes on raw material exports and exempts processed products from export taxes in pursuit of export substitution industrialization (Laksana, 2022). Furthermore, Pakistan implemented an export tax on raw cotton from 1988 to 1995 with the objective of suppressing the domestic price of cotton, thereby favoring the domestic yarn industry (Hudson and Ethridge, 1999). Furthermore, in the contemporary era, the imposition of export taxes has been employed not solely for the augmentation of revenue but also as a means to ensure the stability of food and mineral resources within the nation. For instance, Russia imposes an export tax on exported wheat with the aim of stabilizing domestic wheat prices and domestic supplies (Götz et al., 2013; Pall et al., 2013; Fellmann et al., 2014; Götz et al., 2016; Svanidze et al., 2022). Furthermore, Russia, a significant exporter of fertilizer, imposes export taxes on fertilizers, including nitrogen, potassium, and phosphate (Liefert, 2024). In contrast, Malaysia and Indonesia implement export taxes to ensure domestic supplies of crude palm oil (CPO) (Hasan et al., 2001; Rifin, 2010).

As demonstrated by the fact that nearly 40 countries imposed export taxes on at least one agricultural product between 2006 and 2014 (Liefert and Westcott, 2016), export taxes, akin to import tariffs, are regarded as pivotal policy instruments for governments to enhance their own economic welfare in the contemporary global economy. Nevertheless, the economic ramifications of export taxes have received scant attention in the domain of international trade literature. The paucity of theoretical studies on the economic effects of export taxes is largely attributable to the prevailing influence of Lerner's symmetry theorem. Lerner's symmetry theorem posits that within a classical framework wherein the trade balance is perpetually in equilibrium, the imposition of import tariffs and export taxes exerts an equivalent effect on resource allocation through alterations in relative prices (Lerner, 1936). This theorem suggests that the resource allocation effect of an export tax can be readily predicted by examining the effect of an import tariff. However, subsequent studies have confirmed that the classical Lerner symmetry theorem is inapplicable in more generalized models that include trade imbalances, capital accumulation, and the presence of multinational corporations. Indeed, a substantial body of literature, originating with Ray (1975) and continuing through Blanchard (2009) and Costinot and Werning (2019), demonstrates that Lerner symmetry is susceptible to dissolution in circumstances involving imperfect competition, international investment, and the activities of multinational corporations. Consequently, even in this paper, which utilizes a two-country open economy dynamic model that accounts for imperfect competition and international firm mobility, the economic consequences of export taxes and import tariffs are anticipated to vary. This finding indicates that within models that consider imperfect competition, trade imbalances, and the presence of multinational corporations, there is potential to examine the theoretical impact of export tariffs independently of import tariffs.[1]

In the context of the preceding discussion, a question arises: In the context of mounting globalization, marked by the surge in the international mobility of firms, does the policy of unilaterally augmenting export taxes in a particular nation prove conducive to global economic growth? To answer this question, we must analyse the effects of increasing export taxes within an endogenous growth model that considers the international movement of firms.

In addition to the aforementioned studies, several studies in the new economic geography literature on endogenous growth have examined the relocation of firms with technological knowledge

[1] Recent work examining the impact of global value chains on trade policy includes studies by Bown et al. (2021), Ghodsi and Stehrer (2022), and Blanchard et al. (2025). Antrás and Chor (2022) provide a thorough survey of the theoretical and empirical aspects of global value chains.

spillovers (e.g., Martin, 1999; Martin & Ottaviano, 1999; Martin & Ottaviano, 2001, Johdo, 2024, 2025a, 2025b).[2] However, this literature has yet to analyse the effect of a rise in export taxes on global growth. For these reasons, this paper finds it meaningful to analyse the growth effects of unilateral export taxes, as they have been overlooked in endogenous growth models until now.

This paper examines how a unilateral increase in export taxes affects the world growth rate through the relocation of firms. For the purpose of this study, export taxes are introduced into the two-region endogenous growth model of Martin (1999) or Martin and Ottaviano (1999, 2001). We demonstrate that when the elasticity of substitution between differentiated goods is large, the transport cost is high, consumption spending on differentiated goods is low, and the export tax rate of the agglomeration (non-agglomeration) country is low, an agglomerated country's increase in export taxes decreases the world growth rate. Conversely, an increase in export taxes by a non-agglomerated country enhances the global growth rate under the same conditions. Furthermore, welfare analysis results show that an export tax increase in an agglomeration country diminishes the welfare of agglomeration and non-agglomeration countries if the labor endowment is substantial and R&D sector productivity is high. However, an export tax increase in a non-agglomeration country improves the welfare of both countries under the same conditions.

The remainder of the paper is organized as follows: Section 2 outlines the model's features. Section 3 describes the equilibrium location of firms. Section 4 describes the R&D behavior. Section 5 examines how a rise in export taxes in each country affects the global growth rate through the relocation of firms. Section 6 analyses the welfare implications of such a rise. Section 7 concludes the article.

2. Model

There are two countries: the domestic (or home) country and the foreign country. The typical household maximizes the following lifetime utility function:

$$U = \int_0^\infty \log\left(C(t)^\theta Z(t)^{1-\theta}\right) e^{-\rho t} dt, \tag{1}$$

where $C(t)$ is the index of differentiated goods at period t and $Z(t)$ is the numeraire good. In equation (1), $C(t)$ is defined as follows

[2] For a review of the literature on geographical space and economic growth, see Fujita and Krugman (2004) and Fujita and Mori (2005).

$$C(t) = \left(\int_{i=0}^{N(t)} C(i,t)^{1-1/\sigma} di\right)^{1/(1-1/\sigma)}, \sigma > 1, \quad (2)$$

where $N(t)$ is the total number of differentiated goods produced in the world and $C(i,t)$ is the consumption of differentiated good i. Each country's government levies export taxes. These taxes apply to all exported differentiated goods. The government then redistributes the revenue to domestic households through lump-sum transfer. The intertemporal budget constraint is $\dot{S}(t) = r(t)S(t) + W(t) - E(t) + T(t)$, where $S(t)$, $E(t)$, $T(t)$, $r(t)$, and $W(t)$ denote per capita asset holdings, per capita consumption spending, and the lump-sum transfer per capita, and the interest rate, the wage rate, respectively. We assume that the international transport of differentiated goods incurs iceberg-type costs: τ ($\tau \geq 1$). Then, E is defined as follows:

$$E = \int_{i\in n} P(i)C(i)di + \int_{j\in n^*} (1+\varphi_f)\tau P^*(j)C(j)dj + Z, \quad (3)$$

where $P(i)$ is the price of a differentiated good i, $\varphi_f(\varphi_h)$ is the export tax of the foreign (home) country, and $n + n^* = N$. As shown in (3), n firms are in the home country and n^* firms are in the foreign country. Then, the consumption price indices are calculated as follows:

$$P^C = \left(\int_{i\in n} P(i)^{1-\sigma} di + \int_{j\in n^*} \left((1+\varphi_f)\tau P^*(j)\right)^{1-\sigma} dj\right)^{1/(1-\sigma)}, \quad (4)$$

$$P^{C*} = \left(\int_{i\in n} \left((1+\varphi_h)\tau P(i)\right)^{1-\sigma} di + \int_{j\in n^*} P^*(j)^{1-\sigma} dj\right)^{1/(1-\sigma)}. \quad (5)$$

In the sector of differentiated goods, the production of each good requires a patent. Therefore, the patent requirement can be interpreted as a fixed cost. Firms issue shares to finance this cost and distribute all profits to shareholders. Additionally, each good requires α units of labor. Standard profit maximization, achieved through the selection of $P(i)$, yields the following equation: $P(i) = \alpha\sigma W/(\sigma - 1)$. The profit flow for firm i, $\Pi(i)$, is expressed as follows: $\Pi(i) = P(i)Y\big(P(i)\big) - \alpha WY\big(P(i)\big) = \alpha WY\big(P(i)\big)/(\sigma - 1)$. In this expression, $Y\big(P(i)\big)$ denotes the amount of output. The numeraire good Z is produced utilizing the input of one unit of labor for each unit of the numeraire good. The assumption underlying this study is that production of the numeraire good occurs in both countries. Therefore, free trade in the numeraire good guarantees that $W = W^* = 1$. We then obtain $P = P^* = \alpha\sigma/(\sigma - 1)$. Here we define $\delta \equiv \tau^{1-\sigma} \in (0, 1)$. From the static utility optimization, given the choice of $C(i)$, $C(j)$ and Z, we obtain

$$C(i) = \left(\frac{\sigma-1}{\alpha\sigma}\right)\left(\frac{\theta E}{n+n^*\left(1+\varphi_f\right)^{1-\sigma}\delta}\right),\ C(j) = \left(\frac{\sigma-1}{\alpha\sigma}\right)\left(\frac{\theta E\left(1+\varphi_f\right)^{-\sigma}\tau^{-\sigma}}{n+n^*\left(1+\varphi_f\right)^{1-\sigma}\delta}\right),\ Z = (1-\theta)E. \quad (6)$$

Here, we define b as a firm's equity value. Therefore, considering $\Pi(i) = \alpha Y\big(P(i)\big)/(\sigma-1)$, in capital markets, a no-arbitrage condition gives $\alpha Y/(\sigma-1) + \dot{b} = rb$. The condition for maximizing (1), given $\dot{S}(t) = r(t)S(t) + W(t) - E(t) + T(t)$, is that $\dot{E}/E = \dot{E}^*/E^* = r - \rho$.

3. Aggregation and industrial distribution

We can obtain the market-clearing condition for any differentiated product $Y(i)$ by aggregating the demand in (6) over all households worldwide:

$$Y(i) = LC(i) + L\tau C^*(i) = \frac{\theta L(\sigma-1)}{\alpha\sigma}\left(\frac{E}{n+n^*\left(1+\varphi_f\right)^{1-\sigma}\delta} + \frac{E^*(1+\varphi_h)^{-\sigma}\delta}{n^*+n(1+\varphi_h)^{1-\sigma}\delta}\right) = Y, \quad (7)$$

where it is posited that L, the labor endowment, remains constant in the two countries. Analogously, for $Y^*(j)$, we obtain:

$$Y^*(j) = L\tau C(j) + LC^*(j) = \frac{\theta L(\sigma-1)}{\alpha\sigma}\left(\frac{E\left(1+\varphi_f\right)^{-\sigma}\delta}{n+n^*\left(1+\varphi_f\right)^{1-\sigma}\delta} + \frac{E^*}{n^*+n(1+\varphi_h)^{1-\sigma}\delta}\right) = Y^*. \quad (8)$$

For a firm to demonstrate indifference between two countries, the profits of both countries must be equal: $\Pi = \Pi^*$. Therefore, from equations $\Pi = \Pi^*$ and $\Pi(i) = \alpha Y\big(P(i)\big)/(\sigma-1)$, it can be deduced that $Y = Y^*$. In this model, S and S^* represent the domestic and foreign stock of capital, respectively. In addition, the total stock of capital held by agents is found to directly correlate with the overall number of firms, thus establishing a relationship of $S + S^* = N$. By resolving the equations (7), (8), $\Pi = \Pi^*$, and $n + n^* = N$ for a specified level of consumption spending (E, E^*), the home share of firms, ω, is derived:

$$\omega = \frac{n}{N} = \frac{\left((1+\varphi_h)^{-\sigma}\delta-1\right)\left(1+\varphi_f\right)^{1-\sigma}\delta E^* - \left(\left(1+\varphi_f\right)^{-\sigma}\delta-1\right)E}{\left(\left(1+\varphi_f\right)^{-\sigma}\delta-1\right)\left((1+\varphi_h)^{1-\sigma}\delta-1\right)E + \left((1+\varphi_h)^{-\sigma}\delta-1\right)\left(\left(1+\varphi_f\right)^{1-\sigma}\delta-1\right)E^*}. \quad (9)$$

The equilibrium amount of production of each country is:

$$Y = Y^* = \frac{\theta L(\sigma-1)}{\alpha\sigma}\left(\frac{I}{N}\right)\left\{\frac{(1+\varphi_h)^{-\sigma}\delta\left(1+\varphi_f\right)^{-\sigma}\delta-1}{\left((1+\varphi_h)^{1-\sigma}\delta\left(1+\varphi_f\right)^{1-\sigma}\delta-1\right)\left((1+\varphi_h)^{-\sigma}\delta-1\right)\left(\left(1+\varphi_f\right)^{-\sigma}\delta-1\right)}\right\}, \quad (10)$$

where

$$I = \left(\left(1+\varphi_f\right)^{-\sigma}\delta - 1\right)\left((1+\varphi_h)^{1-\sigma}\delta - 1\right)E + \left((1+\varphi_h)^{-\sigma}\delta - 1\right)\left(\left(1+\varphi_f\right)^{1-\sigma}\delta - 1\right)E^*.$$

In a manner analogous to the models by Martin (1999) and Martin and Ottaviano (1999), which posit $S > S^*$, thereby postulating a larger number of firms to be situated in the domestic country as opposed to the foreign country, we likewise assume this in the ensuing analysis.

4. R&D sector

Researchers' motivations to engage in innovative R&D should be considered. In this case, b will represent the price of a blueprint developed by R&D. As Martin (1999) and Martin and Ottaviano (1999) have demonstrated, the cost of R&D in a given location is inversely proportional to the number of firms previously established in that location. A researcher conducting R&D utilizes β/n units of labor in the domestic country and β/n^* units in the foreign country. So, if there's a difference in the number of firms in the domestic country and the foreign country, it means that all R&D will happen in the place with more firms. In our model, higher real consumption spending on differentiated goods in the domestic country than in the foreign country is led to by the larger capital stock in the domestic country ($S > S^*$). Consequently, the domestic country experiences an increasing returns to scale in the differentiated goods sector, leading to a higher concentration of firms. As a result, all R&D takes place in the domestic country and this determines the global growth. In the following step, the solution for a steady state is derived, in which $\omega = n/N$ and $g = \dot{N}/N$ are constants. The equity price of each firm b is determined by the free entry condition in the R&D sector: $b = \beta/N\omega$. The world labor market is then cleared as follows:

$$2L = \frac{\beta g}{\omega} + (1-\theta)L(E+E^*) + \theta L\left(\frac{\sigma-1}{\sigma}\right)IG, \tag{11}$$

where

$$G = \frac{(1+\varphi_h)^{-\sigma}\delta\left(1+\varphi_f\right)^{-\sigma}\delta - 1}{\left((1+\varphi_h)^{1-\sigma}\delta\left(1+\varphi_f\right)^{1-\sigma}\delta - 1\right)\left((1+\varphi_h)^{-\sigma}\delta - 1\right)\left(\left(1+\varphi_f\right)^{-\sigma}\delta - 1\right)}.$$

In the steady state, if both g and ω are constant, equation (11) implies that expenditure (E and E^*) is constant as well. This yields $r = \rho$ from $\dot{E}/E = \dot{E}^*/E^* = r - \rho$. Then, substituting equation (10), $\dot{b} = -gb$, $b = \beta/N\omega$ and $r = \rho$ into equation $\alpha Y/(\sigma - 1) + \dot{b} = rb$ and considering (11), the equilibrium growth rate of S, S^* and N is obtained:

$$g = \frac{2L}{\beta\sigma}\omega - \frac{(1-\theta)L(E+E^*)\omega}{\beta\sigma} - \left(\frac{\sigma-1}{\sigma}\right)\rho, \tag{12}$$

where

$$E = 1 + \frac{\rho\beta s}{\omega L} + \varphi_h \tau n P(h) D^*(h), \quad E^* = 1 + \frac{\rho\beta(1-s)}{\omega L} + \varphi_f \tau n^* P^*(f) D(f), \tag{13}$$

where s ($\equiv S/N$) and $1-s$ ($\equiv 1 - S/N$). These are constant in the steady state. The initial term in (13) denotes labor income, the second term signifies rent income, and the third term indicates the transfer of income to households from the domestic government as a consequence of the export taxes. In the following, we assume that $\kappa_h \equiv \theta\varphi_h(1+\varphi_h)^{-\sigma}\delta \approx 0$, $\kappa_f \equiv \theta\varphi_f\left(1+\varphi_f\right)^{-\sigma}\delta \approx 0$, and $\rho\beta < L$. Intuitively, if the parameters σ and τ are large, and the parameters θ, φ_h, and φ_f are small, then it can be concluded that κ_h and κ_f are close to zero. In summary, these conditions imply that under conditions of high elasticity of substitution between two goods (σ), high transport cost of icebergs (τ), low consumption spending on the differentiated goods (θ), and low export tax rates ($\varphi_f(\varphi_h)$), the parameters $\kappa_h \approx 0$ and $\kappa_f \approx 0$ are applicable. These assumptions allow us to identify the impact of an increase in the export tax rate in each country. In this case, world consumption spending is given by $(E+E^*)|_{\kappa_h\approx 0, \kappa_f \approx 0} = 2 + \rho\beta/\omega L$. Subsequently, from the equation (12) and $(E+E^*)|_{\kappa_h\approx 0, \kappa_f \approx 0} = 2 + \rho\beta/\omega L$, the world growth rate is derived as follows:

$$g = \frac{2\theta L}{\beta\sigma}\omega - \left(\frac{\sigma-\theta}{\sigma}\right)\rho. \tag{14}$$

Substituting (13) into equation (9) and considering $\kappa_h \approx 0$ and $\kappa_f \approx 0$, we obtain the following:

$$\omega = \frac{n}{N} = \frac{[1-(1+\varphi_f)^{-\sigma}\delta]\left(L+\frac{\rho\beta s}{\omega}\right) - [1-(1+\varphi_h)^{-\sigma}\delta](1+\varphi_f)^{1-\sigma}\delta\left[L+\frac{\rho\beta(1-s)}{\omega}\right]}{[1-(1+\varphi_f)^{-\sigma}\delta][1-(1+\varphi_h)^{1-\sigma}\delta]\left(L+\frac{\rho\beta s}{\omega}\right) + [1-(1+\varphi_h)^{-\sigma}\delta][1-(1+\varphi_f)^{1-\sigma}\delta]\left[L+\frac{\rho\beta(1-s)}{\omega}\right]}. \tag{15}$$

From (15), we obtain the following quadratic equation in ω:

$$\mu_1\omega^2 + \mu_2\omega + \mu_3 = 0, \tag{16}$$

where

$$\mu_1 = L\left[1-\left(1+\varphi_f\right)^{-\sigma}\delta\right][1-(1+\varphi_h)^{1-\sigma}\delta] + L[1-(1+\varphi_h)^{-\sigma}\delta]\left[1-\left(1+\varphi_f\right)^{1-\sigma}\delta\right], \tag{17}$$

$$\mu_2 = \rho\beta s\left[1-\left(1+\varphi_f\right)^{-\sigma}\delta\right][1-(1+\varphi_h)^{1-\sigma}\delta]+\rho\beta(1-s)[1-(1+\varphi_h)^{-\sigma}\delta]\left[1-\left(1+\varphi_f\right)^{1-\sigma}\delta\right]-L\left[1-\left(1+\varphi_f\right)^{-\sigma}\delta\right]+L[1-(1+\varphi_h)^{-\sigma}\delta]\left(1+\varphi_f\right)^{1-\sigma}\delta, \quad (18)$$

$$\mu_3 = -\rho\beta s\left[1-\left(1+\varphi_f\right)^{-\sigma}\delta\right]+\rho\beta(1-s)[1-(1+\varphi_h)^{-\sigma}\delta]\left(1+\varphi_f\right)^{1-\sigma}\delta. \quad (19)$$

The positive root of this equation,

$$\omega = \frac{-\mu_2+\sqrt{\mu_2^2-4\mu_1\mu_3}}{2\mu_1}, \quad (20)$$

is the valid solution when evaluated at $\varphi_h = \varphi_f = 0$ (see Appendix).

5. Effects of export taxes

First, we will examine how changes in export tax rates in different countries affect their locations. From equation (20), the effect of an increase in the domestic country's export tax on the equilibrium share of domestic firms is as follows:

$$\left.\frac{\partial\omega}{\partial\varphi_h}\right|_{\varphi_h=\varphi_f=0} < 0. \quad (21)$$

Similarly, the effect of an increase in the foreign export tax on industry location is shown in equation (22):

$$\left.\frac{\partial\omega}{\partial\varphi_f}\right|_{\varphi_h=\varphi_f=0} > 0. \quad (22)$$

Equation (21) demonstrates that a rise in the export tax of the agglomerated domestic country prompts the relocation of firms to the non-agglomerated foreign country. The following is an intuitive explanation for this result. First, an increase in the domestic country's export tax decreases its production of differentiated goods due to the intra-sectoral substitution effect.[3] This phenomenon results in a decline in the profits of firms located in the domestic country, consequently motivating

[3] The intra-sectoral substitution effect emerges due to a rise in the domestic country's export tax, leading to a rise in the price of domestic country-differentiated goods for households in the foreign country. Consequently, foreign country consumption demand shifts from imported domestic-differentiated goods to foreign-differentiated goods.

them to relocate to the foreign country. Similarly, equation (22) implies that an increase in the export tax of a non-agglomerated foreign country causes firms to relocate to the domestic country. The aforementioned results offer the key to comprehending the beneficial or harmful impacts of a rise in each country's export tax on the global growth, which will be explored below. The next step is to examine how a rise in the export tax affects the global growth, taking into account the location effect. From (14) and taking into account the results of (21) and (22), we obtain

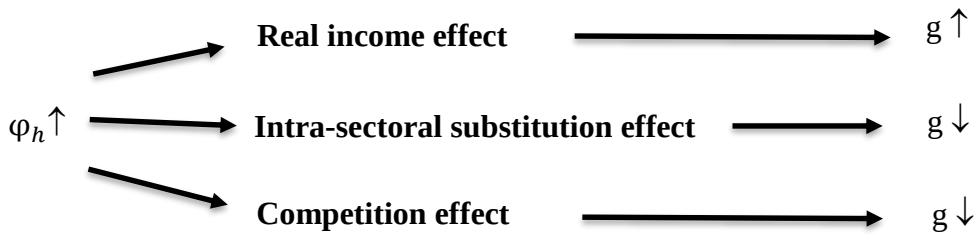
$$\left.\frac{\partial g}{\partial \varphi_h}\right|_{\varphi_h=\varphi_f=0} = \left(\frac{2\theta L}{\beta\sigma}\right)\left.\frac{\partial \omega}{\partial \varphi_h}\right|_{\varphi_h=\varphi_f=0} < 0, \tag{23}$$

$$\left.\frac{\partial g}{\partial \varphi_f}\right|_{\varphi_h=\varphi_f=0} = \left(\frac{2\theta L}{\beta\sigma}\right)\left.\frac{\partial \omega}{\partial \varphi_f}\right|_{\varphi_h=\varphi_f=0} > 0. \tag{24}$$

In accordance with the model under consideration, the growth effects of a rise in the export tax are found to comprise four effects: the intra-sectoral substitution effect, the competition effect, the real income effect, and the tax revenue effect. Initially, a rise in the export tax by the agglomerated domestic country results in an increase in the price of home-produced differentiated goods in the foreign country. This leads to a shift in consumption as the demand for differentiated goods produced in the foreign country increases due to the relative price increase of differentiated goods produced in the domestic country. This phenomenon has been observed to induce domestic-located firms to relocate to the foreign country, driven by the increase in the profits of foreign-located firms. As previously mentioned, in the model under consideration, the R&D cost in the domestic country is negatively proportional to the number of firms, and all R&D takes place in the domestic country, which determines the global growth. Therefore, the relocation effect of a unilateral increase in export taxes in the domestic country is detrimental to the global growth rate because it leads to a decline in the number of firms producing differentiated goods in the domestic country. Consequently, the initial effect, designated as the intra-sectoral substitution effect, exerts a deleterious influence on the global growth rate. Second, a decrease in domestic firms reduces the number of new entrants to domestic R&D by decreasing the externality of local knowledge. Consequently, the growth rate of blueprints declines, which reduces inter-firm competition and has a positive effect on firms' monopoly profits, ultimately increasing firm values. An increase in the firm values leads to an increase in the value of stocks held by agents, which, in turn, results in a rise in household income. Consequently, this rise in income leads to a rise in household consumption spending, which, in turn, contributes to a rise in global consumption spending. A rise in global consumption spending indicates a greater demand for labor in the production of goods to meet these demands, resulting in a reduction in labor available for

the R&D sector. Therefore, the competition effect, a secondary phenomenon, exerts a deleterious influence on the global growth rate. Thirdly, a rise in the export tax by the domestic country in a unilateral manner results in an increase in the foreign consumption price index. Consequently, this leads to a decrease in real consumption expenditure, which in turn results in a decrease in the real demand for differentiated goods in the foreign country. In the model under consideration, a positive relationship is exhibited between the price index and the export tax. An increase in the export tax by the domestic country has the effect of decreasing the purchasing power of the foreign country's income. Therefore, this decrease forces the foreign country's households to purchase smaller amounts of the differentiated goods as well as the numeraire good. In this case, reduced labor input is evident in the production of goods for global consumption, and augmented labor availability is apparent in the R&D sector according to the equilibrium condition for the labor market. Consequently, this third effect, designated as the real income effect, exerts a favorable influence on the global growth. Fourthly, an augmentation in the agglomerated domestic export tax will result in the domestic country government's transfer of export tax revenues to domestic country households, thereby increasing domestic country consumption spending and, consequently, global consumption spending. An increase in global consumption spending indicates a greater demand for labor in the production of goods to meet these demands. Consequently, as the equilibrium condition for the labor market is met, there is a decrease in available labor for the R&D sector. Consequently, the fourth effect—the tax revenue effect—exerts a deteriorate influence on the global growth. However, the fourth effect disappears under $\kappa_h \approx 0$ and $\kappa_f \approx 0$. In summary, the positive effect of a rise in the domestic export tax is the real income effect, while the negative effect of an increase in the domestic export tax is the sum of the intra-sectoral substitution effect and the competition effect. Consequently, the net growth effect of a rise in the domestic country's export tax is contingent upon the relative strength of these positive and negative effects, as shown in Figure 1.

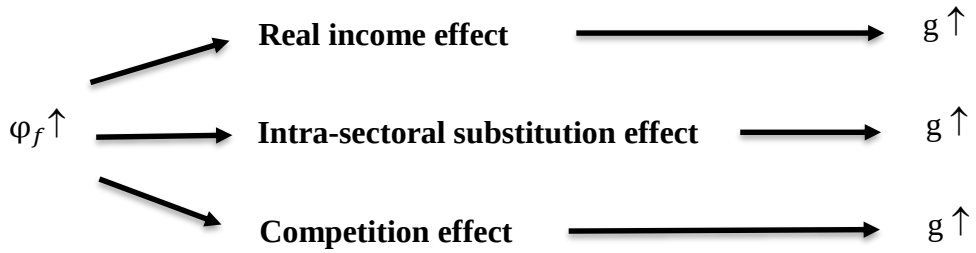
Figure 1: Effects of a rise in the domestic country’s export tax on the global growth rate.



However, as demonstrated in equation (23), the initial two effects (the intra-sectoral substitution effect and the competition effect) invariably exceed the real income effect under $\kappa_h \approx 0$ and $\kappa_f \approx 0$, thereby yielding the results of (23). Therefore, it can be concluded that if there is a high level of

substitution between any two goods that are different from one another; if the cost of transporting goods is significant, yet the share of their consumption expenditure is low; and if the export tax rate of the domestic (or foreign) country is low, then it can be expected that $\kappa_h \approx 0$ and $\kappa_f \approx 0$. Consequently, an increase in the export tax of the domestic country will have the effect of decreasing the growth rate on a global scale. Conversely, a rise in the export tax of the foreign country will enhance the global growth due to the larger concentration of firms in the agglomerated domestic country. Because, in this case, the three effects—the intra-sectoral substitution effect, the real income effect, and the competition effect—become positive all, as shown in Figure 2.

Figure 2: Effects of a rise in the foreign country's export tax on the global growth rate.



To provide a more intuitive illustration of the relative strength of the aforementioned three effects, the focus will now be on the elasticity of substitution between differentiated products (σ). In the model presented here, in economies with a large σ, a higher export tax in the domestic country results in diminished product demand for the domestic country's differentiated products. This phenomenon can be attributed to the substitution effect, which states that as the degree of substitutability between products increases, a given increase in the domestic export tax will cause foreign consumption demand to shift from domestic goods to foreign goods. Consequently, if σ is sufficiently high, an increase in the domestic export tax will result in an increase in the intra-sectoral substitution effect. Thus, if σ is large enough for $\kappa_h \approx 0$ and $\kappa_f \approx 0$ to hold, a rise in the domestic export tax will lower the global growth and a rise in the foreign export tax will increase the world growth rate.

6. Welfare

In this section, an analysis of the impact of export taxes on the welfare of each country will be conducted. The indirect domestic and foreign utilities are as follows:

$$U(0) = \frac{1}{\rho}\log\left\{\theta^{\theta}(1-\theta)^{1-\theta}E\left(\frac{\sigma-1}{\alpha\sigma}\right)^{\theta}N(0)^{\frac{\theta}{\sigma-1}}\left[\left[1-\left(1+\varphi_f\right)^{1-\sigma}\delta\right]\omega+\left(1+\varphi_f\right)^{1-\sigma}\delta\right]^{\frac{\theta}{\sigma-1}}e^{\frac{\theta g}{\rho(\sigma-1)}}\right\}, \quad (25)$$

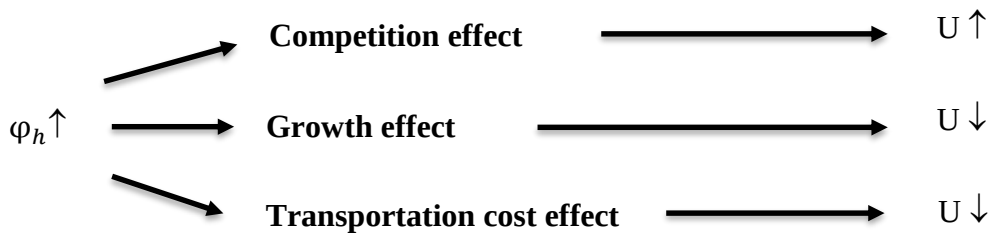
$$U^*(0) = \frac{1}{\rho}\log\left\{\theta^{\theta}(1-\theta)^{1-\theta}E^*\left(\frac{\sigma-1}{\alpha\sigma}\right)^{\theta} N(0)^{\frac{\theta}{\sigma-1}}[1-[1-(1+\varphi_h)^{1-\sigma}\delta]\gamma]^{\frac{\theta}{\sigma-1}}e^{\frac{\theta g}{\rho(\sigma-1)}}\right\}. \quad (26)$$

First, we analyse the welfare impact of a rise in the domestic country's export tax on the domestic welfare through the relocation of firms. Differentiating equation (25) with respect to φ_h yields

$$\left.\frac{\partial U(0)}{\partial \varphi_h}\right|_{\varphi_h=\varphi_f=0} = -\left(\frac{\beta s}{\omega^2 L+\rho\beta\omega s}\right)\left.\frac{\partial \omega}{\partial \varphi_h}\right|_{\varphi_h=\varphi_f=0} + \left(\frac{2L\theta^2}{\rho^2\beta\sigma(\sigma-1)}\right)\left.\frac{\partial \omega}{\partial \varphi_h}\right|_{\varphi_h=\varphi_f=0} + \left(\frac{\theta}{\rho(\sigma-1)}\right)\left(\frac{1-\delta}{(1-\delta)\omega+\delta}\right)\left.\frac{\partial \omega}{\partial \varphi_h}\right|_{\varphi_h=\varphi_f=0}. \quad (27)$$

The first term in (27) is the positive competition effect that a decrease in ω due to a rise in φ_h has on the wealth of the domestic country. This phenomenon can be attributed to the decentralization of firms across two countries, which further reduces the number of new entrants into R&D in the domestic country. This is due to the diminished local knowledge externalities and the reduced competition that accompanies the decrease in additional blueprints. Consequently, this shift leads to a rise in the profits of existing firms. A rise in the firm values leads to an increase in the value of stocks held by owners, which in turn increases household income. The second term signifies the negative growth effect that a decrease in ω due to a rise in φ_h has on the global growth. This is due to the resulting firms' decentralization across two countries, which leads to a decline in new R&D entrants in the domestic country because of diminished local knowledge externalities. This, in turn, results in a subsequent decrease in the wealth of the domestic country. In this paper, we propose the term "growth effect" to describe this phenomenon, aligning with the conceptual framework established by Martin and Ottaviano (1999). The third term signifies the deterioration in welfare resulting from the increase in transportation costs for households in the domestic country when ω is diminished by an augmentation in φ_h. This phenomenon can be attributed to the decline in the number of domestic firms, which compels households to increase their reliance on foreign imports, consequently leading to unnecessary transportation expenditures. This phenomenon is referred to in the present paper as the "transport cost effect." In summary, the model demonstrates that a positive welfare effect emerges due to the competition effect, while a negative effect is attributed to the growth and transportation cost effects, which collectively impact the domestic nation's welfare outcomes. Consequently, the net welfare effect on the domestic country of an increase in the domestic country's export tax is contingent upon the relative strength of these positive and negative effects, as shown in Figure 3.

Figure 3: Effects of a rise in the domestic country's export tax on the domestic welfare.



However, when L is large and β is small, the positive competition effect decreases and the negative growth effect increases, resulting in negative welfare gains for domestic households:

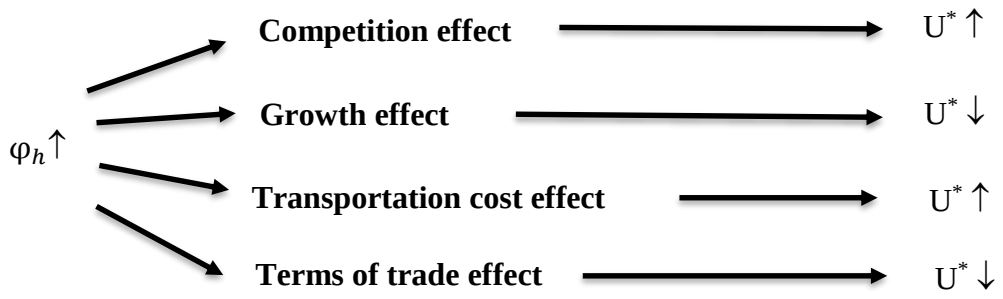
$$\frac{\partial U(0)}{\partial \varphi_h}\Big|_{\varphi_h=\varphi_f=0} < 0. \tag{28}$$

To analyse the welfare impact in the case of the foreign country, differentiate equation (26) with respect to φ_h to obtain the following:

$$\frac{\partial U^*(0)}{\partial \varphi_h}\Big|_{\varphi_h=\varphi_f=0} = -\left(\frac{\beta(1-s)}{\gamma^2 L+\rho\beta\omega(1-s)}\right)\frac{\partial \omega}{\partial \varphi_h}\Big|_{\varphi_h=\varphi_f=0} + \left(\frac{2L\theta^2}{\rho^2\beta\sigma(\sigma-1)}\right)\frac{\partial \omega}{\partial \varphi_h}\Big|_{\varphi_h=\varphi_f=0} - \left(\frac{\theta}{\rho(\sigma-1)}\right)\left(\frac{1-\delta}{1-(1-\delta)\omega}\right)\frac{\partial \omega}{\partial \varphi_h}\Big|_{\varphi_h=\varphi_f=0} + \left(\frac{\theta}{\rho}\right)\left(\frac{\delta\omega}{1-(1-\delta)\omega}\right). \tag{29}$$

The first term in (29) denotes the positive competition effect that a decrease in ω through an increase in φ_h exerts on the wealth of the foreign country. The second term signifies the negative growth effect of a decrease in ω due to a rise in φ_h. The third term signifies the positive welfare effect attributable to the decline in transportation cost burden on households in the foreign country when ω is diminished by an augmentation in φ_h. The fourth term is the terms of trade effect of the export tax, which decreases purchasing power by increasing the price index. In summation, the competition effect and transportation cost effect have been demonstrated to exert positive effects on welfare. Conversely, the growth effect and terms of trade have been shown to exert negative effects on welfare. Consequently, the net welfare effect of a rise in φ_h on the welfare of the foreign country is contingent on the relative strength of these positive and negative effects, as shown in Figure 4.

Figure 4: Effects of a rise in the domestic country's export tax on the foreign welfare.



However, when the parameter L is large and the parameter β is small, the positive competition effect is negligible, and the negative growth effect is substantial. Thus, it is evident that the welfare gains of foreign households can be negative:

$$\left.\frac{\partial U^*(0)}{\partial \varphi_h}\right|_{\varphi_h=\varphi_f=0} < 0. \tag{30}$$

Next, by differentiating equation (25) with respect to φ_f, the following result is obtained:

$$\left.\frac{\partial U(0)}{\partial \varphi_f}\right|_{\varphi_h=\varphi_f=0} = -\left(\frac{\beta s}{\gamma^2 L+\rho\beta\omega s}\right)\left.\frac{\partial \omega}{\partial \varphi_f}\right|_{\varphi_h=\varphi_f=0} + \left(\frac{2L\theta^2}{\rho^2\beta\sigma(\sigma-1)}\right)\left.\frac{\partial \omega}{\partial \varphi_f}\right|_{\varphi_h=\varphi_f=0} +$$

$$\left(\frac{\theta}{\rho(\sigma-1)}\right)\left(\frac{1-\delta}{\delta+(1-\delta)\omega}\right)\left.\frac{\partial \omega}{\partial \varphi_f}\right|_{\varphi_h=\varphi_f=0} + \left(\frac{\theta}{\rho}\right)\left(\frac{\delta(1-\omega)}{\delta+(1-\delta)\omega}\right). \tag{31}$$

The initial term of (31) signifies the negative impact of competition, as evidenced by a rise in ω concomitant with a rise in φ_f, on the wealth of the domestic country. The second term signifies the positive growth effect of a rise in ω due to a rise in φ_f. The third term signifies the positive welfare effect attributable to the decline in transportation cost obligations on households in the domestic country when ω is augmented by a rise in φ_f. The fourth term is the terms of trade effect of the export tax, which decreases the purchasing power associated with the increase in the domestic price index. Thus, the net welfare effect on the domestic country of an increase in the foreign country's export tax is contingent upon the relative strength of these positive and negative effects. However, when L is large and β is small, the negative competition effect is small and the positive growth effect is large, ensuring that the welfare gains of households are always positive:

$$\left.\frac{\partial U(0)}{\partial \varphi_f}\right|_{\varphi_h=\varphi_f=0} > 0. \tag{32}$$

Next, we differentiate equation (26) with respect to φ_f to get the following equation:

$$\left.\frac{\partial U^*(0)}{\partial \varphi_f}\right|_{\varphi_h=\varphi_f=0} = -\left(\frac{\beta(1-s)}{\omega^2 L+\rho\beta\omega(1-s)}\right)\left.\frac{\partial \omega}{\partial \varphi_f}\right|_{\varphi_h=\varphi_f=0} + \left(\frac{2L\theta^2}{\rho^2\beta\sigma(\sigma-1)}\right)\left.\frac{\partial \omega}{\partial \varphi_f}\right|_{\varphi_h=\varphi_f=0} - \left(\frac{\theta}{\rho(\sigma-1)}\right)\left(\frac{1-\delta}{1-(1-\delta)\omega}\right)\left.\frac{\partial \omega}{\partial \varphi_h}\right|_{\varphi_h=\varphi_f=0}. \quad (33)$$

The initial term of (33) signifies the negative impact of competition on the wealth of a foreign nation due to a rise in ω concurrent with a rise in φ_f. The second term signifies the positive growth effect of a rise in ω due to a rise in φ_f. The third term signifies the negative welfare effect that arises from the elevated transportation cost burden for households in the foreign country when ω is augmented by a rise in φ_f. Thus, the net welfare effect on the foreign country of a rise in the foreign country's export tax is contingent upon the relative strength of these positive and negative effects. However, when *L* is substantial and β is negligible, the negative competition effect is minimal and the positive growth effect is substantial, ensuring that the welfare gains of foreign households are invariably positive:

$$\left.\frac{\partial U^*(0)}{\partial \varphi_f}\right|_{\varphi_h=\varphi_f=0} > 0. \quad (34)$$

Accordingly, the results of the aforementioned welfare analysis demonstrate that the impact of an export tax on global growth is contrary, contingent upon the implementation of the policy in an agglomeration or non-agglomeration country. With respect to welfare effects, a rise in the export tax rate in the agglomerated domestic country results in a reduction of welfare for both agglomeration and non-agglomeration countries. Conversely, a rise in the export tax rate in the non-agglomerated foreign country leads to an enhancement of welfare for both.

7. Conclusion

This paper analysed the effect of a rise in the export tax in each country on the global growth through the relocation of firms. The findings of this study suggest that in the context of local spillovers in R&D, a unilateral rise in the export tax of the agglomerated home country where firms are concentrated will lead to a decline in the global growth, attributable to a reduction in the concentration of firms in the domestic country. Conversely, a unilateral increase in the export tax of a non-agglomerated foreign country where firms are not agglomerated will increase the global growth through the larger concentration of firms in the domestic country. In addition, the results of the welfare analysis suggest that the implementation of export tax policies in the agglomerated country

is associated with a deterioration in the welfare of both domestic and foreign households. In the context of export taxes in non-agglomeration countries, it has been demonstrated that these taxes can, in contrast, enhance the economic welfare of both agglomeration and non-agglomeration countries. This suggests that the welfare implications of the same export tax policy can differ depending on whether it is implemented by an agglomeration or a non-agglomeration country.

Recently, US-based semiconductor manufacturers Nvidia and AMD reached an agreement with the Trump administration whereby they would pay the US government 15% of their revenue from chip sales in China in exchange for licences to export semiconductors to the country (Sevastopulo and Acton, 2025). The export licence fees paid by Nvidia and AMD to the US government can be considered a form of export tax. The research in this paper suggests that if the US is an industrial agglomeration country and China is a non-agglomeration country, a US export tax on semiconductors would worsen global growth and economic welfare in both countries. Conversely, if the US were a non-agglomeration country and China an agglomeration country, a US export tax on semiconductors could stimulate global growth and improve economic welfare in both countries. Therefore, as a policy implication, the results of this paper suggest that, from the perspective of the impact on not only the domestic country's welfare but also global growth and global welfare, export taxes should be imposed on domestic-located firms only if the country is an industrial non-agglomeration country.

In this paper, we analysed how raising export taxes affects growth and welfare through the cross-border relocation of firms, considering regional knowledge spillovers. Although the model is simple, it allows for many extensions. One theoretical limitation of this paper is that it does not consider the interactions between the two governments necessary to determine the optimal export tax rate. Thus, it would be beneficial to expand this model by treating export tax rates as strategic variables and analysing the optimal export tax rate in a model involving the cross-border relocation of firms. Second, this paper treats international relocation in a simplified manner. However, in reality, cross-border relocation of firms is influenced by factors such as environmental regulations, public infrastructure, the exchange rate, and inflation. Our model assumes that it depends only on differences in firm profits. Thus, an important research topic would be to consider an extended model that includes the above factors in the relocation mechanism. Finally, this paper has shed light on the theoretical aspects of the growth and welfare effects of a unilateral export tax increase in the context of international firm relocation. However, it is essential to verify whether our results are consistent with empirical evidence as a next step. Overcoming the limitations of this analysis through such extended research remains an area of future research.

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Appendix

In this appendix, we shall ascertain the conditions under which the equilibrium domestic country's share of firms exists within the range of $1/2 < \omega < 1$. As demonstrated in (20), the share of firms is expressed by the following equation:

$$\omega = \frac{-\mu_2 + \sqrt{\mu_2^2 - 4\mu_1\mu_3}}{2\mu_1}. \tag{20}$$

From equation (20), the condition for $\omega > 1/2$ is $\mu_1 + 2\mu_2 + 4\mu_3 < 0$. However, it must be noted that this condition is only valid under the assumptions that $S > S^*$ and $\varphi_h = \varphi_f = 0$. Because when $S > S^*$ and $\varphi_h = \varphi_f = 0$ holds, we obtain the following:

$$\mu_1 + 2\mu_2 + 4\mu_3 = -2\rho\beta(1-\delta)(1+\delta)\big(s-(1-s)\big) < 0. \quad \text{(A.1)}$$

Therefore, from s >1/2, ω >1/2 is always valid. Next, from equation (20), the condition for ω < 1 is $\mu_1 + \mu_2 + \mu_3 > 0$, where

$$\mu_1 + \mu_2 + \mu_3 = L(1-\delta)^2 + \rho\beta(1-\delta)\big((1-s) - s\delta\big). \quad \text{(A.2)}$$

Therefore, according to (B.2), if L and τ are large and ρ and β are small enough, then ω < 1 is always valid. Thus, under these conditions, the share of firms exists within the range 1/2 < ω < 1.