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EXPORT-PROMOTING POLICIES, AGGLOMERATION, AND GROWTH

Wataru Johdo

Tokyo Keizai University, Department of Economics, Tokyo Japan

✉ *johdo@tku.ac.jp*

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Review paper

Abstract: This paper examines the impact of trade subsidies on global growth and national welfare through the cross-border movement of firms in an endogenous growth model. In particular, our model focuses on two key aspects: the cross-border movement of firms and the reallocation of labor resources between the production and innovation sectors. In this paper, we show that, in the presence of local knowledge spillovers, an increase in the trade subsidy by the country where firms are agglomerated leads to an increase in the global growth rate under certain parameter conditions, while an increase in the trade subsidy by the country that is not agglomerated results in a decrease in the global growth rate. Moreover, the results of the welfare analysis show that trade subsidies in the agglomeration country enhance the welfare of both the agglomeration and the non-agglomeration countries, whereas trade subsidies in non-agglomeration country diminish the welfare of both countries.

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Introduction

The purpose of this paper is to clarify the impact of trade subsidies by one country on the global growth rate in an open economy endogenous growth model. In this model, firms are free to relocate internationally, and research and development (R&D) know-how is a local public good. In the past four decades, the expansion of economic globalization and the deregulation of the access of foreign firms have led to a notable increase in the cross-border movement of firms in order to achieve greater profits in the markets of other countries.[1] This cross-border movement of firms not only transfers technological knowledge to the host country, but also contributes to global economic growth through the knowledge spillover effect caused by the agglomeration of firms in the host country. Nevertheless, despite a wealth of econometric evidence showing the importance of cross-border firm movement and foreign direct investment (FDI) as channels for the diffusion of technological knowledge from source to destination countries (e.g. Coe and Helpman, 1995; Keller, 1998, 2002, 2004; Klenow and Rodriguez-Clare, 2004; Park, 2004; Zhu and Nam Jeon, 2007), cross-border firm movement has so far been excluded from theoretical studies on the link between trade subsidies and growth in the literature on endogenous growth (e.g., Grossman and Helpman, 1991, ch. 10; Afonso and Silva, 2012). For example, Afonso and Silva (2012) employ an endogenous growth model that incorporates the innovative R&D sector to analyze the impact of trade subsidies on growth. Their findings indicate that trade subsidies result in increased profits within the intermediate goods sector, which, in turn, stimulates R&D investment and elevates the growth rate. However, their study was conducted in a closed economy, which raises the question of whether their conclusions hold in an open economy model framework. Another study is that of Grossman and Helpman (1991, Chapter 10). Unlike the closed economy model of Afonso and Silva (2012), their study employs an open economy model and examines the impact of trade subsidies on high-tech tradable products on the global growth rate through its influence on innovative activity. In their research, they show that trade subsidies in each country lead to a reduction in the rate of technological progress. This is due to a decrease in production factor resources invested in the innovation sector, which competes with the high-tech production sector. Consequently, the global growth rate is reduced. However, their result is contingent upon the model being an open economy model with a fixed location of firms. Consequently, although their model assumes an open economy, it is not necessarily the case that the same conclusions would be reached even in an open economy where high-tech firms exhibit cross-border location behavior.

In the context of the preceding discussion, a further question arises: Is the policy of unilaterally increasing trade subsidies in one country beneficial for the growth rate of the world economy in the presence of increasing market globalization, which is accompanied by an increase in the cross-border movement of firms? To answer this question, at least within the framework of an open economy

[1] Empirical evidence suggests that increased globalization and the easing of restrictions on the entrance of foreign firms have led to the strong growth (*e.g.*, Darku and Yeboach 2018; D'Costa, Garcilazo and Martins 2019; Haini and Loon 2022; Kinfack and Bonga-Bonga 2023). Moreover, empirical evidence suggests that export expansion led positively to the growth (e.g., Tyler 1980; Kavoussi 1984; Ram 1985; Esfahani 1991; Islam 1998; Kónya 2006).

endogenous growth model that takes into account the cross-border movement of firms, it is essential to analyze the effects of increasing trade subsidies.

In addition to the aforementioned studies, several studies in the new economic geography literature on endogenous growth have examined the cross-border movement of firms with technological knowledge spillovers. The most representative papers in this field are Baldwin (1999), Martin (1999), Martin and Ottaviano (1999, 2001), Baldwin and Forslid (2000), Baldwin, Martin, and Ottaviano (2001), and Baldwin, Braconier, and Forslid (2005).[2] For example, Martin (1999) and Martin and Ottaviano (1999, 2001) use an open-economy model consisting of two regions to analyze the impact of economic integration due to a reduction of transport costs on the global growth rate through their effect on the cross-border movement of firms. However, the new economic geography literature mentioned above has not yet analyzed the effects of a unilateral increase in trade subsidies on global growth.

This paper examines the impact of a unilateral increase in trade subsidies on the rate of global growth through the cross-border movement of firms. For this purpose, trade subsidies are introduced into the two-region endogenous growth model of Martin (1999) or Martin and Ottaviano (1999, 2001). It should be noted that Johdo (2024) and Johdo (2025a, b) are related recent studies to this paper that analyze the growth effects of trade policy using Martin and Ottaviano's (1999) two-country endogenous growth model with firm transfers between two regions, as in this paper. Johdo (2024) examines the impact of a globally uniform tariff cut on global growth and the welfare of each country under the same case of local knowledge spillovers as in our study. It shows that a small, globally uniform tariff cut will always induce firms to relocate to the agglomeration country, increasing the productivity of the R&D sector and, as in Martin and Ottaviano (1999), leading to an increase in the global growth rate. Furthermore, in contrast to Martin and Ottaviano (1999), Johdo (2024) also shows that, under certain conditions, such as sufficiently high transportation costs, economic integration through a globally uniform tariff cut will worsen the welfare of each country. In contrast to the case of simultaneous and uniform tariff reductions around the world in Johdo (2024), Johdo (2025a) examines the growth effects of a unilateral tariff increase by one country under the same case of local knowledge spillovers as in this paper. Johdo (2025a) shows that a unilateral tariff hike by an agglomeration country increases the global growth rate by promoting the global agglomeration effect, but a unilateral tariff hike by a non-agglomeration country has a negative impact on the global agglomeration effect, thereby reducing the global growth rate. However, Johdo (2025a) does not examine the welfare effects of a unilateral tariff increase by

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

a country. Finally, Johdo (2025b) examines the growth and welfare effects of simultaneous and uniform export subsidies raised by two countries under the case of local knowledge spillovers as in this paper. Johdo (2025b) shows that simultaneous and uniform export subsidies stimulate the global agglomeration effect and increase the global growth rate. In addition, the welfare effects of common export subsidies are generally ambiguous, but it is shown that the welfare of both countries improves more when the population size is large and innovation productivity is high. However, Johdo (2025b) does not consider the growth effects of unilateral export subsidies by one country and the welfare effects of each country. As described above, Johdo (2024) and Johdo (2025a, b) have shown how trade policies such as tariffs and export subsidies affect global growth and welfare by using a two-country endogenous growth model that accounts for the cross-border movement of firms, transportation costs, and local knowledge spillovers. The purpose of this study is to show the global growth and welfare effects of unilateral trade subsidies by a country through cross-border changes in firm location, which has not been shown in these studies.

The results of this analysis show that an increase in the trade subsidy rate of the home country (foreign country) leads to an increase (decrease) in the global growth rate through an increase (decrease) in the agglomeration of firms in the home country, contingent on local knowledge spillovers in R&D. Moreover, the results of the welfare analysis indicate that trade subsidies provided by the country in which the firms are agglomerated have a positive impact on the economic welfare of both countries, whereas export subsidies provided by the country in which the firms are not agglomerated have a detrimental effect on the economic welfare of both countries.

The rest of the paper is organized as follows: Section 2 delineates the characteristics of the model, Section 3 details the equilibrium position of firms, Section 4 characterizes the innovation sector, Section 5 analyzes the repercussions of a unilateral increase in trade subsidies in each nation on the global growth rate through the international movement of firms, and Section 6 analyzes the welfare implications of a unilateral increase in trade subsidies in each nation. Finally, Section 7 concludes the paper.

2. Model

Two countries are considered: the home country and the foreign country. To denote the variables associated with the foreign country, an asterisk is utilized. The ensuing discourse will primarily center on a portrayal of the home country. The intertemporal objective of a typical household is to maximize the below utility function:

$$U(0)=\int_0^\infty \log\left(X(t)^\alpha Z(t)^{1-\alpha}\right)e^{-\rho t}dt, \tag{1}$$

where $X(t)$ is a consumption index, and $Z(t)$ is defined as the numeraire good. The definition of $X(t)$ is as follows:

$$X(t)=\left[\int_{i=0}^{N(t)} X(i,t)^{(\sigma-1)/\sigma} di\right]^{\sigma/(\sigma-1)}, \sigma > 1, \tag{2}$$

where $X(i, t)$ is the differentiated good i and $N(t)$ is the total number of goods in the world. The home government imposes a lump-sum tax on households to finance the trade subsidy. For the transportation of differentiated goods between countries, we assume iceberg transportation costs: τ ($\tau \geq 1$). The time subscript is omitted below. The expenditure of a household, C, is then given by

$$C=\int_{i\in n} p(i)X(i)di+\int_{j\in n^*}\left(1-s_f\right)\tau p^*(j)X(j)dj+Z, \tag{3}$$

where $p(i)$ is the price of a good i and $p^*(j)$ is its price in the foreign location, s_f (s_h) is the trade subsidy rate of the foreign (home) location. As seen in (3), the home location is composed of n firms and the n^* firms are located in the foreign country, and therefore $n + n^* = N$. The consumption price indices (CPI) are then given by

$$P^X=\left(\int_{i\in n} p(i)^{1-\sigma}di+\int_{j\in n^*}\left(\left(1-s_f\right)\tau p^*(j)\right)^{1-\sigma}dj\right)^{1/(1-\sigma)}, \tag{4}$$

$$P^{X*}=\left(\int_{i\in n}\left(\left(1-s_h\right)\tau p(i)\right)^{1-\sigma}di+\int_{j\in n^*} p^*(j)^{1-\sigma}dj\right)^{1/(1-\sigma)}. \tag{5}$$

On the production side of differentiated goods, first a patent is required to start production of each variety of goods. Therefore, this patent can be interpreted as a fixed cost of production. To finance this fixed cost, firms typically issue shares and subsequently distribute the resulting profits to shareholders in the form of dividends. In addition, every good requires β labor units. Maximizing profit by choosing $p(i)$ gives $p(i) = \sigma\beta W/(\sigma - 1)$, where W is the wage rate. The profit flow of each firm ($= \Pi(i)$) is then

$$\Pi(i)=p(i)x(i)-\beta Wx(i)=\frac{\beta Wd(i)}{(\sigma-1)}, \tag{6}$$

where $d(i)$ is the amount of product. On the other hand, it is assumed that one unit of labor is used to produce one unit of Z. Some production of the good takes place in both countries. Then, we ensure that $W = W^*$ because the good trades freely.

Since Z is the numeraire, we have $W = W^* = 1$ at each location. This gives us $p = p^* = \sigma\beta/(\sigma - 1)$. Here we define $\delta \equiv \tau^{1-\sigma} \in (0, 1)$. From the static maximization of the utility due to the choice of $X(i)$, $X(j)$ and Z, we obtain the following equation

$$X(i) = \frac{(\sigma - 1)}{\sigma\beta}\left(\frac{\alpha C}{n + n^*(1 - s_f)^{1-\sigma}\delta}\right), \tag{7a}$$

$$X(j) = \frac{(\sigma - 1)}{\sigma\beta}\left(\frac{\alpha C(1 - s_f)^{-\sigma}\tau^{-\sigma}}{n + n^*(1 - s_f)^{1-\sigma}\delta}\right), \tag{7b}$$

$$Z = (1 - \alpha)C. \tag{7c}$$

Let q be the value of the stock and r be the return of the risk-free bond. Therefore, considering (6), a no-arbitrage condition gives

$$\frac{\beta d(i)}{\sigma - 1} + \dot{q} = rq. \tag{8}$$

Maximizing (1), subject to the intertemporal budget constraint and free capital mobility between countries, requires that

$$\dot{C}/C = \dot{C}^*/C^* = r - \rho. \tag{9}$$

3. Aggregation and the share of firms

Aggregating the demand in (7a) and the corresponding demand in (7a) abroad, we obtain the market-clearing condition for $d(i)$:

$$d(i) = LX(i)D_i + L\tau X^*(i) = \frac{\alpha L(\sigma - 1)}{\sigma\beta}\left(\frac{C}{n + n^*(1 - s_f)^{1-\sigma}\delta} + \frac{C^*(1 - s_h)^{-\sigma}\delta}{n^* + n(1 - s_h)^{1-\sigma}\delta}\right) = d \tag{10a}$$

where L is labor endowment, which is equal in both countries. For product $d^*(j)$, we obtain:

$$d^*(j) = L\tau X(j) + LX^*(j) = \frac{\alpha L(\sigma - 1)}{\sigma\beta}\left(\frac{C(1 - s_f)^{-\sigma}\delta}{n + n^*(1 - s_f)^{1-\sigma}\delta} + \frac{C^*}{n^* + n(1 - s_h)^{1-\sigma}\delta}\right) = d^* \tag{10b}$$

The profits of the two locations must be equal for a firm to be neutral between the home and the foreign location after location arbitrage:

$$\Pi = \Pi^{*}. \tag{10c}$$

Therefore, using (6), (10c) and $W = W^{*} = 1$, we obtain $d = d^{*}$. Here, we set B and B^{*} as the home and foreign capital stocks, respectively. In addition, the total stock of capital determines the total number of firms, so that the total number of firms is

$$B + B^{*} = n + n^{*} = N. \tag{10d}$$

We obtain the share of firms in the home country, which we define as γ, by solving (10a)-(10d):

$$\gamma = \frac{n}{N} = \frac{\left((1-s_h)^{-\sigma}\delta - 1\right)(1-s_f)^{1-\sigma}\delta C^{*} - \left((1-s_f)^{-\sigma}\delta - 1\right)C}{\left((1-s_f)^{-\sigma}\delta - 1\right)\left((1-s_h)^{1-\sigma}\delta - 1\right)C + \left((1-s_h)^{-\sigma}\delta - 1\right)\left((1-s_f)^{1-\sigma}\delta - 1\right)C^{*}} \tag{11}$$

The profit flow of each firm is

$$\Pi = \frac{\alpha L \overline{C}}{\sigma N}\left\{\frac{(1-s_h)^{-\sigma}\delta(1-s_f)^{-\sigma}\delta - 1}{\left((1-s_h)^{1-\sigma}\delta(1-s_f)^{1-\sigma}\delta - 1\right)\left((1-s_h)^{-\sigma}\delta - 1\right)\left((1-s_f)^{-\sigma}\delta - 1\right)}\right\} \tag{12}$$

where

$$\overline{C} = \left((1-s_f)^{-\sigma}\delta - 1\right)\left((1-s_h)^{1-\sigma}\delta - 1\right)C + \left((1-s_h)^{-\sigma}\delta - 1\right)\left((1-s_f)^{1-\sigma}\delta - 1\right)C^{*}.$$

In accordance with the studies conducted by Martin (1999) and Martin and Ottaviano (1999), which postulate $B > B^{*}$ as an initial condition, thereby resulting in a greater number of firms being located within the home country, we likewise posit $B > B^{*}$.

4. Innovation sector

Let q denote the value of a design developed through innovation to consider the incentive for researchers to engage in innovative R&D. According to Martin's (1999) and Martin and Ottaviano's (1999) research, the cost of innovative activities in a specific location exhibits a negative correlation with the number of firms already established in that location. This cost is defined by the ratio of labor utilized for innovative R&D in both the home nation, where the ratio is expressed as λ/n, and the foreign nation, where this ratio is denoted as λ/n^*. This implies that all innovative activity will take place in the location with the larger number of firms if the number of firms in the home country differs from the number of firms in the foreign country. In our model, real expenditures on differentiated goods are higher in the home country than in the foreign country because of the larger capital stock in the home country ($B > B^*$). Thus, the home country ends up with a higher concentration of firms due to increasing returns to scale in the differentiated goods sector. Consequently, all innovative activity occurs within the home country, thereby influencing the global growth rate. Consequently, the phenomenon of free entry into the innovation sector results in the following equation: $q = \lambda/n$.

In the following step, we will derive a solution for a steady state in which $g = \dot{N}/N$ and $\gamma = n/N$ are constant. The free entry condition in the innovation sector determines the equity value of each firm q: $q = \lambda/N\gamma$. This implies that q decreases at the rate $g = \dot{N}/N = \dot{n}/n$ if there is a balanced growth path. Then, the global labor market clearing condition is:

$$\lambda\frac{g}{\gamma} + (1-\alpha)L\left(C + C^*\right) + \alpha AL\overline{C}\left(\frac{\sigma-1}{\sigma}\right) = 2L\,, \tag{13}$$

where

$$A = \frac{(1-s_h)^{-\sigma}\delta(1-s_f)^{-\sigma}\delta - 1}{\left((1-s_h)^{1-\sigma}\delta(1-s_f)^{1-\sigma}\delta - 1\right)\left((1-s_h)^{-\sigma}\delta - 1\right)\left((1-s_f)^{-\sigma}\delta - 1\right)}.$$

In the steady state, the constancy of both γ and g would imply the constancy of expenditure (C and C^*). This results in $r = \rho$ from (9). Then the following global growth rate of B, B^* and N is obtained by substituting (12), $r = \rho$, $\dot{q} = -gq$, and $q = \lambda/N\gamma$ into (8) and considering (13):

$$g = \frac{2L\gamma}{\lambda\sigma} - \frac{(1-\alpha)L\gamma\left(C + C^*\right)}{\lambda\sigma} - \left(\frac{\sigma-1}{\sigma}\right)\rho\,, \tag{14}$$

where

$$C = 1 + \frac{\rho\lambda b}{\gamma L} - s_h\tau np(h)X^*(h)\,, \tag{15}$$

$$C^* = 1 + \frac{\rho\lambda(1-b)}{\gamma L} - s_f \tau n^* p^*(f) X(f), \tag{16}$$

where the shares of home and foreign ownership, denoted by b ($\equiv B/N$) and $1-b$, respectively, are constant in the steady state. The first term in the aforementioned equations signifies labor income; the second term denotes the dividends revenue on shares; and the third term indicates the tax burden imposed on agents by the government sector to finance trade subsidies. In the following, we assume that $\varepsilon_h \equiv \alpha s_h (1-s_h)^{-\sigma} \delta \approx 0$, $\varepsilon_f \equiv \alpha s_f (1-s_f)^{-\sigma} \delta \approx 0$, and $\rho\lambda < L$. Intuitively, if σ and τ are sufficiently larger, and α, s_h, and s_f are sufficiently smaller, then ε_h and ε_f are approximately zero. In other words, these expressions state that if the elasticity of substitution between any two goods is high, transportation costs are high, the share of consumption expenditure on the differentiated goods is small, and the trade subsidy rates are small, then $\varepsilon_h \approx 0$ and $\varepsilon_f \approx 0$ hold. We can clearly see the impact of an increase in the trade subsidy rate under these assumptions. In this case, the value of global consumer spending is the following:

$$\left(C + C^*\right)\Big|_{\varepsilon_h \approx 0, \varepsilon_f \approx 0} = 2 + \frac{\rho\lambda}{\gamma L}. \tag{17}$$

From (14) and (17), we then obtain the following global growth rate:

$$g = \frac{2\alpha L \gamma}{\lambda\sigma} - \frac{\rho(\sigma - \alpha)}{\sigma}. \tag{18}$$

Substitute (15) and (16) into the share of home firms from (11) and consider $\varepsilon_h \approx 0$ and $\varepsilon_f \approx 0$, and we get

$$\gamma = \frac{\left[L + \frac{\rho\lambda(1-b)}{\gamma}\right]\left[(1-s_h)^{-\sigma}\delta - 1\right](1-s_f)^{1-\sigma}\delta - \left(L + \frac{\rho\lambda b}{\gamma}\right)\left[(1-s_f)^{-\sigma}\delta - 1\right]}{\left(L + \frac{\rho\lambda b}{\gamma}\right)\left[(1-s_f)^{-\sigma}\delta - 1\right]\left((1-s_h)^{1-\sigma}\delta - 1\right) + \left[L + \frac{\rho\lambda(1-b)}{\gamma}\right]\left[(1-s_h)^{-\sigma}\delta - 1\right]\left((1-s_f)^{1-\sigma}\delta - 1\right)} \tag{19}$$

From (19) we get the following second-order equation in γ:

$$D_1\gamma^2 + D_2\gamma + D_3 = 0, \tag{20}$$

where

$$D_1 = L\left[1-\left(1-s_f\right)^{-\sigma}\delta\right]\left(1-\left(1-s_h\right)^{1-\sigma}\delta\right)+L\left[1-\left(1-s_h\right)^{-\sigma}\delta\right]\left(1-\left(1-s_f\right)^{1-\sigma}\delta\right)>0\,, \quad (21)$$

$$D_2 = \rho\lambda b\left[1-\left(1-s_f\right)^{-\sigma}\delta\right]\left(1-\left(1-s_h\right)^{1-\sigma}\delta\right)+\rho\lambda\left(1-b\right)\left[1-\left(1-s_h\right)^{-\sigma}\delta\right]\left(1-\left(1-s_f\right)^{1-\sigma}\delta\right)$$
$$-L\left[1-\left(1-s_f\right)^{-\sigma}\delta\right]+L\left[1-\left(1-s_h\right)^{-\sigma}\delta\right]\left(1-s_f\right)^{1-\sigma}\delta \quad (22)$$

$$D_3 = -\rho\lambda b\left[1-\left(1-s_f\right)^{-\sigma}\delta\right]+\rho\lambda\left(1-b\right)\left[1-\left(1-s_h\right)^{-\sigma}\delta\right]\left(1-s_f\right)^{1-\sigma}\delta\,. \quad (23)$$

The positive root of (20),

$$\gamma = \frac{-D_2+\sqrt{D_2{}^2-4D_1D_3}}{2D_1}\,, \quad (24)$$

is the valid solution when evaluated at $s_h = s_f = 0$ (see Appendix).

5. Growth Effects of trade subsidies

First, the effects of an increase in the trade subsidy rate on the location of production are analyzed. From equation (24), the effect of an increase in the home trade subsidy on the equilibrium share of home firms is as follows:

$$\left.\frac{d\gamma}{ds_h}\right|_{s_h=s_f=0} = \frac{1}{\left(2D_1\right)^2}\left(D_2{}^2-4D_1D_3\right)^{-\frac{1}{2}}$$
$$\times\left\{\left\{-D_2{}'\left(D_2{}^2-4D_1D_3\right)^{\frac{1}{2}}+\frac{1}{2}\left\{2D_2D_2{}'-4\left(D_1{}'D_3+D_1D_3{}'\right)\right\}\right\}\times 2D_1-2D_1{}'\left\{-D_2\left(D_2{}^2-4D_1D_3\right)^{\frac{1}{2}}+\left(D_2{}^2-4D_1D_3\right)\right\}\right\}>0 \quad (25)$$

where

$$\left.\frac{dD_1}{ds_h}\right|_{s_h=s_f=0} = \left.D_1{}'\right|_{s_h=s_f=0} = -L\sigma\delta\left(1-\delta\right)-L\left(\sigma-1\right)\delta\left(1-\delta\right)<0\,, \quad (26)$$

$$\left.D_1\right|_{s_h=s_f=0} = 2L\left(1-\delta\right)^2>0\,, \quad (27)$$

$$\left.\frac{dD_2}{ds_h}\right|_{s_h=s_f=0} = \left.D_2{}'\right|_{s_h=s_f=0} = -\delta\{\rho\lambda b(1-\delta)(\sigma-1)+\rho\lambda\sigma(1-b)(1-\delta)+L\sigma\delta\}<0\,, \tag{28}$$

$$\left.D_2\right|_{s_h=s_f=0} = (1-\delta)^2(\rho\lambda-L), \tag{29}$$

$$\left.\frac{dD_3}{ds_h}\right|_{s_h=s_f=0} = \left.D_3{}'\right|_{s_h=s_f=0} = -\rho\lambda\sigma\delta^2(1-b)<0\,, \tag{30}$$

$$\left.D_3\right|_{s_h=s_f=0} = -\rho\lambda(1-\delta)(b-\delta(1-b))<0\,. \tag{31}$$

In a similar vein, the impact of an increase in the foreign trade subsidy on industry location is demonstrated in the subsequent equation (32):

$$\begin{aligned}\left.\frac{d\gamma}{ds_f}\right|_{s_h=s_f=0} &= \frac{1}{(2D_1)^2}\left(D_2{}^2-4D_1D_3\right)^{-\frac{1}{2}} \\ &\times\left\{\left\{-D_2{}'\left(D_2{}^2-4D_1D_3\right)^{\frac{1}{2}}+\frac{1}{2}\left\{2D_2D_2{}'-4\left(D_1{}'D_3+D_1D_3{}'\right)\right\}\right\}\times 2D_1-2D_1{}'\left\{-D_2\left(D_2{}^2-4D_1D_3\right)^{\frac{1}{2}}+\left(D_2{}^2-4D_1D_3\right)\right\}\right\}<0\end{aligned} \tag{32}$$

where

$$\left.\frac{dD_1}{ds_f}\right|_{s_h=s_f=0} = \left.D_1{}'\right|_{s_h=s_f=0} = -L\sigma\delta(1-\delta)-L(\sigma-1)\delta(1-\delta)<0\,, \tag{33}$$

$$\left.D_1\right|_{s_h=s_f=0} = 2L(1-\delta)^2>0\,, \tag{34}$$

$$\left.\frac{dD_2}{ds_f}\right|_{s_h=s_f=0} = \left.D_2{}'\right|_{s_h=s_f=0} = -\sigma\delta[\rho\lambda b(1-\delta)-L]-\delta(\sigma-1)(1-\delta)[\rho\lambda(1-b)-L], \tag{35}$$

$$\left.D_2\right|_{s_h=s_f=0} = (1-\delta)^2(\rho\lambda-L), \tag{36}$$

$$\left.\frac{dD_3}{ds_f}\right|_{s_h=s_f=0} = \left.D_3'\right|_{s_h=s_f=0} = \rho\lambda b\sigma\delta + \rho\lambda(1-b)(1-\delta)(\sigma-1)\delta > 0, \tag{37}$$

$$\left.D_3\right|_{s_h=s_f=0} = -\rho\lambda(1-\delta)(b-\delta(1-b)) < 0. \tag{38}$$

Equation (25) shows that an increase in the home country's trade subsidy induces the global movement of firms to the home country. The result can be intuitively explained as follows. First, through the intra-sectoral substitution effect, an increase in the home country's trade subsidy increases the home country's production of differentiated goods.[3] As a result, the relative profits of firms in the home country increase and foreign firms move to the home country. In a similar way, equation (32) shows that an increase in the trade subsidy of the foreign country will induce the cross-border movement of firms to the foreign country. The aforementioned results offer insight into the positive impact of a unilateral increase in each country's trade subsidy on the global growth rate, a subject to be examined in more detail below.

The impact of a trade subsidy increase on the global growth rate through the relocation effect is then analyzed. From (18) and taking into account the results of (25) and (32), we obtain

$$\begin{aligned} \left.\frac{dg}{ds_h}\right|_{s_h=s_f=0} &= \left(\frac{2\alpha L}{\lambda\sigma}\right)\left.\frac{d\gamma}{ds_h}\right|_{s_h=s_f=0} > 0, \\ \left.\frac{dg}{ds_f}\right|_{s_h=s_f=0} &= \left(\frac{2\alpha L}{\lambda\sigma}\right)\left.\frac{d\gamma}{ds_f}\right|_{s_h=s_f=0} < 0\cdot \end{aligned} \tag{39}$$

In our model, we find that the growth effects of a unilateral increase in the trade subsidy have four effects: the intra-sectoral substitution effect, the competition effect, the real income effect, and the financial burden effect. First, the import price of the differentiated goods of the home country in the foreign country is lowered by a unilateral increase in the trade subsidy by the home country. This leads to consumption switching, as consumption demand in both countries shifts to the differentiated goods produced in the home country as a result of the decline in the relative price of the differentiated goods produced in the home country. This phenomenon induces foreign-located firms to move to the home country because of

[3] The intra-industry substitution effect arises because a unilateral increase in the trade subsidy of the home country causes the relative price of the differentiated goods of the home country to fall for households in the foreign country, and consumption demand in the foreign country switches from the differentiated goods of the foreign country to imported differentiated goods of the home country.

the increase in the relative profits of home-located firms. Recall that in our model the cost of innovative R&D in the home country is negatively proportional to the number of firms, and that all innovative R&D takes place in the home country, which fully determines the global growth rate. Therefore, by increasing the number of firms producing differentiated goods in the home country, the relocation effect of the unilateral trade subsidy increase is positive for the global growth rate. Therefore, this first effect, which we call the intra-sectoral substitution effect, has a positive impact on the global growth rate. Second, the agglomeration of firms in the home country leads to a further increase in the number of new entrants engaged in innovative activities within the home country. This phenomenon is attributed to local knowledge spillovers. Moreover, the increased competition resulting from the aforementioned increase in blueprints reduces the profits of existing firms. A decline in the value of firms leads to a decline in the value of stocks held by agents, which in turn reduces agent income. This, in turn, results in a decrease in agent consumption expenditure, which consequently leads to a reduction in global consumption expenditure. A decline in global consumption expenditure signifies a reduction in the labor force required for the production of goods to meet global consumption needs. In accordance with the equilibrium condition for the labor market, an increase in labor availability is consequently available for the innovation sector. Therefore, this second effect, the competition effect, has a positive impact on the global growth rate. Third, an increase in the home country's trade subsidy reduces the foreign CPI, thereby increasing real consumption expenditure in the foreign country. This leads to an increase in the real demand for differentiated goods in the foreign country. Given the existence of a negative relationship between the CPI and the trade subsidy in the model, the increase in the trade subsidy rate by the home country leads to an increase in the foreign country's purchasing power of income. This, in turn, causes the consumers of the foreign country to purchase larger quantities of both differentiated goods and homogeneous goods. Consequently, a greater amount of labor is employed in the production of global consumption goods, and, from the equilibrium condition for the labor market, a reduced amount of labor is available for the innovation sector. Consequently, this third effect, which is referred to as the real income effect, exerts a negative influence on the global growth rate. Fourth, an increase in the home country’s trade subsidy will lead the home country government to impose a tax burden on home country households to finance the trade subsidy, thereby reducing home country consumption expenditure and thus reducing global consumption expenditure. A decline in global consumption expenditure signifies a reduction in the labor force required to produce goods and services to satisfy global consumption expenditure. Consequently, from the equilibrium condition for the labor market, an increase in labor becomes available for the innovation sector. Therefore, this fourth effect, the financial burden effect, has a positive impact on the global growth rate. However, the fourth effect disappears under $\varepsilon_h \approx 0$ and $\varepsilon_f \approx 0$. In summary, the positive effect of an increase in the home country's trade subsidy is the sum of the following effects: the intra-sectoral substitution effect and the competition effect. Conversely, the negative effect of an increase in the home trade subsidy is the real income effect.

Consequently, the net growth effect of an increase in the home country's trade subsidy is contingent upon the relative strength of these three opposing pressures. However, according to equation (39), the first two effects invariably dominate the last effect under $\varepsilon_h \approx 0$ and $\varepsilon_f \approx 0$, so we obtain the results of (39). In other words, an increase in the home country's trade subsidy increases the global growth rate when the elasticity of substitution between any two goods is high, transportation costs are high, the share of consumption expenditure on differentiated goods is small, and the trade subsidy rates are small. Conversely, due to the reduced agglomeration of firms in the home country, an increase in the foreign country's trade subsidy rate reduces the global growth rate. Because, in this case, both the intra-sectoral substitution effect and the real income effect will be negative, but since firms are decentralized across two countries, the emergence of new firms due to the knowledge spillover effect caused by firm agglomeration will disappear, and the competition effect will also disappear.

For a more intuitive illustration of the relative strength of the three effects above, we focus here on σ. Within the framework of our model, in economic systems characterized by large σ, a higher trade subsidy in the home country leads to a higher demand for the home country's differentiated products. This phenomenon occurs because as the degree of substitutability between products increases, a given increase in the trade subsidy of the home country prompts a shift in foreign consumption demand from the foreign country's differentiated goods to the home country's similar goods. Consequently, if σ is sufficiently large, the trade subsidy of the home country exerts an effect on the increase in the intra-sectoral substitution effect. Thus, a unilateral increase in the home country's trade subsidy increases the global growth rate, and an increase in the foreign country's trade subsidy decreases the global growth rate, if σ is large enough for $\varepsilon_h \approx 0$ and $\varepsilon_f \approx 0$ to hold.

6. Welfare effects of trade subsidies

We now consider the welfare implications of an increase in trade subsidies for each country. The home and foreign utilities are as follows:

$$U(0)=\frac{1}{\rho}\log\left(\alpha^{\alpha}(1-\alpha)^{1-\alpha}C\left(\frac{\sigma-1}{\sigma\beta}\right)^{\alpha}N(0)^{\frac{\alpha}{\sigma-1}}\left\{\left[1-\left(1-s_f\right)^{1-\sigma}\delta\right]\gamma+\left(1-s_f\right)^{1-\sigma}\delta\right\}^{\frac{\alpha}{\sigma-1}}e^{\frac{\alpha g}{\rho(\sigma-1)}}\right) \tag{40}$$

$$U^*(0) = \frac{1}{\rho}\log\left(\alpha^{\alpha}(1-\alpha)^{1-\alpha} C^*\left(\frac{\sigma-1}{\sigma\beta}\right)^{\alpha} N(0)^{\frac{\alpha}{\sigma-1}}\left\{1-\left[1-(1-s_h)^{1-\sigma}\delta\right]\gamma\right\}^{\frac{\alpha}{\sigma-1}} e^{\frac{\alpha g}{\rho(\sigma-1)}}\right) \tag{41}$$

First, through the agglomeration of firms in the home country, we examine the welfare impact of a unilateral increase in the home country's trade subsidy on the home country's welfare. Differentiation of equation (40) with respect to s_h yields

$$\frac{\partial U(0)}{\partial s_h} = -\left(\frac{\lambda b}{\gamma^2 L + \rho\lambda b\gamma}\right)\frac{\partial\gamma}{\partial s_h} + \left(\frac{2L\alpha^2}{\rho^2\lambda\sigma(\sigma-1)}\right)\frac{\partial\gamma}{\partial s_h} + \frac{\alpha}{\rho(\sigma-1)}\left[\frac{1-(1-s_f)^{1-\sigma}\delta}{\left[1-(1-s_f)^{1-\sigma}\delta\right]\gamma + (1-s_f)^{1-\sigma}\delta}\right]\frac{\partial\gamma}{\partial s_h} \tag{42}$$

The negative competitive effect of an increase in γ due to an increase in s_h on the wealth of the home country is the first term on the right-hand side of (42). This phenomenon occurs because the agglomeration of firms in the home country further increases the number of new entrants into innovative R&D in the home country due to local knowledge spillovers, and the increased competition that results from the increase in additional designs reduces the profits of existing firms. This decline in the value of firms corresponds with a decline in the value of stocks held by agents. This decline results in a reduction of agent income. The second term indicates the positive impact of an increase in γ, owing to an increase in s_h, on the global growth rate. This is because agglomeration of firms in the home country increases the number of new firms by increasing innovative activity, which further increases home country wealth. We define this as the innovation effect in this paper. The third term signifies the enhancement in welfare that is attributable to the diminution in transportation expenses for agents in the home country when γ is augmented by an increase in s_h. This phenomenon can be attributed to the increase in the number of firms in the home country. This increase enables agents in the home country to reduce the amount of imports, thereby avoiding unnecessary transportation costs. This phenomenon is referred to in this study as the transportation effect. In summary, our model shows a negative effect of the competition effect and positive effects of the innovation and transportation effects on the welfare of the home country. Thus, it is the relative strength of these countervailing effects that determines the net welfare effect of an increase in the home country's trade subsidy. However, when λ is small and *L* is large, the negative competition effect becomes sufficiently small and the positive innovation effect becomes sufficiently large so that the welfare gains of home households can always be positive:

$$\frac{\partial U(0)}{\partial s_h} > 0 . \tag{43}$$

Similarly, for the welfare impact on the foreign country, differentiating equation (41) with respect to s_h yields the following:

$$\frac{\partial U^*(0)}{\partial s_h} = -\left(\frac{\lambda(1-b)}{\gamma^2 L + \rho\lambda\gamma(1-b)} \right) \frac{\partial\gamma}{\partial s_h} + \left(\frac{2L\alpha^2}{\rho^2\lambda\sigma(\sigma-1)} \right) \frac{\partial\gamma}{\partial s_h}$$
$$- \frac{\alpha}{\rho(\sigma-1)} \left[\frac{1-(1-s_h)^{1-\sigma}\delta}{1-\left[1-(1-s_h)^{1-\sigma}\delta\right]\gamma} \right] \frac{\partial\gamma}{\partial s_h} + \left(\frac{\alpha}{\rho} \right) \left[\frac{(1-s_h)^{-\sigma}\delta\gamma}{1-\left[1-(1-s_h)^{1-\sigma}\delta\right]\gamma} \right] . \tag{44}$$

The negative competitive effect of an increase in γ due to an increase in s_h on the wealth of the foreign country is the first term on the right-hand side of (44). The second term is the positive innovation effect of an increase in γ due to an increase in s_h. The third term denotes the adverse welfare consequence stemming from the elevated transportation cost burden on foreign agents when γ is increased by an increase in s_h. The fourth term is the terms-of-trade effect of the trade subsidy, which increases purchasing power through a reduction in the price index. It is noteworthy that the terms of trade effect materializes in the non-agglomerated foreign country and is contingent on the number of firms in the home country (γ). The magnitude of the positive terms of trade effect in the foreign country is directly proportional to the number of firms in the home country (γ). This is because the larger the number of firms located in the home country (γ), the greater the foreign country's dependence on the home country in terms of imports, and thus the larger the terms of trade effect of increasing purchasing power through a lower price index in the foreign country. To summarize, there are negative effects from the competition and transportation effects and positive effects from the innovation and terms of trade effects on the foreign country's welfare by increasing s_h. Thus, it is the relative strength of these offsetting effects that determines the net welfare effect of an increase in s_h on foreign welfare. However, when λ is small and L is large, the negative competition effect is small and the positive innovation effect is sufficiently large that the welfare gains of foreign agents can always be positive:

$$\frac{\partial U^*(0)}{\partial s_h} > 0 . \tag{45}$$

Next, the welfare impact on the home country of a unilateral increase in the foreign country's trade subsidy is obtained by differentiating equation (40) with respect to s_f:

$$\frac{\partial U(0)}{\partial s_f} = -\left(\frac{\lambda b}{\gamma^2 L + \rho\lambda b\gamma}\right)\frac{\partial\gamma}{\partial s_f} + \left(\frac{2L\alpha^2}{\rho^2\lambda\sigma(\sigma-1)}\right)\frac{\partial\gamma}{\partial s_f}$$
$$+\left(\frac{\alpha}{\rho(\sigma-1)}\right)\left[\frac{1-(1-s_f)^{1-\sigma}\delta}{\left[1-(1-s_f)^{1-\sigma}\delta\right]\gamma+(1-s_f)^{1-\sigma}\delta}\right]\frac{\partial\gamma}{\partial s_f} + \left(\frac{\alpha}{\rho}\right)\left[\frac{(1-s_f)^{-\sigma}\delta(1-\gamma)}{\left[1-(1-s_f)^{1-\sigma}\delta\right]\gamma+(1-s_f)^{1-\sigma}\delta}\right] \quad (46)$$

The positive competitive effect of a decrease in γ due to an increase in s_f on the wealth of the home country is the first term on the right-hand side of (46). The second term is the negative innovation effect of a decrease in γ resulting from an increase in s_f. The third term is the negative welfare effect caused by the increase in the transportation cost burden on the home agent when γ is reduced by an increase in s_f. The fourth term represents the terms of trade effect of the export subsidy. This effect increases the purchasing power by decreasing the price index in the home country. Consequently, the net welfare effect on the home country of a unilateral increase in the foreign country's trade subsidy is contingent upon the respective strengths of these countervailing effects. However, when λ is small and L is large, the positive competition effect becomes sufficiently small and the negative innovation effect becomes sufficiently large so that the welfare gains of home agents can always be negative:

$$\frac{\partial U(0)}{\partial s_f} < 0 \,. \quad (47)$$

Next, differentiating equation (41) with respect to s_f gives the following equation:

$$\frac{\partial U^*(0)}{\partial s_f} = -\left(\frac{\lambda(1-b)}{\gamma^2 L + \rho\lambda(1-b)\gamma}\right)\frac{\partial\gamma}{\partial s_f} + \left(\frac{2L\alpha^2}{\rho^2\lambda\sigma(\sigma-1)}\right)\frac{\partial\gamma}{\partial s_f} - \left(\frac{\alpha}{\rho(\sigma-1)}\right)\left[\frac{1-(1-s_h)^{1-\sigma}\delta}{1-\left[1-(1-s_h)^{1-\sigma}\delta\right]\gamma}\right]\frac{\partial\gamma}{\partial s_f} \quad (48)$$

The positive competitive effect of a decrease in γ due to an increase in s_f on foreign wealth is the first term on the right-hand side of (48). The second term is the negative innovation effect of a decrease in γ resulting from an increase in s_f. The third term signifies the positive welfare effect attributable to the diminution of transportation costs borne by agents in the foreign nation when γ is reduced through an augmentation of s_f. Consequently, the overall net welfare effect of an increase in a foreign country's trade subsidy depends on the respective strength of these opposing effects. However, when λ is small and L is large, the positive competition effect is sufficiently small and the negative innovation effect is sufficiently large, so that the welfare gains of foreign agents can always be negative:

$$\frac{\partial U^*(0)}{\partial s_f} < 0. \tag{49}$$

Thus, from the welfare analysis above, we find that the effects of trade subsidies on global growth are opposite depending on whether the policy is implemented in an agglomeration or non-agglomeration country, but in terms of welfare effects, when R&D productivity is high and labor supply is large in both countries, export subsidies in the agglomeration country improve the welfare of both agglomeration and non-agglomeration countries, while export subsidies in the non-agglomeration country reduce the welfare of both countries.

7. Concluding remarks

In this paper, we analyzed the impact of increased trade subsidies on the global growth rate and welfare of countries through the cross-border movement of firms. Our results suggest that an increase in the trade subsidy of the home country in which firms are agglomerated will increase the global growth rate through the greater agglomeration of firms in the home country under local knowledge spillovers in innovative activities. Conversely, through the reduced agglomeration of firms in the home country, an increase in the trade subsidy of the foreign country where firms are not agglomerated will lower the global growth rate. Furthermore, when R&D productivity is high and labor supply is large in both countries, the welfare analysis indicates that trade subsidy policies, when implemented in the agglomerated country, improve the welfare of both agglomerating and non-agglomerating countries, although firms move from the non-agglomerated country to the agglomerated country. In the case of trade subsidies in the non-agglomerating country, it has been shown that when R&D productivity is high and labor supply is large in both countries, they negatively affect the economic welfare of both agglomerating and non-agglomerating countries. This implies that depending on whether the subsidy policy is implemented by the agglomeration or the non-agglomeration country, the welfare effects of the subsidy policy are opposite.

Appendix

In this appendix, we establish the conditions under which the share of firms in the home country falls within the range of $1/2 < \gamma < 1$. The share of firms in the home country is given by the following equation, as shown in (24):

$$\gamma = \frac{-D_2 + \sqrt{D_2{}^2 - 4D_1D_3}}{2D_1}. \tag{24}$$

From equation (24), the condition for $\gamma > 1/2$ is $D_1 + 2D_2 + 4D_3 < 0$. However, from the assumptions of $B > B^*$ ($b > 1/2$) and $s_h = s_f = 0$, this condition is always valid. Because when $B > B^*$ and $s_h = s_f = 0$ holds, we obtain the following:

$$D_1 + 2D_2 + 4D_3 = -2\rho\lambda(1-\delta)(1+\delta)(b-(1-b)) < 0. \tag{A.1}$$

Therefore, from $b > 1/2$, $\gamma > 1/2$ is always valid. Next, from equation (24), the condition for $\gamma < 1$ is $D_1 + D_2 + D_3 > 0$, where

$$D_1 + D_2 + D_3 = L(1-\delta)^2 + \rho\lambda(1-\delta)((1-b) - b\delta). \tag{A.2}$$

Therefore, by (A.2), if L is large, τ is sufficiently large, and ρ and λ are sufficiently small, then $\gamma < 1$ is always valid. Thus, if L is large, τ is sufficiently large, and ρ and λ are sufficiently small, the share of firms in the home country is present in the range $1/2 < \gamma < 1$.

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POLITIKE PODSTICANJA IZVOZA, AGLOMERACIJA I EKONOMSKI RAST

Apstrakt: Ovaj rad ispituje uticaj trgovinskih subvencija na globalni rast i nacionalnu dobrobit kroz prekogranično premeštanje preduzeća u okviru modela endogenog rasta. Posebna pažnja u modelu usmerena je na dva ključna aspekta: prekogranično premeštanje firmi i preraspodelu radne snage između sektora proizvodnje i inovacija. U radu pokazujemo da, u prisustvu lokalnih preliva znanja, povećanje trgovinske subvencije u zemlji u kojoj su firme aglomerisane dovodi do povećanja stope globalnog rasta pod određenim parametrima, dok povećanje subvencija u zemlji koja nije aglomeracijski centar rezultira smanjenjem globalne stope rasta. Nadalje, rezultati analize blagostanja pokazuju da trgovinske subvencije u zemlji aglomeracije unapređuju dobrobit i zemlje aglomeracije i one koja to nije, dok trgovinske subvencije u zemlji van aglomeracije umanjuju dobrobit obe zemlje.

Ključne reči: trgovinske subvencije, aglomeracija, globalni rast, prelivanje lokalnog znanja.

Author's biography

Wataru Johdo, professor at Tokyo Keizai University, department of economics holder of Ph.D. in 2001, from Osaka University in Japan; He then worked as a lecturer at the Faculty of Economics at Tezukayama University, where he was active in teaching microeconomics, international macroeconomics, and introductory economics etc. In 2016, he started his current position as a professor of economics at Tokyo Keizai University, where he is currently active in teaching macroeconomics, etc. His current research interests include various macroeconomic policies, trade policies, deregulation, new-open-economy-macroeconomics, open economy endogenous growth theory, new economic geography, new trade theory, and the exchange rate.