Economics and Business Letters
14(3), 156-165, 2025

Effects of export subsidies in an endogenous growth model with transport costs and firm location

Wataru Johdo[*]

Tokyo Keizai University, Japan

Received: 24 June 2024
Revised: 12 March 2025
Accepted: 19 March 2025

Abstract

This paper analyzes the impact on world growth of an increase in export subsidies in one country based on an open economy endogenous growth model in which there are transportation costs and the movement of firms across international borders. In contrast to the negative effect of export subsidies on world growth in the open economy endogenous growth model without transportation costs and the movement of firms, the paper shows that an increase in export subsidies in one country increases world growth under specific conditions.

Keywords: export subsidies, endogenous growth, transport costs, firm location
JEL Classification Codes: F12, F23, F43, H29, O31

1. Introduction

Through decades of empirical research, the positive relationship between export expansion and growth is now widely accepted by policymakers and economists. For example, well-known studies that find a positive relationship between export expansion and growth include Tyler (1981), Kavoussi (1984), Ram (1985), Esfahani (1991), Islam (1998), Kónya (2006). However, despite this body of empirical work, the precise channels through which export subsidies promote the global growth rate through export expansion are not well analyzed in the R&D-based endogenous growth literature. Indeed, as a similar prior research related to this issue, in the R&D-based endogenous growth literature, despite a large number of studies reach the conclusion that long-run growth is positively affected by R&D subsidies through an increase in the profits of each firm in the monopolistic competition sector (e.g., Grossman and Helpman, 1991; Helpman, 1992; Davidson and Segerstrom, 1998; Howitt, 1999; Segerstrom, 2000;

* E-mail: johdo@tku.ac.jp.

Citation: Johdo, W. (2025) Effects of export subsidies in an endogenous growth model with transport costs and firm location, *Economics and Business Letters*, 14(3), 156-165. DOI: 10.17811/ebl.14.3.2025.156-165.

ISSN: 2254-4380

Laincz 2009; Chu and Wang, 2022), few theoretical studies analyze the global growth effects of a unilateral increase in export subsidies.

One exception is Afonso and Silva (2012), who uses an endogenous growth model that includes the R&D sector and examines the growth effect of export subsidies. From this study, Afonso and Silva (2012) conclude that an increase in export subsidies leads to an increase in profits in the intermediate goods sector, which encourages R&D investment and increases growth rates. However, the study focuses on the growth effects of export subsidies in a closed economy, and therefore it is not necessarily true that the same conclusions would be reached in an open economy. This is because when examining the growth effects of export subsidies in an open economy model, the growth effects of international income transfers and changes in the terms of trade must also be taken into account. Another study is Grossman and Helpman (1991, chapter 10). Unlike the closed-economy model of Afonso and Silva (2012), their study uses an open-economy model consisting of two countries to analyze the impact of export subsidies on tradable high-tech products on global economic growth through their effect on R&D activities. In their study, they show that production subsidies in each country lead to a reduction in the rate of technological progress through a contraction of production factor resources invested in the R&D sector, which competes with the high-tech manufacturing sector, thereby reducing the overall global economic growth rate. However, their result holds only if the model is an open economy model with no transportation costs and fixed location of firms. Thus, although their model assumes an open economy, it is not necessarily true that the same conclusions would be reached even in an open economy under the existence of transportation costs associated with foreign trade and cross-border location behavior of high-tech firms.

Under the above unsettled studies of endogenous growth theory, this paper examines the impact of a unilateral increase in export subsidies on the world growth rate by introducing export subsidies into the two-country R&D-based endogenous growth model of Martin and Ottaviano (1999). The Martin and Ottaviano (1999) model is a simple framework for studying the growth effects of different government policies in an open economy with iceberg-type trade costs and cross-border firm location. By adopting the model, which allows us to include export subsidies, we are able to consider the combined effects of multiple effects of export subsidies in affecting the world growth rate in the presence of transportation costs and cross-border location of firms.

Our main results are as follows: a unilateral increase in a country's export subsidy, regardless of the country where the policy is implemented, raises the world growth rate by shifting labor from the non-innovative sector to the R&D sector under specific conditions. This result is the opposite of that found by Grossman and Helpman (1991, ch. 10). This is because in our model, labor input is the main factor for R&D as in Grossman and Helpman (1991, ch. 10), but export subsidies lead to an increase in the equilibrium world growth rate by reducing world consumption expenditure due to the increase in the tax burden for financing subsidies, thereby reducing labor resources for differentiated goods and increasing labor resources for R&D. Thus, in contrast to the results of Grossman and Helpman (1991, ch. 10), where the steady state world growth rate is negatively affected by export subsidies, in our model we reach an opposite conclusion that export subsidies have a positive impact on the equilibrium world growth rate.

2. Model

There are two countries, the home country and the foreign country. We use an asterisk to denote the variables for the foreign country. We focus mainly on a description of the home country. The intertemporal objective of a representative household is to maximize the following lifetime utility function:

$$U = \int_0^{\infty} \log(D(t)^{\alpha} Y(t)^{1-\alpha})\, e^{-\rho t} dt, \tag{1}$$

where $Y(t)$ is the numeraire good in period t and $D(t)$ is the consumption index of differentiated goods defined as

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

where $D_i(t)$ is the consumption of differentiated good i in period t and $N(t)$ is the total number of differentiated goods produced in the world. In this model, the government provides export subsidies to the differentiated goods sector and levies a lump-sum tax on households as a source of export subsidies. We also assume iceberg transport costs for the transport of differentiated goods between countries: τ ($\tau \geq 1$). Then the per capita expenditure of a typical household, E, is

$$\int_{i\in n} p_i D_i di + \int_{j\in n^*} (1 - s_f)\tau p_j^* D_j dj + Y = E, \tag{3}$$

where $s_f (s_h)$ is the export subsidy rate for the foreign (home) country, p_i is the producer price of a typical variety i and p_j^* is its price in the foreign country. In this model, as shown in (3), the home country consists of n firms and the remaining n^* firms are in the foreign country, where $n + n^* = N$. The consumption price indices are then

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

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

In the differentiated goods sector, a patent is required to start production of each variety of good, so we can interpret this capital requirement as a fixed cost of production. Each firm issues shares to finance the fixed cost of the patent and distributes any profits to shareholders as dividends. In addition, each good requires β units of labor. Standard profit optimization by choosing p_i gives $p_i = w\beta\sigma/(\sigma - 1)$, where w is the wage rate. The profit flow of each firm (= π_i) is then

$$\pi_i = p_i x_i(p_i) - w\beta x_i(p_i) = w\beta x_i(p_i)/(\sigma - 1), \tag{6}$$

where $x_i(p_i)$ is the quantity of output.

The homogeneous good Y is assumed to be produced using one unit of labor to produce one unit of Y. We assume that some production of the homogeneous good occurs in both countries. Thus, we ensure that $w = w^*$ due to free trade in the homogeneous good. Since the numeraire is the homogeneous good, the wage rate is $w = w^* = 1$. We therefore obtain $p = p^* = \beta\sigma/(\sigma - 1)$. Here we define $\delta \equiv \tau^{1-\sigma} \in (0, 1)$ for convenience.

Given the choices of D_i, D_j, and Y, the standard static utility optimization yields

$$D_i = \left(\frac{\sigma-1}{\beta\sigma}\right)\left(\frac{\alpha E}{n+n^*(1-s_f)^{1-\sigma}\delta}\right),\ D_j = \left(\frac{\sigma-1}{\beta\sigma}\right)\left(\frac{\alpha E(1-s_f)^{-\sigma}\tau^{-\sigma}}{n+n^*(1-s_f)^{1-\sigma}\delta}\right),\ Y = (1-\alpha)E. \quad (7)$$

Here we define v as the equity value of a firm and r as the return on a riskless bond. Thus, by considering (6), we obtain a no-arbitrage condition in the world capital market:

$$\frac{\beta x}{\sigma-1} + \dot{v} = rv. \quad (8)$$

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

$$\frac{\dot{E}}{E} = \frac{\dot{E}^*}{E^*} = r - \rho. \quad (9)$$

3. Aggregation and equilibrium firm location

If the demand in (7) is aggregated over all households in the world, then the market clearing condition for any differentiated product x is as follows:

$$x_i = LD_i + L\tau D_i^* = \frac{\alpha L(\sigma-1)}{\beta\sigma}\left(\frac{E}{n+n^*(1-s_f)^{1-\sigma}\delta} + \frac{E^*(1-s_h)^{-\sigma}\delta}{n^*+n(1-s_h)^{1-\sigma}\delta}\right) = x, \quad (10)$$

where L is the amount of labor endowment, which is the same in both countries. Similarly, for each product x^*:

$$x_j^* = L\tau D_j + LD_j^* = \frac{\alpha L(\sigma-1)}{\beta\sigma}\left(\frac{E(1-s_f)^{-\sigma}\delta}{n+n^*(1-s_f)^{1-\sigma}\delta} + \frac{E^*}{n^*+n(1-s_h)^{1-\sigma}\delta}\right) = x^*. \quad (11)$$

For a firm to be indifferent between its home and foreign locations following location arbitrage, the operating profits of the two locations must also be equal:

$$\pi = \pi^*. \quad (12)$$

Therefore, from equations (6), (12) and $w = w^* = 1$, we obtain $x = x^*$. Here we set K and K^* as the domestic and foreign capital stocks, respectively. In addition, the total stock of capital owned by agents determines the total number of firms, so that:

$$n + n^* = K + K^* = N. \tag{13}$$

Solving (10)-(13), we obtain the share of firms in the home country, which we define as:

$$\gamma = \frac{n}{N} = \frac{((1-s_h)^{-\sigma}\delta-1)(1-s_f)^{1-\sigma}\delta E^* - \left((1-s_f)^{-\sigma}\delta-1\right)E}{\left((1-s_f)^{-\sigma}\delta-1\right)((1-s_h)^{1-\sigma}\delta-1)E + ((1-s_h)^{-\sigma}\delta-1)\left((1-s_f)^{1-\sigma}\delta-1\right)E^*}. \tag{14}$$

The level of production of each firm is:

$$x = x^* = \frac{\alpha L(\sigma-1)}{\beta\sigma}\left(\frac{\bar{E}}{N}\right)\left\{\frac{(1-s_h)^{-\sigma}\delta(1-s_f)^{-\sigma}\delta-1}{\left((1-s_h)^{1-\sigma}\delta(1-s_f)^{1-\sigma}\delta-1\right)((1-s_h)^{-\sigma}\delta-1)\left((1-s_f)^{-\sigma}\delta-1\right)}\right\}, \tag{15}$$

where $\bar{E} = \left((1-s_f)^{-\sigma}\delta-1\right)((1-s_h)^{1-\sigma}\delta-1)E + ((1-s_h)^{-\sigma}\delta-1)\left((1-s_f)^{1-\sigma}\delta-1\right)E^*$.

4. R&D sector

Following Martin and Ottaviano (1999), we assume that knowledge about new products is an international public good that can be accessed and used by researchers in any other country without restrictions or costs. To consider the incentive for researchers to engage in innovative R&D, let v denote the value of a blueprint developed through R&D. In our model, a researcher who performing R&D requires η/N units of labor, since the cost of R&D cost is the same in both locations due to global knowledge spillovers. Therefore, free entry into the R&D sector leads to $v = \eta/N$.

In this section, we derive the solution for a steady state where $\gamma = n/N$ and $g = \dot{N}/N$ are both constants. If there is a balanced growth path, this implies that v decreases at the rate $g = \dot{N}/N = \dot{n}/n$. The world labor market-clearing condition is as follows:

$$\eta g + (1-\alpha)L(E+E^*) + \alpha L\left(\frac{\sigma-1}{\sigma}\right)\bar{E}\bar{T} = 2L, \tag{16}$$

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

If g is constant in the steady state, equation (16) implies that expenditure must be constant. This gives $r = \rho$ from (9). Then, substituting equation (15), $v = \eta/N$, and $r = \rho$ into equation (8) and considering (16), the following equilibrium growth rate of K, K^* and N is obtained:

$$g = \frac{2L}{\eta\sigma} - \frac{(1-\alpha)L(E+E^*)}{\eta\sigma} - \left(\frac{\sigma-1}{\sigma}\right)\rho. \tag{17}$$

The respective steady-state levels of per capita expenditure for each country are:

$$E = 1 + \frac{\rho\eta k}{L} - s_h \tau n p_h D_h^*, \; E^* = 1 + \frac{\rho\eta(1-k)}{L} - s_f \tau n^* p_f^* D_f, \tag{18}$$

where k ($\equiv K/N$) and $1-k$ ($\equiv 1-K/N$) are the share of firms owned in each country, which are constant in the steady state. The first term in the above equations denotes per capita labor income, the second denotes rent income per capita and the third denotes the per capita tax burden on households imposed by the government to finance export subsidies.

5. Effects of export subsidies

To examine the growth effects of export subsidies, we assume that $\varepsilon_h \equiv \alpha s_h (1-s_h)^{-\sigma}(1-s_f)^{1-\sigma}\delta^2 \approx 0$ and $\varepsilon_f \equiv \alpha s_f (1-s_f)^{-\sigma}(1-s_h)^{1-\sigma}\delta^2 \approx 0$. This implies that if σ is sufficiently large and δ, α, s_h and s_f are sufficiently small, then ε_h and ε_f are approximately zero. Under these assumptions, we can clearly show the growth impact of an increase in export subsidies in each country.

In particular, in this paper we focus on the effect of an increase in the export subs idy rate in each country on the world growth rate through the effect on world consu mption expenditure. This is because, from equation (17), under global knowledge spillovers about new products, the world growth rate depends negatively on world consumption expenditure. From equation (18), we obtain the following steady-state world consumption expenditure:

$$(E+E^*)|_{\varepsilon_h\approx 0,\varepsilon_f\approx 0} = \left(L + \frac{\alpha s_h (1-s_h)^{-\sigma}\delta L}{((1-s_h)^{-\sigma}\delta - 1)\left((1-s_h)^{1-\sigma}\delta(1-s_f)^{1-\sigma}\delta - 1\right)}\right)^{-1}(L+\rho\eta k) + \left(L + \frac{\alpha s_f (1-s_f)^{-\sigma}\delta L}{((1-s_f)^{-\sigma}\delta - 1)\left((1-s_h)^{1-\sigma}\delta(1-s_f)^{1-\sigma}\delta - 1\right)}\right)^{-1}\left(L+\rho\eta(1-k)\right). \tag{19}$$

Here, equation (19) is rewritten as

$$(E+E^*)|_{\varepsilon_h\approx 0,\varepsilon_f\approx 0} = \frac{1}{A_h|_{\varepsilon_h\approx 0}}(L+\rho\eta k) + \frac{1}{A_f|_{\varepsilon_f\approx 0}}\left(L+\rho\eta(1-k)\right), \tag{20}$$

where

$$A_h|_{\varepsilon_h\approx 0} = L + \frac{\alpha s_h (1-s_h)^{-\sigma}\delta L}{((1-s_h)^{-\sigma}\delta - 1)\left((1-s_h)^{1-\sigma}\delta(1-s_f)^{1-\sigma}\delta - 1\right)}, \tag{21}$$

$$A_f\big|_{\varepsilon_f\approx 0} = L + \frac{\alpha s_f(1-s_f)^{-\sigma}\delta L}{\left((1-s_f)^{-\sigma}\delta-1\right)\left((1-s_h)^{1-\sigma}\delta(1-s_f)^{1-\sigma}\delta-1\right)}. \quad (22)$$

Differentiating equation (20) with respect to the export subsidy of each location yields

$$\frac{d(E+E^*)}{ds_h}\bigg|_{\varepsilon_h\approx 0,\varepsilon_f\approx 0} = -\frac{(A_h)'}{\left(A_h|_{\varepsilon_h\approx 0}\right)^2}(L+\rho\eta k) - \frac{(A_f)'}{\left(A_f|_{\varepsilon_f\approx 0}\right)^2}\left(L+\rho\eta(1-k)\right) < 0, \quad (23)$$

$$\frac{d(E+E^*)}{ds_f}\bigg|_{\varepsilon_h\approx 0,\varepsilon_f\approx 0} = -\frac{(A_h)'}{\left(A_h|_{\varepsilon_h\approx 0}\right)^2}(L+\rho\eta k) - \frac{(A_f)'}{\left(A_f|_{\varepsilon_f\approx 0}\right)^2}\left(L+\rho\eta(1-k)\right) < 0. \quad (24)$$

Equations (23) and (24) imply that an increase in the export subsidy of the home and foreign countries will reduce world consumption expenditure. Next, differentiating equation (17) with respect to each location's export subsidy and taking into account equations (23) and (24), we obtain the following:

$$\frac{\partial g}{\partial s_h}\bigg|_{\varepsilon_h\approx 0,\varepsilon_f\approx 0} = -\left(\frac{(1-\alpha)L}{\eta\sigma}\right)\frac{d(E+E^*)}{ds_h}\bigg|_{\varepsilon_h\approx 0,\varepsilon_f\approx 0} > 0, \quad (25)$$

$$\frac{\partial g}{\partial s_f}\bigg|_{\varepsilon_h\approx 0,\varepsilon_f\approx 0} = -\left(\frac{(1-\alpha)L}{\eta\sigma}\right)\frac{d(E+E^*)}{ds_f}\bigg|_{\varepsilon_h\approx 0,\varepsilon_f\approx 0} > 0. \quad (26)$$

Recall our earlier explanation that the world growth rate in equation (17) depends negatively on the world consumption expenditure given by equation (19). Therefore, equations (25) and (26) imply that an increase in the export subsidy rate in any country will increase the world growth rate through the decrease in world consumption expenditure.

Why does a unilateral increase in export subsidies in the home (or foreign) country increase the world growth rate in our model? First, a unilateral increase in export subsidies by the home country lowers the price index of differentiated goods in the foreign country (P^{D*}), as shown in equation (5), which increases both the consumption expenditure of the foreign country on differentiated goods and global consumption expenditure. When global consumption expenditure is higher, more labor is used to produce global consumption goods and thus, from the equilibrium condition for labor markets, less labor is available for the innovative R&D sector. Therefore, this effect of increased export subsidies has a negative impact on the world growth rate. We will refer to this as the "demand stimulation effect". Second, a unilateral increase in export subsidies by the home country lowers the foreign consumption price index. Since the home export subsidy is a kind of negative indirect tax for foreign households, an increase in the home export subsidy leads to a proportional increase in real income through a decrease in the foreign consumption price index. Therefore, similar to the demand stimulation effect, in this case more labor is used in the production of global consumption goods and, from the equilibrium condition for the labor market, less labor is available for the innovative R&D

sector. Therefore, this second effect has a negative impact on the world growth rate. We will refer to this as the "terms of trade effect". Third, a unilateral increase in the home country's export subsidy leads to an increase in the home country's tax burden to finance that subsidy, thereby reducing consumption expenditure in the home country and thus reducing global expenditure. In contrast to the demand stimulation and terms of trade effects, lower global consumption expenditure implies that less labor is used in the production of goods to satisfy global consumption expenditure and, from the equilibrium condition for the labor market, more labor is available for the innovative R&D sector. Therefore, this third effect has a positive impact on the world growth rate. In the following, we will refer to it as the "tax burden effect".

Thus, the net growth effect of an increase in home export subsidies depends on the relative strength of the three effects. However, under $\varepsilon_h \approx 0$ and $\varepsilon_f \approx 0$, the latter positive effect, tax burden effect, always dominates the former negative demand-increasing effects, the demand stimulation effect and the terms of trade effect, giving the results in equations (25) and (26). More explicitly, when σ is large, α is small, δ is small and the export subsidy rate for the home (foreign) country s_h (s_f) is small, an increase in the export subsidy has a positive effect on the world growth rate through the smaller increase in world consumption expenditure.

As mentioned above, the relationship between export subsidies and growth in existing endogenous growth models has been analyzed by assuming a model without transport costs and international relocation of firms. In such models, export subsidies lead to lower economic growth, as shown by Grossman and Helpman (1991). On the other hand, this paper shows that the effect of unilateral export subsidies on growth is opposite to the result of Grossman and Helpman (1991), which does not include transport costs and firm relocation. Why is the result of this paper the opposite of that of Grossman and Helpman (1991) under the condition $\varepsilon_h \approx 0$ and $\varepsilon_f \approx 0$? In the following, we will explain that the existence of transportation costs is essential to obtain the results of this paper by focusing on the magnitude of transportation costs δ that satisfy $\varepsilon_h \approx 0$ and $\varepsilon_f \approx 0$. First, in our model, when transport costs are zero or close to zero, as in Grossman and Helpman (1991), the relationship between home and foreign consumption expenditures is likely to be a trade-off. This is because unilateral export subsidies by the home country reduce the home household's consumption expenditure through an increase in the home country's tax burden, but if transport costs are small, foreign households can easily compensate for the reduction in the home household's consumption expenditure through imports from the home country. Therefore, even if an increase in the home export subsidy reduces the home household's spending, if the transportation cost is small, the foreign household's consumption expenditure will increase instead, and the total decrease in world spending (the tax burden effect in this paper) will be smaller. Therefore, in our model, if unilateral export subsidies are implemented when transport costs are small, the tax burden effect, which is the positive growth effect of export subsidies, will be smaller than the demand stimulation effect and the terms of trade effect, which are negative growth effects, and consequently the world growth rate will decrease. This is consistent with the results of Grossman and Helpman (1991), who assume that transport costs are zero. On the other hand, when transportation costs are high, which is the condition assumed in this paper to satisfy $\varepsilon_h \approx 0$ and $\varepsilon_f \approx 0$, the trade-off between home consumption expenditure and foreign consumption expenditure becomes smaller. This is because even if the home country's export subsidies reduce the home country's consumption expenditure, this does not lead to an increase in the foreign country's consumption expenditure through imports from the home country due to high transportation costs. Therefore, when transportation costs are high, the reduction in the home country's consumption expenditure due to the increase in the tax burden caused by the home country's export subsidies leads to a reduction in total world expenditure. The tax burden effect is precisely the positive growth effect of the reallocation of labor resources from the world production sector to the R&D sector due to the decline in total world consumption expenditure. Therefore, when transportation costs are large as assumed in this paper (i.e., when $\varepsilon_h \approx 0$ and $\varepsilon_f \approx 0$ hold), the positive growth effect of export subsidies, the tax burden effect, outweighs the negative growth effects, the demand stimulation effect and the terms of trade effect, and as a result, unilateral export subsidies increase the world growth rate.

Note, however, that the presence or absence of international firm relocation is unrelated to the growth effect of export subsidies in our model. This is because we assume global knowledge spillovers, so that firms have immediate access to the latest knowledge regardless of the country in which they are located. In other words, in an endogenous growth model with global knowledge spillovers, there is no agglomeration effect where R&D productivity in a country increases with the number of firms located in that country. Therefore, unlike Grossman and Helpman (1991), who fix the location of firms, our model allows for bilateral firm relocations, but there is no direct relationship between cross-border firm relocations and economic growth. Of course, the cross-border relocation of firms has an impact on the economic welfare of each country. This is because if export subsidies in the home country induce firms to relocate from the foreign country to the home country, the household in the home country will be able to reduce imports from the foreign country and thus save proportionally on transportation costs. This has a positive welfare effect for the household in the home country, but for the household in the foreign country, which is forced to increase imports from the home country, the additional transportation cost burden will increase, resulting in a negative welfare effect. In sum, the reason why the results of this paper differ from those of the existing literature on the growth effect of export subsidies is largely due to the presence of transportation costs rather than the presence of international firm relocation.

6. Conclusions

This paper used a two-country endogenous growth model to analyze the growth effects of an increase in export subsidies in one country, given transport costs and international relocation of firms. In contrast to the negative effect of export subsidies on world growth in Grossman and Helpman (1991, ch. 10), we showed that an increase in the export subsidy of one country (regardless of which country) raises the world growth rate through an increase in the labor force in the R&D sector.

Acknowledgements. I am grateful to an anonymous referee for helpful comments and suggestions. Financial support from Tokyo Keizai University is gratefully acknowledged.

References

Afonso, O. and Silva, A. (2012) Non-scale endogenous growth effects of subsidies for exporters, *Economic Modelling*, 29(4), 1248-1257.

Akcigit, U. and Melitz, M. (2022) *International trade and innovation,* in Gopinath, G., Helpman, E. and Rogoff, K. (eds): Handbook of International Economics, 377-404, North-Holland: Netherlands.

Chu, A.C. and Wang, X. (2022) Effects of R&D subsidies in a hybrid model of endogenous growth and semi-endogenous growth, *Macroeconomic Dynamics*, 26(3), 813-832.

Davidson, C. and Segerstrom, P. (1998) R&D subsidies and economic growth, *Rand Journal of Economics*, 29(3), 548-577.

Esfahani, H.S. (1991) Exports, imports, and economic growth in semi-industrialized countries, *Journal of Development Economics*, 35(1), 93-116.

Grossman, G. and Helpman, E. (1991) *Innovation and Growth in the Global Economy*, Cambridge Massachusetts London: MIT Press.

Helpman, E. (1992) Endogenous macroeconomic growth theory, *European Economic Review*, 36(2-3), 237-267.

Howitt, P. (1999) Steady endogenous growth with population and R&D inputs growing, *Journal of Political Economy*, 107(4), 715-730.

Islam, M.N. (1998) Export expansion and economic growth: testing for cointegration and causality, *Applied Economics*, 30(3), 415-425.

Kavoussi, R.M. (1984) Export expansion and economic growth, *Journal of Development Economics*, 14(1), 241-250.

Kónya, L. (2006) Exports and growth: Granger causality analysis on OECD countries with a panel data approach, *Economic Modelling*, 23(6), 978-992.

Laincz, C.A. (2009) R&D subsidies in a model of growth with dynamic market structure, *Journal of Evolutionary Economics*, 19, 643-673.

Martin, P. and Ottaviano, G.I.P. (1999) Growing locations: Industry location in a model of endogenous growth, *European Economic Review*, 43(2), 281-302.

Ram, R. (1985) Exports and economic growth: some additional evidence, *Economic Development and Cultural Change*, 33(2), 415-425.

Segerstrom, P. (2000) The long-run growth effects of R&D subsidies, *Journal of Economic Growth*, 5, 277-305.

Tyler, W.G. (1981) Growth and export expansion in developing countries, *Journal of Development Economics*, 9(1), 121-130.