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The Effect of Globalization in an Endogenous Growth Model with Heterogeneous Firms and Endogenous International Spillovers: Note*

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Abstract

This paper shows that globalization increases (decreases) the growth rate if and only if the beachhead cost for the domestic market is strictly higher (lower) than that for the foreign market in a endogenous growth model with firm heterogeneity, international trade, and endogenous international spillover under specified necessary and sufficient conditions for exporting firms being more productive than non-exporting firms.

JEL Classification: F12, F15, O30, O33

Keywords: heterogeneous firms, endogenous international spillovers,
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1. Introduction

How does globalization affect economic growth and welfare? Many economists studying international trade and economic growth have tackled this theme empirically and theoretically. Empirical papers show that the relationship between globalization and economic growth is ambiguous. Frankel and Romer (1999) show that globalization increases the growth rate, but Vamvakidis (2002), Clemens and Williamson (2004), and Minier and Unel (2013) finds that globalization increases or decreases the growth rate. International trade increases welfare through many ways. First, new imported varieties increase welfare. For instance Broda and Weinstein (2006) argue that new varieties increased US GDP by 2.6 % between 1972 and 2001 and Coe and Helpman (1995) argue that international spillover depends on the amount of imported goods from trade partner. Second, as trade reallocates resources from the less productive non-exporting to more productive exporting firms, industrial productivity rises (Bernard, Jensen, and Schott, 2006)[2]

Recently, many economists have analyzed the role of firm heterogeneity in international trade and economic growth. Baldwin and Robert-Nicoud (2008) extend Grossman and Helpman (1991) into an R&D-based growth model with firm heterogeneity as modeled by Melitz (2003). They show that globalization reduces

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[2] Melitz (2003) construct a monopolistic competition model with firm heterogeneity which is consistent with this empirical evidence.

economic growth in an economy both with exogenous and with the Coe and Helpman type endogenous international knowledge spillovers[3]. In the former model, globalization leads to higher R&D costs and a lower growth rate due to greater competition through importing under a sufficient condition that productivity for exporters is higher than that for non-exporters, that is, the sunk cost for the foreign market is lower than that for the domestic market and to higher or lower welfare due to higher productivity of production firms and higher R&D cost. In the latter model, under a sufficient condition that the productivity of exporting firms be higher than that for non-exporters, the negative effect of rises in R&D costs unambiguously dominates the positive effects of the decrease in R&D costs that results from increases in international knowledge spillover. Thus, economic growth rate decreases. Moreover, there is an ambiguous effect on welfare because there is a negative channel of decreases in the growth rate and higher R&D costs and there is a positive effect through increases in the weighted average of productivity among production firms, but they do not derive a parameter condition for gains from trade. Unel (2010) extends Romer (1990) into an R&D-based growth model with firm heterogeneity and endogenous international knowledge spillover[4]. They show that globalization increases or decreases economic growth and welfare, but his paper also does not derive a condition for gains from trade. Moreover, Gustafsson and Segerstrom (2010) show that due to diminishing returns to knowledge in the R&D sector globalization does not affect economic growth. Dinopoulos and Unel (2011) show that globalization affects economic growth

[3] The international knowledge spillover depends on the fraction of exporting firms among production firms, that is, the cutoff point for the foreign market relative to the domestic market in this model.

[4] Unel (2010) assumes that international knowledge spillover depends on the value of total trade relative to the value of intermediate goods produced domestically.

ambiguously because there is a positive effect that the number of researchers devoted increases due to an increase in the mark-up rate and a negative effect of higher R&D costs. They find that per capita expenditures and growth rates vary inversely, but they do not derive a condition for gains from trade.

This paper derives the necessary and sufficient conditions under which globalization increases (decreases) economic growth when the sunk beachhead cost for the domestic market is higher (lower) than that for the foreign market in a model with firm heterogeneity and endogenous international spillover[5]. This result is more relevant to the empirical evidence cited above. This paper shows that endogenous international spillover plays an important role in economic growth because Baldwin and Robert-Nicoud (2008) and Unel (2010) show that further exposure to international trade necessarily decreases economic growth in the exogenous international spillover model and may increase economic growth in all other endogenous international spillover models.

The rest of the paper is organized as follows: Section 2 describes the elements of the model and derives the basic results. Section 3 offers concluding remarks.

2. The Model

2.1 Basic Structure

We follow Baldwin and Robert-Nicoud (2008) except that the sunk beachhead cost for the foreign market may be higher than, equal to, or lower than that for the domestic market. There are two symmetric countries. Each consumer supplies inelastically one

[5] We assume the sunk cost for the foreign market relative to that for the domestic market is higher than a measure of free trade, $\tau^{1-\sigma}$, where τ is the iceberg cost and $\sigma > 1$ is the elasticity of substitution between varieties.

unit of labor that is the only production factor and serves as the numeraire in each period. There are monopolistically competitive goods and perfectly competitive R&D sectors. Firms are heterogeneous with regard to the marginal cost of manufacturing, which is drawn from a Pareto distribution after incurring the sunk cost of variety creation. To enter a market, each firm has to incur a sunk cost of variety creation, and then chooses whether to exit the market immediately, serve the domestic market only or to serve both the domestic and export markets. Each market requires expenditures associated with fixed costs. Exporters face iceberg-type unit transportation costs as well. In the R&D sector, there are constant returns to knowledge, and the growth rate is endogenously determined. We follow Baldwin and Robert-Nicoud (2008) and Unel (2010) who assume endogenous international spillovers consistent with Coe and Helpman (1995).

2.2. Consumers

All consumers are identical. Each consumer supplies inelastically one unit of labor in each time period. The total amount of labor supplied equals the size of the population. Thus, labor supply can be denoted by L_t. Each consumer earns income from his or her assets and labor, and chooses the path of consumption expenditure and assets so as to maximize the sum of his or her discounted value of utility. The intertemporal utility function is given by $u(c_t) = \int_0^\infty \log c_t e^{-\rho t} \mathrm{d}t,$ where c_t is a consumption index which depends on the consumption of a continuum of varieties, given by $c_t = \left(\int_{\Omega_t} (x_{Lt}(i))^{\frac{\sigma-1}{\sigma}} \mathrm{d}i + \int_{\Omega_t} (x_{Et}(i))^{\frac{\sigma-1}{\sigma}} \mathrm{d}i \right)^{\frac{\sigma}{\sigma-1}}, \sigma > 1,$ where Ω_t is the set of varieties that can be consumed, $x_{Lt}(i)$ $(x_{Et}(i))$ the individual demand for the i-th variety produced domestically (produced abroad and exported), and ρ the individual's subjective discount rate.

The inter-temporal budget constraint is $\dot{S}_t = r_t S_t + w_t L_t - E_t$, where S_t is aggregate assets, r_t the rate of return on assets, w_t the wage, and E_t the economy-wide expenditure. Solving the dynamic optimization problem implies that $\frac{\dot{E}_t}{E_t} = r_t - \rho$. Static optimization yields the demand for each variety, given by $x_t(i) = \frac{p_j(i)^{-\sigma}}{(P_t)^{1-\sigma}} E_t, j = L, E,$ where $P_t = \left(\int_{i\in\Omega} [p_L(i)]^{1-\sigma}\,\mathrm{d}i + \int_{i\in\Omega} [p_E(i)]^{1-\sigma}\,\mathrm{d}i\right)^{\frac{1}{1-\sigma}}$ is the price index, $p_L(i)$ the price of varieties produced domestically, and $p_E(i)$ the price of the varieties produced abroad and exported.

2.3 Innovation

We next analyze firm behavior. For firms to enter the market, they have to pay the sunk cost of variety creation $b_{It}F_I$, where $b_{It} \equiv \frac{1}{m_t[1+\left(\frac{B_E}{B_L}\right)^k]}$ represents the unit labor requirement for knowledge creation, $m_t(\frac{B_E}{B_L})^k$ the international knowledge spillover, and m_t the number of varieties produced. This specification is consistent with the empirical findings of Coe and Helpman (1995). R&D researchers learn to generate knowledge more efficiently over time. Increased efficiency is reflected in lower unit labor requirements. Then they find the unit labor requirement for manufacturing from a Pareto distribution, given by $G(B) = \int_0^B g(B)dB = (\frac{B}{\bar{B}})^k,$ where $1 + k - \sigma > 0$ and $B \in [0, \bar{B}]$.

To enter the market, each firm has to pay the domestic and exporting sunk costs, given by $b_{It}F_L$ and $b_{It}F_E$, respectively. For one unit of good entering the domestic and exporting markets, 1 and τ□units of goods, respectively, must be transported. Firms with unit labor requirement $B > B_L$ exit the market immediately. Firms with unit labor requirement $B_E < B < B_L$ enter the domestic market. Firms with unit labor requirement $B < B_E$ enter both markets.

2.4 Product Markets

If a firm with unit labor requirement B enters the market, the firm earns profits $\pi_{Lt}(B) = p_{Lt}(B)x_{Lt}(B) - Bx_{Lt}(B)$. The profit-maximizing price is given by $p_{Lt}(B) = \frac{\sigma B}{\sigma-1}$. Thus, the profit function is given by $\pi_{Lt}(B) = \frac{\sigma^{-\sigma}(\sigma-1)^{\sigma-1}B^{1-\sigma}E_t}{(P_t)^{1-\sigma}}$. For given consumer expenditure and price index, the profit function monotonically decreases with the level of the unit labor requirement in manufacturing. For a firm to export one unit of a good, the firm must produce $\tau > 1$ units, and the profit-maximizing price would be $p_{Et}(B) = \frac{\tau\sigma B}{\sigma-1}$. Thus, the profit function for exporting is given by $\pi_{Et}(B) = \frac{\tau^{1-\sigma}\sigma^{-\sigma}(\sigma-1)^{\sigma-1}B^{1-\sigma}E_t}{(P_t)^{1-\sigma}}$. A consumer has two methods to accumulate assets: firm shares and riskless bonds. The rate of return on the former type of assets depends on dividends and capital loss (gain). The latter type comes from interest. In equilibrium, the two rates of return are equalized. Thus, the following no-arbitrage condition holds: $\frac{\pi_{jt}(B)}{V_{jt}(B)} + \frac{\dot{V}_{jt}(B)}{V_{jt}(B)} = r_t, j = L, E$. This equation determines the value of a firm serving the market as a function of the level of its unit labor requirement. The cost associated with serving the domestic market is $b_{It}F_L$. Thus, the local cutoff B_L is determined as follows:

$$V_{Lt}(B_L) = \frac{\sigma^{-\sigma}(\sigma-1)^{\sigma-1}(B_L)^{1-\sigma}E_t}{(P_t)^{1-\sigma}(r_t+g)} = b_{It}F_L, \tag{1}$$

where $g \equiv \frac{\dot{m}_t}{m_t}$. Similarly, there exists a foreign cutoff B_E satisfying

$$V_{Et}(B_E) = \frac{\tau^{1-\sigma}\sigma^{-\sigma}(\sigma-1)^{\sigma-1}(B_E)^{1-\sigma}E_t}{(P_t)^{1-\sigma}(r_t+g)} = b_{It}F_E. \tag{2}$$

Using the cutoff conditions (1) and (2), we obtain the cutoff ratio as a function of iceberg costs and the ratio of the second stage sunk costs $\frac{B_E}{B_L} = \left(\frac{\tau^{1-\sigma}F_L}{F_E}\right)^{\frac{1}{\sigma-1}} < 1$. Baldwin and Robert -Nicoud (2008) assume the following sufficient condition for exporters being more productive than non-exporters: $1 > \frac{F_E}{F_L} > \tau^{1-\sigma}$. On the other hand, we assume the necessary and sufficient condition for exporters being more productive than non-exporters: $\frac{F_E}{F_L} > \tau^{1-\sigma}$.

2.5 Innovation Incentives

A firm does not know its own productivity before entering the market, and decides whether to enter or not by weighing its ex-ante value (benefits) against expected R&D sunk cost. Due to free entry and exit, and the constant returns to scale technology in R&D, the free-entry condition is given by $\int_0^{B_L}[V_L(B) - b_I F_L]g(B)\mathrm{dB} + \int_0^{\mathrm{B_E}}[V_E(B) - b_I F_L]g(B)\mathrm{dB} = b_I F_I$. It can be rewritten as

$$\frac{\sigma^{-\sigma}(\sigma-1)^{\sigma-1}\Delta E_t}{(P_t)^{1-\sigma}(\rho+g)} = b_{It}\bar{F}. \tag{3}$$

The left-hand side of (3) is the expected excess benefit from creating a new variety and the right-hand side of (3) is the expected cost for creating a new variety;

$\Delta \equiv \int_0^{B_L} B^{1-\sigma} \frac{g(B)\mathrm{dB}}{G(B_L)} + \tau^{1-\sigma} \int_0^{B_E} B^{1-\sigma} \frac{g(B)\mathrm{dB}}{G(B_L)} = \frac{k(B_L)^{1-\sigma}\Phi}{1+k-\sigma}$ is the weighted average of productivity, $\bar{F} \equiv \frac{F_I}{G(B_L)} + \int_0^{B_L} F_L \frac{g(B)\mathrm{dB}}{G(B_L)} + \int_0^{B_E} F_E \frac{g(B)\mathrm{dB}}{G(B_L)} = F_I \left(\frac{\bar{B}}{B_L}\right)^k + F_L \Phi$ is the expected cost of a producing firm's creating a new variety, and $\Phi \equiv 1 + \tau^{-k} \left(\frac{F_E}{F_L}\right)^{\frac{\sigma-1-k}{\sigma-1}}$ measures the increase in R&D costs owing to globalization or the rise in competition due to importing. The first term of the R&D cost is the cost of choosing the unit labor requirement for manufacturing equal to or less than the domestic market cutoff level. The second term of the last equation is the beachhead cost for the domestic market and the final term of the last equation is the sunk beachhead cost for the foreign market.

The production function for a new variety is given by $\dot{m}_t = \frac{L_R}{b_{It}\bar{F}}$, where L_R represents the R&D researchers. R&D technology can be written as $g = \frac{\chi L_R}{\bar{F}}$, where $\chi \equiv 1 + \tau^{-k} \left(\frac{F_L}{F_E}\right)^{\frac{k}{\sigma-1}}$ measures the degree of endogenous international spillover.

2.6 Full Employment Condition

The labor market is perfectly competitive, and labor is used for R&D or manufacturing. The full employment condition is $L_t = L_R + L_x$ where $L_x = \int_0^{B_L} B x_L(B)\, m_t \frac{g(B)\mathrm{dB}}{G(B_L)} + \tau \int_0^{B_E} B x_E(B) m_t \frac{g(B)\mathrm{dB}}{G(B_L)}$ is the labor used for manufacturing. The price index is given by $(P_t)^{1-\sigma} = m_t \left(\sum_{j=L,E} \int_0^{B_j} P_{jt}(B)^{1-\sigma} \frac{g(B)\mathrm{dB}}{G(B_L)}\right) = \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} m_t \Delta$. Thus, $L_x = \frac{\sigma-1}{\sigma} E_t$.

2.7 Steady-State Equilibrium

Substituting the free-entry condition, costs for creating a new variety, the weighted average of the unit labor requirement of production firms, and the Pareto distribution into the local cut-off condition yields the unique solution of the local market cutoff level, determined by $\frac{1+k-\sigma}{k\Phi} = \frac{F_L}{F_I\left(\frac{\bar{B}}{B_L}\right)^k + F_L\Phi}$. The closed-form solution of the local cut-off level[6] is given by $B_L = \left(\frac{(1+k-\sigma)F_I}{(\sigma-1)F_L}\right)^{\frac{1}{k}} \frac{\bar{B}}{\Phi^{\frac{1}{k}}}$. The intuition behind this equation follows Furusawa and Konishi (2012). A decrease in the iceberg cost leads to more competition due to imports from abroad, and leads to lower demand for each variety and higher demand for labor. Thus, a variety with lower productivity than the cutoff productivity level cannot serve the domestic market.

Next we derive the closed-form solutions for per capita expenditure and R&D difficulty. We obtain the first relationship between per capita expenditure and R&D difficulty from full employment, which becomes $L = \frac{\sigma-1}{\sigma}E + \frac{kF_L\Phi g}{(1+k-\sigma)\chi}$. The full employment condition is represented by a line with negative slope and a positive E-intercept in the (E, g) plane, because an increase in E implies a larger number of manufacturing firms and a lower value of g implies a smaller number of researchers are needed to maintain the equality. We obtain the second relationship between aggregate expenditure and the growth rate from the free-entry condition $\frac{E}{\sigma(\rho+g)} = \frac{kF_L\Phi}{(1+k-\sigma)\chi}$. The free-entry condition is an upward sloping curve with a positive E-intercept in the (E, g) plane, because an increase in E□implies that a larger benefit from creating a new variety and associated costs must be offset by an increase in g to maintain the equality. Using these conditions, the closed-form solutions for aggregate expenditure and the

[6] We assume $1 + k - \sigma > 0$.

growth rate[7] are given by $E = \frac{L(1+k-\sigma)\chi + \rho k F_L \Phi}{(1+k-\sigma)\chi}$ and $g = \frac{(1+k-\sigma)L\chi}{k\sigma F_L \Phi} - \frac{\rho(\sigma-1)}{\sigma}$, respectively.

We next analyze the effects of trade liberalization on the growth rate. We obtain higher R&D knowledge spillover from a foreign country and an increase in R&D cost by increasing the value of firms, which in turn increases the cost of creating a new variety through decreasing the domestic cutoff level and increasing the exporting cutoff level to satisfy the cutoff conditions. The condition for an increase in the growth rate resulting from further exposure to trade is

$$-\frac{\partial g}{\partial \tau} > 0 = \frac{kL\tau^{-k-1}(1+k-\sigma)}{k\sigma F_L \Phi^2}\left[\left(\frac{F_L}{F_E}\right)^{\frac{k}{\sigma-1}} - \left(\frac{F_L}{F_E}\right)^{\frac{1+k-\sigma}{\sigma-1}}\right] > 0.$$

The growth rate increases (decreases) from further exposure to international trade when the sunk beachhead cost for the domestic market is strictly larger (smaller) than the sunk cost for entering the foreign market. This is because there is a positive effect through endogenous international spillover, which depends on the sunk cost for entering the domestic market relative to that for the foreign market and a negative effect of an increase in R&D cost through changes in cutoff points, which depends on the sunk cost for entering the domestic market relative to that for the foreign market. This result seems to be relevant to empirical evidence between globalization and economic growth because its empirical evidences shows conflicting results.

3. Conclusions

This paper shows the necessary and sufficient conditions under which further exposure to international trade raises the growth rate in an endogenous growth model with firm

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7 We assume $\frac{(1+k-\sigma)L\chi}{k\sigma F_L \Phi} - \frac{\rho(\sigma-1)}{\sigma} > 0$.

heterogeneity, endogenous international spillovers, and international trade. When the sunk cost for the domestic market is strictly higher (lower) than that for the foreign market, the growth rate increases (decreases). We can extend this model into a scale invariant endogenous growth model by introducing population growth and diminishing returns to knowledge in the R&D sector as in Jones (1995).

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