THE JOURNAL OF THE KOREAN ECONOMY, Vol. 6, No. 1 (Spring 2005), 91-102

Import Tariffs and Growth*

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In this paper I study the effects of import tariffs in a small open economy. Using endogenous growth model, I show that an increase in a country's trade liberalization caused by a fall in any of a country's tariffs reduces the steady-state level of R&D investment and real expenditure on a country's non-traded good sector. On the other hand, lower tariffs raise the steady-state level of R&D investment and steady-state real expenditure in a country's trade sector. Second, since higher tariffs increase the steady-state real expenditure on non-traded good and reduce on traded good, higher tariffs shift resources from traded to non-traded sector. This result creates negative effects of spillovers in the rest of the world. This paper also suggested that in the model, a change of tariff does not affect the steady-state level of R&D investment in the non-traded and traded sectors of the other country.

JEL Classification: F13, O41
Keywords: import tariff, endogenous growth, R&D, spillovers, productivity

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* Received January 13, 2005. Accepted April 27, 2005.
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1. INTRODUCTION

How is trade linked to long-run economic growth? Should less developed countries protect certain key industries to grow faster?

Economists have widely agreed that a country's economic growth level depends on its own R&D as well as on the R&D efforts of its trade partners. In this way, trade, like diffusion, leads to sharing of technology and to higher rates of economic growth. Thus international trade might be the engine of growth that determines the long-run growth rate.

Recently there has been a growing literature suggesting that imports of foreign R&D are an important determinant of the link between trade and growth. Grossman and Helpman (1991), Rivera-Batiz and Romer (1991) and Keller (1999) showed that international trade could increase the growth rate by providing a wide range of intermediate inputs. In particular, Coe and Helpman (1995) have found that a country's total factor productivity depends not only on domestic R&D capital but also on foreign R&D capital. Moreover, their estimates suggest that the foreign R&D has a larger impact on total factor productivity than does domestic R&D in the smaller countries.

If one views technological change as an endogenous process that is affected by trade policies, then it is natural to ask the question: what are the dynamic effects of protecting domestic firms? This question has received much attention in the theoretical literature on endogenous growth and international trade.

This paper addresses the relationship between tariff structure and growth for a small open economy with endogenous growth model. The ultimate goal of this paper is to study the growth and effects of a tariff. This model differs from the ones in the studies mentioned above in a number of respects. For example, I consider a two-country setting with a final good produced in each country and investigate demand-based channels of tariff changes. The ones in the above studies did not investigate the effects of tariff policies on growth explicitly and none of these studies analyzed the role of non-traded goods.

The rest of this paper is organized as follows: Section 2 reviews the related works on import tariffs and growth. I present the model of a small open economy with endogenous growth in section 3. Section 4 contains a summary of the major findings.

2. AN OVERVIEW OF THE LITERATURE ON IMPORT TARIFFS AND GROWTH

A growing body of literature has examined the effects of tariffs on growth. Grossman and Helpman (1991, Chap. 6) found that protection (or promotion) of the human capital – intensive final goods industry draws resources out of the R&D sector and thus slows growth. Protection of the labor – intensive final good has the opposite effect on growth. They also considered the welfare implications of import tariff in a model of a small open economy with endogenous innovations. They found that import tariff that promotes growth may reduce its aggregate welfare, and one that impedes growth may raise its welfare. The ambiguity is entirely consistent with the theory of the second best.

Rivera-Batiz and Romer (1991) showed these higher common tariffs between two structurally identical countries slow technical change and economic growth. And they also analyzed the effects of symmetric, across-the-board tariffs on global growth in a two-country model with innovation taking the form of increased varieties in the traded goods sector. They found a U-shaped relationship between tariffs and long-run growth. This paper, however, concentrates on steady-state effects, and therefore ignores important transitional effects. As a consequence, the focus is on level or growth effects rather than welfare effects.

Brock and Turnovsky (1993) analyzed the impact of import tariffs on growth and welfare in a small neoclassical economy. They found that tariffs generate short-run benefits but long-run costs for the intervening country. Galor (1994) also examined the effects of income redistribution, induced by tariffs, on the welfare of a small, overlapping generation economy. He identified sufficient conditions under which an infinitesimal tariff raises short-run and long-run welfare. Osang and Pereira (1996) studied the effects of tariffs on growth and welfare in a small open economy with endogenous growth based on human capital accumulation. They showed that tariffs reduce growth even in the short-run and that their welfare effects are generally ambiguous.

Since the theoretical literature does not provide a clear answer, empirical work is needed to help resolve the debate. Trefler (1993) estimated trade and NTB equations for the United States and showed that taking into account the simultaneous determination of imports and trade protection results in a substantially larger estimate of the effects of protection on imports. He also found that political factors and proxies for industrial structure, such as measures of union density and industry concentration, have the expected positive impact on the level of protection in the United States. Harrison (1996) examined the impact of a wide range of openness measures on economic growth. The results suggested that greater openness is associated with higher growth.

3. THE MODEL

The model developed in this section is a two countries (Home & Foreign) version of Grossman and Helpmans'(GH, 1991: Chap. 3) growth model. However, I assume that there are two final goods (1&2), one of which is a non-traded good (1). Labor is the only factor of production which can be allocated to two broadly defined activities: manufacturing of final goods and production of R&D. R&D activity is needed for the better production techniques that would increase the productivity of labor in the manufacturing of final goods.

3.1. Consumer Behavior

As in GH Chap 3, the representative consumer in each country maximizes her expected discounted lifetime utility. The intertemporal function of the representative consumer in country i is

$$U^i = \int_0^\infty e^{-\rho t} \log(u^i(t))dt, \quad i = H, F. \tag{1}$$

Here $\log(u^i(t))$ is the consumer's instantaneous utility at time t, and ρ is the subjective discount rate. The function $u^i(t)$ takes the Cobb-Douglas form

$$u^i(t) = \prod_{j=1}^{2}\left[d_j^i(t)\right]^{\alpha_j}, \quad 0 < \alpha_j < 1, \ \sum_{j=1}^{2} \alpha_j = 1. \tag{2}$$

$d_j^i(t)$ is consumption of good j demanded by the representative consumer in country i at time t.

At time t, the consumer spends on expenditure $E^i(t)$. Solving the consumer's static optimization problem yields the instantaneous demand function:

$$d_j^i(t) = \frac{\alpha_j E^i(t)}{P_j^i(t)}, \tag{3}$$

where $P_j^i(t)$ is the price of good j in country i.

Let L^i represent the number of consumers in country i and assume that each individual is endowed with one unit of labor. Then the aggregate demand for good j in country i $D_j^i(t) = L^i \cdot d_j^i(t)$.

Given the demand behavior, maximizing (1) subject to the household's intertemporal budget constraint yields the well-known differential equation.[1)]

[1)] See GH (1991), Chap. 2.

$$\frac{\overset{g}{E^i}(t)}{E^i(t)} = \gamma^i(t) - \rho \ , \tag{4}$$

where $\gamma^i(t)$ is the market interest rate at time *t*.

I impose a normalization of prices that makes nominal spending constant through time. With $E(t) = 1$ for all *t*, equation (4) implies $\gamma^i(t) = \rho$.

Let $P_2^w(t)$ and $\tau_2^i(t)$ denote the world price and tariff that country *i* levies on its imports of good *j* at time *t*. Then $P_2^i(t) = \left(1 + \tau_2^i(t)\right) P_2^w(t) = T^i P_2^w(t)$, where $T^i = (1 + \tau^i)$

3.2. Producer Behavior

On the production side, let $w^i(t)$ be country *i*'s wage rate. And several simplifying assumptions are used. The first is that endogenous innovations in every country *i* improve the productivity of labor employed in manufacturing. Let A_j and n_j^i denote the labor productivity per innovation in sector *j* and number of process innovations in sector *j* in country *i* respectively. Then success of innovation raises the labor productivity from A^n to A^{1+n} . The second is that labor can move freely and without cost across activities within each country, so each worker receives the same reward regardless of where they are employed.

The other assumption is that an entrepreneur can enter freely into R&D by devoting given finite competitors, so success of one firm in innovation does not influence the market price.

In this kind of environment, a simple functional form for final goods is:

$$\begin{aligned} X_j^i &= A_j^{n_j^i} L_j^i, \quad (a)\ \textit{market production function} \\ &= A_j^{1+n_j^i} L_j^i, \quad (b)\ \textit{success firm's production function} \end{aligned} \tag{5}$$

This production function expresses that if one firm succeeds in innovations, then one unit of labor can produce $A_j^{1+n_j^i}$ units of the good *j*.

Consider now the firm that wins an arbitrary race. This firm reduces its marginal cost of manufacturing goods. The profits of the winner are maximized at a price set slightly below the marginal cost of its closest competitor (Bertrand competition). So given the wage rate, $w^i(t)$, the instantaneous profits of successful firm in country *i*'s sector is given by

$$\pi_1^i = \left[p_1^i - \frac{w^i}{A_1^{1+n}} \right] D_1^i ,$$

$$\pi_2^i = \left[p_2^w - \frac{w^i}{A_2^{1+n}} \right] \sum_{i=H\&F} D_2^i . \qquad (6)$$

The expression in the first bracket of equation (6) denotes the instantaneous, per-unit profit flow of the winner in the non-traded good sector of country *i*. The expression in the second bracket equation (6) corresponds to the aggregate demand for country *i*'s trade good.

Now using a price $p_j^i(t) = \frac{w^i}{A_j^n}$,[2)] and let $Y_j^i(t)$ denote the expenditure on good *j* by country *i* and $Y_j(t) = \sum_{i=H\&F} Y_j^i(t)$, we can rearrange these to give:

$$\pi_1^i = \left[P_1^i - \frac{A_1^n}{A_1^{1+n}} P_1^i \right] D_1^i = (1 - \frac{1}{A_1}) p_1^i D_1^i = (1 - \frac{1}{A_1}) Y_1^i ,$$

$$\pi_2^i = \left[\frac{P_2^i}{1+\tau} - \frac{A_2^n}{A_2^{1+n}} P_2^i \right] \sum_{i=H\&F} D_2^i = \left[(1 - T^i \frac{1}{A_2}) \right] p_2^i \sum_i D_2^i = \left[1 - T^i \frac{1}{A_2} \right] Y_2 . \quad (7)$$

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2) By assumption, success of one firm in innovation does not influence the market price, and the market for final goods is perfectly competitive, so from the market production function (equation 5(a)), we can derive $p_j^i = MC_j^i = \frac{w^i}{A_j^n}$.

Since the A_1^i and A_2^i in equation (7) are constant, it follows that the profit flow of the winner is proportional to the aggregate expenditure on good j (=1, 2).

3.3. R&D Sector

I turn next to the R&D sector for productivity improvement. I suppose that R&D entails uncertain prospects. Let φ denote the intensity of R&D investment for a time interval *dt*. Then φdt is the probability of success of the new process innovation that raises the number of innovations from n to n+1. And I assume that the arrival of these research successes is guided by independent Poisson processes.

The decision to participate in R&D depends on a comparison of the expected discounted profits and the cost of initial investment in R&D. If one unit of labor generates θ_j units of R&D services, then the cost of the initial investment in R&D is $\frac{w^i}{\theta_j}$. At every date, it must therefore be true that[3)]

$$\frac{\pi_j^i}{\gamma^i + \varphi_j^i} = \frac{\pi_j^i}{\rho + \varphi_j^i} = \frac{w^i}{\theta_j^i}. \tag{8}$$

Equation (8) implies that a successful innovator discounts the flow on instantaneous profits π_j^i by the market interest rate γ^i plus the industry-wide instantaneous probability φ_j^i that the next innovation will occurs.

Substituting in the expression for π_j^i from equation (7) yields

$$\frac{\varphi_1^i}{\theta_1} = \left[1 - \frac{1}{A_1}\right]\frac{Y_1^i}{w^i} - \frac{\rho}{\theta_1},$$

[3)] Equation (8) can be derived from the definition of expected discounted profits,

Expected Discounted Profits = $\int_0^\infty \left[\int_0^z \pi_j^i \exp(-\gamma(s))ds\right] \cdot \varphi_j^i \exp(-\varphi_j^i z)dz$.

For more detail, see Romer (1990), GH (1991, Chap. 4, pp. 91-93) and Morris H. DeGroot (1989, pp. 252-257).

$$\frac{\varphi_2^i}{\theta_2} = \left[1 - T^i \frac{1}{A_2}\right] \frac{Y_2}{w^i} - \frac{\rho}{\theta_2} . \tag{9}$$

I turn now to the labor market. Equilibrium in country i's non-traded good and traded good requires $p_1^i D_1^i = Y_1^i$ and $p_2^w \left[\sum_i D_2^i\right] = Y_2$, Using equation (5), those conditions can be rewritten as $\frac{Y_1^i}{p_1^i} = A_1^{1+n} L_1^i$ and $\frac{Y_2}{p_2^w} = A_2^{1+n} L_2^i$.

Since $p_j^i = \frac{w^i}{A_j^n}$,

$L_1^i = \left[\frac{1}{A_1}\right]\left[\frac{Y_1^i}{w^i}\right]$, $L_2^i = \left[\frac{1}{A_2}\right](1+\tau)\left[\frac{Y_2}{w^i}\right]$ and $\frac{\varphi_j^i}{\theta_j}$ units of labor engaged in R&D sector. So, the labor market clears when

$$\frac{\varphi_1^i}{\theta_1} + \frac{\varphi_2^i}{\theta_2} = \left[\frac{1}{A_1}\right]\left[\frac{Y_1^i}{w^i}\right] + \left[\frac{1}{A_2}\right] T^i \left[\frac{Y_2}{w^i}\right] = L^i . \tag{10}$$

Using equation (9), we can rearrange this to give:

$$\frac{Y_1^i}{w^i} + \frac{Y_2}{w^i} = L^i + \frac{\rho}{\theta_1} + \frac{\rho}{\theta_2} . \tag{11}$$

I am ready to describe the steady-state equilibrium. By definition, we can get $Y_2 = \sum_i Y_2^i$. This equation implies that world expenditure on traded good is equal to sum of each country i's expenditure on traded goods.

Using equation (3) and $D_j^i(t) = L^i \cdot d_j^i(t)$, we can rewrite this equation as[4)]

[4)] Equation (12) can be derived as follows:

$$Y_2 = \Sigma Y_2^i$$
$$= \Sigma p_2^w D_2^i = \Sigma \frac{1}{T^i} p_2^i D_2^i = \Sigma \frac{1}{T^i} p_2^i (d_2^i L^i) = \Sigma \frac{1}{T_i} p_2^i \left(\frac{\alpha_2 E^i}{p_2^i}\right) L^i = \Sigma \frac{1}{T^i} \alpha_2 E^i L^i$$
$$= \Sigma \frac{\alpha_2}{\alpha_1}\left(\frac{1}{T^i}\right) \alpha_1 E^i L^i = \delta \cdot p_1^i \frac{\alpha_1 E^i}{p_1^i} L^i = \delta \cdot p_1^i d_1^i L^i = \delta \cdot p_1^i D_1^i = \delta \cdot Y_1^i .$$

$$Y_2 = \sum \frac{\alpha_2}{\alpha_1}\left(\frac{1}{T^i}\right) Y_1^i = \delta \cdot Y_1^i \tag{12}$$

$$\Leftrightarrow \frac{Y_2}{w^i} = \delta \cdot \frac{Y_1^i}{w^i}, \quad \text{where} \quad \delta = \sum \left(\frac{\alpha_2}{\alpha_1}\right)\left(\frac{1}{T^i}\right), \quad \text{tariff structure.}$$

Equations (9), (11) and (12) yields the following solution for steady-state equilibrium R&D investments:

$$\varphi_1^i = \theta_1 \left(1 - \frac{1}{A_1}\right)\left[\left(\frac{1}{1+\delta}\right)\left(L^i + \frac{\rho}{\theta_1} + \frac{\rho}{\theta_2}\right)\right] - \rho ,$$

$$\varphi_2^i = \theta_2 \left(1 - T^i \frac{1}{A_2}\right)\left[\left(\frac{\delta}{1+\delta}\right)\left(L^i + \frac{\rho}{\theta_1} + \frac{\rho}{\theta_2}\right)\right] - \rho . \tag{13}$$

Almost all the content of the model is contained in equation (13), which summarizes the effects of the tariffs. I first ask how tariffs affect R&D investment. Equation (13) implies that a fall of tariffs in any country *i* reduces the steady-state level of R&D investment in non-traded sector (φ_1^i), and also reduces the steady-state real expenditure on country *i*'s non-traded good ($\frac{Y_1^i}{w^i}$).[5)]

On the other hand, this raises the steady-state level of R&D investment in country *i*'s traded good (φ_2^i), and also raises the steady-state real expenditure on country *i*'s traded good ($\frac{Y_2}{w^i}$).

[5)] From equations (11) and (12),

$$\frac{Y_1^i}{w^i} = \left(\frac{1}{1+\delta}\right)\left[L^i + \frac{\rho}{\theta_1} + \frac{\rho}{\theta_2}\right],$$

$$\frac{Y_2^i}{w^i} = \left(\frac{\delta}{1+\delta}\right)\left[L^i + \frac{\rho}{\theta_1} + \frac{\rho}{\theta_2}\right].$$

4. CONCLUSION

In this paper I study the effects of import tariffs in a small open economy. I derive several important results with respect to the effects of decreases in tariff rates. First, I show that an increase in a country's trade liberalization caused by a fall in any of a country's tariffs reduces the steady-state level of R&D investment and real expenditure on a country's non-traded good sector. Second, on the other hand, lower tariffs raise the steady-state level of R&D investment and steady-state real expenditure in a country's trade sector. Finally, since higher tariffs increase the steady-state real expenditure on non-traded good and reduce on traded good, higher tariffs shift resources from traded to non-traded sector. This result creates negative effects of spillovers in the rest of the world.

This paper also suggested that in the model, a change of tariff does not affect the steady-state level of R&D investment in the non-traded and traded sectors of the other country.

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