E C O N O M I C S   B U L L E T I N

Strategic Import Policies in a Three Country Model with Vertically Related Industries

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Abstract

This note examines strategic import policies in a three-country model with vertical production and trade relationship. Reflecting horizontal and vertical effects of the import policy, each country's optimal policy can be either tariff or subsidy, depending on the relative numbers of upstream and downstream firms.

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1 Introduction

Along with the growing importance of international trade in intermediate goods in the world economy [1], models of strategic trade policy with vertically related markets have been developed in recent years. Using variants of the third-market oligopoly model originated by Brander and Spencer (1985), the existing studies have shown that a downstream country's optimal policy is influenced not only by the horizontal profit-shifting motive but also by the motive to extract profits from upstream firms (Bernhofen, 1997; Ishikawa and Spencer, 1999; Chang and Sugeta, 2004).

The existing studies have examined optimal export policies. In this paper, by contrast, we focus on optimal *import* policies [2]. Moreover, instead of the *third-market* models that existing studies have analyzed, we consider a *three-country* model, in which a homogenous final good is produced in two countries using an imported intermediate good, and the intermediate good is produced in another country that also consumes the final good [3]. We show that each country's optimal unilateral policy can be either tariff or subsidy, depending on the relative numbers of upstream and downstream firms, which reflect horizontal and vertical effects of the import policy. We also show that when the optimal policy for a country exporting the intermediate good and importing the final good is a tariff (subsidy), the optimal policy is a subsidy (tariff) for its trading partner. We consider a policy game as well as the unilateral policy choice, and derive the similar result.

2 The Model

The world economy consists of three countries (A, B and C), where a final good and an intermediate good are traded in addition to a numeraire good that balances trade. There are $n > 1$ identical firms producing the final good in country B and C, respectively, while no downstream firms in country A. The intermediate good, by contrast, is produced only in country A, which has $m > 1$ identical firms. Moreover, we assume that consumption of the final good only takes place in country A. Therefore, the trade pattern is that country A exports the intermediate good to country B and C, and the final good is traded in the opposite direction.

Let us denote the tariff rate on the final good by T_A, and that on the intermediate good imposed by the government in country $i = B, C$ by t_i [4]. The model involves three stages of action. In stage 1, governments determine the tariff rates. In stage 2, the

[1] For example, the trade values of intermediate goods from Japan and NIEs to China and ASEAN grew from $ 24 billion in 1990 to $182 billion in 2003 (METI, 2006).

[2] Although Ishikawa and Spencer (1999) examined the import policy applied to intermediate goods, their main focus is on the strategic export policies.

[3] The effects of tariffs on intermediate and final goods in a two-country model with a foreign vertically integrated firm are examined by Spencer and Jones (1992) and Ishikawa and Lee (1997).

[4] We assume that discriminatory tariffs on final goods are not applied because of the principle of most-favored-nation treatment.

upstream firms located in country A play a Cournot game to choose output, and the intermediate goods are sold to country B and C. In stage 3, given the prices of the intermediate good, the downstream firms located in country B and C play a Cournot game in country A's market to choose output. [5] We solve the model backwards.

2.1 Stage 3: Cournot competition by final-good firms

We assume that producing one unit of the final good requires one unit of the intermediate good. Then, a representative firm in country $i = B, C$ chooses the output y_i so as to maximize the profit

$$\pi_i = [P(Y) - r_i - T_A]y_i, \quad i = B, C, \tag{1}$$

taking r_i and other (both domestic and foreign) firms' output as given, where $P(Y)$: inverse demand, Y: total output, and r_i: price of the intermediate good. The Cournot-Nash equilibrium in the final-good market is characterized by the following conditions [6]:

$$P(ny_B + ny_C) + P'(ny_B + ny_C)y_B = r_B + T_A, \tag{2}$$

$$P(ny_B + ny_C) + P'(ny_B + ny_C)y_C = r_C + T_A. \tag{3}$$

These conditions define the equilibrium outputs $y_i = \tilde{y}^i(r_B, r_C, T_A)$, $i = B, C$.

Let X^i be the total supply of the intermediate good in country $i = B, C$. The market-clearing conditions $X^B = n\tilde{y}^B(r_B, r_C, T_A)$ and $X^C = n\tilde{y}^C(r_B, r_C, T_A)$ derive the inverse demand functions of the intermediate goods; $r_i = \tilde{r}^i(X^B, X^C, T_A)$, $i = B, C$.

2.2 Stage 2: Cournot competition by intermediate-good firms

With a constant marginal cost of producing the intermediate good $k > 0$, a representative firm in country A earns profits

$$\pi_A = [\tilde{r}^B(X^B, X^C, T_A) - k - t_B]x_A^B + [\tilde{r}^C(X^B, X^C, T_A) - k - t_C]x_A^C, \tag{4}$$

where x_A^i: the firm's supply of the intermediate good to country i's market. The firm determines x_A^B and x_A^C so as to maximize (4), taking other firms' output as given. [7] In the

[5] Models of vertical Cournot oligopolies, in which upstream and downstream firms are respectively under Cournot competition, are widely examined in the literature of industrial organization (e.g., Greenhut and Ohta, 1979; Salinger, 1988; Lin, 2006) and trade theory (e.g., Bernhofen, 1995, 1997; Spencer and Raubitschek, 1996; Ishikawa and Lee, 1997; Ishikawa and Spencer, 1999). The assumption that the downstream firms recognize their market power in the final good market, but act as price-takers in the input market, may be subject to criticism. However, as Ishikawa and Spencer (1999, pp. 204–205) justifies, the downstream firms' monopsony power becomes vanishingly small when the number of these firms increases or when a large number of identical downstream industries demand the same input and our downstream industry is a 'representative' one.

[6] Eqs. (2) and (3) follow from the final-good firms' first-order conditions for profit maximization.

[7] If the upstream firms play a Bertrand game, they reduce the price of the intermediate good to the marginal cost plus the tariff rate ($r_i = k + t_i$. $i = B, C$) because the intermediate goods are assumed

Cournot-Nash equilibrium in the intermediate-good markets, the following conditions hold:

$$\tilde{r}^B(mx_A^B, mx_A^C, T_A) - k - t_B + \frac{\partial \tilde{r}^B}{\partial X^B} x_A^B + \frac{\partial \tilde{r}^C}{\partial X^B} x_A^C = 0, \tag{5}$$

$$\tilde{r}^C(mx_A^B, mx_A^C, T_A) - k - t_C + \frac{\partial \tilde{r}^B}{\partial X^C} x_A^B + \frac{\partial \tilde{r}^C}{\partial X^C} x_A^C = 0. \tag{6}$$

These conditions jointly determine the equilibrium outputs of the intermediates as a function of the tariff rates; $x_A^i = x^i(T_A, t_B, t_C)$, $i = B, C$.

Substituting $x^i(T_A, t_B, t_C)$ into the equilibrium outputs and prices in stage 3, we have the subgame-perfect equilibrium solutions as a function of tariff rates:

$$\begin{aligned} r^i(T_A, t_B, t_C) &\equiv \tilde{r}^i(mx^B(T_A, t_B, t_C), mx^C(T_A, t_B, t_C), T_A), \qquad i = B, C, \\ y^i(T_A, t_B, t_C) &\equiv \tilde{y}^i(r^B(T_A, t_B, t_C), r^C(T_A, t_B, t_C), T_A), \qquad i = B, C, \\ p(T_A, t_B, t_C) &\equiv P(Y(T_A, t_B, t_C)), \end{aligned}$$

where $Y(T_A, t_B, t_C) \equiv \sum_{i=B,C} n\tilde{y}^i(r^B(T_A, t_B, t_C), r^C(T_A, t_B, t_C), T_A)$.

We assume a linear demand: $P(Y) = \alpha - Y$, where $\alpha > 0$ is large enough to ensure positive outputs. Then, uniqueness and stability of the Cournot-Nash equilibrium in both final- and intermediate-goods markets are guaranteed, and the second-order conditions for profit maximization and welfare maximization (in the next section) are satisfied. Moreover, the comparative static results are obtained:

$$\frac{\partial x^i}{\partial T_A} = -\frac{n}{(2n+1)(m+1)} < 0, \quad \frac{\partial x^i}{\partial t_i} = -\frac{n(n+1)}{(2n+1)(m+1)} < 0, \quad \frac{\partial x^i}{\partial t_j} = \frac{n^2}{(2n+1)(m+1)} > 0, \tag{7a}$$

$$\frac{\partial r^i}{\partial T_A} = -\frac{1}{m+1} < 0, \quad \frac{\partial r^i}{\partial t_i} = \frac{m}{m+1} > 0, \quad \frac{\partial r^i}{\partial t_j} = 0, \tag{7b}$$

$$\frac{\partial y^i}{\partial T_A} = -\frac{m}{(2n+1)(m+1)} < 0, \quad \frac{\partial y^i}{\partial t_i} = -\frac{m(n+1)}{(2n+1)(m+1)} < 0, \quad \frac{\partial y^i}{\partial t_j} = \frac{mn}{(2n+1)(m+1)} > 0, \tag{7c}$$

$$\frac{\partial p}{\partial T_A} = \frac{2mn}{(2n+1)(m+1)} > 0, \quad \frac{\partial p}{\partial t_i} = \frac{mn}{(2n+1)(m+1)} > 0, \tag{7d}$$

$i, j = B, C$, $j \neq i$. An increase in T_A raises marginal costs of final-good producers, whose output decreases and so does Y, leading to increased p. The reduction of final-good outputs reduces demand for intermediate goods x^i, the price of which r^i declines so as to avoid further shrinking in demand. An increase in t_i raises marginal costs of intermediate-good producers, whose output is reduced, leading to increased r^i. This price increase reduces y^i and augments the rival's output y^j, but the total supply of the final good decrease, and hence p rises.

to be homogeneous. This implies that country B and C cannot reduce their respective import price of the intermediate good, which contributes to an improvement in their terms of trade, by raising tariffs.

3 Strategic Import Policies

3.1 Optimal import policy for country A

Country A's welfare consists of the sum of consumer surplus, profits of the intermediate-good firms, and tariff revenue (or minus government spending if $T_A < 0$):

$$\begin{aligned} W_A = & \int_0^{Y(T_A,t_B,t_C)} p(v)dv - p(T_A,t_B,t_C)Y(T_A,t_B,t_C) \\ & + m \sum_{i=B,C} [r^i(T_A,t_B,t_C) - k - t_i]x^i(T_A,t_B,t_C) + n \sum_{i=B,C} T_A y^i(T_A,t_B,t_C). \end{aligned} \quad (8)$$

The government in country A chooses T_A so as to maximize (8), taking t_B and t_C as given. The optimal tariff rate is derived as

$$T_A^* = \frac{(m-2n-1)(2\alpha - 2k - t_B - t_C)}{4m(n+1)}. \quad (9)$$

Proposition 1 *The optimal unilateral policy for country A is an import tariff (resp. subsidy) if and only if $m - 2n - 1 > 0$ (resp. $m - 2n - 1 < 0$).*

The intuition behind Proposition 1 is as follows. Starting from free trade, an increase in T_A affects welfare in the following way [8]:

$$\begin{aligned} \left.\frac{\partial W_A}{\partial T_A}\right|_{T_A=0} &= \underbrace{-\sum_{i=B,C}\left(\frac{\partial p}{\partial T_A} - \frac{\partial r^i}{\partial T_A} - 1\right) ny^i}_{\text{profit-capturing effect } (+)} + \underbrace{\sum_{i=B,C} m(r^i - k - t_i)\frac{\partial x^i}{\partial T_A}}_{\text{efficiency-loss effect } (-)} \\ &= \left[\frac{m}{(2n+1)(m+1)} - \frac{1}{m+1}\right] Y. \end{aligned} \quad (10)$$

The profit-capturing effect indicates that by raising T_A, country A can extract the profits of foreign final-good firms in the form of increased tariff revenue net of deterioration in its terms of trade. Meanwhile, an increase in T_A reduces y^i, which shrinks demand for intermediate goods and hence home firms' profits. This reduction in π_A does not contribute to any gain in π_i, $i = B, C$, and hence we call this an efficiency-loss effect. Both the profit-capturing and efficiency-loss effects stem from the vertical trade structure. If m is large, the profit-capturing effect is reinforced while the efficiency-loss effect diminishes, both enhance country A's welfare. If n is large, the profit-capturing effect diminishes, which reduces welfare.

[8] We make use of the market-clearing condition for intermediate goods $mx^i = ny^i$ and comparative static results (7).

3.2 Optimal import policy for country B and C

As for country B and C, their welfare consists of the sum of profits of the final-good firms, and tariff revenue:

$$W_i = n[p(T_A, t_B, t_C) - r^i(T_A, t_B, t_C) - T_A]y^i(T_A, t_B, t_C) + mt_i x^i(T_A, t_B, t_C), \quad i = B, C. \tag{11}$$

Country B (C) chooses t_B (t_C) so as to maximize (11), taking T_A and t_C (t_B) as given. The optimal tariff rate is derived as

$$t_i^* = \frac{(2n+1-m)(\alpha + nt_j - k - T_A)}{2(n+1)[(m+2)n+1]}, \quad i, j = B, C, j \neq i. \tag{12}$$

Proposition 2 *The optimal unilateral policy for country B and C is an import tariff (resp. subsidy) if and only if $m - 2n - 1 < 0$ (resp. $m - 2n - 1 > 0$).*

The optimal policy is dependent on the sign of $m - 2n - 1$, as in Proposition 1, but the condition is opposite to that for country A. The intuition is as follows. From free-trade situation, an increase in t_i affects welfare according to

$$\begin{aligned} \left.\frac{\partial W_i}{\partial t_i}\right|_{t_i=0} &= \underbrace{\frac{\partial p}{\partial t_i} ny^i - \left(\frac{\partial r^i}{\partial t_i} - 1\right) mx^i}_{\text{surplus-capturing effect } (+)} \underbrace{+ n(p - r^i - T_A)\frac{\partial y^i}{\partial t_i}}_{\text{profit-shifting effect } (-)} \\ &= \left[\frac{mn + 2n + 1}{(2n+1)(m+1)} - \frac{m(n+1)}{(2n+1)(m+1)}\right] mx^i. \end{aligned} \tag{13}$$

The surplus-capturing effect represents the extraction of country A's consumers surplus and profits by country i. The profit-shifting effect is in the horizontal sense that, e.g., an increase in t_B raises r_B and hence the firms in country C has a cost advantage over country B's firms. If m is large, the surplus-capturing effect diminishes while the profit-shifting effect is reinforced, and hence the total welfare effect is negative. If n is large, the opposite holds.

3.3 Policy game

When we consider a noncooperative policy game, the Nash equilibrium tariff rates are derived from (9) and (12) as follows:

$$T_A^N = \frac{(m - 2n - 1)(n+1)(\alpha - k)}{m[2n(n+2)+1] + 2n + 1}, \quad t_B^N = t_C^N = \frac{(2n + 1 - m)(\alpha - k)}{m[2n(n+2)+1] + 2n + 1}. \tag{14}$$

The results under unilateral actions apply to the policy game.

Proposition 3 *In the Nash equilibrium of the policy game, country A uses import tariff (resp. subsidy) while country B and C use import subsidy (resp. tariff) if and only if $m > 2n + 1$ (resp. $m < 2n + 1$).*

4 Conclusion

This paper examined a three country model with a vertical production and trade structure, and derived each country's optimal import policy. Depending on the relative numbers of upstream and downstream firms, each country's optimal policy can be either tariff or subsidy. Moreover, when the optimal policy for a country exporting the intermediate good and importing the final good is a tariff (subsidy), the optimal policy is a subsidy (tariff) for its trading partner.

In the current world economy, there have been active movements toward expanding and deepening regional integration. Given such movements, it will be interesting to examine the effects of preferential trade agreement in our three-country model. This will be our next task.

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