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Protection Policy in a Dynamic Oligopoly Market

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### Abstract

This paper demonstrates how domestic government interventions in an infant industry can help the domestic firm compete with the foreign firm in an investment race, using Spence's (1979) model. When protection is believed to be temporary, the threat of future entry by the foreign firm gives the domestic firm strategic incentive to accelerate investment to preempt its foreign rival. On the other hand, under permanent protection, the lack of competitive pressure might lead to industrial stagnation. The model fits well with the Japanese experiences in the 1960s.

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## 1. Introduction

This paper demonstrates how the domestic government intervention in an infant industry can help the domestic firm compete with the foreign firm in an investment race, using the dynamic oligopoly model developed by Spence (1979). In particular, it is shown that temporary protection may boost investment by the domestic firm more than permanent protection. When protection is believed to be temporary, the threat of future entry into the domestic market by the foreign firm gives the domestic firm strategic incentive to accumulate its capital stock, thereby preempting its foreign rival.

The policy implication is clear. Protection may be useful to enhance competitiveness since it provides the domestic firm with first-mover advantages. However, protection should be temporary because, if protection is imposed indefinitely, the lack of competitive pressures may lead to industrial stagnation.

Although, as a theoretical exercise, our argument can be applied to a variety of situations, we put special emphasis on the Japanese experiences in the 1960s. Recently, industrial policies in Japan have attracted much attention from government officials, business people and academic economists. There are active debates on how much Japan's industrial policies have contributed to her impressive industrial success. Some even argue that other nations should adopt Japanese-style industrial policies to emulate Japan's performance.

We do not intend to summarize this abundant literature.<sup>1</sup> Instead, we will discuss one neglected, but, in our view, very crucial feature of Japanese policies: that is, liberalization measures were taken according to announced schedules, and therefore, protection policies were expected to be temporary.

When Mr. Hayato Ikeda's government took office in 1960, the liberalization

of Japanese markets was one of the two pillars of his economic policies, along with the famous "National Income Doubling Plan." Originally as a response to pressures from abroad, particularly from the United States, the government published its "Boh-eki Kawase Jiyuka Keikaku Taikoh" (General Guideline for Liberalization of Foreign Trade and Exchanges) in June 1960. Although external pressures played an important role, the liberalization of Japanese markets and the shift to Article 8 status in the IMF and to Article 11 status in the GATT were also regarded as necessary steps towards the national goal of the era--to recover as quickly as possible from economic destruction in World War II, to achieve rapid economic growth and to obtain the recognition as an equal partner among advanced nations. Moreover, it was widely held (perhaps outside of the business community) that Japan, with her high dependency on imported raw materials, would benefit from the expansion of world wide free trade more than any other advanced nations. In fact, policymakers were apprehensive that the failure to liberalize Japanese markets would invite further discriminatory restrictions on Japanese imports into Europe, where fundamental liberalization measures had been taken in the late 1950s.

In this political and social environment, the opening of Japanese markets was considered unavoidable. Therefore, announcing schedules for liberalization was taken seriously and it greatly stimulated domestic investment. The tax system and government loan program also provided an additional stimulus. Investment for modernization was especially brisk in the automobile and machinery industries, where the fear of an influx of foreign products and capital was particularly strong. Moreover, in response to the rapid development of the mass consumer society, automobile and home electronic appliance industries increased investment in wholesale and retail facilities. By

mid-1960s, all major producers in these industries had completed their keiretsu distribution networks, i.e., the manufacturer-affiliated retail outlets.<sup>2</sup> This rapid capital expansion during the period immediately before the liberalization not only served as a locomotive of the high speed growth of the Japanese economy, but also rendered the Japanese markets impenetrable.

In summary, the announcement of detailed schedules of liberalization for each industry played two roles. On the one hand, it provided the domestic firms with some respite, during which they were able to accumulate their capital stocks. On the other hand, it proved the administration's strong commitment toward the liberalization, thereby stimulating investment.

We believe that this paper offers a theoretical explanation for the Japanese experiences described above. Section 2 briefly reviews the Spence model in the context of the questions addressed in this paper. Section 3 then investigates the effect of temporary and permanent protection on the dynamic performance of the market and the welfare implication of these policies. Section 4 discusses further implications drawn from the model, such as the dynamic inconsistency of temporary protection, the importance of locationally specific capital and the complementary roles of restriction and subsidization policies. Section 5 concludes the paper.

## 2. The Basic Model

The basic framework we utilize is the model introduced by Spence (1979) and further analyzed by Fudenberg and Tirole (1983). In this section we summarize their model in the context of the questions addressed in the present paper.<sup>3</sup>

We consider a market with two firms: one firm is domestic and the other is

foreign. The two firms compete in the domestic market. We assume that there is no essential interaction between the domestic market and foreign market. We thus omit foreign markets from our analysis. The two firms hold  $K(t)$  and  $K^*(t)$  units of capital at time  $t$ , where starred variables are always those of the foreign firm. At time zero, both firms start with no capital. Given the capital stocks  $K(t)$  and  $K^*(t)$ , there is instantaneous equilibrium in the product market, with associated net revenues (i.e., the total revenues minus operating costs)  $P=P(K(t),K^*(t))$  and  $P^*=P^*(K(t),K^*(t))$ . The instantaneous net revenue functions are the reduced forms of profits arising from short-run competition through prices or quantities. Implicit is the assumption that the choice of prices and quantities at each moment of time has no effect on the game later. This "black box approach" (Kreps and Spence (1985)) or "state space assumption" (Fudenberg and Tirole (1986)) permit us to ignore the product market and to focus on commitment via investment.

We further assume that  $P$  ( $P^*$ ) is differentiable, strictly concave in  $K$  ( $K^*$ ) and that:

$$(1) P_{K^*}, P_{KK^*}, P^*_K, P^*_{KK^*} < 0,$$

where the subscripts  $K$  and  $K^*$  denote partial differentiation with respect to  $K$  and  $K^*$ . Appendix provides justification for assumption (1).

The capital stocks of the two firms,  $K(t)$  and  $K^*(t)$  represent various tangible and intangible assets which are specific to the domestic market. Capital stocks that the foreign firm accumulates in foreign countries are not included in  $K^*(t)$ : they appear in our argument only through the functional forms of the net revenue functions and the investment technology introduced below. Specificity of the capital stocks to the market is a crucial assumption. A distribution and service network, consumer's habit formation and

producer's reputation are examples of capital specific to the domestic market.

Capital is assumed not to depreciate and thus capital stocks are non-decreasing. This assumption highlights the nature of early commitment by investment, which is the central issue in the following argument.

The costs of investment (new capital) of the two firms are given by the investment cost functions  $C(I(t))$  and  $C^*(I^*(t))$ , where  $I(t)$  and  $I^*(t)$  are the rates of investment at time  $t$ . It is assumed that each firm's rate of investment is bounded by  $\bar{I}$  and  $\bar{I}^*$ ; that is  $C$  and  $C^*$  take finite values only for  $0 \leq I(t) \leq \bar{I}$ , and  $0 \leq I^*(t) \leq \bar{I}^*$ . The change in the capital stocks is equal to investment at the time:  $\dot{K}(t) = I(t)$ ,  $\dot{K}^*(t) = I^*(t)$ . This investment technology is a simple way to capture the impossibility of infinite investment speed. The shapes of the investment cost functions do not play any essential role due to the assumption discussed below, and therefore they are not specified here. However, we will come back to this issue in section 4.c.

The domestic firm is assumed to maximize average profit defined as follows:

$$(2) \quad Y = \lim_{T \rightarrow +\infty} (1/T) \int_0^T \{P(K(t), K^*(t)) - C(I(t))\} dt.$$

The foreign firm maximizes the same function with relevant variables starred. There is no time discount in this objective function, which simplifies the analysis considerably without losing the essential points. (The case with discounting will be discussed in section 4.c.) Under this objective function each firm cares only about its profit in the steady state.<sup>4</sup> However, it is important to notice that the early investment path is crucial since it determines the positions of the two firms in the steady state.<sup>5</sup>

As pointed out by Fudenberg and Tirole (1983), there are many perfect-Nash equilibria in this type of model. However, all of these equilibria share one

common property: the investment race in the early stage determines the distribution of profits between the two firms in late stages. Since this property is adequate for our purpose, we deal only with the solution proposed by Spence (1979).

Figure 1 illustrates the Spence outcome when there is no governmental intervention. In this figure,  $K$  is plotted on the horizontal axis and  $K^*$  on the vertical axis. Curve  $R$  is the domestic firm's steady state reaction curve, which can be defined by the pair of  $K$  and  $K^*$  satisfying:

$$(3) P_K(K, K^*) = 0.$$

From assumption (1), it is easy to show that  $R$  is downward-sloping. Similarly, curve  $R^*$  is the foreign firm's steady state reaction curve defined by:

$$(4) P_{K^*}(K, K^*) = 0,$$

which slopes downward. As in the standard Cournot game, we assume that  $R$  and  $R^*$  have a unique intersection,  $C = (K_C, K^*_C)$ , and the absolute value of the slope of  $R$  is greater than that of  $R^*$ . Point  $S = (K_1, K^*_1)$  is the steady state Stackelberg equilibrium with the domestic producer being a leader. The domestic producer's profit is maximized at  $S$  along  $R^*$ . Point  $S^* = (K_2, K^*_2)$  is defined analogously. Given assumption (1), it is easy to show that  $K_1 > K_C > K_2$ ,  $K^*_1 < K^*_C < K^*_2$ ,  $P(S) > P(C) > P(S^*)$  and  $P^*(S) < P^*(C) < P^*(S^*)$ .

Line  $OA$  is what Spence called the "Industrial Growth Path". This line depicts the path of  $K(t)$  and  $K^*(t)$  when the two firms invest at their maximal speeds,  $\bar{I}$  and  $\bar{I}^*$ . The slope of this line is  $\bar{I}^*/\bar{I}$ . The figure is drawn in such a way that the foreign firm has a much higher maximum speed of investment than the domestic firm. This assumption is introduced to demonstrate our point in a dramatic way.

A capital expansion path of this economy takes the following form.



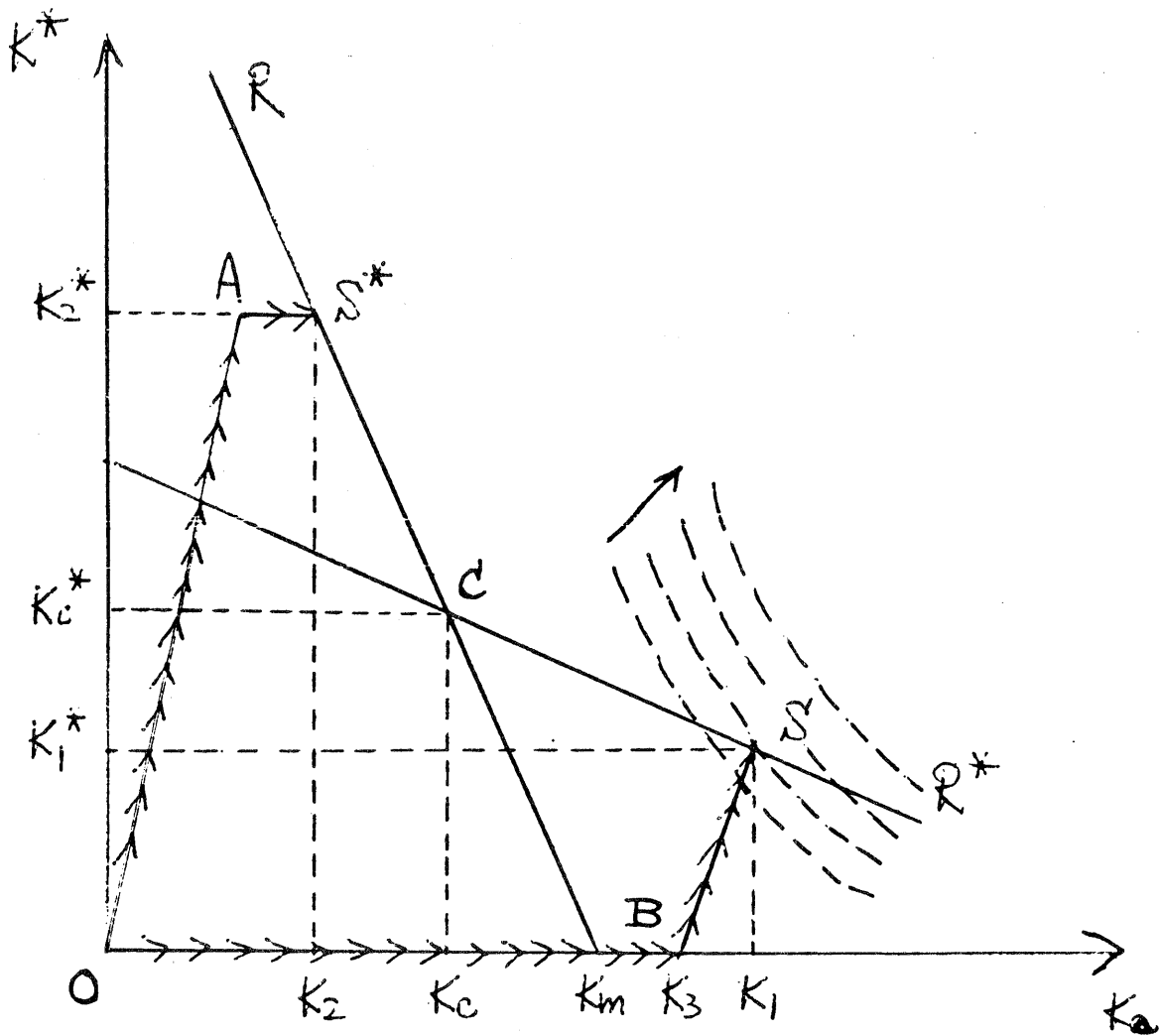


Figure I

Initially, both firms invest at their maximal speeds,  $\bar{I}$  and  $\bar{I}^*$ , and capital stocks follow path OA in the figure. Once its capital stock reaches  $K^*_2$ , the foreign firm stops investing, while the domestic firm continues to invest until point  $S^*$  is reached. The steady state of this game is the Stackelberg point with the foreign leader. The foreign firm's capital stock  $K^*_2$  far exceeds  $K^*_C$ , and the domestic firm's capital stock  $K_2$  comes short of  $K_C$ . The mechanism behind this result is clear. Due to its technological superiority, the foreign firm can accumulate capital stock faster than the domestic firm, providing the foreign firm with first-mover advantage. The foreign firm will invest beyond its Cournot point, thereby partially preempting the domestic firm's capital expansion.

### 3. Protection Policy

The dynamic path will be considerably different if the domestic government intervenes in the market in an early stage. Suppose that the government temporarily prohibits the foreign firm's operation in the domestic market. (The government intervention by subsidization on investment will be discussed in section 4.c.) Then, the foreign firm cannot accumulate capital stock during the period of protection and the domestic firm is given an opportunity to move first.

Suppose, for example, that the length of protection period is  $K_3/\bar{I}$ , where  $K_3$  is the domestic firm's capital stock level at B. Point B is taken in such a way that the slope of line segment BS is equal to  $\bar{I}^*/\bar{I}$ . Then, the domestic firm will accumulate capital stock at its maximal speed during the period of protection. When the protection period ends, the domestic firm has accumulated  $K_3$  units of capital stock. From point B the capital stocks of the two firms

will move along the industrial growth path BS up to point S, where the domestic firm takes the leader position.

If the length of the protection period is shorter than  $K_3/\bar{I}$ , the domestic firm cannot accumulate enough capital to reach S. The steady state ends up somewhere on SCS\*. When the length is longer than  $K_3/\bar{I}$ , the domestic firm can achieve S. An "excessively" long period of protection does not have any effect on the steady state, but the time required to reach it becomes longer.

On the other hand, if protection is permanent, the domestic firm accumulates up to the level  $K_M = \text{argmax}_K P(K,0)$  and stop investing. Whether temporary protection gives the domestic firm stronger or weaker incentive to expand its capacity than permanent one depends on the shapes of net revenue functions. (Figure 1 is drawn such that  $K_I > K_M$ , but this need not be the case.) This is because two offsetting effects are at work.

The first is the direct effect on profitability of capital determined at the instantaneous equilibrium in the product market. The presence of and competition with the foreign firm reduces the return on capital ( $P_{KK}^* < 0$ ). Therefore, the expectations of future removal of barrier have negative effect on investment by the domestic firm. However, this effect is not unique to dynamic oligopoly markets and relatively well understood. The second effect is related to strategic investment to deter the foreign firm from accumulating capital. Since the foreign firm's return on capital is smaller as the domestic firm accumulates more capital ( $P_{KK}^* < 0$ ), the domestic firm finds it advantageous to expand its capacity to deter the foreign firm as long as the future entry of the foreign firm is expected. Permanent protection eliminates this strategic motive of investment. Therefore, under this effect, temporary protection policy stimulates investment more than permanent protection policy.

Note that we have this result despite the assumption of zero discount rate, which may surprise those who have studied the standard investment theory, in which intertemporal substitution plays an essential role.<sup>6</sup>

The overall effect depends on the relative magnitude of these two effects. If the first effect dominates, the domestic firm accumulates more capital when protection is permanent ( $K_M > K_I$ ). If the second effect dominates, then temporary protection is a more effective way of promoting investment by the domestic firm than permanent protection ( $K_M < K_I$ ). In what follows, we will concentrate on the latter: the case which is unique to dynamic oligopoly markets.

Let us next discuss the welfare implication of the protection policy. We restrict ourselves to the domestic country's national welfare, not world welfare. First, we introduce  $V=V(K, K^*)$  representing the instantaneous consumer's surplus. As in the case of firms, we assume that social welfare function does not discount the future consumer's surplus. The national welfare level (denoted by  $W$ ) is then given by the sum of consumer's surplus and the domestic firm's net revenues in the steady state:

$$(5) \quad W = \lim_{T \rightarrow +\infty} (1/T) \int_0^T [P(K(t), K^*(t)) - C(I(t)) + V(K(t), K^*(t))] dt.$$

$$= P(K(+\infty), K^*(+\infty)) + V(K(+\infty), K^*(+\infty)).$$

Furthermore, it is reasonable to assume that  $W(K, K^*) = P(K, K^*) + V(K, K^*)$  satisfies:

$$(6) \quad W_K, W_{K^*} > 0,$$

for the relevant range, which implies that the social indifference curves are downward sloping in Figure 1. Appendix provides a justification for assumption (6).

We cannot derive any specific results about the welfare implication of protection policy unless some assumptions are introduced regarding the functional forms. However, we make the following general statement. Since the

domestic welfare consists of consumer's surplus and the domestic firm's profit, a shift of profit from the foreign firm to the domestic firm will contribute to an increase in the domestic welfare unless the shift of profit reduces consumer's surplus considerably.<sup>7</sup>

To illustrate this point, consider the following simple case. Suppose that the two firms are symmetric except for the speed limits of investment,  $I$  and  $I^*$ ; that is:

$$P(X,Y)=P^*(Y,X) \text{ and } V(X,Y)=V(Y,X) \text{ for all } X \text{ and } Y.$$

This condition implies that the two Stackelberg equilibria  $S$  and  $S^*$  are symmetric and consumer's surplus is the same at the two points. It is then obvious that the domestic welfare level is higher at  $S$  than at  $S^*$ , since the domestic firm's profit is larger at  $S$  than at  $S^*$ . Therefore, temporary protection, whose length is equal to or longer than  $K_3/\bar{I}$  is preferred to no intervention. This temporary protection is also superior to permanent protection, since higher levels of capital stocks are desirable ( $W_K, W_{K^*} > 0$ ). Protection should be temporary to promote investment by both firms.

#### 4. Discussions

The model presented above is simple but rich enough to suggest some new insights on the issue of infant industry protection policy. In this section we discuss implications drawn from the model.

##### a. Temporary versus Permanent Protection

The model demonstrates that the temporary nature of protection plays an essential role in stimulating investment by the domestic firm. If protection is permanent or believed to be so, the domestic firm may have weaker incentive to invest. If protection is credibly temporary, threat of future entry of

foreign firms induces domestic firms to accumulate their capital stocks during the protection period.

This investment promoting mechanism of temporary protection has been neglected in previous studies on protection policy. In the traditional literature, the argument for temporary protection is based on the technological assumption that dynamic external economies, which could justify protection policies, disappear once the industry becomes mature. For example, Corden (1974, p.256) discusses why protection should be temporary.

The temporary element can enter in three ways. (1) The learning may itself be temporary, being a characteristic of the firm's infancy period. (2) The imperfection of information or of the capital market, as these apply to the firm concerned, may be temporary: as the firm expands and its costs fall it may find it easier to finance further investments, whether in visible or invisible capital. (3) We may be constrained to the use of a tariff as a method of protection (the fiscal constraint ruling out direct or indirect export subsidization), so that the tariff could end once imports of the product have been completely replaced, and should end if the firm has monopoly power and above-normal profits are to be avoided.

Our analysis suggests an alternative rationale for temporary protection. Unlike the standard argument, however, it rests on the property of the equilibrium, which stresses commitment and expectations of the players of the game, rather than on the technological assumptions. Therefore, expectations of future removal of the barrier are the key factors in our argument, while the actual removal of the barrier is of secondary importance.

This brings us the question of the dynamic consistency of temporary protection.<sup>8</sup> Consider the temporary protection whose length is  $K_3/\bar{I}$ , which is ex ante optimal. Suppose that  $K_3$  is greater than  $K_M$  (as depicted in Figure 1). Then, this policy is dynamically inconsistent in the following sense. Suppose that the domestic firm simply ignores the announcement of future removal of barrier. Then the government would observe that the domestic firm does not

accumulate enough capital by the end of the protection period and would be tempted to postpone the liberalization. Since prolonged protection is not desirable, the government may prefer to commit to its original plan, if there is a way to make the commitment credible.<sup>9</sup>

This inherent inconsistency of temporary protection may provide a key to understand another possible reason why infant industry protection policies seemed to have worked in Japan while they have not in many developing countries. As already discussed in the introduction, the opening of Japanese markets was considered unavoidable. The political and social factors, which cannot be analyzed in formal models, were significant in this regard. There were strong external pressures from the United States, which worried about rapid increases in its balance-of-payments deficits. Discriminatory restrictions against Japanese imports into Europe were always looming to Japanese policymakers. Moreover, it was widely argued that the liberalization was inevitable for Japan to be treated as an equal partner among the advanced nations. On the other hand, the histories of economic policy in most developing countries are marred with abortive attempts in liberalization.<sup>10</sup> Political and social pressures to liberalize their markets have been weak in many cases. Indeed, there have been some pressures from the United States and from the IMF, but the nationalistic sentiments always countered against them. In some countries political instability also impaired the credibility of announcement of government policies. Under these circumstances, threat of future competition with foreign firms is ineffective and the domestic firms have no strong incentive to modernize their technologies and rationalize their operations.

#### b. Locationally Specific Capital

The assumption of locational specificity of capital plays an important

role in our argument. If capital is not locationally specific, temporary protection policy will not work well. In this case the foreign firm will accumulate capital in the foreign country, anticipating the future removal of the trade and investment barrier in the home country. The domestic firm, observing this capital accumulation, cannot take the leader position, since the foreign firm's capital accumulation in the foreign country is a credible commitment against the domestic firm.

Temporary protection is more effective when there is capital specific to the domestic market. As we have already mentioned, the assumption of locational specificity is not unrealistic for many manufactured products. Consumer's habit formation and producer's reputation are crucial intangible assets for most consumer products. A distribution and service network is also important for some products. These factors are particularly important in Japanese markets with keiretsu distribution networks and brand-conscious consumers. Locational specific capital in our model represents these types of tangible and intangible assets.

When locationally specific capital is critical for the sale of the product, restriction of direct investment becomes relevant. Without restricting direct investment, it is difficult to protect domestic firms. It is interesting to note that there is significant difference between Western Europe and Japan in protecting their automobile industries in the 1950s and 60s. In Western Europe, protective tariffs were imposed but direct investment was allowed, while in Japan the latter was severely restricted until the 70s. This difference in their stances about inward direct investment may explain the difference of the industrial structures in these two regions.



### c. Restrictions versus Subsidizations

So far we have assumed that, when the government intervenes, it simply restricts the foreign firm's operation in the domestic market. But restrictions are not the only policy tools available to the domestic government. Many countries introduce various types of subsidies to nurture their domestic infant industries, and perhaps for that reason, subsidies have attracted considerable attention in the protection policy literature.<sup>11</sup> It is thus useful to assess the relative merit of subsidization and restriction policies. Since investment is the firm's only activity explicitly considered in this paper, we will discuss investment subsidies only.<sup>12</sup>

In our model of no discounting, subsidies are ineffective and cannot alter the dynamic path of capital accumulation. Both domestic and foreign firms always invest at their maximal speed until they reach their steady state levels of capital stocks. Subsidies, unlike restrictions policies, are impotent because the firms are concerned only with their steady state positions. Only by restricting the foreign firm's operation, the government can affect the industry dynamics.

We obtain wider possibilities in a more general setting where the discount rate is positive and there is a trade-off between the short run and long run performances. Subsidization and restriction policies now have different effects on the dynamics. Subsidization will speed up the domestic firm's capital accumulation by reducing the effective marginal cost of investment. Restriction policies will give the domestic firm an opportunity to move first.

Subsidies are preferable to restrictions in one respect. The deadweight loss would be smaller under subsidization policies than under restriction policies, since consumers have access to foreign products under the former.

The case for subsidization is familiar in the standard argument on the second best commercial policies.

However, restrictions are preferable to subsidizations in other respects. Without restriction policies, the foreign firm may accumulate capital stock at a very high speed. Facing this foreign firm's expansion, the domestic firm is forced to raise its pace of investment. Although the domestic government can help the domestic firm speed up its expansion by subsidies, the social costs of this subsidization might be substantial when the cost of investment increases rapidly with the speed of investment. Restriction policies, on the other hand, allow the domestic firm to invest at a modest speed. If the slope of marginal cost of investment is steep, it would be desirable to use restriction policies instead of costly subsidization policies.

In general, both subsidization and restriction policies should be used in order to achieve a higher domestic welfare level. Restriction policies should be used so that the domestic firm need not accelerate the pace of investment unnecessarily. Subsidization policies should also be used to shorten the restriction period.

## 5. Concluding Remarks

Using Spence's (1979) model, we have shown how protection policies work in a dynamic oligopoly market. The model is simple but rich enough to suggest some new insights on infant industry protection, such as a) the investment promoting mechanism of temporary protection, b) the importance of locationally specific capital and c) the complementary roles of restriction and subsidization policies.

The traditional literature on infant industry protection cannot capture

these points. This is because the model on which traditional results are based cannot address the issue of a capital expansion race and the associated social cost. This racing feature in the early stage of a market is important for a deeper understanding of the issue of infant industry protection.

Furthermore, the model fits well with experiences in Japan, where:

- 1) Protection was temporary and credibly so.
- 2) During the period immediately before the liberalization, the speed of investment and output expansions were substantial.
- 3) When the barrier was removed, domestic firms had already accumulated a large amount of tangible and intangible assets, which make the Japanese markets impenetrable.
- 4) Unlike in Europe, not only the imports of products but also direct investment were severely restricted.

Although our model offers some theoretical explanations for "success" of Japan's industrial policy, we do not intend to advocate adopting a temporary protection policy. In fact, we believe that the case for interventionist trade policy presented here is limited and narrow. First, some criticisms made against the Brander and Spencer (1984,1985) type strategic trade policy can be also applied here: that is, the problems of how to "pick up winners" and of how to evaluate the costs and benefits and the danger of inviting foreign retaliation.<sup>13</sup> Second, some of the simplifying assumptions in the model might be responsible for the superiority of temporary protection. For example, instead of homogeneous capital assumption, suppose that there are two types of capital. Type A mainly contributes to production capacity, while type B mainly contributes to entry barriers. Then, compared to permanent protection, temporary protection would be more biased in stimulating investment in type B. Another

implicit assumption which favors temporary protection over permanent one is that entering the domestic market is the only choice available to the foreign firm. If the foreign firm can license its technology to the domestic firm, temporary nature of protection might discourage technology transfer from abroad. Finally, as argued before, the temporary protection might be dynamically inconsistent. Unless the government can make a credible commitment to future liberalization, any protection policy which is said to be temporary, might last indefinitely and the lack of competitive pressure might lead to industrial stagnation.

## Appendix

In this appendix, we provide some justifications for the assumptions made on  $P(K, K^*)$  and  $W(K, K^*) = P(K, K^*) + V(K, K^*)$ .

The simplest example is that the instantaneous equilibrium <sup>is</sup> Cournot given instantaneous costs, which are taken to be  $C(q, K) = cK$  for  $q \leq K$ ,  $= +\infty$  for  $q > K$ ,  $C^*(q^*, K^*) = c^*K^*$  for  $q^* \leq K^*$ ,  $= +\infty$  for  $q^* > K^*$ : that is, capital stocks function solely as capacity constraints. When both capacity constraints are binding, assumptions on  $P(K, K^*)$  and  $P^*(K, K^*)$  made in the text are nothing but the standard assumptions in the static Cournot model.

In order to discuss consumer's surplus, we assume that consumers have the utility function of the following form:

$$(A1) \quad U(q, q^*) + x,$$

where  $x$  is consumption of an outside good. The function  $U$  is increasing in both arguments, concave and satisfies  $U_{12} < 0$ : the domestic firm's product is a substitute for the foreign firm's. Prices are then given by:

$$(A2) \quad p = U_1(q, q^*), \quad p^* = U_2(q, q^*).$$

The concavity of  $U$  implies  $dp/dq = U_{11} < 0$  and  $dp^*/dq^* = U_{22} < 0$ . The assumption  $U_{12} < 0$  implies  $dp/dq^* = dp^*/dq = U_{12} < 0$ .

Given the capacity constraint model, consumer's surplus is given by:

$$(A3) \quad V(K, K^*) = U(K, K^*) + x_0 - pK - p^*K^* \\ = U(K, K^*) + x_0 - U_1(K, K^*)K - U_2(K, K^*)K^*,$$

where  $x_0$  is the domestic consumer's initial holding of the outside good. The net revenues of the domestic firm is given by  $P(K, K^*) = (p - c)K = (U_1(K, K^*) - c)K$ .

Therefore,

$$(A4) \quad W(K, K^*) = P(K, K^*) + V(K, K^*) = U(K, K^*) - cK - U_2(K, K^*)K^* + x_0,$$

which implies:

$$(A5) \quad W_K = U_1(K, K^*) - c - U_{12}(K, K^*)K^* = P(K, K^*)/K - U_{12}(K, K^*)K^* > 0,$$

and,

$$(A6) \quad W_{K^*} = U_2(K, K^*) - U_2(K, K^*) - U_{22}(K, K^*)K^* = -U_{22}(K, K^*)K^* > 0,$$

since  $U_{12}, U_{22} < 0$ . The logic underlying (A5) and (A6) is easy to grasp. Given  $K^*$ , a higher  $K$  and therefore a higher output by the domestic firm is desirable ( $W_K > 0$ ) for two reasons. First, the monopoly power of the domestic firm leads to an underproduction ( $U_1 > c$ , or  $P > 0$ ). An increase in the domestic firm's output reduces the deadweight loss due to the monopoly power. Second, it lowers the price of the foreign product ( $U_{12} < 0$ ), thereby transferring surplus from the foreign firm to the domestic consumers. Given  $K$ , a higher  $K^*$  and therefore a higher output by the foreign firm is also desirable ( $W_{K^*} > 0$ ). It lowers the price of the foreign product ( $U_{22} < 0$ ), thereby increasing the domestic consumer's surplus. It also reduces the price of the domestic firm's product, but, given the domestic firm's output constant, this simply redistributes surplus from the domestic firm to the domestic consumers, and therefore, has no effect on the total national welfare. This justifies assumption (6).

If one further assume that two products are homogeneous, then the slope of social indifference curve is (in absolute terms) greater than the foreign reaction curve between  $C$  and  $S$ : that is, an increase in  $K$  along  $R^*$  improves the national welfare. This can be proved as follows. First, an increase in  $K$  along  $R^*$  increases the domestic firm's profit until  $S$  is reached. Second, under the homogeneity assumption, it also increases the domestic consumer's surplus because the slope of  $R^*$  is less than one.

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Footnotes:

1. Komiya, Okuno and Suzumura (1984) is the most informative sources on Japan's industrial policies. For recent industrial policy debate in the United States, see Bluestone and Harrison (1982), Reich (1983) and Thurow (1980) for advocates' views and Krugman (1984), Lawrence (1984), Schultze (1983) and U.S. Council of Economic Advisers (1984) for critical views.
2. For emergence of the mass consumer society in Japan and development of keiretsu distribution networks, see Yoshino (1971, Chs.2 and 3).
3. See Fudenberg and Tirole (1983,1986) for details of the analysis of the model.
4. We assume that the two profit functions take their maximum values at some finite levels of  $K$  and  $K^*$ . Coupled with non-decreasing capital stocks, this assumption guarantees that the dynamic game has a steady state.
5. In other words, this model has multiple steady states and competition in the early stage determines which steady state will be reached along the equilibrium path.
6. See Abel (1979) for an example of the standard discussion on the effects on temporary and permanent policies on investment. In the standard framework, any temporary policy has no effect on the steady state and therefore, on investment if the discount rate is zero and the firm cares only about the steady state. Our framework differs in that there are multiple steady states. Temporary policies have long run impact even with zero discount rate by affecting which steady state will be reached.
7. Brander and Spencer (1984,1985) first argue for the government intervention on the ground of "profit shifting" in a static game framework. Eaton and Grossman (1986) criticize Brander and Spencer's argument by showing that their conclusion crucially depends on the choice of strategic variables, which implicitly determines the firm's conjecture on the competitor's response. In a dynamic game framework like ours, however, the choice of strategic variables is straightforward and less problematic.
8. Kydland and Prescott (1977) first discusses the dynamic inconsistency of the optimal plan in the context of macroeconomic policy.
9. This statement on the dynamic consistency is not based on a rigorous analysis and it is no more than just a story. A further investigation on this issue is highly desirable. In order to do so, one need to construct a sequential game in which the strategy space of the government as well as that of the domestic firm are carefully specified.
10. See Krueger (1978).

11. In Japan, low interest rate loans by Japan Development Bank and special depreciation provisions were often used to reduce the cost of capital for emerging industries. However, only a small share of government subsidies (1 or 2 percent) go to these industries, while the agriculture sector benefits most (80-90 percent). See Ogura and Yoshino (1984) for the role of the tax system and government loan program in Japan's industrial policy.

12. Brander and Spencer (1985) and Eaton and Grossman (1986) discuss export subsidies in a static framework. Our blackbox approach does not allow us to deal with export subsidies and tariffs explicitly in our analysis.

13. See Grossman (1986) for a critique on the strategic trade policy of Brander and Spencer (1984,1985) variety.