86-F-4

Welfare Enhancing Export Subsidies

by

Motoshige Itoh

and

Kazuharu Kiyono

The University of Tokyo

May 1986

PREPARED UNDER
THE PROJECT ON APPLIED ECONOMICS
RESEARCH INSTITUTE FOR THE JAPANESE ECONOMY

Abstract

This paper shows that export subsidies on marginal goods and those on non-marginal goods have opposite welfare effects for the country imposing these subsidies, where marginal goods are the ones that would be exported by only a small amount or not at all under free trade but whose export can be promoted considerably by export subsidies: The former enhances the imposing country's welfare, while the latter worsens it. The paper also throws light on related issues such as industrial targeting policy.

Welfare Enhancing Export Subsidies

by

Motoshige Itoh and Kazuharu Kiyono

The University of Tokyo

I. Introduction

The role of subsidies in export industries has attracted considerable interest among economists in recent years. This might be due partly to the acknowledged success of Japan where an export promotion policy has played such an important role. There are several cases in which export promotion policy can be justified from the viewpoint of national (but not international) welfare.

First, as pointed out by Spencer and Brander [1983], export subsidies may improve national welfare when the export-subsidized commodity is supplied under international oligopolistic conditions.[1] Here, gains from export subsidies result from a shift of the oligopolistic profit from foreign to domestic firms. Second, subsidizing the export of a commodity which is produced under increasing returns to scale may enhance the country's economic welfare. In this case the social return from expanded output of the industry may exceed the private return. Third, when there is a large number of unemployed workers in the economy due to wage rigidity or some other type of distortion, production expansion induced by export subsidies may increase employment and thereby improve the country's economic welfare.

However, without these special conditions justifying an export subsidy policy in the standard model is not easy. In fact, it seems to be a

well-established fact that export subsidies always reduce a country's economic welfare in a competitive economy with full price flexibility.

The present paper shows that, contrary to the above presumption, a certain type of export subsidy policy does improve the country's economic welfare even under perfect competition with full price flexibility. Our result is based on a model of more than two goods, which captures various features of the trade structure lost in the standard two-good trade model. Subsidizing exports in the standard two-good trade models is equivalent to uniform export subsidy in many-good trade models. Obviously, a uniform export subsidy (imposing the same export subsidy rate on all exported goods) worsens or at best does not change the country's terms of trade. Therefore, it lowers the country's trade welfare level.

However, if export subsidies are not uniform, they do not necessarily damage the country's terms of trade. In fact, we can prove that when export subsidies are concentrated in marginal goods, the country's economic welfare level actually rises. We define marginal goods as goods that are not exported at all or are exported only in small amounts under free trade but whose export can be promoted considerably by export subsidies.

Export subsidies on non-marginal goods and those on marginal goods have opposite welfare implications for the export-subsidizing country. The welfare implications of the two types of export subsidies are different because of their differing effects on the country's production structure: the former expands the supply of non-marginal goods solely supplied by the subsidizing country in the world market, while the latter contracts the supply of those goods. Owing to its monopolistic position for those goods, the former worsens the country's terms of trade while the latter may improve it.

Our analysis --based on the model of a continuum-of-goods à la Dornbusch-Fischer-Samuelson [1977]-- also shows that these distinct welfare effects of export subsidies are related to the two roles that export subsidies can play: expanding the export volume of the goods that would be exported even under free trade, and expanding the set of export goods by turning marginal goods into exportables. In fact, we can show that in a continuum-of-goods model export subsidies improve the subsidizing country's economic welfare only when they expand the set of export goods. The traditional literature often neglects this second role of export subsidies since the trade pattern is often assumed to be unaffected by trade and industrial policies. For example, in the standard two-good trade model, one good is called an export good and the other an import good, and the role played by each good is not affected by export subsidies at all.

Our findings on export subsidies also provide some insights into the following related issues. One issue is that of so-called industrial targeting policy.[2] Under this policy, the government gives substantial protection to a limited number of industries. In most cases, the industries are those not well-established but have great potential to be leading export industries. Our findings with respect to export subsidies provide one possible explanation of how such industrial policies may enhance a country's welfare.[3]

Another related issue is that of equivalence between export subsidies and import taxes. On the one hand, academic economists often argue that export subsidies and import taxes have opposite effects on economic welfare. Lerner's symmetry theorem (Lerner[1936]) deals with this point though the theorem holds only in the case of uniform taxes and subsidies. On the other hand, businessmen often believe that the two policies have a qualitatively

similar impact on the national welfare; their beliefs are sometimes based on the crude idea that both policies protect domestic producers. Krugman [1982] presented an interesting argument which contends that the two policies may have a similiar economic effect in the presence of scale economies. Our findings with respect to export subsidies also explain the intuitive similarity between the two policies: we can show that both export subsidies and import taxes on marginal goods improve the country's economic welfare.

The organization of the paper is as follows. In section II we present a simple example in which an export subsidy improves the national welfare. The example is based on a three-goods trade model, which is quite special but useful for understanding the basic mechanism in its simplest form. In section III we characterize welfare-improving export subsidies in the more general framework of a continuum-of-goods trade model. Based on that model, in section III-1 we analyze which types of export subsidies improve economic welfare, and in section III-2 which types worsen it. In sections III-3 and -4, we discuss some issues related to our basic findings with regard to export subsidies: the industrial targeting policy and the similarity between export subsidies and import taxes. Finally, a brief summary is provided in section IV.

II. Welfare Improving Export Subsidies: A Three-Goods Case[4]

The essence of our argument can be illustrated in a simple two-country, three-goods Ricardian trade model. Suppose that there are two countries, the home and the foreign countries, and three goods, goods 1, 2, and 3. The production technology of this Ricardian economy can be represented by labor

requirement coefficients of the three goods in the two countries. Let a_i and $a_i^*(i=1,2,3)$ respectively represent the amount of labor required to produce one unit of good i in the home country and the amount required in the foreign country. (All variables of the foreign country are starred.) The goods are numbered so that the smaller the subscript number the greater is the home country's comparative advantage in the production of the good concerned:

(1) $$a_1^*/a_1 > a_2^*/a_2 > a_3^*/a_3$$

It is assumed that each country has an inelastic supply of labor. We measure the unit of labor in each country in such a way that the amount of the total labor supply is unitary in each country.

As for the demand side, we assume simple Cobb-Douglas utility functions such as

(2) $$U=\sum_{i=1}^{3} \delta_i \cdot \ln c_i$$

(3) $$U^*=\sum_{i=1}^{3} \delta_i^* \cdot \ln c_i^*,$$

where c_i and c_i^* are the consumption amounts of good i in the two countries, U and U^* are the utility levels, ln is the natural logarithm operator, and δ_i and δ_i^* are parameters satisfying

$$0 < \delta_i, \ \delta_i^* < 1, \ \sum_{i=1}^{3} \delta_i = \sum_{i=1}^{3} \delta_i^* = 1,$$

where δ_i and δ_i^* represent expenditure shares on good i in the two countries. The indirect utility (welfare) function of the home country can be then derived as follows.

(4) $$U = A + \ln y - \sum_{i=1}^{3} \delta_i \cdot \ln p_i ,$$

where $A = \sum_{i=1}^{3} \delta_i \cdot \ln \delta_i$, y is the national income level, and p_i is the price of good i. A similar indirect utility function can be derived for the foreign country.

Under the above setting various patterns of specialization and trade can arise. However, it is not the purpose of this section to spell out all these possibilities. We thus assume that various parameters take values so that the home country produces goods 1 and 2 and the foreign country produces goods 2 and 3.[5]

Assume now that the home government places ad valorem export subsidy (the subsidy rate is denoted by s) on good 2. It should be noted that two-way trade occurs if the home government imposes only an export subsidy on good 2. The home consumers will then purchase from the foreign producers and the home producers will sell only to the foreign consumers. To avoid this two-way trade problem, we assume that the home government imposes a prohibitively high import tariff on good 2 at the same time.[6] This assumption is only for the sake of simplifying our later analysis, The subsidy is assumed to be financed by a lump-sum tax.[7]

The equilibrium conditions under the export subsidy can be summarized by the following equations:

(5) $$w/w^* = [1/(1-s)] \cdot (a_2^*/a_2),$$

(6) $$w/w^* = y/y^* + zm^*,$$

(7) $$y/y^* = (\delta_1^* + m^*)/\delta_3,$$

where $z=s/(1-s)$, w and w^* are the wages in the home and the foreign country, y and y^* represent the national income levels of the two countries, and m^* is the ratio of the foreign country's import of good 2 to its income level (the foreign country's average propensity to import good 2). We assume that the export subsidy rate s is not so high that the foreign country produces good 2. We also assume that the home country is not an importer of good 2 under free trade; that is, $a_2^*/a_2 \geq \delta_1^*/\delta_3$.

Let us now spell out the implications of these three equations. Equation (5) implies that the production costs of good 2 is the same in both countries. Since both countries produce good 2, the relative wage w/w^* must be adjusted so that the supply prices of good 2 are equalized for both home and foreign producers in the international market. (Note that price is equal to production costs due to the assumption of perfect competition.) Equation (6) describes the relation between the relative wage (the factorial terms of trade) w/w^* and the relative income y/y^*: the relative income is equal to the relative wage minus the export subsidy expense measured in the unit of the foreign wage (the term zm^*). Equation (7) is the trade balance condition. The value of imports can be expressed as the product of income and the average propensity to import. This equation is easily derived by noting that δ_3 and $\delta_1^*+m^*$ respectively stand for the home and the foreign propensity to import.

In equations (5)-(7) we have three endogenous variables, the relative wage w/w^*, the relative income y/y^*, and the foreign average propensity to import good 2, m^*. It is easy to verify that these variables can be uniquely

solved, as long as the value of s is not so high that the pattern of specialization changes.

Let us now examine how an infinitestimal increase in the subsidy rate s affects the home country's welfare level through changes in the three endogenous variables. We can easily derive the following:

(8) $d(w/w^*)/ds=(a_2^*/a_2)/(1-s)^2>0$,

(9) $dm^*/ds=[(a_2^*/a_2)-m^*]/[(1-s)^2\cdot(z+1/\delta_3)]$,

(10) $d(y/y^*)/ds=(1/\delta_3)(dm^*/ds)>0$,

(11) $dU/ds|_{s=0}=[\delta_3\cdot(a_2^*/a_2)-m^*]/(w/w^*)>0$.

Thus, a small amount of an export subsidy on good 2 raises the home country's welfare level. Note that $\delta_3\cdot(a_2^*/a_2)-m^*=(\delta_3 w-m^* w^*)/w^*>0$ follows from the trade balance condition $\delta_3 w=(\delta_1^*+m^*)w^*$ at the free trade equilibrium point.[8]

A similar result may be obtained for a production subsidy on good 2. Suppose that the home government imposes an ad valorem production subsidy (the subsidy rate is denoted by s') on the production of good 2. Then, the following result can be derived as in the case of export subsidies.[9]

(12) $dU/ds'|_{s'=0}=[\delta_3\cdot(a_2^*/a_2)-m^*]/(w/w^*)$,

which is identical to (11).

In standard two-good trade models, export subsidies always lower a country's welfare level since they lead to deterioration in the terms of trade. However, the point of the above exercise is that this result cannot

be extended in a straightforward manner to trade models with more than two goods. To see this, suppose that a country is exporting more than two goods and that the government subsidizes exports of only one of these goods. Then, although the external relative price of that particular good in terms of other goods falls, it does not necessarily imply that the country's overall terms of trade deteriorates. Quite possibly, the relative price of the other export good in terms of the import good will rise. In our simple example, the external price of good 2 falls relative to the price of good 1 but stays constant relative to the price of good 3. At the same time, the relative price of good 1 (another export good of the home country) in terms of good 3 moves in a direction that favors the home country. Thus, the terms of trade of the home country improve rather than deteriorate as a result of the subsidy.

It is not surprising to see that non-uniform export subsidies improve a country's welfare in a many-good economy.[10] However, characterizing the types of export subsidies which will actually improve the country's economic welfare is not easy. Our simple example in this section suggests an answer to this question.

Export subsidies on good 1 (a non-marginal good) and on good 2 (a marginal good) have opposite effects on the production pattern of the home country: the former expands the production of good 1, while the latter contracts it. Since the home country has monopoly power in the world market of good 1, the former turns the terms of trade against the home country. Furthermore, export subsidies on good 2 force some of the foreign producers who would produce good 2 under free trade to produce good 3. This shift in foreign factors of production from the good 2 industry to the good 3 industry causes a fall in the price of good 3 through its output expansion.

This is the mechanism through which export subsidies on marginal goods improve the country's terms of trade.

III. Welfare Improving Export Subsidies in a Continuum-of-Goods Trade Model

III-1. The Model

In this section we analyze the welfare effects of export subsidization in a continuum-of-goods, two-country, Ricardian trade model à la Dornbusch-Fischer-Samuelson [1977]. Goods are now indexed by a real number n on the closed interval [0,1] on the real line. The labor requirement coefficients of good n in the home and foreign countries are denoted respectively by a(n) and $a^*(n)$. The index n is ordered so that

(13) $\alpha(n) = a^*(n)/a(n)$

is a decreasing function of n. In other words, the goods are indexed so that the home country has a comparative advantage in the production of goods with smaller n. We also assume for expository simplicity that $\alpha(n)$ is a strictly monotone-decreasing differentiable function of n over the interval.[11]

We assume that a fixed amount of labor is supplied in each country. Total labor supply in each country is by normalization set equal to one.

We assume that all consumers in the home country have identical utility functions of the Cobb-Douglas type. This utility function, identical to the home country's welfare function, can be written in its logarithmic form as:

(14) $U=\int_0^1 \delta(n)\ln c(n)dn,$

And similarly for the foreign country, we assume the following utility function:

(15) $U^*=\int_0^1 \delta^*(n)\ln c^*(n)dn,$

where $c(n)$ and $c^*(n)$ are the amounts of consumption of good n in the two countries, and $\delta(n)$ and $\delta^*(n)$ are the parameters of the utility fucntions which represent the expenditure shares on good n. We thus have:

(16) $\int_0^1 \delta(n)dn=\int_0^1 \delta^*(n)dn=1.$

It is easy to derive the following indirect utility functions that correspond to (14) and (15):

(14)' $V(\{p(n)\},y)= \int_0^1 \delta(n)\ln\delta(n)dn - \int_0^1 \delta(n)\ln p(n)dn + \ln y$

(15)' $V^*(\{p^*(n)\},y^*)= \int_0^1 \delta^*(n)\ln\delta^*(n)dn - \int_0^1 \delta^*(n)\ln p^*(n)dn + \ln y^*$

where $p(n)$ and $p^*(n)$ are the prices of good n in the home and the foreign country, and y and y^* are the income levels of the home and the foreign country.

Let us now introduce export subsidies into the above system. Throughout the following analysis we assume that the foreign country imposes no taxes or subsidies. When the home government imposes an ad valorem export subsidy rate $s(n)$ (when negative it indicates a tax) on good n, we have:

$$p(n)=p^*(n)+s(n)p(n)$$

or, equivalently,

(17) $$p(n)=[1+z(n)]p^*(n),$$

where

$$z(n)=s(n)/[1-s(n)].$$

Here, as in the previous section, we assume that the home government imposes a prohibitively high import tariff, when necessary, to avoid two-way trade.[12]

We are now prepared to write down the equations characterizing trade equilibrium between the home and the foreign country. Corresponding to (5), (6) and (7) in the previous section, we have the following three equations;

$$(18) \qquad w/w^* = [1/(1-s(N))] \cdot [a^*(N)/a(N)]$$

$$(19) \qquad w/w^* = y/y^* + \int_0^N z(n)\delta^*(n)dn$$

$$(20) \qquad y/y^* = [\int_0^N \delta^*(n)dn]/[\int_N^1 \delta(n)dn],$$

where endogenous variables are w/w^*, y/y^* and N. (N is the index of the marginal good, the meaning of which will be explained below.) Equation (18), which corresponds to (5), implies that the unit production costs for the marginal good are the same for the home and the foreign country. The marginal good is here defined as that good located on the boundary between each country's set of export and import goods. Specifically, N, the index of the marginal good satisfies;[13]

$$(21) \qquad w/w^* \leq [1/(1-s(n))] \cdot [a^*(n)/a(n)] \text{ for } n \leq N,$$

$$(22) \qquad w/w^* > [1/(1-s(n))] \cdot [a^*(n)/a(n)] \text{ for } n > N.$$

We assume that when (21) is satisfied with equality, the good is exported from the home country to the foreign country. This assumption simplifies the exposition substantially, but it does not change the essential character of the following results.

Equation (19), which corresponds to (6), indicates the relation between the relative wage w/w^* and the relative income y/y^*. When an export subsidy

schedule {s(n)} is imposed, the subsidy expense for the home government becomes

$$\int_0^N z(n)\delta^*(n)dn \cdot w^*$$

Eauation (19) can be derived by noting that income is equal to the wage minus the subsidy expense. Finally, equation (20), which corresponds to (7), is the trade balalance condition. Note that the denominator of the right hand side of (20) is the home country's average propensity to import, and the numerator is the foreign country's average propensity to import. This equation implies that the relative income y/y^* increases with N; that is, the higher the value of the index N of the marginal good, the larger the home country's relative income. This relation between the relative income and the trade pattern between the two countries plays a central role in the following argument.

Figure 1 illustrates the equilibrium value of w/w^* and N determined by (18)-(20). The curve BB', which we call the "supply wage schedule", corresponds to equation (18). It is negatively sloped, since the lower the value of w/w^*, the larger N becomes (i.e., the home country exports a larger number of goods). The upward-sloping curve AA' is derived from (19) and (20). We call this curve the "demand wage schedule". As we have already explained when we discussed equation (20), the home country's relative income y/y^* becomes larger as the foreign (home) country imports more (less) of the home (foreign) good, where "more" and "less" are defined in terms of the size of the average propensities to import. The positively sloped demand wage schedule can then be derived by noting that w/w^* is given as the sum of y/y^* and the second term on the right hand side of (19) (i.e., the term

representing the subsidy expense). Trade equilibrium between the two countries is depicted by the intersection of the two curves.

III-2. Main Theorems

Let us characterize which types of export subsidies improve the home country's economic welfare and which types reduce it. Our first result is summarized as follows:

Proposition 1 The tax-subsidy schedule $\{s(n)\}$ on export goods lowers the home country's welfare when $s(n)=0$ for $n\in(N_0,1]$ and

(23) $\int_0^1 [s(n)/\{1-s(n)\}]\delta^*(n)dn > 0$,

where N_0 is the index of the marginal good under free trade.

Proof. See the Appendix.

This proposition generalizes the traditional result of the welfare impact of export subsidies. Note that $z(n)(=s(n)/[1-s(n)])$ is positive when exports of good n are subsidized and negative when taxed. Thus, the condition (23) means that the export subsidy rates $z(n)$ weighted by the foreign country's expenditure share $\delta^*(n)$ sum up to be positive. Put another way, export goods under free trade are subsidized on average. Needless to say, if export goods are never taxed but only subsidized, the condition (23) always holds. Thus, the proposition includes the following statement: "export subsidies always worsen the home country's economic welfare as long

as they are imposed only on the good exported even under free trade". A uniform subsidy schedule on $[0,N_0]$ is a special case of this.

Although we prove this proposition in the Appendix, it is worthwhile to present a brief explanation of why it holds. It will also give the reader some insight into what types of export subsidies improve the home country's economic welfare. We restrict our argument to the case where s(n) is non-negative; i.e., no tax is imposed on the export of any good. (See the Appendix for the general case.)

It is useful to rewrite the home country's indirect utility function (14') in the following way:[14]

$$(14)'' \qquad V=A-[\ln(w/w^*)-\ln(y/y^*)]\int_0^N \delta(n)dn+\ln(y/y^*)\int_N^1 \delta(n)dn,$$

where

$$A=\int_0^1 \delta(n)\ln\delta(n)dn-\int_0^N \delta(n)\ln a(n)dn-\int_N^1 \delta(n)\ln a^*(n)dn.$$

Equation (14)" indicates that the home country's economic welfare is essentially determined by two variables, namely the relative income y/y^* and the ratio of the relative wage to the relative income $(w/w^*)/(y/y^*)$.[15] The home country's welfare level rises with relative income y/y^*, since a higher y/y^* allows home consumers to purchase larger amounts of foreign goods. Note that the coefficient of the term $\ln(y/y^*)$ in the indirect utility function is the home country's average propsensity to import. The home country's utility level falls as the term $\ln(w/w^*)-\ln(y/y^*)$ becomes smaller, since a higher value of w/w^*relative to y/y^* implies higher prices of the home goods for home consumers. Note that the coefficient of this term in the indirect

utililty function equals the home consumers' average propsensity to consume the domestically produced goods.

Figure 1 describes how a change of export subsidy schedule affects the equilbrium pair of the marginal good N and the relative wage w/w^* under free trade. This schedule has the properties stated in Proposition 1. Let AA' and BB' depict the demand and the supply wage schedule under free trade. If any export subsidy schedule is imposed, the two curves shift. The demand wage shcedule AA' shifts upward by the amount $\int_0^N z(n)\delta^*(n)dn$ for each N (See (19)). The supply wage schedule also shifts upward for each N by an amount proportional to the export subsidy on the good, but it does not shift at any point where index is larger than N_0. The dotted curves in the figure illustrate the way the two curves shift. It is now apparent that as a result of the export subsidy, the relative wage w/w^* rises, yet relative income y/y^* falls or at most does not change. Thus, the home country's welfare level declines.

In our model the elasticity of substitution in consumption is one. so the home country's relative income y/y^* increases if and only if the set of goods it exports becomes larger; that is, unless N increases, y/y^* does not increase. However, the type of export subsidies described in Proposition 1 cannot expand the set of the home country's export goods, since subsidies are imposed only on the goods that would be exported even under free trade. To improve the national welfare, an export subsdiy schedule must be designed so as to expand the set of the home country's export goods. In terms of our model, the export subsidy schedule must increase the index of the marginal good.

Figure 2 illustrates a typical form of an export subsidy schedule that improves the national welfare. The curves AA' and BB' in the figure are the demand and the supply wage schedule under free trade. The kinked curve $BB_1B_2B_3B'$ depicts the supply wage schedule under the export subsidy schedule of concern here. This curve indicates that exports of the goods n ($N_1 < n \leq N_2$) are subsidized. The vertical distance between $BB_1B_2B_3B'$ and BB' represents the amount of subsidy on each good. The subsidy schedule is designed so that the index N of the marginal good is raised in the most efficient way from the view point of the national welfare. As proved in Proposition 1, any excessive export subsidy lowers the home country's utility level. The subsidy rates must be kept at the smallest amounts just sufficient for making all goods $n(\leq N_2)$ be exported.

We can prove the following proposition concerning the type of export subsidy schedule illustrated in Figure 2.

Proposition 2 By introducing the export subsidy shcedule as shown in Figure 2, the home government can achieve a higher welfare level than that under free trade.

Proof. See the Appendix for the exact specification of the subsidy schedule and the proof.

The proof of this proposition essentially goes as follows. Suppose that the home government imposes an infinitesimally small export subsidy on the marginal goods and those goods which almost qualify of such home country

(see Figure 2). An expansion of the set of export goods by an export subsidy shrinks the home country's supply of non-marginal export goods. Furthermore, foreign producers are forced to produce a smaller set of goods, and therefore the foreign output of these goods is expanded. Both of these effects contribute to the increase in the home country's relative wage w/w^*.

As compared with the above positive welfare impact of the export subsidy, the social cost of the subsidy is much smaller as long as the subsidy rate is low and restricted only to marginal goods. Note that the cost of the subsidy, (which is the same as the social cost of the subsidy), is equal to the product of the (average) amount of the subsidy of each good and the measure (number) of goods on which the subsidy is imposed. As long as the subsidy schedule is designed so that it raises N only by an infinitesimally small amount, both the subsidy rate and the measure (number) of the goods subsidized will be very small. The cost of the subsidy, which is essentially the product of these two amounts, therefore far exceeds the positive welfare impact of the subsidy.[16]

III-3. Industrial Targeting Policy

As we have seen above, export subsidies improve the home country's economic welfare only when they are imposed on the marginal industries. This characterization of welfare-improving export subsidies is related to the problem of industrial targeting policy. The essence of the industrial targeting policy can be illustrated by the following simple problem. Suppose that the government can pick a small number of industries, say the industries with indices $[m-\varepsilon, m+\varepsilon]$, where $\varepsilon>0$ is a very small number, and that it can improve labor productivity in these industries by spending a

certain fixed subsidy for R&D activities. Suppose that the levels of ε, X and the amount of the subsidy for R&D are given exogenously, but that the government can freely choose m -- that is, the industries that it provides with the subsidy. (Assume that the production and consumption structure of the economy is identical to the model presented in Section II-1 except for the above points.)

If the government selects for subsidization non-marginal export industries, the resulting technological improvement of these industries will not change the relative wage w/w^*, the relative income y/y^* nor the index N of the marginal good.[17] Thus, both the home and the foreign country gain from the technological improvement in the form of cheaper prices for the goods whose productivity rose.

When the government targets the marginal industries for subsidization, then the home country's factorial terms of trade will improve. The home country will gain from the technological improvement not only in the form of a fall in the price of the goods which are subsidized, but also and more importantly in the form of a fall in price of all imported goods. The foreign country may suffer a loss in this case. Technological improvement arising in the marginal industries has a substantial income redistributional effect between the home and the foreign country through a change in the factorial terms of trade. Thus, if the home country can freely choose industries for subsidization in order to maximize its welfare, it should choose marginal industries.

Technological improvement and export subsidization have a common character: both affect the relative competitive position of the home and the foreign producers. Thus, the export subsidy also has the feature that we discussed above with respect to a technological improvement; export

subsidies on marginal industries will cause an income reditribution effect, as a result of which the home country's utility level rises.

III-4. Similarity between Export Subsidies and Import Taxes

In the model discussed above the roles played by export subsidies and import tariffs were not clearly distinguished. When export subsidies were introduced to improve the national welfare, a prohibitive import tariff was introduced at the same time in order to avoid two-way trade. (However, as shown in Section II, the government can avoid the two-way trade problem by using a production subsidy rather than an export subsidy.) Two-way trade does not occur when transport costs are large relative to the subsidy rate.

By considering a model with non-zero transport costs, we can obtain a result which suggests a similarity between export subsidies and import taxes. Although we do not present a complete analysis of the model with transport costs, the basic mechanism of the model can be discussed by analogy with our previous analysis. (See Itoh and Kiyono [1983] for a more detailed analysis of a model with transport costs.)

Suppose that, as in the "iceberg" model of Samuelson [1954] and Dornbusch, Fischer and Samuelson [1977], transport costs force a decline (or "shrinkage") in the value of goods exported. We assume that the shrinkage rate is identical for all goods and the same for shipments in either direction.[18] In other respects, the structure of the model is identical to that in Section III-1. As Dornbusch et. al. [1977] showed, the goods can then be grouped into three categories; first the set of the home country's export goods $[0,N_1]$, whose export prices from the home country are lower than the foreign production costs, second the set of non-traded goods

$[N_1, N_2]$, whose export prices from each country are higher than the domestic production costs of the other country, and third the set of the home country's import goods $[N_2, 1]$, whose export prices from the foreign country are lower than the home country's domestic production costs.

The relative income of the home country is then given by

$$(24) \qquad y/y^* = [\int_0^{N_1} \delta^*(n)dn]/[\int_{N_2}^1 \delta(n)dn].$$

Thus, the essential structure of the model is the same as our previous model except that we have two types of marginal goods, N_1 and N_2; that is, the marginal good between export goods and non-traded goods and the one between non-traded goods and import goods. Relative income y/y^* becomes an increasing function of N_1 and N_2; an increase in N_1 raises the foreign country's average propensity to import, while an increase in N_2 lowers the home country's average propensity to import -- both of which increase y/y^*.

The home government now has two indices, N_1 and N_2, to manipulate by trade policies. Export subsidies on the first marginal good, N_1, raise N_1 by changing some non-traded goods to export goods, while a prohibitive import tariff on the second marginal good, N_2, increases N_2 by changing some import goods to non-traded goods. It can be easily shown that the two policies have qualitatively the same effect on the home country's welfare. Note also that two-way trade is not caused by subsidies as long as transport costs are high relative to the subsidy rates.

IV. Summary

This paper shows that concentrattion of export subsidies on marginal goods improves the economic welfare of the country imposing the subsidy, where marginal goods are those that would be exported in small quantities or not at all under free trade but whose export can promoted by export subsidies. This result is based on the fact that export subsidies on non-marginal goods and those on marginal goods have opposite welfare implications for the country imposing these measures. The former expands the output of non-marginal goods, while the latter contracts them. Since the country has monopoly power over the supply of non-marginal goods in the world market, the former worsens the country's welfare while the latter improves it. The existing literature, which deals mostly with uniform export subsidies, cannot distinguish these two opposing welfare effects of export subsidies. However, since export taxes and subsidies are in most cases not uniform , it is important to distinguish between these two opposing effects to better understand the overall welfare impact of export subsidies.

Our analysis also shows that these opposing welfare effects are related to the two roles played by export subsidies; one role is to expand the volume of exports of the goods that would be exported even under free trade, and the other is to expand the range of export goods. We can show that, in a continuum-of-goods model, export subsidies improve the imposing country's welfare only when they expand the set of export goods. A further advantage of the approach employed here is that the second role cannot be considered in the standard two-good model, where one good is always an export good and the other an imported good.

Appendix

Proposition 1. A tax-subsidy schedule $\{s(n)\}$ on export goods lowers the home country's welfare level when $s(n)=0$ for $n\in(N_0,1]$ and

$$(23)\quad \int_0^1 [s(n)/\{1-s(n)\}]\delta^*(n)dn > 0,$$

where N_0 is the index of the marginal good under free trade.

Proof. Consider any export tax-subsidy schedule satisfying the conditions of the proposition. The schedule $s(n)$ is assumed to be continuous from the left, otherwise the functions might not be integrable. Define the sets E_1 (the set of export goods), M_1 (the set of import goods), and G_1 (the set of non-traded goods) as follows:

$$E_1=\{n|\ a^*(n)/a(n)\geq[1-s(n)](w/w^*)_1\},$$

$$M_1=\{n|\ a^*(n)/a(n)<(w/w^*)_1\} - E_1,$$

$$G_1=\{n|\ 0\leq n\leq 1\ \} -(E_1 \cup M_1),$$

where $(w/w^*)_1$ is the equilibrium relative wage under the given tax-subsidy schedule. Note that the definition of M_1 reflects the fact that prohibitive import taxes are imposed on the goods:

$$\{n|\ a^*(n)/a(n) < (w/w^*)_1\} \cap E_1.$$

Denote by E_0 and M_0 the sets of export and import goods under free trade. E_0 and M_0 can be expressed in terms of the free trade equilibrium relative wage $(w/w^*)_0$ as follows:

$$E_0=[o,N_0]=\{n|\ a^*(n)/a(n)\geq(w/w^*)_0\},$$

$$M_0=(N_0,1]=\{n|\ a^*(n)/a(n)<(w/w^*)_0\}.$$

We now prove the proposition by respectively considering the case of (i) $(w/w^*)_1>(w/w^*)_0$ and (ii) $(w/w^*)_1\leq(w/w^*)_0$.

Case (i). $(w/w^*)_1>(w/w^*)_0$:

In this case we have

$E_1 \subset E_0$, $M_1 \supset M_0$ (for $s(n)=0$ for all $n>N_0$).

We thus have

$$(y/y^*)_1=[\int_{E_1}\delta^*(n)dn]/[\int_{M_1}\delta(n)dn]<[\int_{E_0}\delta^*(n)dn\ ]/[\int_{M_0}\delta(n)dn]=(y/y^*)_0\ ,$$

where $(y/y^*)_1$ and $(y/y^*)_0$ are the relative income under the tax-subsidy schedule and under free trade, respectively, and $\int_E$ and $\int_M$ indicate integration over the sets E and M. If we denote the home country's utility level under the tax-subsidy schedule and under free trade by V_1 and V_0, we have

$$V_1-V_0=-[\ln(w/w^*)_1-\ln(w/w^*)_0]\int_{E_1}\delta(n)dn + [\ln(y/y^*)_1-\ln(y/y^*)_0]$$

$$+\int_{E_0-E_1}\delta(n)\ln[(w/w^*)_0\cdot\{a(n)/a^*(n)\}]dn<0.$$

(Note that $(w/w^*)_0\leq a^*(n)/a(n)$ for all $n\in E_0$.)

Case (ii). $(w/w^*)_1\leq(w/w^*)_0$:

In this case $E_0 \subset E_1 UG_1$ and $M_0 \supset M_1$ are satisfied. We first show that $(y/y^*)_1 < (w/w^*)_1$.

Define schedule $\{\hat{z}(n)\}$ as follows:

$$\hat{z}(n)=\begin{cases} 0 & \text{for all } n\varepsilon G_1 \\ z(n)=s(n)/\{1-s(n)\} & \text{for all } n\notin G_1 \end{cases}.$$

Here note that

$$\int_{E_1} z(n)\delta^*(n)dn=\int_{E_1 UG_1} \hat{z}(n)\delta^*(n)dn \quad (\text{for } \hat{z}(n)=0 \text{ for all } n\varepsilon G_1)$$

$$=\int_{E_1 UG_1-E_0} \hat{z}(n)\delta^*(n)dn+\int_{E_0} \hat{z}(n)\delta^*(n)dn \quad (\text{for } E_0 \subset E_1 UG_1)$$

$$=\int_{E_0} \hat{z}(n)\delta^*(n)dn \geq \int_{E_0} z(n)\delta^*(n)dn>0,$$

where use were made of the fact that $z(n)=0$ for all $n\notin E_0$ and the fact that $z(n) \leq 0$ for $n \varepsilon G_1$.

We thus have

$$(y/y^*)_1=(w/w^*)_1-\int_{E_1} z(n)\delta^*(n)dn<(w/w^*)_1.$$

We can now easily calculate that

$$V_1-V_0$$

$$=\ln(y/y^*)_1-\ln(y/y^*)_0-\{\ln(w/w^*)\}_1\int_{E_1 UG_1}\delta(n)dn+\{\ln(w/w^*)_0\}\int_{E_0}\delta(n)dn$$

$$+\int_{E_1 UG_1}\delta(n)\ln\{a^*(n)/a(n)\}dn-\int_{E_0}\delta(n)\ln\{a^*(n)/a(n)\}dn$$

$$=\ln(y/y^*)_1-\ln(w/w^*)_0+[\ln(w/w^*)_0-\ln(w/w^*)_1]\int_{E_1 UG_1}\delta(n)dn$$

$$+\int_{E_1 UG_1-E_0}\delta(n)[\ln\{a^*(n)/a(n)\}-\ln(w/w^*)_0]dn$$

(for $(y/y^*)_0=(w/w^*)_0$ and $E_0 < E_1 U G_1$)

$$<\ln(w/w^*)_1-\ln(w/w^*)_0+[\ln(w/w^*)_0-\ln(w/w^*)_1]\int_{E_1UG_1}\delta(n)dn$$

$$+\int_{E_1UG_1-E_0}\delta(n)[\ln\{a^*(n)/a(n)\}-\ln(w/w^*)_0]dn \quad (\text{for } (y/y^*)_1<(w/w^*)_1)$$

$$=-[\ln(w/w^*)_0-\ln(w/w^*)_1]\int_{M_1}\delta(n)dn$$

$$-\int_{E_1UG_1-E_0}\delta(n)[\ln(w/w^*)_0-\ln\{a^*(n)/a(n)\}]dn<0,$$

for $\ln (w/w^*)_0-\ln\{a^*(n)/a(n)\}>0$ for all $n\in E_0$.

Q.E.D.

Specification of Welfare-Improving Export Subsidy and Proof of Proposition 2.

Take a number N, which is very close to N_0(the index of the marginal good under free trade). N, which is assumed to be either larger than or equal to N_0, is the target level of the marginal good that the home government intends to achieve by the following export subsidy schedule $s(n;N)$:

(A-1) $$s(n;N)=\begin{cases} 0 & \text{for all } n>N \text{ or } n\leq N_1 \\ [(w/w^*)-(a^*(n)/a(n))]/(w/w^*) & \text{for all } N_1<n\leq N \end{cases}$$

where N_1 and (w/w^*) are given by the following two equations.

(A-2) $$a^*(N_1)/a(N_1)=(w/w^*), \text{ i.e., } N_1=\alpha^{-1}(w/w^*),$$

(A-3) $$(w/w^*)=(y/y^*)+\int_{N_1}^{N}[s(n;N)/\{1-s(n;N)\}]\delta^*(n)dn,$$

where

$$(y/y^*)=[\int_0^N \delta^*(n)dn]/[\int_N^1 \delta(n)dn].$$

It is easy to see that the subsidy schedule $\{s(n;N)\}$ is that illustrated in Figure 2.

Proposition 2. By introducing the export subsidy schedule as shown in Figure 2 (defined mathematically above by (A-1)), the home government can achieve a higher utility level than under free trade.

Proof. By substituting (A-1) into (A-3), we obtain

$$(A\text{-}4) \qquad (w/w^*)-[\int_0^N \delta^*(n)dn]/[\int_N^1 \delta(n)dn]-(w/w^*)\int_{N_1}^N \{\delta^*(n)/\alpha(n)\}dn=H(w/w^*,N)=0,$$

where

$$N_1=\alpha^{-1}(w/w^*).$$

By differentiating $H(w/w^*,N)$ with respect to w/w^* and N, we obtain

$$(A\text{-}5) \qquad \partial H/\partial(w/w^*)=1-\int_{N_1}^N \{\delta^*(n)/\alpha(n)\}dn,$$

$$(A\text{-}6) \qquad \partial H/\partial N=-[\int_0^N \delta^*(n)dn]/[\int_N^1 \delta(n)dn]-\delta(N)(y/y^*)/[\int_N^1 \delta(n)dn]$$

$$-\delta^*(N)(w/w^*)/\alpha(N)<0.$$

Note that $N_1=N=N_0$ at the point of free trade. Thus, as long as N is close to N_0,

$$(A\text{-}7) \qquad \partial(w/w^*)/\partial N\big|_{H=0}>0$$

is satisfied.

The welfare impact of the export subsidy schedule near the free trade equilibrium point can be examined by differentiating the indirect utility

function with respect to N at the point of free trade: Thus, we can easily obtain:

$$\partial V/\partial N|_{N=N_0} = (w/w^*)\int_{N_0}^{1} \delta(n)dn \cdot \{\partial(w/w^*)/\partial N\}|_{\substack{H=0 \\ N=N_0}} > 0.$$

The government can therefore improve the national welfare by the type of export subsidy schedule as defined above. Q.E.D.

References

Bresnahan, Timothy F. "Duopoly Models with Consistent Conjectures." American Economic Review 71 (December 1981): 934-45.

Dornbusch, Rudiger, Fischer, Stanley, and Samuelson, Paul A. "Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods." American Economic Review 67 (December 1977): 823-839.

Eaton, Jonathan, and Grossman, Gene M. "Optimal Trade and Industrial Policy Under Duopoly." Working Paper No. 1236, National Bureau of Economic Research.

Itoh, Motoshige, and Kiyono, Kazuharu "Strategic Export Subsidization policy and the National Welfare: Lerner's Symmetry Theorem Reconsidered." Discussion Paper 83-7, The University of Tokyo, 1983.

Jones, Ronald W. "Technical Progress and Real Incomes in a Ricardian Trade Model." In R. W. Jones, International Trade: Essays in Theory, Amsterdam: North-Holland.

Krugman, Paul. "Import Protection as Export Promotion: International Competition in the Presence of Oligopoly and Economies of Scale." In Monopolistic Competition and International Trade, edited by H. Kierzkowski Oxford: Oxford University Press, 1984.

_____, "The Narrow Moving Band, the Dutch Disease, and the Competitive Consequence of Ms. Thatcher: Notes on Trade in the Presence of Dynamic Scale Economies." Mimeographed. Cambridge: Massachusetts Institute of Technology, 1984.

Lerner, Abba P. "The Symmetery between Import and Export Taxes." Economica 3 (August 1936): 306-313.

Spencer, Barbara J., and Brander, James A. "International R&D Rivalry and Industrial Strategy." Review of Economic Studies 50 (1983): 707-722.

Samuelson, Paul A. "The Transfer Problem and Transport Costs II: Analysis of Effects of Trade Impediments." Economic Journal 64 (June 1954): 264-289.

Wolff, Alan W, The Effect of Government Targeting on World Semiconductor Competition: A Case History of Japanese Industrial Strategy and its Costs for America, Semiconductor-Industry Association, 1983.

Footnotes

We wish to thank John Pomery and Ron Jones for many valuable comments and suggetions. We also indebted to G. M. Grossman, C. Kowlczyk, I. McLean, T. Negishi, M. Ohyama, and M. Okuno.

[1]This result, however, depends on what type of equilibrium concept is considered. Eaton and Grossman [1984] show that no governmental tax or subsidy policy is dersirable even under oligopolistic condition when the equilibrium is a consistent conjectural variation equilibrium.

[2]See Wolff [1983] for the concept of industrial targetting policy.

[3]We admit that dynamic scale economies such as learning and R&D play an important role in the industrial targeting policy issue. These are not included in our analysis. However, our analysis can be extended to the case where learning plays an important role.

[4]We are indebted to John Pomery for pointing out an error in a previous version of this section.

[5]The necessary and sufficient condition for this production pattern to arise under free trade is

$$(\delta_1^*+\delta_2^*)/\delta_3 > a_2^*/a_2 > \delta_1^*/(\delta_2+\delta_3).$$

[6]It is justifiable for the following reasons. First, as will be discussed later in this section, the home government can obtain essentially the same welfare gain through production subsidies without running into this two-way trade problem. Second, unless the export subsidy rate s is very high, two-way trade does not occur in a more realistic model where transport costs are not zero. We discuss this point more in detail in section III-4.

Third, there is a reason why an export subsidy and a prohibitive import tax should be simultaneously introduced in this particular model. This is due to the similarity between an export subsidy and an import tax that we mentioned in Section I. We will also discuss this issue in Section III-4.

[7]We assume that the foreign country is engaged in free trade. If the foreign country retaliates by taxes or subsidies, the nature of the trade equilibrium will differ from what we have in the present paper. Since it is not the purpose of the present paper to investigate the nature of such tariff-subsidy wars, we simply assume that the foreign country does not introduce any taxes or subsidies.

[8]We are indebted to Ron Jones for pointing this out. We also learned from him that he derived a similar result concerning technological improvement in Jones [1983]: technological improvement of the home country in the second industry lowers the utility level of the foreign country. He also pointed out that our result can be extended in the following way. In an n-good, two-country Ricardian model, where, within the range of goods produced by each country, a single good is simultaneously produced by each, a uniform export subsidy by the home country will increase the home country's utility level as long as the following two conditions are satisfied. First, the subsidy rate must be low enough, and second, there must be at least one good exported by the home country, which the foreign country does not produce and for which the export subsidy rate is zero. (The export subsidy rate on other goods is positive and uniform.)

[9]The equilibrium conditions for the case of the production subsidies can be written as

$$w/w^{*}=(a_2^{*}/a_2)/(1-s'),$$

$$w/w^* = (1+z'\delta_2)(y/y^*)+z'm^*,$$

$$y/y^* = (\delta_1^*+m^*)/\delta_3,$$

where

$$z' = s'/(1-s').$$

[10]For example, whether or not export subsidization of a particular good improves the country's terms of trade critically hinges upon whether the subsidized good is a complement or substitute of other export goods.

[11]Relaxation of this assumption of strict monotonicity and differentiability provides no additonal insight.

[12]A prohibitive tariff is required for those goods satisfying

$$[1-s(n)]wa(n) \leq w^*a^*(n)$$

$$wa(n) > w^*a^*(n).$$

[13]The reader might find that there exists some values of $n<N_1$ not satisfying (21). In fact, equations (18)-(20) cover only the case where the set of goods [0,1] is divided into two connected sets; i.e., a set of home export and a set of home import goods. However, as one can easily see in the following argument, our result does not depend on this assumption at all. Since the notation becomes quite complicated, we restrict our argument in the text to the above case. The general case will be dealt with in the proofs of Propositions 1 and 2 in the Appendix. Equations (18)-(20) are replaced by

$$w/w^* = y/y^* + \int_E [s(n)/\{1-s(n)\}]\delta^*(n)dn,$$

$$y/y^* = [\int_E \delta^*(n)dn]/[\int_M \delta(n)dn],$$

$$E=\{n \mid w/w^{*} \leq [1-s(n)][a^{*}(n)/a(n)]\},$$

$$M=\{n \mid w/w^{*} > a^{*}(n)/a(n)\}-E,$$

where it is assumed that the subsdiy schedule function s(n) is continuous from the left, which is necessary for integrability. E is the set of home export goods, M that of home import goods, and G=[0,1]-(EUM) that of non-traded goods.

[14]By substituting $p(n)=wa(n)$ for $n \leq N$ and $p(n)=w^{*}a^{*}(n)$ for $n>N$ into (14)', we obtain (14)".

[15]We ignored the term A in our argument in the text. As will be shown in the Appendix, this term carries no significance.

[16]It is not easy to charcterize the form of an optimal export subsidy schedule. However, we can prove the following; it is not optimal to maximize the index N of the marginal good. See Itoh and Kiyono [1983] for the proof.

[17]We neglect the effect of the lump-sum tax needed to finance these subsidy costs.

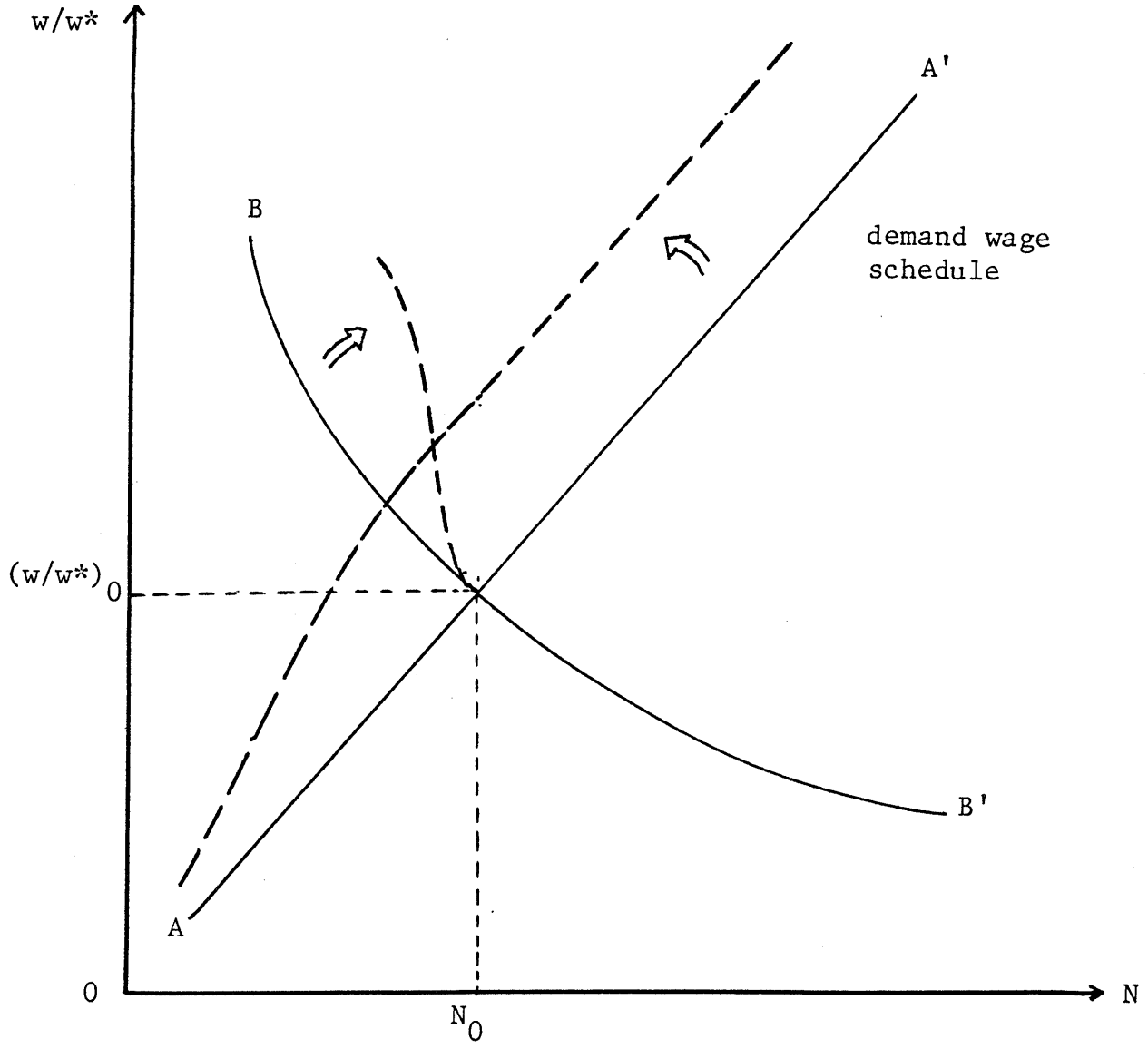

Figure 1

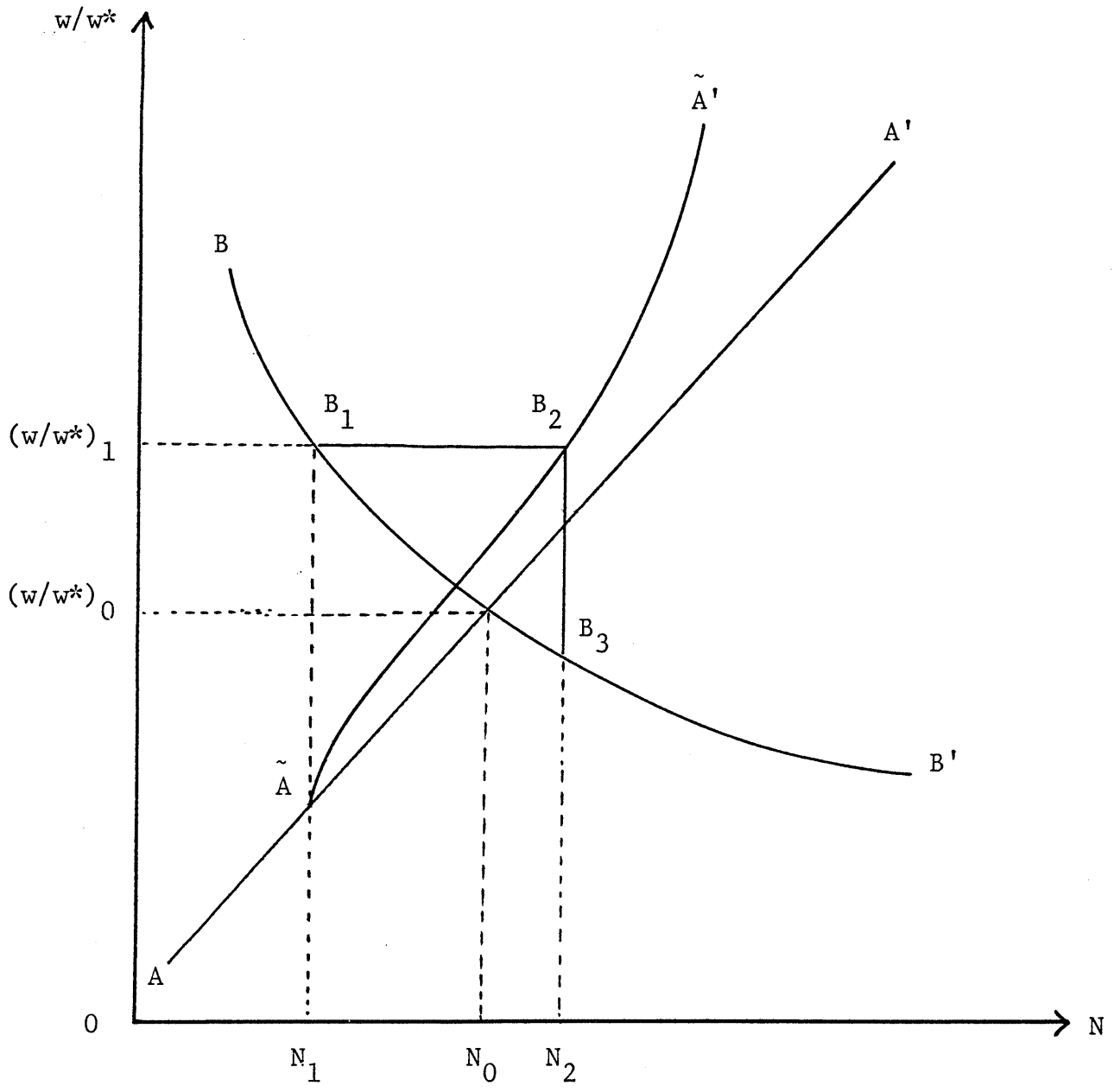

Figure 2