A GENERAL EQUILIBRIUM ANALYSIS
OF TRADE RESTRICTIONS
UNDER IMPERFECT COMPETITION
THEORY AND SOME EVIDENCE FOR THE AUTOMOTIVE TRADE

Junichi Goto
July 1985

Development Research Department
Economics and Research Staff
World Bank

The World Bank does not accept responsibility for the views expressed herein which are those of the author(s) and should not be attributed to the World Bank or to its affiliated organizations. The findings, interpretations, and conclusions are the results of research supported by the Bank; they do not necessarily represent official policy of the Bank. The designations employed, the presentation of material, and any maps used in this document are solely for the convenience of the reader and do not imply the expression of any opinion whatsoever on the part of the World Bank or its affiliates concerning the legal status of any country, territory, city, area, or of its authorities, or concerning the delimitations of its boundaries, or national affiliation.
A GENERAL EQUILIBRIUM ANALYSIS
OF TRADE RESTRICTIONS
UNDER IMPERFECT COMPETITION

THEORY AND SOME EVIDENCE FOR THE AUTOMOTIVE TRADE

July 1985

Junichi Goto

* The author would like to thank J.M. Finger, T.N. Srinivasan, M.J. Peck, R. Crandall, R. Lawrence, and H. Kierzkowski for helpful comments and advices, and Susan Wallick and Nellie Artis for excellent typing.
ABSTRACT

The purpose of this paper is to present a formal general equilibrium model which is based upon: (i) imperfect competition in both product and labor markets; (ii) increasing returns to scale; (iii) product differentiation. Based upon this new framework, which is suitable for the analysis of various manufactured-goods trades, the effect of trade restrictions is examined. It is rigorously shown that trade restrictions bring about the following five sources of losses in addition to the orthodox loss based on the (Baldwin) availability locus: (i) less consumer satisfaction due to the decrease in the variety of goods; (ii) market inefficiency due to the increase in the monopolistic power; (iii) technical inefficiency; (iv) increase in unemployment due to the increased imperfections in the labor market; and (v) possible delay in the economic development.

In the final section, the magnitude of the above losses is evaluated for the US automotive trade which is used as an example. The magnitude of losses is found to be substantial: the net loss (not a transfer of the income from consumers to manufacturers) is as much as 555 dollars per vehicle (or more than 5 billion dollars every year) due to various trade barriers: and the structural unemployment will be substantially reduced if such barriers are removed.
INTRODUCTION

1. Growing tendency toward Protectionism

As Japan has rapidly increased her exports of automobiles after the Oil Crises, most industrialized countries have imposed restrictions on automotive imports in order to protect the automotive industry in their own countries. Nowadays, there are very few countries which are not imposing restrictions on automotive imports. In addition to tariffs, various types of non-tariff restrictions (e.g. explicit quota, so-called voluntary export restraints) are imposed, and such non-tariff barriers (NTBs) to automobile trade seem to be increasing their importance worldwide.

A typical example of such non-tariff restrictions would be the Japanese "voluntary export restraints" (VER) on the automotive exports to the U.S. market in 1981-85. In May 1981 the Japanese government announced that Japanese export of passenger cars to the U.S. would be limited to 1.68 million vehicles in 1981 and that the ceiling would be increased by 16.5 percent of the growth in the U.S. market in 1982 and 1983. (Actually, however, the ceiling of 1.68 million units per year was maintained in 1982 and 1983 because the demand in the U.S. market did not grow very much.) As is widely known, the announcement of "voluntary" export restraints was made under the growing protectionism in the United States. For example, in 1980 separate petitions for import relief were made to the International Trade Commission (ITC) by the UAW and by Ford Motor Company. Although the ITC turned down the petitions, protectionism continued in the U.S. Congress. Several bills which were intended to restrict Japanese imports were submitted, the most famous being the bill introduced by Senators Danforth and Bentsen in 1981.
Although the VER was "officially" lifted in March 1985 after having been extended by one year for 1984, in actuality, the VER did not end. When the Japanese government announced in April 1985 that Japan would increase its automotive exports to the U.S. market by 25 percent, a figure which was much smaller than that which would have been realized under free trade 1/, frantic protective movements against Japan burst out in the U.S. Congress. The Japanese government gave in, and the tacit VER is expected to continue. As will be discussed in detail below, such restrictions would hurt not only Japan (exporting country) but also the U.S (importing country) in the long run, because such restrictions would increase imperfections in the automobile product and labor markets.

Such a tendency toward restrictions on automobile trade seems to affect not only industrialized countries but developing countries as well. Nowadays, some developing countries, e.g. Korea, Mexico, and Brazil, are producing and exporting automobiles. For example, Korea is now exporting automobiles to Canada, and is reported to be planning to export them to the United States in the near future. It is expected that production and export of automobiles will play an increasingly important role in the late stage of economic development in many developing countries. Therefore, a growing tendency toward import restrictions on automobiles would have serious effects on many developing countries in the future, just as these restrictions are now affecting Japan. On the other hand, excessive import restrictions by developing countries may impair the interests of developing countries

1/ For example, the International Trade Commission (1985) has estimated that, without the VER, Japanese imports would have been larger by one million vehicles, or by 54 percent, than otherwise in 1984.
themselves in the long run. For example, such restrictions might protect domestic producers too much, and thereby facilitate imperfect market structures, which may cause various losses in developing countries, as will be analyzed in detail below.

2. Three characteristics of automobile trade

In view of the importance of automobile trade and of the tendency toward increasing restrictions, various, sometimes emotional, arguments have been made on the effect of the restrictions on automobile trade, and various attempts have been made to evaluate the magnitude of the effect of import restrictions such as the VER (see Tarr and Morkre (1984) for example). However, in spite of many arguments and many empirical studies, it seems that there are few formal theoretical studies of automobile trade which are based upon a rigorous general equilibrium framework. One of the major difficulties in rigorously modeling the automobile trade results from the fact that characteristics of automobile trade are very different from basic assumptions of orthodox theories of international trade, and therefore, the general equilibrium framework of orthodox trade theories cannot be easily applied. While, generally speaking, the orthodox trade theories have been based upon perfect competition, constant returns to scale, and homogeneous products, automobile trade seems to be better characterized by the opposite extremes. In fact, a suitable framework of the international trade of many manufactured goods, including automobiles, seems to be as follows:

(i) imperfect competition;
(ii) increasing returns to scale;
(iii) differentiated products.
First of all, product markets of many industries, such as automobile, are far from being perfectly competitive and they could be better characterized as monopolistic competition or oligopoly. Instead of taking price as given, the firm is often aware of the effect of its output decision upon price (in other words, it faces a downward-sloped demand curve). In addition to the product market, the labor market of some industries is often imperfectly competitive due to the bargaining and lobbying power of strong labor unions. When we imagine the American automotive industry, for example, such imperfections in both product and labor markets would become apparent.

Secondly, production of automobiles requires a large setup cost, so that average cost would decrease at least up to a certain level of production. According to the study of E. Toder (1978), for example, minimum optimal plant scale (MOS) of the American automotive industry is 400,000 units per year, and MOS would be much greater if multi-plant, firm-level economies of scale are taken into account. As his study suggests, when we analyze the automobile industry (and many manufacturing sectors which require huge fixed costs), a suitable framework would be increasing returns to scale rather than constant returns to scale.

Thirdly, automobiles are differentiated, rather than homogeneous, products. Consumers do care about which model they purchase. Due to characteristics of products and/or advertisement, people are not indifferent, for example, between Toyota, Lincoln, and Volkswagen even though all of them can be classified as an automobile. Therefore, it would be absurd to assume that automobiles are homogeneous products and that consumers always purchase whichever model has the cheapest price. Instead, it seems reasonable to regard automobiles as differentiated products.
3. New theories of trade under imperfect competition

Faced with the growing importance of manufactured goods trade, for which assumptions of orthodox trade theories are not necessarily suitable as explained above, new theories of international trade have emerged recently, and substantial efforts have been made to develop formal models of trade, especially of intraindustry trade, by distinguished economists, including Krugman, Dixit and Norman, Lancaster, and Helpman. Based upon the new framework suitable for the trade of many manufactured goods (i.e. imperfect competition, increasing returns to scale, and product differentiation), they are trying to explain why intraindustry trade among similar countries has been increasing, because the increase in (even its existence of) intraindustry trade gives theoretical difficulties to the orthodox trade theories: according to orthodox theories, international trade occurs between countries because of differences in technologies, factor endowments, or tastes, and therefore, there are no trade creating forces if countries are the same in these respects. Actually, however, since World War II, we have observed an increasing amount of trade of similar goods among similar countries. Indeed, according to Grubel and Lloyd (1975), the share of such intraindustry trade in all trades is more than 50 percent and increasing.

Although it has been suggested by some prominent economists, including Balassa (1967), that increasing returns to scale would be a key factor in explaining intraindustry trade between similar countries, it was not until recently that the formal theory of intraindustry trade has attracted intense professional interest. Until recently, fairly unsatisfactory explanations based upon "border trade" etc. had been given to the intraindustry trade. One of the reasons for the lack of the formal model of
intraindustry trade based on increasing returns to scale had been the well-known difficulty in modeling the economy where technology is characterized by increasing returns to scale. Namely, under increasing returns to scale the competitive equilibrium may not exist. However, Dixit and Stiglitz (1977) overcame this theoretical difficulty in their pioneering work. They showed that under increasing returns to scale and product differentiation there exists a competitive equilibrium. The essence of their argument is: consumers prefer more diversity while producers tend to decrease differentiation in order to further exploit the benefit of increasing returns to scale. By these two conflicting forces the competitive equilibrium is obtained.

Krugman (1979) first applied the framework of Dixit and Stiglitz to international trade, and showed that even if countries are the same in terms of tastes, technologies, and factor endowments, intraindustry trade will occur in order to further exploit the benefit of increasing returns to scale, and that, in fact, the more similar the trading partners are, the more trade will occur. Dixit and Norman (1980) also derived similar conclusions by using a two sector model. Lancaster (1980), based upon his characteristics approach, derived similar conclusions. Their major contributions are the explanation of intraindustry trade based on the three realistic assumptions: (i) imperfect competition; (ii) increasing returns to scale; (iii) differentiated products.

4. Additional insights into the effects of trade restrictions

These new theories of international trade under imperfect competition seem to give a suitable framework for the analysis of the effect of trade restrictions on automobiles and many other manufactured goods, because they are based upon three assumptions which seem to grasp the realities of those
industries. Especially, models of Krugman and of Dixit and N. man seem to be promising for application because their frameworks have a lot of similarities to the neoclassical general equilibrium models, on which numerous applied studies have been made.

While their frameworks are path-breaking, it seems that a number of extensions and modifications are possible and necessary before applying to the trade of automobiles and other manufactured goods. First of all, their models incorporate imperfect competition in the product market alone, and it is assumed that factor markets are perfectly competitive and that factors are always in full employment. As discussed above, however, the labor market is far from being perfectly competitive in many industries, such as the automotive industry, because of the existence of strong labor unions. It is sometimes emotionally argued, for example, that the protectionism resulting from lobbying efforts by strong labor unions like the UAW is harmful to the interest of consumers. And international trade has often been blamed for being a major cause of massive unemployment in the U.S. automotive industry after the second oil crisis. While many arguments have been made about the impact of labor unions on international trade or the impact of international trade on employment, very few formal studies have been made on these problems. Therefore, it is desirable to establish a formal model which consistently incorporates imperfect competitions in both markets.

Secondly, in most cases the elasticity of substitution among differentiated goods has been assumed to be constant in their models. In other words, the degree of the substitutability of differentiated goods where the choice available to consumers is between only two types of goods is the same as where the choice is available among, say, hundreds of types of
goods. Actually, however, it seems plausible that goods become closer and closer substitutes as the number of types of goods available to consumers increases. In addition to the lack of intuitive appeal, the assumption of invariant substitutability encounters empirical difficulties, although the assumption is useful in simplifying discussion. As was reviewed by Jacquemin (1982), for example, many empirical studies have found the following three empirical regularities (or stylized facts as they are fashionably called) about the effects of the opening up of trade under imperfect competition:

(i) increase in variety of goods available;
(ii) decrease in monopolistic power;
(iii) decrease in average cost.

However, as will be discussed in detail below, (ii) and (iii) cannot be well explained if we assume invariant substitutability. Therefore, it is desirable to incorporate in the model variant substitutability, as well as labor market imperfections, if we are to apply the model to international trade in the real world, such as automobile trade.

In the next section, a formal general equilibrium model of international trade is established which is based upon imperfect competition, increasing returns to scale, and product differentiation. The model also incorporates labor market imperfections and variable elasticity of substitution. In the following section, effects of trade restrictions will be analyzed by using the model. It will be rigorously shown that restrictions on automobile trade (and on many manufactured goods trade) can cause various losses:
(i) less consumer satisfaction due to a decrease in the variety of goods;
(ii) increase in monopolistic power;
(iii) technical inefficiency due to an increase in average cost;
(iv) decrease in employment due to increased imperfections in the labor market;
(v) taking away more capital resources from the rest of the economy.

Losses (i)-(iii) correspond to the stylized facts on gains from trade reviewed by Jacquemin. In addition to giving a theoretical foundation to the three stylized facts, the following model gives additional insights into the effects of trade restrictions. Surprisingly enough, it will be shown that trade restrictions will decrease employment (or increase unemployment), at least in the long run, through the increase in the labor market imperfections. Loss (v) would be especially relevant to the developing countries where capital is relatively scarce resource, because when more capital becomes necessary for the automotive industry the rest of the economy has to be content with fewer capital resources, which may result in a delay in the economic development.

Intuition behind the above various losses from trade restrictions would be as follows: trade restrictions decrease the number of types of differentiated goods available to consumers, and thereby substitutability between the goods will be decreased. Due to the decreased substitutability each producer faces less elastic demand, and thereby the price markup and wage markup can be increased. Increase in wage markup will increase unemployment by reducing employment in the long run. Further, faced with no import competition, the market structure would become less efficient than before.
After making qualitative analyses of such various losses from restrictions by using a rigorous model, an attempt will be made in the final section of the paper to evaluate the magnitude of such losses by taking the U.S. automotive trade as an example. The major purpose of this paper, however, is to present a rigorous analytical framework to the international trade of automobiles and many other manufactured goods, and to give additional insights into the effects of trade restrictions. Therefore, such evaluation of the magnitude of losses from U.S. trade restrictions on automobiles is given for the illustrative purpose only. A full-fledged empirical estimation of the effects of the VER in the U.S. market is beyond the scope of this paper, and it will be left to future studies.
A MODEL IN THE CLOSED ECONOMY

In this section a formal general equilibrium model is established for the closed economy first, and in subsequent sections effects of trade restrictions will be analyzed by using the model. The economy in the model consists of two sectors: the perfectly competitive sector and the distorted sector. The former sector produces homogeneous products under constant returns to scale, and both product and labor markets are perfectly competitive. The latter sector consists of many individual firms which are producing differentiated products in the framework of Chamberlinian monopolistic competition, and the technology is characterized by increasing returns to scale. In the latter sector, the labor market is also imperfect in that the labor union sets the wage rate higher than the competitive wage in the rest of the economy. The latter sector may be considered as the automotive industry, for example, because the framework grasps various realities of the automotive industry in many countries as discussed above. In the following discussion, the perfectly competitive sector and the distorted sector will often be referred to as the rest of the economy and the automotive sector, respectively. Although the latter sector is referred to as the automotive sector for convenience, the model is intended to be so general that it can be applied to the analyses of many other manufactured goods trade.

1. Consumers

Consumers are characterized by the following individualistic social utility function.

\[
U = \sum_{i=1}^{N} \left( \frac{c_i^{1-\alpha}}{c_o} \right)^{\alpha}, \quad 0 < \alpha < 1
\]
(2) \[ 8 = 1 - \gamma/(\ln N + \gamma), \quad 0 < \gamma \]

where \( c_i \) is the amount of consumption of the \( i \)-th differentiated good, or the consumption of a particular model of automobiles, and \( c_0 \) is the amount of consumption of the goods produced by the rest of the economy (numeraire goods). \( N \) is the number of types of differentiated products, which consumers consider to be available to them. \( N \) will be the same as \( n \) (the number of types of goods actually available to consumers) in equilibrium. Namely, the behavioral assumption here is that consumers maximize utility, taking the prices and the number of types of products as given, and the utility is a function of \( c_i, c_0, \) and \( N \).

The utility function (1) is similar to that of Dixit and Norman (1980), where the utility was Cobb-Douglas in the quantity of the numeraire goods and a scalar measure of consumption of differentiated product, this scaler measure being a CES function in the quantity of each product type. However, the model used here has a crucial difference from their model: in Dixit and Norman, \( \beta \) is given by a parameter, and therefore, the elasticity of substitution between differentiated goods \((= 1/(1-\beta))\) is invariant without regard to the number of product types, while in the model here, \( \beta \) is assumed to be an increasing function of the number of types of goods available to consumers, i.e. differentiated goods become closer and closer substitutes as the variety of goods increases. As shown in (2), \( \beta \) is an increasing function of \( N \). Further, it seems reasonable to assume that the utility will increase as \( N \) increases even if \( \sum_{i=1}^{N} c_i \) (physical quantity of the differentiated goods) remains constant. Namely, the society would be better off in the situation where, for example, 100 units of model A and 100 units of model B are available than in the situation where 200 units of model A alone are
available, if both models enter the social utility function symmetrically. As long as \( \beta \) satisfies those conditions for reasonable properties of the utility function, it can take any functional form. But here we assume the specific functional form (2) for the sole purpose of mathematical simplification.

Consumers maximize utility function (1) subject to the budget constraint (3),

\[
(3) \quad c_0 + \sum_{i=1}^{N} p_i c_i = Y
\]

where price of the numeraire good is set to 1, \( p_i \) and \( Y \) are the price of the \( i \)-th differentiated product and income, respectively. From this maximization problem, we get the following two demand functions.

\[
(4) \quad c_0 = (1-\alpha)Y
\]
\[
(5) \quad p_i = \alpha c_i^{\alpha-1} Y/Z
\]
\[
(6) \quad Z = \sum_{i=1}^{N} c_i^{\alpha}
\]

Elasticity of demand of \( i \)-th differentiated goods (\( \epsilon_i \)) is obtained by taking the derivative of (5).

\[
(7) \quad \frac{1}{\epsilon_i} = -\frac{3p_i}{\partial c_i} \cdot \frac{c_i}{p_i}
\]

\[
= (1-\alpha) - \frac{3Z}{\partial c_i} \frac{c_i}{Z}
\]

Note that the second term of (7) approaches to zero as \( N \) goes to infinity. Assuming large \( N \), and neglecting the second term, we get,

\[
(8) \quad \epsilon_i = \frac{1}{1-\alpha}
\]

2. Producers

Production of the numeraire goods is characterized by the following Cobb-Douglas cost function.

\[
(9) \quad TC_0 = r a \omega_o^{1-a} x_o, \quad 0 < a < 1
\]
where $r$ is rental rate of capital and $w_o$ is competitive wage rate, both of which are expressed in terms of the price of numeraire good, and $x_o$ is the output of the numeraire good, and $TC_o$ is total cost. Note that the production technology exhibits constant returns to scale, and there is no profit in equilibrium. So, unit production cost is the same as price, which is set to unity here.

$$r^{1-a}w_o = 1$$

Demand for capital input in the numeraire good sector can be obtained by taking the derivative of the cost function (9) with respect to the rental rate (i.e. by using Shepard's lemma).

$$K_o = \frac{\partial (TC_o)}{\partial r} = ar^{a-1}w_o^{1-a}x_o$$

where $K_o$ is the amount of capital input in the numeraire goods sector.

Similarly, labor input ($L_o$) is given by,

$$L_o = \frac{\partial (TC_o)}{\partial w_o} = (1-a)r^a w^{-a}x_0$$

On the other hand, production of the $i$-th differentiated good is characterized by the following cost function.

$$TC_i = rF + r^a w^{1-a} x_i , \text{ if } x_i > 0$$
$$= 0 , \text{ if } x_i = 0$$

where $TC_i$, $w_i$, and $x_i$ are total cost, wage rate, output level of the $i$-th firm, respectively. Namely, each firm has to commit $F$ units of capital as a fixed cost first if it is to produce any positive amount. In addition to the fixed cost $rF$, constant marginal cost $r^a w_i^{1-a}m$ is necessary thereafter. Note that the production of each differentiated good exhibits increasing returns to scale because of the fixed cost. Costless differentiation is assumed in the
model, and therefore, no two firms ever produce the same types of
differentiated products in equilibrium because the firm is always better off
by differentiating its product type from the existing types to a new type.
Equilibrium is given by monopolistic competition: each firm maximizes its
profits, and equilibrium profit is forced to be zero due to free entry and
exit. The optimization problem of the representative firm \( i \) is given by,

\[
\text{(14) } \quad \text{Max } \pi_i = p_i(x_i) x_i - (rF + r^a \omega_i^{1-a} mx_i)
\]

where \( \pi_i \) is the profit of the \( i \)-th firm. Since each firm has monopoly power
for that particular type of differentiated goods, the optimization problem is
essentially the same as regular profit maximization of the monopolist. So,
from (8) and (14), and noting that \( N \) (i.e. the number of product types which
consumers consider to be available to them) is the same as \( n \) (i.e. the actual
number of available product types) in equilibrium, we get the following profit
maximizing price:

\[
\text{(15) } \quad p_i = r^a \omega_i^{1-a} m/\beta
\]

In addition, free entry and exit are assumed in the model. So, whenever there
is a positive profit entry occurs, and therefore, profit is forced to be zero,
or price must be the same as average cost in equilibrium.

\[
\text{(16) } \quad p_i x_i = rF + r^a \omega_i^{1-a} mx_i
\]

By invoking the Shephard's lemma, as in (11) and (12), we get factor
demand functions of the firm \( i \) as follows:

\[
\text{(17) } \quad k_i = \partial (TC_i) / \partial r
\]

\[= F + ar^a \omega_i^{1-a} mx_i
\]

\[
\text{(18) } \quad l_i = \partial (TC_i) / \partial \omega_i
\]

\[= (1-a) r^a \omega_i^{-a} mx_i
\]
where \( k_i \) and \( l_i \) are the (conditional) demand for capital and the demand for labor of the firm \( i \), respectively.

The elasticity of derived demand for labor is obtained from the inverse demand function (5) and conditional demand function (18). It can be shown by simple algebra that the elasticity of derived demand for labor \( (\eta_i) \) is reduced to (19).

\[
\eta_i = \frac{3w_i l_i}{3w_i l_i} = \frac{1-a}{1-a}
\]

Note that equation (19) shows the essence of the Hicks-Marshall Laws of Derived Demand. As is widely known, the main point of the Hicks-Marshall Laws is that, other things being equal, the own wage elasticity for a category of labor is high when:

1. the price elasticity of demand for the product being produced is high;
2. the cost of employing the category of labor is a large share of the total cost of production;
3. other factors of production can be easily substituted for the category of labor.

From equation (8) we know that the price elasticity of demand for the product \( (\varepsilon_i) \) is equal to \( 1 / (1 - \varepsilon) \). Hence, equation (19) shows that the elasticity of derived demand for labor is an increasing function of the elasticity of product demand (Law (i)). Further, from cost function (13) it is obvious that the share of labor cost in total variable cost is \( (1-a) \).

Therefore, equation (19) also shows that the derived demand for labor is more elastic, the larger the share of labor cost (Law (ii)). Law (iii) is not applicable as long as we use a Cobb-Douglas function, where the elasticity of
substitution between the two factors is always unity. We can easily get the
elasticity of derived demand for capital by doing the same calculation, but we
omit this because it is unnecessary in the following discussions.

3. Labor Market 2/

The labor market in the differentiated goods sector (automotive
sector) is assumed to be imperfect while that in the rest of the economy is
perfectly competitive. The labor market in the automotive industry is assumed
to be controlled by a single labor union. This kind of labor market
imperfections would be easily imagined if we think of the U.S. automotive
industry, for example, where the powerful UAW is exerting a strong influence
in the wage determination. Although everyone would agree that the labor
market is imperfect in many cases and that unions are important players, there
is no consensus on the objective function of unions. While there is a high
degree of consensus on the utility maximization by consumers and the profit
maximization by firms, a wide variety of arguments have been made on the
objective function of the unions. Johnson (1975) went as far as to assert
that "... the problem of modeling trade union behavior has proved to be
virtually intractable." Some authors, including Dunlop (1944), Hieser (1970)
and Johnston (1970), have argued that unions seek to maximize the wage bill.
Rosen (1970) and Calvo (1978) argued that the union seeks to maximize the
difference between its members' income and what they would get under no

2/ If we are to analyze the trade of the industry where only the product
market is imperfect, all we have to do is to set the wage rate in the
sector equal to the competitive wage rate in the rest of the economy and
to disregard the specifications of labor market imperfections here.
unionization. Farber (1978) argued that unions try to maximize the expected utility of the median-aged union member, which is analogous to the median voters argument in political science.

In spite of the variety of arguments, it seems that the majority would agree that the union's utility is a (quasi-concave) increasing function of wage and employment, as Oswald (1982) suggested. In the model here we will use the objective function (20), which is of the same functional form as that of Calvo. The behavioral assumptions in the model here are: firms decide the employment level, taking the wage set by the union as given; the union decides the wage rate in order to maximize the following objective function.

\[
\text{(20) } \max_{\omega_i} V = \sum_{i=1}^{n} l_i (\omega_i - \omega_o)
\]

Namely, the union is seeking to maximize the difference between its (employed) members' income and what they would get without a union (i.e. the competitive wage in the rest of the economy). 3/ By rearranging the first order conditions of the maximization problem (20) we get the following.

\[
\text{(21) } \frac{\omega_i - \omega_o}{\omega_i} = \frac{1}{\eta_i}, \text{ for all } "i"
\]

Equation (21) shows that the rate of wage markup in each firm is equal to the inverse of the elasticity of derived demand for labor of the firm, which seems to have a resemblance to the so-called Ramsey pricing rule.

---

3/ Note that for simplicity workers are assumed to be homogeneous in their productivity here. So, in empirical applications, we would have to adjust the number of workers and the wage rate in each sector according to the productivity difference.
Note that because of the symmetry of the problem, $c_i$, $p_i$, $x_i$, $\varepsilon_i$, $\omega_i$, and are the same for all $i$. So, let us adopt the short-hand notations without subscript in the following discussions. Further, note that the elasticity of demand for labor by the differentiated goods sector as a whole is the same as the elasticity of demand for labor by the individual firm, because each of many firms in the industry is assumed here to make its input decision under monopolistic competition without taking the interactions between firms into account.

Workers allocate themselves to one of the two sectors by comparing the competitive wage in the rest of the economy with the expected wage in the automotive industry. The framework here is an application of the Harris-Todaro model, which was used to analyze migration. The probability of getting a job after allocating themselves to the automotive sector is as follows:

$$\Pr = \frac{L_A}{N_A}$$

where $Pr$, $L_A$, and $N_A$ are the probability of getting an automotive job, the amount of the employment in the automotive sector, and the amount of supply of auto workers, respectively. Workers are assumed to be risk neutral for simplicity here. 4/ Through the movement of workers between the two industries the expected wage in the automotive industry will be equated with the competitive wage in the rest of the economy in equilibrium. Therefore, in equilibrium, equation (23) holds.

$$w \cdot \frac{L_A}{N_A} = \omega_o$$

4/ It is easy to incorporate the risk averseness of workers. All we have to do for that purpose is to put some measure of degree of risk aversion in equilibrium condition (23).
where \( w \) is the wage rate in the automotive sector. Note that we are denoting it without subscript because the wage rate in each firm turns out to be the same in equilibrium, as discussed above. Equation (23) can be rearranged as follows.

\[
(24) \quad \frac{w - w_o}{w} = \frac{N_A - L_A}{N_A}
\]

The right-hand side of the equation (24) is the unemployment rate in the automotive industry while the left-hand side can be interpreted as the rate of wage markup in the industry, which bears a strong analogy to the Lerner Index. Equation (24) shows that the unemployment rate in the imperfectly competitive sector becomes higher, the higher the wage markup.

The intuition behind this would be: when there is a big wage difference between the two sectors, some workers tend to remain unemployed because they do not pick up the lower wage job in the competitive sector, hoping that they would be able to find a job in the high wage sector sooner or later. Such behavior would be especially true for the workers who were laid off from the high wage industry. Even if there are sufficient job openings in the low wage sector, they may wait until being employed again by the high wage sector. Such prolonged unemployment tends to be higher, the larger the wage difference between the two sectors. From (21) and (24), we know that the (long run) unemployment rate in the imperfectly competitive sector is a decreasing function of the elasticity of derived demand for labor.

Labor supply is assumed to be given, i.e. there are no wage-leisure tradeoffs. Therefore, the sum of labor supply in both sectors is the same as the labor endowment of the economy (L).

\[
(25) \quad L_o + N_A = L
\]
Further, due to the symmetry of the problem, the amount of labor demanded by the firm is the same for all firms in the differentiated goods sector. So, the amount of labor demanded by the automotive sector as a whole \( L_A \) is,

\[
L_A = nL
\]

4. Capital Market

Different from the labor market, the capital market is assumed to be perfectly competitive. Therefore, the sum of the capital demand in both sectors is equal to the capital endowment of the economy \( K \).

\[
K_0 + \sum_{i=1}^{n} k_i = K
\]

Since we are assuming that the cost function of each firm in the differentiated goods sector is identical, and that each type of differentiated goods enters the utility function symmetrically, (27) reduces to (28).

\[
K_0 + K_A = K
\]

(29) where \( K_A = nk \)

5. National Income

Since there are no pure profits in the whole economy, the national income is the same as total factor payments. Note that due to free entry and exit the profit in the monopolistically competitive sector is always reduced to zero in the long run equilibrium. It is obvious that there is no profit in the perfectly competitive sector, where technology exhibits constant returns to scale. Therefore, the national income is,

\[
Y = rK + \omega L_0 + \omega L_A
\]
Equilibrium conditions

The equilibrium values of the 18 endogenous variables (x, x, p, n, r, w, w, w, w, K, K_A, k, L_0, L_0, L_0, N_A, Y, Y, e, n) are obtained by solving the system of the following 18 independent equations.

\[
\begin{align*}
(2)' & \quad \beta = 1 - \gamma/(\ln n + \gamma) \\
(4)' & \quad x_o = (1 - a) Y \\
(8)' & \quad \varepsilon = 1 / (1 - \beta) \\
(10)' & \quad r^a w^{1-a} = 1 \\
(11)' & \quad K_o = a r^a w^{1-a} x_o \\
(12)' & \quad L_0 = (1-a) r^a w^{1-a} x_o \\
(15)' & \quad p = r^a w^{1-a} m/s \\
(16)' & \quad px = rF + r^a w^{1-a} mx \\
(17)' & \quad k = f + a r^a l_{-1-a} w^{1-a} mx \\
(18)' & \quad l = (1-a) r^a w^{1-a} mx \\
(19) & \quad n = (1-a) / (1 - \beta) \\
(21) & \quad (w - w_o) / w = 1/n \\
(23) & \quad w \cdot (L/A / N_A) = w_o \\
(25) & \quad N_A + L_0 = L \\
(26) & \quad L_A = n l \\
(28) & \quad K_o + K_A = K \\
(29) & \quad K_A = nk \\
(30) & \quad Y = rK + w_o L_0 + wL_A \\
\end{align*}
\]

In the following section, the losses from trade restrictions (or gains from trade liberalization) will be analyzed by using the above system of equations.
1. Gains from trade under an orthodox framework

The basic proposition on the gains from trade of orthodox trade theories is that free trade is better than no trade because the availability locus under free trade lies outside of the autarky production possibility frontier (PPF). For a small country a stronger statement can be made: free trade is the best policy. The optimality of free trade has been demonstrated in the following familiar diagram.

(Figure 1)

In the free trade equilibrium of a small country the optimality condition (31) is satisfied because, by definition, the small country cannot influence its terms of trade.

(31) \[ \text{DRS} = \text{DRT} = \text{FRT} \]

Since the availability locus of the small country is given by a straight line, as is depicted in Figure 1, it is assured that the three marginal rates are
equal: domestic rate of substitution in consumption (DRS), domestic rate of transformation in production (DRT), and foreign rate of transformation in international trade (FRT). It is therefore assured that there is no room for improving welfare by deviating from the free trade equilibrium point. For a large country free trade may not be the best policy because the large country can influence its terms of trade, but it is still better than no trade. This can be demonstrated by the famous diagram due to Baldwin.

(Figure 2)

In Figure 2 the dashed curve is the famous Baldwin envelope which can be derived by connecting intersections of foreign offer curves and social budget lines corresponding to various terms of trade. A large country may improve its welfare by imposing an optimal tariff, because the optimality condition (31) is not satisfied at free trade equilibrium, where \( \text{DRS} = \text{DRT} \neq \text{FRT} \). However, even in the case of a large country, free trade is better than no trade, because every point on the Baldwin envelope lies outside of the autarky production possibility frontier.
2. Effects of trade restrictions under imperfect competition

In addition to the orthodox gains from trade briefly described above, there are various sources of gains from trade liberalization in the real world, and trade restrictions would prevent the economy from benefitting by such gains. As discussed above, many econometric studies have found at least three-fold empirical regularities (i.e. stylized facts) on gains from trade: (i) increase in the variety of goods; (ii) decrease in monopolistic power; (iii) decrease in average cost. The model developed in the previous section, which is based upon imperfect competition, would give theoretical ground to these three stylized facts. Further, the model would also explain the losses resulting from factor market imperfections.

In what follows, the losses from trade restrictions are rigorously analyzed by using the formal model. We examine the effects of trade between the two countries which are identical in tastes, technology, and relative factor endowment. Further, the sizes of the two countries are assumed to be the same for simplicity. Based upon these assumptions, we will compare the two extreme situations: autarky and free trade. Since two countries are assumed to be identical, opening up of trade is essentially equivalent to the doubling of factor endowments of the economy.

It would be convenient to solve the model before examining the effects of trade and its restrictions. Since we have eighteen independent equilibrium conditions in the model, the system can be solved for eighteen

---

5/ The last assumption can be easily relaxed, and in the next section the magnitude of losses from trade restrictions between many countries of different size will be evaluated.
endogenous variables. After some simple but tedious algebra we get the following reduced forms.

\[ (32) \quad x_0 = (1-\alpha) (G^a + G^{a-1}) K^a L^{1-a} \]

\[ (33) \quad x = F \cdot G^{a-1} \cdot (K/L)^{a-1}/E \]

\[ (34) \quad p = r^a \omega^{1-a} m/3 \]
\[ = D^{1-a} m/3 \]

\[ (35) \quad n = \frac{1-a (1-\alpha) (1+G)}{F (1+aD^{1-a} m/E)} K \]

\[ (36) \quad r = G^{a-1} (K/L)^{a-1} \]

\[ (37) \quad \omega_0 = C^a (K/L)^a \]

\[ (38) \quad \omega = DG^a (K/L)^a \]

\[ (39) \quad K_o = a (1-\alpha) (G+1) K \]

\[ (40) \quad K_A = \{1-a (1-a) (G+1)\} K \]

\[ (41) \quad k = F (1+aD^{1-a} m/E) \]

\[ (42) \quad l = (1-a)D^{1-a} mF/(D \cdot E \cdot G) \]

\[ (43) \quad L_o = (1-a) (1-\alpha) \frac{G}{2} (1+G^{-1}) L \]

\[ (44) \quad L_A = \{1-(1-a) (1-\alpha) (1+G^{-1})\} L/D \]

\[ (45) \quad N_A = \{1- (1-a) (1-\alpha) (1+G^{-1})\} L \]

\[ (46) \quad Y = rK = \omega_0 L \]
\[ = (C^a + C^{a-1}) K^a L^{1-a} \]
\( (47) \quad \beta = \frac{1-\gamma}{(\ln n+\gamma)} \)

\( (48) \quad \varepsilon = \frac{1}{(1-\beta)} \)

\( (49) \quad \gamma = \frac{(1-a)}{(1-\beta)} \)

where

\( (50) \quad D = \frac{1-a}{\beta-a} \), note \( D > 1, \frac{3D}{3n} < 0 \)

\( (51) \quad E = D^{1-a} m \cdot (1-\beta)/\beta \), note \( E > 0, \frac{3E}{3n} < 0 \)

\( (52) \quad G = \frac{(1-a)(\varepsilon-a)}{a(\varepsilon-a)+a} \), note \( G > 0, \frac{3G}{3n} > 0 \)

(a) Less Variety of Goods

First of all, international trade gives consumers greater satisfaction through a wider selection of goods than in autarky. This gain corresponds to stylized fact (i) above. For example, as the automobile trade with Japan expanded, the choices available to American consumers rapidly increased. They can choose not only from domestic models but also from a variety of foreign models. Yet the current situation of automotive trade is far from free trade, and only a portion of the models available in the producing countries have been introduced to the U.S. market. For example, Japanese firms are producing very small passenger cars for the domestic market. The engine capacity of those ultra-mini models is less than half of the subcompact model. Naturally, such small cars are inexpensive and extremely fuel efficient. They are able to run at 55 miles per hour on highways, although passengers in such a small car may not be very comfortable. Some extremely economy-conscious American consumers with small families living in a large city may prefer such an ultra-mini model, although
the number of these consumers may not be very large. If import restrictions on Japanese cars are totally lifted and the demand for Japanese cars further increases, some Japanese producers may introduce their ultra-mini models to the U.S. market and the choice available to American consumers would further increase. Conversely, if Japanese imports were totally prohibited, the choices open to U.S. consumers would be severely limited. They would no longer be able to choose small fuel efficient Japanese models. Of course, some new American models would be introduced to fill the gap. But even after an introduction of new models, the number of models available to American consumers would be probably less than before.

Such effects of trade on the variety of goods are rigorously shown by using equation (35) above. By differentiating (35) we can show

\[ \frac{\partial n}{\partial K} > 0 \text{ and } \frac{\partial^2 n}{\partial K^2} < 0. \]

Namely, the number of types of differentiated goods \( n \) will increase as capital endowment of the economy \( K \) increases, although the rate of increase in \( n \) is less than proportional to the increase in \( K \). As explained above, the opening up of trade between the two countries is essentially equivalent to the doubling of factor endowments. So, the opening up of trade means the doubling of \( K \) available to the integrated economy. The doubling of \( K \), in turn, increases the number of types, which is the same as the number of firms (or plants) due to the assumption of costless differentiation, as explained in the previous section. Further, note that as social utility function (1) shows, the increase in the number of types of goods will increase utility even if the physical quantity of differentiated goods remains constant. Hence, trade liberalization will increase consumer satisfaction through the greater variety of goods, which is brought about by the increase in the size of the integrated economy. Conversely, trade
restrictions would decrease consumer satisfaction to the extent that such restrictions reduce the size of the integrated economy. However, note that the increase in the number of types of goods is less than proportional to the increase in the size of the economy, i.e. the number of firms in each country after trade is less than before trade. This last point will become important when we analyze other losses from trade restrictions below.

Intuition behind the above gain from trade, or loss from restrictions, would be as follows. Since consumers prefer variety, from a consumers' viewpoint it will be the best situation where the number of types of goods is so large that each consumer can purchase a custom-built car with the exact specifications of his choice. Production technology, however, prevents such an almost infinite differentiation. In order to produce any positive amount of a particular type of goods, each producer has to put in a certain amount (probably a huge amount) of capital as a fixed cost. Therefore, from a viewpoint of efficiency in production, it will be the best policy to produce only one type of good because unit production cost is minimized then. The equilibrium number of product differentiation is given by these two conflicting forces, as shown by Dixit and Stiglitz. The integration of the two economies by international trade would increase capital endowment which can be employed in the integrated way. Such an increase in the integrated capital endowment will make it possible to increase the number of types of goods available to the integrated economy. Note that the amount of capital utilized as a fixed cost in the integrated economy is less than the sum of the capital for fixed costs of the two countries before trade. In other words, although the number of types of goods available after trade liberalization is less than the sum of the number of types of the two
countries before trade, the number of types available to consumers in both countries increases through the economic integration. Namely, trade liberalization will enable the society to enjoy greater variety of consumption with less fixed cost, and various restrictions on trade would prevent such a gain.

(b) Market Inefficiency -- Increase in Monopolistic Power

As is pointed out as stylized fact (ii) above, trade liberalization would decrease the market power of domestic producers. Many empirical studies have been made on the relationship between the degree of foreign competition, which is usually expressed by the import ratio of the industry, and the degree of market power of domestic producers, which is usually measured by profit margins. Most studies seem to agree that import competition reduces market power. For example, Jacquemin, De Ghellinck and Huvenfers (1980) found a negative relationship between import ratio and profit margins in Belgian manufacturing industries.

Theoretical explanations given to this stylized fact have been normally based on two firms (foreign and domestic) producing homogeneous goods under a duopoly framework, and new trade theories based upon the three basic assumptions above are not necessarily able to explain this stylized fact very well. For example, in the monopolistic competition model of Dixit and Norman (1980), elasticity of demand for each differentiated good is constant without regard to the degree of foreign competition. But such a conclusion is not very realistic, and if we adopt the assumption of variable substitutability, as is assumed in the model here, the effect of trade on market power is well explained.
A commonly used measure of the market power is the Lerner Index (L.I.), which is defined as follows:

\[ (53) \quad \text{L.I.} = \frac{p - MC}{p} \]

where MC is marginal cost. From equation (13) we know that the marginal cost of each firm in the automotive sector is \( r_{a,1}w_{1-m} \). Substituting (13) and (34) into equation (53), we get (54):

\[ (54) \quad \text{L.I.} = 1 - \beta \]

where \( \beta \) is an increasing function of \( n \) as is shown in equation (47), and we know from the discussion above that trade liberalization would increase \( n \) through the increase in the integrated capital endowment. Hence, equation (54) shows that the trade liberalization will reduce the market power of the firm, which is expressed here as the Lerner Index (or the rate of price markup).

Intuition behind it is as follows. Trade liberalization increases the number of types of differentiated goods through the increase in the market size of the integrated economy, as explained in the previous subsection. Due to the increased variety of goods available to consumers, they have a wider selection than before. Since the range of selection is widened, goods become closer and closer substitutes than before, and each firm faces more elastic demand for its products. Therefore, the price markup by the monopolistic firm would be lessened, because if a firm increases the price, it would lose more customers than before and profit of the firm would become less than before trade liberalization. Conversely, trade restrictions would encourage the firm to increase the price markup because the firm faces less elastic demand without foreign competition, and therefore, these restrictions would increase
the market inefficiency due to monopolistic power of domestic producers. In this sense, international trade would play the role of an antitrust policy.

(c) Technical Inefficiency

International trade often becomes a catalyst to more efficient production. First of all, import competition forces domestic firms to reorganize their production lines in a more efficient way. Many empirical studies have found the negative relationship between protection and technical efficiency: Block (1974) found that tariff protection in Canada has contributed to inefficient industrial structures; Carlsson (1972) found that the reduction of import competition due to tariff protection increased the number of inefficient producers for Sweden; Jacquemin et al. (1980) found a similar relationship for the case of Belgium. Secondly, the expansion of market size by trade liberalization will contribute to technical efficiency through exploitation of the benefits of increasing returns to scale technology. Scherer et al. (1975), for example, found the positive relationship between technical efficiency and the export fraction of total shipment in six industrialized countries.

Such impact of trade restrictions on technical efficiency can be rigorously shown as follows. The production level of each firm \( x \) is given by equation (33) above. By differentiating (33) we can show \( \frac{3x}{3n} > 0 \). And we already know that trade liberalization will increase \( n \), as discussed above. Hence, after trade liberalization the production level of each firm increases. Since technology of the differentiated goods sector is characterized by increasing returns to scale (IRS), average cost of production will be decreased by trade liberalization. Thus the positive relationship
Further, trade liberalization would also contribute to the decrease in average cost through another channel. Due to free entry and exit, pure profit is forced to be zero in the long run, or average cost (AC) must be equal to unit price (p). So, from equation (34) we get (55).

\[ AC = p = D^{1-\alpha}m/\beta \]

From (10) and (13) we know that the numerator of the right-hand side of equation (55) is equal to the marginal cost of production, which is an increasing function of D. Dividing equation (38) by equation (37) we get (56).

\[ D = w/w_o \]

Namely, D turns out to be a degree of wage markup in the differentiated goods sector where the labor market is imperfect. By differentiating D, we can show \( 3D/3n < 0 \). This means that marginal cost will be decreased by the decline of wage markup after trade liberalization. 6/ 7/ Hence, from (55), trade liberalization brings about an average cost decrease (i.e. technical efficiency) through two channels: further exploitation of IRS technology and decline in wage markup.

Intuition behind the above effect of trade liberalization would be as follows. The opening up of trade increases the market size, and it enables

---

6/ It can be shown that rental rate (r) also declines after trade liberalization.

7/ Note that in spite of the decrease in \( w \) the total wage of auto workers \((w L_A)\) increases after the liberalization of trade. (We can show \( \frac{\partial^2 (w L_A)}{\partial k \partial k} > 0 \) by using (38) and (44)).
each firm to capture more customers in the world market as a whole. This increased production level of each firm will result in the decrease in average cost (technical efficiency), because each firm has to put in a certain amount of capital as a fixed cost without regard to the level of production. In other words, trade liberalization reduces the fixed cost per product. In addition, due to increased competition, the firm faces more elastic demand than before, which in turn makes derived demand for labor more elastic. Faced with more elastic demand for labor, wage markup by the union is lessened, and therefore, the production cost of differentiated goods further decreases. Conversely, trade restrictions would contribute to the higher average cost (technical inefficiency) through these two channels.

(d) **Increase in unemployment**

In the previous subsections, theoretical explanations have been given to the three stylized facts on gains from trade liberalization, all of which concern the product market. In addition to the triple gains in the product market, trade liberalization would bring about another important effect through the change in the degree of labor market distortion.

As shown in equation (24) above, unemployment can exist even in the long run equilibrium if union power creates a sectoral wage differential, and the degree of wage markup in the imperfect sector is high when the elasticity of labor demand is low as shown in (21). In fact, when workers are risk-
neutral, the following equilibrium condition is obtained from (21) and (24).

\[ \frac{w - w_0}{w} = \frac{N_A - L_A}{N_A} = \frac{1}{n} \]

Note that \( \frac{(N_A - L_A)}{N_A} \) is the unemployment rate in the automotive industry, as explained in the previous section. And from (47) and (49), it can be shown that the elasticity of demand for labor \( (n) \) is an increasing function of \( n \).

\[ 3n/3n > 0 \]

Hence, from (57) and (58), trade liberalization, which increases \( n \) in the integrated economy, will decrease unemployment, or trade restrictions will increase it at least in the long run.

The above finding may be a little surprising because proponents for trade restrictions often argue that such restrictions are necessary in order to reduce unemployment. Actually, however, trade liberalization decreases unemployment through correcting distortions in the labor market. The intuition behind such an effect would be as follows. As shown above, trade liberalization increases the variety of goods available to consumers. This increase in variety makes goods closer and closer substitutes to each other. Demand for each type of differentiated goods becomes more elastic because of the increased substitutability, and each firm faces more elastic demand than before. When demand for a product becomes more elastic, derived demand for labor in each firm also becomes more elastic (Hicks-Marshall Laws of Derived Demand). Such an increase in elasticity of derived demand for labor in each firm...

---

Note that it is very easy to incorporate risk averseness of workers in the model, as explained in the footnote above. Risk neutrality is assumed here for the sole purpose of mathematical simplification.
firm, in turn, will decrease wage markup by the union. 9/ Faced with lower wage markup, producers of differentiated goods will hire more workers in order to substitute labor for capital because labor becomes cheaper than before. In addition the demand for products is increased by the decrease in price, as examined in the above subsections. Employment in the differentiated goods sector will, therefore, be increased for two reasons: higher demand for products due to lower price markup; and the factor substitution due to lower wage markup. Finally, increase in employment will reduce unemployment. Through such mechanism of many steps trade liberalization will reduce unemployment, or trade restrictions will increase it.

However, one caveat seems to be necessary here. The above finding is based upon comparative statics, and therefore, it is true only in the long run equilibrium after everything has been adjusted. The above analysis does not necessarily preclude possible gains from trade restrictions in the adjustment period.

(e) Possible Delay in Economic Development

Trade restrictions may cause an additional loss which is especially relevant to developing countries where capital is a relatively scarce resource. As shown below, under trade restrictions the differentiated goods sector tends to take more capital from the rest of the economy than under free trade, although capital is very important for economic development.

By differentiating equation (40) we can show the following.

(59) $\frac{\partial^2 K}{\partial K^2} < 0$

9/ Note that the union is assumed here to negotiate with each firm separately. So, wage markup happens to be the same for every firm because of the symmetry of the problem.
where $K_A$ is input of capital in the differentiated goods sector (e.g., automotive industry) and $K$ is the capital endowment of the economy. Namely, (59) shows that input of capital in the automotive industry of each country will decrease after trade liberalization. And from (33) and (35) we can show the following.

\[(60) \quad \frac{\partial^2 (n_x)}{\partial K^2} > 0\]

where $n$ is the number of firms in the automotive industry, which is the same as the number of automobiles due to the assumption of costless differentiation. (60) shows that the amount of automobile production in each country after trade liberalization is larger than that in autarky. Hence, from (59) and (60), after trade liberalization, the automotive industry in each country requires less capital although production of automobiles in each country increases. Conversely, under trade restrictions, the automotive industry requires more capital input for less production of automobiles.

Intuition behind the above effect is as follows. As examined in the previous subsections, the integration of two economies of the same size will increase the number of types of differentiated products but not by as much as 100%. Therefore, fixed cost per capita of automotive industry declines. The decrease in fixed cost per capita, in turn, decreases the capital requirement in the automotive industry, and thereby makes it possible to release capital resources to the rest of the economy. Where capital is scarce but very important to economic development (this situation probably holds for many developing countries), such release of capital to the rest of the economy could be counted as an additional gain from trade liberalization.

The mechanism of the quintuple losses from trade restrictions shown above is summarized in Figure 3 below.
MECHANISM OF QUINTUPLE LOSSES FROM TRADE RESTRICTIONS

Trade Restrictions

(Product Market)

Shut-out of Foreign Goods

Partial offset by an introduction of new domestic products

Number of Types of Goods

(Loss 1)

(capital market)

Number of Domestic Models

(Loss 2)

More Capital in Distorted Sector

Less Substitutability

Elasticity of Demand for Each Model

Price Markup

Less Capital in the Rest of the Economy

Output per Firm

Average Cost

More Capital in Distorted Sector

Possible Delay in Economic Developments

(Loss 5)

Figure 3
AN ESTIMATE OF LOSSES FROM TRADE RESTRICTIONS

The previous sections, which contain a qualitative analysis of the effect of trade restrictions under a new framework, rigorously show that trade restrictions bring about five sources of losses: (i) less variety of goods; (ii) market inefficiency; (iii) technical inefficiency; (iv) increased unemployment; and (v) a possible delay in economic development.

This section undertakes a quantitative analysis of these losses due to trade restrictions, using U.S. automobile trade in 1984 as an example. Estimates of losses are made in a new general equilibrium framework (as developed in this paper).

1. Method

The basic method of estimation is as follows: Parameter values in the model are identified first, and the model is solved to get predicted values of endogenous variables in the current real-world situation (partially opened trade). The model is then solved for the changed parameter values so that the values of endogenous variables in the hypothetical situation (no trade barriers) are obtained. Finally, the values of the endogenous variables in the real-world case will be compared with those under no trade barriers in order to evaluate the magnitude of losses from such trade barriers.

Note that in the following estimation, we are comparing the real-world case in 1984 with the situation where the existing auto producing countries are totally integrated without any artificial and natural barriers to automotive trade. Therefore, it should be pointed out that there are problems of both overestimation and underestimation in the figures of Table 3 below.
On the one hand, the figure is an overestimation of the real losses from various (tariff and non-tariff) trade restrictions because we are comparing here the current situation with the situation where no barriers to automotive trade exist. Obviously, even after the total integration of the world economy, there exist some natural barriers, such as transportation costs. On the other hand, the figure in Table 3 is an underestimation of losses because we are considering here only the current size of auto production in each country. As mentioned in the introduction, in the near future some developing countries will start producing automobiles while others expand their production. If we take potential auto production into account the size of the integrated economy (and the gains from economic integration) would become greater than the figure in Table 3.

As is clear from the specification of the model in the previous section, the model can be solved if the values of seven parameters \((a, a, \gamma, F, m, K, L)\) are identified. Unfortunately, however, because most parameters are unobservable, their values are calculated indirectly.

First, \(a\) in the utility function (1) must be identified.

\[
U = \left( \sum_{i=1}^{N} c_i^{\alpha} \right)^{1-\alpha} c_0, \quad 0 < \alpha < 1.
\]

\[
\beta = 1 - \gamma / (1 + N + \gamma), \quad 0 < \gamma
\]

Since the utility function is of the Cobb-Douglas functional form, \(a\) turns out to be the same as the share of the differentiated products (in this case, automobiles) in total expenditure. Table 1 shows the trend of the share of expenditures on new passenger cars. Since automobiles are durable goods, the
expenditure share fluctuates substantially according to economic conditions. Therefore it is reasonable to use the average value and set $a$ to 0.034.

Table 1: THE SHARE OF NEW AUTOS IN TOTAL CONSUMPTION EXPENDITURES

<table>
<thead>
<tr>
<th>Year</th>
<th>Share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971</td>
<td>4.2</td>
</tr>
<tr>
<td>1972</td>
<td>4.3</td>
</tr>
<tr>
<td>1973</td>
<td>4.2</td>
</tr>
<tr>
<td>1974</td>
<td>3.1</td>
</tr>
<tr>
<td>1975</td>
<td>3.0</td>
</tr>
<tr>
<td>1976</td>
<td>3.5</td>
</tr>
<tr>
<td>1977</td>
<td>3.7</td>
</tr>
<tr>
<td>1978</td>
<td>3.6</td>
</tr>
<tr>
<td>1979</td>
<td>3.3</td>
</tr>
<tr>
<td>1980</td>
<td>2.8</td>
</tr>
<tr>
<td>1981</td>
<td>2.7</td>
</tr>
<tr>
<td>1982</td>
<td>2.7</td>
</tr>
<tr>
<td>1983</td>
<td>3.0</td>
</tr>
<tr>
<td>1984</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Source: Bureau of Economic Analysis, U.S. Department of Commerce
Second, since the cost function (9) is also a Cobb-Douglas, a similar argument can be made, i.e. \((1-a)\) is equal to the labor share of total output.  

\[
(9) \quad \text{TC}_a = r^a w^{1-a} x, \quad 0 < a < 1
\]

It is widely known that the percentage of labor share is very stable over a long period of time (see Douglas (1976) for example). This stability is also verified by the recent data in Table 2. Therefore it is reasonable to use the average of data from 1970 to 1984 and set \((1-a)\) to 0.748 (or \(a=0.252\)).

**Table 2: THE SHARE OF COMPENSATION TO WORKERS IN THE NATIONAL INCOME**

<table>
<thead>
<tr>
<th>Year</th>
<th>Share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>75.5</td>
</tr>
<tr>
<td>1975</td>
<td>75.1</td>
</tr>
<tr>
<td>1977</td>
<td>74.3</td>
</tr>
<tr>
<td>1978</td>
<td>73.9</td>
</tr>
<tr>
<td>1979</td>
<td>74.1</td>
</tr>
<tr>
<td>1980</td>
<td>75.6</td>
</tr>
<tr>
<td>1981</td>
<td>74.7</td>
</tr>
<tr>
<td>1982</td>
<td>76.2</td>
</tr>
<tr>
<td>1983</td>
<td>75.0</td>
</tr>
<tr>
<td>1984</td>
<td>73.4</td>
</tr>
</tbody>
</table>

*Source:* Survey of Current Business

---

10/ Exactly speaking, this statement is not correct because only the rest of the economy, which does not include the auto industry, exhibits constant returns to scale (CRS). However, since the share of automobiles is only 3.4%, CRS in the whole economy may well be assumed for the purpose of the estimation here.
Third, $\gamma$ in equation (2) above must be identified. Since it is extremely difficult to directly estimate $\gamma$, a different approach was taken. Namely, $\gamma$ is calculated by using the actual values of the endogenous variables $\beta$ and $n$. Once we identify the value of $\epsilon$, $\beta$ can be calculated by using equation (8)'. Therefore, the estimate of $\gamma$ can be derived from actual values of $n$ (number of the models of automobiles) and $\epsilon$ (elasticity of demand for each model). \footnote[11]{Substituting the values of $n$ and $\epsilon$ into (2) and (8)', we got $\gamma = 0.7331$.}

$\gamma$ was identified.

\begin{equation}
TC = rF + r^{a-\alpha} nx, \text{ if } x > 0
\end{equation}

$\beta$ was calculated by using the actual data in 1983 \textit{(Automotive News)} after adjusting effective availability of imports. We neglected the models which had a very small volume of sales (i.e. less than 10% of average sales). In 1983 a strict VER was in effect, and it was common for customers to wait many months to get an automobile from Japan. Some customers might have chosen to relinquish a Japanese import in favor of a less satisfactory domestic model. In this circumstance, the Japanese models were not effectively available to those customers. Therefore, we estimated the number of foreign models which were effectively available by dividing the total quantity of foreign imports by the average number of sales of each domestic model. \footnote[12]{($\epsilon = 7.06$) used in this section is an estimation of Cowling and Cubbin (1971). Several attempts to estimate elasticity of demand for each model have been made, including Hunker (1983) and Toder (1978). Hunker's estimate is a short-run elasticity and Toder's estimates vary widely according to the regression equation specifications. See Appendix for results obtained using Hunker and Toder elasticities.}
F = 188.93 million and m = 7424 were estimated using a technique similar to that used in estimating $\gamma$ --- the actual value of the price of each car ($p$) and the average number of the production of automobiles in each firm ($x$) $^{13}$ were substituted into equations (15)' and (16)' above. For mathematical simplification, the rental rate ($r$) and the (competitive) wage rate ($w_o$) in 1984 are, without loss of generality, set to unity by the choice of units of endowments of capital ($K$) and labor ($L$). Note that costs considered here include normal profit of the firms, which is to be distributed to the owners of capital. Finally, the values of $K$ and $L$ are calculated so that rental rate and competitive wage rate in the current situation become unity.

2. Results of Estimation

With values for all parameters, the model can be solved for the 18 endogenous variables. The first column of Table 3 shows the predicted values of the selected endogenous variables in the real-world case for 1984. The second column shows the predicted values of the same endogenous variables under the hypothetical situation where all barriers to automobile trade are removed. As explained in the previous section, trade liberalization is essentially the same as the increase in the factor endowments in the integrated economy. Therefore, the size of the integrated economy is calculated to evaluate a loss from trade restrictions. $K$ and $L$ are multiplied by the inverse of the share of the passenger cars produced in the United

$^{13}$ p and x are calculated by using data in Automotive News and Survey of Current Business.
States in the total car output in the world, and the figure is adjusted to take into account the degree of openness of the current U.S. market.

By using Table 3, the real-world case can be compared to the hypothetical case in order to examine the magnitude of the five previously analyzed losses from barriers to trade.
Table 3: LOSSES FROM BARRIERS TO AUTOMOTIVE TRADE

(A Simulation)

<table>
<thead>
<tr>
<th>Available models:</th>
<th>Current</th>
<th>No trade barrier</th>
<th>Autarky</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreign and Domestic (n)</td>
<td>85</td>
<td>243</td>
<td>68</td>
</tr>
<tr>
<td>Domestic models (n₁)</td>
<td>65</td>
<td>54</td>
<td>68</td>
</tr>
<tr>
<td>Production in each plant (x)</td>
<td>131,779</td>
<td>107,216</td>
<td>124,253</td>
</tr>
<tr>
<td>Total domestic production (nx) *</td>
<td>100.0</td>
<td>105.8</td>
<td>98.6</td>
</tr>
<tr>
<td>Relative wage (w/w₀)</td>
<td>1.234</td>
<td>1.188</td>
<td>1.246</td>
</tr>
<tr>
<td>Price (p) **</td>
<td>10,122</td>
<td>9,567</td>
<td>10,279</td>
</tr>
<tr>
<td>Auto employment (Lₐ) *</td>
<td>100.0</td>
<td>106.7</td>
<td>98.2</td>
</tr>
<tr>
<td>Supply of auto workers (Nₐ) *</td>
<td>100.0</td>
<td>102.7</td>
<td>99.3</td>
</tr>
<tr>
<td>Unemployed workers (Nₐ-Lₐ) *</td>
<td>100.0</td>
<td>85.7</td>
<td>103.8</td>
</tr>
<tr>
<td>Capital in auto industry (Kₐ) *</td>
<td>100.0</td>
<td>95.2</td>
<td>101.3</td>
</tr>
<tr>
<td>Lerner Index ( (p-MC)/p ) *</td>
<td>0.142</td>
<td>0.118</td>
<td>0.148</td>
</tr>
</tbody>
</table>

* Index (current level = 100.0)

** Current dollars (1984)
(i) Loss 1: Less Variety of Goods

First of all, if all trade barriers are removed, the number of models available to U.S. consumers would increase from current 85 to 243, and the social welfare would increase due to the increase in the variety of automobiles. Conversely, consumers are obliged to be content with less variety due to various barriers. Note that the number of models available to consumers after trade liberalization (= 243) is fewer than the sum of available models in both countries before trade. As explained in the previous section, although the number of domestic models in each country is decreased by foreign competition after the trade liberalization, consumers are able to enjoy greater variety by the economic integration.

(ii) Loss 2: Market Inefficiency

When trade barriers exist, market distortion is greater than otherwise. As shown in Table 3, Lerner Index (= price markup) is decreased from 0.142 to 0.118 by the removal of trade barriers. Monopolistic power of domestic firms is thus decreased by foreign competition after the opening up of trade.

(iii) Loss 3: Technical Inefficiency

The most interesting point is probably the effect on the prices of automobiles. Average price of an automobile would decrease from current 10,122 dollars to 9,567 dollars (or become 555 dollars cheaper), if various trade barriers are removed. Note that this price change is a net gain (not a transfer of income from producers to consumers) to the U.S. society, because, as examined above, the price is equal to the average cost of production in the
Long run due to the entry and exit. In other words, due to various barriers to the automotive trade, the U.S. society is losing more than 5.5 billion dollars every year. This is greater than the FTC estimate ($1 billion) but smaller than the ITC estimate ($8.52 billion).

(iv) Loss 4: Increased Unemployment

The effect on structural unemployment is also substantial. Note that two long-run equilibria are compared here, and that the unemployment considered must be distinguished from cyclical unemployment resulting from short-run macroeconomic disturbances. As examined above, such structural unemployment exists even in the long-run equilibrium due to the wage markup in the imperfect labor market. It is often pointed out that the structural unemployment in the U.S. economy has increased since the early 1970s, which corresponds to the increase in the gap between the average wage in the whole economy and the wage of certain industries, such as automobile and steel. Using the model, it is estimated that the predicted value of the current relative wage of auto workers is 1.234, or the auto workers are paid 23.4% higher than average workers due to labor market imperfection. 14/ This wage markup would decrease to 18.8% if trade barriers were removed. Due to the decrease in wage markup and the increase in the demand for automobile, the amount of structural unemployment would decrease by 16.3 percent, thus various trade barriers present obstacles to such a reduction in the structural unemployment.

14/ Note that the relative wage of auto workers was 1.523 in 1984. (The figure was calculated from the data in Employment and Earnings.) But part of the wage difference is due to the difference in their skill level etc. The figure of 23.4% is to be considered as a pure wage markup.
(v) Loss 5: Possible Delay in Economic Development

Finally, due to the decrease in the necessary fixed cost in the auto industry in the United States after the removal of trade barriers (note that the number of the domestic models available decreases from 65 to 54), some capital resources (4.8% of total capital in the auto industry) are released from the auto industry, although the total domestic production of automobiles are increased by 5.8%. The released capital resources can be used for additional investment in the rest of the economy. Although the economic development may be a little irrelevant to the United States, such release of capital could be very important to many developing countries.

As summarized above, the magnitude of the quintuple losses from trade restrictions, which were rigorously derived in the previous sections, is substantial. While the loss resulting from higher prices of automobiles is in the range of the estimates of existing studies based on the partial equilibrium framework, it can be seen that under the general equilibrium framework based on the three realistic assumptions, other losses are also substantial. In particular, it is an unexpected finding that the removal of trade barriers could decrease the amount of unemployment by as much as fifteen percent.

Although the intention of this paper is to present an analytical framework based on a general equilibrium approach which can shed new light on the effects of trade restrictions, the work is by no means complete. Future studies using this model should yield more explicit results of estimates of the magnitude of the costs of protection to an economy.
APPENDIX

SIMULATION RESULTS FOR VARIOUS VALUES
OF THE ELASTICITY OF DEMAND

As pointed out in the footnote of the main text, there are various estimates of values of $\varepsilon$ (elasticity of demand for each model of automobiles):

| Source: Original publications of the above authors. |

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>7.06</td>
<td>3.5</td>
<td>1.4 - 18.3</td>
</tr>
<tr>
<td>1956 - 68</td>
<td>not shown</td>
<td>1961 - 73</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>United States</td>
<td>United States</td>
</tr>
</tbody>
</table>

Simulation results obtained from various values of $\varepsilon$ are reported below.

Simulation is not conducted for the lowest figure of Toder estimates ($\varepsilon=1.4$) because it is unbelievably low.

*/

*/ Many empirical studies seem to agree that the long-run elasticity of demand for automobiles as a whole is around two. Therefore, it does not seem plausible that the demand elasticity for each model is less than two.
Case 1: \( \epsilon = 7.06 \) (The figure of Cowling and Cubbin; the same as Table 3)

<table>
<thead>
<tr>
<th>Available models:</th>
<th>Current</th>
<th>No trade barrier</th>
<th>Autarky</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreign and domestic ( (n) )</td>
<td>85</td>
<td>243</td>
<td>68</td>
</tr>
<tr>
<td>Domestic models ( (n_1) )</td>
<td>65</td>
<td>54</td>
<td>68</td>
</tr>
<tr>
<td>Production in each plant ( (x) )</td>
<td>131,779</td>
<td>167,316</td>
<td>124,253</td>
</tr>
<tr>
<td>Total domestic production ( (nx) ) *</td>
<td>100.0</td>
<td>105.8</td>
<td>98.6</td>
</tr>
<tr>
<td>Relative wage ( (w/w_o) )</td>
<td>1.234</td>
<td>1.188</td>
<td>1.246</td>
</tr>
<tr>
<td>Prices ( (p) ) **</td>
<td>10,122</td>
<td>9,567</td>
<td>10,279</td>
</tr>
<tr>
<td>Auto employment ( (L_A) ) *</td>
<td>100.0</td>
<td>106.7</td>
<td>98.2</td>
</tr>
<tr>
<td>Supply of auto workers ( (N_A) ) *</td>
<td>100.0</td>
<td>102.7</td>
<td>99.3</td>
</tr>
<tr>
<td>Unemployed workers ( (N_A - L_A) ) *</td>
<td>100.0</td>
<td>85.7</td>
<td>103.8</td>
</tr>
<tr>
<td>Capital in auto industry ( (K_A) ) *</td>
<td>100.0</td>
<td>95.2</td>
<td>101.3</td>
</tr>
<tr>
<td>Lerner Index ((p-MC)/p) *</td>
<td>0.142</td>
<td>0.118</td>
<td>0.148</td>
</tr>
</tbody>
</table>

* Index (current level = 100.0)

** Current dollars (1964)
Case 2: $\varepsilon = 3.5$ (The figure of Hunker estimate)

<table>
<thead>
<tr>
<th>Available models:</th>
<th>Current</th>
<th>No trade barrier</th>
<th>Autarky</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreign and Domestic $(n)$</td>
<td>85</td>
<td>250</td>
<td>67</td>
</tr>
<tr>
<td>Domestic models $(n_1)$</td>
<td>65</td>
<td>55</td>
<td>67</td>
</tr>
<tr>
<td>Production in each plant $(x)$</td>
<td>131,779</td>
<td>174,116</td>
<td>122,558</td>
</tr>
<tr>
<td>Total domestic production $(nx)$</td>
<td>100.0</td>
<td>112.9</td>
<td>96.1</td>
</tr>
<tr>
<td>Relative wage $(\omega/\omega_0)$</td>
<td>1.618</td>
<td>1.485</td>
<td>1.659</td>
</tr>
<tr>
<td>Price $(p)$</td>
<td>10,122</td>
<td>8,952</td>
<td>10,439</td>
</tr>
<tr>
<td>Auto employment $(L_A^*)$</td>
<td>100.0</td>
<td>115.4</td>
<td>96.0</td>
</tr>
<tr>
<td>Supply of auto workers $(N_A^*)$</td>
<td>100.0</td>
<td>105.7</td>
<td>98.4</td>
</tr>
<tr>
<td>Unemployed workers $(N_A^* - L_A^*)$</td>
<td>100.0</td>
<td>90.1</td>
<td>103.2</td>
</tr>
<tr>
<td>Capital in auto industry $(K_A^*)$</td>
<td>100.0</td>
<td>93.6</td>
<td>101.7</td>
</tr>
<tr>
<td>Lerner Index $(\frac{(p-MC)}{p})$</td>
<td>0.286</td>
<td>0.244</td>
<td>0.297</td>
</tr>
</tbody>
</table>

* Index (current level = 100.0)

** Current dollars (1984)
Case 3: $\varepsilon = 5$

<table>
<thead>
<tr>
<th>Available models:</th>
<th>Current</th>
<th>No trade barrier</th>
<th>Autarky</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreign and Domestic (n)</td>
<td>85</td>
<td>246</td>
<td>68</td>
</tr>
<tr>
<td>Domestic models (n_1)</td>
<td>65</td>
<td>55</td>
<td>68</td>
</tr>
<tr>
<td>Production in each plant (x)</td>
<td>131,779</td>
<td>169,865</td>
<td>127,530</td>
</tr>
<tr>
<td>Total domestic production (nx)</td>
<td>100.0</td>
<td>108.4</td>
<td>98.5</td>
</tr>
<tr>
<td>Relative wage ($w/w_0$)</td>
<td>1.365</td>
<td>1.291</td>
<td>1.386</td>
</tr>
<tr>
<td>Price (p)</td>
<td>10,122</td>
<td>9,325</td>
<td>10,347</td>
</tr>
<tr>
<td>Auto employment ($L_A$)</td>
<td>100.0</td>
<td>110.0</td>
<td>97.5</td>
</tr>
<tr>
<td>Supply of auto workers ($N_A$)</td>
<td>100.0</td>
<td>103.9</td>
<td>99.0</td>
</tr>
<tr>
<td>Unemployed workers ($N_A - L_A$)</td>
<td>100.0</td>
<td>87.2</td>
<td>103.1</td>
</tr>
<tr>
<td>Capital in auto industry ($K_A$)</td>
<td>100.0</td>
<td>94.3</td>
<td>101.5</td>
</tr>
<tr>
<td>Lerner Index ( (p-MC)/p )</td>
<td>0.200</td>
<td>0.168</td>
<td>0.208</td>
</tr>
</tbody>
</table>

* Index (current level = 100.0)

** Current dollars (1984)
### Case 4: $\varepsilon = 10.0$

<table>
<thead>
<tr>
<th>Available models:</th>
<th>Current</th>
<th>No trade barrier</th>
<th>Autarky</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreign and Domestic ($n$)</td>
<td>85</td>
<td>242</td>
<td>68</td>
</tr>
<tr>
<td>Domestic models ($n_1$)</td>
<td>65</td>
<td>54</td>
<td>68</td>
</tr>
<tr>
<td>Production in each plant ($x$)</td>
<td>131,779</td>
<td>165,779</td>
<td>124,535</td>
</tr>
<tr>
<td>Total domestic production ($nx$)</td>
<td>100.0</td>
<td>104.0</td>
<td>99.1</td>
</tr>
<tr>
<td>Relative wage ($\mu/\omega$)</td>
<td>1.154</td>
<td>1.124</td>
<td>1.163</td>
</tr>
<tr>
<td>Price ($p$)</td>
<td>10,122</td>
<td>9,733</td>
<td>10,231</td>
</tr>
<tr>
<td>Auto employment ($L_A$)</td>
<td>100.0</td>
<td>104.6</td>
<td>98.8</td>
</tr>
<tr>
<td>Supply of auto workers ($N_A$)</td>
<td>100.0</td>
<td>101.9</td>
<td>99.5</td>
</tr>
<tr>
<td>Unemployed workers ($N_A - L_A$)</td>
<td>100.0</td>
<td>84.0</td>
<td>104.2</td>
</tr>
<tr>
<td>Capital in auto industry ($K_A$)</td>
<td>100.0</td>
<td>96.2</td>
<td>101.1</td>
</tr>
<tr>
<td>Lerner Index ($\frac{(p-MC)}{p}$)</td>
<td>0.100</td>
<td>0.083</td>
<td>0.105</td>
</tr>
</tbody>
</table>

* Index (current level = 100.0)

** Current dollars (1984)
Case 5: \( \epsilon = 18.3 \) (the highest figure of the Toder estimate)

<table>
<thead>
<tr>
<th></th>
<th>Current</th>
<th>No trade barrier</th>
<th>Autarky</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available models:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foreign and Domestic ( n )</td>
<td>85</td>
<td>240</td>
<td>68</td>
</tr>
<tr>
<td>Domestic models ( n_1 )</td>
<td>65</td>
<td>53</td>
<td>68</td>
</tr>
<tr>
<td>Production in each plant ( x )</td>
<td>131,779</td>
<td>164,136</td>
<td>124,827</td>
</tr>
<tr>
<td>Total domestic production ( nx ) *</td>
<td>100.0</td>
<td>102.1</td>
<td>99.3</td>
</tr>
<tr>
<td>Relative wage ( \omega/\omega_0 )</td>
<td>1.079</td>
<td>1.064</td>
<td>1.083</td>
</tr>
<tr>
<td>Prices ( p ) **</td>
<td>10,122</td>
<td>9,912</td>
<td>10,181</td>
</tr>
<tr>
<td>Auto employment ( L_A ) *</td>
<td>100.0</td>
<td>102.5</td>
<td>99.3</td>
</tr>
<tr>
<td>Supply of auto workers ( N_A ) *</td>
<td>100.0</td>
<td>101.0</td>
<td>99.7</td>
</tr>
<tr>
<td>Unemployed workers ( N_A - L_A ) *</td>
<td>100.0</td>
<td>82.6</td>
<td>104.6</td>
</tr>
<tr>
<td>Capital in auto industry ( K_A ) *</td>
<td>100.0</td>
<td>97.6</td>
<td>100.7</td>
</tr>
<tr>
<td>Lerner Index ( (p-MC)/p )</td>
<td>0.055</td>
<td>0.045</td>
<td>0.057</td>
</tr>
</tbody>
</table>

* Index (current level = 100.0)

** Current dollars (1984)
References


Dunlop, J.T., Wage Determination under Trade Unions, New York, Macmillan, 1944


Jacquemin, A., DeChellinck, and Huveneers, E., "Concentration and Profitability in a Small Open Economy," Journal of Industrial Economics, 1980


Krugman, P.R., "Increasing Returns, Monopolistic Competition, and International Trade," Journal of International Economy, 1979


Krugman, P.R., "Intraindustry Specialization and the Gains from Trade," Journal of Political Economy, 1981


