ESTIMATING THE EFFECTS OF TRADE POLICY

Robert C. Feenstra

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Department of Economics
University of California
Davis, California 95616-8578

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Abstract

This paper reviews empirical methods used to estimate the impact of trade policies under imperfect competition. We decompose the welfare effects of trade policy into four possible channels: (i) a deadweight loss from distorting consumption and production decisions; (ii) a possible gain from improving the terms of trade; (iii) a gain or loss due to changes in the scale of firms; and, (iv) a gain or loss from shifting profits between countries. For each channel, we discuss the appropriate empirical methods to determine the sign or magnitude of the effect, and illustrate the results using recent studies. Two other channels by which trade policy affects social or individual welfare - through changes in wages and changes in product variety - are discussed more briefly. Recent developments in the analysis of trade policies under perfectly competition are also reviewed.

Estimating the Effects of Trade Policy

Contents

1. Introduction

Governments of all countries routinely intervene in trade across borders, through the use of tariffs, quotas, and other non-tariff barriers, in ways that they would not do within their borders. Reductions in these trade restrictions are regularly achieved through international negotiations, but even as one set of trade barriers are lowered, there remain barriers in other sectors waiting to be addressed. An important part of this ongoing policy process is the measurement of the costs of trade restrictions. Beginning with the deadweight loss calculations of Johnson (1960), each new round of tariff negotiations has seen an attempt to measure the gains to the countries involved. The small size of gains for industrial countries has been adjusted upwards by more! recent estimates, that incorporate economies of scale, while the developing countries are typically estimated to receive larger gains.[1]

In a way, those involved in the initial calculations of the gains from tariff removal had it easy: everyone knew that the gains were positive, and only the magnitude remained to be determined. This iron-clad rule has been challenged by the recent theories of imperfect competition and trade, which suggest various ways that a country may gain through the use of 'strategic' trade policy. Krugman (1987) has argued that the presumption in favor of free trade is still a reasonable rule of thumb, though not a guarantee, under these circumstances. This conclusion is reinforced by computable models of imperfect competition and trade, in which the ambiguity of the theoretical results is resolved by introducing a minimum amount of data. These models often show that the scope for strategic policy is very limited.[2] It can be questioned, however, whether the results from these computable models are really convincing. They share with the deadweight loss calculations the reliance on elasticity assumptions, but add onto this another layer of assumptions on the conduct of firms, which are not verified from any empirical evidence. While the qualitative conclusions may not be guaranteed from the start, there is enough structure forced on the models that the data could never refute the theory.

In this chapter we shall examine how imperfect competition affects the gains and losses from trade policies, but focus on empirical models that estimate the impact of trade policies, with minimum structure imposed on the data. Like Krugman, we will conclude that there is little support for national gains due to strategic trade policies, but unlike the computable models, the data has an opportunity to accept or reject the hypotheses being considered. In their chapter in this volume. Leamer and Levinsohn adopt the principle of "'estimate, don't test' as a desirable methodology for evaluating trade theory. The analogous message of this chapter for the evaluation of trade policy is 'estimate, don't calculate.' This message applies equally well to the analysis of trade policies under perfectly competition, and recent developments in that context will also be reviewed.

We begin in section 2 by decomposing the welfare effects of trade policy under imperfect competition into four possible channels:

(i) a deadweight loss from distorting consumption and production decisions;

(ii) a possible gain from improving the terms of trade;

(iii) a gain or loss due to changes in the scale of firms; and.

(iv) a gain or loss from shifting profits between countries.

These channels are listed in decreasing order from the greatest to the least amouni of available empirical evidence, end our discussion of each will vary accordingly. Two others channels by which trade policy affects social or individual welfare - through changes in wages and changes in product variety - are not examined in the theoretical model, but will be discussed at the end of the chapter.

Deadweight losses and the terms of trade will be the focus of our analysis in section 3, where tariffs are considered. An important insight of the imperfect competition models is that 'no country is small': a tariff can be expected to lower the price at which the foreign firms are willing to sell their products, so that the tariff has a beneficial terms of trade effect. We find that this prediction has received indirect empirical support from studies of exchange rates, but that the magnitude of the terms of trade impact differs a great deal across industries. It follows that We cannot presume that tariffs will lead to a terms of trade gain in most industries, so that this channel does not amount to an argument for strategic trade policy. On the contrary, the use of tariffs in the form of antidumping duties has been found to lead to a terms of trade loss, due to collusion between firms, even in cases where the duties are riot imposed.

Attention is shifted to import quotas in section 4, and their effect on product quality. In many industries, quotas have led to an increase in the quality of imports purchased, which is an optimal response by consumers and firms. We argue that this upgrading imposes an additional deadweight loss, over and above the loss from a tariff of the same average magnitude. We introduce an index number method that can be used to measure this loss, and which applies more generally to any non-uniform trade harriers over multiple goods. The effects of the 'voluntary' export restraint on Japanese auto sales to the U.S. are also considered. Extensive modeling of the automobile industry has led to estimates of how the price-cost margins, and profits of firms. have responded to quotas. These studies provide indirect evidence on the hypothesis of Bhagwati (1965), Harris (1985) and Krishna (1989), that quotas lead to more collusive market conduct.

In sections 5 the effects of trade policy on the markups of firms, and thereby on their output and profits, is considered. Recent studies for developing countries have demonstrated that trade liberalization can lead to substantial reductions in price-cost margins, at least in those industries that are imperfectly competitive. Corresponding to these reductions in margins will be an increase in firm-level output, which leads to welfare gains if there are economies of scale. Conversely, in industrial countries it is more common to treat import competition as a potential source of unemployment, with private (if not social) losses. The evidence linking import competition, wages and employment for the United States is reviewed in section 6, and the impact of changes in product variety is also considered. In section 7 we describe an ongoing project to provide international data, and present conclusions.

2. General Framework

In order to organize our subseqent discussion, we first show how the welfare effects of trade policy under imperfect competition can be decomposed into separate components. We shall slightly extend the framework of Rodrik (1988), and treat imports and domestically produced goods as imperfect substitutes. Let the index i denote goods $i=1,...,I$, each of which is available in an import and domestic variety. Imports are sold at the international price p_i^a and the domestic price p_i, where $(p_i - p_i^a)$ is a wedge reflecting tariffs or quotas. Domestically produced goods are exported and sold domestically at the price q_i, where for convenience we ignore export taxes or subsidies. We let C_i denote the consumption of each import good, and let D_i denote the consumption of the domestically produced variety. The overall level of expenditure needed to obtain the level of utility U can be written as a function $E(p,q,U)$, depending on the price vectors $p=(p_1,...,p_I)$ and $q=(q_1,...,q_I)$. The derivatives of the expenditure function with respect to prices equal the levels of consumption:

$$\partial E/\partial p_i = C_i \text{ and } \partial E/\partial q_i = D_i, \qquad i=1,...,I. \tag{1}$$

We will suppose that each domestically produced good is sold by n_i firms, where the output each firm is denoted by y_i, and industry output is $Y_i \equiv n_i y_i$. The total costs for each firm in industry i are denoted by $\phi_i(y_i,w)$, where w is the vector of wages. Under increasing return to scale, average costs exceed marginal costs, so that $\phi_i/y_i > \phi_{iy} \equiv \partial\phi_i/\partial y_i$. Denote the endowment of each factor of production by v_j, $j=1,...,J$. Under full employment, the endowment equals the total demand for each factor, which is obtained by differentiating the cost function with respect to wages. and summing across firms and industries:

$$v_j = \sum_i n_i(\partial\phi_i/\partial w_j), \qquad j=1,...,J. \tag{2}$$

Under any system of import tariffs and quotas, the level of home utility can be determined by setting expenditure E equal to the value of income from all sources:

$$E(p,q,U) = \sum_i [q_i - (\phi_i/y_i)]Y_i + \sum_j w_j v_j + \sum_i (p_i - p_i^*)C_i \ . \qquad (3)$$

The first term on the right of (3) is profits earned across the industries, which would equal zero under free entry. The second term is the value of factor income. The third term is total tariff revenues or quota rents, if these are redistributed to consumers. If the quota rents are instead captured by foreigners, as occurs under a 'voluntary' export restraint (VIER), then these rents will not appear in the third term in (3) because $p_i = p_i^*$.

Let U^0 be the level of welfare obtained under free trade, with expenditure equal to income in (3). Our goal to compare the level of welfare obtained under free trade with that obtained under some trade policies. Rather than directly compare utilities, it is convenient to ask how much income the consumers need to give up (or be compensated) in the presence of the trade policies, to obtain the *same* level of utility U^0 as under free trade. This income is computed by taking the difference between total income received under the trade policies, and consumer expenditure $E(p,q,U^0)$ at the free trade utility U^0:

$$B(p,q,p^*,U^0) = \{\sum_i [q_i - (\phi_i/y_i)]Y_i + \sum_j w_j v_j + \sum_i (p_i - p_i^*)C_i\} - E(p,q,U^0) \ , \qquad (4)$$

where p^* is the vector of world prices for imported goods. The right side of (4) is just the difference between the right and left sides of (3), except that we compute consumer expenditure at the free trade utility level U^0. If (4) is positive, it represents the gains due to the trade policies, while if (4) is negative then it represents the losses, so that B can be interpreted as a measure of welfare or "benefits.' In addition, B can be interpreted as the *balance* of *trade* **surplus** (deficit if negative) obtained with the utility level U^0 in the presence of the trade policies.

2.1 Welfare Effects

To determine the effect of any small change in trade policy, let U^0 now denote the utility level at any initial equilibrium with tariffs and quotas, satisfying (3).

Then the change in welfare due to a small change in trade policy can be obtained by totally differentiating (4), holding U^0 fixed. Making use of (1) and (2), the resulting change in welfare can be written as.

$$dB = \sum_i (p_i - p_i^*)dC_i + \sum_i [(Y_i - D_i)dq_i - C_i dp_i^*]$$

$$+ \sum_i [(\phi_i/y_i) - \phi_{iy}]n_i dy_i + \sum_i [q_i - (\phi_i/y_i)]dY_i \ . \qquad (5)$$

The first term on the right of (5) is the deadweight loss caused by the change in import volume. The second summation is the terms of trade effect, on both exports $(Y_i - D_i)$ and imports C_i. The third term is the difference between average and marginal costs (which is positive), multiplied by the change in industry outputs due to changes in *firm* outputs, reflecting the potential for raising welfare through greater use of economies of scale.[3] The final term on the right of (5) is the change in profits caused by a change in industry outputs. This term disappears if profits were equal to zero initially, as under free entry.

We should also mention two other channels by which trade policy affects welfare, that are ignored in (5). The first is changes in employment in the presence of wage distortions across industries. In this case, an expansion of employment in the highest-wage industries increases welfare: in terms of equation (5), the average costs of production exceed the social opportunity costs of withdrawing workers from other industries. Katz and Summers (1989a,b) have argued that wage distortions across industries justify the use of trade policy, as will be discussed in section 6. The second is changes in the number or range of differentiated products available. While we have treated the import and domestic variety as imperfect substitutes, we have not allowed for changes in the range of these varieties available, as would occur under monopolistic competition. The welfare impact of changes in domestic variety requires a comparison of marginal costs and benefits, but the impact of an increase (decrease) in *import* variety is always positive (negative). The welfare effects of changes in product variety has received little empirical attention.[4] though it is an important area for further research, as also discussed in section 6.

2.2 Mode of Market Conduct

So far, we have not specified the form of industry pricing. In some cases in this chapter we will concentrate on perfectly competitive pricing, and in other cases allow for oligopoly pricing. These can be nested by using a general form of the pricing relation, which is written for the domestic firms as:

$$q_i[1-(\theta_i/\eta_i)] = \phi_{iy}(y_i, w) \, , \tag{6}$$

where $\eta_i \equiv -\partial \ln D_i/\partial \ln q_i$ denotes the elasticity of demand for the domestic good, and θ_i denotes the firm's 'mode of market conduct': $\theta_i = 0$ under perfect competition, and $\theta_i > 0$ under oligopoly. For example, if we assume Cournot-Nash pricing, then θ_i equals the share $(1/n_i)$ of an individual firm. More generally, θ_i reflects the strategies played by domestic firms, as well as their size-distribution. Methods for estimating the market conduct have been developed as part of the 'new empirical industrial organization,' surveyed by Bresnahan (1989). While we will not discuss these methods until section 5, it will be clear that some of the empirical techniques dealt with before then provide information on the market conduct parameter.

The analogous pricing relation for the foreign firms is:

$$p_i^*[1-(\theta_i^*/\eta_i^*)] = \phi_{ix}^*(x_i^*, w^*) \, , \tag{7}$$

where x_i^* denotes the exports (or output) of each foreign firm, with total exports $X_i^* \geq C_i$; $^*(x_i^*, w^*)$ are foreign costs: $\eta_i^* \equiv -\partial \ln C_i/\partial \ln p_i$ denotes the elasticity of demand for imports; and θ_i^* denotes the foreign firms' 'mode of market conduct.' Finally, if there is free entry of firms, prices will equal average cost, so that.

$$q_i = \phi_i(y_i, w)/y_i \, . \tag{8}$$

and

$$p_i^* = \phi_i^*(x_i^*, w^*)/x_i^* \, , \tag{9}$$

for the domestic and importing firms, respectively.

3. Tariffs

In this section and the next, we focus on the first two terms in *(5)* - the deadweight loss and terms of trade effect - while ignoring the welfare effect of changes in domestic output arid profits, which will be considered in section *5.* Initially, we will consider an ***ad valorem*** tariff of τ applied to a single good, and suppose that the prices of all other goods are held constant. Then dropping the subscript i, the first two terms in (5) can be written as:

$$\frac{dB}{dt} = (p - p\ )\frac{dC}{d\tau} - C\frac{dp^*}{d\tau} , \qquad (10)$$

where C denotes imports of the good in question.

Let p^a denote the initial, free trade price of the good. By integrating (10) over the tariff levels between 0 and t. we can obtain an expression for the total change in welfare due to the tariff:

$$\Delta B = \int_0^t (p - p^*)\frac{dC}{d\tau}\,d\tau - \int_0^t C\frac{dp^*}{d\tau}\,d\tau \qquad (11a)$$

$$= \int_0^t (p - p^0)\frac{dC}{d\tau}\,d\tau + (p^0 - p^*)C . \qquad (11b)$$

This derivation can be understood' by referring to Figure 1, where we show the domestic import demand curve C and the foreign export supply curve X^*. The effect of the tariff is to lower the international price from p^a to p^*, and raise the domestic price from p^a to $p=p^*(1+t)$. The first term on the right of (1la) is the deadweight loss, equaling areas F+H in Figure 1, and the second term is the terms of trade gain. equaling areas G+H. Alternatively, we can cancel area H in both these terms, and obtain (11b), where the first term on the right is the deadweight loss F, and the second term is the terms of trade gain G.

If the demand curve is linear, then the deadweight loss F can be written as

$\frac{1}{2}(p-p^0)(C^0-C^1)$, where C^1 is expenditure on imports at the domestic price $p=p^*(1+t)$. To measure this cost we need estimates of the change in imports due to the tariffs, as well as the change in the domestic price of the importable. If international prices are fixed, then the change in the domestic price is just the (specific) tariff. The crop in imports is frequently obtained by multiplying the *(ad valorem)* tariff by a 'reasonable' import demand elasticity. As simple as this triangle formula is, it is frequently used in policy analysis (e.g. Hufbauer and Elliott, 1994).

Despite the attractiveness of using a simple formula to measure the deadweight loss, this approach has several limitations. The most obvious is that it is extremely sensitive to the projected change in imports, so that the deadweight loss has a standard error that is proportional to that of the demand elasticity used, which is most often not reported in this context. Furthermore, studies such as Leamer (1988a.b. 1990) have directly estimated the impact of tariff and non-tariff barriers on imports, and found that this impact is very small or even of the 'wrong' sign. This leads us to question whether the use of "reasonable' import demand elasticities to measure the loss in (11) is supported by the data at all.

Leamer suggests that the unusual magnitudes obtained from direct estimation of the effects of tariffs on import's may be due to a simultaneity problem: high tariffs may be applied to those industries with high imports. In this case, a regression of imports on tariffs could not be expected to uncover the import demand elasticity. Instead, the elasticity should be obtained by explicitly recognizing the endogeneity of tariffs and non-tariff barriers, and modeling these with another equation motivated from a political-economy framework:. This is the approach taken by Trefler (1993), with dramatic results: when trade protection for the U.S. in 1983 is modeled endogenously, its estimated impact on imports is 10 times larger than obtained by treating it as exogenous. While additional work would be desirable to see how this estimate extends to other samples, these results illustrate the usefulness of an estimation approach.

3.1 Trade Distortion Index

A second limitation of the triangle formula arises when non-uniform tariffs are applied over multiple industries. In this case, a common empirical practice is to average the tariff rates, and then compute a deadweight loss triangle for this average. The problem with this approach is that the average tariff is computed by adding up tariff revenue over all the goods being considered, and then dividing by total expenditure on imports. For example, applying this method to the U.S. yields an average tariff level of 3.7% in manufacturing. However. this method of computing the average tariff is completely wrong for making any welfare inference. The reason is that a prohibitive tariff would lead to zero tariff revenue, and therefore not be counted at all in the average. A valid averaging procedure, however, can be obtained from the balance of trade function in (4), and is referred to as a 'trade restrictiveness index' by Anderson and Neary (1992, 1994a.b) and Anderson (1994a,b).[5]

To develop their index, let τ_i denote the *ad valorem* tariff on good i. Suppose that international prices are fixed at p_i^0, so that domestic prices of the imports are $p_i = p_i^0(1+\tau_i)$, or the vector p. Letting U^0 be the level of utility obtained with free trade, then $B(p,q,p^0,U^0)$ is interpreted as welfare under the tariffs. Now consider obtaining the same level of welfare under a *uniform* import tariff at the rate T, so that domestic prices are $p_i^0(1+T)$, or the vector $p^0(1+T)$. Then the 'trade restrictiveness index' is defined as the value of T that results in the same level of welfare as the individual tariffs τ_i.

$$B[p^0(1+T),q,p^0,U^0] = B(p,q,p^0,U^0). \qquad (12)$$

In order to determine the index corresponding to any pattern of individual tariffs, we would need to solve for T from (12), as could be done with a computable general equilibrium (CGE) model. However, some insight into the properties of this index can be obtained by differentiating (12) with respect to T and τ_i, holding world prices constant. This exercise yields,

$$\sum_i \frac{\partial B}{\partial p_i} p_i^0 \, d\tau_i = \sum_i \frac{\partial B}{\partial p_i} p_i^0 \, dT. \tag{13}$$

For fixed world prices, the derivative of B with respect to domestic prices is given by the first term in (10), or $\partial B/\partial p_i = (p_i - p_i^0)\partial C_i/\partial p_i$, which is interpreted as the marginal deadweight loss of the tariff. Assuming that the import demand curves are linear, we can integrate (13) over values of the individual tariffs from 0 to ti, $i=1,\ldots,I$, and for the trade restrictiveness index between 0 and T. Performing this exercise, we obtain.

$$T = \left[\frac{\sum_i (\partial C_i/\partial p_i)(p_i^0 t_i)^2}{\sum_i (\partial C_i/\partial p_i)(p_i^0)^2} \right]^{1/2} \tag{14}$$

The trade restrictiveness index is therefore a weighted average of the ***squared values*** of individual tariffs t_i, where the weights reflect the ***change*** in import expenditures caused by a one percent change in the price: $(\partial C_i/\partial p_i)(p_i^0)^2 = p_i^0(\partial C_i/\partial \ln p_i)$, evaluated at the free trade prices p_i^0. Using these weights, prohibitively high tariffs will still receive positive weight in the index.[6] Having the squared value of individual tariffs appear in (14) means that the restrictiveness index will depend on both the weighted average level of the tariffs, and their variance, where both these measures are sometimes used by policy analysts.[7] This reflects the general result that increases in the dispersion of tariff rates will raise their deadweight loss.

Given an estimate of the trade restrictiveness index T, the deadweight loss of these tariffs could be obtained by using a triangle formula, applied to the change in the Hicksian aggregate of imports between the price $\mathbf{p}^0$ and $\mathbf{p}^0(1+T)$. The problem, however, is that this hypothetical change in aggregate imports is not the same as the observed change due to the actual tariffs, and would therefore need to be calculated using some elasticity for the Hicksian aggregate, multiplied by T. This leads us to the same limitation discussed above. namely, that the use of a 'reasonable' elasticity for the Hicksian aggregate would not be based on the drop in imports in the data. The same reliance on elasticity parameters occurs in the calculation of the trade restrictiveness index itself (to obtain $\partial C_i/\partial p_i$ for the individual imports i). Thus. while this index solves the problem of how to aggregate tariffs over multiple goods, it does not really meet our criterion of 'estimate, don't calculate.' In section 4.1, we will discuss an alternative method for measuring the deadweight loss from trade barriers applied over multiple goods, which goes some distance toward meeting this criterion. These two methods for measuring the deadweight loss are noted in the first row of Table 1, where we shall keep a running list of trade policy issues and the available estimation methods.

3.2 *Terms of Trade*

Returning to the case of a tariff on a single good, let us now consider the possible terms of trade effect. In competitive models. the tariff results in a terms of trade gain only if the reduction in import demand is large enough to lower the world price, as illustrated in Figure 1. Since any country is but a fraction of the world market, there has been a tendency to treat the terms of trade as fixed in policy analysis. However, the imperfect competition literature suggests that tariffs will result in terms of trade gains regardless of the buyer's size, since foreign exporters will generally not allow consumer prices in the importing country to rise by the full amount of the tariff. This behavior simply reflects profit-maximization by the foreign exporters, and we refer to it as 'incomplete pass-through' of the tariffs. This result was first noted by Katrak (1977), De Meza (1979) and Svedberg (1979) for a monopoly model, while Brandler and Spencer (1984) further developed it in a monopoly and oligopoly context, and Gros (1987) extended it to a monopolistic competition framework. We shall illustrate the result for the simple case of a foreign monopolist facing a linear demand curve in the home country.

In Figure 2, the foreign firm faces the home demand curve of C, and has constant marginal costs of production of ϕ_x^*. The profit-maximizing price and imports are p^0, C^0, where marginal revenue equals marginal cost. If a specific tariff of s is applied.

then the marginal costs of selling in the home market rise by the amount s. leading to a fall in sales from C^0 to C^1, and an increase in the domestic price from p^0 to p. However, because the demand curve is only half as steep as the marginal revenue curve, the increase in price is only one-half as much as the rise in marginal costs: it follows that the net price received by the foreign firm has fallen, $p^* = (p - s) < p^0$, which is a terms of trade gain for the importing country. For small specific tariffs, this terms of trade gain will occur whenever the demand curve is flatter than the marginal revenue curve.

The welfare gain for the! importing country equals G-F in Figure 2, where these areas have the same interpretation as in the competitive case illustrated in Figure 1 To maximize the gains, the home country should apply a tariff until the derivative in (10) equals zero. Writing the change in import demand as $\partial C/\partial\tau = (\partial C/\partial p)(\partial p/\partial\tau)$, the optima'l *ad valorem* tariff τ^* can be readily solved as:

$$\tau^* = \left(\frac{1}{\eta^*}\right)\left[\left(\frac{\partial \ln p}{\partial \ln(1+\tau)}\right)^{-1} - 1\right], \tag{15}$$

where η^* is the elasticity of import demand, and $\partial \ln p/\partial \ln(1+\tau)$ is the response of the tariff-inclusive price to changes in the tariff, or the "pass-through elasticity.' If the pass-through elasticity is less than one, then the foreign firms are absorbing part of the tariff by lowering their selling price, and the optimal tariff is positive. This expression for the optimal tariff contrasts with the more conventional 'inverse of the foreign supply elasticity" formula, which is not a helpful way to think about the optimal tariff when the foreign firm is imperfectly competitive, and has no supply curve (but just points of optimal supply).

There have only been a few cases where the pass-though elasticity has been estimated for tariffs, but a large number of cases where this elasticity has been estimated for changes in exchange rates, in what is called 'pricing to market' behavior (Krugman, 1987). To see the connection between these, suppose that the import is provided by a single foreign firm with output equal to import demand, $x^* = C$.

Write the marginal costs of the foreign firm as $\phi_x^* = v^*(C)w^*e$, where $v^{*\prime} > (<) 0$ denotes rising (falling) marginal costs, w^* is an aggregate of foreign factor prices. and e denotes the (actual or expected) exchange rate to convert the foreign costs into the domestic currency.[8] An appreciation of the exporter's currency corresponds to a rise in e. The first-order condition (9) is now written as:

$$\frac{p}{(1+\tau)}\left[1 - \left(\frac{\theta^*}{\eta^*}\right)\right] = v^*(C)w^*e \ , \tag{16}$$

where $p/(1+\tau)$ is the import price net of the tariff, and θ^* denotes the mode of market conduct. Assuming that the domestic and import varieties of the good in question are weakly separable from other goods in the expenditure function, then import demand C and the elasticity η^* depend on the prices p and q of the import and domestic goods, as well as consumer expenditure E on just these goods. Then multiplying both sides of (16) by the tariff factor $(1+\tau)$, the tariff-inclusive price of the importable can be solved from (16) as an implicit function:

$$p = \psi^*[w^*e(1+\tau), q, E, \theta^*] \ . \tag{17}$$

It is immediate from (17) that changes in the tariff, $d\ln(1+\tau)$, and changes in the expected exchange rate, $d\ln e$, should have *equivalent* effects on the domestic price: Feenstra (1989) refers to this as 'symmetric' pass-through of tariffs and exchange rates. The pass-through elasticity can be solved from (16) as:

$$\frac{\partial \ln p}{\partial \ln e} = \frac{\partial \ln p}{\partial \ln(1+\tau)} = \left[1 + \left(\frac{\theta^*}{\eta^* - \theta^*}\right)\frac{\partial \ln \eta^*}{\partial \ln p} + \eta^*\left(\frac{Cv^{*\prime}}{v^*}\right)\right]^{-1} , \tag{18}$$

where $\partial \ln \eta^*/\partial \ln p$ is the change in the demand elasticity η^* with respect to a change in the import price. This term reflects changes in the price-cost margins charged by firms. For demand curves that are less convex than a constant-elasticity curve, the elasticity η increases with price, $\partial \ln \eta^*/\partial \ln p > 0$. This means that exporters lower their markups as their currency appreciates, so the pass-through elasticity is less than unity. However, it is evident from (14) that rising marginal costs ($v^{*\prime} > 0$) will also make the pass-through less than unity. Thus, the empirical finding of incomplete pass-through is consistent with either imperfectly competitive pricing, or rising marginal costs under perfect competition. When foreign firms are exporting to multiple markets, as discussed below, we will be able to control for changes in marginal cost due to changes in output or other reasons: in this case, a pass-through elasticity less than unity will be interpreted as evidence of imperfect competition, or 'pricing to market' behavior.

Feenstra (1989) tests for equal pass-through of tariffs and exchange rates for U.S. imports of heavyweight motorcycles and compact trucks from Japan. The former was subject to a tariff between April 1983 and October 1987, declining from 45 to 10 percent. while the latter has had a 25 percent tariff imposed since August 1980. A log-linear form for (17) is used,

$$\ln p_t = \alpha_0 + \alpha \ln(w_t^* e_t) + \beta \ln(1+\tau_t) + \sum_i \gamma_i \ln q_{it} + \delta \ln E_t + \varepsilon_t \ , \qquad (19)$$

where p_t is the annual price of Japanese cycles or trucks, q_{it} refers to the price of various competing varieties, and ε_t is a random error. The expected exchange rate e_t is modeled as a weighted average of past spot rates (though a forward rate could also be used). Several of the regressors in (19) are endogenous, including the prices q_{it} and expenditure E_t, so the regression is estimated with instrumental variables.

Symmetric pass-though of exchange rates and tariffs is tested as the equality of α and β. For compact trucks the estimated coefficients (standard errors) were 0.63 (0.08) and 0.57 (0.141, respectively, while for heavyweight cycles the point estimates were 0.89 (0.22) and 1.13 (0.16). The hypothesis that these two coefficients are equal for each product is accepted, and when this hypothesis is imposed, the estimated coefficients are 0.58 (0.06) for trucks and 1.08 (0.15) for motorcycles. The pass-through of less than unity for compact trucks means that the tariff led to a terms of trade gain, but this apparently did not occur for motorcycles, where the pass-through is insignificantly different from unity. Feenstra argues that the difference in the pass-through in these two industries reflects the different market shares of Japanese imports: in trucks, the Japanese imports faced significant competition from American compact models that were newly developed: whereas in heavyweight cycles, the only competitor was Harley-Davidson, which had a relatively small market share.

3.3 Exchange Rate Pass-Through

Many other studies have estimated the pass-through of exchange rates rather than tariffs. Knetter (1989,1993) and Gagnon and Knetter (1992) use panel data for industry exports to several destination markets. Marginal costs to destination market k are written as $v^*(x_t^*)w_t^*e_{kt}$, depending on total exports x_t from each firm, and the exchange rate e_{kt} between the source country and destination market k. In this case foreign marginal costs, $v^*(x_t^*)w_t^*$, can be estimated as a fixed-effect for each period. Letting $\omega_t \equiv \ln[v^*(x_t^*)w_t^*]$ denote this fixed-effect, the estimating equation becomes:

$$\ln p_{kt} = \lambda_k + \omega_t + \alpha_k \ln e_{kt} + \delta_k \ln E_{kt} + \varepsilon_{kt} , \qquad (20)$$

where p_{kt} is the price of the export in the destination market currency. λ_k is a fixed effect across destination markets, and E_{kt} is consumer expenditure in that market. The aggregate price of competing goods is used as a deflator for all the variables in (20), so it does not appear explicitly.[9] The advantage of this formulation over (19) is that we are able to control for any changes in foreign marginal costs using the fixed effect ω_t. For example, the prices of imported intermediate inputs would depend on the exchange rate, which would affect the degree of pass-through unless controlled for.[10] By estimating foreign marginal costs as a fixed effect, the pass-through coefficient α_k reflects only changes in price-cost margins, so that $\alpha_k < 1$ is evidence of imperfect competition.

Knetter (1989,1993) finds incomplete pass-through over a wide range of manufactured goods, for exporters from several countries. Generally, exporters frorn the Germany. Japan or the U.K. are found to have lower pass-through coefficients than exporters from the United States (high pass-through for U.S. exporters was also found by Mann, 1986). However, this pattern appears to be primarily due to differences *across* industries. In the industries for which comparable export data were available for these four countries, no significant difference in the pass-through behavior of the exporters could be found.[11] Knetter concludes that industry effects appear to be more important than either source or destination-market effects in explaining differences in pass-through behavior.

The mode of market conduct parameter θ^* appearing in (18) will influence the degree of pass-through.[12] Feinberg (1986,1989a,1991) tests the related hypothesis that market concentration affects the pass-through of exchange rates to *domestic* prices. In terms of our framework, assuming for simplicity that output y goes entirely to domestic demand (i.e. there are no exports). the first-order condition (6) can be solved to determine the equilibrium level of domestic prices,

$$q = \psi[w,p,E,\theta] \tag{21}$$

Analogous to the determination of import prices in (18), domestic prices depend on the mode of market conduct, as well as on the import prices themselves. This is one route by which changes in exchange rates will influence domestic prices, and a second route is the use of imported intermediate inputs, which affects the factor price aggregate w in (21). Feinberg finds that the impact of exchange rates on domestic prices is higher for those industries depending more heavily on imported interme-diates, or producing goods that are close substitutes for imports, and lower for capital-intensive and concentrated industries. The estimating equation should be viewed as a reduced form of (18) and (21), where domestic prices are solved in terms of the variables $[w^*e(1+\tau),w,E,\theta^*,\theta]$. More recently, Ceglowski (1991) and Feinberg (1993) have simultaneously estimated (18) and (21), and Feinberg finds that the indirect effect of exchange rates on U.S. prices - through the import prices -

dominates the direct effect through imported intermediates.

The general conclusion to be drawn from these studies of exchange rates and international prices is that pass-through is less than unity for many manufactured products, but its magnitude differs a great deal across industries. This conclusion is indicated in the second row of Table 1. Even without relying on complete symmetry of pass-through between tariffs and exchange rates (as would not occur with imported intermediates. for example), these results indicate we should not have any presumption about the extent of terms of trade gain due to tariffs, but must treat each industry on a case-by-case basis. Moreover, it should be emphasized that the terms of trade is but one component of the welfare effects discussed in section 2, and evidence of a large terms of trade gain does not necessarily mean that a tariff in that industry is desirable. For example, in the cases of U.S. import of compact trucks and heavyweight motorcycles, the tariff on motorcycles was temporary (lasting four years) and allowed Harley-Davidson to recover its profitability, while the tariff on compact trucks is still in effect. For this reason alone. the tariff on cycles might: be judged superior to that on trucks, even though it did not yield a terms of trade gain.

3.4 Antidumping Duties

In recent years there has been a surge in cases of alleged dumping, which is defined in U.S. law as foreign products exported to the US. at prices below 'fair value,' i.e. either below the prices of comparable goods sold in the exporter's home market, or below the cost of production. In cases where it is determined that dumping has occurred, antidumping duties can be applied. Researchers have recently turned their attention to these cases to understand both the reasons for their frequency (Baldwin and Steagall. 1993; Hansen and Prusa, 1993). and the welfare effects.

One explanation for the frequency of cases is related to the incomplete pass-through of exchange rates. If foreign currencies appreciate, and foreign exporters raise their prices (in the importer's currency) by less than the appreciation, then it is quite possible that the import price will be less than the foreign cost or price of comparable goods, when these are converted at the current exchange rate. Thus, the appreciation of foreign currencies makes the finding of 'less than fair value' more likely. On the other hand, the imposition of a dumping duty also requires that imports cause "material injury' to the domestic industry, which is less likely when foreign currencies are appreciating. Feinberg (1989b) finds that the first of these effects dominates, and the frequency of dumping complaints in the U.S. (particularly those against Japan) increases with the appreciation of foreign currencies.

A second explanation for the frequency of cases is that filers expect some benefit even before a case is concluded. Prusa (1992) was the first to recognize that antidumping petitions can be ***withdrawn*** prior to their resolution, in which case the domestic and foreign firms are permitted to jointly determine the selling price for imports (typically negotiated through the Department of Commerce). Cases can also be ***suspended*** prior to their termination, in exchange for a promise by the foreign firms to stop dumping. We expect that both these actions would lead to an increase in import prices, and a terms of trade loss. In addition, the ***investigation*** of 'less than fair value' may also lead exporting firms to increase their prices, to lower the probability of a positive finding. Harrison (1991) and Staiger and Wolak (1994) examine the impact of these various "non-duty' channels on imports, and find that the impact is substantial. In particular. Staiger and Wolak find that suspended agreements lead to a reduction in imports (with an implied increase in price) similar in magnitude to cases were duties are applied. Furthermore, the impacts of investigations themselves are substantial. providing about one-half the reduction in imports that would occur from duties.

Thus, we see that the application of anti-dumping law has increased collusion between domestic and foreign firms and reduced imports, even when duties are not levied. This conclusion in indicated in Table 1, and shows how rather than imperfect competition leading to a strategic use of trade policy. the antidumping policy itself has led to an enhancement of collusive behavior. Without any tariff revenue collected in this case, the importing country very likely suffers a welfare loss.[13]

4. Quotas

For nearly all quotas used in the United States, the rents are earned by the foreign exporters in the form of higher prices, as under 'voluntary' export restraints (VERs).[14] In terms of equation (5), the domestic and international prices of imports are equal ($p_i = p_i^*$), and the importer faces an increase in this price, which is a terms of trade loss. With the competitive foreign supply curve X^* in Figure 1, a quota at the level C^1 would increase the (domestic and international) price of imports to p, resulting in quota rents of E+G. Relative to free trade, the cost to the importing country equals the areas E+F. Calculations of these losses for the principal U.S. quotas are summarized in Feenstra (1992).

While the fact that foreign exporters earn the quota rents means that they might gain from the trade restriction, this result is not assured. In Figure 1, where competitive foreign exporters have the supply curve X^*, the foreign gain due to a quota at C^1 equals E-H, where H is a deadweight loss for the foreign producers. This gain will be negative if the quota is sufficiently restrictive. In the case of monopolistic foreign supplier, the impact of the quota at C^1 on foreign profits is measured by E-H in Figure 2, which is necessarily negative since profits were maximized initially. In contrast, under oligopoly a quota at near the free trade level can raise the profits of foreign exporters, and possibly also of domestic firms, due to more collusive market conduct. This is demonstrated by Harris (1985) and Krishna (1989), extending the analysis of Bhagwati (1965). Indirect evidence of the impact of quotas on market conduct will be presented in section 4.2. The ***converse*** hypothesis - that trade liberalization will lead to less collusive pricing - has recently been confirmed for several developing countries, as we shall discuss in section **5.1.**

In comparison with tariffs, estimation of the welfare costs of quotas is more difficult for two reasons. First, the amount by which the quota raises the domestic price - or the price-equivalent of the quota - is not directly observed, but must be estimated. One common method for doing so is just the reverse of what we described in section 3 for calculating the drop in imports under a tariff: take the difference between the quota level and some projected (free trade) imports as the drop in quantity, and multiply this (percentage) drop by a 'reasonable' import demand elasticity, to obtain the increase in price due to the quota. This method suffers from the same problems discussed for the tariff case: the estimated price increase is very sensitive to both the projected imports and the demand elasticity that are used, and would have a standard error depending on both of these. In order to directly estimate the impact of the quota on price. an alternative method is to compare the price in the quota-restrained market to that in some similar market that does not have the quota. This method will be described for the automobile industry, in section 4.2.

In order to estimate the impact of quotes on import quantity, the method used by Leamer (1988a,b, 1990) and Trefler (1993) is to specify a structural model of imports, the Hecksher-Ohlin-Vanek (HOV) model, and then investigate how tariffs. quotas, and other non-tariff barriers affect the import levels. Leamer uses this approach to develop measures of the 'openness' of the industries and countries in his sample. The advantage of these measures is that they consistently estimate the impact of the trade barriers arid their standard errors. The disadvantage, however, is that they are very sensitive to the structural model used to estimate the import equations. This disadvantage is seen most clearly by considering studies that also use the HOV model, but do not include data on trade barriers. For example, Lawrence (1987) and Saxonhouse (1989) are both interested in the question of whether Japan imports 'too little' as compared with other countries, and both use the HOV model extended to allow for intra-industry trade to specify the import equations. But without having explicit data on trade barriers, the hypothesis of importing 'too little' is evaluated by the residuals in the estimated import equations, and these authors are simply not able to agree on the statistical and economic significance of these residuals. This controversy appears to be resolved by Harrigan (1991), whose results support the conclusion that Japan does indeed import 'too little,' but then. so does the United States! This conclusion is listed in Table 1.

A second feature not taken into account in the welfare costs is the possibility that the quota leads to *quality upgrading.* This upgrading can refer to either a shift in demand towards higher priced import varieties (i.e., a change in product mix). or to the addition of improved characteristics on each variety. Using the terms suggested by Helpman and Krugman (1985), the first case fits the 'love of variety' approach used to describe consumer preferences under monopolistic competition, since we use a utility function defined over ell varieties; whereas the second case fits the 'ideal variety' approach. In both cases. we will argue that the quality change leads to an additional deadweight loss due to the quota. These two cases are discussed in the following sections, the first dealing with an index number method to measure the upgrading and its welfare loss, and the second focusing on hedonic methods applied to U.S. imports of automobiles.

4.1 Quality Upgrading and Welfare Loss

To illustrate the change in product mix, let the subscript i now denote varieties of some differentiated import good, where p_i is the price of each variety. We will suppose that these imports are weakly separable from all other goods in the overall. utility function, and let $U(C)$ denote the sub-utility function corresponding to these imports, where $C \equiv (C_1,\ldots,C_I)$ is the import vector. In the case where the imports are intermediate goods, then $U(C)$ is interpreted as a production function, and we shall suppose in general that it is Ihomogeneous of degree one. The corresponding expenditure function can then be written as $E(p,U) = e(p)U$, where $p = (p_1,\ldots,p_I)$, and $e(p)$ is the expenditure function to obtain one unit of utility. We will treat each import variety as sold under perfect competition with a fixed marginal cost of v_i^*, though many of the results below can be generalized to imperfect competition.[15]

Each foreign firm faces an import quota on their sales to the domestic market, and also collects the quota rents (as under a VER). While this quota restricts the *total* sales to the domestic market - denoted by $\bar{C}$ - it can be expected to also change the *relative* sales of the various import varieties. To see this, suppose that each firm can produce several possible import varieties. Then to maximize the rents obtained, each firm would ensure that they earn the *same* quota premium s from each variety exported (if this were not true, then the firm would export more of the variety with the highest quota premium, and thereby lower its price and premium). Thus, import prices after the quota will equal marginal cost plus the quota premium, or $v_i^* + s$.[16] Relative to their free trade values, import prices have risen by $(v_i^* + s)/v_i^* = 1 + (s/v_i^*)$, so that the *higher-priced* import varieties have the *lowest* percentage increase in price. It follows that demand will shift towards the higher-priced import varieties.

This shift in the relative! composition of imports is sometimes called an increase (or upgrading) in import 'quality'. The definition of 'quality' implicitly being used in this case is the *total utility per unit of the import,* or $U(C)/\overline{C}$. Since expenditure equals $E(p,U) = e(p)U$, this definition of quality can be rewritten as $U(C)/\overline{C} = [E(p,U)/\overline{C}]/e(p) \equiv UV/e(p)$, where $UV \equiv E(p,U)/\overline{C}$ denotes the *unit-value* of imports (which is simply the average price). Thus, we see that quality equals the ratio of the unit-value to the unit-,expenditure function $e(p)$. The quota will increase the unit-value for two reasons: because the price of each variety increases, and because demand shifts towards the higher-priced varieties, thereby pulling up the average. However, the quota will increase the unit-expenditure only due to the first reason - the price increase for each variety. Thus, the quota can be expected to increase the unit-value more than the price index, and therefore raise this measure of quality (Falvey, 1979).

To empirically test for the change in quality due to a quota, we construct the ratio of quality in two years t-1 and t:

$$\frac{UV_t/e(p_t)}{UV_{t-1}/e(p_{t-1})} = \left(\frac{UV_t}{UV_{t-1}}\right)/\pi(p_t,p_{t-1},C_t,C_{t-1}), \tag{21}$$

where $\pi(p_t,p_{t-1},C_t,C_{t-1}) = e(p_t)/e(p_{t-1})$ denotes an *exact* price index that can be constructed using data on import prices and quantities, and equals the ratio of the unit-expenditure functions. The idea behind an exact price index is that it measures the ratio of unit-expenditure functions, even when the functions themselves are not fully known. For example, if the unit-expenditure function is a quadratic function of prices, then a Fisher-Ideal price index can be used to measure the ratio (where the Fisher-Ideal is a geometric mean of the Paasche and Laspeyres indexes).[17] The change in import quality between two years is measured by taking the natural log of (21),

$$\ln\left(\frac{UV_t/e(p_t)}{UV_{t-1}/e(p_{t-1})}\right) = \ln\left(\frac{UV_t}{UV_{t-1}}\right) - \ln\pi(p_t, p_{t-1}, C_t, C_{t-1}) \qquad (21')$$

Thus, an increase in import quality occurs when the unit-values rise by a greater percentage amount than an exact price index. The impact of the quota on quality is evaluated by letting $t-1$ and t denote years before and after the quota comes into effect. and comparing the change in quality during this period with other years when trade policy did not change.

This method has been applied to U.S. imports of footwear and steel. In footwear, Aw and Roberts (1986) evaluate the 1977-81 quota with Korea and Taiwan. Upgrading of the import bundle was observed in most quota categories throughout this period, and accounted for 12% of the observed rise in the unit-value of footwear imports. For steel. Boorstein and Feenstra (1991) measure quality upgrading due to the VER negotiated with Japan and the European Community in 1969. Comparing that year with 1968. the unit-value rose by 15%. but nearly half of this increase (7%) was due to an increase in import quality, or a shift towards higher-priced varieties of steel. Some of this upgrading was reversed in 1971, when the agreement broke down. but when it was renewed during 1972-73 quality again rose by a modest amount (3%). The agreement lapsed in 1974, and in subsequent years the change in import quality was erratic, and quite small. The evidence from these and other industries strongly supports the hypothesis of upgrading under quotas. as indicated in Table 1.

It could be expected that the change in import composition - or quality - due to the quota would have a deadweight loss over and above the cost of an 'equivalent' tariff. One reason to expect this is from our discussion of the trade distortion index, in section 2.1. There we argued that when the *percentage* tariffs across products differed. the deadweight loss would depend on both the mean and the variance of these rates. The same observation applies to a quota. Even when the quota premium (denoted by s) is equal in *dollar* terms across products, when expressed as a percentage of marginal cost (i.e. s/v_i^*) the premium is highest on the lower-priced products. This explains the shift in import composition, and will result in an additional deadweight loss. For example, Anderson (1991) applies the trade distortion index to evaluate U.S. quotas on cheese, and finds that the shift in import composition due to the quotas accounts for 16% of the total consumption cost.[18]

Anderson's methods requires that the trade surplus function in (4) and (12) be calculated. An alternative way to measure the additional deadweight loss of the quota using index numbers is developed by Boorstein and Feenstra (1991), and is illustrated in Figure 3. There we show the! case of two import varieties C_1 and C_2, where the free trade price (equal to marginal cost) of the first exceeds the second, $p_1^0 \equiv v_1^* > p_2^0 \equiv v_2^*$. Under free trade, consumption is at C^0 where utility of U^0 is obtained. A quota on these two goods, with the quota premium of s. will lead to a greater percentage increase in the price of variety 1. For fixed total expenditure, the budget line shifts inward and rotates counter-clockwise, so at the new consumption point of C^1 there is greater *relative* demand for variety 1: this illustrates the shift in import composition, or quality upgrading.

Utility under the quota is U^1, but higher utility could be obtained from an *ad valorem* tariff of $\bar{\tau}$, with tariff revenue equal to the quota rents at the point C^1. By setting the revenue equal to rents at this consumption point, the *ad valorem* tariff $\bar{\tau}$ is what would typically be calculated as the price-equivalent to the quota. Applying this tariff, however. leads to a parallel inward shift of the original budget line, to the point where C^1 is still affordable (since revenue equals rents at that point). The optimal choice for the consumer on this budget line is C^2, with utility of U^2. Thus. higher utility of U^2 is available than with the quota. and the difference (U^2-U^1) can be interpreted as the ***extra deadweight loss*** due to the quality upgrading.

While Figure 3 is probably familiar to the reader, it is not generally recognized that the difference $(U^2-U^1)/U^0$ can be easily calculated with available data. To see this, note that the ratio U^1/U^0 can be measured by an ***exact quantity index*** between the free trade and quota-induced consumption points C^0 and C^1.[19] Since we kept total expenditure fixed when comparing free trade and the quota, the exact quantity index equal the inverse of the exact price index. Thus, utility under a quota, relative to free trade, is $U^1/U^0=\pi(p^0,p^1,C^0,C^1)^{-1}$, where p^1 denotes the quota-inclusive prices and p^0 the free-trade prices.

Turning to the ratio U^2/U^0. it can be measured by the inverse of the increase in prices from p^0 to $p^2=p^0(1+\bar{\tau})$, relative to any fixed consumption point. Choosing the quota-induced consumption point C^1, we obtain $U^2/U^0=(\sum_i p_i^2C_i^1/\sum_i p_i^0C_i^1)^{-1}$. However, since the budget lines under the tariff and quota both pass though the point C^1 (reflecting the fact that the tariff revenue equals the quota rents). we have that $\sum_i p_i^2C_i^1=\sum_i p_i^1C_i$. It follows that $U^2/U^0=(\sum_i p_i^1C_i^1/\sum_i p_i^0C_i^1)^{-1}$, which is precisely the inverse of the ***Paasche price index*** between the free trade and quota-induced points. Thus, we have shown that the extra deadweight loss equals.

$$\frac{(U^2-U^1)}{U^0}=\pi(p^0,p^1,C^0,C^1)^{-1}-\left(\frac{\sum_i p_i^1C_i^1}{\sum_i p_i^0C_i^1}\right)^{-1} \tag{22}$$

which is the inverse of an exact price index minus the inverse of the Paasche. If the data are consistent with utility maximization, then the Paasche index understates the true rise in prices, so that (22) is positive.

Boorstein and Feenstra (1991) have applied this formula to the quota on U.S. steel imports during 1969-74, and obtain a deadweight loss due to quality upgrading of about 1% of import expenditure during 'these years. Based on the 1970 expenditure. this is a welfare cost of about **$15** million. It should be stressed that this cost is ***additional to*** the conventional deadweight loss triangle that would be calculated using the price-equivalent tariff $\bar{\tau}$. This tariff has been estimated at about 7%, which can lead to a deadweight loss triangle between 0.5 - 1% of import expenditure, depending on what estimate is used for the change in imports. Thus, the extra deadweight loss; due to the quality upgrading is at least as high as the conventional deadweight loss triangle, and possibly larger.[20]

It is worth noting that the formula in (22) can also be derived using the trade surplus function from (4), as in Boorstein and Feenstra (1991). In that case, a tariff and quota leading to the same increase in the import price index are compared. The difference between the trade surplus with these two instruments, relative to initial: import expenditure, is given by (22). In general, this index number method is an alternative to the trade distortion index for evaluating the welfare loss due to a non-uniform tariff structures.[21] In comparison with the trade distortion index, this method seems to impose less structure on the data. Whereas the trade distortion index is typically calculated from a CGE model, and relies on the elasticity parameters used, the index number comparison in (22) simply reflects the extent of substitution between products in the data. This is clear from Figure 3, where the distance $(U^2-U^1)/U^0$ depends on how much the consumption point C^1 differs from C^2. In addition to the application we have described in steel, this index number method has also been applied to quality upgrading in autos. but not for any other industries; lurther work is necessary to determine its general usefulness.

4.2 U.S. Automobile Imports

One of the most extensively studied quotas in the United States is the 'voluntary' export restraint (VER) on Japanese automobiles, that began in 1981 and expired only recently. For this trade policy we have estimates of the price impact of the VER. its effect on product quality. and its impact on the profits of U.S. producers. as will be reviewed in this section.

The appropriate concept of quality for automobiles is the utility obtained frorn its characteristics. Empirically, the market equilibrium locus between prices and characteristics is estimated using a ***hedonic regression*** (Griliches, 1971), which is a linear regression of prices (usually in logs) on characteristics. The estimated coefficients in this regression are! generally interpreted as the marginal value that consumers place on the characteristics, which in equilibrium also equals the marginal cost to firms.[22] Then quality can be measured by a weighted average of the characteristics, using their estimated coefficients as weights. It has been shown in various theoretical models, under either perfect or imperfect competition, that a quota may cause an increase in product characteristics, though this result is not guaranteed (Rodriguez. 1979; Das and Donnenfeld. 1987. 1989; Krishna. 1987).

Using a hedonic regression, Feenstra (1988a) estimates both the price the quality change in Japanese automobiles exported to the U.S. under the VER that began in 1981. The regression is specified as:

$$p_{it} = s_t + \exp(\alpha_t + \beta' z_{it}) + \varepsilon_{it} , \qquad (23)$$

where z_{it} is a vector of characteristics for each car model i in year t, such as weight. width, height, and horsepower. and s_t is the price effect of the VER in year t. Note that the VER is modeled as leading to a *specific* (dollar) price increase, whereas the coefficient α_t allows for any other *percentage* change in prices (due to inflation, for example). When both s_t and α_t are estimated, multicollinearity between them leads to very high standard errors. Feenstra solves this problem by pooling the auto data in (23) with data for imports of Japanese compact trucks to the U.S. Trucks were not subject to the VER, but did have a tariff of ***25%*** imposed since 1980. The hedonic regression for trucks omitted the specific price terms st, and allowed for different coefficients on the characteristics. while imposing the same coefficients on the percentage price changes α_t (after correcting for the impact of the *ad valorem* tariff). In this way, the increase in the quality-adjusted prices of both Japanese cars and trucks that would have occurred *without* trade barriers are treated as identical. and the remaining impact of the VER in cars is estimated by α_t. Rather precise estimates of this price impact are obtained, ranging from $434 in 1981 to $1,096 in 1984 (with standard errors of $250 and $267. respectively).

Using the coefficient estimates from (23), the quality of each car is measured by $\exp(\alpha_{1980} + \beta' z_{it})$. The increase in product quality accounted for a substantial portion of the nominal prices increases in Japanese auto imports during the **VER.** For example, in the first year of the VER quality rose by 7% on average over the models, which was one-third of the average price increase. Over the entire 1980-85 period, quality upgrading accounted for fully one-half of the increase in prices. We expect this upgrading to have a deadweight loss for two reasons: due to the changing composition of imports (as corisumers substituted towards luxury models), and also because consumers would attach a ***declining*** shadow value to the extra characteristics added onto each model. Using a more general version of (18). Feenstra (1993) shows that the deadweight loss of the upgrading is surprisingly large, between one-quarter and one-third of the quality increase itself, or about $500 in 1985. Combining the transfer of quota rents and the deadweight loss due to upgrading, we obtain $1,500 over the 1.8 million autos imported, for a welfare loss to the U.S. of $2.7 billion annually (not including the conventional deadweight loss).

Dinopoulos and Kreinin (1988) have also used hedonic regressions and several other methods to estimate the increase in the prices of European cars exported to the U.S., and find that these prices increased by about one-third, with a further cost to the U.S. of $3.4 billion annually. Unless the European firms had strongly increasing marginal costs for their sales to the U.S., which seems unlikely, these price increases support the hypothesis of a change in market conduct. That is, if initially the European producers were engaged in Bertrand competition in prices with the Japanese firms, then the presence of the **VER** would cause them to instead treat Japanese quantities as fixed (since the **VER** specified the total sales of each company), with a corresponding increase in price. This seems like the most plausible explanation for the increase in the European prices found by Dinopoulos and Kreinin, though a direct estimate of the mode of market conduct is not made.[23]

In order to estimate the effect of the **VER** on profits of auto producers, it is necessary to jointly estimate demand and costs. Bresnahan (1981) provided the first, fully-specified estimates of the oligopoly equilibrium in the U.S. automobile market. where each consumer has an ideal auto variety on a line of characteristics. Later work by Goldberg (1992) and Berry. Levinsohn and Pakes (1994) has generalized the demand side of this model while jointly estimating the cost side, and these authors calculate the impact of various trade policies. There is some disagreement concerning which years the VER was most binding. Goldberg finds that in 1983 and 1984 the VER was binding with a price impact of about $1,000 (similar to that found by Feenstra, 1988a). The quota was increased in 1985, and Goldberg finds that it was not binding in that year or 1986. though it becomes binding again in 1987. In contrast, Berry, Levinsohn and Pakes obtain estimates of the price impact of the VER that are insignificant in 1981-83, and then rise steadily in subsequent years.

However, these authors are in agreement on the overall conclusions for trade policy: the quota was much worse than a equivalent tariff, that would have led to the same reduction in Japanese import's. Both studies find a substantial increase in American and European prices due to the VER, again offering indirect evidence of the change in market conduct. Berry, Levinsohn and Pakes estimate that European producers increased their profits by about $1 billion annually in 1987-89, while the profits of U.S. producers increased by $3-5 billion annually. This gain for American firms illustrates the 'profit-shifting" effects of trade policy, and would not be present in a competitive model. The profits of Japanese producers fall only slightly, because the quota rents nearly offset the reduction in profits through lost sales. Over the entire 1984-1990 period. these authors estimate that the VER increased U.S. profits by $16 billion, but created a loss for U.S. consumers of $18 billion, for a cumulative net loss to the U.S. of $2 billion. In contrast, the revenue raised from an equivalent tariff is estimated at $14.5 billion, so that the U.S. welfare gain from this tariff would have been $12.5 billion. Thus, this industry appears to be an instance were strategic trade policy - in the form of a tariff - could have worked, but this was not the policy that was actually used.

5. Estimating Markups

In the previous sections, we have ignored the potential change in the output of domestic firms due to trade policy. This appears as the third term on the right side of (5), where a change in the output of domestic firms is multiplied by the difference between average and marginal cost: an expansion in the output of firms with increasing returns provides a welfare gain. There is some indirect evidence that increasing returns serve as a source of comparative advantage, which suggests welfare gains (Tybout. 1993). Rather than directly test the effect of trade policy on industry output, however, an alternative method has been to estimate the impact of policy on the price-cost margins charged by firms.

Under freedom of entry and zero profits, the price-cost margins and the output levels can be related by dividing conditions (6) and (8), to obtain:

$$\lambda_i \equiv \frac{\phi_i(y_i, \mathbf{w})/y_i}{\phi_{iy}(y_i, \mathbf{w})} = \left[1 - \left(\frac{\theta_i}{\eta_i}\right)\right]^{-1} \equiv \mu_i. \qquad (24)$$

The left-hand side of (24) is the ratio of average to marginal costs, which is sometimes called the degree of increasing returns to scale, and we shall denote it by λ_i. The right-hand side is the ratio of price to marginal cost, or the degree of monopoly power, and is denoted by μ_i. It: is normally assumed that the degree of increasing returns to scale *falls* as output increases. In that case, there will be a *negative* relationship between firm output and the price-cost ratio μ_i: an increase in output is associated with a fall in this ratio, and conversely. Thus, trade policies that lead to a fall in markups can be expected to have a beneficial welfare effect. through the expansion of firm outputs.[24] Effects of this type have been captured in a CGE model of Cameroon by Devarajan and Rodrik (1991), who calculate the welfare gains from trade liberalization as between one and two percent of national income. The question we address in this section is how one could econometrically estimate the impact of liberalization on markups.

5.1 Hall **Method**

One method for estimating markups has been suggested by Hall (1988), and relies on the same data that could be used to estimate productivity in an industry. Levinsohn (1993) and Harrison (1994a) have applied this method to panel data sets on firms in developing countries, facing trade liberalization; Levinsohn considers the 1984 trade liberalization in Turkey, while Harrison considers the 1985 reform in Cote d'Ivoire. Their applications are described as follows.

Let the production function for a domestic firm denoted by i be specified as $y_{it} = A_{it} f(L_{it}, K_{it})$, where L_{it} and K_{it} denote the labor and capital inputs (materials can also be added), and A_{it} is a productivity parameter. We shall suppose that this function is homogeneous of degree Xi, which is the degree of increasing returns to scale. Firms will hire inputs until their marginal-revenue product equals their wage. or using the price-cost margin μ_{it} from (24) along with (6):

$$(q_{it}/\mu_{it}) \frac{\partial f_{it}}{\partial L_{it}} = w_t \text{ , and } (q_{it}/\mu_{it}) \frac{\partial f_{it}}{\partial K_{it}} = r_t \qquad (25)$$

Then totally differentiating the production function, and using (25), we obtain,

$$\frac{dy_{it}}{y_{it}} = \mu_{it} \left[\alpha_{it} \left(\frac{dL_{it}}{L_{it}} \right) + \beta_{it} \left(\frac{dK_{it}}{K_{it}} \right) \right] + \frac{dA_{it}}{A_{it}} , \qquad (26)$$

where $\alpha_{it} \equiv w_t L_{it}/q_{it} y_{it}$ denotes the share of labor in total revenue, and $\beta_{it} \equiv r_t K_{it}/q_{it} y_{it}$ denotes the share of capital. Thus, (26) states that the growth in output is a weighted average of the growth in inputs, where the weights are $\mu_{it}\alpha_{it}$ and $\mu_{it}\beta_{it}$. It is readily confirmed that these weights sum to Xi, the degree of increasing returns to scale of the production function (see e.g. Harrison, 1994a, note 3).

This formulation can be contrasted with the conventional measurement of productivity under perfect competition, where *total factor productivity* (TFP) is defined as.

$$TFP_{it} \equiv \frac{dy_{it}}{y_{it}} - \left[\alpha_{it} \left(\frac{dL_{it}}{L_{it}} \right) + (1-\alpha_{it}) \left(\frac{dK_{it}}{K_{it}} \right) \right] . \qquad (27)$$

In words, TFP (also called the "Solow residual") is defined as the difference between the growth in output and a weighted average of the growth in inputs, where the weights sum to unity by construction. Under this weighting scheme, any portion of revenue not paid to labor - such as pure profits - is attributed to capital. This scheme gives *too little* weight to the growth in labor input as compared to (26). $\alpha_{it} < \mu_{it}\alpha_{it}$. The reason for this is that under oligopolistic conduct, firms will restrict their output and hire less inputs than under perfect competition. It follows that the marginal physical product of labor *exceeds* its real wage. The weight α_{it} in (27) is essentially using the real wage (w_t/q_{it}) to proxy for the marginal physical product of labor, so it gives too little weight to the labor input.

In order to see how conventionally measured TFP in (27) can mismeasure the true productivity shock dA_{it}/A_{it}, we can combine (26) and (27) to obtain:

$$TFP_{it} = (\mu_{it}-1)\alpha_{it}\left(\frac{dL_{it}}{L_{it}} - \frac{dK_{it}}{K_{it}}\right) + (\lambda_i - 1)\left(\frac{dK_{it}}{K_{it}}\right) + \frac{dA_{it}}{A_{it}}, \tag{28}$$

where we have used $\lambda_i = \mu_{it}(\alpha_{it} + \beta_{it})$. The first term on the right side of (28) reflects changes in the labor-capital. ratio, and arises due to the mismeasurement of the weight on labor. The second term reflects increasing returns to scale in the production function. In studies of developing countries, it is quite common to correlate total factor productivity with trade volumes, to determine whether firms exposed to international competition are more efficient.[25] From (28), it is apparent that variation in TFP - across industries or over time - could be caused by *either* productivity shocks dA_{it}/A_{it}, by changes in markups, by changes in the labor-capital ratio, or by changes in the capital input under increasing returns to scale, so that changes in conventionally measured TFP must be interpreted with great caution.[26]

One example of an attempt to relate protection to TFP performance is Krueger and Tuncer (1982), who argue that there is little connection between these two variables for a cross-section of Turkish industries. They conclude, therefore, that there is little support for the idea of "infant industry" protection. In contrast, Harrison (1994b) finds that the same data show a *positive* correlation between tariffs or non-tariff barriers and TFP. From (28), the correlation could be explained by either higher markups and/or higher input growth in protected industries, both of which are plausible. The presence of these effects means that conventional TFP measures do not estimate the true productivity shock dA_{it}/A_{it}, so that a simple comparison of TFP with tariffs is not a valid test for "infant industry' protection.

In order to properly determine the effects of trade policy on productivity. then. it is necessary to also estimate its effects on markups μ_{it}. The markups can be estimated by rewriting (26) in discrete form as,

$$\Delta \ln y_{it} = \mu_{it} \overline{\alpha}_{it} [\Delta \ln L_{it} - \Delta \ln K_{it}] + \lambda_i \Delta \ln K_{it} + \gamma_t + \varepsilon_{it} \ , \qquad (29)$$

where the productivity changes are specified as $\Delta \ln A_{it} = \gamma_t + \varepsilon_{it}$, and $\overline{\alpha}_t$ refers to an average of the labor shares in years t-1 and t. It is not feasible to allow the markup μ_{it} to vary in all years, so it is generally restricted to be constant over some intervals, while possibly changing discretely at a major break. In addition, μ_{it} and λ_i are typically restricted to be equal across firms (though this can be relaxed).

It should be expected that the labor and capital inputs in (29) are affected by the changes in productivity ε_{it}, so that instrumental variables must be used in the estimation. Appropriate instruments should be correlated with demand for factors but not with productivity shocks. Examples include variables shifting product demand. international prices and exchange rates, and sectoral or economy-wide factor prices. Instruments of this type are used by Harrison (1994a) in her study of trade liberalization in Cote d'Ivoire. She finds declining markups due to trade reform for a number of industries. although the changes in the markups are not statistically significant. Harrison also finds that correcting the measurement of TFP for changes in markups, and allowing for non-constant returns to scale, leads to a positive and substantial effect of trade reform on productivity.

Levinsohn (1993) exploits the panel nature of the data set to estimate an annual productivity shock γ_t (common across firms), assuming that remaining shocks ε_{it} are not forecast by firms, and therefore uncorrelated with factor demand. He finds evidence of decreased markups due to liberalization in Turkey when comparing the years 1984 with 1985-86, for those industries that were imperfectly competitive initially (i.e. with the markup significantly greater than zero). In contrast, for the two industries where protection increased, markups were also found to increase. Thus, the results for both Turkey and (to a weaker extent) Cote d'lvoire are consistent with the hypothesis of declining markups due to trade liberalization. as indicated in Table 1.

5.2 Other Methods

Our discussion of price-cost margins has taken for granted that these cannot be directly measured from firm or industry data. The reason is that accounting data on costs cannot generally be relied upon to obtain a marginal cost measure, used to compute the price-cost margins. Instead, marginal cost must be estimated, which was implicitly done in the Hall method. The joint estimation of marginal cost and marginal revenue, together with a market conduct parameter, is the starting point of the "new empirical industrial economics." as surveyed by Bresnahan (1989) which is highly recommended for reading. Some of these methods have already been mentioned in our discussion of the automobile industry (section 4.2).

Aw (1992, 1993) has taken the approach of this literature to estimate the markup conduct of textiles exporters from Hong Kong. She specifies a functional form for the demand curve. from which marginal revenue is calculated. Then the first-order condition (6) is estimated jointly with the demand curve, which yields an estimate of the market conduct parameter θ_{it}. Not surprisingly, Aw finds that the textile exporters act in a perfectly competitive manner. Schembri (1989) takes a similar approach to estimate the markups of a major Canadian export industry, which are then used to simulate the pass-through behavior. The incomplete pass-through that he finds provides additional evidence of the exercise of market power by exporters, as was discussed in section 3.

6. Wages and Employment

So far, the only form of imperfect competition we have considered is that exercised by firms. However, it is realistic to suppose that unions will also exercise some monopoly power in the labor market, with the result that workers with the same skills in various industries may earn different wages. In principle, this might justify some type of trade policy. Katz and Summers (1989a,b) have argued that such wage distortions are pervasive in industrial countries, with more capital-intensive industries paying higher wages, even after correcting for characteristics of workers, union activity, etc. This means that the high-wage industries are producing too little: in terms of equation (5), the average costs of production exceed the social opportunity costs of withdrawing workers from other industries, so that a rise in output is welfare increasing. Based on this wage evidence, they argue that trade subsidies to the capital-intensive industries, which in the United States are the export industries. would be in the national interest.

The recommendation of Katz and Summers is highly controversial, to say the least. One response is that the wage distortions they identify may be endogenous, so that the application of wage subsidies could lead to even ***greater*** differences in the wages paid across industries. Possible evidence supporting this idea is provided by Gaston and Trefler (1994a), in their study of wage premia and protection in U.S. manufacturing. They find a strong positive correlation between exports and wage premia across industries. If this correlation also applies in a time-series context, it suggests that an expansion of exports would increase the premia, so it is unlikely that there would be any gain from applying an export subsidy.

In any case, it is unlikely that trade policy as practiced in the U.S. is directed at resolving inefficiencies due to wage distortions. Instead, this policy seems to have an equity rationale. Under Article XIX of the General Agreement on Tariffs and Trade (GATT), the use of tariffs and quotas is limited to cases where there is evidence of harm in the importing industry. In the United States, these rules are legislated in Section 201 of the Trade Act of 1974, under which trade protection can be granted if "increased imports of an article are a substantial cause of serious injury, or threat thereof, to the domestic industry.' The following criteria can be used to determine if the industry has suffered 'serious injury': 'the significant idling of productive facilities in the industry, the inability of a significant number of firms to operate at a reasonable level of profit, and significant unemployment or underemployment within the industry.' All of these criterion are related to a drop in income faced by some factors in the industry.

One reason to base trade policy on a change in factor income is to achieve the following equity goal: that *all* inclividuals gain from increases in trade, so that 'Pareto gains' are achieved. This equity goal is not related to income distribution in the usual sense, since workers in import-competing industries (such as autos) may be more highly paid then elsewhere in the economy. If Pareto gains are specified as a goal, however, then these workers should be compensated for reductions in their income due to import competition. There is considerable evidence that workers forced to change industries experience a Large drop in their income, due to the loss of their firm-specific skills (Bale, 1976, Hamermesh, 1987). The question is then how to best compensate these workers. The idea of "lump-sum' transfers, under which individuals are each fully compensated for their losses, is highly impractical, since the government would not know the! losses faced by each person. Recently, policies that require less information have been explored in theoretical models.[27] This work is very recent, however, and there! is no consensus as to how compensation should be achieved. or if is always feasible.

6.1 Import Prices versus Shares

Thus, the provisions of Section 201 can be viewed as one method of achieving compensation, in a world where the best policy is not known. This legislation restricts the use of tariffs or quotas to cases where import competition is a "substantial cause' of unemployment or other injury, which is defined as a 'cause that is important and not less than any other cause.' In order to implement this rule.

there must be some basis to judge the importance of various causes of injury within an industry. One method is to compare changes in the share of expenditure within an industry going to imports, with changes in overall expenditure, and grant protection only if the former is greater. For example, in the report of the U.S. International Trade Commission (USITC, 1980, A-70) to evaluate the industry request for a tariff in automobiles, it was found that the import share rose from 25% in Jan.-June 1979 to 30% in July-Dec., and 35% in Jan.-June 1980. However, over the same period U.S. consumption of autos fell by about 20%. so that a majority of ITC commissioners determined that import competition was *not* the principal cause of unemployment. As a result, protection was not granted under Section 201, but instead, the VER with Japan was negotiated.

As simple as the above calculation is, the use of import shares to determine the effects of trade on unemployment extends to many studies, as surveyed in Deardorff and Hakura (1994). For example, Krueger (1980a,b) uses the import share in a decomposition of the sources of unemployment for the United States, as do Berman, Bound and Griliches (1994) more recently, while Freeman and Katz (1991) have used import volumes as an explanatory variable in regressions explaining employment and wages. The use of import shares has been criticized by Grossman (1982,1986,1987), however, who argues that the import share is *endogenous* and may change due to many underlying causes. Grossman's argument can be briefly summarized as follows.

Suppose that real expenditure for industry i is denoted by (E_i/q_i), and that the import share is m_i, so that $Y_i = (1-m_i)(E_i/q_i)$ equals domestic output. If a_i workers are needed per unit of output, then employment in the industry is:

$$L_i \equiv a_i(1-m_i)(E_i/q_i) . \tag{30}$$

According to this expression, changes in employment can be decomposed into changes in real expenditure, changes in the import: share, and changes in technology a_i. However, it would be incorrect to attribute any *causality* to these relations. For example. if the import share rises by 10 percentage points, so that employment falls by 10%, it would be incorrect to conclude that the fall in employment is caused by import competition. Instead, it might be that a fall in productivity within the domestic industry, or a rise in wages, has caused both the decline in employment and the rise in imports. The point to recognize is that the import share m_i, or import quantities. are endogenous variables, which should be taken into account when estimating their effects on employment or wages.

To correctly assess the impact of import competition on employment, Grossman (1986, 1987) recommends that *import prices* rather than shares be used to measure international competition. He derives a log-linear relation between industry wages or employment, and exogenous variables including the prices of inputs, international price and exchange rate, tariffs, industry output, and possibly industry wages. In one application, Grossman (1986) estimates the impact of import competition - measured by the international price - on employment and wages in the U.S. steel industry. It is found that job losses due to import competition depend primarily on the appreciation of the dollar after 1979. In the period 1979-83, the job losses due to appreciation are comparable to those due to a secular decline in employment, picked up by a time trend in the regression.[28] Over the longer period 1976-83, however, the job losses due to appreciation are an order of magnitude smaller than those due to the secular decline. Based on these results. Grossman concludes that whether import competition is considered the most important cause of injury depends on the time period used, and on whether exchange rate effects qualify as 'injury caused by imports."[29]

Grossman (1987) applies the same! methods to a wider group of U.S. industries over 1969-79, but finds a significant effect of import competition on employment in only one of the nine industries,, and a significant effect of import competition on wages in only two. A greater impact of import competition on employment and wages is obtained by Revenga (1992). Her data applies to a wide sample of U.S. industries, with the advantage that she has a better measure of the import prices than used by Grossman, though the disadvantage that she pools data across the different industries. Revenga treats the *import prices as endogenous,* which is to be expected from our discussion of pricing under imperfect competition in section 3: the import price in (17) depends on domestic prices, and therefore depends on domestic productivity, wages, etc. Using industry-specific indexes of exchange rates and foreign costs, she finds a significant impact of import prices on both employment and wages: a 10% reduction in import prices reduced employment by 3.5-3.9%, and reduces wages by about 1%. According to these est'imates, the reduction in import prices due to dollar appreciation over 1980-85 reduced employment by 6.5-7.5%. In addition, Revenga (1990) re-estimates the relation between import volumes and wages reported in Freeman and Katz (1991), using instrumental variables. She finds that the revised estimates reinforce the findings of Freeman and Katz, that industry wages respond significantly to import prices.

From the results of Grossman and Revenga, we conclude there is weak evidence that import competition lowers wages. Surprisingly, however, the converse hypothesis doe not appear to hold empirically: tariffs of non-tariff barriers need not raise wages. In particular, Gaston and Trefler (1994a) find a ***negative*** relationship between tariffs and wages. They suggest that this may be due to a willingness of unions to accept lower wages in exchange for employment guarantees, when protection is granted. This hypothesis is confirmed in later work (Gaston and Trefler, 1994b), where the negative correlation between tariffs and wages is found to occur only for a union sample, while non-union wages are insignificantly related to tariffs. Gaston and Trefler argue that this is consistent with optimizing behavior on the part of unions, if they use tariff protection as an opportunity to increase employment rather than wages. This is demonstrated in the theoretical model of Grossman (1984), for example, where workers with less seniority would be more willing to accept lower wages in exchange for employment guarantees. The negative correlation between wages and tariffs found by Gaston and Trefler deserves further empirical study.[30]

6.2 Product Variety

We have argued above that the problem with using import shares to measure competition is that they are endogenous: yet, Revenga also finds that the prices need to be treated this way. It follows that either import shares or prices could be used to measure international competition in a regression framework, provided that instrumental variables are used in the estimation.[31] The question then arises as to which variable is preferred. While this question can only be settled by further research, there is one reason to believe that import *shares* will be the preferred variable when products are differentiated. In that case, an increase in the variety of imports available will shift demand away from domestic varieties, and reduce output and employment. It is doubtful, however, that this impact would be reflected in an import price index, but it would be reflected in import shares or volumes, which are then a better measure of international competition.

There is indirect evidence that changes in the range of product varieties has had an important impact on trade. This evidence come from the estimation of import demand. Since the work of Houthakker and Magee (1969), it has been known that the estimated income elasticity of demand for U.S. imports exceeds unity, and also exceeds the foreign income elasticity of demand for U.S. exports.[32] One explanation for the high income elasticity is that it is a *spurious* result of omitting new product varieties from indexes of U.S. import prices (see Helkie and Hooper, 1988; Hooper, 1989; and Krugman, 1989). According to this argument. over the past several decades the U.S. has experienced an expansion in the range of new imports from rapidly growing, developing countries, but no corresponding decrease in import prices. Then the rising share of imports is attributed to a high income elasticity in the import demand equations.

To precisely determine the connection between import prices and product variety, suppose that all import varieties within some industry enter into a constant elasticity of substitution utility or production function. Let the elasticity of substitution be denoted by a, and let $\pi(p_{t-1},p_t,C_{t-1},C_t)$ denote the exact price index for imports. This index will decline as new product varieties become available, because the new varieties lower the cost of obtaining any level of utility or output.

In contrast, a conventionally measured price index - denoted by $P(p_{t-1},p_t,C_{t-1},C_t)$ - would not reflect the presence of new product varieties. Let the set I_t denote the varieties that are available in period t, and let $I \subseteq (I_t \cap I_{t-1})$, $I \neq \emptyset$, denote any non-empty subset of the product varieties available in *both* periods. Then Feenstra (1994) shows that the exact index is related to the conventional index by:

$$\pi(p_{t-1},p_t,C_{t-1},C_t) = P(p_{t-1},p_t,C_{t-1},C_t)(\lambda_t/\lambda_{t-1})^{1/(\sigma-1)}, \qquad (31)$$

where,
$$\lambda_r \equiv \sum_{i \in I} p_{ir}x_{ir} \Big/ \sum_{i \in I_r} p_{ir}x_{ir}, \text{ for } r=t-1,t.$$

This result states that the exact price index $\pi(p_{t-1},p_t,C_{t-1},C_t)$ equals the conventional price index $P(p_{t-1},p_t,C_{t-1},C_t)$ times the additional term $(\lambda_t/\lambda_{t-1})^{1/(\sigma-1)}$ To interpret this term, note that λ_t equals the fraction of expenditure in period t on the goods $i \in I$ relative to the entire set $i \in I_t$. Alternatively, λ_t measures *one minus the share of expenditure in period t on the new product varieties.* If these new varieties have a substantial share of expenditure, then λ_t will be small, and this will tend to make the exact index $\pi(p_{t-1},p_t,C_{t-1},C_t)$ significantly lower than the index $P(p_{t-1},p_t,C_{t-1},C_t)$. In other words, the introduction of new product varieties will *lower* the exact price index. The term λ_{t-1} equals *one minus the share of expenditure in period t-1 on the product 'varieties that are not available in t.* Thus, if there are many disappearing varieties between the two periods, this will tend to make λ_{t-1} small, and *raise* the exact price index.

It is clear from (31) that increases in the share of differentiated imports from new suppliers will lower the exact price index, which will reduce employment in the domestic import-competing industry. This reduction in the effective price due to new product varieties would not be reflected in a conventional price index. Thus, for industries where product differentiation is important, it is desirable to include import shares (either over all countries or just the new suppliers) as measures of import competition, where these shares must be treated as endogenous.

7. Conclusions

In this chapter, we have attempted to show how the evaluation of trade policy, which has traditionally been based on models of competitive industries, can be extended to incorporate imperfect competition. Our major conclusions have been summarized in Table 1. For tariffs, the key insight is that imperfectly competitive foreign firms will generally choose to pass-through only a portion of the tariff, resulting in a terms of trade gain for the importing country. Most empirical studies of incomplete pass-through have focused on exchange rates rather than tariffs, though we expect that there is at least a partial symmetry between these effects. These studies of exchange rate pass-through provide an indication of imperfectly competitive market conduct. However, because the magnitude of pass-through differs substantially across industries, the possibility of a terms of trade gain cannot be used as a general argument for strategic trade policy.

Indeed, rather than imperfect competition forming the basis for national gains due to trade policy, the actual policies that have been used have sometimes led to losses from enhanced collusion. This has occurred due to the application of anti-dumping policies, for example. It has also occurred in the one case where strategic trade policy in the form of tariffs might have led to a welfare gain: U.S. automobile imports. The VER that was actually used led to an increase in profits for American firms, but not by enough to offset the loss to consumers, so that the United States suffered a net welfare loss.

The quality upgrading that occurred under the VER in autos, as measured by the change in product characteristics, has also been observed in a number of other industries, where it is measured by, a change in the composition of imports. We have suggested that the first measure of quality-upgrading fits the 'ideal variety' approach to modeling consumer preferences under monopolistic competition, whereas the second measure fits the "love of variety" approach. In either case, an additional deadweight loss due to the quality change can be estimated using index number techniques. We have suggested that this technique imposes less structure on the data than the 'trade distortion index" of Anderson and Neary (1992, 1994a,b), though they can both be used to measure the impact of any non-uniform trade policy over multiple goods.

Direct estimates of the markups charged by firms have been made for several developing countries, drawing on methods from the 'new empirical industrial organization'. It has been confirmed that trade liberalization tends to reduce the markups charged by firms. Again, these empirical results lend no support to a strategic role for trade policy, and on the contrary, suggest that the application of tariffs may enhance collusion with corresponding welfare losses. The one instance we have found where protection may reduce the distortions caused by imperfect competition comes from a surprising source: the reduction in union wages under protection. The negative correlation between wages and tariffs observed for the U.S. is consistent with unions accepting employment gains rather than wage increases as a result of protection. Further work is needed to determine the generality of this result.

We conclude by mentioning a future source of data on trade patterns and trade policy. The National Science Foundation is currently funding a project to collect large data sets on trade - some of which have been used in the studies reported in this chapter - and make them widely available on CD-ROM. This project will be completed by late 1996, and the data will be described in a working paper of the National Bureau of Economic Research, and also will be announced in the Journal of International Economics. If you are unaware of how to obtain this data by December 1996, please contact me by e-mail at rcfeenstra@ucdavis.edu.

Footnotes

[1] Some of these studies are summarized in Lindert (1991, Table D.1, p. 607).

[2] The theoretical arguments for strategic trade policies and reviewed and the computable models are discussed in chapter 4 in this volume, by James Brander.

[3] The fact that social welfare depends on changes in firm-level output to exploit economies of scale has been emphasized by Horstmann and Markusen (1986). In particular, an increase in industry output by the entry of firms will not add to welfare through economies of scale, but: might instead reflect inefficient entry.

[4] An exception is Feenstra (1988b), who estimates the welfare impact of new American varieties following a U.S. tariff on compact trucks from Japan. This tariff increased the number of American models available, but each of these models were very similar to existing Japanese models in characteristics, so that the domestic models added very little to consumer welfare. Romer (1994) also examines the welfare cost of trade restrictions with changing product variety.

[5] The early results of Leamer (1974) anticipate some features of the trade restrictiveness index.

[6] More generally, Anderson (1994a) shows that import expenditures in the *tariff-ridden* equilibrium are the appropriate weights to use if and only if the balance of payments function has a constant elasticity of substitution form.

[7] Letting $\bar{t}$ denote the weighted mean of the individual tariffs, and V denote the coefficient of variation (ratio of the weighted stanaard deviation to the mean), it is readily shown that $T=\bar{t}(V^2+1)^{1/2}$.

[8] We will not make a distinction between actual and expected exchange rates, though this can be introduced into the model, and has been investigated empirically by Froot and Klemperer (1989) and Feinberg and Kaplan (1992).

[9] In general, the function ψ^* in (18) is homogeous of degree one in its arguments. It follows that one price can be used as a deflator for all other variables appearing on the right and left.

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[10] Harrison (1992) finds that the pass-through behavior of European and Japanese steel exporters to the U.S. was heavily affected by their use of imported intermediate inputs, and also by changes in U.S. trade policy.

[11] An exception is automobiles, where Gagnon and Knetter (1992) find that Japanese producers have the lowest pass-through coefficient, followed by German producers and then American. They suggests that this may be due to differences in the models exported by each country. Feenstra, Gagnon and Knetter (1993) relate the pass-through behavior in autos to the share held by exporters in their destination markets.

[12] For example, if a market is highly competitive so that θ^* is close to zero. and marginal costs are constant or controlled for, then the pass-through in (18) will be close to unity. More generally, we expect that pass-through will depend on the degree of product differentiation, as found by Yang (1993).

[13] Unless the domestic firm obtains an sufficient increase in profits at the expense of the foreign firm - a case that has not been investigated empirically.

[14] One exception to this is U.S. dairy imports, where the quota rents are shared between U.S. and foreign firms. In addition. Krishna and Tan (1993) have recently argued that some sharing of rents occurs for U.S. imports of textiles from Hong Kong, and other countries as well, despite the fact that exporters from Hong Kong can sell their quotas on an open market (Hamilton, 1986).

[15] Rodriguez (1979) considers the competitive case, while Falvey (1979), Das and Donnenfeld (1987,1989) and Krishna (1987) allow for imperfect competition.

[16] The quota premium can vary across foreign firms, depending on the amount they are allowed to export, but we shall not take this into account.

[17] A complete exposition of exact price indexes is Diewert (1976), which is not easy reading, but is well worth the effort.

[18] Anderson and Neary (1994b) apply the trade restrictiveness index to U.S. quotas on textiles under the Multi-Fibre Arrangement, while Anderson, Bannister and Neary (1994) apply it to evaluate Mexican agricultural policy.

[19] In the same way that an exact price index measures the ratio of unit-expenditure functions, an exact quantity index measures the ratio of utility or production functions (see Diewert, 1976), where we are assuming that the utility function is homogenous of degree one.

[20] On the other hand, it should be recognized that both these losses are substantially less than the loss to the U.S. due to the transfer of quota rents to foreign producers;, which was about 7% of import expenditure.

[21] In general applications, it would be important to include products not subject to the trade barriers in the calculation, so that substitution towards them is taken into account. Then the formula in (18) would measure both the conventional deadweight loss triangle, and the extra loss due to upgrading.

[22] Rosen (1974) establishes this resu'lt under perfect competition, while Feenstra (1993) discusses the noncompetitive case.

[23] For a later year. 1987, Feenstra and Levinsohn (1994) have found that European producers appear to use quantity as their strategic variable, while American producers use price (and the strategic variable of Japanese producers cannot be distinguished), though a comparison with earlier years is not made.

[24] This is sometimes referred to as a 'rationalization' of the domestic industry. Brown and Stern (1989) note that rationalization may fail to occur due to differential effects on factor prices, and provide simulation results for U.S.-Canada trade.

[25] A theoretical justification for this hypothesis, based on imperfect monitoring of managerial effort, is developed in Horn. Lang and Lundgren (1991).

[26] Note that this difficulty would not arise when productivity is measured by directly estimating the production function (for example, Aw and Hwang, 1993), without relying on real wages to measure marginal physical products.

[27] See Dixit and Norman (1986) and the papers in the May 1994 Journal of International Economics. A particularly dramatic example of an attempt to achieve Pareto gains from trade is in the union of East and West Germany, where the political

goal was that no citizen should lose from this union; in particular, wages in the East and West should be equalized. To offset the resulting high costs in East Germany, Akerlof *et al* (1991) argue that wage subsidies should be applied there. There is a remarkable affinity between this recommendation and the theoretical policies of Dixit and Norman (1986), where factor subsidies (or taxes) play a significant role.

28 This secular decline reflects technological and product changes in purchasing industries (such as smaller cars). labor-saving technological change in steel, or growth in other sectors than would pull resources out of the steel industry.

29 Despite this, on June 12, 1984, the ITC concluded that import protection was justified in the steel industry under Section 201.

30 Quite different results for. Canada are reported by Fung and Huizinga (1991), who find that tariffs increase union wages at the expense of non-union wages.

31 In the context of Section 201 protection. Pindyck and Rotemberg (1987) specify a regression equation that explains injury in terms of variables shifting domestic supply and demand, along with import volume, which is treated as endogenous: their approach is an alternative to the regression specified by Grossman (1986, 1987).

32 This result applies more generally when comparing the income elasticity of demand for imports into industrial countries, with the developed country's income elasticity of import demand, as discussed in the survey by Goldstein and Khan (1985).

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Table 1: Trade Policv Issues and Estimation Methods

Trade Policy Issue	Estimation Method (section)	Results
Deadweight Loss of tariffs or quotas over multiple goods	Trade distortion index (3.1) Index number method (4.1)	Index number method imposes less structure on the data, but there is little experience with its use.
Terms of trade impact of tariffs	Pass-through regression of tariffs (3.2), or of exchange rates (3.3)	Strong evidence that pass-through is less than unity, though its size differs substantially across industries.
Effects of antidumping duties	Comparison of import prices or quantities at various stages of dumping actions (3.4)	Strong evidence that the dumping actions reduce imports, even when duties are not applied.
Effects of trade barriers on imports, and measures of "openness"	Regressions of imports on factor endowments and trade barriers (3 and 4)	Simultaneity between trade bamers and imports must be taken into account; measures of "openness" are sensitive to the structural model. Both Japan and the U.S. import "too little."
Quality upgrading under quotas	Comparison of unit-value and exact price index (4.1), and hedonic regression (4.2)	Strong evidence from various industries of upgrading, which has an additional deadweight loss.
Effects of the VER on Japanese autos in the U.S.	Hedonic regression; joint estimation of demand and cost functions (4.2)	Very large rents or profits created for Japanese, European, and U.S. producers. Overall negative impact for the U.S., though equivalent tariff could have raised welfare.
Changes in markups of firms when trade liberalization occurs	Hall method incorporating imperfect competition into TFP measures (5.1)	Weak evidence that markups have fallen for some developing countries. Invalid to correlate tariffs with TFP to assess "infant industry" protection.
Effects of import competition on employment and wages	Regressions of import shares or prices on employment and wages (6.1 and 6.2)	Simultaneity of import prices or shares must be taken into account. Weak evidence that import competition lowers employment and wages, but tariffs do not raise union wages.

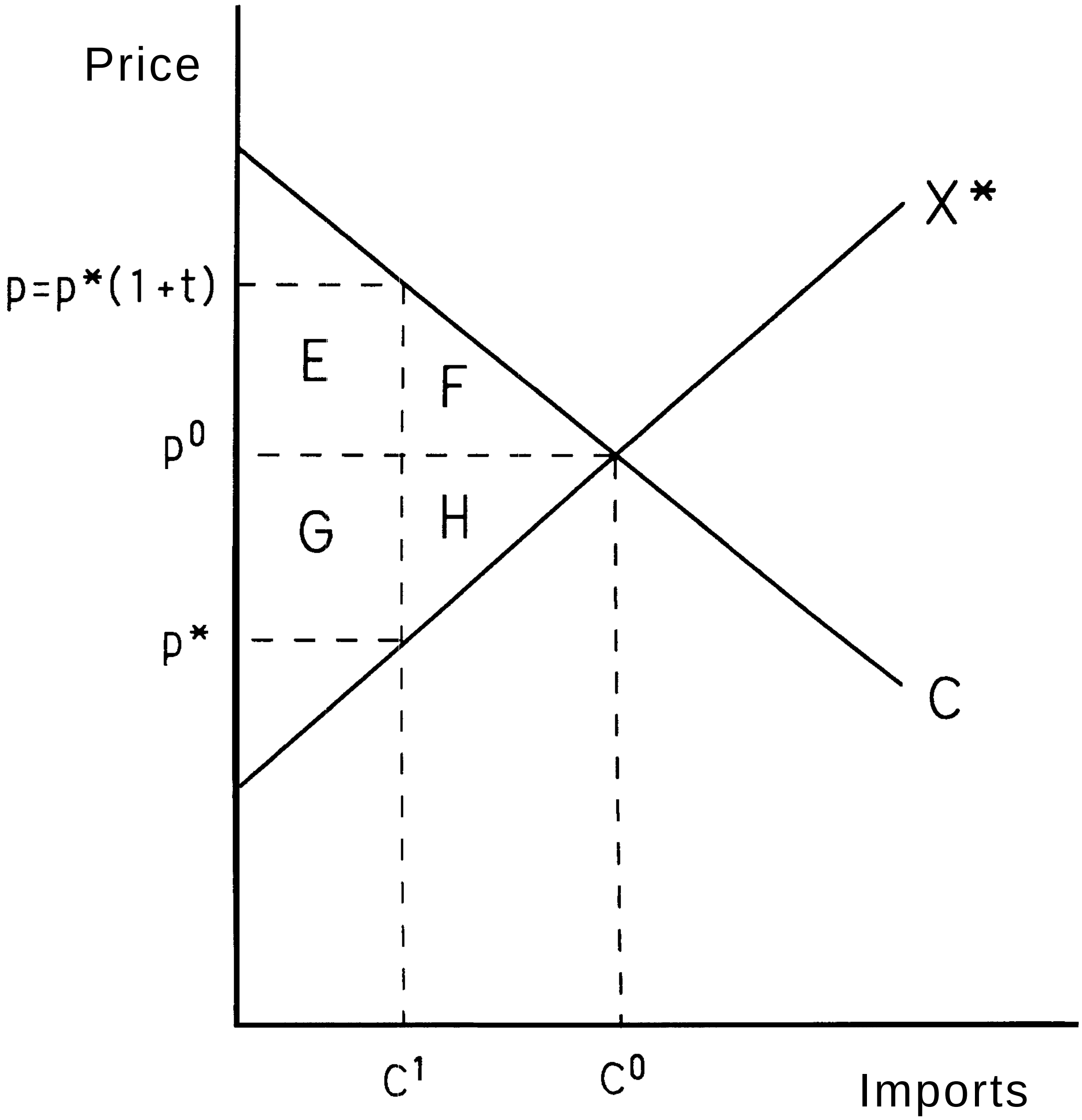

Figure 1

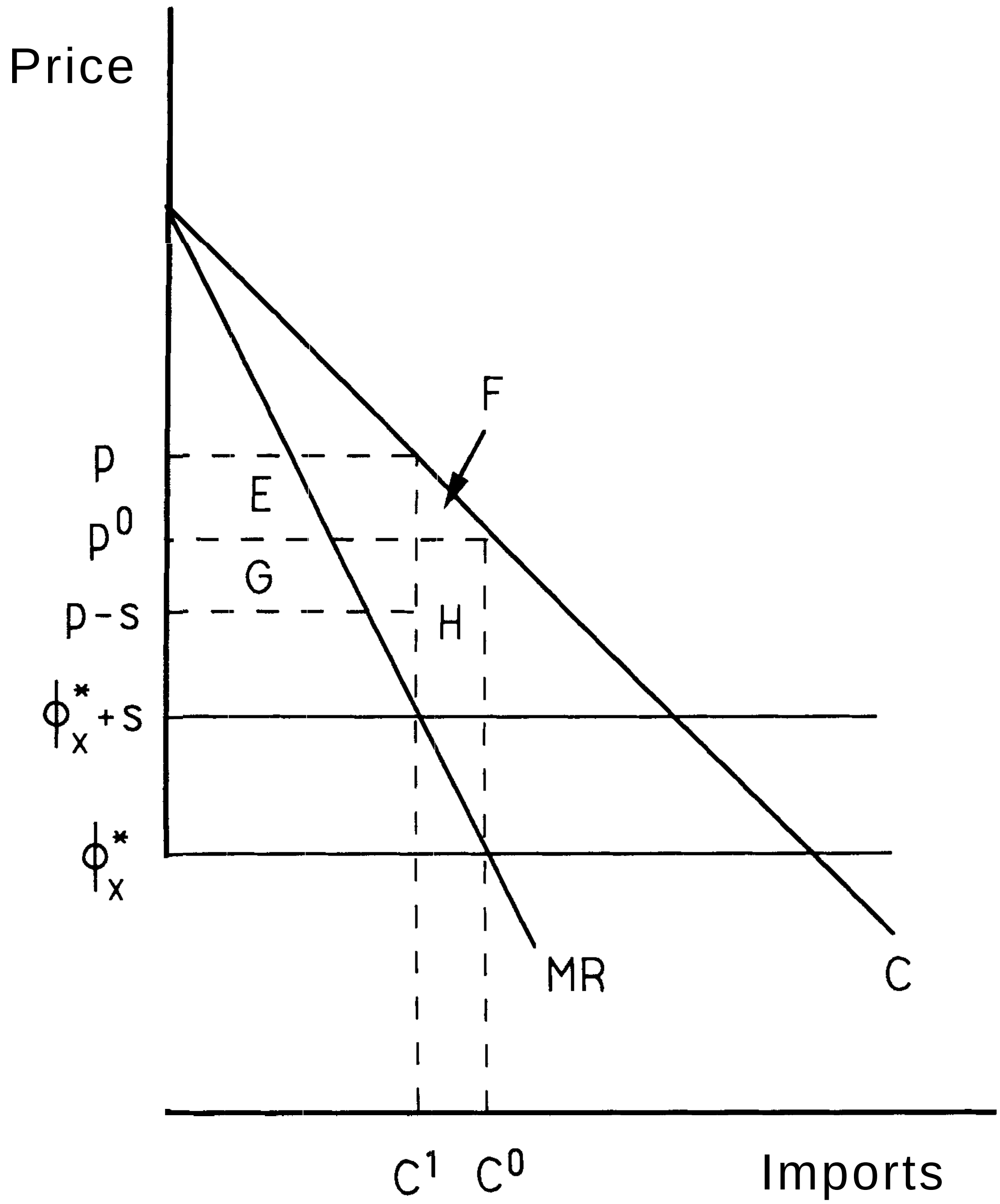

Figure 2

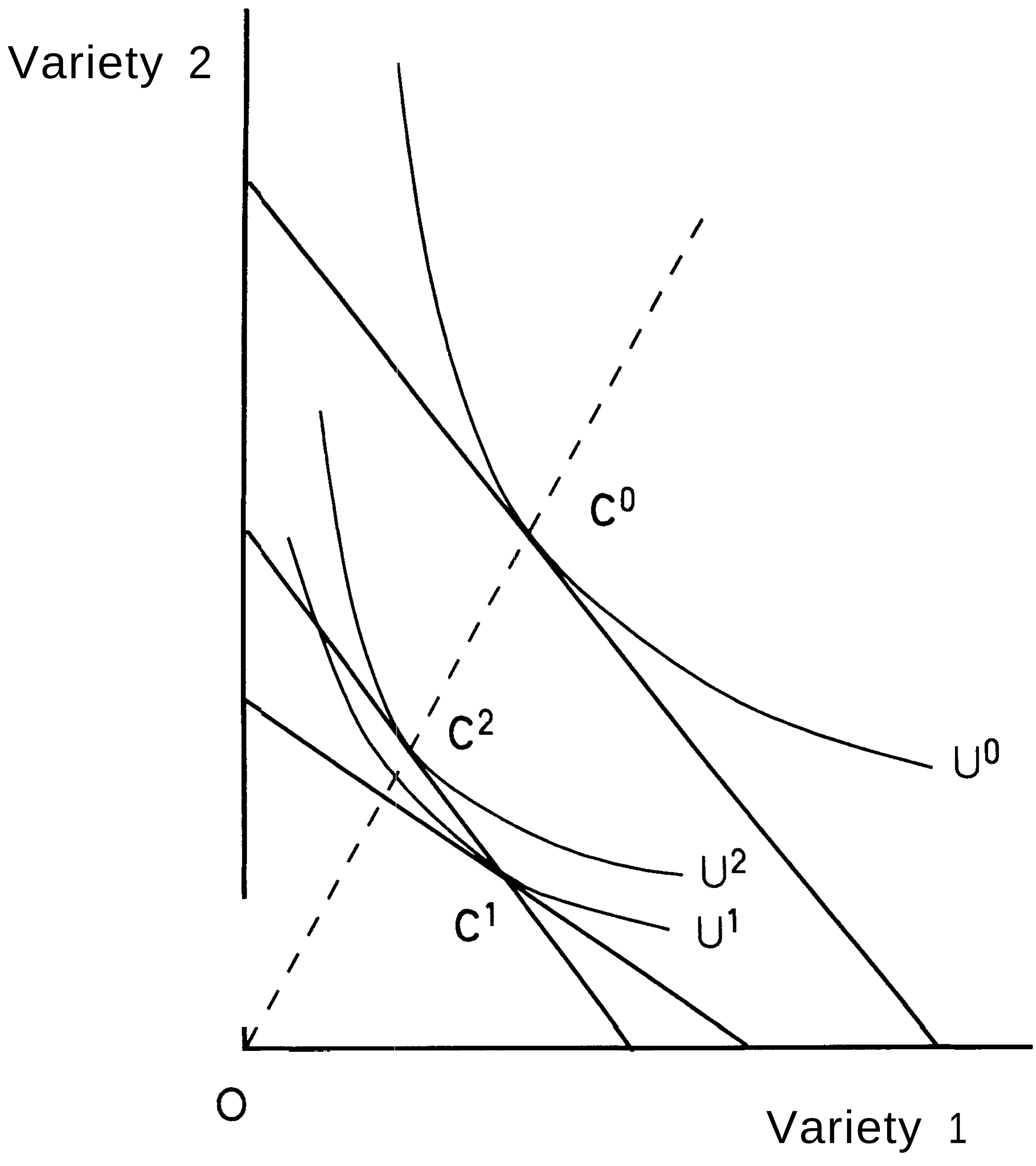

Figure 3