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The Non-Equivalence of Specific and *Ad Valorem* Tariffs with Quality-Differentiated Goods

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Abstract

This paper is an extension of the literature inaugurated by Falvey that examines the effects of tariffs when the affected goods are quality-differentiated. I demonstrate that an ad valorem tariff may actually increase the sales and market shares of some imported qualities, and that the protection offered to the domestic industry may not be spread among all domestically produced qualities. A specific tariff also does not distribute the burden and benefits to all firms in the market. Only those qualities that are closest substitutes for imports will be affected. For either type of tariff, the total sales in the market contract only if the lowest quality is imported.

I. Introduction

Traditionally, the theory of tariffs has treated commercial policies as if they were levied on single homogeneous goods. In reality, a large number of markets consist of differentiated goods and policy markers do not make fine distinctions between product types when imposing trade policies. As a result, it is generally true that when tariffs are imposed, they are applied uniformly over a broad class of differentiated goods instead of applying a

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different tariff for each variety. In the present paper, we are interested in the effects of tariffs when they are imposed on markets in which the goods are differentiated by the level of quality they embody.

In an oft-cited paper, Falvey [1979] established a relationship between quantity-based policies, such as quotas and specific tariffs, and the average quality of imports. He found that such policies should lead to an increase in the average quality of imports because they decrease the relative prices of high quality goods.[1] Falvey also examines *ad valorem* tariffs and shows that they have no effect on the quality composition because they do not affect the relative prices of the varieties.

As shown by Wall [1992], Falvey's results are sensitive to the type of consumer choices allowed in the model. If an imported good is one in which each consumer buys only one quality, instead of all (both) qualities as in Falvey, it is not relative prices that matter but the differences in prices. For such a good, an *ad valorem* tariff creates an incentive for consumers to downgrade their purchases, and the average quality of imports falls.

The present paper extends the theory of tariffs to the broad class of differentiated goods for which each consumer does not buy all available qualities. Also, by allowing for the existence of domestically produced qualities, we are able to examine the affect that tariffs have on the choice between domestic and imported qualities, as well as among imported qualities. In doing so, the differences between tariffs in this context and tariffs in the traditional homogeneous-goods context can be examined. Also, further differences between specific and *ad valorem* tariffs than those highlighted by Falvey [1979] and Wall [1992] become apparent.

Following the above-cited literature, we examine goods for which quality is fixed. That is, we allow commercial policies to alter the mix of the qualities purchased but not to change the qualities of the goods produced. There is a separate but related literature dealing with the question of endogenous quality and commercial policies (see Das and Donnenfeld [1989] and Feen-

1. Empirical evidence of this is provided by Anderson [1985] for the cheese industry, Aw and Roberts [1986] for the footwear industry, and Boorstein and Feenstra [1991] for the steel industry.

stra [1988] for references). Also following Falvey and the bulk of the subsequent literature, the analysis is restricted to partial equilibrium. These assumptions are retained to illuminate the basic result that when a good is quality-differentiated, the distribution of the costs and benefits differs from that described by classical tariff theory. Relaxation of any of these assumption should modify but not reverse the results.

With the model described below, three new results for *ad valorem* tariffs arise. (i) The burden of protection is not evenly distributed among the foreign qualities. The tariff may actually *increase* the sales and market shares of one or more imported qualities even as it is decreasing the total amount of imports sold. (ii) For domestic firms, the protection provided is not spread out among all the producers. Only the closest competitor of a foreign quality will see increased sales. (iii) For the market as a whole, only if the lowest quality available in the market is imported will the *ad valorem* tariff result in a decrease in the total amount sold.

There are two new results obtained for specific tariffs. (i) The burden and benefit of protection are not distributed among the firms. The only qualities affected are those that are next to qualities produced in the other country on the quality spectrum. (ii) Only if the lowest quality is imported does the tariff decrease the total sales in the market.

Section II develops the basic model used throughout the analysis. The effects of *ad valorem* and specific tariffs are examined in sections III and IV. Section V provides concluding remarks.

II. The Basic Model

The model used here is variant of that first developed by Mussa and Rosen [1978].[2] In this type of model, demand for different types of a good arises from consumers who all have the same income but who differ in their preferences for quality. A consumer purchases at most one variety of the differentiated good and the remainder of his income is spent on some compos-

2 See Bond [1984, 1988], Das and Donnenfeld [1987, 1989], Krishna [1990], and Wall [1992] for other variants of Mussa and Rosen's model applied to trade questions.

ite good, m.[3] All consumers have separable utility functions of the form

$$U = \theta q + m,$$

where q is the quality of the differentiated good and θ is a quality preference parameter. The consumer set is characterized by a distribution of preference parameters over the interval $[\underline{\theta}, \bar{\theta}]$, and $g(\theta)$ is the number of consumers with preference θ. The function $g(\theta)$ is assumed to be everywhere continuous and differentiable.

The finite number of qualities are arranged along the quality continuum so that q_1 is the lowest quality produced and q_n is the highest. The quality levels are a monotonic transformation of the indices.

A consumer's budget constraint is $I = m + p_j$, where p_j is the price of variety j and the composite good is priced at unity. Income, I, is assumed to be sufficiently large for the purchase of any variety of the differentiated good. A consumer who consumes variety j attains surplus, or indirect utility, of

$$V_j = \theta q_j + I - p_j$$

Schedule V_j indicates the indirect utility from the consumption of variety j over the consumer preference spectrum. As indicated by figure 1 for $n = 4$, the consumer who is just indifferent between purchasing the lowest quality and not consuming the differentiated good at all is the consumer for whom $V_1 = I$. This consumer has preference parameter

$$\theta_1 = \frac{p_1}{q_1} \tag{1}$$

The consumer who is just indifferent between consuming q_j and q_{j-1}, for whom $V_j = V_{j-1}$, has preference parameter

$$\theta_j = \frac{p_j - p_{j-1}}{q_j - q_{j-1}}, \qquad j = 2,\ldots,n. \tag{2}$$

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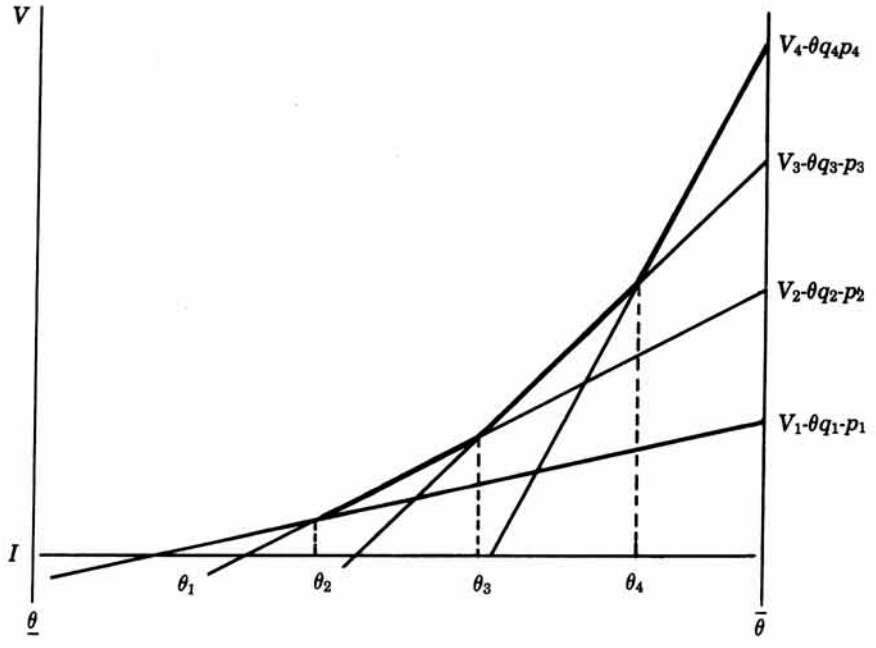
3 In these models, consumers are exogenously restricted to a corner solution in their choices of which quality or qualities to consume. This is obviously for simplicity because of the complicated task of making this endogenous.

Figure 1



The indirect utility schedules and the cornerpoint preferences are indicated by figure 1. The highest levels of consumer surplus that consumers can attain are indicated by the upper envelope of the V_j's starting from the lowest preference satisfied, θ_1, and becoming steeper at each cornerpoint as the quality which best satisfies the preferences rises.

The range of consumer types purchasing the differentiated good stretches from $\bar{\theta}$ down to θ_1. The higher end of the preference spectrum is always satisfied and any excluded consumers are located at the lower end. This is simply because the willingness to pay, as measured by consumer surplus, is positively related to quality preference.

Because each θ characterizes a single consumer type, the quantities demanded of the n varieties are

$$x_j = \int_{\theta_j}^{\theta_{j+1}} g(\theta)d(\theta) = G(\theta_{j+1}) - G(\theta_j) \qquad j = 1,\ldots,n; \tag{3}$$

where $\theta_{n+1} \equiv \overline{\theta}$ and $G'(\theta) \equiv g(\theta)$.[4]

Some of the n varieties are imported and may then be subject to a specific or *ad valorem* tariff applied uniformly to all imported varieties. The prices, cornerpoints, and quantities sold are then functions of the tariff, T.

Using (3), the effect that a tariff has on the quantity sold on the n varieties is

$$\frac{dx_j}{dT} = g(\theta_{j+1})\frac{\partial \theta_{j+1}}{\partial T} - g(\theta_j)\frac{\partial \theta_j}{\partial T}, \qquad j = 1,\ldots,n. \tag{4}$$

Throughout this paper, it is assumed that overseas and home firms are perfect competitors, which implies that the market price of each variety is the marginal cost plus the per unit tariff revenue. Additionally, it is assumed that the marginal cost of each variety, c_j, is constant. The parameter c_j denotes the marginal cost for either home or overseas firms. The assumption of constant marginal costs is unimportant for the analysis of the effects of tariffs on the sales of the different varieties of the good. The marginal cost variable, c_j, could instead be considered the cost at the intersection of the marginal and average cost curves, the long run price.

Home welfare, W, is the sum of consumer surplus and tariff revenue. Let $V_i^f = \theta q_i + I - c_i$ denote the surplus attained by consumer type θ under free trade.

$$W(T) = \sum_{i=1}^{n} \int_{\theta_i(T)}^{\theta_{i+1}(T)} V_i^f(\theta) g(\theta) d\theta.$$

Differentiating the above expression with respect to τ, the marginal effect of the tariff on home welfare is obtained.

$$\frac{dW}{dT} = \sum_{i=1}^{n} \left[V_i^f(\theta_{i+1}) g(\theta_{i+1}) \frac{\partial \theta_{i+1}}{\partial T} - V_i^f(\theta_i) g(\theta_i) \frac{\partial \theta_i}{\partial T} \right] \tag{5}$$

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4. We are assuming that there will always be some consumers who choose to not consume the differentiated good, *i.e.* $\theta_1 > \overline{\theta}$.

III. *Ad Valorem* Tariffs

This section considers three alternative quality specialization cases in which the home government levying a uniform *ad valorem* tariff on all imported varieties. Subsection *A* examines the situation where the market for the good is split into two ranges of specialization with overseas firms providing all lower qualities while home firms provide all higher qualities. Subsection *B* considers the opposite case of a market where overseas firms provide all high qualities and home firms provide all low qualities. Subsection *C* applies these results to derive results for the general case in which quality range can alternate between the two countries as one moves along the quality spectrum.

A. Home Specialization in High Qualities

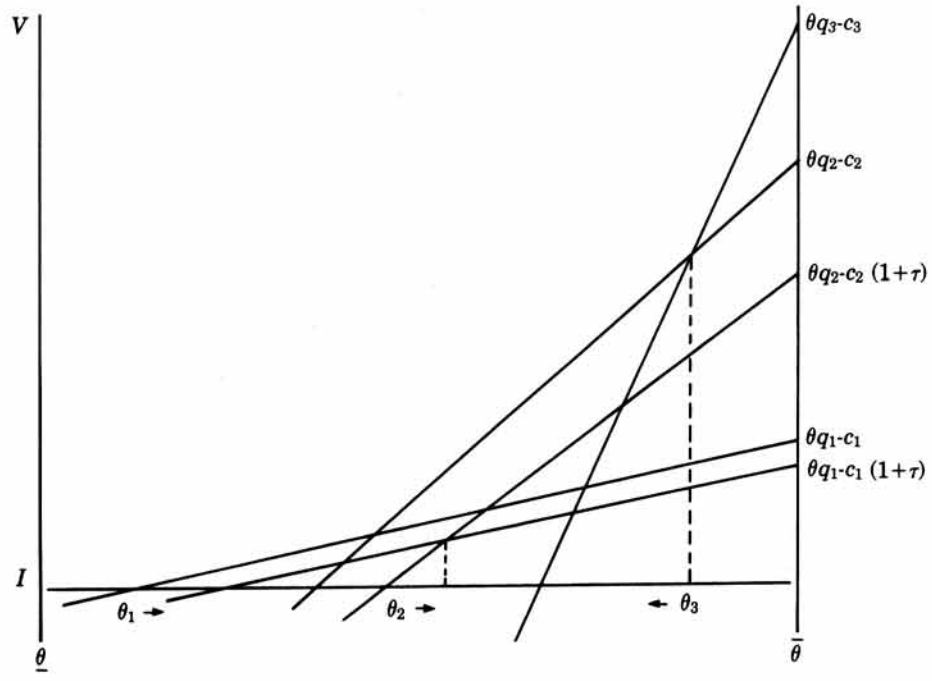
Assume that qualities indexed from 1 through k are imported while the remaining qualities, $k + 1$ through n, are produced at home. When an *ad valorem* tariff of τ is levied uniformly on all imports, the prices in the home market for the n varieties when there is perfect competition and constant marginal costs are $p_j = c_j(1 + \tau)$, $j = 1, \ldots, k$; and $p_j = c_j$, $j = k + 1, \ldots, n$. Substituting these prices into (1) and (2), the post-tariff cornerpoints are obtained.

Lemma 1: *The tariff increases by $\tau\theta_j$ those cornerpoints that define the ranges of preferences satisfied by all but the highest quality import, $j = 1, \ldots, k$. The upper bound of the range of preferences satisfied by imports, θ_{k+1}, falls by $c_k\tau$ while all other cornerpoints, $j = k + 2, \ldots, n$, are unchanged.*

The effects of the *ad valorem* tariff on the range of preferences satisfied by the different varieties is illustrated by figure 2, where $n = 3$ and $k = 2$. For all consumers, the tariff decrease s the indirect utility of each imported variety, as indicated by the downward shifts of the V_j for each imported qualities. Because the tariff burden is positively related to the quality purchased, some consumers who under free trade buy imported varieties downgrade their purchases after the imposition of an *ad valorem* tariff, *i.e.* θ_1 and θ_2 rise with the tariff.

It is important to note that for those consumers purchasing imported varieties, the incentive to downgrade is positively related to quality. Thus, the

Figure 2



effect of the tariff on a cornerpoint is positively related to the value of the free-trade cornerpoint and the range of preferences satisfied by each of the imported qualities, except for the highest, is expanded by the tariff. However, the range of preferences satisfied by the highest quality import shrinks with the tariff as does the range satisfied by imports as a whole.

The case of a uniform distribution of preferences provides an interesting benchmark for examining the effects of the tariff on the quantities sold. With a uniform distribution, saying that a variety satisfies a wider (narrower) range of preferences is equivalent to saying that the quantity sold of the variety increases (decreases). Therefore, it is clear that the quantity sold of each of the lower $k-1$ imported qualities *increases* when an *ad valorem* tariff is levied and preferences are uniformly distributed . The total quantity of imports sold decreases but this owes entirely to a decrease in the sales of the highest quality import.

The distribution of preferences is crucial in determining the quantity

effects of an *ad valorem* tariff. The output effects are summarized by the following Proposition for a general preference distribution.

Proposition 1: *When all home varieties are of higher quality than all imports, an ad valorem tariff decreases the quantity sold of any imported quality j, $j \neq k$, is negatively related to an ad valorem tariff if and only if $g(\theta_{j+1})$ is sufficiently less than $g(\theta_j)$. The total quantity of imports and the quantity sold of the highest quality import are negatively related to the tariff. For home varieties, only the sales of the lowest home quality are positively related to the tariff.*

As is the case whenever there is perfect competition, an import tariff decreases home welfare. For the situation examined in this section where $T \neq \tau$, the welfare loss is measured by

$$\frac{dW}{d\tau} = -V_1^f(\theta_1)g(\theta_1)\frac{\partial\theta_1}{\partial\tau} - \sum_{i=2}^{k+1}\left[V_i^f(\theta_i) - V_{i-1}^f(\theta_i)\right]g(\theta_i)\frac{\partial\theta_i}{\partial\tau} < 0. \qquad (6)$$

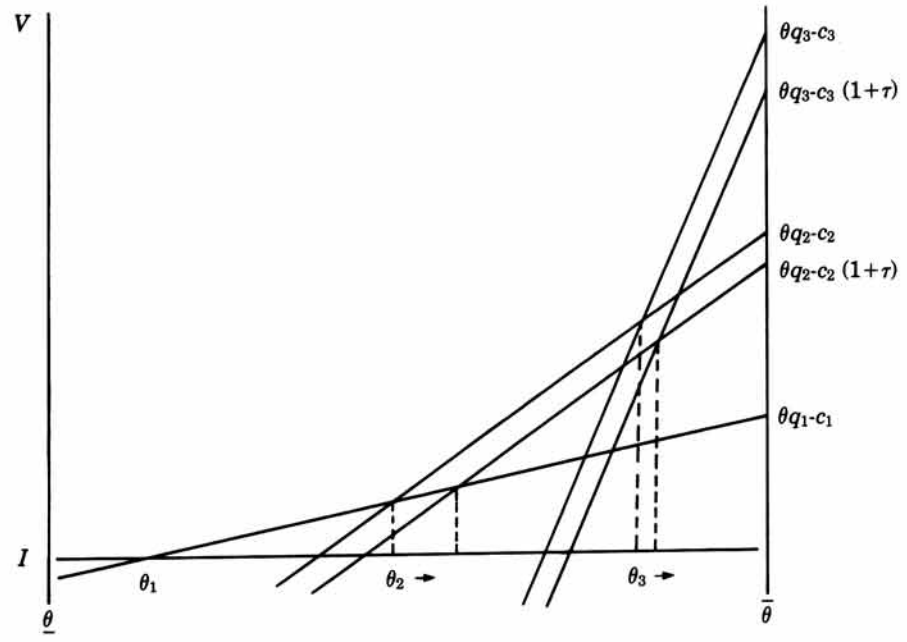
The welfare loss is from a consumption distortion at each margin within the import range. Because the tariff causes all marginal consumers buying an imported variety to choose a less preferred quality, the consumer surplus loss outweighs any revenue gain and there is a net surplus loss to society. Also, some consumers stop buying the product altogether, despite the fact that its value exceeds the cost of producing it. For each consumer who does not alter his choice of quality, the revenue from the tariff exactly offsets any consumer surplus loss.

B. Home Specialization in Low Qualities

Assume that the home country specializes in all qualities 1 through k while imports comprise qualities $k + 1$ through n. With perfect competition and constant marginal costs, the market prices for the n varieties when an *ad valorem* import tariff τ is imposed are $p_j = c_j$, $j = 1, ..., k$; and $p_j = c_j(1 + \tau)$, $j = k + 1, ..., n$. Use (1) and (2) to obtain the post-tariff cornerpoints.

Lemma 2: *The tariff has no effect on the cornerpoints defining the ranges of preferences satisfied by the lower k home varieties. The lower bound of the range of preferences satisfied by imports, θ_{k+1}, rises by c_{k+1} while all other cornerpoints rise by $\tau\theta_j$, $j = k + 2, ..., n$.*

Figure 3



As indicated by Lemma 2, each cornerpoint used to define a range of preferences satisfied by an imported quality is positively related to the *ad valorem* tariff. This situation is illustrated by figure 3, where $n = 3$ and $k = 1$. For each preference parameter, the tariff decreases the consumer surplus of an imported quality by $c_j\tau$ so that V_3 shifts down more than does. V_2.

The effect of a tariff in this situation is similar to the previous case:

Proposition 2: *When all home varieties are of lower quality than all imports, the an ad valorem tariff has the same effects on the sales of the imported qualities as when the quality specialization is reversed. For home varieties, the difference is that in the present case it is the highest home quality into which some consumers switch.*

It is straightforward to show the following Corollary by noting that an *ad valorem* tariff has no effect on θ_1 in this situation.

Corollary 1: *When all home varieties are of lower quality than all imported varieties, an ad valorem tariff has no effect on the total amount of the good*

sold in the home market.

This Corollary indicates that an *ad valorem* tariff has no effect on total market output when the country levying the tariff is specialized in the low end of the market. This results from the fact that a consumer's choice of whether or not to enter market by buying the lowest quality is unrelated to the prices of the higher qualities. A tariff in this case only affects the choices among the different imported varieties and between the lowest imported quality and the highest home quality. This result is related to that of Itoh [1983] which shows that a monopolist's introduction of a new variety has no effect no the price of any lower quality variety. If there is no effect on the price of the lowest quality, θ_1 is unaffected and the total quantity sold is unchanged.

The net welfare effect of an *ad valorem* tariff in this situation is negative and is derived using the above cornerpoints and (5):

$$\frac{dW}{d\tau} = -\sum_{i=k+1}^{n-1}\left[V_i^f(\theta_i) - V_{i-1}(\theta_i)\right]g(\theta_i)\frac{\partial\theta_i}{\partial\tau} - V_n(\theta_n)g(\theta_n)\frac{\partial\theta_n}{\partial\tau} < 0. \qquad (7)$$

In general, it is unclear whether the tariff decreases welfare more in the country specialized in high qualities or in the country specialized in low qualities. However, when one of the countries produces only the highest quality of the good, *i.e.* when $k = n - 1$, the following Proposition can be made:

Proposition 3: *For $k=n-1$, when two identical countries impose ad valorem tariffs, the country specializing in the highest the quality of a good faces a greater welfare loss than the country specializing in lower qualities.*

Proposition 3 is true because a tariff imposed in a market where the home good is the highest quality decreases the total amount of the good sold. In the other market, applying a tariff to only the highest quality does not affect the total quantity sold.

C. Alternating Ranges of Specialization

Consider the situation where the quality spectrum is not split into two distinct ranges of specialization. Instead, assume that the ranges of specialization alternate between home and imported varieties as one moves along the

quality spectrum.

The results of the previous two subsections can be easily applied to this more general case and no reformulation of the model is necessary. (i) Within an import range, consumers downgrade their purchases such that the spread of preferences satisfied by each imported variety, exclusive of the highest and lowest qualities in the range, expands with the tariff. The spread of preferences satisfied by the varieties at the ends of the import range contracts with the tariff. As a result, the output of each imported variety at the edge of an import range falls with a tariff while the output of all other varieties rises or falls depending on the distribution of preferences. (ii) For each home variety abutting an import range, the spread of preferences satisfied expands with the tariff. For each other home variety, the spread of preferences satisfied is identical to that under free trade. Therefore, the outputs of those home varieties which abut an import range rise with the tariff. The outputs of all other home varieties are unchanged. (iii) Only if the lowest quality is imported does a tariff decrease the total quantity sold in a market. Otherwise, the tariff has no effect on total market sales.

IV. Specific Tariffs

The simpler case of specific tariffs is handled by looking only at the general case of alternating ranges of specialization. For each imported good facing the specific tariff, t, the price is $p_j = c_j + t$. The price of each domestic quality remains $p_j = c_j$. Substituting these prices into (1) and (2), it is easy to prove the following Lemma:

Lemma 3: *For $j = 2, \ldots n$, if quality j is domestic (imported) and quality $j + 1$ is imported (domestic), θ_j is positively (negatively) related to a specific tariff. Otherwise, the tariff has no effect on θ_j. A specific tariff has a positive effect (no effect) on θ_1, if the lower quality is imported (domestic).*

The choices between any two domestic qualities or any two imported qualities are unaffected by a specific tariff. No matter which one is bought, the tariff paid is the same. Only if two neighboring qualities are from different countries does the tariff affect a consumer's decision, inducing some consumers to shift from a foreign to a domestic quality, but not from one quality to another from the same country. Thus, the following Proposition

and Corollary follow and are independent of the distribution of preferences.

Proposition 4: *For any domestic quality j, only if quality* $j-1$ *and/or* $j+1$ *are imported is the specific tariff positively related to sales. Otherwise, the tariff and the sales of a domestic quality are unrelated. For any imported quality j, only if quality* $j-1$ *and/or quality* $j+1$ *are domestically produced is the specific tariff negatively related to sales. Otherwise, the tariff and the imports of a foreign quality are unrelated.*

Corollary 2: *Only if the lowest quality is imported does a specific tariff decrease the total sales in the market.*

Thus, the protection and burden of the tariff are not spread among domestic and imported qualities. Only those qualities that are next to a quality from the other country on the quality spectrum are affected.

V. Concluding Remarks

The above analysis is valid for monopolistic markets as well as for perfect competition. When the monopolist decides how much to produce after a uniform tariff is imposed on all its qualities, it is the differences in marginal revenues between qualities which is important. Because the effect that the tariff has on the marginal revenue of the varieties is positively related to quality, the effect is analogous to the perfectly competitive case. See Krishna [1990] and Wall [1992] for a discussion.

The concept of the quality composition of imports has sometimes been simplified to mean the *average* quality of import ⟨see Falvey [1979] and Boorstein and Feenstra [1991]⟩. While the two concepts are compatible in their models, they are not compatible presently. Although the present model indicates that an *ad valorem* tariff provides incentives for consumers to upgrade their purchases of imports, the average quality of imports does not necessarily rise as a result. This depends on the distribution of consumer preferences. The effect of specific tariffs on the average quality of imports is also ambiguous.

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