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Relative efficiency of specific and ad-valorem tariffs in a model of monopolistic competition

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ABSTRACT

The relative efficiency of ad-valorem and specific tariffs is still an active debate in the international trade literature. Contrary to the general belief about the ad-valorem tariff being superior under various imperfectly competitive market settings, it is shown that the specific tariff generates more welfare under monopolistic competition. We argue that this result is not general. If we follow the empirical evidence that firms use variable mark-ups and use a utility function that allows for it, we find that the ad-valorem tariff is more efficient when consumers' love for variety is low. The relative efficiency overturns to the specific tariff as consumers' love for variety increases.

1. Introduction

Although tariffs can be imposed in a number of ways, the most common are ad-valorem and specific. There is a long debate in the trade literature on the relative efficiency of these tariff regimes. In a perfectly competitive market, for every specific tariff rate there exists an equivalent ad-valorem tariff level. However, in an imperfectly competitive environment this equivalence result breaks down; an ad-valorem tariff generates higher welfare than a specific tariff. This has been proven for different tariff equivalence definitions such as revenue or import equivalence.[1] Jørgensen and Schröder (2005) showed that in contrast to the general belief, a specific tariff generates higher welfare in a symmetric two-country setting with homogenous firms competing monopolistically and consumers who have constant elasticity of substitution (CES) utility functions. This reverses the findings of previous work that studies tariff policy in an imperfectly competitive market setting. When the ad-valorem tariff is imposed, profit-maximizing firms increase their output. Higher output reduces prices, decreasing the wedge between the price consumers pay and the price producers receive. Consumers are therefore better off with the increased output and lower prices of ad-valorem tariffs versus specific tariffs. In contrast, under a specific tariff regime, lower output levels are sufficient to offset the fixed entry costs. Thus, more firms (varieties) can survive. Jørgensen and Schröder (2005) argue that higher variety generated under the specific tariff dominates the lower prices generated under the ad-valorem tariff regime for all parameter values. However, we argue that the variety effect should deteriorate as love for variety decreases and the ad-valorem tariff should dominate again. We further argue that their parameter independent result is due to the CES utility specification where price is a constant multiple of the marginal cost of production. If we replace the utility specification with the one that allows for endogenous markup, we show that their result is not general. For certain parameter values, the ad-valorem tariff is a more efficient regime than an import equivalent specific tariff when consumers' love for variety is low.

Taxation and tariff policy is not a policy tool used only in international trade settings. There is a substantial public economics literature comparing the market outcomes and welfare implications of ad-valorem and specific tax policies. This literature's conclusion regarding the welfare ranking of the ad-valorem and specific taxes are in line with the international trade literature.[2] The discussion made in this paper can be easily extended to the public economics literature as well.

2. Model description and analysis

The model is based on Melitz and Ottaviano (2008). As mentioned earlier, the quadratic utility function allows for

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1 See Helpman and Krugman (1989) for the non-equivalence of these tariff regimes under imperfectly competitive market structures.

2 See Keen (1998) for a review of the literature.

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endogenous mark-ups since it permits firms to respond to competition by varying their mark-ups. With the CES utility function, firms have constant mark-ups and pricing policy is not affected by the competitiveness of the market.[3]

There are L identical consumers in each country. Their preferences are defined over a continuum of differentiated products that can be either domestic or foreign, and a numeraire good. They choose differentiated products that are indexed by i from the set of home, H and foreign, F varieties, $H \cup F$. A numeraire good is indexed by 0. Then, a consumer j's utility function is:

$$U = q_0^j + \alpha \int_{i \in H \cup F} q_i^j di - \frac{1}{2}\gamma \int_{i \in H \cup F} (q_i^j)^2 di - \frac{1}{2}\eta \left(\int_{i \in H \cup F} q_i^j di \right)^2,$$

where q_0^j is the numeraire good consumption and q_i^j is the differentiated good consumption of variety i.[4] A consumer's inverse demand for each variety is given as $p_i = \alpha - \gamma q_i^j - \eta Q^j$, where Q^j is the total quantity consumed by consumer j.

In each country these L consumers who are endowed with one unit of labor inelastically supply it. There is no leisure in the utility function. Furthermore, labor is the only factor of production. The numeraire good is produced under constant returns to scale at the cost of a unit of labor. Demand for numeraire good in both countries is ensured to be positive with the assumption that income is high enough and it is freely traded in a perfectly competitive market. If the price of the numeraire good is normalized to one and since workers receive their revenue of marginal product, the wage is unity. Moreover, wages are identical across countries.

All firms producing differentiated products have the same technology. They pay a one-time fixed cost f_e to enter the differentiated good sector. Each good is produced at a constant marginal cost of c (equal to c unit labor requirements). There is no one-time fixed cost to enter the foreign market; exporting firms only pay the tariff. All firms have the same technology and face the same problems. Therefore, if it is profitable for one home firm to export, it is profitable for all home firms to export. Countries are symmetric in terms of consumers, firms, and tariff restrictions. Therefore the number of firms in the foreign country and the home country is equal in equilibrium, i.e. $N_H = N_F = N$. The total number of varieties available is twice the number of varieties produced at home.

Firms maximize their profits by taking the total number of varieties and average price in the market as given. Since firms are homogenous and countries are symmetric, the profit maximizing prices of home and foreign firms' products in their own domestic markets are equal at $q_i^d = q^d$ for every i in both countries. The profit-maximizing price p^d and the output level of a home firm q^d satisfy $q^d = \frac{L}{\gamma}(p^d - c)$ where d denotes the domestic market variables.

First, we analyze the market if the government restricts imports using an ad-valorem tariff. The government collects a fraction t of the price per unit of an imported good. Following the symmetry assumptions, all home firms and foreign firms set the same prices for their exported goods in equilibrium i.e. $q_i^x = q^x$ for every i. Additionally, markets are assumed to be segmented; firms therefore maximize the profit earned in both markets separately. From the first order condition of the firm's maximization problem, we obtain the price of the exported good in the destined market p_t^x and quantity produced q_t^x satisfying $q_t^x = \frac{L}{\gamma}\left(p_t^x - \frac{c}{1-t}\right)$ where superscript x denotes the export market variables, and subscript t denotes the ad-valorem tariff variables. Firms enter the market until the ex-post profit of a firm $\Pi_t(c)$ is driven to zero; this is the free entry condition.

Suppose that exporting firms now face a specific tariff. Firms must pay s for each unit exported. The profit-maximizing price in the foreign market p_s^x and the quantity supplied q_s^x satisfy $q_s^x = \frac{L}{\gamma}\left(p_s^x - (c+s)\right)$ where x denotes export variables, and s denotes specific tariff variables.

The two tariff regimes are compared with the assumption that they create the same level of imports, $\overline{Q}$. We further compare the number of varieties, the levels of output produced in both domestic and foreign markets (size of the firms), and the welfare implications of different import restriction implementations.

Lemma 1. *For a given specific tariff s and an import equivalent ad-valorem tariff t,*

1. *The domestic and foreign output levels of firms under a specific tariff are lower than that under an ad-valorem tariff: $q_s^d < q_t^d$ and $q_s^x < q_t^x$.*
2. *The total varieties available under a specific tariff are higher than under an ad-valorem tariff: $N_s > N_t$.*

Proof. In the Appendix. □

Briefly, a specific tariff creates smaller firms compared to an ad-valorem tariff. Firms facing ad-valorem tariff restrictions in the export market increase their output and decrease their price. Firms therefore decrease the wedge between the price consumers pay and the price producers receive. This is a result of an ad-valorem tariff decreasing the marginal revenue. On the other hand, a specific tariff acts as an increase in marginal cost. Firms therefore tend to decrease their output while they increase their prices. Hence, with higher operating surplus, smaller outputs are sufficient to offset the fixed entry costs to enter the market. This allows more firms to exist in the market under a specific tariff.

The results for firm size and number of varieties are in line with Jørgensen and Schröder (2005). However, this paper departs from theirs when we compare the welfare implications of the two tariff regimes. For low levels of love for variety we reestablish the non-competitive welfare ranking results that an ad-valorem tariff generates higher welfare than an import-equivalent specific tariff. We demonstrate this result below using a numerical analysis.[5]

Fig. 1 shows the welfare ranking of an ad-valorem tariff and a specific tariff. It is created as follows: take particular values for the demand parameters α, γ, and η, specific tariff rate s, and the cost parameters f_e and c.[6] Using the free-entry condition, the first-order condition of profit maximization in the domestic market, the first-order condition of profit maximization in the export market, and the inverse demand function we find q_s^x, q_s^d and the number of home varieties in the market, N_s. The total import is $q_s^x N_s$. The ad-valorem tariff rate t is set so that the import level is same under both tariff regimes. Using the above identical conditions for the ad-valorem tariff, we find q_t^x, q_t^d, the number of home varieties

3 See Feenstra (2003) for an extensive comparison between CES utility functions and utility functions that allow endogenous mark-ups.

4 For a detailed discussion of this quadratic utility function and the model, see Melitz and Ottaviano (2008).

5 The model proposed by Melitz and Ottaviano (2008) is simple enough to analyze and finds closed-form solutions not only for the identical firm case, but also for the heterogeneous firm case. However, the comparison in this model requires finding import equivalent ad-valorem and specific tariffs. In order to find closed form solutions, one must solve $N_t q_t^x = N_s q_s^x$ and solve for t, given s or vice versa. The terms on both sides of the equation are quadratic functions in t and s respectively. The closed form solutions therefore require tedious algebra, and the results are presented using numerical analysis.

6 The values chosen for the parameters are as follows: $c = 0.01$ $f_e = 1000$, α ranges from 4 to 20, γ ranges from 0.001 to 0.1, η is 100, and s is taken as 0.5.

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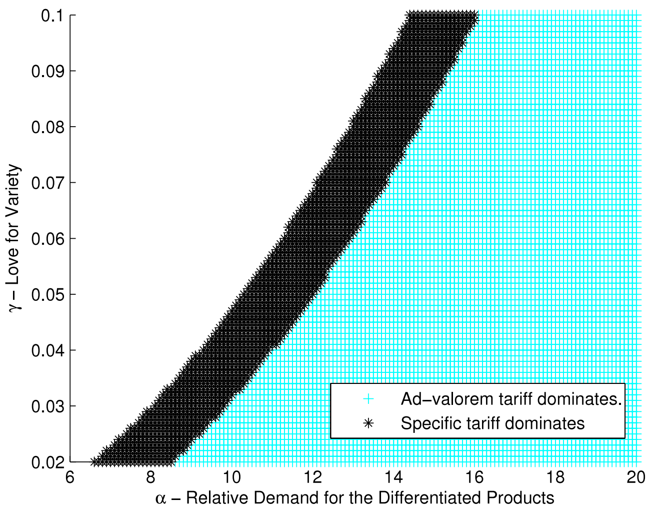

Fig. 1. Welfare comparison of ad-valorem and specific tariffs.

in the market N_t, and the import equivalent ad-valorem tariff rate t. The parameters are chosen such that the problem is well defined i.e., the demand for a numeraire good is positive. The figure shows us that there exist sets of parameters for which the superiority of a specific tariff shifts to an ad-valorem tariff. This gives a counterexample for the general result of Jørgensen and Schröder's (2005) specific tariff dominance.

3. Discussion

There are two effects at work when a tariff is imposed. First, it affects number of varieties by affecting firms' price–cost margin. Second, it increases total income by raising tariff revenue. For low levels of love for variety, consumers value total consumption more than consuming variety. An ad-valorem tariff therefore generates more welfare, first by generating more tariff revenue and more income, and second by keeping the number of firms close to an efficient level. However, as love for variety increases creating less variety or inducing excessive firm exit decreases welfare. We therefore observe the specific tariff being more efficient. Similarly, Anderson et al. (2001) argued that the relative efficiency of the two tax forms depends on the government's revenue requirements and the strength of tastes for variety relative to entry costs. They discussed models with completely inelastic aggregate demand to provide counterexamples to the superiority of the ad-valorem tariff. This paper uses a utility specification that has sufficiently elastic demand schedule, and enables us to show the superiority of the specific tariff for a range of parameters.

This paper departs from Jørgensen and Schröder (2005) by modeling consumer demand using a utility function that allows for endogenous mark-up.[7] As a result, as the love for variety parameter changes the firms can not only adjust their output, but also adjust their price by changing their mark-up. Hence, the total number of firms in the market changes by both the change in love for variety and the variable mark-up. On the other hand, the CES utility function is more restrictive than a utility function that allows endogenous mark-up. Under a constant mark-up, the price is already determined as a constant multiple of firms' marginal cost. Firms can respond to changes in competitive environment by adjusting only their outputs. The number of firms therefore doesn't adjust much compared to the endogenous mark-up utility model when they face competition. Hence, the superiority of the specific tariff holds for all parameter values due to higher variety.

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Appendix

When firms decide on their output levels, in both the domestic and foreign markets, they optimize the level of production given the residual demand in each market. We also argued that the two markets are segmented, and the optimal level of output in the domestic market is therefore not a function of the foreign market variables. However, the total profit level in both markets must cover the fixed entry costs. The free entry condition describes how the domestic market output level and foreign market output level are related. In addition, using the pricing and inverse demand rules one can describe the difference between the domestic and foreign output levels. The equations for these two import restrictions are described below,

The free entry condition for an ad-valorem tariff is simplified to:

$$\left(q_t^d\right)^2 + (1-t)\left(q_t^x\right)^2 = fe\frac{L}{\gamma}, \tag{A.1}$$

the difference between the quantity produced in the domestic and foreign market is:

$$q_t^d - q_t^x = \frac{L}{2\gamma}\frac{t}{1-t}c, \tag{A.2}$$

the free entry condition for a specific tariff is simplified to:

$$\left(q_s^d\right)^2 + \left(q_s^x\right)^2 = fe\frac{L}{\gamma}, \tag{A.3}$$

and the difference between the quantities produced is:

$$q_s^d - q_s^x = \frac{L}{2\gamma}s. \tag{A.4}$$

Proof of Lemma 1. Assume an ad-valorem tariff rate t_L such that t_L generates the same level of domestic output as the specific tariff rate s, i.e. $q_s^d = q_{t_L}^d$. From simplified free entry conditions (A.1) and (A.3), we find $q_{t_L}^x > q_s^x$. When we calculate the aggregate import levels, the import level with specific rate s is $\overline{Q}_s = N_s q_s^x = \frac{L(\alpha-c)-2\gamma q_s^d}{\eta(q_s^d+q_s^x)} q_s^x$. The import level under an ad-valorem tariff rate of t_L is $\overline{Q}_{t_L} = N_{t_L} q_{t_L}^x = \frac{L(\alpha-c)-2\gamma q_{t_L}^d}{\eta(q_{t_L}^d+q_{t_L}^x)} q_{t_L}^x$. The difference between the two import levels under both regimes is:

$$\begin{aligned}
\overline{Q}_s - \overline{Q}_{t_L} &= \frac{L(\alpha-c)-2\gamma q_s^d}{\eta(q_s^d+q_s^x)} q_s^x - \frac{L(\alpha-c)-2\gamma q_{t_L}^d}{\eta(q_{t_L}^d+q_{t_L}^x)} q_{t_L}^x, \\
&= \frac{L(\alpha-c)\left(q_s^x q_{t_L}^d - q_{t_L}^x q_s^d\right) - 2\gamma q_{t_L}^d q_s^d \left(q_s^x - q_{t_L}^x\right)}{\eta\left(q_s^d+q_s^x\right)\left(q_{t_L}^d+q_{t_L}^x\right)}, \quad \text{and} \\
&= \frac{\left(q_s^x - q_{t_L}^x\right)\left(L(\alpha-c)q_{t_L}^d - 2\gamma q_{t_L}^d q_s^d\right)}{\eta\left(q_s^d+q_s^x\right)\left(q_{t_L}^d+q_{t_L}^x\right)} < 0.
\end{aligned}$$

Therefore $\overline{Q}_s < \overline{Q}_{t_L}$, meaning that t_L is not restrictive enough to generate equal import levels for a given s. In order to decrease

[7] Ottaviano et al. (2002) showed the existence of reciprocal dumping with differentiated products under monopolistic competition with representative firms. Martin (2010) found that firms perform reverse-dumping for distant countries. He argues that one of the explanations is the variable mark-up pricing and form of tariff regimes. Furthermore, Greenhut and Norman (1986) argued that imposing trade restriction in the form of an ad-valorem tariff rather than a specific tariff will result in reverse dumping. However, in this paper, we observe dumping (tariff absorption) under both regimes. $p_s^d - (p_s^x - s)$ and $p_t^d - (1-t)p_t^x$ are both greater than zero.

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imports under an ad-valorem tariff, we must increase the import restriction. The import equivalent t must be less than t_L, and therefore $q_t^d > q_{t_L}^d = q_s^d$.

Assume an ad-valorem tariff rate t_H that creates the same level of foreign output for a firm as the specific tariff rate s, i.e. $q_{t_H}^x = q_s^x$. From simplified free entry conditions (A.1) and (A.3), we know that $q_s^d < q_{t_H}^d$. If we calculate the difference between total imports generated by import restriction levels s and t_H, we get:

$$\overline{Q}_s - \overline{Q}_{t_H} = \frac{L(\alpha - c) - 2\gamma q_s^d}{\eta(q_s^d + q_s^x)} q_s^x - \frac{1}{2} \frac{L(\alpha - c) - 2\gamma q_{t_H}^d}{\left(q_{t_H}^d + q_{t_H}^x\right)} q_{t_H}^x,$$

$$= \frac{L(\alpha - c) q_{t_H}^x \left(q_{t_H}^d - q_s^d\right) - 2\gamma q_{t_H}^x q_s^x \left(q_s^d - q_{t_H}^d\right)}{\eta \left(q_s^d + q_s^x\right)\left(q_{t_H}^d + q_{t_H}^x\right)}, \quad \text{and}$$

$$= \frac{\left(q_{t_H}^d - q_s^d\right) q_{t_H}^x \left(L(\alpha - c) + 2\gamma q_{t_H}^x\right)}{\eta \left(q_s^d + q_s^x\right)\left(q_{t_H}^d + q_{t_H}^x\right)} > 0.$$

There are more imports under the specific tariff than under the ad-valorem tariff regime t_H which is too restrictive. The import equivalent t should be less than t_H to generate higher imports and therefore $q_s^x = q_{t_H}^x < q_t^x$.

There are more varieties under a specific tariff restriction than an ad-valorem tariff. $N_s = \frac{L(\alpha-c)-2\gamma q_s^d}{\eta(q_s^d+q_s^x)}$ and $N_t = \frac{L(\alpha-c)-2\gamma q_t^d}{\eta(q_t^d+q_t^x)}$. Since $q_s^d < q_t^d$ and $q_s^x < q_t^x$, N_s is greater than N_t. □

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