E C O N O M I C S B U L L E T I N

Strategic Trade Policy with Polynomial Costs

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Abstract

ÿWe investigate how the superiority of the optimal subsidy or tariff in an international Cournot oligopoly depends on the production technology used in the industry, an interesting issue that has not been analyzed in the literature. We establish that the welfare superiority of the optimal subsidy or tariff depends on the relative steepness of the firms' common marginal cost curve: when it is relatively steep, tariffs are superior to subsidies in enhancing domestic welfare, and vice versa. When both instruments are used simultaneously, the tariff component becomes more important as the marginal cost curve steepens.

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1. Introduction

In recent years, many countries around the world have opened up their formerly closed markets to foreign firms, creating oligopolistic industries served by both domestic and foreign firms. For instance, the Indian automobile market was virtually closed to foreign companies until 1990. Thanks to the recent economic reforms, now domestic automobile manufacturers such as Hindustan Motors, Maruti, and Tata compete with various foreign automobile manufacturers such as Ford, Hyundai, Kia, and Mercedes.

Interestingly, at the same time, almost all of these countries are also using various strategic trade policies. For instance, India has imposed a significant import tariff on foreign-made cars. In the context of these markets, what are the justifications behind favoring one set of policies over another? This note addresses the issue by comparing the welfare implications of two commonly used strategic trade policies, an import tariff and a domestic production subsidy, in the context of a market that is served by a quantity-setting oligopoly, consisting of both domestic and foreign firms.

It is well known that under perfect competition, a domestic production subsidy always boosts welfare more than an import tariff (Bhagwati, 1971). If the domestic market is imperfectly competitive, however, the comparison is less clear (Eaton and Grossman, 1986; Dixit 1988). When the firms compete in quantities (Cournot competition), it is often presumed that a domestic production subsidy is superior to an import tariff in enhancing domestic welfare. This is because a subsidy tends to correct the source of production distortion that is associated with Cournot competition, and thus it is likely to enhance welfare more than an import tariff. No general result, however, is available with respect to increasing marginal costs, which render the additional domestic production encouraged by the subsidy more costly.

The aim of this note is to demonstrate how the superiority of a subsidy or tariff depends on the production technology used in the industry, an intriguing question that has not been analyzed in trade literature so far. We establish that the superiority of a subsidy or tariff depends on the relative steepness of the marginal cost curves of the firms. If the marginal cost curve is perfectly flat (as with constant marginal cost) or relatively flat, a production subsidy is indeed superior to an import tariff in enhancing domestic welfare, because the additional domestic output encouraged by the subsidy does not increase marginal cost significantly. However, if the marginal cost curve is relatively steep, the result is reversed; an import tariff yields a higher level of welfare than a production subsidy, because domestic output is not increased as much, and rather profit-shifting and tariff revenue boost welfare. Furthermore, when the government commits to a combination of tariff and subsidy, we demonstrate that the relative size of the tariff in the optimal tariff-subsidy combination grows as the marginal cost curve becomes steeper, which is consistent with the findings regarding each instrument when used alone.

Interestingly, despite a perceived welfare supremacy of a subsidy in a Cournot oligopoly, an import tariff remains the more commonly used trade instrument. Usually, administrative difficulties, political constraints, and deadweight losses associated with production subsidies are arguments commonly used to explain the use of import tariffs. This note provides an economic justification for using import tariffs based on their ability to enhance domestic welfare when marginal costs are increasing significantly.

2. The Model

The basic model we use is similar to that in Brander and Spencer (1984) and Dixit (1988). We consider an international duopoly consisting of one domestic firm and one foreign firm,[1] both producing a homogeneous product for the domestic market alone and competing in quantities. Demand is represented by the inverse demand function $p = a - Q$, where p is the market price and Q is the total quantity brought to the market. Both firms have identical technology, given by the cost function $C(q) = F + cq + \frac{1}{2}kq^2$. This cost function allows us to consider constant marginal cost ($k = 0$) as well as quadratic cost ($k \neq 0$); since we do not focus on entry, we assume $F = 0$ with no loss of generality. We also assume zero transportation costs for the foreign firm.

We assume a two-stage game: in stage one, the domestic government credibly commits to a trade policy instrument, either a domestic production subsidy, or an import tariff imposed on the foreign firm, or both. In stage two, the firms produce their respective profit-maximizing quantities given the trade policies determined in stage one. We solve the model by backward induction; first we solve for the firms' optimal production levels in terms of tariffs and/or subsidies, and then we solve stage one, where the domestic government takes the firms' behavior into account and determines the optimal trade policy.

In stage one, the government may commit to a domestic production subsidy s and/or an import tariff t. Thus, given the government policy in stage one, the profit of the domestic firm in stage two is given by:

$$\pi^d = px - cx - \tfrac{1}{2}kx^2 + sx = \left[a - (x + y) - c - \tfrac{1}{2}kx + s\right]x, \tag{1}$$

where x is the output of the domestic firm; y is the output of the foreign firm, and s is the subsidy provided to the domestic firm per unit of output.

Similarly, the profit of the foreign firm is given by:

$$\pi^f = py - cy - \tfrac{1}{2}ky^2 - ty = \left[a - (x + y) - c - \tfrac{1}{2}ky - t\right]y, \tag{2}$$

where t is the tariff imposed by the domestic government on imports from the foreign firm.

We solve the first-order conditions for each firm, resulting in the equilibrium quantities produced by the firms in terms of the given levels of subsidy and tariff:

$$x^*(s,t) = \frac{(a-c)(k+1) + s(k+2) + t}{(k+1)(k+3)}, \tag{3}$$

$$y^*(s,t) = \frac{(a-c)(k+1) - s - t(k+2)}{(k+1)(k+3)}. \tag{4}$$

In stage one, the government's objective is to choose the optimal value(s) of s and/or t to maximize domestic welfare:

[1] All qualitative results extend to the case with multiple firms in either country.

$$W = CS + \pi^d - sx + ty = \tfrac{1}{2}(x+y)^2 + [a-(x+y)-c-\tfrac{1}{2}kx]x + ty. \quad (5)$$

3. Comparing Optimal Subsidy and Tariff

First, we examine the scenario in which the government chooses either a subsidy or a tariff, but not both. We will show that while a production subsidy is optimal for a relatively flat marginal cost curve, an import tariff is optimal if the marginal cost curve is steep.

When the government chooses a subsidy, we exogenously set $t = 0$. Substituting x and y from equations (3) and (4) into the welfare expression (5), and maximizing with respect to s, we derive the optimal level of subsidy:

$$s^* = \frac{(a-c)(k+1)(2k+3)}{k^3+5k^2+8k+3}. \quad (6)$$

Substituting s^* into equations (3) and (4), we derive the firms' second stage equilibrium quantities.[2] Furthermore, substituting the second stage equilibrium quantities into equation (5), we derive the level of welfare obtained under the optimal subsidy:

$$W^s = \frac{(a-c)^2(k^2+5k+3)}{2(k^3+5k^2+8k+3)}. \quad (7)$$

Next, we repeat the analysis above, but in the context of a tariff rather than a subsidy. When the government commits to a tariff alone, we exogenously set $s = 0$, and maximize welfare, based on the output expressions in (3) and (4), with respect to t. The resulting optimal tariff and the resulting level of welfare are:

$$t^* = \frac{(a-c)(k+1)(k^2+3k+3)}{2k^3+11k^2+19k+9}, \quad (8)$$

$$W^t = \frac{(a-c)^2(3k^2+11k+7)}{2(2k^3+11k^2+19k+9)}. \quad (9)$$

Finally, we compare the two levels of welfare to determine whether welfare is higher under a subsidy or a tariff:

$$W^t - W^s = \frac{(a-c)^2(k+1)^2(k+2)(k^2+k-3)}{2(k^3+5k^2+8k+3)(2k^3+11k^2+19k+9)} \quad (10)$$

The only ambiguously signed term in (10) is the final term in the numerator, which is positive if $k > \tfrac{1}{2}(\sqrt{13}-1)$, or approximately 1.30, and negative otherwise. Therefore, if marginal cost is constant ($k = 0$), then $W^t < W^s$, verifying the welfare supremacy of subsidy in this case. More

[2] All expressions and calculations are available from the author.

generally, the optimal subsidy yields a higher welfare as long as k is relatively small, or the marginal cost curve is relatively flat. When k is relatively large, however, the result reverses, and the optimal tariff provides more welfare than does the optimal subsidy. Therefore, contrary to common belief, the optimal tariff provides higher welfare than the optimal subsidy if the marginal cost curve is relatively steep.

The comparison of welfare under each trade instrument is presented in the proposition below.

Proposition 1: In an international duopoly in which both firms produce for the domestic market, and the domestic government chooses between an import tariff and a domestic production subsidy, welfare is higher under the import tariff (production subsidy) if the firms' marginal cost curve is relatively steep (flat).

The intuition behind Proposition 1 is simple. Both an import tariff and a domestic production subsidy have two effects: they encourage domestic production and discourage imports. The primary effect of an import tariff is to discourage imports and the secondary effect is to encourage domestic production. On the other hand, the primary effect of a domestic production subsidy is to stimulate domestic output and the secondary effect is to discourage imports. If k is large (the marginal cost curve is steep), the additional domestic output encouraged by a subsidy would be costly, whereas an import tariff boosts the domestic firm's profits while lowering its marginal (and total) cost. On the other hand, if k is small (the marginal cost curve is flat), domestic production is less costly, and welfare can be better enhanced with a domestic production subsidy, which boosts consumer surplus and shifts profits from the foreign firm.[3]

4. The Optimal Combination of Subsidies and Tariffs

We now analyze the scenario in which the government commits to a combination of a production subsidy and an import tariff in the first stage. This enables us to study the effect of the slope of the marginal cost curve on the relative weight of the tariff in the optimal tariff-subsidy combination.

Substituting x and y from equations (3) and (4) into welfare (5), and maximizing W with respect to both s and t, we derive the optimal subsidy and tariff:

$$s^* = \frac{2(a-c)(k+1)}{(k+2)(2k+1)}, \quad t^* = \frac{k(a-c)(k+1)}{(k+2)(2k+1)}. \tag{11}$$

Note that $t^*/s^* = k/2$, implying that in the optimal tariff-subsidy combination, the relative importance of the tariff grows as the marginal cost curve steepens. Also, for all $k > 0$, the optimal tariff is strictly positive; only when $k = 0$ is the optimal tariff equal to zero. Thus, for constant marginal cost, we get back the welfare supremacy of a domestic production subsidy alone, even

[3] As mentioned above, the general results of this model hold when the number of firms in each country. Unfortunately, the expressions become too complex to assess the effect of the numbers of firms on the critical value of k that separates the domains of the optimal subsidy and tariff.

when a tariff is available, but otherwise, a combination of both is optimal, and the balance between them conforms to the intuition governing their separate use.

The following proposition follows from the above discussions.

Proposition 2: When the government commits to a combination of production subsidy and import tariff, the optimal tariff is zero if the marginal cost curve is perfectly flat and is positive otherwise, the relative size of the tariff in the optimal tariff-subsidy combination increasing as the marginal cost curve steepens.

5. Conclusion

We compare the welfare implications of two commonly used strategic trade policies, an import tariff and a domestic production subsidy, in the context of a quantity-setting oligopoly consisting of both domestic and foreign firms. Recent open door policies in many countries makes such an undertaking relevant. We demonstrate how the superiority of a subsidy or tariff depends on the production technology used in the industry; an interesting issue that has not been analyzed in the literature.

We establish that the welfare superiority of a tariff or subsidy depends on the relative steepness of the marginal cost curve. When the marginal cost curve is relatively steep, import tariffs are superior to production subsidies in enhancing domestic welfare. Production subsidies are superior only when the marginal cost curve is relatively flat. Indeed, for constant marginal cost, we confirm the welfare superiority of subsidies. Furthermore, when the marginal cost curve is increasing, welfare is higher when tariffs and subsidies are used together than either is used by itself. More importantly, we demonstrate that the relative importance of the tariff in the optimal tariff-subsidy combination grows as the marginal cost curve becomes steeper.

6. References

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