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A Welfare Enhancing Production Subsidy When Consumers Have Economies of Scale in Shopping

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Abstract

There has been considerable theoretical development of imperfect competition in trade models. Little attention has been directed to imperfections in consumption, however. This paper contributes to this issue by considering consumers that incur shopping costs, with economies of scale in shopping, in the purchase of a horizontal product line. In a free trade equilibrium in which a foreign firm produces the entire product line and the home firm produces a proper subset of it, there is a welfare enhancing opportunity for the home government to subsidize production. This is consistent with the activist recommendation of profit shifting models.

I. Introduction

The "New International Economics," pioneered by Brander and Spencer [1985], has provided a theoretical justification for an activist commercial policy. This is in sharp contrast to the free trade prescription of Classical trade theory. The theoretical underpinning of the recent developments is substantially different from that of the Classical paradigm. The newer approach is

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based upon partial equilibrium imperfectly competitive models, while the Classical model relies upon perfect competition in general equilibrium.

Although there has been considerable theoretical development of the producer (firm strategic behavior) side of the new paradigm, little attention has been directed to imperfections on the consumer side of the market. The present paper makes a contribution to this issue by considering consumers that incur shopping costs, with economies of scale in shopping, in the purchase of at least some goods in a horizontal product line.[1,2,3] It is demonstrated that an asymmetric free trade equilibrium provides a welfare enhancing opportunity for the home government to subsidize production. In such a free trade equilibrium, the foreign firm produces the entire product line and the home firm produces a proper subset of it. The home government's subsidy will induce the home firm to offer the entire line. This is to the benefit of the home consumers. This is consistent with the activist recommendation of the profit shifting models. However, the foreign firm's profits are reduced and the home consumers' surplus increases. This is in contrast to a shift in profits from the unsubsidized to the subsidized firm in the earlier models.[4]

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1. There has been discussion of vertical product lines in the context of commercial policy. For example, Falvey [1979, 1983] disclosed that a specific tariff will induce consumers to buy a higher quality good than they will in free trade. Aw and Roberts [1986] have provided an empirical assessment of the effect of quotas on imports of a vertical product line. Das and Donnenfeld [1989] (and several of their references) analyzed quantity and quality restrictions as a commercial policy. Lancaster [1991] has discussed optimal product variety and trade policy for a horizontal product line.
2. There has been some interest in consumer imperfections and in market linkages. Feenstra [1986] has discussed market linkages in the context of a perfectly competitive general equilibrium model. Benson and Hartigan [1983] have considered a spatial model of trade policy in which consumers must pay a shipping cost in buying a homogeneous good. Hartigan [1992] analyzed tariff policy, when consumers incur search costs to locate the lower cost producer of a homogeneous good, for firms that can rapidly revise prices. Hartigan [1995] discussed export subsidies in the context of consumer switching costs.
3. Shopping (visiting) costs differ from search costs. In the case of the latter, consumers incur a cost to draw a price from a (possibly) known distribution of firm prices for a product. With the former, consumers know the price each firm charges, but must absorb a cost to contact each firm.
4. This distinction is discussed at length after the results of the present model are generated.

A one shot Nash-Bertrand model with homogeneous goods is developed. This constitutes the free trade equilibrium. A production subsidy is then introduced. A conclusion follows.

II. Homogeneous Goods

A. Free Trade

Suppose that consumers in the home market maximize utility from the consumption of the goods in a horizontal product line. The goods are produced by a home and a foreign duopolist. Although each good is homogeneous, there will be a heterogeneity among the home consumers. Some consumers will purchase a proper subset of the line, whereas other consumers' preferences dictate that they buy the entire line.

For simplicity, the product line will consist of a pair of goods. There are no network externalities, so that a consumer desiring both goods makes his (her) decision on the basis of price. In this context, some consumers will consume only good 1, others will consume only good 2, and still others buy both goods.

What distinguishes this paper from other work concerning product lines, and what provides an interesting policy implication, is that consumers incur shopping costs. That is, they must incur a cost $v \in R+$ every time they contact (receive a price quote) from a producer. This cost v is invariant with respect to the number of products for which a consumer receives quotes from a producer. As such, it may be viewed as a visiting cost.[5]

The firms' production functions entail constant marginal costs and zero fixed costs. Because relative production costs are what matter in this model, the presentation is simplified by assuming that the foreign firm incurs zero marginal costs for the production of both goods. The home firm produces good 2 with zero marginal costs. However, its marginal costs for good 1 are given by $c_1^d > 0$ where d indicates the home firm. Moreover, each firm is completely informed about its rival's costs.

The demand function of the foreign firm for good 1 is expressed as

5. So that shopping from the foreign firm and the home firm requires the same consumer expenditure, assume that a dealer or importer markets the foreign product in the home country.

$$q_1^f = q_1(p_1^f; v). \tag{1}$$

In (1), q_1^f indicates output, p_1^f is price, and the foreign firm is denoted by f. Since consumers base their willingness to consume upon total expenditure for the product, which includes visiting costs, v is a parameter of (1). This demand function is "not too convex," so that a unique profit maximizing price can be determined from the profit (total revenue) function

$$\pi_1^f = p_1^f q_1^f (p_1^f; v). \tag{2}$$

Define the price that a profit maximizing monopolist would charge for good 1 as p_m. Let us assume that $p_m < c_1^d$, so that the foreign firm is indeed a monopolist in the production of good 1 of the product line.[6] That is, the home firm could only offer this good for sale at a loss.

The firms play a modified Nash-Bertrand game in the market for good 2. They select profit maximizing prices simultaneously. Letting $\tilde{q}_2(p_2; v)$ where $p_2 = (p_2^f, p_2^d)$, denote the market demand by consumers of the entire product line, we can state that

$$\begin{aligned} \tilde{q}_2^f &= \tilde{q}_2(p_2; v) && \text{if } p_2^f \le p_2^d + v, \\ \tilde{q}_2^f &= 0 && \text{if } p_2^f > p_2^d + v, \\ \tilde{q}_2^d &= \tilde{q}_2(p_2; v) && \text{if } p_2^f > p_2^d + v. \end{aligned} \tag{2'}$$

Equations (2) reveal that consumers that must visit the foreign firm to purchase good 1 regard the shopping cost as sunk. That is, they prefer to buy both goods from the foreign firm as long as $p_1^f - p_1^d \le v$. It is only when the price disparity exceeds the visiting cost that it will maximize the consumers' utility (minimize total expenditure) to visit both firms.

For consumers that only buy product 2, the modified Nash-Bertrand demand functions apply:

$$\begin{aligned} q_2^i &= q_2(p_2^i, p_2^j; v) && \text{if } p_2^i < p_2^j;\ i, j = d, f;\ i \ne j; \\ q_2^i &= q_2(p_2^i, p_2^j; v)/2 && \text{if } p_2^d = p_2^f, \\ q_2^i &= 0 && \text{if } p_2^i > p_2^j. \end{aligned} \tag{3}$$

The consumers take into account the cost of visiting a firm in the demand

6. If $p^m \ge c_1^d$, the foreign firm would retain its status as a monopoly by limit pricing.

functions (3). That is, they maximize utility subject to the total expenditure on consumption, which includes visiting costs.

The demand functions (2) and (3) are used to define the foreign firm's profit function for good 2:

$$\pi_2^f = p_2^f(\tilde{q}_2^f(p_2; v)+q_2^f(p_2; v)). \tag{4}$$

The home firm's profit function is

$$\pi_2^d = p_2^d q_2^d (p_2; v). \tag{5}$$

The foreign firm maximizes

$$\pi^f = \pi_1^f + \pi_2^f. \tag{6}$$

The home firm maximizes π_2^d. The market equilibrium is given by the triple $(p_1^f = p_m, p_2^f = v, p_2^d = 0)$. That is, the foreign firm charges the price that a profit maximizing monopolist would set for good 1. Recall that this is denoted by p_m. However it is less than the price that a profit maximizing monopolist would select in the absence of shopping costs, as long as $\partial q_1/\partial v < 0$.

The equilibrium for good 2 may be regarded as quasicompetitive.[7] Rather than the traditional Nash-Bertrand result of price equaling marginal cost, the foreign firm earns economic profits from the sale of good 2. This is because the foreign firm concedes the sales of all the home consumers that buy only good 2 to the home firm. To be sure that its price is not undercut, the home firm sets its price equal to marginal cost. Since marginal costs are zero, $p_2^d = 0$. Recall from (2), however, that some home consumers prefer to buy the entire product line. These consumers must visit the foreign firm, as it is the only source of good 1. They then face the choice of paying $p_2^f = v$ for good 2, or incurring the expense of another visit to pay $p_2^d = 0$ to the home firm. Since the cost of visiting the foreign firm (its distributor in the home market) is already sunk, the total expenditure for buying good 2 is v in both in instances. Thus these consumers choose to buy both goods from the foreign producer.[8]

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7. I appreciate the anonymous referee for suggesting this characterization of the market equilibrium.
8. Although the total expenditure (price plus visiting cost) is invariant with respect to the firm from which the purchase is made, consumers are assumed to buy from the

Let us consider the home country's welfare in free trade. Welfare w^d will be the sum of the home firm's profits π^d and the home consumers' surplus s^d. This is expressed as

$$w^d = \pi^d + s^d. \tag{7}$$

Since the free trade equilibrium entails $p_2^d = 0$, with the foreign firm being a monopolist in the production of good 1, $\pi^d = \pi_2^d = 0$ in (7). Home consumer surplus is given by

$$s^d = \int_{p_m}^{\bar{p}_1} q_1^f(p_1^f;\, v)dp_1^f + \int_{v}^{\bar{p}_2} \tilde{q}_2^f(p_2;\, v)dp_2^f + \int_{0}^{\bar{p}_2} q_2^d(p_2;\, v)dp_2^d > 0. \tag{8}$$

In (8), $\bar{p}_k\ \forall k = 1, 2$ is the choke price for each good. For a linear demand curve, this would be the price intercept. The first term in (8) is the consumer surplus derived from buying good 1 from the foreign monopolist. The second term is the surplus accruing to those consumers that buy good 2 from the foreign firm. The third term is the surplus derived from buying good 2 from the home firm.[9] Because the market equilibrium price is less than the choke price for each good, $s^d > 0$. Hence $w^d > 0$.

B. A Home Production Subsidy

Although the equilibrium for good 2 is quasi competitive, the foreign firm extracts monopoly profits from selling good 1 in the home market. This is because $c_1^d > p_m$. For example, the foreign firm may possess a superior technology for producing a subset of the product line. If the home government were to subsidize the home firm's production of good 1, it would permit the home firm to expand its line of products to encompass the entire spectrum of horizontally related goods.

Suppose that the production subsidy is given by σ. Let $\sigma = c_1^d$, so that the

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foreign firm. If consumers selected randomly, the foreign firm could simply charge $p_2^f = v - \varepsilon$, $\varepsilon > 0$. This would enable it to retain all of the home consumers that buy both goods, and would generate essentially the same level of profits.

9. Note that because the model partitions consumers into those that buy the entire line and those that buy a single good, the existence of shopping costs results in the surplus from consumption of good 2 being calculated from two distinct demand curves for this good.

foreign firm's cost advantage is negated. In this instance, consumers of product 1 will have a choice of suppliers, and can minimize their total expenditure (price plus shopping cost) for their consumption of one or both goods.

When the home government introduces its production subsidy, we have the following demand functions:

$$\begin{aligned} &\tilde{\tilde{q}}_k^i = q_k(p_k^i, p_k^j; v) && \text{if} \quad p_1^i < p_1^j, \ k = 1, 2, \\ &\tilde{\tilde{q}}_k^i = q_k(p_k^i, p_k^j; v)/2 && \text{if} \quad p_1^i = p_1^j, \\ &\tilde{\tilde{q}}_k^i = 0 && \text{if} \quad p_1^i > p_1^j. \end{aligned} \tag{9}$$

These can be construed as modified Nash-Bertrand demand functions. That is, they differ from the demand functions in an otherwise identical market without shopping costs. This is a result of $\partial q_k/\partial v < 0$.

The market equilibrium for the home production subsidy ($\sigma = c_1^d$) case is the quadruple ($p_k^i = 0$; $i = d, f$; $k = 1, 2$). That is, it is the classic Nash-Bertrand result of price being equal to marginal cost. For the home firm's production of good 1, price is equal to net marginal cost.[10]

To determine the effect of this policy on the home country's welfare, consider an adjustment to (7). The activist welfare function is

$$w_\sigma^d = \pi^d + s^d - \sigma\tilde{\tilde{q}}_1^d(p_1; v), \quad p_1 = (p_1^f, p_1^d). \tag{10}$$

In (10), the home government's expenditure on the subsidy is deducted from the home duopolist's profits and the home consumers' surplus. Since the home firm earns zero economic profits under free trade and under the production subsidy, an increase in home welfare requires consumer surplus to increase by more than the home government's expenditure on the subsidy. This requires

$$\begin{aligned} \Delta = &\sum_{k=1}^{2} \int_0^{\bar{p}_k} \tilde{\tilde{q}}_k(p_k^i, p_k^j; v)dp_k^i - \int_{p_m}^{\bar{p}_1} q_1^f(p_1^f; v)dp_1^f - \int_v^{\bar{p}_2} \tilde{q}_2^f(p_2^f; p_2^d; v)dp_2^f \\ &- \int_0^{\bar{p}_2} q_2^d(p_2^d; p_2^f; v)dp_2^d - \sigma\tilde{\tilde{q}}_1^d(0, 0; v) > 0. \end{aligned} \tag{11}$$

In (11), the first term refers to home consumer surplus generated through

10. Net marginal cost is $c_1^d - \sigma$ which in this case is zero.

consumption of the pair of goods in the line when there is a production subsidy. The second, third, and fourth terms have been defined in (8). The last term has been defined in (10). It reflects the fact that prices are zero in the free trade equilibrium.

If the home government were to choose a production subsidy σ: $\sigma < c_1^d$, the foreign firm could preserve its monopoly status by charging $p_1^f < c_1^d - \sigma$. That is, it could undercut the home firm by charging $p_1^f < p_1^d - \varepsilon$, $\forall\ \varepsilon > 0$. Hence to enable the home firm to be able to compete in the market for good 1, the home government must set $\sigma \geq c_1^d$.[11] Thus the welfare function (10) will exhibit a discontinuity at $\sigma = c_1^d$. This is because a small increase in σ in the neighborhood of $\sigma = c_1^d$ will result in p_2^f declining precipitously from $p_2^f = v$ to $p_2^f = 0$.[12] As a result, the effect on welfare given by (11) is not assessed by the derivative of w_σ^d with respect to σ.

Clearly home consumer surplus must rise when a production subsidy of $\sigma = c_1^d$ is introduced. The consumers that buy good 1 pay $p_1^i = 0 < p_m$. Those consumers that buy both goods pay $p_2^i = 0 < v$. Those that only buy good 2 pay a price of zero with or without the production subsidy.

Because the least costly subsidy that eliminates the monopoly power of the foreign firm for good 1 is $\sigma = c_1^d$, and because $\partial\Delta/\partial\sigma < 0$, the value of c_1^d for which $\Delta = 0$ can be determined. This value is $\bar{c}_1^d$. It is the highest level of the home firm's cost for which a production subsidy would occur. For $c_1^d < \bar{c}_1^d$ the home government's production subsidy improves home welfare.

This permits a proposition.

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11. For $\sigma > c_1^d$, the home firm becomes a monopolist in the production of good 1. This enables it to set $p_2^d = v$. Therefore $\sigma > c_1^d$ results in less consumer surplus than $\sigma = c_1^d$. Raising the subsidy *slightly* above c_1^d would result in a transfer of surplus from home consumers to home producers (relative to $\sigma = c_1^d$). This is readily apparent because home (net) marginal costs are zero. Because demand is inversely related to price, there would be consumption deadweight losses for both goods (relative to $p_k^d = p_k^f = 0$). The cost of subsidization may fall, however, as the home firm may restrict output as a monopolist for good 1. (However, this tendency might be counteracted by the home firm's status as the only source of good 1. When $\sigma = c_1^d$, both firms would sell good 1.) As long as the consumption deadweight losses exceeded any reduction in the home government's expenditure on the subsidy, the home government would not set $\sigma > c_1^d$.

12. That is, as σ is increased in a neighborhood for which $\sigma < c_1^d$, and c_1^d is an accumulation point of that neighborhood.

Proposition 1: *When home consumers incur shopping costs in purchasing goods from a product line, economies of scale in shopping exist, and an asymmetric free trade equilibrium occurs in which the home (foreign) firm produces a proper subset (all) of the goods in the line, the home government can increase home welfare by subsidizing the production of those goods that the home firm does not produce in free trade. This requires* $c_1^d < \bar{c}_1^d$.

The welfare gain of the present model differs from the classic profit shifting model pioneered by Brander and Spencer [1985]. In their model, a Nash-Cournot game with homogeneous goods is played in which a foreign and a domestic duopolist export to a third country. There is no consumption in the domestic and foreign countries, and there is no production in the third country. Because there is not any consumption in either producing country, Brander and Spencer can ignore the effect of their export subsidy on consumers in their welfare analysis. The Nash-Cournot assumption results in both firms earning positive profits under both free trade and the export subsidy. An export subsidy by one government can result in a shift in profits from the unsubsidized firm to the subsidized firm in equilibrium. Thus their welfare analysis consists of a discussion of the effect of a government's subsidy on its constituent firm's profits net of the cost of the subsidy. In the present paper, the Nash-Bertrand homogeneous goods assumption generates zero profits to the home firm in both free trade and subsidization of production. Because there is consumption in the home country, however, the production subsidy can generate a welfare gain from an increase in home consumer surplus.[13] Both models are supportive of the interventionist prescriptions of the "New International Trade" that is founded upon imperfect competition in product markets.

III. Conclusion

By considering a generally overlooked issue in the functioning of markets, that of imperfections on the consumer side, a new argument for an

13. In this context, the subsidy does not constitute a violation of the General Agreements on Tariffs and Trade (GATT). It does not facilitate the export of good 1 by the home firm.

activist commercial policy is developed. This reinforces the activist prescriptions of the imperfectly competitive models that have been initiated by Brander and Spencer's [1985] seminal work. A caveat is that the policy prescriptions are specific to the model being discussed. For example, the subsidy recommendation of the present model arises from the home firm's providing fewer products in a line than the foreign firm.

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