

# Export Subsidies versus Export Quotas with Incompletely Informed Policy Makers\*

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## Abstract

This paper analyzes export subsidies (price incentives) and export quotas (quantity controls) in the Brander-Spencer (1985) model when policy makers have limited information on demand and cost structures. We examine necessary or sufficient information for policy makers to determine the right policies. It is crucial that they know the elasticity values of the slope of the inverse demand curve and the market share. It is also shown that for policy makers, export quotas are superior to export subsidies under certain conditions.

*Keywords:* Export subsidies; Export quotas; Strategic trade policy; Asymmetric information

*JEL Classification Numbers:* F12, F13

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# 1. Introduction

Since Brander and Spencer (1985) demonstrated that domestic export subsidies can raise domestic welfare due to rent shifting from the foreign country to the domestic country, the strategic roles for trade policies in oligopolistic industries have drawn considerable attention. The model of strategic trade policy has been extended in a number of directions (see Brander (1995)). One of the directions is to deal with the presence of asymmetric information among players in the model. In particular, as Brander (1995) mentions, it is reasonable to believe that the government does not know the cost and demand structures as much as the producers themselves.

There is a large literature that analyzes trade policies with incomplete information using the third market model developed by Brander and Spencer (1985) (the BS model hereafter). These studies are based on two approaches. One is to tailor optimal policies (e.g., Qiu (1994); Maggi (1996,1999); Brainard and Martimort (1996,1997)), and the other is to make a comparison among various policies under various situations (e.g., Cooper and Riezman (1989); Qiu (1995); Grossman and Maggi (1999)).

This paper investigates export subsidies (price incentives) and export quotas (quantity controls) in the BS model when policy makers have limited information on demand and cost structures.<sup>1</sup> The purpose of this paper is twofold. The first purpose is to compare export subsidies with export quotas. Regarding this aim, a seminal work is Cooper and Riezman (1989) which compares export quotas with export subsidies in the presence of uncertainty in demand. They specifically assume that firms have complete knowledge about market demand, while governments do not.<sup>2</sup> It is shown that export subsidies dominate export quotas when uncertainty is severe, while export quotas dominate when uncertainty is not very severe. Following Cooper and Riezman (1989), Hwang and Schulman (1993) introduced non-intervention as well as export quotas and export subsidies and made a comparison among them. Shivakumar (1993) endogenizes both the choice of policy and the timing of its implementation. It is shown that depending on the degree of uncertainty, governments move either simultaneously or sequentially.

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<sup>1</sup> Export subsidies could be negative (i.e. export taxes). In this paper, export quotas mean direct export quantity controls. We deal with export expansions through quotas as well as export restraints.

<sup>2</sup> In practice, firms may not have complete information on the market either. Then firms' perception of demand uncertainty as well as governments' plays a significant role in determining the optimal policy. See Caglayan (2002), for example.

In those models, however, what governments may not observe is only one parameter, i.e., the intercept of the demand curve. It is assumed that the shapes of the demand and cost functions, which are linear, and the distribution of the random intercept are common knowledge. In contrast, we consider situations where information governments possess may be much coarser. What governments surely know in our analysis is that a single domestic firm and a single foreign firm supply a homogeneous good to the third market and compete in a Cournot fashion. Because of this informational restriction, however, we focus on a simple situation where only the domestic government intervenes by introducing a single policy (which increases or decreases its exports by a small amount) under free trade.<sup>3</sup> We examine what information is necessary or sufficient to carry out welfare-enhancing policies in this situation. This is the second purpose of our analysis. Therefore, our analysis is an extension of the work by Furusawa *et al.* (2003), which investigates policies related to imports (such as tariffs and production subsidies) when policy makers are less informed than producers, to the case of export policies.

We show that whether or not policy makers know the values of the elasticity of the slope of the inverse demand curve and the market share is crucial to determine whether exports should be encouraged or discouraged. It is also shown that for policy makers, export quotas may dominate export subsidies from the viewpoint of acquiring information. That is, policy makers may be able to obtain useful information from the firm when export quotas are adopted.

It should be noted that Maggi (1996) specifically introduces capacity constraints into the BS model and shows that a small capacity subsidy (weakly) raises the domestic country's income regardless of the demand and cost parameters of the model. However, his focus is on uncertainty that a government faces concerning the mode of oligopolistic competition. In contrast, the mode of competition is exogenously given in our model. We would rather compare export subsidies with export quotas when policy makers are less informed about costs and demand than firms.

The rest of the paper is organized as follows. Section 2 provides the basic model. Section 3 considers the intervention in the presence of asymmetric information between producers and policy makers. Section 4 provides some discussions and section 5 concludes the paper.

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<sup>3</sup> This method is often used to analyze piecemeal or partial policy reforms. See Dixit (1985) and Vousden (1990), for example.

## 2. Basic Model

We consider BS model in which a domestic firm (firm  $d$ ) and a foreign firm (firm  $f$ ) export a homogeneous good to a third-market. Demand in the third-market is given by the following inverse demand function which is twice continuously differentiable:

$$P = P(X), \quad P'(X) < 0, \quad (1)$$

where  $P$  and  $X$  are, respectively, the consumer price and the total demand. We define the elasticity of the slope of the inverse demand function  $\epsilon(X) \equiv [-XP''(X)/P'(X)]$  for the following analysis.<sup>4</sup> The inverse demand curve is concave if  $\epsilon(X) \leq 0$  for all  $X$  and convex if  $\epsilon(X) \geq 0$  for all  $X$ . A prime (double prime) denotes the derivative of the first (second) order.

The firms compete in quantities with Cournot conjectures. The domestic government introduces specific export subsidies or export quotas before the firms act. Thus, taking those policies as given, the firms set their outputs. The profit function of firm  $i$  is given by

$$\Pi^i(x^d, x^f; s^d, s^f) = (P + s^i)x^i - C^i(x^i), \quad i = d, f, \quad (2)$$

where  $x^i$  and  $s^i$  ( $i = d, f$ ) are, respectively, firm  $i$ 's output and the specific subsidy provided to firm  $i$ . Since the foreign government is passive,  $s^f = 0$ .  $C^i(\cdot)$  is the cost function of firm  $i$ . The marginal cost may not be constant.  $X = x^d + x^f$  holds.

We assume that the profit function is strictly concave in  $x^i$  for each fixed  $x^j$  ( $i, j = d, f; i \neq j$ ). We focus on the equilibrium with  $x^i > 0$ . The first-order conditions under the Cournot assumption are

$$\frac{\partial \Pi^i}{\partial x^i} = (P + s^i) + P'x^i - C^{i'} = 0, \quad i = d, f. \quad (3)$$

The second-order sufficient conditions hold globally:

$$2P' + P''x^i - C^{i''} < 0, \quad i = d, f. \quad (4)$$

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<sup>4</sup> It is well known that this elasticity plays a crucial role in various analyses of monopoly and oligopoly. See Greenhut and Ohta (1976), Seade (1980b), Brander and Spencer (1984), and Ishikawa and Spencer (1999), for example. When  $\epsilon$  is constant, the inverse demand function is given by  $P = a_1X^{1-\epsilon}/(\epsilon - 1) + a_2$  for  $\epsilon \neq 1$  and  $P = -b_1 \ln X + b_2$  for  $\epsilon = 1$  (where  $a_1, a_2, b_1$  and  $b_2$  are positive parameters); and the price elasticity  $\eta(X) \equiv -XP'(X)/P(X)$  is given by  $\eta = a_2X^{\epsilon-1}/a_1 + 1/(\epsilon - 1)$  for  $\epsilon \neq 1$  and  $\eta = -\ln X + b_2/b_1$  for  $\epsilon = 1$ . In the case of iso-price-elastic demand, it can easily be verified that  $\epsilon$  is also constant and is given by  $\epsilon = 1 + 1/\eta$ . Moreover, one can show that the relationship between  $\epsilon$  and the elasticity of the slope of the "direct" demand function,  $\bar{\epsilon}(\equiv PX''(P)/X')$ , where  $X(P)$  is the "direct" demand function), is given by  $\epsilon = \bar{\epsilon}\eta$ .

The welfare measure we adopt is the standard total surplus function. Thus, welfare of country  $i$  ( $i = d, f$ ) consists of profits and tax revenue in country  $i$ :<sup>5</sup>

$$W^i(x^d, x^f; s^d, s^f) = \Pi^i(x^d, x^f; s^d, s^f) - s^i x^i = Px^i - C^i(x^i). \quad (5)$$

### 3. Intervention with limited information

We introduce asymmetric information between the producers and the domestic government into our analysis. Specifically, we assume that the firms have full information on cost and demand structures, whereas the government is not fully informed about them. What the government certainly knows is that a single domestic firm and a single foreign firm supply a homogeneous good to the third market and compete in a Cournot fashion; and that the firms have full information. We also assume that the firms know what information the government has.

The objective of the domestic government is to improve its welfare by introducing either a small export subsidy under free trade or a quota to raise or reduce the free-trade level exports by a small amount. Thus, the conditions for our results need not hold globally. We suppose that they hold at least in the neighborhood of the free trade equilibrium.

First, we analyze the case of domestic export subsidies. To determine the effect of a domestic export subsidy, we totally differentiate (3) to obtain

$$\begin{pmatrix} 2P' + P''x^d - C^{d''} & P' + P''x^d \\ P' + P''x^f & 2P' + P''x^f - C^{f''} \end{pmatrix} \begin{pmatrix} dx^d/ds^d \\ dx^f/ds^d \end{pmatrix} = \begin{pmatrix} -1 \\ 0 \end{pmatrix} \quad (6)$$

with the solution

$$\begin{pmatrix} dx^d/ds^d \\ dx^f/ds^d \end{pmatrix} = \frac{1}{\Omega} \begin{pmatrix} 2P' + P''x^f - C^{f''} & -(P' + P''x^d) \\ -(P' + P''x^f) & 2P' + P''x^d - C^{d''} \end{pmatrix} \begin{pmatrix} -1 \\ 0 \end{pmatrix}$$

where  $\Omega \equiv (2P' + P''x^d - C^{d''})(2P' + P''x^f - C^{f''}) - (P' + P''x^d)(P' + P''x^f)$ . We assume the stability condition:<sup>6</sup>

$$\Omega > 0. \quad (7)$$

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<sup>5</sup> Although we assume that the social cost of public funds is equal to unity, some literature such as Neary (1994) assumes that it exceeds unity. If this is the case, the incentive for the government to provide export subsidies becomes weaker.

<sup>6</sup> See Seade (1980a, 1985) for a discussion on the local stability of dynamics of strategic behavior.

Thus, the effects of a change in  $s^d$  on outputs are given by

$$\frac{dx^d}{ds^d} = -\frac{1}{\Omega}(2P' + P''x^f - C^{f''}) > 0, \quad (8)$$

$$\frac{dx^f}{ds^d} = \frac{1}{\Omega}(P' + P''x^f), \quad (9)$$

$$\frac{dX}{ds^d} = -\frac{1}{\Omega}(P' - C^{f''}) > 0. \quad (10)$$

The output of firm  $f$  falls (rises) if and only if  $P' + P''x^f < 0$  ( $P' + P''x^f > 0$ ). Differentiating (5) with respect to  $s^d$  and evaluating it at  $s^d = 0$ , we have

$$\left. \frac{dW^d}{ds^d} \right|_{s^d=0} = P'x^d \frac{dx^f}{ds^d}. \quad (11)$$

A small export tax (subsidy) raises domestic welfare if and only if  $P' + P''x^f > 0$  ( $P' + P''x^f < 0$ ). We should note that  $P' + P''x^f > 0$  ( $P' + P''x^f < 0$ ) holds if outputs are strategic complements (substitutes).

Next, we examine export quotas. Setting  $s^d = s^f = 0$ , we differentiate (5) with respect to the supply of the domestic firm,  $x^d$ , and obtain

$$\frac{dW^d}{dx^d} = P'x^d \frac{dx^f}{dx^d}. \quad (12)$$

Thus, a small export reduction (expansion) by an export quota raises domestic welfare if and only if  $P' + P''x^f > 0$  ( $P' + P''x^f < 0$ ) holds.

We should notice that whether the sign of  $(P' + P''x^f)$  is positive or negative is crucial in determining the right export quota as well as the right export subsidy. We thus examine under what conditions  $P' + P''x^f > 0$  or  $P' + P''x^f < 0$  holds. Noting

$$P' + P''x^f = -P'[(1 - \sigma^d)\epsilon - 1], \quad (13)$$

where  $\sigma^d \equiv x^d/X$  (i.e. the market share of the domestic firm), we can draw the relationship between  $\sigma^d$  and  $\epsilon$  which leads to  $P' + P''x^f = 0$  (i.e.  $ff$  in Figure 1).  $P' + P''x^f > 0$  holds above  $ff$  curve, whereas  $P' + P''x^f < 0$  holds below  $ff$ .

[Figure 1 around here]

The following lemma is straightforward:

**Lemma 1** *If  $P' + P''x^f > 0$ , then  $\epsilon > 1$ .  $P' + P''x^f < 0$  holds if  $\epsilon < 1$ .*

Thus, if  $\epsilon < 1$ , a small export subsidy or a small increase in exports by an export quota unambiguously enhances domestic welfare. It should be emphasized that this result only requires information on the demand structure. On the other hand, if  $\epsilon \geq 1$ , the government needs information on the market share as well as the demand structure to determine the right policy (i.e., the welfare-enhancing policy). We should note that information on the market share in turn requires detailed information on the cost and demand structures; and that a domestic export expansion harms the foreign country while a domestic export restriction benefits the foreign country.

We thus obtain the following proposition.

**Proposition 1** *Suppose that the domestic government introduces either export subsidies or export quotas under free trade. If  $\epsilon < 1$  holds and if this is known to the domestic government, then it can raise domestic welfare by a small export subsidy or a small increase in exports by an export quota. If  $\epsilon \geq 1$ , the domestic government needs to know the values of both  $\epsilon$  and  $\sigma^d$  to certainly improve domestic welfare.*

This proposition implies that it is not easy for policy makers to determine the right strategic export policies due to the informational requirements. In particular, it is probably difficult for the domestic government to acquire information on demand (i.e., the value of  $\epsilon$ ) in the third country.

In the rest of this section, we compare export subsidies with export quotas from the viewpoint of acquiring information. For this, we specifically consider the case where the domestic government tries to obtain necessary information from the domestic firm. It is expected that the domestic firm provides the government with true information if the policy which is based on the provided information benefits the domestic firm.

In the following, therefore, we examine under what situation the interests of the domestic firm coincide with those of the domestic government. First, we consider the effects of an export subsidy on profits:

$$\frac{d\Pi^d}{ds^d} = x^d \left( 1 + P' \frac{dx^f}{ds^d} \right), \quad (14)$$

$$\frac{d\Pi^f}{ds^d} = P' x^f \frac{dx^d}{ds^d} = \frac{dW^f}{ds^d} < 0. \quad (15)$$

It is obvious from (14) and (15) that the profits of firm  $d$  rise and those of firm  $f$  fall when the right policy is an export subsidy (i.e. when  $P' + P''x^f < 0$ ). Thus, as long as the equilibrium

is located below  $ff$ , the domestic firm has an incentive to inform the domestic government of the true values of  $\epsilon$  and  $\sigma^d$ .<sup>7</sup> If the right policy is an export tax (i.e.  $P' + P''x^f > 0$ ), however, the domestic firm may cheat. This is the case when  $-1 \leq P'(dx^f/ds^d) < 0$  (i.e. the equilibrium is located just above  $ff$ ). In this case, there is a conflict of interest between the domestic government and the domestic firm.

In the case of the export quota, its effects on profits are

$$\frac{d\Pi^d}{dx^d} = P'x^d \frac{dx^f}{dx^d} = \frac{dW^d}{dx^d}, \quad (16)$$

$$\frac{d\Pi^f}{dx^d} = P'x^f = \frac{dW^f}{dx^d} < 0. \quad (17)$$

Obviously, the interests of the domestic firm coincide with those of the domestic government. The difference stems from the monetary transfer which is absent under export quotas but is present under export subsidies.

Thus, the following proposition is immediate:

**Proposition 2** *If the domestic government tries to acquire necessary information from the domestic firm, export quotas are superior to export subsidies.*

## 4. Discussion

It should be noted that our main message remains valid even in more general models. First, it is not crucial for our analysis to assume that the initial equilibrium is free trade. In the case of export subsidies, for example, we can no longer set  $s^d = 0$  when we evaluate the effect on welfare of a change in the export subsidy rate. Thus, (11) is modified as follows:

$$\left. \frac{dW^d}{ds^d} \right|_{s^d=s_0^d} = P'x^d \frac{dx^f}{ds^d} - s_0^d \frac{dx^d}{ds^d},$$

where  $s_0^d$  is the initial level of the subsidy. Suppose  $s_0^d > 0$ . Then a decrease in the subsidy raises welfare when  $P' + P''x^f > 0$ , whereas an increase in the subsidy may not improve welfare when  $P' + P''x^f < 0$ . This result is reversed when  $s_0^d < 0$ . Put differently, as long as the initial export subsidy or tax is small in the sense that its level is less than the optimal one, our results remain unchanged. The same argument holds for export quotas.

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<sup>7</sup> In fact, the domestic firm does not have to tell the values of  $\epsilon$  and  $\sigma^d$ . What the firm needs to indicate is that the free trade equilibrium is located below  $ff$  in this case.

Second, even if the good is differentiated, we can obtain similar conditions. Suppose that the inverse demand for the good produced by firm  $i$  ( $i = d, f$ ) is given by  $P^i = P^i(x^d, x^f)$  and that the goods are substitutes, i.e.,  $P_j^i \equiv \partial P^i / \partial x^j < 0$  ( $i \neq j$ ). One can verify that it is crucial whether  $P_j^i + P_{ij}^i x^i < 0$  or  $P_j^i + P_{ij}^i x^i > 0$  (where  $P_{ij}^i \equiv \partial^2 P^i / \partial x^i \partial x^j$ ).

Lastly, although we have confined ourselves to the case where there is a single firm in each country, the essence of our analysis would not alter much even if the number of firms increases. The modification in our analysis stems from a well-known feature that as the number of firms increases, the government has the stronger incentive to restrict exports in order to correct overproduction. Thus, the domestic government may not have an incentive to raise its exports even in the region below  $ff$  in Figure 1.<sup>8</sup> However, Proposition 2 is still valid.

## 5. Concluding Remarks

In the framework of the BS model, we have compared export subsidies with export quotas when policy makers have limited information on demand and cost structures. The information required to conduct the right export subsidies is the same with that required to conduct the right export quotas. We have shown that the values of the elasticity of the slope of the inverse demand curve and the market share are crucial in determining the right policies (i.e., the welfare-enhancing policies).

The domestic elasticity values of the slope of the inverse demand curve also play a crucial role in the case of import policies as analyzed in Furusawa *et al.* (2003). However, their notable result is that a small production subsidy always improves domestic welfare regardless of both cost and demand structures. In contrast, the value of the elasticity of the slope of the inverse demand function is indispensable for policy makers in the present study. If the demand curve is very convex in the sense that  $\epsilon > 1$ , the government needs additional information on the market share. Therefore, we can claim that the practical use of strategic export policies is not easy.

It should be noted that the government may be able to obtain information from the firm when they adopt export quotas as their policy measures, because the interests of the government coincide with those of the firm. In the case of export subsidies, those interests may conflict with each other because of the presence of monetary transfers between the

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<sup>8</sup> The shape of  $ff$  is somewhat modified with general number of the firms.

government and the firm. In this sense, for policy makers, export quotas are superior to export subsidies as strategic export policies.

In the present study, we have not considered the optimal levels of the policies, but rather the directions of policies (i.e., whether the policy should be a small export subsidy or tax starting from the no intervention point, or whether the policy should be a small increase or decrease of the free trade level of exports). In addition to the practical difficulty of introducing a large tax/subsidy or a large export-reduction/-expansion by a quota, there are two reasons why we focus on this case. First, if this is not the case, the corner solution, in which there are no domestic or foreign exports, could arise. Second, in the case of a small change in exports, it is not required that the conditions in some of our results should globally hold. They are required in the neighborhood of the free trade equilibrium.

We should note that in our model, policy makers cannot observe the market share before they decide the policies. If the firms compete in the third market before the policies are introduced, the governments can observe the market share. In this case, however, if the firms anticipate the introduction of policies based on the market share, they may have incentive to manipulate the market share.

We have also focused on the case of unilateral intervention (i.e., only the domestic government introduces an export policy and the foreign government is passive). The case of bilateral intervention is complicated because we need to specify what information both governments have. Depending on this information, there are many cases to examine, and the intervention may be simultaneous or sequential. These are interesting extensions, but they are beyond the scope of this paper and are left for future research.

As a final remark, we should emphasize that this paper in no way advocates the use of strategic trade policy. We would argue that it is rather difficult for policy makers to determine the right strategic trade policies.

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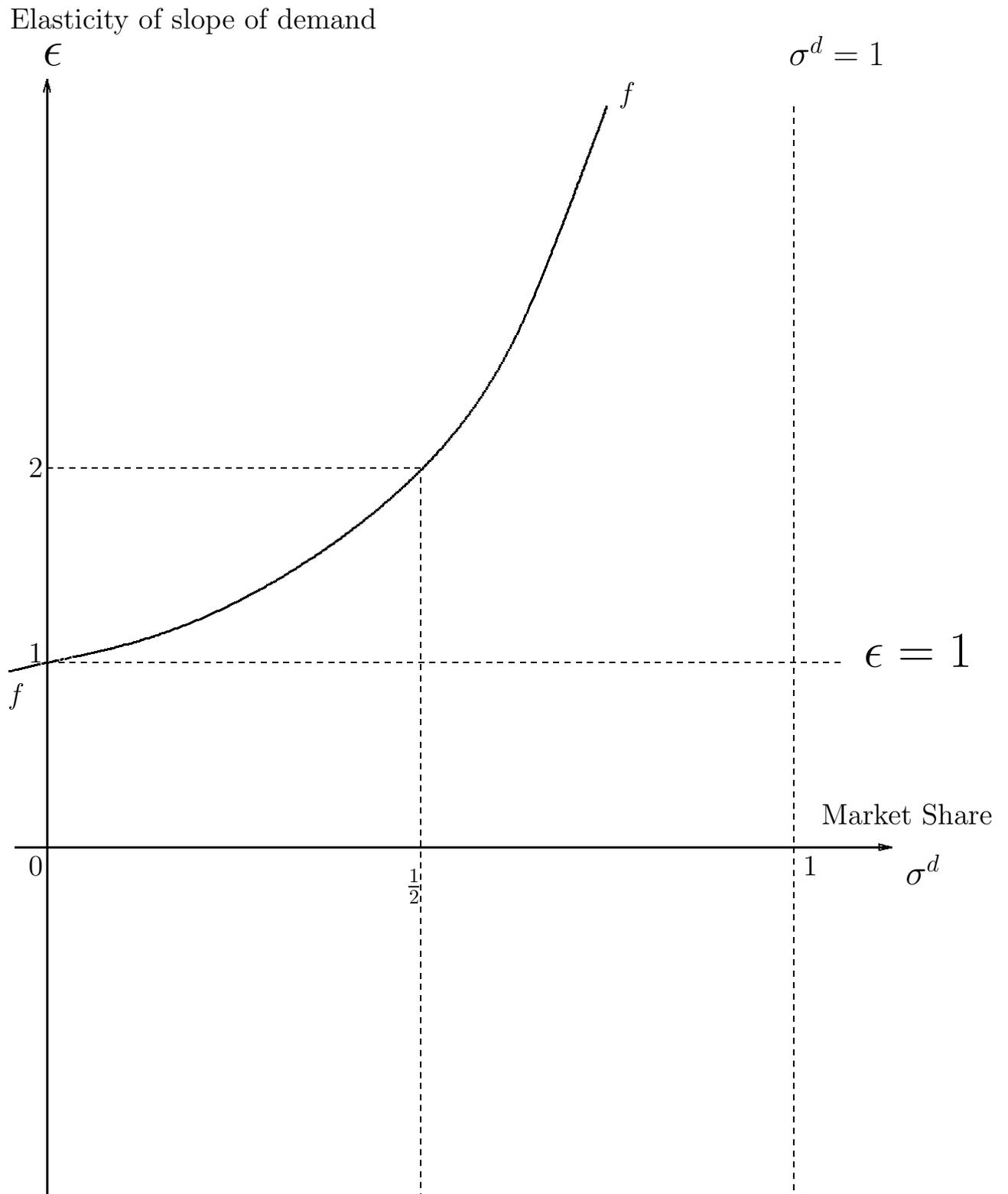


Figure 1:  $ff$  curve