

# A Note on VIE and Import Subsidy

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## *Abstract.*

This paper provides a model of market-share Voluntary Import Expansion(VIE) with an enforcement mechanism and compares it with an equivalent import subsidy. We obtain followings: i) a VIE increases commodity price while an import subsidy reduces it, ii) a VIE is welfare worsening not only for importing country but also for the world, iii) an import subsidy is welfare worsening for importing country but it is welfare enhancing for the world, and iv) for importing country a VIE is better than an import subsidy when the market-share of foreign product increases. This paper provides a justification of the use of VIE in the semi-conductor agreement in 1986.

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## 1. Introduction

Since the middle of 1980s, how to open the markets that are considered closed has become the heart of trade frictions and a new import expansion policy has been devised. This is the Voluntary Import Expansion. We now have two bilateral import expansion policies by an importing country. One is VIE and the other is import subsidy.

The VIE originates from the semi-conductor agreement between Japan and USA in 1986. It is a result-oriented trade policy and is against to the rule-oriented GATT/WTO system. Its target was to expand the market-share of USA product in the Japanese market. Even if the trade conflicts between Japan and USA have already been settled, the result-oriented trade policies still prevail. In fact, the WTO includes the articles of minimum market access requirements in many agricultural products.

Following Bhagwati(1987), seminal papers including Bjorksten(1994), Cronshaw and Markusen(1995), Dinopoulos and Kreinin(1990), Ethier and Horn(1996), Greaney (1996, 1999), Irwin(1994), Ishikawa(1999) and Yin(2004) have been written on the implications of VIE. Specifically, using a Bertrand model, Greaney(1996) shows that a market-share VIE does not increase competition and does not reduce the equilibrium prices of both goods.

This paper is motivated by the following facts. First, the welfare analysis of VIE and import subsidy under Cournot model is an open question. Second, the previous literatures on VIE do not consider the enforcement mechanisms explicitly. Third, the previous literatures have paid little attentions to the effects of two policies on the world

welfare. The purpose of this paper is to take a step to tackle these problems. We provide a Cournot model of market-share VIE with an explicit enforcement mechanism and consider the voluntary natures of two policies.

This paper is organized as follows. Section 2 sets up a model of VIE in which an increase in the market-share of foreign product is realized by the reduction of output of domestic firm and evaluates its voluntary nature. Section 3 considers the welfare effects of import subsidy and shows that it is welfare enhancing for the world. Then, in section 4 we compare our results from two aspects: i) comparisons of a VIE with an import subsidy in our model and ii) comparisons of our model with Greaney(1996). It will be shown that a VIE is better than an import subsidy for an importing country. Section 5 concludes the paper. We will use a simple, specific and partial equilibrium model in order to obtain concrete results.

## **2. A VIE**

This section sets up a model of VIE based on the experiences in the semi-conductor agreement. In that agreement both governments thought that the implementation is to be undertaken by Japan. However, the Japanese government did not have enforcement mechanisms. It undertook two actions. First, it surveyed the purchase plans of semi-conductor users. Second, it used the moral suasions by administrative guidance with implicit threats of penalty to the semi-conductor users. These actions worked to reduce the output of Japanese firms, forced users to switch from the Japanese to the US

products and increased imports from the US. Based on these facts, we set up a model where the import expansion is realized by the reduction of the output of domestic firm.

Suppose two countries, domestic (importing) and foreign (exporting) and each has one firm. Both firms produce a homogeneous product and compete in the domestic market in the Cournot fashion.<sup>1</sup> Suppose that as the result of the pressures of foreign firm and government a VIE is made between the two governments. A two stage game occurs. In the first stage, both governments negotiate on the market-share of foreign product in the domestic market. In the second stage, based on this agreement both firms compete non-cooperatively in the Cournot fashion.

Let the inverse demand function for the product  $X$  as

$$p = p(X) = a - bX, \quad (1)$$

where  $p$  is the price of  $X$  and both  $a$  and  $b$  positive constants. Let  $x(x^*)$  be the output of domestic (foreign) firm. Then  $x + x^* \equiv X$ , where the asterisk denotes the foreign variables. Assume that the fixed cost is zero and the marginal cost is constant and same for both firms.<sup>2</sup> The cost functions of two firms are:  $C(x) = cx$ ,  $C^*(x^*) = cx^*$ , where  $c$  is the common marginal cost. The best response functions of two firms are

$$x(x^*) = \frac{(a-c)}{2b} - \frac{x^*}{2}, \quad (2a)$$

$$x^*(x) = \frac{(a-c)}{2b} - \frac{x}{2}. \quad (2b)$$

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<sup>1</sup> We assume a Cournot competition because a Bertrand model has been used by Greaney(1996) and the welfare analysis of VIE and import subsidy under a Cournot model is an open question.

<sup>2</sup> This assumption produces the 0.5 market-share initially. This is only for the analytical simplicity.

Assume a unique and stable Cournot-Nash equilibrium.<sup>3</sup> The commodity price, output of each firm and total supply at the initial free trade (denoted by subscript  $f$ ) are

$$p_f = \frac{a+2c}{3}, \quad x_f = x_f^* = \frac{(a-c)}{3b}, \quad X_f = \frac{2(a-c)}{3b}. \quad (3a)$$

From (3a), the corresponding profit of each firm and the consumer's surplus and welfare of domestic country are

$$\pi_f = \pi_f^* = \frac{(a-c)^2}{9b}, \quad CS_f = \frac{2(a-c)^2}{9b}, \quad W_f = \frac{(a-c)^2}{3b}. \quad (3b)$$

where the domestic welfare is the sum of profit and consumer's surplus and  $\pi_f^* = W_f^*$ .

Now introduce a VIE implemented through the constraint on the output of domestic firm. Let the market-share of foreign product under the VIE and the initial free trade be  $m_v$  and  $m_f$  respectively. Their relationships are

$$\frac{x^*}{(x+x^*)} = m_v \geq m_f, \quad (4)$$

where  $0 \leq m_f \leq m_v \leq 1$ .

In Fig. 1,  $x(x^*)$  is measured horizontally (vertically) and the outputs at the initial free trade are  $x_f(x_f^*)$ . The response curve of domestic (foreign) firm is  $hh'(ff')$  and  $gg'$  is a line with the slope of minus 1. The free trade Cournot-Nash equilibrium point is  $E_f$ . Draw two straight lines from the origin:  $m_f/(1-m_f)$  and  $m_v/(1-m_v)$ . Since  $m_f \leq m_v$ , the slope of  $m_v/(1-m_v)$  is greater or equal to that of  $m_f/(1-m_f)$ . Now, (4) is rewritten as

$$x \leq \frac{(1-m_f)x^*}{m_f}. \quad (5)$$

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<sup>3</sup>  $(a-c) > 0$  is assumed in order to ensure positive outputs.

This relationship works as an enforcement mechanism of VIE. Placing such a constraint produces a kink at  $E_f$  on  $hh'$ . The new domestic reaction curve consists of two parts,  $0E_f$  and  $E_f h$ . These are represented by

$$x_v(x^*) = \frac{(1-m_f)x^*}{m_f}, \text{ if } x^* \leq x_f^*, \quad (6a)$$

$$x_v(x^*) = x(x^*), \text{ if } x^* > x_f^*, \quad (6b)$$

where  $x_v(x^*)$  is the reaction function of the domestic firm under the VIE (denoted by subscript  $v$ ). (6a) and (6b) imply followings.

i) If the foreign supply under the VIE is not greater than that under free trade, the

reaction function of domestic firm is equal to  $(1-m_f)x^*/m_f$ . This is represented by

$$0E_f.$$

ii) If the foreign supply under the VIE is greater than that under free trade, the reaction

function of domestic firm is equal to (2a). This is represented by  $E_f h$ .

Thus the effective domestic reaction function is  $0E_f h$  and the VIE produces an equilibrium point on  $fE_f$  of the foreign reaction curve.

From  $x^* = m_v x / (1 - m_v)$  and (2b), we obtain the commodity price, output of each firm and total supply under the VIE<sup>4</sup>

$$p_v = \frac{am_v + c}{1 + m_v}, \quad x_v = \frac{(a-c)(1-m_v)}{b(1+m_v)}, \quad x_v^* = \frac{(a-c)m_v}{b(1+m_v)}, \quad X_v = \frac{(a-c)}{b(1+m_v)}. \quad (7a)$$

From (7a), the profit of domestic and foreign firm and the domestic consumer's surplus under the VIE are

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<sup>4</sup> Similar to Greaney(1996), we also assume that the VIE does not affect the foreign response function.

$$\pi_v = \frac{(a-c)^2 m_v (1-m_v)}{b(1+m_v)^2}, \quad \pi_v^* = \frac{(a-c)^2 m_v^2}{b(1+m_v)^2}, \quad CS_v = \frac{(a-c)^2}{2b(1+m_v)^2}. \quad (7b)$$

From (7b), the domestic and foreign welfare are

$$W_v = \frac{(a-c)^2 (2m_v (1-m_v) + 1)}{2b(1+m_v)^2}. \quad (8a)$$

$$W_v^* = \frac{(a-c)^2 m_v^2}{b(1+m_v)^2}. \quad (8b)$$

Thus from (8a) and (8b), we obtain

$$\frac{dW_v}{dm_v} = -\frac{3(a-c)^2 m_v}{b(1+m_v)^3} < 0, \quad (9a)$$

$$\frac{dW_v^*}{dm_v} = \frac{2(a-c)^2 m_v}{b(1+m_v)^3} > 0. \quad (9b)$$

Thus we have

*PROPOSITION 1. When a VIE is implemented through adding the constraint on the output of domestic firm, it is welfare worsening for domestic county while welfare enhancing for foreign country.*

The effects on world welfare are

$$\frac{dW_v}{dm_v} + \frac{dW_v^*}{dm_v} = -\frac{(a-c)^2 m_v}{b(1+m_v)^3} < 0. \quad (10)$$

From (9a),(9b) and (10), we obtain

*PROPOSITION 2. As the reduction of welfare in domestic country dominates the increase of welfare in foreign country, the world suffers from the VIE.*

In addition, from (3a) and (7a), the difference in commodity prices between at the VIE and free trade is

$$p_v - p_f = \frac{(a-c)(2m_v-1)}{3(1+m_v)} > 0. \quad (11a)$$

if  $0.5 < m_v < 1$ . Also from (3b) and (8a), assuming  $0.5 < m_v < 1$ , we obtain

$$W_v - W_f = -\frac{(a-c)^2(4m_v+1)(2m_v-1)}{6b(1+m_v)^2} < 0. \quad (11b)$$

As the result of the VIE, the commodity price increases and domestic welfare declines.

### 3. An Import Subsidy

An import subsidy, an alternative policy by an importing country, is utilized to increase the imports of foreign products by providing a subsidy to foreign firm. Assuming that the demand and cost functions are the same as before, suppose that the domestic country provides an import subsidy to foreign firm per unit of its export. The profit of foreign firm under the import subsidy is

$$\pi_s^* = (a - b(x + x^*))x^* - (c - s)x^*, \quad (12)$$

where  $s (> 0)$  is the rate of import subsidy. From (12), the foreign reaction function is

$$x^*(x, s) = \frac{(a-c) + s}{2b} - \frac{x}{2}. \quad (13)$$

As the reaction function of domestic firm is (2a), the outputs of two firms and total supply under the import subsidy are

$$x_s = \frac{(a-c) - s}{3b}, \quad (14a)$$

$$x_s^* = \frac{(a-c) + 2s}{3b}, \quad (14b)$$

$$X_s = \frac{2(a-c) + s}{3b}. \quad (14c)$$

Comparing (14c) with (3a), the total supply increases as the result of the import subsidy.

From (14b) and (14c), we obtain

$$m_s \equiv \frac{x_s^*}{X_s} = \frac{(a-c) + 2s}{2(a-c) + s}, \quad (15)$$

where  $m_s$  is the market-share of foreign product under the import subsidy.

Suppose that the government of importing country attains the same market-share of foreign product by providing an import subsidy. By equating  $m_s$  with  $m_v$ , we obtain

$$\tilde{s} = \frac{(a-c)(2m_v - 1)}{2 - m_v}, \quad (16)$$

where  $\tilde{s}$  is the rate of import subsidy that attains the same market-share as the VIE.

If  $0.5 < m_v < 1$ ,  $d\tilde{s}/dm_v > 0$ .

In Fig.1, the import subsidy equal to (16) shifts the foreign reaction curve  $ff'$  to  $f_s f_s'$ . We find a point  $E_s$ , where  $f_s f_s'$  crosses with the domestic reaction curve  $hh'$ . Let the line  $m_v/(1-m_v)$  passes  $E_s$ . As both  $E_s$  and  $E_m$  are on  $m_v/(1-m_v)$ , the market-share of foreign product is the same under two policies.

Now consider the welfare effects of import subsidy. The commodity price, the profit of domestic and foreign firm and domestic consumer's surplus under the import subsidy (denoted by subscript  $s$ ) are

$$p_s = \frac{a + 2c - \tilde{s}}{3}, \quad \pi_s = \frac{((a-c) - \tilde{s})^2}{9b}, \quad \pi_s^* = \frac{((a-c) + 2\tilde{s})^2}{9b},$$

$$CS_s = \frac{(2(a-c) + \tilde{s})^2}{18b}. \quad (17)$$

The cost of import subsidy is  $\tilde{s}x^* = \frac{\tilde{s}(a-c+2\tilde{s})}{3b}$ . Summing the profit and consumer's surplus and subtracting the cost of import subsidy, the domestic welfare under the import subsidy is

$$W_s = \frac{2(a-c)^2 - 2\tilde{s}(a-c) - 3\tilde{s}^2}{6b}. \quad (18a)$$

Also the welfare of foreign country is

$$W_s^* = \frac{(a-c+2\tilde{s})^2}{9b}. \quad (18b)$$

From (18a) and (18b), we obtain

$$\frac{dW_s}{d\tilde{s}} = -\frac{(a-c)+3\tilde{s}}{3b} < 0, \quad (19a)$$

$$\frac{dW_s^*}{d\tilde{s}} = \frac{4(a-c+2\tilde{s})}{9b} > 0. \quad (19b)$$

Thus we obtain

**PROPOSITION 3.** *An import subsidy is welfare worsening for domestic country while welfare enhancing for foreign country.*

This proposition says that the voluntary nature of an import subsidy is the same as a VIE for each country, i.e., both policies are welfare worsening for importing country and welfare enhancing for exporting country.

However, there is a difference on world welfare. From (19a) and (19b), we have

$$\frac{dW_s}{d\tilde{s}} + \frac{dW_s^*}{d\tilde{s}} = \frac{(a-c) - \tilde{s}}{9b}. \quad (20)$$

From (16), we see that if  $m_v = 0.5$ ,  $\tilde{s} = 0$  and if  $m_v = 1$ ,  $\tilde{s} = (a - c)$ . Thus, if  $m_v \in [0.5, 1]$ ,  $\tilde{s} < (a - c)$ . Thus we obtain

**PROPOSITION 4.** *An import subsidy is always welfare enhancing for the world.*

Proposition (3) and (4) provide an interesting result about import subsidy: it is not desirable for an importing country but it is desirable for the world. This is an important difference between VIE and import subsidy.

Similar to the case of a VIE, we can calculate the differences in price and welfare between the import subsidy and free trade. From (3a) and (17), we obtain

$$p_s - p_f = -\frac{\tilde{s}}{3} < 0, \quad (21a)$$

Also from (3b) and (18a), we obtain

$$W_s - W_f = -\frac{2\tilde{s}(a - c) + 3\tilde{s}^2}{6b} < 0. \quad (21b)$$

Both commodity price and welfare decline as the result of import subsidy.

#### 4. Comparisons

This section compares our results from two aspects: the comparisons of VIE with import subsidy in our model and the comparisons our model with Greaney(1996).

Comparisons of VIE with import subsidy in our model

Two policies are compared from two aspects: commodity prices and welfare. First, from

(7a) and (17), we obtain

$$p_s - p_v = - \frac{(a - c)(2m_v - 1) + \tilde{s}(1 + m_v)}{3(1 + m_v)}. \quad (22)$$

(22) shows that if  $0.5 < m_v < 1$  the commodity price under the import subsidy is lower than that under the VIE. Gathering (11a), (21a) and (22) together, if  $0.5 < m_v < 1$ , we obtain:  $p_s < p_f < p_v$ .

On the welfare, two aspects should be divided: the world welfare and the welfare of each country. As already shown, a VIE always reduces the world welfare while an import subsidy always increases it. On the welfare of each country, while the domestic country suffers from two import expansion policies the foreign country gains from them.

Now consider the difference of welfare of domestic country under two policies. Substituting (16) into (18a) and subtracting from (8a), we obtain

$$W_v - W_s = \frac{(a - c)^2(1 + 4m_v)(1 - 2m_v)^2}{2b(1 + m_v)^2(2 - m_v)^2}. \quad (23)$$

From (23), we see that if  $m_v = 0.5$ ,  $W_v - W_s = 0$ . However if  $m_v$  takes other values it is always positive. Thus we obtain followings

**PROPOSITION 5.** *For an importing country a VIE is better than an import subsidy when she is obliged to increase the market-share of foreign product.*

The intuition of this difference is simple: two policies produce different effects on the

outputs of two firms. While a VIE just kinks the domestic reaction curve an import subsidy must shift the foreign reaction curve outside and it is costly.

This difference is reflected by the curvature of welfare functions under two policies.

From (9a), we obtain

$$\frac{d^2W_v}{dm_v^2} = -\frac{3(a-c)^2(1-2m_v)}{b(1+m_v)^4}. \quad (24)$$

On the other hand, from (19a) we obtain

$$\frac{d^2W_s}{d\tilde{s}^2} = -\frac{1}{b} < 0. \quad (25)$$

As long as  $0.5 < m_v < 1$  (24) is positive while (25) is negative. This implies that the welfare function under a VIE is strictly convex in  $m_v$  while that under an import subsidy is strictly concave in  $\tilde{s}$ . Considering (8a),(9a),(16),(18a) and (19a) along with (24) and (25), we see that as the loss of welfare under a VIE becomes less than that under an import subsidy, a VIE is better than an import subsidy when the market-share of foreign product increases.

In order to confirm proposition 5, we calculate the levels of welfare of domestic country numerically at two extreme cases by specifying  $(a-c)^2/b = 1$ . If  $m_v = 0.5$ , then we have  $\tilde{s} = 0$  and  $W_v = 0.333 = W_s$ . On the other hand if  $m_v = 1$ , then we have  $\tilde{s} = (a-c)$  and  $W_v = 0.125$  and  $W_s = -0.500 < 0$ . Thus as the values of  $m_v$  increases from 0.5 to 1, while the domestic welfare declines from 0.333 to 0.125 in the case of VIE, in the case of import subsidy it declines from 0.333 to  $-0.500$ . This shows that an import subsidy is more welfare worsening.

#### 4.2 Comparisons our model with Greaney(1996)

A seminal previous paper on VIE is Greaney(1996) and its model and focus are different from ours. However, since it provided benchmark results it is necessary to compare two models. The model of Greaney(1996) has following features. First, it focuses on the effect of importing country. Second, it considers the profit of the firms. Third, it uses a general Bertrand model. Then it derives followings: i) the commodity prices rise under a VIE and fall under an import subsidy, ii) the domestic profit rises under a VIE and fall under an import subsidy and iii) domestic firm prefers a VIE set within the neighborhood of the pre-VIE market share to an equivalent import subsidy.

In contrast, our model has following features. First, we also consider an exporting country and the world. Second, we also consider consumer's surplus of domestic country. Third, we use a Cournot model with linear demand function and identical cost function. Then we derive followings: i) the commodity price rises under a VIE and falls under an import subsidy, ii) under both VIE and import subsidy the profit of domestic firm falls and that of foreign firm rises, iii) two policies reduce domestic welfare and rise foreign welfare, iv) a VIE reduces world welfare while an import subsidy increases it and v) domestic country will prefer a VIE rather than an import subsidy in expanding the market-share of foreign product. Thus even if our model is more specific, we provided new results in the analysis of VIE and import subsidy.

#### 5. Concluding Remarks

This paper provided a Cournot model of VIE with an explicit enforcement mechanism, compared it with an equivalent import subsidy and considered the welfare effects of VIE and import subsidy. We show that both policies are welfare worsening for an importing country while an import subsidy is welfare enhancing for the world. It is also shown that an import subsidy is more welfare worsening than a VIE for an importing country when the market-share of foreign product increases. Our analysis could justify the use of VIE in the semi-conductor agreement in 1986.

Despite the recent trade disputes over the access to Chinese market as well as the existence of market access requirement in the WTO frameworks, previous literatures have paid little attentions to the welfare implications of two import expansion policies. Our analysis shows that contrary to a conventional wisdom a VIE is a less costly policy for importing country to attain a market-share of foreign product. Even if our model is specific and simple, i.e., partial equilibrium analysis with linear demand function, one firm in each country and constant and identical cost, this paper will contribute to the policy choice when an importing country is obliged to expand the market-share of foreign products.

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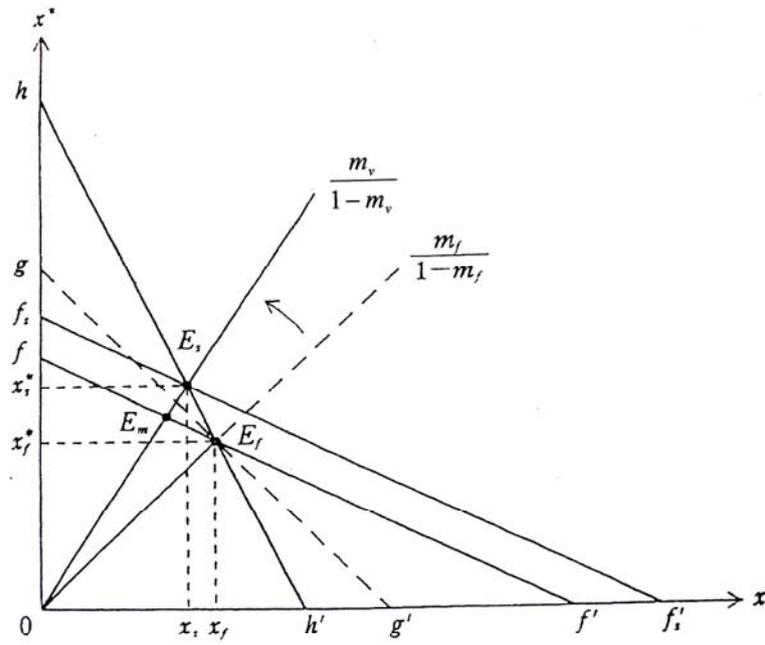


Fig.1. Effects of VIE and import subsidy