

On the Welfare Effects of Voluntary Import Expansions

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Abstract

This paper examines the welfare effects of Voluntary Import Expansions (VIEs) in the Cournot duopoly model from the view point of an importing country. In the benchmark case where each country has one firm and each firm produces homogeneous product under the same marginal cost, a market share VIE is not voluntary for the importing country. The model is extended to the cases of the asymmetry in the economies of scale and differentiated products. It is shown that in the case of asymmetric economies of scale a strategic import expansion by a VIE is justified under certain conditions. We claim that the voluntary nature of a VIE depends on the model and assumptions.

Keywords: VIEs; VERs; Cournot model; semi-conductor agreement

JEL Classification: F12; F13

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1. Introduction

Since the middle of 1980s, in addition to Voluntary Export Restraints (VERs), Voluntary Import Expansions (VIEs) have become new protective trade policies among industrialized countries. Following the pioneering paper by Bhagwati(1987), literatures such as Bjorksten(1994), Cronshaw and Markusen(1995), Dinopoulos and Kreinin(1990), Ethier and Horn(1996), Greaney (1996, 1999), Irwin(1994), and Ishikawa(1999) have been written on the implications of VIEs from various aspects.. However, in spite of increasing attention to VIEs, the voluntary nature from the viewpoint of an importing country has not been taken up in the literatures.

The VIEs originate from the famous semi-conductor agreement between the US and Japan in 1986. This agreement aims to expand the access of American firms to the Japanese market. It is a compulsory expansion of imports from the US. Thereafter the VIEs have become important market access trade policies that aim to open foreign markets that are considered closed. They are implemented on the ground of fair trade argument and have natures of results-oriented trade policies that focus on concrete outcomes.

These result-oriented trade policies are against to the rule-oriented system of the GATT/WTO and have been criticized by Bhagwati(1987) among others. However in order to settle trade conflicts these types of trade policy have already become popular among industrialized countries. In fact, although WTO aims to attain the rule-oriented multilateral trade system, it includes articles of minimum market access requirements in some agricultural products. These bilateral and results- oriented trade arrangements will continue in the future.

The first rigorous analysis of VIEs is Greaney(1996). Using a Bertrand model of duopoly with differentiated substitute goods, she analyzed the effects of VIEs. Specifically, she showed that a minimum market share VIE does not increase competition and does not reduce the equilibrium prices of both goods. She showed also that under price competition a VIE benefits both firms if it increases the market share of imports by a small margin and that under quantity competition a VIE hurts the home firm. However, she did not explicitly analyze the effects of VIEs on the welfare of importing country.

On the voluntary nature of VERs, Harris(1985) and Mai and Hwang(1988) have considered the conditions under which a VER is voluntary and many papers have already been written on VERs such as Krishna(1989) among others. However, compared with the case of VERs, the voluntary nature of VIEs has not been taken up in the literatures. The purpose of this paper is to fill this gap and find out the possibility of voluntary VIEs from the viewpoints of an importing country. This paper provides a complement to Greaney(1996).

This paper is organized as follows. Section 2 sets up a benchmark Cournot duopoly model of VIE where an increase in the share of foreign product is attained by the reduction of output of home firm and shows that the VIE is not voluntary for the importing country. In section 3, the model is extended to the cases of asymmetry in the economies of scale and differentiated products in order to find out the cases of voluntary VIE. We provide a necessary and sufficient condition for a VIE to be voluntary for an importing country. Section 4 concludes the paper. In the appendix, we compare a VIE with an import subsidy in attaining the same market share of imports.

2. A model of VIE

In order to consider the welfare effects of a market share VIE, we set up a benchmark model with homogenous goods and identical marginal cost. In the case of semi-conductor agreement between the US and Japan in 1986, the Japanese government asked the Japanese users to use the US semi-conductor rather than Japanese one, which made the agreement enforceable. This suasion reduced the output of Japanese semi-conductor and the import expansion by the VIE is attained through a constraint to the Japanese firm's output. Based on this fact, we set up a benchmark model where an increase in the market share of foreign product is realized by the reduction of the output of home firm.

Assume two countries, home (Japan) and foreign (US), and that each country has one firm. Both firms produce a homogeneous product and compete in the home market in the Cournot fashion.¹ Assume that the fixed cost is zero and that the marginal cost is constant and same for both firms. Suppose that as the result of the pressures of the foreign firm, the foreign government asks the home government to increase the market share of foreign product and that a VIE is agreed between the two governments.²

Consider a two stages game. In the first stage, the governments of the two countries negotiate on the market share of foreign product in the home market. In the second stage, based on this agreement, both firms compete non-cooperatively in the home market in the Cournot fashion.

Let the representative consumer's utility function of home country be quasi-linear: $u(X, Y) = U(X) + Y = aX - (bX^2)/2 + Y$, where X is the quantity of the good in question and Y is that of other (numeraire) good. Maximizing the utility subject to

the budget constraint: $I = pX + Y$, we obtain the inverse demand function for the product:

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

where p is the price of X and both a and b are some positive value. a may be considered as a parameter that represents the market size of the home country.

Let $x(x^*)$ be the output of home (foreign) firm. Then $x + x^* \equiv X$, where the asterisk denotes the foreign variables. By assumption, the cost functions of two firms are written as: $C(x) = cx$, $C^*(x^*) = cx^*$. The best response functions of the home and foreign firms are:

$$\begin{aligned} x(x^*) &= (a - c)/2b - x^*/2, \\ x^*(x) &= (a - c)/2b - x/2. \end{aligned} \quad (2)$$

Assume that a unique and stable Cournot-Nash equilibrium exists. Then the free trade Cournot-Nash equilibrium output of domestic and foreign firm; x_f, x_f^* and total supply; X_f are:

$$x_f = x_f^* = (a - c)/3b, \quad X_f = 2(a - c)/3b. \quad (3)$$

In Fig. 1, hh' (ff') is the best response function of home (foreign) firm and gg' is a line with the slope of minus 1. The free trade Cournot-Nash equilibrium point is E_f .

[Fig.1. around here]

As in the case of semi-conductor agreement, a VIE agreement is made in terms of market share of foreign good and it is based on the initial share under free trade. Thus

we can consider two levels of market share of foreign good: the free trade level and the VIE level. The relations between them are represented by:

$$x^*/(x+x^*) \geq m \geq m_f, \quad (4)$$

where m_f and m are the market share of foreign good under initial free trade and the VIE respectively. In Fig. 1, we added two straight lines from the origin: $m_f/(1-m_f)$ and $m/(1-m)$. Since $m \geq m_f$, it is clear that the slope of $m/(1-m)$ is greater than that of $m_f/(1-m_f)$. From Eq.(4), we obtain:

$$x \leq (1-m_f)x^*/m_f. \quad (5)$$

Placing such a constraint alters the domestic firm's best response function and it is now divided into two parts:

$$\begin{aligned} x_m(x^*) &= (1-m_f)x^*/m_f, \text{ if } (1-m_f)x^*/m_f \leq x_f(x^*), \\ x_m(x^*) &= x(x^*), \text{ if } (1-m_f)x^*/m_f > x_f(x^*), \end{aligned} \quad (6)$$

where $x_m(x^*)$ is the reaction function of the domestic firm under the VIE. Eq. (6) implies the followings:

- i) If the foreign supply under the VIE is not greater than that under free trade, the reaction function of domestic firm under the VIE is equal to $(1-m_f)x^*/m_f$. This is represented by OE_f in Fig. 1.
- ii) If the foreign supply under the VIE is greater than that under free trade, the reaction function of the domestic firm under the VIE is equal to the reaction function of Eq.(2). This is represented by $E_f h$ in Fig. 1.

Thus the reaction function of domestic firm under a VIE has a kink at point E_f and the new reaction function is $0 E_f h$. As m increases as the result of an increase in VIE, the new equilibrium point is determined such as at E_m on the fE_f part of the foreign reaction function.

Assume that a VIE starts from the free trade level and it is binding. Then from Eq.(2) and (6), the equilibrium output of each firm and total supply under the VIE are the function of m and they are:

$$x_m = [(a-c)(1-m)]/b(1+m), \quad x_m^* = [(a-c)m]/b(1+m),$$

$$X_m = (a-c)/b(1+m) .$$

(7)

For example, suppose $m = m_f = 1/2$. Then we have: $X_m = 2(a-c)/3b$, which is equal to X_f in Eq.(3). From Eq. (7), the profits of domestic and foreign firm under the free trade VIE are:

$$\pi(m) = [m(1-m)(a-c)^2]/b(1+m)^2,$$

$$\pi^*(m) = [(a-c)^2 m^2]/b(1+m)^2 . \quad (8)$$

From the demand function, the consumer's surplus of the domestic country is:

$$\begin{aligned} CS(m) &= \int_0^{X_m} p(u)du - pX_m = aX_m - bX_m^2/2 - (a-bX_m)X_m \\ &= bX_m^2/2 . \end{aligned} \quad (9)$$

Assuming that the welfare of the domestic country is the sum of the profits of the domestic firm and consumer's surplus, we obtain:

$$W(m) = [(a-c)^2(2m(1-m)+1)]/2b(1+m)^2 . \quad (10)$$

From Eq.(10), we obtain:

$$dW(m)/dm = -\left[3(a-c)^2 m\right]/\left[b(1+m)^3\right] < 0. \quad (11)$$

This produces following result:

Result 1. *A VIE is not voluntary for the home country in the Cournot duopoly model where both firms produce homogeneous product under identical and constant costs.*

The implications of this result are as follows: In this model, the imposition of compulsory expansion of imports is achieved by adding the constraint to the best response function of domestic firm, so that the market share of imports is above the free trade level; that is, the import expansion is achieved by restraining the domestic firm's output. The sum of outputs of domestic and foreign firm under the VIE is lower than under free trade, leading to a higher price and hence a lower consumer's surplus. We see that the welfare – the sum of the consumer's surplus and the producer's surplus – decreases as the market share of imports increases. In Fig. 1, a VIE changes the equilibrium point from E_f to E_m . As the slope of the foreign firm's reaction curve is equal to $-1/2$, the total supply is lower than under free trade. A VIE in this model cannot be voluntary.

3. Extensions of the model

The above result is derived under two severe assumptions: identical marginal cost and homogenous product. It is natural and plausible to consider the voluntary nature of VIE under more general settings. In order to find out the possibility for voluntary VIE,

we extend this model to the cases of asymmetric marginal cost and differentiated products.

3.1. Asymmetric marginal cost

Since the asymmetry in the economies of scale and the cost asymmetry are common, consider a case where while the marginal cost of domestic firm is constant, the foreign firm enjoys the economies of scale. This type of asymmetry is justified when, as in the case of VIE in semi-conductor, the scale of production in foreign firm is greater than that of the home firm and the marginal cost of foreign firm declines as the result of the economies of scale. We show that if the economies of scale for the foreign firm is sufficiently large, import expansions (and hence the expansion of the foreign firm's production) will improve the welfare by sufficiently reducing the equilibrium price, i.e., increasing the consumer's surplus. We see that in this case a strategic import expansion by a VIE is justified under certain conditions.

Assume the following cost functions:

$$C = C(x) = cx, \quad C'(x) = c, \quad C''(x) = 0,$$

$$C^* = C^*(x^*), \quad C^{*'}(x^*) > 0, \quad C^{*''}(x^*) < 0.$$

The profit function of the foreign firm is: $\pi^*(x, x^*) = (a - bx - bx^*)x^* - C^*(x^*)$. The first and second order conditions for the profit function are assumed to hold:

$$\partial \pi^* / \partial x^* = -2bx^* + a - bx - C^{*'}(x^*) = 0,$$

$$\partial^2 \pi^* / \partial x^{*2} = -2b - C^{*''}(x^*) < 0. \tag{12}$$

The first order condition of Eq.(12) gives us an implicit function: $F(x, x^*) = 0$. Applying

the Implicit Function Theorem, we obtain: $dx^*/dx = -F_x/F_{x^*}$. Since $F_x = -b$ and

$F_{x^*} = -2b - C^{**}(x^*) < 0$, we have:

$$dx^*/dx = -b/[2b + C^{**}(x^*)] < 0. \quad (13)$$

Our target is to find out the conditions under which an increase in m raises the total supply of commodity and the welfare of home country. In order for a VIE to increase the total supply in home market, the following condition must be satisfied:

$$1 < -dx^*(x)/dx = b/[2b + C^{**}(x^*)] < 2. \quad (14)$$

According to the value of denominator of the third term of Eq.(14), two cases are divided;³

case 1: $2b + C^{**}(x^*) > 0$. In this case, we have: $-1.5b < C^{**}(x^*) < -b$.

case 2: $2b + C^{**}(x^*) < 0$. This case is excluded by the second order condition in Eq.(12).

Thus the case 1 is relevant. In this case, if the value of $C^{**}(x^*) < 0$ lies within this range, an increase in m raises the total supply in home market. More analyses are necessary in order to find out the conditions for a VIE to be voluntary.

Define $\phi^*(x^*) \equiv C^{**}(x^*)/b$ as the relative slope of the foreign marginal cost curve to the demand curve. By the use of $\phi^*(x^*)$, Eq.(13) is written as:

$$dx^*/dx = -1/[2 + \phi^*(x^*)]. \quad (13')$$

Now we consider a change in welfare of home country. The change in domestic profit is: $d\pi = (p - c)dx + xdp$. On the other hand, the change in consumer's surplus is: $dCS = p dX - X dp - p dX = -X dp$. Thus the change in domestic welfare is: $dW = dCS + d\pi = -X dp + (p - c)dx + xdp = -x^* dp + (p - c)dx = -x^* p' dX + (p - c)dx$. From this

we obtain:

$$dW / dx = -x^* p'(dX / dx) + (p - c). \quad (15)$$

Since an increase in VIE implies $dx < 0$, in order for a VIE to enhance the welfare, we must have $dW / dx < 0$. Evaluating Eq.(15) at the initial free trade, we obtain:

$$dW / dx|_{FT} = -x^* p'(dX / dx) - xp' = -p'[x^* (dX / dx) + x], \quad (15')$$

where the first order condition for the profit maximization for home firm: $p - c = bx = -xp'$ is used.

From Eq.(15'), the necessary and sufficient condition for a VIE to be welfare enhancing is:

$$[x^* (dX / dx) + x] < 0. \quad (16)$$

Since $dX / dx = 1 + dx^* / dx$, by the use of Eq.(13'), we obtain:

$$dX / dx = [1 + \phi^*(x^*)] / [2 + \phi^*(x^*)]. \quad (17)$$

For a VIE to increase the total supply in the home market, we have: $dX / dx < 0$. From Eq.(16) and (17), we finally obtain a necessary and sufficient condition for a VIE to be voluntary:

$$x^* / x > -[2 + \phi^*(x^*)] / [1 + \phi^*(x^*)]. \quad (18)$$

Eq. (18) is the most important equation that represents the condition under which the VIE is voluntary. This produces following result:

Result 2. *If $x^* / x > -[2 + \phi^*(x^*)] / [1 + \phi^*(x^*)]$, a VIE is voluntary for home country.*

The result 2 provides following novel implications. First, for a VIE to be voluntary the

relative output of the foreign firm to the domestic firm should be greater than some critical value. The critical value depends on the relative slope of foreign marginal cost curve to the demand curve. This assumption will be satisfied when the foreign firm is relatively large than the domestic firm. Second, if Eq.(18) is satisfied, a strategic import expansion by the use of VIE is justified even under this type of enforcement mechanism.

The intuitions of this result are as follows: An increase in the foreign firm's output level in response to a decrease in the domestic firm's output level reduces the foreign firm's marginal costs, which further increases the foreign firm's production, reducing equilibrium price and increasing consumer's surplus. If an increase in consumer's surplus is large enough, then a VIE is welfare improving.

3.2. Differentiated products

As another extension of the model, we provide a model of duopoly with differentiated products and consider the voluntary nature of VIE under product differentiation. Since our focus is on the effects of product differentiation, we assume that the commodities are produced under zero cost.

Let the representative consumer's utility function of home country as:

$$u(x, x^*, y) = U(x, x^*) + y = (x + x^*) - (\alpha x^2 + \alpha^* x^{*2})/2 - \beta x x^* + y,$$

where x (x^*) is the product of home (foreign) firm and y is the numeraire good. x and x^* are differentiated goods. From this utility function, we obtain the inverse demand functions of each good:

$$\begin{aligned} p &= 1 - \alpha x - \beta x^*, \\ p^* &= 1 - \beta x - \alpha^* x^*, \end{aligned} \tag{19}$$

where $p(p^*)$ is the price of home (foreign) good. It is assumed that the cross price effect β is symmetric. If $\beta = 0$, two goods are independent and the value of $\beta^2 / \alpha\alpha^*$ shows the degree of product differentiation. When $\beta^2 / \alpha\alpha^*$ is zero, two goods are independent and when it is 1, they are perfect substitute. Usually, $0 \leq \beta^2 / \alpha\alpha^* \leq 1$. Two cases can be divided depending on the value of α and α^* . However since there exists no difference analytically, we assume $\alpha = \alpha^*$.

The profit functions of home and foreign firms are: $\pi(x, x^*) = (1 - \alpha x - \beta x^*)x$ and $\pi^*(x, x^*) = (1 - \beta x - \alpha x^*)x^*$. From these we obtain the reaction functions of two firms:

$$x = (1 - \beta x^*) / 2\alpha, \quad x^* = (1 - \beta x) / 2\alpha. \quad (20)$$

Thus the Cournot-Nash equilibrium outputs of each firm and total output are:

$$x_n = x_n^* = 1 / (2\alpha + \beta), \quad X_n = 2 / (2\alpha + \beta). \quad (21)$$

From Eq.(20), we see that the slope of the reaction curve of foreign firm is zero if both goods are independent and it is $-1/2$ if they are perfect substitute. Furthermore, we see that if the degree of product differentiation is in between these two extremes, the slope of foreign reaction curve is flatter than minus 1.

Starting from the initial Cournot-Nash equilibrium given by Eq.(21), suppose that the foreign firm's share of imports increases as the result of a VIE. This reduces total supply and increases commodity prices. We have following result:

Result 3. *A VIE that reduces total supply will not be voluntary under any degree of product differentiation.*

The implications of this result are as follows: The foreign reaction curve is flat if the goods are independent and its slope is $-1/2$ if the goods are perfect substitute. Thus as a result of VIE, the total supply to the home market declines and the commodity prices increase, reducing consumer's surplus and welfare. We see that the product differentiation cannot justify a VIE from the aspect of importing country. This result is similar to Greaney (1996), where two firms compete in Bertrand competition with differentiated goods.

4. Conclusions

To analyze the welfare effects of a market share VIE, this paper provided a Cournot duopoly model that fits observed facts. When each country has one firm and both firms produce a homogenous good under identical marginal cost, a VIE is not voluntary for the importing country. We extended the model to the cases of cost asymmetry and differentiated products in order to find out the conditions for a VIE to be voluntary. In the case of cost asymmetry, if the economies of scale for the foreign firm is sufficiently large, a VIE can improve the welfare. In this case, a strategic import expansion by a VIE is justified. In the case of differentiated products, a VIE that reduces total supply will not be voluntary for any degree of product differentiation.

This paper assumed that the import expansion is attained through a constraint to the domestic firm's output because it is the enforcement mechanism in the case of semi-conductor agreement. However, if different enforcement mechanisms are used, different results will come out. This is a question left for further research. Also left for future research in the analyses of VIEs are questions as to how to measure the

enforcement cost and how the cost is burdened between the two countries. In our model, if the enforcement cost is burdened by the foreign country, the VIE may be welfare increasing for the home country. Nevertheless, this paper provided a necessary and sufficient condition for a VIE to be welfare increasing when the target is attained through a constraint to the domestic firm's output. Our paper suggests that the voluntary nature of VIE depends on the specifications of the model and assumptions.

Appendix

In this appendix, we consider the effects of a VIE and an import subsidy on the total commodity supply when both policies produce an equal market share of foreign firm. In our benchmark model, an import subsidy to the foreign firm shifts the foreign response curve to the right. In Fig. 1, suppose that $f_s f_s'$ is the new foreign best response curve under the import subsidy. E_s is the new equilibrium point under the import subsidy where hh' and $f_s f_s'$ cross. On the other hand, we already demonstrated that when a VIE is set equal to m , the equilibrium point is E_m . Now we have three equilibrium points: E_s , E_f , and E_m . Since E_s and E_m are on the same line: $m/(1-m)$, the market share of foreign firm is the same between them. However, the ranking of total commodity supply at these points is $E_s > E_f > E_m$. Thus if these two trade policies are available to increase the market share of foreign firm in the domestic market, an import subsidy reduces commodity price and increases welfare, while price rises and welfare falls under a VIE.

Acknowledgements

We thank Ian Wooton, Hajime Sugeta, and Makoto Tanaka for useful comments on the earlier version of this paper. We are solely responsible for any remaining shortcomings.

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Footnotes

1. A Cournot competition rather than Bertrand competition is used for the following reasons. First, this paper intends to be a complement to Greaney (1996), which assumes Bertrand competition. Second, in the case of Bertrand competition with homogenous product, the low cost firm becomes the sole producer of the product. However this is not the case in the real world.
2. A VIE agreement must be made at least in three aspects: the share of foreign product in the domestic market, the enforcement mechanism, and the cost burden of enforcement. Here we assume that the import expansion is attained through a constraint to the domestic firm's output. This implies that the home country pays the entire cost of enforcement. On the enforcement mechanism, see for example, Greaney(1996), and Krishna, Roy, and Thursby(1998).

3. To ensure the stability of the Cournot Nash equilibrium, we assume: $\pi_{xx}\pi_{x^*x^*}^* -$

$$\pi_{xx^*}\pi_{x^*x}^* = 3b^2 + 2bC^{**}(x^*) > 0, \text{ which implies: } C^{**}(x^*) > -1.5b.$$

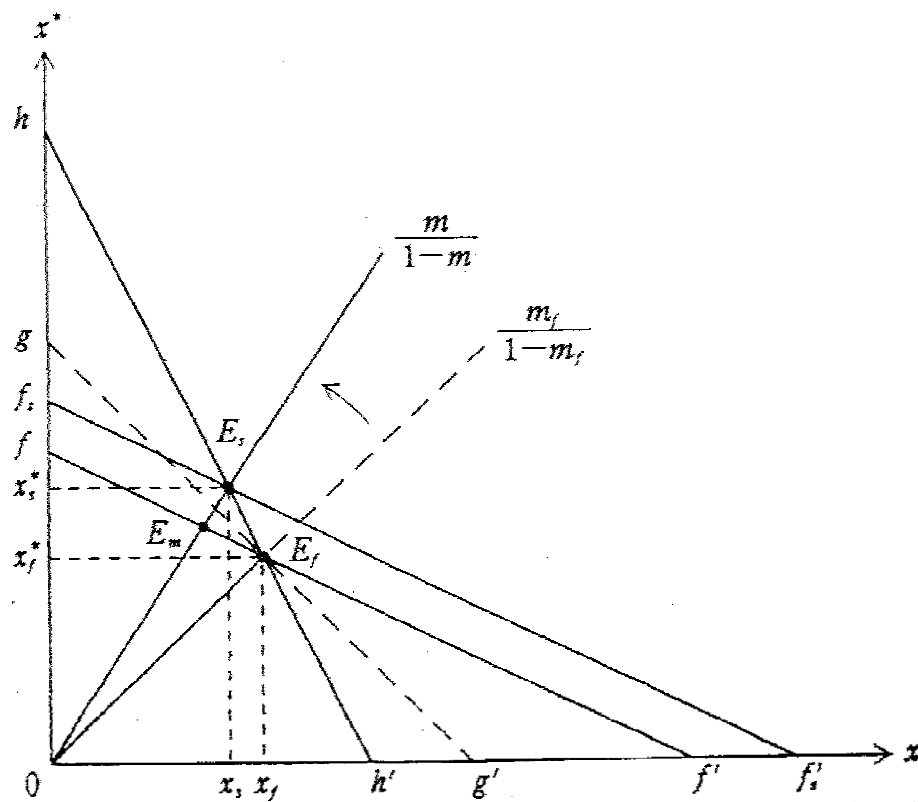


Fig.1. Effects of a VIE and the comparisons with an import subsidy

