Voluntary Export Restraints on Intermediate Good Market and Economic Welfare

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Abstract

We examine the effects of a VER imposed on a differentiated intermediate-good market under international duopoly. We will analyze two cases in which duopolists in the intermediate-good markets compete in quantities and in prices. We will show that the effects of VERs crucially depend on the relations between the price-elasticity of demand for the final-good produced by the intermediate goods and the cross-elasticities of demand for the intermediate-goods, and on the market structure of the raw-material markets under free trade.
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1. Introduction

Voluntary Export Restraints (VERs) have become one of the major protective measures and many trade researchers have paid much attention to the effects of that form of protection in the context of international oligopoly. In a model of Bertrand price competition in a differentiated final-good market, Harris (1985) analyzed the effects of VERs set at the free trade level of imports on the behavior of firms and consumer welfare. He showed that VERs facilitate price leadership by the protected domestic firms and lead to an increase in profits for both the foreign and domestic firms and a decrease in consumer welfare relative to the free trade equilibrium.

Mai and Hwang (1988) assumed that duopolists producing a homogeneous good compete in quantities in the domestic market and, taking a conjectural variations approach, showed that (1) if the free trade equilibrium is Cournot then a VER set at the free trade level of imports will have no impact on the equilibrium situation, that (2) when the equilibrium is more collusive than Cournot, the VER will reduce the prices of the domestic good and of the import competing good and lower the profit of the foreign firm, and that (3) the opposite is true if the market is more competitive than Cournot.

On the other hand, Suzumura and Ishikawa (1997), based on more general assumptions about preferences and the costs of firms, re-examined the welfare effects of VERs in a model of a differentiated final-good market with conjectural variations. They showed that, whether xompetition is in prices or quantities, a VER set equal to the free trade level of exports enhances the welfare of the importing country if and only if it reduces the profit of the exporting firm. In the derivations of these results, the substitutability of the final goods plays a crucial role.

Kemp, Shimomura and Okawa (1997) extended the Suzumura-Ishikawa model to a two-country, three-good, many-factor general equilibrium framework and provided sufficient conditions for the continued validity of the Suzumura-Ishikawa conclusions.

Almost all analyses including the papers cited above have focused on VERs in a context of international oligopoly in final-good markets. However, in the real world, VERs are sometimes adopted in intermediate-goods markets, for example, steel and machines.

There are seminal papers which have examined the effects of tariffs, export tax or subsidy in the context of vertical market structures: Spencer and Jones (1991, 1992) and Chan and Chen (1994) among others. In their analyses, it is assumed that the intermediate-good is the only input or that the technology of the final-good industry is of the fixed coefficient type.

On the other hand, many trade theorists have emphasized the importance of product-differentiation in the intermediate-goods markets. Thus we will explicitly introduce substitutability between intermediate-goods and show that it can play an essential role in the analysis of the VERs imposed on the intermediate-good industry.

The purpose of this paper therefore is to study the effects of a VER imposed on a *differentiated* intermediate-good market under international duopoly with one producer in each country. We shall examine the effects of VERs on the behavior of the duopolists that strategically operate in the intermediate-goods markets and the effects on the welfare of each economic group in the importing and exporting countries. We will proceed by analyzing two cases, in which duopolists in the intermediate-good markets compete in quantities and in prices.

We will show that the effects of VERs crucially depend on the relations between the price-elasticity of demand for the final good and the cross-elasticities of demand for the intermediate goods, and on the market structure of the raw-materials markets under free trade. We will see that when the price-elasticity of demand for the final good is larger than Allen's partial elasticity for factor substitution between the intermediate goods, we will obtain new and unconventional results: In the quantity-setting case, if the market structure of the intermediate-goods markets is more competitive (resp. more collusive) than Cournot under free trade, the monopolist's output of the intermediate good in the importing country is greater (resp. smaller) under a VER than under free trade. In contrast, in the price-control case, whatever the relation between the price-elasticity of demand for the final good and Allen's partial elasticity of factor substitution between the intermediate goods, and whether the market structure of the intermediate-goods under free trade is more competitive or more collusive than Bertrand-Nash, if the market structure is near Bertrand-Nash under free trade then the monopolist's price of the intermediate-good in the importing country is higher under a VER than under free trade.

This paper is organized as follows. In section 2 we set up our model. We analyze the case in which the duopolists compete in their quantities in the differentiated intermediate-good markets in section 3. Section 4 is devoted to the study of the case in which the duopolists compete in prices. Concluding remarks are in Section 5.

2. The model

Let us consider a two-country (α and β), one primary factor trading model. In country α, three goods, two final goods (good 1 and 2) and one intermediate good M are produced. On the other hand, in country β, two goods, a final good 1 and an intermediate good N are produced. Good 1 (the numeraire) and intermediate goods M and N are produced by means of one primary factor (labor) only while, in country α, final good 2 is produced by using labor and two intermediate goods, M and N, where intermediate good N is imported from country β. The two intermediate goods are *substitutable*. In each country, final good 1 is produced under free entry and perfect competition. The technology of the good is subject to constant returns to scale. Therefore the wage rate of labor is constant in each country. In country α, final good 2 is also produced under the conditions of free entry and perfect competition and the technology of the industry is subject to constant returns to scale.. On the other hand, intermediate goods M and N are produced by monopolists and the production technologies of the intermediate goods are subject to increasing returns to scale.

In each country, there are two classes of economic agents: factor owners and a monopolist producing an intermediate good. Each factor owner is endowed with a fixed amount of labor and consumes two final goods 1 and 2. Without loss, we normalize the number of factor owners in each country to 1. On the other hand, the monopolists supply no labor, own their firms and consume final good 1 only. Thus each monopolist maximizes utility by maximizing profit.

We take a conjectural variations approach to the strategic behavior of the two monopolists operating in the intermediate goods markets. The advantage of this approach is that some familiar special solutions such as the Cournot, Bertrand and collusive solutions emerge as special cases. On the other hand, we assume that, in maximizing their profits, the two monopolists in the intermediate good markets exactly conjecture the responses of the perfectly competitive final good industry 2 in country α.

We assume that country α exports final good 2 to country β and imports intermediate good N from country β while country β imports final good 2 and exports intermediate good N to country α. Final good 1 is a nontraded good. However the assumption of the nontradedness of good 1 is inessential.

3. Quantity competition

3. 1 Free trade equilibrium

In this subsection, we examine the optimal behavior of the monopolists that compete in their quantities in the intermediate goods markets under free trade. Let us first examine the behavior of the M-monopolist in country α under free trade. The profit of the monopolist is

$$\Pi_M = p_M M - C_M(M) = \{p_M - [a_M(M)/a_1^{\alpha}]\} M \tag{1}$$

where $C_M(M)$ is the cost of producing M, $a_j(j)$, $(j=M, N)$ is the amount of labor needed to produce a unit of intermediate good j, a_1^i $(i=\alpha, \beta)$ is the amount of labor needed to produce a unit of final good 1 in country i. We obtain a simple form of the first-order condition for the monopolist

$$p_M + M(dp_M/dM) - C_M(M)' = 0 \tag{1'}$$

where $C_M(M)' = (1-\rho_M)(a_M/a_1^{\alpha})$ and $\rho_M \equiv -(M/a_M)(da_M/M) > 0$. We assume that $0 < \rho_M < 1$. To elucidate the feedback term, (dp_M/dM), we resort to the zero-profit condition for the final good industry 2:

$$c_2(w^{\alpha}, p_M, p_N) = p_2 \tag{2}$$

where $a_{j2}(.)$ is the input / output ratio of each factor of production in industry 2. Differentiating (2), we find that

$$a_{M2} dp_M + a_{N2} dp_N = dp_2 \tag{2'}$$

Let us next turn to the world market-clearing condition for final good 2 and the market-clearing conditions for intermediate goods M and N:

$$\sum_{i=\alpha,\beta} D^i(p_2, y^i) = X_2 \tag{3}$$

$$M = a_{M2}(w^{\alpha}, p_M, p_N) X_2 \tag{4}$$

$$N = a_{N2}(w^{\alpha}, p_M, p_N) X_2 \tag{5}$$

Differentiating (3)-(5), we find that

$$dM = A dp_M + B dp_N \tag{4'}$$

$$\lambda^M dM = B dp_M + E dp_N \tag{5'}$$

where

$$A \equiv -[(a_{M2})^2 X_2/p_2][\eta - \tau_{MM}] < 0$$
$$B \equiv -(a_{M2} a_{N2} X_2/p_2)[\eta - \tau_{MN}]$$
$$E \equiv -[(a_{N2})^2 X_2/p_2][\eta - \tau_{NN}] < 0,$$

and where $\eta \equiv -[p_2/\sum_{i=\alpha,\beta} D^i(p_2, y^i p)][\partial(\sum_{i=\alpha,\beta} D^i(p_2, y^i))/\partial p_2] > 0$ is the price elasticity of the world demand for final good 2, y^i is the constant labor income of the factor owner in country i and $\lambda^k \equiv d\ell/dk$ $(k, \ell = M, N; k \neq \ell)$ is a conjectural variations term of the k-monopolist. λ^k describes the change in the output of the ℓ-monopolist anticipated by the k-monopolist in response to a unit change in the latter's output; in principle, it can take any value, with special interest attaching to the value of zero (the Cournot-Nash case). The τ_{ij}'s are the Allen partial elasticities of factor substitution and it can be shown that $\tau_{ij}=\tau_{ij}$ [Takayama (1985)]. We assume that $B\neq 0$. Solving (4′) and (5′), we obtain

$$dp_M/dM=(E-B\lambda^M)/\Delta \tag{6}$$

where

$$\Delta\equiv\frac{(X_2)^2 a_{M2}a_{N2}}{p_M p_N}\{-\eta[\theta_{M2}(\sigma_{NN}-\sigma_{MN})+\theta_{N2}(\sigma_{MM}-\sigma_{NM})]+(\sigma_{MM}\sigma_{NN}-\sigma_{MN}\sigma_{NM})\} \tag{7}$$

We here first assume that the intermediate goods M and N are *substitutes*:

(A. 1) $\sigma_{ij}>0 \quad i, j=M, N$

The last term of the RHS of (7) is non-negative from concavity of the unit cost function. Thus we have

$$\Delta>0$$

Secondly we assume, with out loss, that the conjecture of the monopolists are symmetrical[1]:

(A. 2) $\lambda^M=\lambda>0$

Thus if $\lambda=0$, the markets are Cournot and if $\lambda<0$ (resp. $\lambda>0$), the markets are more competitive (resp. collusive) than Cournot.

Substituting from (6) in (1′), we obtain a more explicit form of the first-order condition for the M-monopolist under free trade

$$p_M+M[(E-B\lambda)/\Delta)]=C_M' \tag{8}$$

Symmetrically we obtain the first-order condition for the N-monopolist under free trade:

$$p_N+N(A-B\lambda)=C_N' \tag{9}$$

where $C_N(N)'=(a_N/a_1^{\alpha})(1-\rho_N)$, $0<\rho_N\equiv-(N/a_N)(da_N/dN)<1$.

We assume that there exists a unique and stable equilibrium[2].

3. 2 VER equilibrium and welfare

We now examine the optimal behavior of the M-monopolist under a VER and the welfare effects of the VER. We assume that the N-monopolist has agreed to limit its production (or exports) of intermediate good N to the equilibrium level of exports under free trade. We moreover assume that under a VER the premium, $(p_N^{\alpha}-p_N)N^F$, where p_N^{α} is the price of intermediate good N under a VER in country α and N^F is the equilibrium level of exports of intermediate good N under free trade, accrues to the N-monopolist.

Let us now consider the optimal behavior of the M-monopolist under the VER. We first obtain

$$J(M) \equiv (d\Pi_M^{VER}/dM) = p_M + M(dp_M/dM) - C_M(M)' \tag{10}$$

Noting that the supply of intermediate good N in country α under a VER is constant, we obtain from the market-clearing conditions for intermediate goods M and N under a VER:

$$dp_M/dM = E/\Delta \tag{11}$$

Substituting from (11) in (10), we obtain

$$J(M) \equiv (d\Pi_M^{VER}/dM) = p_M + M(E/\Delta) - C_M(M)' \tag{10'}$$

Let M^{VER} be the optimal output of the M-monopolist under a VER. Then $J(M^{VER}) = 0$. Moreover we assume that the second-order condition for the optimum is satisfied:

$$dJ(M)/dM = d^2\Pi_M^{VER}/dM^2 < 0 \tag{12}$$

We now compare the optimal outputs of the M-monopolist under the VER and under free trade. Evaluating (10′) at the optimal output of the M-monopolist under free trade, $M = M^F$, we find from (9) that

$$J(M^F) = (M^F/\Delta^F) B^F \lambda^{\alpha F} \tag{13}$$

where variables with the superscript F are evaluated at the free trade equilibrium. Thus we find that

$$M^{VER} \gtreqless M^F \Leftrightarrow B^F \lambda^F \gtreqless 0$$

In earlier analyses which focused on differentiated final-good markets based on the conjectural variations approach, the effects of VERs on the behavior of the home monopolist depend solely on whether the market structure under free trade is Cournot, or more competitive or more collusive than Cournot. On the other hand, in our analysis, the effects of a VER are the composite effects of (1) the change in the market structure of the intermediate-goods markets determined by the change in the sign of λ from a non-zero value to zero (Cournot-Nash), and (2) the relation between the price-elasticity of the demand for the final-good 2 and the cross-elasticity of the demand for the intermediate-goods, the sign of B^F. Therefore we can summarize our results as follows:

(i) If the free-trade equilibrium is Cournot ($\lambda^F = 0$), the imposition of a VER set equal to the equilibrium level of exports from country β under free trade has no effect on the equilibrium.

(ii) If $\tau_{MN}^F > \eta^F$ and the free-trade equilibrium is more collusive than Cournot ($\lambda^F > 0$), the equilibrium output of the M-monopolist is greater under the VER than under free trade.

(iii) If $\tau_{MN}^F > \eta^F$ and the free-trade equilibrium is more competitive than Cournot ($\lambda^F < 0$), the equilibrium output of the M-monopolist is smaller under the VER than under free trade.

(iv) If $\tau_{MN}^F < \eta^F$ and the the free-trade equilibrium is more collusive than Cournot ($\lambda^F > 0$), the equilibrium output of the M-monopolist is smaller under the VER than under free trade.

(v) If $\tau_{MN}^F < \eta^F$ and the free-trade equilibrium is more competitive than Cournot ($\lambda^F < 0$), the equilibrium output of the M-monopolist is greater under the VER than under free trade.

The first three results, (i)-(iii), are familiar and similar results are obtained in the papers by, for example, Mai and Hwang (1989), Suzumura and Ishikawa (1997) and Kemp, Shimomura and Okawa (1997). In these papers the effects of VERs are examined in the context of international duopoly in which the duopolists produce and compete in final good markets, and it can be shown that if free trade equilibrium is more collusive (resp. more competitive) than Cournot, the equilibrium output of the monopolist in the importing country is greater (resp. smaller) under a VER than under free trade.

However, in the last two cases, (iv) and (v), these conventional results are reversed. The new and unconventional results are specific to this model in which duopolists compete in differentiated and substitutable intermediate goods markets. The unconventional results can emerge when the price elasticity of the final good 2 is greater than the Allen-partial elasticity of substitution between the intermediate goods ($\eta > \tau_{MN}$). If the intermediate goods are homogeneous ($\sigma_{MN} \to \infty$), then these unconventional results can not occur.

A brief economic interpretation is as follows. In the optimization of the M-monopolist under free trade, the change in p_M caused by a unit change in his output, which includes the effects of the response of the N-monopolist, is

$$dp_M/dM = (\partial p_M/\partial M)_{N:const.} + (\partial p_M/\partial N)_{M:const.} \cdot \lambda$$

where $(\partial p_M/\partial M)_{N:const.} = E/\Delta < 0$ and $(\partial p_M/\partial N)_{M:const.} = -B/\Delta$. The second term represents the change in p_M caused by the conjectured response of the N-monopolist. Thus if $B > 0$ or $(\partial p_M / \partial M)_{M:const.} < 0$, then the M-monopolist's conjecture on the response of the N-monopolist is reflected in $B\lambda$, and we have conventional results. However, in our differentiated intermediate-good model, B can be negative or $(\partial p_M/\partial N)_{M:const.}$ can be positive even if the intermediate goods are substitutes. As it is the sign of $(\partial p_M/\partial N)_{M:const.} \cdot \lambda$ that affects the monopolist's behavior under free trade, when B is negative or $(\partial p_M/\partial N)_{M:const.}$ is positive, the results are opposite to those derived directly from the sign of λ. The behavior of the N-monopolist can be symmetrically explained.

Now let us turn to the welfare effects of the VER. We first look at the profit of the M-monopolist. Since M^F is in the strategy set of the monopolist under the VER and the profit from producing M^F under the VER is identical to Π_M^F, the profit Π_M^{VER} from producing M^{VER} is, by definition of the optimal solution, greater than Π_M^F.

As the wage rate is kept constant in both countries, the welfare of the factor owners depends on the price of final good 2 only. We can see in the appendix that under the VER

$$\hat{p}_2 \gtreqless 0 \Leftrightarrow \widehat{M} \lesseqgtr 0$$

where $\hat{z} \equiv dz/z$. Thus if the output of intermediate good M is greater (resp. smaller) under the VER than under free trade, the factor owners of both countries are better off (resp. worse off) under the VER than under free trade.

We next turn to the welfare of the N-monopolist. We can see in the appendix that $\hat{p}/\widehat{M} \gtreqless 0 \Leftrightarrow \eta \gtreqless \tau_{MN}$. Therefore we have established our first proposition.

Proposition 1

(1) If $\tau_{MN}^F > \eta^F$ and the free-trade equilibrium is more collusive than Cournot ($\lambda^F > 0$), then $M^{VER} > M^F$, $p_2^{VER} < p_2^F$ and $p_N^{VER} < p_N^F$. Therefore the M-monopolist and the factor owners in both countries are better-off under a VER than under free trade, while the N-monopolist only is worse-off under a VER than under free trade.

(2) If $\tau_{MN}^F > \eta^F$ and the free-trade equilibrium is more competitive than Cournot ($\lambda^F < 0$), then $M^{VER} < M^F$, $p_2^{VER} > p_2^F$ and $p_N^{VER} > p_N^F$. Therefore both the M and N monopolists are better-off, while the factor owners in both countries are worse-off under a VER than under free trade.

(3) If $\tau_{MN}^F < \eta^F$ and the free-trade equilibrium is more collusive than Cournot ($\lambda^F > 0$), then $M^{VER} < M^F$, $p_2^{VER} > p_2^F$ and $p_N^{VER} < p_N^F$. Therefore the M-monopolist only is better-off and all other agents, factor owners and N-monopolist are worse-off under a VER than under free trade.

(4) If $\tau_{MN}^F < \eta^F$ and the free-trade equilibrium is more competitive than Cournot ($\lambda^F < 0$), then $M^{VER} > M^F$, $p_2^{VER} < p_2^F$ and $p_N^{VER} > p_N^F$. Therefore all agents in both countries are better-off under a VER than under free trade.

In both cases (2) and (4) of Proposition 1, as the N-monopolist is better-off under a VER than under free trade, a VER is willingly complied with by the monopolist. In case (2), the factor owners must be worse-off under a VER. On the other hand, in case (4) which is specific to our model and can not occur in the analyses of our predecessors, all economic agents are, without any redistribution of income, better-off under a VER than under free trade. Thus a VER equilibrium is Pareto-superior to a free trade equilibrium.

4. Price competition

4. 1 Free trade equilibrium

We now turn to the case in which the monopolists compete in prices. Let us first examine the optimal behavior of the monopolists under free trade. The simple form of the first-order condition for the M-monopolist under free trade is

$$M + (p_M - C_M')(dM/dp_M) = 0 \tag{14}$$

To pin down the feedback term (dM/dp_M), we resort to (1′) and obtain

$$(a_{M2}+a_{N2}\mu)\,dp_M=dp_2 \tag{15}$$

where $\mu \equiv dp_N/dp_M=dp_M/dp_N$ is the symmetrical conjectural variations term of the two price-competing monopolists and the familiar Bertrand-Nash equilibrium can be described when $\mu=0$. From the market-clearing conditions for the final good 2 and the intermediate good M together with (15), we find that

$$dM/dp_M=A+B\mu \tag{16}$$

Substituting from (16) in (14), we obtain a more convenient form of the first-order condition of the M-monopolist under free trade

$$M+(p_M-C'_M)(A+B\mu)=0 \tag{14'}$$

Symmetrically the first-order condition for the N-monopolist is

$$N+(p_N-C'_N)(E+B\mu)=0$$

We again assume that there exists a unique stable equilibrium.

4. 2 VER equilibrium and welfare

We now assume that the N-monopolist has agreed to limit its production (exports) of the intermediate good N to the free trade level ($N=N^F$). Thus the price of the intermediate good N under a VER is determined to clear the market with fixed supply of $N=N^F$ in country α: The N-monopolist turns into a price-follower under a VER.

We first consider the optimal behavior of the M-monopolist under the VER. We obtain

$$H(p_M)\equiv(d\Pi^{VER}/dp_M)=M+(p_M-C'_M)(dM/dp_M) \tag{17}$$

Differentiating the market-clearing conditions for the intermediate goods M and N in (5) and (6) under the VER ($N=N^F$) and solving for (dM/dp_M), we find that

$$dM/dp_M=\Delta/E<0$$

where $\Delta=AC-B^2>0$. Therefore we obtain

$$H(p_M)\equiv(d\Pi^{VER}/dp_M)=M+(\Delta/E)(dM/dp_M) \tag{17'}$$

Evidently $H(p_M^{VER})=0$ and we assume that the second-order condition for the optimum is satisfied: $dH(p_M)/dp_M<0$.

Let us compare the optimal prices of the M-monopolist under the VER and under free trade. Evaluating (17) at $p_M=p_M^F$, we obtain from (14′) that

$$H(p_M^F)=-[(p_M^F-C_M^{\prime F})/E^F][(B^F)^2-B^F E^F \mu^F]$$

where $p_M^F-C_M^{\prime F}>0$. Thus

(1) if $B^F>0$ then $p_M^F \gtreqless p_M^{VER} \Leftrightarrow \mu^{\alpha F} \gtreqless \Phi^F>0$ where $\Phi^F\equiv-(B^F/E^F)$.

and

(2) if $B^F<0$ then $p_M^F \lesseqgtr p_M^{VER} \Leftrightarrow \mu^{\alpha F} \gtreqless \Phi^F<0$

Figure 1 (resp. Figure 2) illustrates the results of case (1) [resp. case (2)]. Here again when $B^F<0$, or $\tau_{MN}^F<\eta^F$, we obtain an unconventional result in case (2).

One interesting point among others is that whatever the relation between the price-elasticity of demand for the final good and the cross-elasticities of demand for the intermediate goods, if the home monopolist's conduct is of the Bertrand-Nash type under free trade then the monopolist's price of the intermediate-good in the importing country is higher under a VER than under free trade.

We now turn to the welfare of each agent under the VER. Comparative statics imply that

$$\hat{p}/\hat{p}_M=(\theta_{M2}\sigma_{NN}-\theta_{N2}\sigma_{NM})(\sigma_{NN}-\theta_{N2}\eta)^{-1}>0 \tag{18}$$

and

$$\begin{aligned}\hat{p}_N/\hat{p}_M&=\theta_{M2}(\eta-\tau_{MN})(\sigma_{NN}-\theta_{N2}\eta)^{-1}\\&\lesseqgtr 0 \Leftrightarrow \eta \gtreqless \tau_{MN}\end{aligned} \tag{19}$$

Therefore we have established our second proposition:

Proposition 2

(1) If $\tau_{MN}^F>\eta^F$ and $\mu^F<\Phi^F>0$, then the optimal price of the M-monopolist is higher under a VER than under free trade ($p_M^{VER}>p_M^F$). Therefore the M-monopolist and the N-monopolist are better off while the factor owners in the two countries are worse off under a VER than under free trade.

(2) If $\tau_{MN}^F>\eta^F$ and $\mu^F>\Phi^F>0$ then the optimal price of the M-monopolist is lower under a VER than under free trade ($p_M^{VER}<p_M^F$). Therefore the M-monopolist and the factor owners in the two countries are better off while the N-monopolist alone is worse off under a VER than under free trade.

(3) If $\tau_{MN}^F<\eta^F$ and $\mu^F>\Phi^F<0$ then the optimal price of the M-monopolist is higher under a VER than under free trade ($p_M^F<p_M^{VER}$). Therefore the M-monopolist alone is better off and all other agents in the two countries, N-monopolist and the factor owners are worse off under a VER than under free trade.

(4) If $\tau_{MN}^F<\eta^F$ and $\mu^F<\Phi^F<0$ then the optimal price of the M-monopolist is lower under a VER than under free trade ($p_M^{VER}<p_M^F$). Moreover all agents in the two countries are better off under a VER than under free trade.

5. Concluding remarks

This paper has examined the effects of a VER imposed on a differentiated intermediate-good market under international duopoly in a simple general equilibrium framework. We considered two cases, in which the duopolists in intermediate-good markets compete in their quantities and in their prices.

We showed that the effects of VERs crucially depend on the relations between the price-elasticity of demand for the final-good and the cross-elasticities of demand for the intermediate goods, and on the initial market structure of the intermediate-goods markets under free trade. Some unconventional results that are specific to our model were obtained: In the quantity-setting case, when price-elasticity of demand for the final-good is larger than Allen's partial elasticity for factor substitution between the intermediate goods and when the market structure of the intermediate-goods markets are more competitive (resp. more collusive) than Cournot under free trade, the output of the intermediate good in the importing country is greater (resp. smaller) under a VER than under free trade. In contrast, in the price-competing case, whatever the relation between the price-elasticity of demand for the final good and Allen's partial elasticity for factor substitution between the intermediate goods, and whether the market structure of the intermediate goods under free trade is more competitive or more collusive than Bertrand-Nash, if it is near Bertrand-Nash under free trade then the monopolist's price of the intermediate good in the importing country is higher under a VER than under free trade. Moreover it was shown that there are circumstances in which a VER is Pareto-superior to the associated free trade equilibrium.

Footnotes

1) The main results of this paper do not depend on the symmetry of the conjecture of the monopolists. When $\lambda^M \neq \lambda^N$, the results depend solely on the conjecture of the monopolist in α under free trade.

2) By the assumption of IRS technologies for raw-material industries, the convexity of the strategy sets of the monopolists is not guaranteed. However we can construct a simple numerical example, with CES utility functions and a Cobb-Douglas production technology for the final good industry 2 in country α, which ensures the existence of a unique equilibrium. The author is very grateful to Professor K. Shimomura for his comment on this point.

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Appendix

In this appendix, we derive some of the comparative static results employed in the text. We restrict our attention to a VER equilibrium in country α.

The zero-profit condition for final-good industry 2 in country α is

$$a_{L2}(w^\alpha,\ p_M,\ p_N)w^\alpha + a_{M2}(w^\alpha,\ p_M,\ p_N)p_M + a_{N2}(w^\alpha,\ p_M,\ p_N)p_N = p_2 \tag{a-1}$$

The market-clearing condition for the labor market in country α is

$$a_1 X_1^\alpha + a_{L2}(w^\alpha,\ p_M,\ p_N)X_2 + a_M M = L^\alpha \tag{a-2}$$

where L^α is the endowment of labor in country α and is constant.

The market-clearing conditions for the intermediate goods M and N under a VER are

$$M = a_{M2}(w^\alpha,\ p_M,\ p_N)X_2 \tag{a-3}$$

$$N^F = a_{N2}(w^\alpha,\ p_M,\ p_N)X_2 \tag{a-4}$$

The world market-clearing condition for final good 2 is

$$\sum_{i=\alpha,\beta} D^i(p_2,\ y^i) = X_2 \tag{a-5}$$

where y^i is constant. In the quantity control case, given the exogenous variables, L^α, w^α, N^F and M, five equations, (a-1)-(a-5), determine five unknowns: p_2, ,p_M ,p_N, X_1^α and X_2. In the price control case, p_M is exogeneous and M is endogenous. Differentiating (a-1)-(a-5), we obtain

$$\begin{bmatrix} -1 & \theta_{M2} & \theta_{N2} & 0 & 0 \\ 0 & \lambda_{L2}\sigma_{LM} & \lambda_{L2}\sigma_{LM} & \lambda_{L1} & \lambda_{L2} \\ 0 & \sigma_{MM} & \sigma_{MN} & 0 & 1 \\ 0 & \sigma_{NM} & \sigma_{NN} & 0 & 1 \\ -\eta & 0 & 0 & 0 & -1 \end{bmatrix} \begin{bmatrix} \hat{p}_2 \\ \hat{p}_M \\ \hat{p}_N \\ \hat{X}_1 \\ \hat{X}_2 \end{bmatrix} = \begin{bmatrix} 0 \\ -\lambda_{LM}(1-\rho_M) \\ 1 \\ 0 \\ 0 \end{bmatrix} \widehat{M} \tag{a-6}$$

where $\lambda_{Lj} \equiv a_{Lj}X_j/L^\alpha$ $(j=1,\ 2)$. The determinant of the coefficient matrix is

$$\Delta \equiv \lambda_{L1}\eta[\theta_{M2}(\sigma_{MN}-\sigma_{NN}{}^N)-\theta_{N2}(\sigma_{MM}-\sigma_{NM})]+\lambda_{L1}(\sigma_{MM}\sigma_{NN}{}^N-\sigma_{MN}\sigma_N{}^N{}_M)>0$$

Solving (a-6), we find that

$$\hat{p}/\widehat{M} = \lambda_{L1}(\theta_{M2}\sigma_{NN}-\theta_{N2}\sigma_{NM})/\Delta<0 \tag{a-7}$$

$$\widehat{X}/\widehat{M} = \lambda_{L1}\eta(\theta_{N2}\sigma_{NM}-\theta_{M2}\sigma_{NN})/\Delta>0 \tag{a-8}$$

$$\hat{p}_M/\widehat{M}=\lambda_{L1}[\theta_{NN}-\theta_{N2}\eta]/\Delta<0 \tag{a-9}$$

$$\begin{aligned}\hat{p}/\widehat{M}&=\lambda_{L1}\theta_{M2}[\eta-\tau_{MN}]\\ &\gtrless 0 \text{ as } \eta\gtrless\tau_{MN}\end{aligned} \tag{a-10}$$

We also obtain

$$\hat{p}_2/\hat{p}_M=(\theta_{M2}\sigma_{NN}-\theta_{N2}\sigma_{NM})(\sigma_{NN}-\theta_{N2}\eta)^{-1}>0 \tag{a-11}$$

$$\begin{aligned}\hat{p}_N/\hat{p}_M&=\theta_{M2}(\eta-\tau_{MN})(\sigma_{NN}-\theta_{N2}\eta)^{-1}\\ &\lesseqgtr 0 \text{ as } \eta\gtrless\tau_{MN}\end{aligned} \tag{a-12}$$