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Intertemporal Optimization under Threat of VER*

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Abstract

The imposition of a commercial policy does not generally come as a complete surprise to the affected parties. Exporting firms have some information about the political climate in their export markets, and thus, can assess the probability of a trade restraint being imposed. In the case of a quantity restriction, it is likely that the volume of trade allowed after the restraint is positively related to the volume of trade before the restraint. Thus, firms have an incentive to increase current production so that the losses they would incur in the event of a restriction are decreased. Such an incentive is referred to in the literature as the 'Yano effect'. This paper uses an imperfectly competitive model to develop a different and more direct channel for the Yano effect and to determine its impact on intertemporal welfare.

I. Introduction

When commercial policies are imposed on exporting firms or countries, they do not come as a complete surprise to those involved. Because firms have some information on the political climate in their export markets, it would be rare that the imposition of some trade restriction was not previously viewed as having some

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positive probability of occurring. Thus, even under free trade, firms face some uncertainty about future trade policy regimes. When firms face such uncertainty about future trade restrictions and there is some dynamic linkage between current decisions and future outcomes, simple static models are incomplete. This uncertainty can arise because of the highly discretionary manner that commercial policies are implemented. Hufbauer, et al. [1986] cite such discretion in U.S. policy implementation by describing several examples of escape clause relief provided under Section 201 of the Trade Act of 1974.

Suppose that a firm in a particular industry feels that there is some probability that a voluntary export restraint, or VER, will be negotiated between its government and the government in its export market.[1] Suppose also that if the VER is negotiated, the level of imports allowed from the foreign industry will be related to the level under free trade. A very simple rule would be that the VER would restrict foreign exports to some given percentage of their current level. Or, foreign firms may face a VER that restricts their market share to a percentage of that in the previous period. As Yano [1989] pointed out, the possibility of a future VER that is tied to current level of exports provides an incentive for the foreign firms to increase their current exports in attempt to capture a larger share of the quota (the 'Yano effect', as coined by Ethier [1991]).

When the Yano effect occurs, the combination of the VER and the threat of the VER has effects in periods other than that in which the policy is actually administered. Several interesting questions are raised by the existence of such intertemporal effects. How do firms react to the threat of the restriction prior to the VER being levied? Do the results for the period when the VER is in place differ from those predicted by static analysis when this intertemporal effect is considered? How does the existence of the Yano effect affect welfare?

Yano [1989] considered these points for an international oligopoly when there is a possibility of a future VER. In that paper, as well as in Ethier [1991], the competition among foreign firms to capture a larger share of the VER fosters an *export drive* from abroad in the period preceding a potential VER regime. Yano raises some interesting questions about the welfare implications of this type of in-

1. A VER here is voluntary on the part of the exporting government, not on the part of the exporting firms as in Harris [1985] and Krishna [1989]. We do not pursue the interesting but separate questions of the objectives of the governments and the nature of their game.

tertemporal effect. In his model, the effects of the export drive on consumer and producer surplus, and therefore total welfare, are generally ambiguous.[2, 3]

In the present analysis, we will consider the simplest VER rule that provides a more direct channel for the Yano effect even when there is only one foreign firm. If there is a VER in the second period, foreign exports will be restricted to a fraction of their first period level. As our primary concern is with the characterization of this direct Yano effect and its implications on the welfare of the domestic country, the structure of the market on the foreign side is made as simple as possible. Furthermore, it enables us to obtain unambiguous intertemporal welfare effects as a consequence of such an effect. Anderson [1991] considers the welfare implications of a related incentive in a perfectly competitive model, but our welfare incentives are related to the capture of monopoly rents, unlike his perfectly competitive case. Generalization of the structure of the foreign industry and the way in which a VER would be imposed would not alter the present analysis of domestic welfare to any great extent. As long as the actions of each foreign firm are more important than the actions of each any domestic firm in determining the distribution or size of the VER, as in Yano [1989] or Anderson [1991], our results can be generalized.

Section II constructs the basic model of intertemporal optimization in an international duopoly and section III analyzes the welfare effects. Concluding remarks are provided by section IV.

II. A Model of Intertemporal Choice

There are two firms, one foreign and one domestic, that produce a homogeneous good for the domestic market only.[4] There are no trade restrictions in the initial period, but there is a probability that in the second period the domestic govern-

2. Dean and Ganpopadhyay [1991] also consider the effects of a VER threat in an oligopolistic market. In their model the threat and the imposition of the VER occur in the same period so that the intertemporal effects of the threat are ignored.
3. Bhagwati and Srinivasan [1976] and Kemp and Ohta [1978] consider the dynamic choices of exporters when they can affect the probability of a quota being imposed. In their model, the level of the quota is fixed. Fischer [1991] extends this idea to a duopoly.
4. Alternatively, we could assume that each firm sells in both markets and that the markets can be segmented. This would allow us to analyze the markets separately.

ment will impose a VER. For simplicity, it is assumed that both firms produce with the same constant marginal costs, c. It is also assumed that the demand function is time independent and is linear with respect to industry output. Throughout the paper, variables referring to the foreign firm are denoted with a '*'. Where q_t and q_t^* denote the output levels in period t, the price in period t is $p_t=\alpha-\beta(q_t+q_t^*)$, where α and β are positive.

The foreign firm maximizes profit over the two periods by choosing first period output contingent on the possibility of a future VER, and second period output in the event that there is no VER. If the VER is levied, foreign sales are δq_1^*, where $0<\delta<1$. The domestic firm chooses first period output under the VER contingency, second period output under no VER, and second period output in the event of a VER. Where $\bar{q}_2$ is the domestic output in the second period if a VER is levied and the probability of a VER in the second period is λ, foreign and domestic profit are

$$\begin{aligned}\Pi^*=&[\alpha-\beta(q_1+q_1^*)-c]q_1^*+(1-\lambda)[\alpha-\beta(q_2+q_2^*)-c]q_2^*\\&+\lambda[\alpha-\beta(\bar{q}_2+\delta q_1^*)-c]\delta q_1^*\end{aligned}\tag{1}$$

$$\begin{aligned}\Pi=&[\alpha-\beta(q_1+q_1^*)-c]q_1+(1-\lambda)[\alpha-\beta(q_2+q_2^*)-c]q_2\\&+\lambda[\alpha-\beta(\bar{q}_2+\delta q_1^*)-c]\bar{q}_2\end{aligned}\tag{2}$$

There are three sub-games to this dynamic game. Sub-game (a) determines first period outcome when there is the possibility of a second period VER. Sub-game (b) determines the second period outcome if no VER is levied and sub-game (c) determines second period domestic output with a VER.[5]

The first order conditions for sub-game (a) are

$$\frac{\partial\Pi^*}{\partial q_1^*}=\alpha-2\beta q_1^*-\beta q_1-c+\lambda\delta[\alpha-2\delta\beta q_1^*-\beta\bar{q}_2-c]=0\tag{3}$$

$$\frac{\partial\Pi}{\partial q_1}=\alpha-\beta q_1^*-2\beta q_1-c=0\tag{4}$$

The marginal effect of period 1 output on two-period foreign profit includes the

5. Note that the equilibrium of the firms' two-period dynamic game is sub-game perfect as defined by Selten [1965]. This is because the equilibrium of each sub-game is a Nash equilibrium.

effect on period 1 profit as well as the expected effect on period 2 profit. The effect on period 2 foreign profit is positive because the VER constrains second period output to a less than optimal level.

For sub-game (b) the first order conditions are

$$\frac{\partial \Pi^*}{\partial q_2^*} = (1-\lambda)(\alpha - 2\beta q_2^* - \beta q_2 - c) = 0 \tag{5}$$

$$\frac{\partial \Pi}{\partial q_2} = (1-\lambda)(\alpha - \beta q_2^* - 2\beta q_2 - c) = 0 \tag{6}$$

The single first order condition for sub-game (c) is a function of domestic output in the event of a VER, $\bar{q}_2$, and first period foreign output, q_1^*.

$$\frac{\partial \Pi}{\partial \bar{q}_2} = \lambda[\alpha - 2\beta \bar{q}_2 - \beta\delta q_1^* - c] = 0 \tag{7}$$

The solution to sub-game (b) coincides with the equilibrium for each period under free trade. This solution will be used as a reference throughout the subsequent analysis and is standard for a Cournot-Nash duopoly with linear demand and identical constant marginal costs. This equilibrium, (q_2, q_2^*), is illustrated in figure 1 by the intersection of the reaction functions for sub-game (b), $\Gamma_2^*(q_2, q_2^*) = \alpha - 2\beta q_2^* - \beta q_2 - c = 0$ and $\Gamma_2(q_2, q_2^*) = \alpha - \beta q_2^* - 2\beta q_2 - c = 0$. The symmetric free trade solution is:

$$q_2^* = q_2 = \frac{\alpha - c}{3\beta} \tag{8}$$

Profit under the Cournot-Nash free trade equilibrium is obtained by substituting (8) into profit in the event of no VER, $\Pi_2 = \Pi_2^* = [\alpha - \beta(q_2 + q_2^*) - c]q_2$.

$$\Pi_2 = \Pi_2^* = \beta q_2^2 \tag{9}$$

The solution to sub-game (c) is the domestic output level in the second period when foreign output is equal to the VER. From (7) it is straightforward to see that this is

$$\bar{q}_2 = \frac{\alpha - c - \delta\beta q_1^*}{2\beta} \tag{10}$$

When (10) is substituted into (3), equations (3) and (4) become the implicit reac-

tion functions for sub-game (a) in terms of first period outputs only.

$$\Gamma_1^*(q_1, q_1^*) = \alpha - 2\beta q_1^* - \beta q_1 - c + \lambda \frac{\partial \bar{\Pi}_2^*}{\partial q_1^*} = 0$$

$$\Gamma_1(q_1, q_1^*) = \alpha - \beta q_1^* - 2\beta q_1 - c = 0$$

The last term in the foreign reaction function is the marginal effect of period 1 foreign output on period 2 foreign profit under a VER and is

$$\frac{\partial \bar{\Pi}_2^*}{\partial q_1^*} = \delta\left[\frac{3(\alpha - \beta\delta q_1^* - c)}{2} c\right] \tag{11}$$

This term multiplied by the probability of the VER represents the degree of export drive undertaken by the firm. It is the net marginal effect of period 1 output on expected second period profit. As illustrated by figure 1, the foreign reaction function for sub-game (*a*), (q_1, q_1^*), lies to the right of that for the static Cournot-Nash game. In addition, foreign output in this sub-game is less responsive to domestic output than in the Cournot-Nash game. Thus, the foreign reaction function is steeper than with no VER threat.

Because of the positive effect of current foreign output on future foreign profit, the foreign output response for any level of domestic output level is higher than under free trade. In contrast, the domestic response to each level of foreign output is unchanged by the possibility of a future VER. Thus, compared to free trade, foreign output is higher and domestic output is lower. This is indicated in figure 1 by the intersection of the first period reaction functions. Because the threat of the VER is only relevant for the foreign reaction function, the foreign output increase is larger than the domestic output decrease. Therefore, total output in the market is above the free trade level and the price is lower.

The explicit solution to sub-game (a) is the following output pair where $\mu = (1+\lambda\delta)/(1+\lambda\delta^2) > 1$ and $\nu = (3-\mu)/2 < 1$:

$$q_1^* = \mu q_2^* \tag{12}$$

$$q_1 = \nu q_2 \tag{13}$$

Because the price and domestic output are lower than under free trade, current domestic profit is lower in the presence of the Yano effect. In contrast, first

period foreign profit is higher than under free trade. Foreign output is affected more by the foreign output expansion than is the price. This is because the decrease in price caused by the increase in foreign output is tempered by a fall in domestic output. As a result, current foreign profit is higher than under free trade. This occurs because the threat of the future VER induces the foreign firm to act less collusively than in the Cournot-Nash free trade situation. This occurs while the domestic firm's strategy is unaffected. Thus, the foreign firm becomes more aggressive and its profit rises.[6]

Unlike for the competitive case of Anderson [1991], dumping, which economists generally define as pricing below marginal costs, does not occur here. However, dumping in the legalistic sense, where the export price is below the price charged at home, may occur.

Profit in the first period is obtained by substituting (12) and (13) into Π_1 and Π_1^* and rearranging,

$$\Pi_1^* = \nu\mu\beta q_2^{*2} = \nu\mu\Pi_2^*, \tag{14}$$

$$\Pi_1 = \nu^2\beta q_2^2 = \nu^2\Pi_2 \tag{15}$$

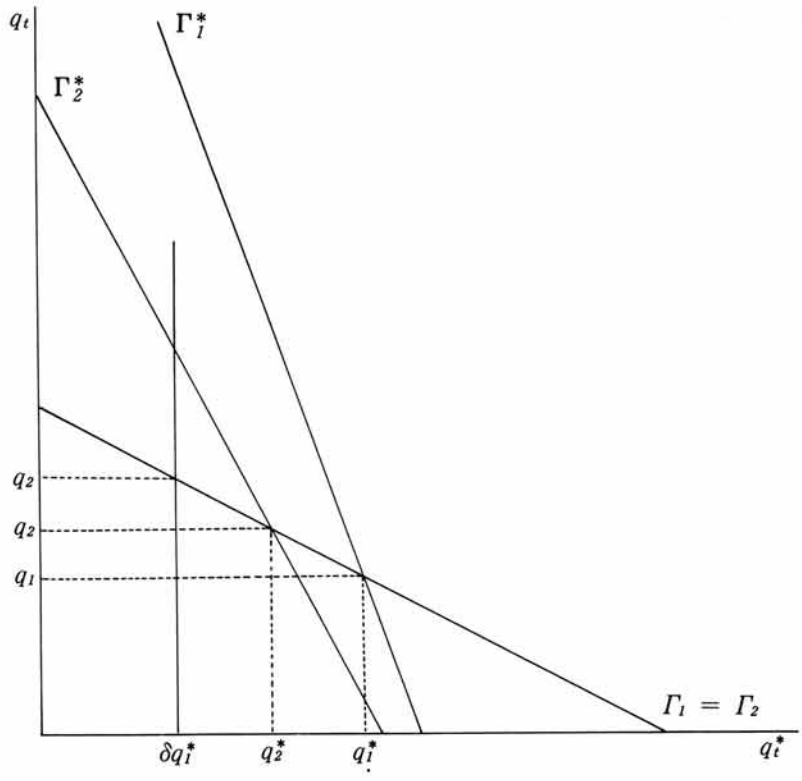
The above described results are summarized in the following Proposition, the proofs of which are provided in the appendix:

Proposition 1: If a possible future VER would restrict foreign sales to a fraction of current foreign output, then compared to free trade: (a) current domestic output is lower and current foreign output is higher; (b) total current output is higher; (c) current domestic profit is lower and current foreign profit is higher.

If the VER is levied in the second period, foreign output will decline to below its free trade level. This is because due to the lower prices it will receive it is not profitable for the foreign firm to increase its exports too much in response to the possible VER loss. The output equilibrium for sub-game (*c*), $(\bar{q}_2, \delta q_1^*)$, is illustrated in figure 1. Domestic output is greater than under free trade be-

6. Foreign profit increases in the first period because there is a single foreign firm. If instead there were two firms, the threat of the VER would force them to compete more with each other as well as with the domestic firm. This would result in lower profits for all firms. Because we are most interested in the intertemporal effects of the VER on the welfare of the domestic country only, the present model is sufficient.

Figure 1



cause the lower foreign sales cause domestic output to be determined at a higher point on the negatively sloped domestic reaction function. Because the own effect of the VER is greater than the cross effect on the domestic firm, total industry output is lower than under free trade.

The solution to sub-game (*c*) is obtained by substituting the first period foreign output (12) into (10). Thus, where $\eta = (3-\delta\mu)/2 > 1$, the second period domestic output in the event of a VER is

$$\bar{q}_2 = \eta q_2 \tag{16}$$

The effect of the VER on the profits of the two firms is the usual Cournot-Nash duopoly result where monopoly rents are transferred from the foreign firm to the domestic firm. Thus, the VER would not be *voluntary* on the part of the firm because the foreign firm does not realize larger profits under the VER.[7]

7. See Mai and Hwang [1988] and Karikari [1991] for discussions of the conditions under which

Profit in the second period under a VER is obtained by substituting (16) and (12) into $\bar{\Pi}_2=[\alpha-\beta(\bar{q}_2+\delta q_1^*)-c]\bar{q}_2$ and $\bar{\Pi}_2^*=[\alpha-\beta(\bar{q}_2+\delta q_1^*)-c]\delta q_1^*$:

$$\bar{\Pi}_2^*=\eta\delta\beta q_2^{*2}=\eta\delta\mu\Pi_2^*, \tag{17}$$

$$\bar{\Pi}_2=\eta^2\beta q_2^2=\eta^2\Pi_2 \tag{18}$$

The above description of sub-game (c) is summarized by the following Proposition, which is proved in the appendix:

Proposition 2: In the second period, if the above described VER is imposed, compared to free trade: (a) foreign output in lower and domestic output is higher; (b) total output is lower; and (c) domestic profit is higher and foreign profit is lower.

III. The Yano Effect and Intertemporal Welfare

Domestic welfare in this partial equilibrium model is measured as the sum of consumer and producer surplus over the two periods. At this stage it is not clear whether the existence of the Yano effect increases or decreases welfare or whether or not the VER can be used to increase welfare. In the first period, the domestic producer is made worse off by the existence of the VER threat while the domestic consumers are made better off by the increased market output and the resulting lower price. Welfare comparisons are similarly ambiguous for the second period. The VER would make the domestic firm better off while consumers would be made worse off.

Producer welfare is measured by profit while consumer surplus is measured as the area below the market demand curve net of market revenue. Thus, for each period t, denoting Q_t as industry output, welfare is measured by:

$$W_t=\int_0^{Q_t}(\alpha-\beta s_t)\,ds_t-(\alpha-\beta Q_t)\,Q_t+\Pi_t,$$
$$=\frac{\beta Q_t^2}{2}+\Pi_t.$$

The levels of welfare under the three sub-games are obtained by substituting the relevant output levels into the above expression:

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a VER in a quantity-choosing duopoly is *voluntary*.

$$W_1=\frac{3\beta q_2^2[\mu^2-2\mu+9]}{8} \tag{19}$$

$$W_2=3\beta q_2^2 \tag{20}$$

$$\bar{W}_2=\frac{3\beta q_2^2[\delta^2\mu^2-2\delta\mu+9]}{8} \tag{21}$$

Because the Yano effect causes lower prices in the first period, consumers are better off than under free trade. Meanwhile, the domestic firm is worse off because of the reduction in its output and in the price. However, consumer welfare is improved more than the firm's profit is worsened. The source of the consumer surplus gain is overproduction by the foreign firm while the source of the firm's loss is its own underproduction. Thus, because foreign output is more responsive to the VER threat than is domestic output, the improvement in consumer welfare dominates the decline in profit and total welfare is higher than under free trade, i.e. $W_1>W_2$.

If the VER is actually levied in the second period, consumers are made worse off and domestic profit rises. The rents transferred to the domestic firm outweigh the loss of consumer surplus and welfare is higher than under free trade, i.e. $\bar{W}_2>W_2$.

These welfare comparisons are summarized by the following Proposition:

Proposition 3: (a) Welfare in the first period under the VER threat is greater than under free trade. (b) Welfare in the second period is higher under the VER than under free trade.

From Proposition 3, the intertemporal welfare comparisons are unambiguous. The best policy to follow over the course of the two periods is to follow through on the threat of the VER. The welfare rankings of the three intertemporal scenarios are as follows:

Corollary 1: The three intertemporal scenarios in order of best to worst are: 1) VER threat in the first period and VER in the second period. 2) VER threat in the first period and free trade in the second. 3) Free trade in both periods.

If should be noted that these welfare comparisons are sensitive to the assumptions of our model. As with Yano [1989], the welfare comparisons are generally ambiguous if demand is not linear. Also, as pointed out by Eaton and Grossman [1986], any commercial policy prescriptions with oligopolistic models are sensi-

tive to the type of competition assumed.

IV. Concluding Remarks

In this paper, the intertemporal effects of the threat of a future VER on the behavior of foreign and domestic firms was analyzed. The possibility of a future VER whose size could be modified by current actions enables the foreign firms to undertake current actions that would reduce the size of the damage. Such actions are referred to as the Yano effect.

The effect on the welfare of the domestic country depends on the welfare of both the domestic firm and the consumers. When foreign firms undertake an export drive, in accordance with the Yano effect, the domestic firm loses but domestic consumers gain from the lower price. Because foreign output is more responsive to the threat of a VER than domestic output, consumer surplus increases more than the reduction in domestic firms welfare. If the VER is actually levied, consumers lose less than domestic producers gain and welfare rises.

In this paper, the only recourse that foreign firms could take to affect their performance in response to the threat of a VER was to increase their current level of exports. It is however, possible for the foreign firms to invest some resources in lobbying against the VER. Such activities would reduce the probability of a VER being imposed. This and the effect of changing the structure of the game to a repeated game are interesting questions that we hope to pursue in future research.

Appendix

Proof of Proposition 1: (1) Because $\nu < 1$ and $\mu > 1$. (b) $Q_1 = q_1 + q_1^* = (\nu + \mu) q_2$ because $\nu + \mu > 2$. (c) Because $\nu < 1$ and $\nu\mu > 1$. Q.E.D.

Proof of Proposition 2: (a) Because $\eta > 1$. (b) $Q_2 = q_2 + \delta q_1^* = (\eta + \delta\mu) q_2 < 2q_2$ because $\eta + \delta\mu < 2$. (c) Because $\eta > 1$ and $\eta\delta\mu < 1$. Q.E.D.

Proof of Proposition 3: (1) This is true iff $(\mu^2-2\mu+9)/8>1$, which is true iff $(\mu-1)^2>0$. (b) This is true iff $(\delta^2\mu^2-2\delta\mu+9)/8>1$, which is true iff $(\delta\mu-1)^2<0$. Q.E.D.

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