Price Undertakings, VERs, and Foreign Direct Investment

Jota Ishikawa
(Hitotsubashi University)
Kaz Miyagiwa
(Emory University)
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Jota Ishikawa* and Kaz Miyagiwa**

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Abstract: This paper compares how a conversion of an antidumping duty to a VER or a price undertaking influences foreign exporters’ incentive to engage in FDI. We emphasize the rivalry between foreign firms as a determinant for FDI. In a model that has the home firm competing with two foreign firms domiciled in the same foreign country, we show that the price undertaking induces more FDI than the VER. If it is subject to the constraint not to hurt the home firm, the home government can achieve greater welfare by settling AD cases with VERs than with price undertakings.

Keywords: Foreign investment, price undertakings, antidumping, voluntary export restraints

JEL code identification: F1

Corresponding author: Kaz Miyagiwa, Department of Economics, Emory University, Atlanta, GA 30322, U.S.A. E-mail: kmiyagi@emory.edu, Telephone: (404) 7272-6363.

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* Faculty of Economics, Hitotsubashi University, Kunitachi, Tokyo 186-8601, Japan; jota@econ.hit-u.ac.jp
** Department of Economics, Emory University, Atlanta, GA, U.S.A.

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1. Introduction

Over the last-quarter century, use of antidumping (AD) has spread from a handful of traditional users (primarily the United States and the European Union) to more than 70 countries (Prusa, 2001). In reality AD petitioners often withdraw their petitions in favor of direct settlements with exporting firms or governments. For example, during the 1980-85 period over one-third of U.S. AD petitions were withdrawn in favor of voluntary export restraints (VERs) negotiated with exporting country governments (Prusa, 1992). Similarly, during the same 1980-1985 period nearly half of the AD petitions in the EU were settled through price undertakings, which are voluntary price increases offered by foreign firms to offset the injury to EU producers due to alleged dumping (Messerlin, 1989).¹

In this paper we compare the relative effect of VERs and price undertakings on foreign exporters’ incentive to engage in FDI. There exists a large literature on protection-jumping FDI.² This literature typically adopts the analytically convenient framework in which one foreign firm competes with one home firm in the home market, thereby ignoring any influence the rivalry among foreign firms has on the incentives to engage in FDI. Our objective is to focus on the role of rivalry among foreign firms as a determinant of protection-jumping FDI under VERs and price undertakings. To the best of our knowledge this is the first attempt to do so in the related literature.

¹ More recently, the U.S. and Canada have begun to employ price undertakings instead of imposing AD. See Moore (2005) for more institutional backgrounds.
The literature on price undertakings is still small relative to that on VERs, but is on the rise. Recent works include Vandenbussche and Wauthy (2001), Pauwels and Springael (2002), Belderbos, Vandenbussche, and Veugelers (2004) and Moore (2005), of which the last two are related to the present work. Moore (2005) compares the effect of price undertakings and VERs in the standard model of differentiated-goods Bertrand duopoly, although he does not consider the possibility of policy-induced FDI. The work of Belderbos, Vandenbussche, and Veugelers (2004), on the other hand, examines the foreign firms’ incentive to engage in FDI under price undertakings (but not under VERs). They consider a three-stage game, in which AD authorities first decide between an AD duty and a price undertaking, the foreign firm then chooses between exporting and FDI, and finally the foreign and the home firm compete in prices. The authors find that inclusion of price undertakings in the home government’s policy options reduces the exporting firm’s incentive to engage in FDI.

The setting we analyze differs from that of Belderbos, Vandenbussche, and Veugelers (2004). We assume that the home government considers converting an AD duty already in place to a VER or a price undertaking agreement, knowing that foreign firms may engage in FDI as a result of the negotiations. As already stated, the main feature of the model is the rivalry among foreign firms for domestic demand. We thus adopt a simple tow-stage game, in which two foreign firms domiciled in the same foreign country first choose either exporting or engaging in FDI, and then compete with one home firm in the home market. We have two main results. A first is that the price undertaking induces more FDI than the VER. To understand this

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3 One reason is that, although use of VERs to settle AD cases was prohibited under GATT in 1994 (Agreement on Safeguards, Article 11) and the existing VERs are to be phased out, price undertakings remain in full compliance under GATT and WTO rules (Article 8).
result intuitively, suppose that one foreign firm switches from exporting to FDI while the other foreign firm chooses to export under the price undertaking. No longer constrained to fulfill the price undertaking agreement, the investing firm then expands its sales, which depresses the price of exports. However, the exporter has the obligation to keep the price up under the price undertaking, and is therefore forced to curtail his exports to avoid the penalty in violation of the agreement. Thus, with the price undertaking FDI by one foreign firm exerts negative externalities on the exporting firm, increasing the incentive to engage in FDI.

Contrast that with the VER, which is an export quota, which the foreign government negotiates with the home firm or government and allocates between its exporting firms. If one foreign firm chooses to invest, it no longer uses its export quota share; therefore, the foreign government can redistribute it to the remaining firm, therefore relaxing the latter’s export constraint. Thus, with the VER, FDI by one foreign firm exerts positive externalities on the exporting firm, thereby diminishing the incentive to engage in FDI. This difference leads to our first result that price undertakings tend to induce more FDI than VERs.

We also compare home country welfare under VERs and the price undertakings subject to the constraint that a conversion of the AD duty to either policy does not reduce the home firm’s profit, a reasonable constraint, for otherwise the home firm would never agree to settle AD through a price undertaking or a VER. We show that, if the home country government acts maximizes national welfare subject to that constraint, then home country welfare is never lower with the VER – and can be higher for particular parameter values – than with the price undertaking. This result follows is a direct consequence of the first result. Because price undertakings are more conducive to FDI than VERs, and since FDI hurts the home firm, the
constraint to protect the home firm’s profit is more binding under the price undertaking than under the VER. Therefore, home country welfare cannot be worse under the VER than under the price undertaking, and can be higher, depending on parameter values.

The reminder of the paper is organized in 7 sections. The next section outlines the model. Section 3 establishes the fundamental equivalence among the AD duty, the price undertaking, and the VER in the absence of FDI. Sections 4 – 6 study the incentive to engage in FDI under AD, price undertakings, and VERs, respectively. Section 7 compares the welfare of the home country under the price undertaking and the VER when the welfare-maximizing home government is constrained not to hurt the home firm’s profit by a conversion of the AD duty to either policy. Section 8 concludes.

2. The model

We consider the model in which one home firm and two foreign firms compete in the home country market. Assume that two foreign firms are domiciled in the same foreign country. This is the diacritical assumption of this model that highlights the role of rivalry between foreign firms as a driving force for FDI under the VER and the price undertaking. Additional assumptions simplify exposition. Firstly, all firms are symmetric and have zero production costs, regardless of location choices made by foreign firms, meaning that FDI offers no production cost advantages to foreign firms. Secondly, FDI requires a fixed setup cost $k > 0$. These two assumptions together then imply that FDI is never chosen over exporting under free trade. Thirdly, all firms produce homogenous goods and play a quantity-setting (Cournot) game. As we show in Proposition 1 below, the AD duty, the VER, and the price undertaking are
equivalent with Cournot competition in the sense that an equilibrium outcome with one policy can be duplicated with the other policies. Thus, the assumption of Cournot competition eliminates any differences between VERs and price undertakings inherent in Bertrand competition and detailed in Moore (2005), and enables us to isolate the relative effect of the VER and the price undertaking on the foreign firms’ incentive to engage in FDI. It is worth emphasizing here however that, with just one foreign firm competing, the VER and the price undertaking are equivalent in the sense just defined, with or without FDI.⁴

We are now ready to describe the model in details. Let \( x_h \) denote the home firm’s output and \( x_1 \) and \( x_2 \) the two foreign firms’ outputs. Home country demand is assumed linear and written

\[
p = a - (x_1 + x_2 + x_h),
\]

where \( a > 0 \).⁵ In the absence of import restrictions, straightforward computation leads to the standard three-firm Cournot equilibrium, so each firm, foreign and domestic, produces \((a/4)\) units of output at the price of \((a/4)\), earning the per-firm profit of \(a^2/16\). The home country imports \(a/2\) units from the foreign country. Home country welfare, defined as the sum of consumer surplus and profit to the home firm, equals \(11a^2/32\).

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⁴ Krishna (1989) is the standard reference in the literature exploring the difference between tariffs and quantitative import restrictions under Bertrand competition. In contrast, Hwang and Mai (1988) show that the tariff and the quota are equivalent with Cournot competition.

⁵ Following convention, we ignore what might be going on in the foreign country market. It should be noted however that we can easily introduce the segmented foreign market where the price is higher than in the home market.
3. Trade policy without FDI

In this section we compare AD, price undertakings and VERs in the absence of FDI opportunities. The main purpose is to establish the equivalence among the three policies without FDI. This result serves as a basis for later analysis.

Begin with the AD duty $t$. By straightforward calculation, the equilibrium output is $(a - 2t)/4$ for each foreign firm and $(a + 2t)/4$ for the home firm. The equilibrium price is

$$p(t) = (a + 2t)/4. \tag{1}$$

The equilibrium profits are

$$\pi(t) = (a + 2t)(a - 2t)/16, \tag{2}$$

for each foreign firm and

$$\Pi(t) = (a + 2t)^2/16 \tag{3}$$

for the home firm.

Consider next a price undertaking, by which the foreign firms agree to maintain their export prices above $p_\text{-.}$ We assume the price undertaking is always binding.\(^6\) For the price undertaking to affect imports, $p_\text{-.}$ must exceed the equilibrium price, $a/4$, under free trade.

Foreign Firm 1 maximizes profit

$$\pi_1 = (a - x_1 - x_2 - x_h)x_1,$$

subject to the price undertaking constraint $p = a - x_1 - x_2 - x_h \geq p_\text{-.}$ The best-response function is

\(^6\) For example, the European Commission closely monitors the price undertakings and imposes penalties to punish violators (Pauwels and Springael, 2002).
\[ b_1 = \max \{ a - x_2 - x_h - p, (a - x_2 - x_h)/2 \} \]

Interchanging subscripts yields the best-response function for foreign firm 2. The home firm is not constrained and hence its best-response function is the same that is obtained under free trade:

\[ b_h = (a - x_1 - x_2)/2. \]

Solving these three-best response functions simultaneously, we obtain the following symmetric equilibrium export sales per foreign firm

\[ x(p) = (a - 2p)/2 \]

and the home firm’s output \( x_h(p) = p \). The equilibrium profit to each foreign firm is

\[ \pi(p) = p(a - 2p)/2, \]

and that to the home firm is

\[ \Pi(p) = p^2. \]

Consider converting the AD duty to a price undertaking, keeping the profit to the domestic firm constant. By (3) and (5), \( \Pi(t) = \Pi(p) \) implies the following conversion formula:

\[ p = (a + 2t)/4. \]

A comparison with (1) shows that the equilibrium price with the price undertaking is the same as that with the AD. It is easy to check that each firm’s equilibrium outputs remain identical.

Consider now a VER of size \( v \) imposed on the total volume of exports from the foreign country:
\[ x_1 + x_2 \leq v. \]

Since the total exports under free trade equal \( a/2 \), we set \( v < a/2 \), and focus on the symmetric equilibrium, in which each foreign firm exports up to \( v/2 \). It is easy to check that the Nash equilibrium is

\[ (x_1, x_2, x_h) = (v/2, v/2, (a - v)/2). \]

The equilibrium industry output is \( (a + v)/2 \), and the equilibrium price is

\[ (7) \quad p = (a - v)/2. \]

The equilibrium profit per foreign firm is

\[ \pi(v) = v(a - v)/2. \]

and the profit to the home firm is

\[ (8) \quad \Pi(v) = (a - v)^2/4. \]

We now compare the VER with the price undertaking on the condition that the home firm’s profit remain constant. By (5) and (8),

\[ (9) \quad (a - v)/2 = p, \]

or

\[ v = a - 2p. \]

The home firm produces \( (a - v)/2 = p \), and each foreign firm exports \( v/2 = (a - 2p)/2 \). These are the same quantities they export under the price undertaking \( p \). Thus, it is possible to duplicate the equilibrium with any price undertaking \( p \) with a VER.
We say the two policies are equivalent if one policy is converted to another without affecting the equilibrium price and firm output levels. We showed that with Cournot competition the three policy options considered here are equivalent in the absence of FDI. We should however point out that the equilibrium profits to the foreign firms are higher with the VER and the price undertaking than with the equivalent AD duty, simply because there are no duties to pay under the first two policies. In the trade literature these windfall profits are regarded as inducements for the foreign firms to “voluntarily” restrain exports by limiting quantities or raising prices. In this paper, we call this shift in profit from the home country to the foreign firms the transfer effect.

We note two facts about the transfer effect. First, the transfer effect is the same with the VER and the price undertaking, given their equivalence. Second, due to the transfer effect home country welfare is higher under the AD duty than under the equivalent price undertaking or VER. We summarize this section with

**Proposition 1:** In the absence of FDI the AD duty, the VER, and the price undertaking are equivalent.

For future use we calculate the optimal AD duty. Home country welfare is given by

\[ W_o(t) = \frac{(a + 2t)^2}{16} + \frac{t(a - 2t)}{2} + \frac{(3a - 2t)^2}{32} \]

where the subscript o implies the absence of FDI. The first derivative is

\[ W'_o(t) = \frac{(a + 2t)}{4} + \frac{(a - 4t)}{2} - \frac{(3a - 2t)}{8} \]

\[ = \frac{(3a - 10t)}{8}. \]
The optimal tariff is therefore \( t_0 = 3a/10 \). With the price undertaking, the equilibrium home country consumer surplus is \((a - p)^2/2\), and the national welfare is

\[
W_0(p) = \frac{(a - p)^2}{2} + p^2,
\]

where \( p \geq a/4 \). \( W(p) \) is decreasing for \( p < a/4 \) and increasing for \( p > a/3 \). It reaches its maximum value of \( 3a^2/8 \) at \( p = a/2 \), at which imports vanish.

4. Anti-dumping and FDI

Suppose that the foreign firm can relocate production to the home country to avoid the AD duty. We consider this choice in a two-stage game, in which the foreign firms simultaneously decide whether to invest in the home country and then all three firms play a quantity-setting game, given the location of foreign firms. Since payoffs depend on the location choices of the foreign firms, we first examine all possible second-stage games and then move back to the first-stage game to examine the foreign firms’ FDI decisions.

If neither foreign firm invests, the equilibrium outcome is the same that is described in the previous section. If both foreign firms invest to escape the AD duty, the outcome is the same as the free-trade equilibrium outcome noted in Section 2 except that the foreign firms’ profits are lowered by the investment cost. The third case is when only one foreign firm invests. In this case, free of the AD duty, the investing firm increases output to \((a + t)/4\), the same output produced by the home firm by symmetry, while the exporting firm contracts output to \((a - 3t)/4\) units. The equilibrium price is \((a + t)/4\), and the equilibrium profit to the investing foreign firm
and the home firm is \((a + t)^2/16\) and that to the exporter is \((a - 3t)^2/16\). We thus obtain the following payoff matrix for the foreign firms, where I denotes investing and E exporting, and first entries are the profits to the column player:

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>E</th>
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<tbody>
<tr>
<td>I</td>
<td>(a^2/16 - k, a^2/16 - k)</td>
<td>((a + t)^2/16 - k, (a - 3t)^2/16)</td>
</tr>
<tr>
<td>E</td>
<td>((a - 3t)^2/16, (a + t)^2/16 - k)</td>
<td>((a - 2t)^2/16, (a - 2t)^2/16)</td>
</tr>
</tbody>
</table>

In the first stage of the game two foreign firms simultaneously choose between I and E. We make these assumptions:

(i) Simultaneous investments are profitable, or \(a^2/16 - k > 0\),

(ii) The AD tariff is non-prohibitive, or \(t < a/3\).

We then obtain the next lemma. (The proofs of this and other lemmas to follow are found in the Appendix.) Figure 1 illustrates Lemma 1.

**Lemma 1.** With AD

(A) \((E, E)\) is the unique equilibrium if \(k > 3t(2a - t)/16\).

(B) \((I, I)\) is the unique equilibrium if \(k < 3t(2a - 3t)/16\).

(C) Either \((E, I)\) or \((I, E)\) is the equilibrium if \(3t(2a - 3t)/16 < k < 3t(2a - t)/16\).
5. Price undertakings and FDI

Suppose that \((E, E)\) is the equilibrium outcome with the AD duty \(t\), and consider converting the duty to the equivalent price undertaking using the formula

\[ p_\ominus = \frac{a + 2t}{4}. \]

Given that \(t < a/3\), \(p_\ominus\) ranges over the open interval \((a/4, 5a/12)\). If both foreign firms export, from Section 3 we know that each earns \(\pi(p) = p(a - 2p)/2\).

When there is FDI, it is convenient to consider the problem in two separate cases, depending on the AD duty rate.

Case I: \(a/4 < p_\ominus < a/3\).

This corresponds to \(t \in (0, a/6)\). If both firms invest, each nets the profit \(a^2/16 - k\), the free-trade profit less the investment cost. With only one foreign firm investing, the exporter must choose output \(x_e\) subject to this constraint:

\[ p = a - X - x_i - x_e \geq p_\ominus, \]

where the subscript \(i\) (\(e\)) denote the investor (the exporter). On the other hand, the investor and the domestic firm choose their outputs without facing such constraints. Straightforward calculations show that in the symmetric Nash equilibrium we have:

\[ x_i = x_h = p_\ominus, \]

and
\[ x_c = a - 3p < p = x_i. \]

As expected, the exporter has fewer sales than the investor. Industry output is

\[ 2p + a - 3p = a - p. \]

The investor and the home firm earn the (gross) profit

\[ \pi_i(p) = p^2 = \Pi(p) \]

while the exporter earns

\[ \pi_e(p) = p(a - 3p). \]

Given the range of \( p \), we have \( \pi_i(p) > \pi_e(p) \), implying that it is more profitable to be an investor than an exporter. The table below summarizes the profits to the foreign firms in all second-stage games.

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<tbody>
<tr>
<td>I</td>
<td>( \frac{a^2}{16} - k, \frac{a^2}{16} - k )</td>
<td>( p^2 - k, (a - 3p)p )</td>
</tr>
<tr>
<td>E</td>
<td>( (a - 3p)p, p^2 - k )</td>
<td>( p(a - 2p)/2, p(a - 2p)/2 )</td>
</tr>
</tbody>
</table>

Lemma 2: With a price undertaking \( p \in (a/4, a/3) \) equivalent to the AD duty \( t \in (0, a/6) \)

(A) \( (I, I) \) is the unique equilibrium if \( k < t(a - 3t)/4 \).

(B) \( (E, E) \) is the unique equilibrium if \( k > t(a + 2t)/4 \).

(C) Either \( (E, I) \) or \( (I, E) \) is the equilibrium if \( t(a - 3t)/4 < k < t(a + 2t)/4 \).
Case II: 5a/12 > \( p \) > a/3

This case occurs when a/3 > t > a/6. The targeted price is set so high that when one foreign firm invests, any amount of exports by the other foreign firm leads to violation of the price undertaking agreement. It follows that investment by one foreign firm leads to the foreclosure of the home market to exports. Then, the home firm and the investing foreign firm play a duopoly game, selling a/3 units at the price of a/3 and earning the profit of \( a^2/9 \). Using this fact, we obtain the following payoff matrix.

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<tbody>
<tr>
<td>I</td>
<td>( a^2/16 - k, a^2/16 - k )</td>
<td>( a^2/9 - k, 0 )</td>
</tr>
<tr>
<td>E</td>
<td>0, ( a^2/9 - k )</td>
<td>( p(a - 2p)/2, p(a - 2p)/2 )</td>
</tr>
</tbody>
</table>

Because investment by one foreign firm forecloses the domestic market for exports, there is a stronger incentive to be a first to invest than in Case I.

**Lemma 3**: With a price undertaking \( p \in (a/3, 5a/12) \) equivalent to the AD duty \( t \in (a/6, a/3) \)

(A) (I, I) is the unique equilibrium if \( k < (7a^2 + 36t^2)/144 \);

(B) The equilibrium is either (I, I) or (E, E) if \( k > (7a^2 + 36t^2)/144 \).

(C) (E, I) and (I, E) are never the equilibrium.
Lemmas 2 and 3 are illustrated in Figure 2. A comparison of Figures 1 and 2 leads to the next proposition.

**Proposition 2**: For $t < a/6$, the price undertaking induces less FDI than the AD duty. For $t \geq a/6$ the price undertaking induces more FDI.

The intuitive understanding of the proposition draws on two effects. First, with AD, an output expansion by an investing firm causes the export price to fall, forcing export sales to contract. The price undertaking, however, does not allow the exporter to lower the price. To keep the price up, the exporter is forced to curtail exports further than under the AD duty. Thus, the price undertaking makes exporting even less attractive than investing, thereby increasing each firm’s incentive to engage in FDI than under the AD. Call this the preemption effect. The second determinant on FDI decisions is the transfer effect alluded to earlier. The price undertaking obviates the AD duty for the exporter, making exporting attractive relative to FDI. The relative attractiveness of FDI depends on which of these two effects is dominant. A comparison of the figure shows that the transfer effect is dominant for $t \leq a/6$, but for $t \geq a/6$ the transfer effect vanishes because of the foreclosure of the home market to exports, making the preemption effect dominant.
6. VERs and FDI

In this section we consider a conversion of AD duty to the equivalent VER. Using (6) and (9), we obtain the conversion formula:

\[ v = \frac{a - 2t}{2}. \]

Given that \( t < \frac{a}{3} \) we have \( v \in (\frac{a}{6}, \frac{a}{2}) \). Under the VER agreement the foreign government allocates the export quota \( v \) to its national firms equally. If one firm invests and hence no longer needs the export quota, the foreign government can allocate the entire quota to the remaining exporter. We consider the two cases from the previous section.

Case I: \( v \in (\frac{a}{3}, \frac{a}{2}) \).

This case corresponds to \( t \in (0, \frac{a}{6}) \). If no firm invests, each firm has the quota \( v/2 \), leading to the results obtained in Section 3. If the two firms invest, the VER is irrelevant, and each foreign firm earns \( \frac{a^2}{16} - k \). Thirdly, if only one firm invests, then as we explained above, the exporter can use the entire quota, \( v \). In the present case, since \( v > \frac{a}{3} \), that is, the total quota exceeds the per-firm symmetric equilibrium output, \( \frac{a}{4} \), the VER ceases to be binding for the exporting firm. With three firms playing a symmetric game, each firm earns the gross profit that it earns under free trade. Of course the profit to the investor is less by the investment cost. Therefore, the equilibrium profits to the investor and exporter are

\[ \pi_i = \frac{a^2}{16} - k, \text{ and } \pi_e = \frac{a^2}{16}. \]

We have obtained the following payoff matrix.
VER (Case I): $v \in (a/3, a/2)$

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</tr>
<tr>
<td>E</td>
<td>$a^2/16, a^2/16 - k$</td>
<td>$v(a - v)/2, v(a - v)/2$</td>
</tr>
</tbody>
</table>

Obviously, (I, I) is never an equilibrium for any $k < a^2/16$. In fact, we have a stronger result.

**Lemma 4:** With a VER $v \in (a/3, a/2)$ equivalent to the AD duty $t \in (0, a/6)$ (E, E) is the unique equilibrium.

Turn next to Case II, in which $v \in (a/6, a/3]$. Notice that for $v \in [a/4, a/3]$, which corresponds to $t \in [a/6, a/4]$, the VER still becomes unbinding when one foreign firm locates in the home country. We can easily verify that (E, E) is the unique equilibrium as in Case I.

Consider $v \in (a/6, a/4)$, which corresponds to $p \in (3a/8, 5a/12)$ or $t \in (a/4, a/3)$. If one firm invests under the VER of size $v < a/4$, the VER becomes binding for the exporter. It is readily shown that the exporter sells $v$ units, fulfilling the quota, while the home firm and the investing firm produce

$$x_h = x_i = (a - v)/3.$$  

The equilibrium industry output is $(2a + v)/3$ and the equilibrium price is $p = (a - v)/3$. The exporter earns $\pi_e(v) = v(a - v)/3$, while the investor earns $\pi_i(v) = (a - v)^2/9$. Given the range of
v under consideration, we have \( \pi_i(v) > \pi_e(v) \), so there is an incentive to invest if the other does not (provided that k is small).

The payoffs from second-stage games are shown in the table below.

**VER (Case II):** \( v \in (a/6, a/4) \)

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<tbody>
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<td>I</td>
<td>( a^2/16 - k, a^2/16 - k )</td>
<td>( (a - v)^2/9 - k, v(a - v)/3 )</td>
</tr>
<tr>
<td>E</td>
<td>( v(a - v)/3, (a - v)^2/9 - k )</td>
<td>( v(a - v)/2, v(a - v)/2 )</td>
</tr>
</tbody>
</table>

In this game, \((I, I)\) is an equilibrium if

\[
(14) \quad a^2/16 - k \geq v(a - v)/3
\]

\((E, E)\) is the equilibrium if

\[
(15) \quad v(a - v)/2 \geq (a - v)^2/9 - k.
\]

**Lemma 5:** With a VER \( v \in (a/6, a/3) \) equivalent to the AD duty \( t \in (a/6, a/3) \)

(A) For \( v \in (a/4, a/3) \) \((E, E)\) is the unique equilibrium.

(B) For \( v \in (a/6, a/4) \) \((E, E)\) is the unique equilibrium if \( k > (44t^2 + 8at + 7a^2)/72 \).

(C) For \( v \in (a/6, a/4) \) \((I, I)\) is the unique equilibrium if \( k < (16t^2 - a^2)/48 \).

(D) For \( v \in (a/6, a/4) \) either \((E, E)\) or \((I, I)\) is the equilibrium if

\[
(16t^2 - a^2)/48 < k < (44t^2 + 8at + 7a^2)/72.
\]
Lemmas 4 and 5 are illustrated in Figure 3. A comparison of Figures 2 and 3 leads to

**Proposition 3.** The price undertaking induces more FDI than the VER.

7. **Policy implications**

In this section we discuss some policy implications of our model. In particular, we consider the following scenario. The home firm petitions for AD protection but stands ready to withdraw the petition only if a price-undertaking (or a VER) agreement can be worked out with the foreign firm (or the foreign government). Suppose that with the AD duty the equilibrium outcome is \((E, E)\), with the home firm earning the profit of \((a + 2t)^2/16\). The home country government’s objective is to maximize national welfare subject to the constraint that the home firm earns at least as much profit with either policy as with AD.\(^7\) Should the home government choose a price undertaking or a VER?

Suppose that the original AD is in Case 1. If the home government is constrained to stay with Case 1 with a price undertaking or with a VER, a conversion to either policy yields the same welfare. To understand this, observe that a conversion to the equivalent VER leads to \((E, E)\), since \((E, E)\) is the equilibrium with the AD. Furthermore, tightening the VER decreases welfare, while relaxing the VER reduces the profit to the home firm. Thus, the a conversion to the equivalent VER is the optimal policy, given the constraint.

\(^7\) Our “optimal” price undertaking or VER is obtained under this constraint.
On the other hand, when the AD is converted to a price undertaking, (E, E), (I, E) and (I, I) are in general all possibilities (compare Figures 1 and 2). (I, I) leads to a smaller profit to the home firm and is unacceptable. With (E, E), the home government cannot do better than choosing the equivalent price undertaking for the same reason explicited in the case of VERs. Finally, with (I, E), the profit to the home firm is computed to equal $p^2 = (a + 2t)^2/16$, the same that accrues under the equivalent AD duty. Further, the consumer surplus remains unchanged at $(a - p)^2/2$. Thus, when only one foreign firm invests, the profit to the home firm and the home country welfare are the same as when both firms export. Recall from Section 3 that $W(p)$ is decreasing for $p \in (a/4, a/3)$, so welfare falls if $p$ is raised from the equivalent level and the profit to the home firm falls if $p$ is lowered.

Thus, when the home government’s choice is limited to the policy range in Case 1, the optimal policy is to impose the VER or the price undertaking at the equivalent level to the AD duty. Either policy leads to (E, E) and yields the identical welfare.

However, the home government can increases protection under the VER and the price undertaking so that Case II results. In that case, whenever (I, I) is the equilibrium under the VER, it is the equilibrium under the price undertaking, and the home profit is smaller under either policy. On the other hand, when (I, I) is the equilibrium under the price undertaking, (E, E) can be the equilibrium under the VER (see Figures 2 and 3). Further, whenever (E, E) is the equilibrium with the price undertaking, (E, E) is also the equilibrium under the VER. What this means is that the policy parameter range resulting in (E, E) under the price undertaking is a
strict subset of that under the VER. Thus, the maximum welfare under the VER is at least as great as that under the price undertaking, and is greater for particular parameter values of \( k \).\(^8\)

**Proposition 4.** Suppose that \((E, E)\) is the equilibrium with the AD. Then, under the constraint that the home firm’s profit is not lowered when it is converted to a VER or a price undertaking, the home government can achieve higher national welfare with the VER than with the price undertaking.

8. Conclusion

In this paper we study the foreign firms’ incentives to engage in FDI under VER and price undertaking agreements, assuming that they and the home firms produce homogeneous goods and compete in the home market. As the novel feature, the model highlights the role of rivalry between two foreign firms domiciled in the same foreign country. Without FDI, the VER and the price undertaking yield the same equilibrium output levels, price and profits and are equivalent in this sense. With FDI however the price undertaking gives foreign firms a greater incentive to engage in FDI than the VER. Further, if the home government maximizes national welfare subject to the constraint that the home firm is never hurt by a settlement of AD duties through VERs or price undertakings, then the optimal home country welfare under the VER dominates that under the price undertaking.

The mechanism leading to these results are straightforward and intuitive enough to be applicable to a broader set of circumstances. For example, one can conceive of multiple home ...

\(^8\) We can easily verify that the VER with \( v = 6/a \) is optimal if \( k > 7a/432 \), under which \((E, E)\) is the unique equilibrium with \( v = 6/a \).
firms competing with multiple foreign firms, not necessarily of the same nationality. As long as import restrictions are imposed on at least two foreign firms exporting from the same country, the model should yield similar results, although details depend on the actual number of firms considered. Having more than one home firm does not much affect our result. However, the greater the number of foreign firms from the country under the VER agreement, the smaller is the quota allocation to each firm. Therefore, the positive externalities associated with investment under the VER are weakened quantitatively. Similarly, the negative externalities associated with FDI under the price undertaking also weaken for the same reason, so the next result involves more computation.

Our results are expected to carry over to Bertrand competition, as well. That is because, with price undertakings, investment by one firm still exerts the downward pressure on the exporter as long as the goods are substitutes, whereas with the VER investment by one firm still relaxes the quota constraint for the exporter. Confirmation of this conjecture is left for future work.
Appendix

**Lemma 1** Result A is true if both these inequalities hold:

\[(a - 3t)^2/16 > a^2/16 - k,\]

\[(a - 2t)^2/16 > (a + t)^2/16 - k\]

The first is written

\[16k > 3t(2a - 3t)\]

and the second is written

\[16k > 3t(2a - t) > 3t(2a - 3t).\]

The last inequality implies Result A. Result B is true if both inequalities hold in reverse. If

\[(a - 3t)^2/16 > a^2/16 - k,\]

\[(a - 2t)^2/16 < (a + t)^2/16 - k,\]

then Result C holds. \(\Box\)

**Lemma 2** Result A is true if both these inequalities hold:

\[a^2/16 - k > (a - 3p)p,\]

\[p^2 - k > p(a - 2p)/2\]

Using the conversion formula, the first is written

\[16k < a^2 - (a - 6t)(a + 2t) = 4t(a - 3t).\]

and the second is written

\[16k < 4t(a + 2t).\]
Since \(4t(a - 3t) < 4t(a + 2t)\), we obtain Result A. Result B is true if both inequalities hold in reverse. If

\[
a^2/16 - k < (a - 3p)p,
\]

\[
p^2 - k > p(a - 2p)/2,
\]

then Result C holds. \(\square\)

**Lemma 3**: Result (A) is true if

\[
a^2/9 - k > p(a - 2p)/2.
\]

Using the conversion formula, this is written

\[
k < (7a^2 + 36 t^2)/144.
\]

If the inequality is reversed, \((E, E)\) also becomes a possible equilibrium outcome. Results (C) is obvious under the assumption that \(k < a^2/16\). \(\square\)

**Lemma 4**: The lemma is true if

\[
v(a - v)/2 > a^2/16 - k.
\]

Since \(v(a - v)/2\) is bounded from below by \(a^2/9\) for \(a/2 > v > a/3\), this inequality always holds. \(\square\)

**Lemma 5**: Result A holds because the proof of Lemma 4 is still valid for \(a/4 < v < a/2\).

Result B is true if both these inequalities hold:
\[ \frac{v(a - v)}{2} > \frac{(a - v)^2}{9} - k \]
\[ \frac{a^2}{16} - k < \frac{v(a - v)}{3}. \]

Using the conversion formula, the first is written
\[ k > \frac{(44 t^2 + 8at - 7a^2)}{72} \]
and the second is written
\[ k > \frac{(16 t^2 - a^2)}{48}. \]

Result B follows because \( \frac{(44 t^2 + 8at - 7a^2)}{72} < \frac{(16 t^2 - a^2)}{48} \) for \( a/4 < t < a/3 \). Result C is true if both inequalities hold in reverse. Result D is true if
\[ \frac{v(a - v)}{2} > \frac{(a - v)^2}{9} - k \]
\[ \frac{a^2}{16} - k > \frac{v(a - v)}{3}. \]
References


Moore, M., O., 2005, VERs and price undertakings under the WTO. *Review of International Economics* 13, 298-310.


Figure 1: Equilibrium outcomes under AD

(E, I), (I, E)

(E, E)

(I, I)

Figure 1: Equilibrium outcomes under AD
Figure 2: Equilibrium outcomes under price undertakings
Figure 3: Equilibrium outcomes under VERs