# Chapter 5

# Exchange Rate Movements, Dumping, and Antidumping-jumping FDI

## 1. Introduction

Although a theoretical model is developed in Chapter 2 to analyze the impact of exchange rate movements on FDI, the influence of government trade policies on the entry or exit decisions of multinational firms is not incorporated into the model. In search of economic development, many governments in developing countries have attempted to attract foreign capital inflows through trade policies. For instance, it has long been recognized that high import tariffs might induce an exporting firm to set up a subsidiary abroad to produce and serve the foreign market in order to circumvent the tariff duties, which is known as "tariff-jumping FDI" in the literature.

Ever since the formation of the General Agreement on Tariffs and Trade (GATT) in 1947, import tariffs have been gradually reduced to a very low level, following eight rounds of multilateral trade negotiation. Consequently, many countries around the world have increasingly relied on non-tariff trade barriers (NTBs) as a substitute for tariff protection. Particularly, over the past three decades, the policy of antidumping (AD) has emerged as the most serious and widespread impediment to trade.

Dumping is defined in article VI of the GATT as offering a product for sale in export markets at a price below "normal" value. Normal or "fair" value usually is defined as the price charged by a firm in its home market, the highest comparable price charged in third markets, or the exporting firm's estimated costs of production. In other words, there are two approaches in defining dumping - namely, the price-based approach (price dumping) versus the cost-based approach (cost dumping).

Dumping has been regarded as international price discrimination (that is, price dumping) by many economists, which occurs under conditions of imperfect competition. Dixit (1989b), by using a real options model to analyze entry and exit decisions under uncertainty, shows that even small firms can practice dumping in the sense of charging a price abroad that is below its cost of production plus delivery to the export market (that is, cost dumping), irrespective of the market structure.[63] One of the objectives of this chapter is to extend the real options model of Dixit (1989b) to show how exchange rate movements might affect a multinational firm's entry or exit decision as well as its pricing strategy in an international imperfectly competitive industry, thus affecting the probability of the occurrence of price dumping.

When dumping occurs, the government of the importing country may impose an AD duty on the dumping firms. Haaland and Wooton (1998) and Belderbos et al. (2004) employ a multiple-stage game to investigate how an AD policy affects the FDI decision of the firm. Haaland and Wooton indicate that an AD policy might stimulate AD-jumping FDI while Belderbos et al. show that the policy of price undertaking might discourage FDI.[64] However, these papers do not consider the effect of exchange rate movements on AD-jumping FDI. Another objective of this chapter is to examine how exchange rate movements influence AD-jumping FDI.

An AD policy has long been regarded as a tool to protect domestic producers. However, recent studies have shown that an AD policy might hurt domestic producers

[63] See Dixit (1989b), p. 631.

[64] In contrast to ambiguous prediction from theory, previous empirical studies consistently find substantial AD-jumping FDI. See, for example, Azrak and Wynne (1995), Belderbos (1997), Blonigen and Feenstra (1997), Barrell and Pain (1999), Girma et al. (2002), and Blonigen (2002).

if the policy induces an AD-jumping FDI and consequently increases domestic competition. Previous studies suggest that the overall social welfare effect of an AD policy depends on the behavior of the potential entrant, the objective of the government, the instrument of trade policy, the reaction of another government, trade costs, and the fixed costs of FDI (see Motta (1992), Anderson et al. (1995), Haaland and Wooton (1998), and Belderbos et al. (2004)). Another objective of this chapter is to use a real options model to show that the level of exchange rate and its volatility are also essential in evaluating the welfare effect of an AD policy.

The remainder of this chapter proceeds as follows. In the following section we set up an imperfect competition model to investigate the firms' pricing behavior. Section 3 employs a real options approach to discuss optimum exit timing and the effect of exchange rate movements on dumping. Section 4 examines the optimal timing of FDI for a dumping firm facing an AD duty. Section 5 analyzes the welfare effect of an AD policy. Brief concluding remarks are given in the final section.

## 2. The model

A two-country, two-firm model is developed in this chapter. Suppose that there are two countries, domestic country $d$ and foreign country $f$, with one producing firm in each country. The firms produce differentiated products. For simplicity, suppose that the firm in the domestic country (Firm 1) can sell in the home country as well as export its product to the foreign country, whereas the firm in the foreign country (Firm 2) can sell in the market of its own country only. Suppose that market demands are linear functions of prices.[65] Let $q_{1d}$ and $p_{1d}$ respectively denote quantity and price in the domestic country. Let $q_{1f}$ and $q_{2f}$ ($p_{1f}$ and $p_{2f}$) denote the quantities (prices) of

[65] The linear demand function is a general setting in this area of literature, e.g., Smith (1987), Motta (1992), Anderson et al. (1995), Haaland and Wooton (1998), and Belderbos et al. (2004).

the firms in the foreign country where subscripts 1 and 2 represent the domestic and the foreign firm, respectively. The demand function in the domestic country is

$$q_{1d} = a_d - p_{1d} . \tag{5-1a}$$

Similarly, the demand functions in the foreign country are

$$q_{1f} = a_f - p_{1f} + b \cdot p_{2f} , \tag{5-1b}$$

$$q_{2f} = a_f - p_{2f} + b \cdot p_{1f} \tag{5-1c}$$

In this chapter we do not consider the case where goods are complements (that is, the case in which $b$ is non-negative). It is also assumed that $0<b<1$, indicating that own price effects are larger than cross price effects.

For simplicity, the production costs are set equal to zero. Suppose that Firm 1 needs to pay a tariff $\tau$, in terms of foreign currency per unit of exports. Moreover, suppose that the firms play a price competition game, and they announce their prices simultaneously. The exchange rate $R$, expressed in units of home currency per foreign currency, is assumed to follow an exogenously geometric Brownian motion

$$\frac{dR}{R} = \mu \cdot dt + \sigma \cdot dz , \tag{5-2}$$

where $\mu$ is the growth rate of the exchange rate; $\sigma$ is the volatility of the exchange rate; $t$ is the time path; and $z$ is a Wiener process.

In each period the profit functions for these firms are:

$$\begin{aligned} \pi_1 &= \pi_{1d} + \pi_{1f} \\ &= p_{1d}\left(a_d - p_{1d}\right) + \left(p_{1f} - \tau\right)\left(a_f - p_{1f} + b \cdot p_{2f}\right)R , \end{aligned} \tag{5-3a}$$

$$\pi_2 = p_{2f}\left(a_f - p_{2f} + b \cdot p_{1f}\right), \tag{5-3b}$$

where $\pi$ denotes the total profit. It is easy to show that the equilibrium price, quantity, and profit of Firm 1 in the home market are:

$$p_{1d}^{*}=\frac{a_d}{2},\ q_{1d}^{*}=\frac{a_d}{2},\text{ and }\ \pi_{1d}^{*}=\frac{a_d^2}{4}, \tag{5-4}$$

where superscript * represents the equilibrium outcome.

The equilibrium prices of Firms 1 and 2 in the host market are:

$$p_{1f}^{*}=\frac{a_f\left(2+b\right)+2\tau}{4-b^2}, \tag{5-5a}$$

and

$$p_{2f}^{*}=\frac{a_f\left(2+b\right)+b\tau}{4-b^2}. \tag{5-5b}$$

The equilibrium quantities are:

$$q_{1f}^{*}=\frac{a_f\left(2+b\right)-\left(2-b^2\right)\tau}{4-b^2}, \tag{5-6a}$$

and

$$q_{2f}^{*}=\frac{a_f\left(2+b\right)+b\tau}{4-b^2}. \tag{5-6b}$$

The equilibrium profit of Firm 1 is:

$$\pi_{1f}^{*}=\frac{\left[a_f\left(2+b\right)-\left(2-b^2\right)\tau\right]^2 R}{\left(4-b^2\right)^2}. \tag{5-7}$$

In order to ensure that all equilibrium quantities are positive, we assume that

$$a_f\left(2+b\right)>\left(2-b^2\right)\tau. \tag{5-8}$$

Finally, the second-order conditions are:

$$\frac{\partial^2\pi_1}{\partial p_{1d}^2}=-2,\ \frac{\partial^2\pi_1}{\partial p_{1f}^2}=-2R,\text{ and }\ \frac{\partial^2\pi_2}{\partial p_{2f}^2}=-2.$$

It is obvious that the second-order conditions are all satisfied.

## 3. The impact of exchange rate movements on dumping

### 3.1 Optimum timing of exit

Suppose that Firm 1 needs to pay a fixed cost $F_1$ , such as advertising expenditures, to maintain its foreign operations. In addition, suppose that it has an option to stop exporting to the foreign country; but, it must pay lump-sum exit costs $K_1$ if it decides to exit the market.[66] The profit flows in terms of the home country's currency fluctuation due to exchange rate movements. If its net profit becomes negative, then the firm may consider exiting the foreign market. Therefore, in each period Firm 1 faces a binary decision problem as follows:

$$V(R) = \max\left\{\xi_{1d}^{*}(R) - K_1, \pi_{1d}^{*} + \pi_{1f}^{*} - F_1 + \frac{1}{1+\Delta t\rho} E\left[V(R')\middle|R\right]\right\}, \tag{5-9}$$

where $V$ is the optimal expected net present value; $\xi_{1d}^{*}(R) = a_d^2/4\rho$ represents the expected present value for domestic sales; ρ is the firm's private discount rate; $\Delta t$ is the time interval; $K_1$ is the exit cost expressed in the home country's currency; and $R'$ is the exchange rate in period $t$+1. The former term on the right-hand side, $\xi_{1d}^{*}(R) - K_1$, is the net value after exiting the foreign market, and the latter term, $\pi_{1d}^{*} + \pi_{1f}^{*} - F_1 +\ (1+\Delta t\rho)^{-1} E[V(R') \mid R]$, is the value of exporting and maintaining the right to exit at the next period.

The decision problem of Firm 1 is to choose an optimal timing to exit the foreign market. Since the profit from exporting in this model is an increasing function in $R$, there is a cutoff point, $R_E^{*}$, at which if $R < R_E^{*}$, then the net exit value is greater than the value of staying in the foreign market, thus causing the firm to exit the foreign

[66] $K_1$ can be less than zero if the scrap value of the firm is positive.

market.[67] Using value-matching and smooth-pasting conditions, we have

$$R_E^* = \frac{\rho-\mu}{A}\frac{\alpha}{1+\alpha}\left(\frac{F_1}{\rho}-K_1\right),^{68} \tag{5-10}$$

where $\alpha = \sigma^{-2}[(\mu-0.5\sigma^2)+\sqrt{(\mu-0.5\sigma^2)^2+2\sigma^2\rho}\,]>0$; $A=\frac{[a_f(2+b)-(2-b^2)\tau]^2}{(4-b^2)^2}>0$. To ensure that there is a possibility for a firm to exit the foreign market, we assume that $F_1/\rho - K_1 > 0$.

### 3.2 Comparative statics

The AD duty level might be imposed on the dumping firm if it undertakes a dumping activity, thereby causing material injury on the domestic firms in the importing countries. Whether a firm is undertaking a dumping activity is determined by a so-called dumping margin. Here, the dumping margin, *DM*, expressed in the home country's currency, is defined as the difference between the firm's home-market price and the price it receives in its export market (net of tariff) multiplied by the exchange rate. According to Equations (5-4) and (5-5a), the dumping margin, *DM*, can be expressed as

$$DM = p_{1d}^* - \left(p_{1f}^* - \tau\right)R = B_1 - B_2 R,^{69} \tag{5-11}$$

where $B_1 = \frac{a_d}{2}$ and $B_2 = \frac{a_f(2+b)-(2-b^2)\tau}{4-b^2} > 0$.

If $DM > 0$, the Firm 1 is regarded as committing dumping.[70] It is obvious that if $R < B_1/B_2 = R_D^*$, then $DM > 0$. However, Firm 1 faces an uncertain world, and thus

[67] See Dixit and Pindyck (1994), p.128.
[68] For the purpose of convergence, we assume $\rho > \mu$.
[69] It is worth noting that since exchange rate changes are usually perceived as cost shocks, no exchange rate pass-through occurs in our model due to the assumption of zero production cost.
[70] If the dumping margin is very small, then the firm can be exempted from imposing an AD duty. We ignore this exception rule in the AD rule.

it may exit when the exchange rate level is low enough. On the other hand, dumping activity only occurs under the situation when $R > R_E^*$. Consequently, Firm 1 dumps its product into the foreign market if $R_E^* < R < R_D^*$. We define the interval of exchange rates in which dumping occurred, *DP*, as

$$DP = R_D^* - R_E^*. \tag{5-12}$$

A larger value of *DP* does not necessarily imply a higher probability of dumping occurrence, since *R* follows a geometric Brownian motion. The probability of dumping can be expressed as:

$$\begin{aligned}\Pr\left(R_E^* < R < R_D^*\right) &= N\left(m_D\right) - N\left(m_E\right) \\ &= f\left(R_E^*\left(\sigma,\mu,K_1,\tau,b\right), R_D^*\left(\tau,b\right),\sigma,\mu\right),\end{aligned} \tag{5-13}$$

where $m_D = \dfrac{\ln R_D^* - E\ln R}{\sigma\sqrt{T}}$ and $m_E = \dfrac{\ln R_E^* - E\ln R}{\sigma\sqrt{T}}$; *N*(.) is a cumulative standard normal distribution. According to Equation (5-13), the probability of dumping occurrence is influenced by two possible channels - namely, threshold effect (*TE*) and distribution effect (*DE*). Here, *TE* is attributed to the changes in $R_D^*$ or $R_E^*$, whereas *DE* is attributed to the changes in the distribution of exchange rate.

From Equation (5-13), it is clear that all variables considered in this chapter may affect the probability of dumping occurrence through *TE*. However, among those variables, only σ and μ may affect the probability of dumping occurrence through *DE* as well. The total effect of σ or μ can be decomposed as follows:

$$\frac{df(\cdot)}{d\sigma} = \underbrace{\frac{\partial f(\cdot)}{\partial R_E^*}\cdot\frac{\partial R_E^*}{\partial\sigma}}_{TE_\sigma} + \underbrace{\frac{\partial f(\cdot)}{\partial\sigma}}_{DE_\sigma}, \tag{5-14a}$$

and

$$\frac{df(\cdot)}{d\mu} = \underbrace{\frac{\partial f(\cdot)}{\partial R_E^*} \cdot \frac{\partial R_E^*}{\partial \mu}}_{TE_\mu} + \underbrace{\frac{\partial f(\cdot)}{\partial \mu}}_{DE_\mu}. \tag{5-14b}$$

**Lemma 5-1** The distribution effect of σ is positive if $m_D > m_E > \omega_H$ or $m_E < m_D < \omega_L$, whereas this effect is negative if $\omega_L < m_E < m_D < \omega_H$, where $\omega_H = \frac{1}{2}(\sigma\sqrt{T} + \sqrt{4 + T\sigma^2}) > 0$ and $\omega_L = \frac{1}{2}(\sigma\sqrt{T} - \sqrt{4 + T\sigma^2}) < 0$.

**Proof**. See Appendix 5-1.

**Lemma 5-2** The distribution effect of μ is positive if $0 < m_E < m_D$ and negative if $m_E < m_D < 0$.

**Proof**. See Appendix 5-1.

**Proposition 5-1** Exchange rate volatility, σ, is positively related to the probability of dumping occurrence if $m_D > m_E > \omega_H$ or $m_E < m_D < \omega_L$.

**Proof**. From Equation (5-14a), the threshold effect of σ is:

$$\frac{\partial f(\cdot)}{\partial R_E^*} \cdot \frac{\partial R_E^*}{\partial \sigma} = \frac{e^{-\frac{1}{2}m_E^2}}{\sqrt{2\pi T}} \frac{1}{\sqrt{2\rho\sigma^2 + (\mu - 0.5\sigma^2)^2}} > 0.$$

According to Lemma 5-1, $df(\cdot)/d\sigma > 0$ if $m_D > m_E > \omega_H$ or $m_E < m_D < \omega_L$. ■

Note that the exchange rate volatility influences the probability of dumping occurrence through its effect on the threshold of exit and distribution of *R* simultaneously. The economic intuition of *TE* is that the exit is like a put option whose value increases if the underlying uncertainty rises. Hence, the exporting firm has more incentive to wait until it gets extra information from the market as the uncertainty grows. Therefore, the exiting threshold $R_E^*$ will be lower as σ rises. In other words, the firm keeps exporting under a very low exchange rate level if the exchange rate volatility is high enough, and thus the probability of dumping occurrence will be higher.

The distribution effect of σ is ambiguous, as shown in Lemma 5-1. It depends on the values of the exiting threshold, $R_E^*$, and dumping threshold, $R_D^*$. If $R_E^*$ and $R_D^*$ are high enough ($m_D > m_E > \omega_H$) or low enough ($m_E < m_D < \omega_L$), then *DE* will be positive; otherwise, it will be negative. This proposition suggests that if $\ln R_E^*$ and $\ln R_D^*$ are close to the expectation of the logarithmic exchange rate (mean), *E*ln*R*, then the exchange rate volatility tends to reduce the probability of dumping occurrence. In contrast, if $\ln R_E^*$ and $\ln R_D^*$ are far away from the mean of logarithmic exchange rate, then the exchange rate volatility might raise the probability of dumping occurrence. Consequently, the effect of exchange rate volatility on dumping seems to be asymmetric.

The logic behind the above result is as follows. An increase in exchange rate volatility raises the probability of extreme values for the exchange rate to occur while it reduces the probability of the exchange rate to remain around its mean. Therefore, an increase in volatility reduces the probability of dumping occurrences when the interval of dumping occurrences is around the mean of the distribution of exchange rate. On the other hand, it does raise the probability of dumping occurrences when the interval of dumping occurrences is located on two tails of the distribution of the exchange rate - that is, far away from its mean.

**Proposition 5-2** Exchange rate trend, μ, is positively related to the probability of dumping occurrences if $0 < m_E < m_D$.

**Proof**: From Equation (5-14b), the threshold effect of μ is:

$$\frac{\partial f(\cdot)}{\partial R_E^*} \cdot \frac{\partial R_E^*}{\partial \mu} = \frac{e^{-\frac{1}{2}m_E^2}}{\sigma\sqrt{2\pi T}} \frac{-R_E^* \cdot \psi}{(1+\alpha)(\rho-\mu)\sqrt{2\rho\sigma^2 + (\mu - 0.5\sigma^2)^2}} > 0,$$

where $\psi = \rho - \mu - (1+\alpha)\sqrt{2\rho\sigma^2 + (\mu - 0.5\sigma^2)^2} < 0$.[71] According to Lemma 5-2, $df(\cdot)/d\mu > 0$ if $0 < m_E < m_D$ ■

Similar to exchange rate volatility, the exchange rate trend μ also affects the probability of dumping occurrence through two channels: threshold effect and distribution effect. As for the threshold effect, since μ represents the expected future exchange rate level, an increase in μ raises the expected profit flows. Hence, it reduces the incentive for exiting the foreign market and lowers the exiting threshold, thus increasing the probability of dumping occurrence.

In regards to the distribution effect, it is ambiguous as shown in Lemma 5-2. However, it is positive if $0 < m_E < m_D$. Note that $0 < m_E < m_D$ implies $\ln R_D^* > \ln R_E^* > E \ln R$. Thus, the exchange rate trend might raise the probability of dumping occurrence if two logarithmic thresholds are greater than the mean of the logarithmic exchange rate. This is because an increase in μ raises the mean of the exchange rate in addition to increasing the probability of the exchange rate level whose value is greater than its mean. Consequently, the relationship between the exchange rate and the probability of dumping occurrence is positive if $0 < m_E < m_D$. Furthermore, Lemma 5-2 shows that the distribution effect of μ is negative if

[71] See Appendix 2-2 for the proof of $\psi < 0$.

$m_E < m_D < 0$ - that is, $E\ln R > \ln R_D^* > \ln R_E^*$. Therefore, the asymmetry also exists in the effect of the exchange rate trend.

**Proposition 5-3** Exit cost, $K_1$, is positively related to the probability of dumping occurrence.

**Proof**: Differentiating Equation (5-13) with respect to $K_1$ yields

$$\frac{\partial f(\cdot)}{\partial K_1} = \frac{1}{\sigma\sqrt{2\pi T}} \frac{1}{\frac{F_1}{\rho} - K_1} e^{-\frac{1}{2}m_E^2} > 0. \blacksquare$$

The intuition of Proposition 5-3 is straightforward. An increase in exit costs reduces the incentive for exiting, thus lowering the exiting threshold and thereby raising the probability of dumping occurrence.

**Proposition 5-4** Tariff rate, τ, is positively related to the probability of dumping occurrence if $e^{-\frac{1}{2}m_D^2} > 2e^{-\frac{1}{2}m_E^2}$.

**Proof**: Differentiating Equation (5-13) with respect to τ yields

$$\frac{\partial f(\cdot)}{\partial \tau} = \frac{1}{\sigma\sqrt{2\pi T}} \frac{2-b^2}{a_f(2+b)-(2-b^2)\tau}\left[e^{-\frac{1}{2}m_D^2} - 2e^{-\frac{1}{2}m_E^2}\right].$$

It is obvious that $\partial f(\cdot)/\partial\tau > 0$ if $e^{-\frac{1}{2}m_D^2} > 2e^{-\frac{1}{2}m_E^2}$. ■

A tariff affects $R_D^*$ and $R_E^*$ simultaneously. The first can be referred to as a price effect while the second is the exit effect. On the one hand, although an increase in the tariff rate raises the price of the exporting firm, the pass-through of a tariff on import prices is less than one, as illustrated in Equation (5-5a). Thus, an increase in the tariff rate raises the dumping margin and the probability of dumping occurrence as well. On the other hand, an increase in the tariff rate tends to reduce the profit flows as in Equation (5-7), thus raising the incentive of exiting as well as reducing the chance of dumping occurrence. Consequently, the effect of changes in the tariff rate on the probability of dumping occurrence is ambiguous. However, if $e^{-\frac{1}{2}m_D^2} > 2e^{-\frac{1}{2}m_E^2}$, then the price effect of trade cost dominates its exit effect, and thus a tariff is positively related to the probability of dumping occurrence under this condition.

**Proposition 5-5** Product substitutability, *b*, is inversely related to the probability of dumping occurrence if $e^{-\frac{1}{2}m_D^2} > 2e^{-\frac{1}{2}m_E^2}$.

**Proof**: Differentiating Equation (5-13) with respect to *b* yields

$$\frac{\partial f(\cdot)}{\partial b} = \frac{1}{\sigma\sqrt{2\pi T}} \frac{a_f (2+b)^2 + 4b\tau}{B_2 \left(4-b^2\right)^2} \left[-e^{-\frac{1}{2}m_D^2} + 2e^{-\frac{1}{2}m_E^2}\right].$$

It is obvious that $\partial f(\cdot)/\partial b < 0$ if $e^{-\frac{1}{2}m_D^2} > 2e^{-\frac{1}{2}m_E^2}$. ■

Similar to a tariff rate, the product substitutability also affects $R_D^*$ and $R_E^*$ simultaneously. Since the products of the firms are strategic complements in our model, an increase in *b* raises the equilibrium export price, thus decreasing the dumping margin and the probability of dumping occurrence as well. At the same time, it increases the profitability of the exporting firm, as Equation (5-7) shows, and thus lowers the exiting threshold. Therefore, its total effect is ambiguous. In contrast to the case of the tariff rate, if $e^{-\frac{1}{2}m_D^2} > 2e^{-\frac{1}{2}m_E^2}$, then the exit effect of product substitutability dominates its price effect, and thus product substitutability is inversely related to the probability of dumping occurrence.

### 3.3 Numerical simulation

To illustrate the asymmetry of the effects of exchange rate volatility as well as the exchange rate trend on the probability of dumping occurrence, numerical simulations are conducted in this subsection. We choose a base set of parameter values as follows: $a_d = 1$, $a_f = 1$, $b = 0.5$, $\tau = 0.05$, $\rho = 0.05$, $F = 0.5$, $K_1 = 6$, $R_0 = 1$, $t = 1$, $\mu = 0$, and $\sigma = 0.1$. To allow the firm to have a chance to exit the market, the values of these parameters chosen exclude the case in which the net profit flows are certainly positive in each period. In addition, it also ensures that the probability of dumping occurrence is positive.

The effects of exchange rate volatility on the probability of dumping occurrence under different parameter values are shown in Figures 5-1a and 5-1b. Figure 5-1a uses the baseline values and the values of two thresholds are $R_E^* = 0.3527$ and $R_D^* = 0.7772$. Figure 5-1b changes the values of $a_d$ and $F$ to be $a_d = 1.4$ and $F = 0.75$, and the values of the two thresholds become $R_E^* = 0.7935$ and $R_D^* = 1.0881$. Since the mean of the exchange rate in our setting is $e^{E \ln R} = 0.9980$, it is obvious that the threshold values in Figure 5-1b are around the mean but those in Figure 5-1a are far away from the mean. Figure 5-1a demonstrates that the relationship between exchange rate volatility and the probability of dumping occurrence is positive whereas Figure 5-1b illustrates that the relationship is negative. Hence, the simulation results are consistent with the prediction of our theory.

Regarding the exchange rate trend μ, Figure 5-2a reveals that an increase in μ tends to reduce the probability of dumping occurrence while Figure 5-2b indicates that it tends to raise the probability of dumping occurrence. Here, $\ln R_D^*$ and $\ln R_E^*$

are smaller than the mean of the logarithmic exchange rate in Figure 5-2a, and thus the *DE* is negative. We can see that the positive *TE* is dominated by the negative *DE*. In contrast, in Figure 5-2b, $R_E^* = 1.0581$ and $R_D^* = 1.1658$, and its total effect is positive, because *DE* becomes positive. These results are also consistent with the prediction of our theory.

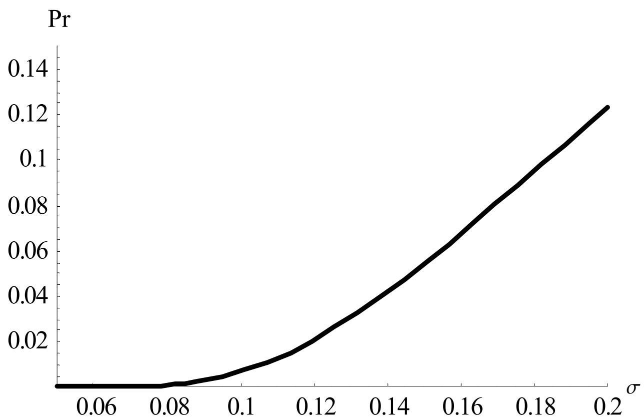


Figure 5-1a. Exchange rate volatility and the probability of dumping occurrence: $a_d$=1; $F$=0.5

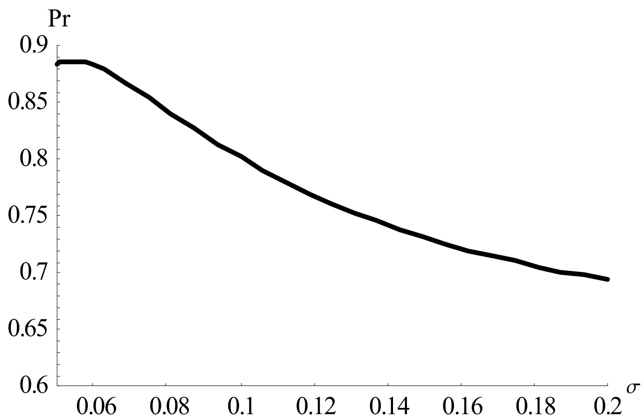


Figure 5-1b. Exchange rate volatility and the probability of dumping occurrence: $a_d$=1.4; $F$=0.75

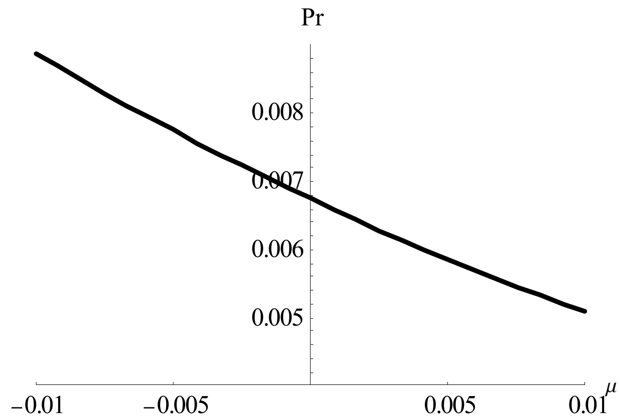


Figure 5-2a. Exchange rate trend and the probability of dumping occurrence: $a_d$=1; $F$=0.5

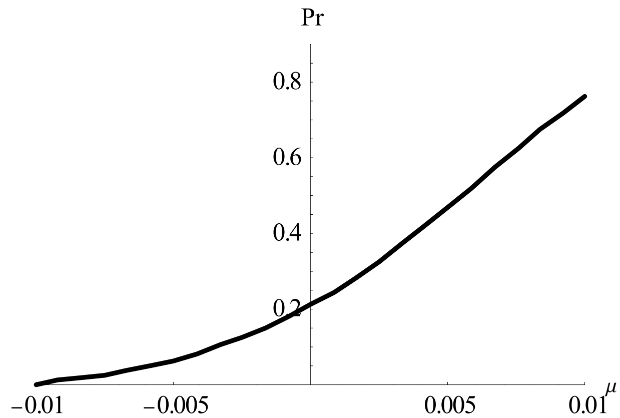


Figure 5-2b. Exchange rate trend and the probability of dumping: $a_d$=1.5; $F$=0.9

## 4. The impact of exchange rate movements on AD-jumping FDI

The purpose of this section is to discuss how an AD policy influences the decision of FDI under exchange rate uncertainty. Suppose that a foreign government adopts an AD policy and imposes a dumping duty on Firm 1's exports. An AD duty is charged according to the dumping margin in the last period. From Equation (5-11), the AD duty, $m$, is

$$m = \frac{B_1}{R_0} - B_2,^{72} \tag{5-15}$$

where $B_1 = \frac{a_d}{2}$ and $B_2 = \frac{a_f(2+b) - (2-b^2)\tau}{4-b^2}$. In addition, suppose that the dumping firm will be imposed with an AD duty forever once it is found that it has been dumping by the government of the importing country.

## 4.1 The optimum pricing

### 4.1.1 The equilibrium export under an AD policy

Facing an AD duty, Firm 1's profit flows from the export per period are:

$$\pi_{1f}^{AD} = \left(p_{1f} - \tau - m\right)\left(a_f - p_{1f} + b \cdot p_{2f}\right)R, \tag{5-16}$$

where superscript *AD* represents the state whereby Firm 1 is imposed with an AD duty. It is easy to show that the equilibriums price, quantity, and profit of Firm 1 are:

$$p_{1f}^{AD*} = \frac{a_f\left(2+b\right) + 2\left(\tau + m\right)}{\left(4-b^2\right)}, \tag{5-17a}$$

$$q_{1f}^{AD*} = \frac{a_f\left(2+b\right) - \left(2-b^2\right)\left(\tau + m\right)}{\left(4-b^2\right)}, \tag{5-17b}$$

$$\pi_{1f}^{AD*} = \frac{\left[a_f\left(2+b\right) - \left(2-b^2\right)\left(\tau + m\right)\right]^2 R}{\left(4-b^2\right)^2}. \tag{5-17c}$$

In order to ensure that quantity is greater than zero, we assume that:

$$a_f\left(2+b\right) > \left(2-b^2\right)\left(\tau + m\right). \tag{5-18}$$

[72] In the AD laws of the U.S., once an AD duty is applied to a product, the importer must pay the U.S. Customs a cash deposit equal to the *ad valorem* AD duty times the value of the subject product. Hence, the effect of an AD duty on a firm's revenues is through the current exchange rate level, not the exchange rate level in the measuring duty. Thus, the AD duty is in terms of foreign currency in our model.

### 4.1.2 Equilibrium AD-jumping FDI

If Firm 1 decides to stop exporting and undertake FDI instead after facing an AD duty, its profit flows become:

$$\pi_{1f}^{FDI} = p_{1f}\left(a_f - p_{1f} + b \cdot p_{2f}\right)R, \tag{5-19}$$

where superscript *FDI* represents the state of undertaking AD-jumping FDI. The equilibrium price, quantity, and profit are:

$$p_{1f}^{FDI*} = \frac{a_f}{2-b}, \tag{5-20a}$$

$$q_{1f}^{FDI*} = \frac{a_f}{2-b}, \tag{5-20b}$$

$$\pi_{1f}^{FDI*} = \frac{a_f^2 R}{\left(2-b\right)^2}. \tag{5-20c}$$

## 4.2 The optimum timing of AD-jumping FDI

### 4.2.1 The FDI decision without an AD duty

Even if there is no AD policy, the exporting firm may still choose to relocate its production abroad in order to circumvent its tariff under some circumstances. If the dumping firm is charged with an AD duty, then it is more likely to undertake FDI because of the increase in the trade cost of its exports. Therefore, we need to differentiate two different motives of FDI - namely, tariff-jumping FDI and AD-jumping FDI.

We first derive the threshold of tariff-jumping FDI. According to Equations (5-7) and (5-20c), the change in profit flows from undertaking tariff-jumping FDI is:

$$\Delta\pi_{1f}^{*} = \pi_{1f}^{FDI*} - \pi_{1f}^{*} = \theta R,^{73} \tag{5-21a}$$

[73] For simplicity, suppose that the fixed cost of the firm producing goods in the foreign country is the

where $\theta = \frac{a_f^2}{(2-b)^2} - \frac{\left[a_f - \frac{2-b^2}{2+b}\tau\right]^2}{(2-b)^2} > 0$. Thus, the expected present value of Firm 1 from undertaking tariff-jumping FDI, $\xi_{1f}^*$, is:

$$\xi_{1f}^*(R) = \int_0^\infty \Delta\pi_{1f}^* e^{-\rho t} dt = \frac{\theta}{\rho - \mu} R. \tag{5-21b}$$

The decision problem of Firm 1 is to choose the optimal time to undertake FDI. In each period Firm 1 faces a binary decision problem as follows:

$$V(R) = \max\left\{\xi_{1f}^*(R) + \xi_{1d}^*(R) - K_2, \pi_{1d}^* + \frac{1}{1+\Delta t\rho} E\left[V(R')\middle|R\right]\right\}, \tag{5-22}$$

where $K_2$ represents the sunk costs of implementing FDI, which is expressed in the home country's currency. Since the change in profits is an increasing function in $R$ and thus there is a cutoff point, $R^*$ - at which if $R > R^*$, then the net entry value is greater than the option value of waiting - and the firm's optimal decision is to undertake FDI. Using value-matching and smooth-pasting conditions, we have:

$$R^* = \frac{\rho - \mu}{\theta} \frac{\beta}{\beta - 1} K_2. \tag{5-23}$$

### 4.2.2 The FDI decision under an AD policy

Following a similar procedure used above, in this subsection we derive the threshold of the exchange rate at which the firm undertakes AD-jumping FDI. The change in profit flows from undertaking AD-jumping FDI is:

$$\Delta\pi_{1f}^{AD*} = \pi_{1f}^{FDI*} - \pi_{1f}^{AD*} = \theta_{AD} R, \tag{5-24a}$$

---

same as in the home country. Thus, we could ignore this cost in comparing the profit of FDI with exports.

where $\theta_{AD} = \frac{a_f^2}{(2-b)^2} - \frac{\left[a_f - \frac{2-b^2}{2+b}(\tau+m)\right]^2}{(2-b)^2} > 0$. Thus, the expected present value of Firm 1 from implementing AD-jumping FDI, $\xi_{1f}^{AD*}$, is:

$$\xi_{1f}^{AD*}(R) = \int_0^\infty \Delta\pi_{1f}^{AD*} e^{-\rho t} dt = \frac{\theta_{AD}}{\rho-\mu} R. \tag{5-24b}$$

In each period Firm 1 faces a binary decision problem as follows:

$$V(R) = \max\left\{\xi_{1f}^{AD*}(R) + \xi_{1d}^{*}(R) - K_2, \pi_{1d}^{*} + \frac{1}{1+\Delta t\rho} E\left[V(R')\middle|R\right]\right\}. \tag{5-25}$$

Here, $\xi_{1f}^{AD*}$ is an increasing function in *R*, and thus there is a cutoff point, $R_{AD}^{*}$, at which if $R > R_{AD}^{*}$, then the firm's optimal decision is to undertake AD-jumping FDI. Using value-matching and smooth-pasting conditions, we have:

$$R_{AD}^{*} = \frac{\rho-\mu}{\theta_{AD}} \frac{\beta}{\beta-1} K_2. \tag{5-26}$$

### 4.3 AD policy and AD-jumping FDI

If $R > R^{*}$, then the firm always chooses to undertake FDI regardless of whether the government adopts an AD policy or not. If $R < R_{AD}^{*}$, then the firm never undertakes FDI. Hence, AD-jumping FDI occurs only if $R_{AD}^{*} < R^{*}$. Therefore, the firm chooses to undertakes FDI under AD policy only when $R_{AD}^{*} < R < R^{*}$. We define the interval of the exchange rate in which AD-jumping FDI occurs, *JFDI*, as:

$$JFDI = R^{*} - R_{AD}^{*}. \tag{5-27}$$

Note that a higher entry threshold ($R^{*}$ or $R_{AD}^{*}$) represents that the firm tends to delay its FDI activity. A positive *JFDI* implies that an AD policy causes the firm to undertake FDI earlier, compared with the case without the AD policy.

**Proposition 5-6** An AD policy will stimulate AD-jumping FDI.

**Proof**. It is obvious that $\theta_{AD} > \theta$, and thus $R_{AD}^{*} < R^{*}$ and $JFDI > 0$. ■

The economic intuition of this proposition is straightforward. Since an AD policy increases the trade cost of exporting firms that commit dumping, it thus changes the relative profitability of exporting versus FDI in favor of FDI. Many empirical studies support this proposition. (e.g., Azrak and Wynne (1995), Barrell and Pain (1999), Belderbos (1997), Belderbos (2003), Blonigen (2002), Blonigen and Feenstra (1997), and Girma et al. (2002))

**Lemma 5-3** The effects on the thresholds resulting from changes in the model parameters are inversely related to the net profit of FDI. Since $\theta_{AD} > \theta$, the variation in the threshold of tariff-jumping FDI is larger than that in the threshold of AD-jumping FDI.

**Proof.** See Appendix 5-1.

**Proposition 5-7** An increase in exchange rate volatility will accelerate AD-jumping FDI.

**Proof**. From Equation (5-27), the effect of exchange rate volatility on AD-jumping FDI is:

$$\begin{aligned}\frac{\partial JFDI}{\partial \sigma} &= \frac{\partial R^{*}}{\partial \sigma} - \frac{\partial R_{AD}^{*}}{\partial \sigma} \\ &= \frac{-R^{*}}{\beta(\beta-1)}\frac{\partial \beta}{\partial \sigma} - \frac{-R_{AD}^{*}}{\beta(\beta-1)}\frac{\partial \beta}{\partial \sigma}\end{aligned}$$

$$= \frac{\sigma}{\sqrt{(\mu - 0.5\sigma^2)^2 + 2\rho\sigma^2}} \left( R^* - R^*_{AD} \right) > 0 \text{ . } \blacksquare$$

It is clear from the proof of Proposition 5-7 that exchange rate volatility raises both entry thresholds, $R^*$ and $R^*_{AD}$, so as to deter FDI in both states. However, the change in $R^*$ is larger than that in $R^*_{AD}$ (Lemma 5-3), and thus the net effect of exchange rate volatility on *JFDI* is positive. Therefore, an AD policy will stimulate AD-jumping FDI activity if exchange rate volatility is higher.

**Proposition 5-8** An increase in the exchange rate trend will deter AD-jumping FDI.

**Proof**. From Equation (5-27), the exchange rate trend's effect on AD-jumping FDI is:

$$\frac{\partial JFDI}{\partial \mu} = \frac{\partial R^*}{\partial \mu} - \frac{\partial R^*_{AD}}{\partial \mu}$$
$$= \frac{\phi}{(\beta - 1)(\rho - \mu)\sqrt{(\mu - 0.5\sigma^2)^2 + 2\rho\sigma^2}} \left( R^* - R^*_{AD} \right) < 0,$$

where $\phi = \rho - \mu - (\beta - 1)\sqrt{2\rho\sigma^2 + (\mu - 0.5\sigma^2)^2} < 0$.[74] ■

The economic intuition behind Proposition 5-8 is as follows. Since the exchange rate trend represents the future expected exchange rate level, an increase in μ raises the expected profit, thus stimulating FDI activity in both states. However, as shown in Lemma 5-3, the reduction in the entry threshold of AD-jumping FDI is smaller than that of tariff-jumping FDI. Therefore, an increase in the exchange rate trend might deter AD-jumping FDI although total FDI increases.

[74] See Appendix 2-2 for the proof of $\phi < 0$.

**Proposition 5-9** An increase in the sunk costs of FDI, $K_2$, will accelerate AD-jumping FDI.

**Proof**. From Equation (5-27), the effect of sunk costs on AD-jumping FDI is

$$\frac{\partial JFDI}{\partial K_2} = \frac{\partial R^*}{\partial K_2} - \frac{\partial R^*_{AD}}{\partial K_2}$$
$$= \frac{1}{K_2}\left(R^* - R^*_{AD}\right) > 0 . \blacksquare$$

The reason why an increase in the sunk costs of FDI might stimulate AD-jumping FDI is that with higher sunk costs the investing firm needs to be compensated by higher revenue from FDI, and thus the thresholds will be higher when sunk costs rise. However, the change in $R^*$ is larger than that in $R^*_{AD}$ as shown in Lemma 5-3, and thus the net effect on *JFDI* is positive. Therefore, although higher sunk costs reduce the willingness of the firm to engage in FDI, they increase the probability of the occurrence of AD-jumping FDI. This proposition implies that an AD policy will result in more AD-jumping FDI from capital-intensive industries.

**Proposition 5-10** An increase in the tariff rate, τ, will deter AD-jumping FDI if $a_d > \frac{2}{2-b} a_f R_0$.

**Proof**. From Equation (5-27), the effect of a tariff rate on AD-jumping FDI is:

$$\frac{\partial JFDI}{\partial \tau} = \frac{\partial R^*}{\partial \tau} - \frac{\partial R^*_{AD}}{\partial \tau}$$
$$= \frac{(\rho-\mu)\beta}{\beta-1} K_2 \left( \frac{\partial \theta_E^{-1}}{\partial \tau} - \frac{\partial \theta_D^{-1}}{\partial \tau} \right)$$
$$= -\frac{(\rho-\mu)\beta}{\beta-1} K_2 \frac{(2-b)^2 (2+b)}{2a_f\left(2-b^2\right)} \left[\Lambda_1 + \Lambda_2\right],$$

where

$$\Lambda_1 = \frac{1}{\tau^2} - \frac{1+\frac{R_0(2-b^2)}{4-b^2}}{(m+\tau)^2},$$

and

$$\Lambda_2 = \frac{1+\frac{R_0(2-b^2)}{4-b^2}}{\left[\frac{2(2+b)a_f}{2-b^2}-(m+\tau)\right]^2} - \frac{1}{\left[\frac{2(2+b)a_f}{2-b^2}-\tau\right]^2}.$$

It is obvious that $\Lambda_2 > 0$, since Equation (5-18) implies that $\frac{2(2+b)a_f}{2-b^2} > (m+\tau)$. Note that

$$\Lambda_1 = \frac{\varphi_1^2 + 4\varphi_1\varphi_2\tau + 4(2-b^2)\varphi_2\tau^2}{\tau^2(m+\tau)^2 4(4-b^2)^2},$$

where $\varphi_1 = (2+b)[a_d(2-b) - 2a_f R_0]$ and $\varphi_2 = 2(2+R_0) - b^2(1+R_0) > 0$. Therefore, $\Lambda_1 > 0$ if $a_d > \frac{2}{2-b}a_f R_0$. Consequently, $\partial JFDI/\partial\tau < 0$ if $a_d > \frac{2}{2-b}a_f R_0$.

■

Since $m = \frac{1}{2R_0}[a_d - \frac{2}{2-b}a_f R_0] + \frac{2-b^2}{4-b^2}\tau$, the condition $a_d > \frac{2}{2-b}a_f R_0$ implies that the scale of the home market must be large enough so that the dumping margin, *m*, is positive even if the tariff rate, τ, equals to zero. The tariff rate affects profit flows from engaging in FDI through two channels - namely, the profitability of export and dumping margin. In our model, a permanent increase in the tariff rate raises the dumping margin as evidenced in Equation (5-11). Hence, the firm will suffer a larger loss in profit flows from exports under an AD policy. Therefore, the net benefits of FDI become higher under an AD policy, such that the entry thresholds drop in both states. However, According to Lemma 5-3, the reduction in the entry threshold of AD-jumping FDI is smaller than that of tariff-jumping FDI. Consequently, an increase in the tariff rate will deter AD-jumping FDI.

To sum up, we obtain several different findings in this section compared with the results from the traditional real options model. For example, we find that the exchange rate volatility tends to stimulate AD-jumping FDI while the traditional model predicts that uncertainty will deter FDI activity. In addition, we also find that sunk costs tend to stimulate AD-jumping FDI while the traditional model predicts the opposite result. The rationale behind these differences is that we define AD-jumping FDI as subtracting the tariff-jumping FDI from total FDI - that is, we focus on the net FDI flows induced by an AD policy. These results have an important implication for the model specification of empirical studies regarding the effect of an AD policy on the occurrence of AD-jumping FDI. It is necessary to control for the influence of tariff or other trade costs on FDI in order to identify the net effect of an AD policy on FDI activity.

## 5. Welfare effect of an AD policy

The social welfare ($W$) of the importing country is defined as the sum of consumer surplus ($CS$), the local firm's producer surplus ($\pi_{2f}$), and tax revenue ($(m+\tau)\cdot q_{1f}$). The tax revenue includes AD duty and tariff revenues. Accordingly, the social welfare function of the importing country can be written as

$$W = CS + \pi_{2f} + (m+\tau)\cdot q_{1f}. \qquad (5\text{-}28)$$

Three possible scenarios are now investigated. First, the government does not adopt an AD policy and Firm 1 serves the foreign market via exports. The social welfare under this scenario is denoted by $W_N$. Second, the government adopts an AD policy, and Firm 1 undertakes AD-jumping FDI. Under this scenario, the government does not receive any tax revenue, and the social welfare is denoted by $W_{FDI}$. Third, the government adopts an AD policy, and Firm 1 continues to export its product to the foreign market without undertaking AD-jumping FDI. Under this scenario, the government collects both tariff revenue and AD duties from Firm 1, and the social welfare is denoted by $W_{AD}$.

Using the results derived in the previous sections, the social welfare under these three scenarios can be written as:[75]

$$\begin{aligned} W_{FDI} &= CS_{FDI} + \pi_{2f}^{FDI*} \\ &= \frac{a_f^2}{(1-b)(2-b)}, \end{aligned} \tag{5-29a}$$

$$\begin{aligned} W_N &= CS_N + \pi_{2f}^{*} + \tau q_{1f}^{*} \\ &= \frac{a_f^2}{(1-b)(2-b)} + \frac{\tau\left[a_f(1+b) - \left(\frac{3}{2} - b^2\right)\tau\right]}{4-b^2}, \end{aligned} \tag{5-29b}$$

and

$$\begin{aligned} W_{AD} &= CS_{AD} + \pi_{2f}^{AD*} + (m+\tau) q_{1f}^{AD*} \\ &= \frac{a_f^2}{(1-b)(2-b)} + \frac{(m+\tau)\left[a_f(1+b) - \left(\frac{3}{2} - b^2\right)(m+\tau)\right]}{4-b^2}. \end{aligned} \tag{5-29c}$$

According to the discussion in the last section, if $R > R^*$, then Firm 1 always chooses to undertake FDI instead of exports, because the savings in the trade costs in terms of the home currency from undertaking FDI are larger than the sunk costs of FDI, $K_2$. Thus, there is no export activity initially, and AD laws become irrelevant. However, if $R < R_{AD}^*$, then Firm 1 always chooses exports as an entry mode to serve the foreign market, while if $R_{AD}^* < R < R^*$, then Firm 1 chooses to undertake AD-jumping FDI instead. The last two cases are discussed further in the following section.

---

[75] $CS = [q_{1f}^2 + q_{2f}^2 + 2bq_{1f}q_{2f}]/2(1-b^2)$. See Belderbos et al. (2004), p.449.

### 5.1 Absence of AD-jumping FDI ( $R < R_{AD}^{*}$ )

**Proposition 5-11** If $R < R_{AD}^{*}$, then an AD policy will hurt consumers and benefit domestic producers in the importing country - that is, $CS_{AD} - CS_{N} < 0$ and $\pi_{2f}^{AD*} - \pi_{2f}^{*} > 0$.

**Proof**. From Equations (5-29b) and (5-29c), we have

$$CS_{AD} - CS_{N} = -\frac{m\left[a_f\left(2+b\right)^2 - \left(2-\tfrac{3}{2}b^2\right)\left(m+2\tau\right)\right]}{\left(4-b^2\right)^2}$$
$$= -\frac{m}{\left(4-b^2\right)^2}\left[a_f\left(2+b\right) - \left(2-\tfrac{3}{2}b^2\right)\left(m+\tau\right)\right]$$
$$-\frac{m}{\left(4-b^2\right)^2}\left[a_f\left(2+b\right)\left(1+b\right) - \left(2-\tfrac{3}{2}b^2\right)\tau\right].$$

Equations (5-8) and (5-17) imply $CS_{AD} - CS_{N} < 0$. It is also easy to show that:

$$\pi_{2f}^{AD*} - \pi_{2f}^{*} = \frac{bm\left(2a_f\left(2+b\right) + b\left(m+2\tau\right)\right)}{\left(4-b^2\right)^2} > 0. \blacksquare$$

**Proposition 5-12** If $R < R_{AD}^{*}$ and $a_f(2+b) > (2-b^2)(m+2\tau)$, then an AD policy will reduce the tariff revenue but increase the total tax revenue of the importing country - that is, $\tau \cdot q_{1f}^{AD*} - \tau \cdot q_{1f}^{*} < 0$ and $m \cdot q_{1f}^{AD*} + \tau \cdot q_{1f}^{AD*} - \tau \cdot q_{1f}^{*} > 0$.

**Proof**. From Equations (5-29b) and (5-29c), we have

$$\tau \cdot q_{1f}^{AD*} - \tau \cdot q_{1f}^{*} = -\frac{\left(2-b^2\right)m\tau}{4-b^2} < 0$$

and

$$m \cdot q_{1f}^{AD*} + \tau \cdot q_{1f}^{AD*} - \tau \cdot q_{1f}^{*} = \frac{m\left[a_f\left(2+b\right)-\left(2-b^2\right)\left(m+2\tau\right)\right]}{4-b^2}.$$

It is obvious that $m \cdot q_{1f}^{AD*} + \tau \cdot q_{1f}^{AD*} - \tau \cdot q_{1f}^{*} > 0$ if $a_f(2+b) > (2-b^2)(m+2\tau)$. ■

In this scenario, if $R < R_{AD}^{*}$, then Firm 1 always chooses exports to serve the foreign market. Thus, if the government adopts an AD policy, then it will have tariff revenue and AD duty revenue as well. The intuition behind Propositions 5-11 and 5-12 is that an AD duty increases Firm 1's marginal cost of exports, resulting in an increase in the import price in the foreign market. Therefore, consumers lose and Firm 2 gains from this policy. The gains in the profit of the local firms are referred to as the **profit-shifting effect** of the trade policy. However, since the higher equilibrium price causes the reduction in Firm 1's sales ($q_{1f}^{AD*} < q_{1f}^{*}$), tariff revenue is also reduced under the AD policy. Nevertheless, the government's gains from collecting AD duty dominate its loss in tariff revenue, if the condition $a_f(2+b) > (2-b^2)(m+2\tau)$ [76] holds. Therefore, the total tax revenue of the government increases.

**Lemma 5-4** If $R < R_{AD}^{*}$ and $a_f > \frac{1}{2}(m+2\tau)$, then:

$\left(CS_{AD} + \pi_{2f}^{AD*}\right) - \left(CS_N + \pi_{2f}^{*}\right) < 0$.

**Proof**. According to Proposition 5-11, we have:

$$\left(CS_{AD} + \pi_{2f}^{AD*}\right) - \left(CS_N + \pi_{2f}^{*}\right) = -\frac{m\left(a_f - \frac{1}{2}\left(m+2\tau\right)\right)}{4-b^2}.$$

Thus, $\left(CS_{AD} + \pi_{2f}^{AD*}\right) - \left(CS_N + \pi_{2f}^{*}\right) < 0$ if $a_f > \frac{1}{2}(m+2\tau)$. ■

[76] Since $a_f$ represents the scale of the foreign market, it is reasonable to believe that $a_f$ is large enough to cover $\tau$ and $m$.

**Proposition 5-13** If $R < R_{AD}^{*}$ and $a_f(1+b) > (\frac{3}{2}-b^2)(m+2\tau)$, then $W_{AD} - W_N > 0$ - that is, an AD policy is welfare-improving.

**Proof**. According to Proposition 5-12 and Lemma 5-4, we have

$$W_{AD} - W_N = \left[m \cdot q_{1f}^{AD*} + \tau \cdot q_{1f}^{AD*} - \tau \cdot q_{1f}^{*}\right] - \left[\left(CS_{AD} + \pi_{2f}^{AD*}\right) - \left(CS_N + \pi_{2f}^{*}\right)\right]$$
$$= \frac{m\left[a_f(1+b) - \left(\frac{3}{2}-b^2\right)(m+2\tau)\right]}{4-b^2}.$$

It is obvious that $W_{AD} - W_N > 0$ if $a_f(1+b) > (\frac{3}{2}-b^2)(m+2\tau)$. ■

Lemma 5-4 indicates that the producer's gains are dominated by the consumers' losses under the condition $a_f > \frac{1}{2}(m+2\tau)$[77]. However, the government benefits from collecting AD duty, $m \cdot q_{1f}^{AD*}$, and these gains are large enough so that the social welfare of the importing country increases. This result is consistent with the prediction of recent theory about strategic trade policy, which suggests that in an international imperfectly competitive industry a government can employ trade policies to increase its social welfare.[78]

### 5.2 Presence of AD-jumping FDI ($R_{AD}^{*} < R < R^{*}$)

**Proposition 5-14** If $R_{AD}^{*} < R < R^{*}$, then an AD policy will hurt domestic producers and benefit consumers in the importing country - that is, $CS_{FDI} - CS_N > 0$ and $\pi_{2f}^{FDI*} - \pi_{2f}^{*} < 0$.

**Proof**. From Equations (5-29a) and (5-29b), it is easy to show that

[77] ibid.
[78] See, for instance, Webb (1992).

$$CS_{FDI} - CS_N = \frac{\tau\left(a_f(2+b)^2 - \left(2-\frac{3}{2}b^2\right)\tau\right)}{\left(4-b^2\right)^2} > 0 \text{ (Equation (5-8)),}$$

and

$$\pi_{2f}^{FDI*} - \pi_{2f}^{*} = -\frac{b\tau\left(2a_f(2+b)+b\tau\right)}{\left(4-b^2\right)^2} < 0 . \blacksquare$$

The rational behind Proposition 5-14 is that under these circumstances an AD policy induces Firm 1 to undertake AD-jumping FDI, which causes more severe price competition in the foreign market, because of the reduction in the delivering costs of Firm 1, compared to the case without the AD policy. This will lower equilibrium market prices in the foreign market. Consequently, consumers gain and Firm 2 loses. This result is in stark contrast with that in the previous case in which there is no AD-jumping FDI.

**Lemma 5-5** If $R_{AD}^* < R < R^*$ and $a_f > \frac{1}{2}\tau$, $\left(CS_{FDI} + \pi_{2f}^{FDI*}\right) - \left(CS_N + \pi_{2f}^{*}\right) > 0$.

**Proof**. According to Proposition 5-14, it can be shown that:

$$\left(CS_{FDI} + \pi_{2f}^{FDI*}\right) - \left(CS_N + \pi_{2f}^{*}\right) = \frac{\tau\left(a_f - \frac{1}{2}\tau\right)}{4-b^2} > 0 . \blacksquare$$

**Proposition 5-15** If $R_{AD}^* < R < R^*$ and $a_f(1+b) > (\frac{3}{2} - b^2)\tau$, then $W_{FDI} < W_N$ - that is, AD policy is welfare-worsening.

**Proof**. According to Lemma 5-5, we have

$$\begin{aligned} W_{FDI} - W_N &= \left[\left(CS_{FDI} + \pi_{2f}^{FDI*}\right) - \left(CS_N + \pi_{2f}^{*}\right)\right] - \tau q_{1f}^* \\ &= -\frac{\tau\left[a_f(1+b) - \left(\frac{3}{2} - b^2\right)\tau\right]}{4-b^2}. \end{aligned}$$

It is obvious that, $W_{FDI} - W_N < 0$ if $a_f(1+b) > (\frac{3}{2} - b^2)\tau$. ■

Proposition 5-15 indicates that an AD policy might hurt the importing country. On the one hand, Firm 1's AD-jumping FDI benefits the consumers and hurts the domestic firm (Proposition 5-14). Lemma 5-5 indicates that the consumers' gains dominate the producer's loss. On the other hand, the government of the importing country is also hurt by the AD-jumping FDI owing to its loss in tax revenue. The net welfare effect becomes negative under the condition $a_f(1+b) > (\frac{3}{2} - b^2)\tau$ [79]. Therefore, the government should not adopt an AD policy when $R^*_{AD} < R < R^*$. This result is also totally different from what we found in the previous case in which there is no AD-jumping FDI.

**Proposition 5-16** If the government's objective function is social welfare maximization, then it should adopt an AD policy only when $R < R^*_{AD}$ - that is, an AD policy should be adopted only under the circumstances in which this policy will not induce AD-dumping FDI.

The result in Proposition 5-16 is different from that proposed by Belderbos et al. (2004). Belderbos et al. (2004) suggest that an AD policy is welfare improving even if it might induce AD-jumping FDI. The difference between their result and ours can be attributed to the fact that they ignore tariff revenue in their model. The difference can be illustrated further with our model.[80] For example, let tariff rate, τ, be zero. When

[79] See footnote 76.

[80] In addition, there are several differences between Belderbos et al. (2004) and our model. For example, they use injury margin while we consider dumping margin in measuring the AD duty. Moreover, they ignore exchange rate uncertainty and tariff-jumping FDI.

$R^*_{AD} < R < R^*$, an AD policy will induce AD-jumping FDI. However, consumers' gains dominate the loss in Firm 2's profits (Lemma 5-5). In this case, an AD policy is welfare improving even if it might induce AD-jumping FDI, simply because there is no loss in tariff revenue. These results reveal that it is essential to consider the changes in tariff revenue when examining the welfare effect of an AD policy.

To sum up, our theoretical results indicate that several important factors should be taken into account when the government decides whether to adopt an AD policy or not. First, the level of exchange rate: the only circumstance under which a government should adopt an AD policy is when the exchange rate level is low enough ($R < R^*_{AD}$). Second, the volatility of the exchange rate: the higher the exchange rate volatility is, the higher $R^*_{AD}$ will be. Hence, the incentive of the foreign firm in undertaking AD-jumping FDI is lower. Therefore, an AD policy is more likely to be welfare-improving. Finally, the level of tariff: if the tariff rate is high enough, then an AD policy might be welfare-worsening, since the government's loss in tax revenue in addition to the local firm's loss in profits will dominate the consumers' gains if Firm 1 undertakes AD-jumping FDI.

## 6. Conclusion

This chapter theoretically examines how exchange rate movements affect dumping occurrences and AD-jumping FDI in addition to the social welfare effect of an AD policy. Our results reveal that the effect of exchange rate volatility on the probability of dumping occurrence is ambiguous, depending on the level of the exchange rate. If the exiting threshold and the dumping threshold are far away from the mean of the exchange rate, then exchange rate volatility is positively related to the probability of dumping occurrence. By contrast, if the two thresholds are close to the mean, then exchange rate volatility and the probability of dumping occurrence are inversely related. These results are different from those in the case of cost dumping illustrated by Dixit (1989b).

If the government adopts an AD policy, then it is shown that this policy might induce exporting firms to undertake AD-jumping FDI. In addition, it is found that exchange rate volatility is positively related to AD-jumping FDI. If an AD policy induces AD-jumping FDI, then the AD policy will hurt domestic producers and benefit local consumers, contrary to the prediction of traditional theory without considering the possibility of AD-jumping FDI. Finally, we find that an AD policy might have a negative impact on the social welfare of the importing country, because of the loss in tax revenue and profits of the local firm as well when the exporting firm chooses to undertake AD-jumping FDI to substitute for its exports.

# Appendix 5-1. Proofs of Lemmas

**Proof of Lemma 5-1**

From Equations (5-13) and (5-14a), we have:

$$DE_{\sigma} = \frac{1}{\sigma\sqrt{2\pi}}\left[e^{-\frac{1}{2}m_D^2}\left(\sigma\sqrt{T}-m_D\right)-e^{-\frac{1}{2}m_E^2}\left(\sigma\sqrt{T}-m_E\right)\right]$$
$$= \frac{1}{\sigma\sqrt{2\pi}}\left[H\left(m_D\right)-H\left(m_E\right)\right], \tag{5A-1}$$

where $H(x) = e^{-\frac{1}{2}x^2}(\sigma\sqrt{T}-x)$. Since $R_D^* > R_E^*$, $m_D > m_E$. Thus, the sign of $DE_{\sigma}$ is positive (negative) if $H(x)$ is a monotonously increasing (decreasing) function of $x$. Differentiating $H(x)$ with respect to $x$ yields

$$\frac{\partial H\left(x\right)}{\partial x} = e^{-\frac{1}{2}x^2}\left[x\left(x-\sigma\sqrt{T}\right)-1\right].$$

It is obvious that $H(x)$ is not a monotone function. However, $\partial H(x)/\partial x > 0$ if $x > \frac{1}{2}(\sigma\sqrt{T}+\sqrt{4+T\sigma^2})$ or $x < \frac{1}{2}(\sigma\sqrt{T}-\sqrt{4+T\sigma^2})$. Therefore, $DE_{\sigma}$ is positive if $m_D > m_E > \frac{1}{2}(\sigma\sqrt{T}+\sqrt{4+T\sigma^2})$ or $m_E < m_D < \frac{1}{2}(\sigma\sqrt{T}-\sqrt{4+T\sigma^2})$. ■

**Proof of Lemma 5-2**

From Equations (5-13) and (5-14b), we have:

$$DE_{\mu} = \frac{\sqrt{T}}{\sigma\sqrt{2\pi}}\left[e^{-\frac{1}{2}m_E^2}-e^{-\frac{1}{2}m_D^2}\right]$$
$$= \frac{\sqrt{T}}{\sigma\sqrt{2\pi}}\left[G\left(m_E\right)-G\left(m_D\right)\right], \tag{5A-2}$$

where $G(x) = e^{-\frac{1}{2}x^2}$. Since $R_D^* > R_E^*$, $m_D > m_E$. Thus, the sign of $DE_{\mu}$ is positive (negative) if $G(x)$ is a monotonously decreasing (increasing) function of $x$. Differentiating $G(x)$ with respect to $x$ yields:

$$\frac{\partial G(x)}{\partial x} = -xe^{-\frac{1}{2}x^2}.$$

It is obvious that $G(x)$ is not a monotone function. However, $\partial G(x)/\partial x > 0$ if $x < 0$. Therefore, $DE_\mu$ is positive if $m_D > m_E > 0$ and negative if $m_E < m_D < 0$. ■

**Proof of Lemma 5-3**

Suppose that the original threshold is $\bar{R}$. Let $\Delta$ denote the changes in the variables and $\bar{\theta}$ denote the net profit of FDI. According to value-matching and smooth-pasting conditions, we have

$$\underbrace{\frac{\bar{\theta}+\Delta\bar{\theta}}{\rho-(\mu+\Delta\mu)}\left(\bar{R}+\Delta\bar{R}\right)-\left(K_2+\Delta K_2\right)}_{\text{the value of undertaking FDI}} = \underbrace{\frac{\bar{\theta}+\Delta\bar{\theta}}{\rho-(\mu+\Delta\mu)}\frac{1}{\beta+\Delta\beta}\left(\bar{R}+\Delta\bar{R}\right)}_{\text{the value of the option to wait}},$$

or

$$\Delta\bar{R} = \frac{\rho-(\mu+\Delta\mu)}{\bar{\theta}+\Delta\bar{\theta}}\frac{\left(K_2+\Delta K_2\right)}{1-\frac{1}{\beta+\Delta\beta}} - \bar{R}.$$

Since the values of $K_2$, $\rho$, $\mu$, and $\beta$ are the same in both tariff-jumping FDI and AD-jumping FDI, it is clear that the effects of $\Delta\bar{\theta}$, $\Delta K_2$, $\Delta\mu$, and $\Delta\beta$ on $\Delta\bar{R}$ are inversely related to $\bar{\theta}$. Since $\theta_{AD} > \theta$, the change in the threshold of tariff-jumping FDI will be larger than that in the threshold of AD-jumping FDI. ■