Antidumping, Price Undertaking and Technology Transfer

Cheng-Hau Peng†
Department of Economics, Fu-Jen Catholic University

Hong Hwang
Department of Economics, National Taiwan University

and

RCHSS, Academia Sinica

This paper is to explore the effect of price undertakings, which is an anti-dumping policy extensively adopted by the EU, on technology transfer in a two-country model with technology licensing between foreign and domestic firms. We assume there are two countries, the US and EU, hosting one firm each. The US firm, with a cost-reducing innovation, serves both the US and the EU markets, while the EU firm is a local enterprise serving only the EU market. The two firms compete in Cournot fashion in the EU market. When dumping occurs, the EU government can implement an antidumping policy (price undertaking) to protect the EU firm. Like other trade barrier, this EU antidumping policy can enhance (decrease) the competitiveness of the EU firm (US firm), and thus encourages the US firm to license its technology to the EU firm. It is found that technology transfer is more likely to occur if the EU imposes the price undertaking policy. In addition, the optimal royalty rate charged by the patent holder is likely to be less than the magnitude of the innovation if trade between the countries entails a cost. This finding runs against the standard result in the licensing literature. We also show that if the cost advantage of the US firm (the constrained firm) relative to the EU firm (the protected firm) is large enough, consumer surplus, producer surplus as well as social welfare of the EU (the protected country) are necessarily higher under price undertaking than that under free trade. This result is interesting and might provide an explanation as why countries with cost disadvantage have initiated many antidumping investigations in past decades.

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1 Introduction

Whereas the use of tariffs, quotas and voluntary export restraints (VERs) has declined due to the regulations of the GATT/WTO over the past two decades,\(^1\) instead, antidumping (AD) has emerged recently as a new and highly widespread form of trade protection. Some authors argue that antidumping has in fact become the most important instrument of trade policy in many countries (Niels, 2000). It is now widely recognized that the growing number of antidumping cases has resulted from the liberalization of tariffs, the lack of satisfactory provisions to safeguard products and increasingly weak antidumping standards.

The first antidumping legislation dates back to the legislation passed in Canada in 1904. According to Article VI of the GATT, dumping occurs when the price charged in the export market is below the ‘normal’ or ‘fair’ value of the good. This can consist of the price in the domestic market, the price charged in other export markets or else an estimate of the total average cost of the good.

The issue on antidumping policy has been studied in many directions. The effect of antidumping policy on outputs, profits and social welfare are examined in the early literature. For example, Reitze (1993) discusses the welfare effects of an antidumping policy under Cournot or Bertrand competition with the products being either perfect or imperfect substitutes. He finds that the threat of antidumping duties could change the strategic behavior of firms which might improve domestic welfare under Cournot competition but definitely worsen it under Bertrand competition. More surprisingly, the welfare of the foreign country always improves. An excellent survey has been conducted by Blonigen and Prusa (2001).

More recently, the major direction concerns the impact of antidumping policy on FDI. For example, Belderbos (1997) and Blonigen (2002) provide empirical evidences that antidumping policies may result in tariff-jumping FDI. Belderbos, Vandenbussche and Veugelers (2004) allow foreign firms to jump on antidumping duties and show that, if the products are not too differentiated, then price undertaking could reduce foreign firm’s incentive to engage in FDI and may even discourage FDI. Blonigen (2005) surveys the determinants of FDI and finds that “trade protection” plays an important role in FDI. Peng and Hwang (2008) conclude that if the fixed cost of FDI is not high, the foreign firm with a higher marginal cost is more likely to will definitely engage in FDI when it is subject to an antidumping policy. For other debates, Gao and Miyagiwa (2005) analyze the impact of antidumping on R&D. They show that the exporting firm, if constrained by antidumping law, will invest more on R&D, whilst the protected firm invests less. Veugelers and Vandenbussche (1999) look at market structure and

\(^1\) Voluntary export restraint has been banned by WTO since 2000.
collusive behaviour of firms in the presence of tariffs and undertakings. Vandenbussche and Wauthy (2001) examine how product quality and price are affected by antidumping. They find that an antidumping policy may change the “winner” of the quality game and decrease the home country’s welfare.

Even though antidumping filings are now widely recognized as being a tool for protecting industries that are injured by low-cost imports or for protecting industries that are struggling to restructure, they nevertheless have surged in recent years (Blonigen and Prusa, 2001; Zanardi, 2004), as is shown in Figure 1. Figure 1 clearly shows the upward trend in the total number of initiated antidumping investigations, reflecting the increasing importance of antidumping action. Remarkably, most of the increase comes from a surge in the amount of cases initiated by developing countries. The traditional users of antidumping (i.e. the EU, Canada, Australia, New Zealand, the US and also South Africa) report a stable to decreasing number of antidumping investigations over time. The increasing antidumping activity of less-developed countries is striking, because it challenges the traditional view that it is mainly rich countries that protect their markets against cheap labor-intensive imports.2

This fact gave rise to the following question: Whether the developing countries take antidumping policies as a means for absorbing new technology? This is the main idea of this paper. In this study, we shall setup a two-country model to examine whether the price undertakings would encourage the high-tech firms to transfer its advanced technology and its welfare implications.

Literature on this strand earned most concern on whether the protection policies would enlarge or mitigate the technology gap between the developed and developing countries. Tornell (1991) finds that, once protection is in place, it is rational for an industry to under-invest in cost-reducing technology even when investment-contingent subsidies are in place. Along the same line, Miyagiwa and Ohno (1995) show that temporary protection (tariffs or quotas) delays the adoption of new technologies and cannot empower domestic industries in (re)gaining competitiveness quicker. Everaert (2003) also shows that the adoption of new technologies is also delayed under a different tool of protection, namely price undertakings. It is worth noting that the research on technology adoption focuses on the behavior of the low-tech firms, and assumes there is a one-time fixed cost when the low-tech firm engages in technology adoption. However, in this study, we concern the strategic behavior of the high-tech

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2 According to Global Trade Protection Report 2009, the countries initiating the most antidumping investigations in 2008 are: India(28), Brazil (23), Turkey(22), Argentina (19), EC (19), US (19), China (14), Indonesia (7), Ukraine (7), Australia(6), Colombia (6), Korea (5), Canada (3), Pakistan (3), Chile (1), Israel (1), Mexico (1) and South Africa (1).
firms which can transfer its technology via licensing.

![Figure 1: Antidumping initiations, 1981 – 2001 (Source: Zanardi, 2004)](chart)

Literature most related to this study are Kabiraj and Marjit (2003) and Mukherjee and Pennings (2006). Kabiraj and Marjit (2003) consider a duopolistic trade model where a tariff induces the foreign firm to transfer its superior technology to the domestic rival. They have shown that a tariff can induce technology transfer of the foreign firm and therefore raises consumers’ surplus relative to the free trade situation. Mukherjee and Pennings (2006) challenge the conventional wisdom that exclusive owners of an advanced technology are always better off when producing as a monopolist than when competing against another firm. They find that the foreign high-efficient firm is more likely to transfer its technology via licensing as the host country imposes a tariff on imports.

Again, these studies focus on the effects of traditional protection policy on technology transfer. The impact of antidumping policies, a new and highly widespread form of trade protection recently, on technology transfer has not been investigated. In this study, we shall analyze the case of price undertakings because, to an important extent, the effect of antidumping duties on technology transfer is similar to that of tariffs and most of EU antidumping filings finalize with the acceptance by the EU of a price undertaking. This holds especially for antidumping filings against Central and
Eastern European Countries with whom the EU has signed Europe Agreements. The study by Zanardi (2004) also shows that countries like Japan, Finland, Sweden and South Korea make frequent use of undertakings. Apart from their importance as instruments of temporary protection, it must also be stressed that price undertakings are different in nature, compared with duties. Whereas duties tend to ‘punish’ the dumping exporters by levying a tax on their exports, price undertakings are perceived to have a more ‘amicable’ character, since they allow the exporting firms to raise their prices and ceteris paribus collect higher profits on exported production. The more friendly character of price undertakings hence explains also why they have become preferred when the EU settles trade disputes with its future member states. Little is known however what the effects of domestic price undertakings are on the technology transfer strategy for the foreign high-tech firms. This paper tends to fill this gap by analyzing the effectiveness of price undertakings in speeding up the transfer of new technologies in the constrained firms. As far as we know, this paper is the first to address this issue and can hence be seen as a novel contribution to the literature.

Our results suggest that the foreign high-tech firm is more likely to transfer its technology via licensing in response to domestic price undertaking policy. This result is in parallel to the literature in which tariffs can induce technology licensing. This implies that price undertakings could also act as a means of efficiency-enhancing for the developing countries. Moreover, in certain innovation levels, we find that an antidumping policy not only improves firms’ profits but also enhance the consumer surplus and the domestic welfare in developing countries. This finding is of interesting as protection policy is usually in favor of domestic producers while it always harms consumers.

This paper makes several contributions and is most directly related to the literature on technology transfer and antidumping. Firstly, the previous studies mainly focus on the behavior of technology adoption of the low-tech firms. Our work differs from then as we examine the incentive of the high-tech firm in licensing its advanced skills. Secondly, different from Kabiraj and Marjit (2003) which consider the traditional trade barrier, we look at the effects of a different protection tool, namely price undertakings.

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3 As agreed on the Essen Summit in 1994, these Agreements grant a preferential role for price undertakings in the case a trade dispute between the EU and its future member states should arise (see e.g. Annex IV to the Conclusions of the Essen European Council 1994; Chapter IV, Article 34 of the European Agreement with Bulgaria).

4 Zanardi (2004) shows that, for the period of 1881-2001, Japan accepted more undertakings, i.e. in about 60% of the cases, as well as Finland and Sweden before their EU membership (82% and 100% respectively).
As we explicitly acknowledge the importance of price undertakings and their potentially different impact on technology transfer comparing to duties or tariffs. To our knowledge, this is the first paper to address this issue. Thirdly, the results of this paper shed a light for the developing counties engaging in technology upgrading.

The reminder of the paper is organized as follows. Section 2 introduces a benchmark (free trade) model. Section 3 examines the unilateral antidumping regimes in which the developing country takes a price-undertaking policy. By adding a licensing stage, Second 4 investigates the optimal royalty rate and the welfare effects in both regimes. Section 5 concludes this paper.

2 The Free Trade Model

We assume there are two countries, a home country (H) and a foreign country (F), hosting one firm each. The high-tech foreign firm (Firm F) serves both the domestic and the foreign markets, while the low-tech domestic firm (Firm H) is a local enterprise serving only the domestic market. Hence, the domestic market is of duopoly, but the foreign market is of monopoly. It is also assumed that the two firms compete in Cournot fashion in the domestic market. We further assume market demands of the host and foreign countries are linear and symmetric which can be specified as follows:

\[ P = a - x - y, \quad (1) \]

\[ P' = a - x', \quad (2) \]

where \( x \) and \( x' \) are the output of Firm F exported to the domestic market and supplied to the foreign market respectively and \( y \) is Firm H’s output supplied to its home market. The profits of Firm H and Firm F under free trade (i.e., no antidumping policy) are specified as follows respectively:

\[ \Pi = (P - c)y, \quad (3) \]

\[ \Pi' = (P' - (c - \varepsilon))x' + (P - (c - \varepsilon) - s)x, \quad (4) \]

where \( s \) is the transportation rate (or trade cost equivalently), \( c \) and \( c - \varepsilon \)

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5 This assumption is to facilitate our analysis on antidumping policy, as there have to be a “referred price” or so-called “fare value” when measuring the dumping margin. Moreover, governments seldom concern about the difference of market structures between countries when they implement antidumping policies. Reitzes (1993) also adopts this market structure with two periods.

6 To ensure Firm F is an insider of the home market (\( x > 0 \)) in either regime, the trade cost \( s \) cannot be too large. Otherwise, Firm F shall become an outsider of the home market.
represent the marginal costs of Firms H and F respectively. The innovation, $\varepsilon$, can be any value less than $c$. Differentiating (3) with respect to $y$ and (4) with respect to $x$ and $x^*$, we obtain the first-order conditions for profit maximization as follows:

$$\frac{d\Pi}{dy} = P + P' y - c = 0,$$  \hspace{1cm} (5)

$$\frac{d\Pi^*}{dx} = P + P' x -(c - \varepsilon) - s = 0,$$  \hspace{1cm} (6)

$$\frac{d\Pi^*}{dx^*} = P' + P'^* x^* -(c - \varepsilon) = 0.$$  \hspace{1cm} (7)

Equation (5) represents Firm H’s reaction function in the home market, while (6) and (7) characterize Firm F’s reaction functions in the foreign and the home markets, respectively. These reaction functions are negatively sloped, due to the strategic substitution nature as defined by Bulow et al. (1985).

Given the nature of constant marginal costs, (5) and (6) together can solve for the home market equilibrium, and (7) alone can solve for the foreign market equilibrium. The optimal output of the two firms and the prices of the foreign and the domestic markets under free trade are as follows:

$$y = \frac{1}{3}(a - c - \varepsilon + s),$$  \hspace{1cm} (8)

$$x = \frac{1}{3}(a - c + 2\varepsilon - 2s),$$  \hspace{1cm} (9)

$$x^* = \frac{1}{2}(a - c + \varepsilon),$$  \hspace{1cm} (10)

$$P = \frac{1}{3}(a + 2c - \varepsilon + s), \text{ and}$$

$$P^* = \frac{1}{2}(a + c - \varepsilon).$$  \hspace{1cm} (12)

The resulting profits of Firm H and F are derived as follows:

$$\Pi = \left(\frac{a - c - \varepsilon + s}{3}\right)^2,$$ \hspace{1cm} (13)

It is to ensure the marginal costs of Firms are always non-negative.
\[ \Pi^* = \left( \frac{a-c+\varepsilon}{2} \right)^2 + \left( \frac{a-c+2\varepsilon-2\gamma}{3} \right)^2. \]  

As the innovation, \( \varepsilon \), can be any value less than \( c \), we shall discuss two cases: non-drastic and drastic innovation, according to the level of innovation. A drastic innovation is one of which the high-tech firm will become monopoly in the domestic market if it does not engage in technology transfer. More specifically, under a drastic innovation, the high-tech firm’s monopoly price is lower than the low-tech firm’s marginal cost in the domestic market and the low-tech firm shall be driven out of the market. By equation (8), it is obviously that the innovation is drastic if \( \varepsilon > a - c + s \). According to Wang (1998), a technology transfer via licensing will not take place when the innovation is drastic. It is worth noting that the critical point of this drastic innovation increases with the transport rate. Therefore, we can construct the following proposition:

**Proposition 1**

*The firms with advanced technology are more likely to engage in technology transfer through licensing as the trade cost increases.*

The intuition behind this proposition is as follows. Firm F’s profit from the home market consists of its sales and licensing revenue. As trade cost increases, the former decreases while the latter increases. Therefore, the technology transfer via licensing is more likely to occur as the trade cost raises.

### 3 Unilateral Antidumping

When dumping is observed and causing injury to the domestic firm, GATT/WTO allows the home government to implement antidumping policies to protect its home firms. After the antidumping policy is initiated, the foreign firm has two options to follow: paying the duty or raising the price to eliminate the dumping margin. The latter is often called as price-undertaking which according to Gao and Miyagiwa (2005) is superior to paying the duty from the foreign firm’s perspective. As the effect of

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8 Note that when this cost is too large for Firm F to export, i.e. Firm F becomes an outsider of the home market; Firm F will engage in fixed fee licensing as proposed by Kamien and Tauman (1984, 1986) regardless of the magnitude of the innovation.

9 Price-undertaking is one of the most commonly used antidumping tools in the EU. It requests foreign firms to eliminate the difference between the ex-factory foreign export price and home price of the good.

10 As the dumping marginal is eliminated under either regime, the profit of the constrained firm is
antidumping duty on technology transfer is similar to that under a tariff, which has
been studied by Kabiraj and Marjit (2003) and Mukherjee and Pennings (2006), we
shall focus on the price undertakings.

Under this regime, the profit function of Firm H is the same as before while that
of Firm F is in need of revision as it is subject to a price undertaking constraint now.
The two profit functions under this regime are specified as follows:

\[ \Pi = (\bar{P} - c)\bar{y}, \]  
\[ \Pi^* = (\bar{P}' - (c - \varepsilon))\bar{x}' + (\bar{P} - (c - \varepsilon) - s)\bar{x}. \]  

s.t. \( \bar{P}'(\bar{x}') = \bar{P} + (\bar{P}' - (c - \varepsilon))\bar{x}' \)

where variables with a bar “−” denote that the variables are associated with the price
undertaking regime.

Under the price undertaking constraint, the foreign firm can no longer freely
choose its sales to the two markets. Instead, the sales have to be adjusted so as to
ensure the equality of the net prices, net of the unit transport cost, of the two markets.
This is achieved by substituting the constraint into (16). After the substitution, Firm F
selects \( \bar{x} \) and Firm H selects \( \bar{y} \) to maximize their profits. The first-order condition
for profit maximization of the foreign and the domestic firms are derivable respectively
as follows:

\[ \frac{d\Pi}{d\bar{y}} = \bar{P} + \bar{P}'\bar{y} - c = 0, \]  
\[ \frac{d\Pi^*}{d\bar{x}} = (\bar{P}' + \bar{P}'(\bar{x}') - (c - \varepsilon))\frac{d\bar{x}}{d\bar{x}} + (\bar{P} + \bar{P}'(\bar{x}' - (c - \varepsilon) - s) = 0. \]

Comparing (17)- (18) with those derived under free trade (i.e., (5)-(7)), we find
that, the price-undertaking measure has no effect on Firm H’s reaction function, but
shifting inward Firm F’s reaction function from \( RF \) to \( \bar{RF} \) and moving the
Cournot equilibrium from \( e \) to \( \bar{e} \) as shown in Figure 2.\(^{11}\) As a result, the output
of Firm F supplied to the host country market decreases from \( x \) to \( \bar{x} \).

\(^{11}\) The first term on the RHS of (18) is negative which implies that the second term is positive,
\( i.e., P' + P'(x') - (c - \varepsilon) > 0. \)
By solving (17) and (18) simultaneously, we can obtain the equilibrium outputs of Firm F and Firm H at the home market as follows:

$$\bar{x} = \frac{1}{5} (a - c + 4e - 6s), \quad (19)$$

$$\bar{y} = \frac{1}{5} (2a - 2c - 2e + 3s). \quad (20)$$

Substituting $\bar{x}$ and $\bar{y}$ into the constraint in (16), we can obtain the output of Firm F supplied to the foreign market as follow:

$$\bar{x}^* = \frac{1}{5} (3a - 3c + 2e + 2s). \quad (21)$$

Given (19) to (21), we can derive the market prices of the two markets and the resulting profits of Firm H and F as follows:

$$\bar{P} = \frac{1}{5} (2a + 3c - 2e + 3s), \quad (22)$$

$$\bar{P}^* = \frac{1}{5} (2a + 3c - 2e - 2s), \quad (23)$$

Figure 2: Reaction Functions under Free Trade and Price Undertaking
\[ \bar{\Pi} = \frac{1}{25} (2a - 2c - 2\epsilon + 3s)^2, \quad (24) \]

\[ \bar{\Pi}^* = \frac{2}{25} (2a - 2c + 3\epsilon - 2s)^2. \quad (25) \]

By comparing (8)-(14) with (19)-(25), we find that the total sales in the host country market declines, leading to a higher price there, but the price in the foreign country market decreases. Summarizing the results above, we can construct the following proposition:

**Proposition 2**

Suppose Firm F is subject to a price-undertaking constraint,

1. it decreases its output to the home market, but increase that to the foreign market;
   
   Firm H also increases its sales to the home market;

2. the price of the home market rises but that of the foreign market falls;

3. Firm H earns more profits while Firm F earns less.

It is worth to note that the critical value for ‘drastic’ innovation is given by \( \epsilon > a - c + s \) under free trade; however, it turns to be \( \epsilon > a - c + 3s / 2 \) when Firm F faces a price undertaking policy.\footnote{This critical value is obtained by setting (20) equals to zero.} This result means that Firm F can serve both markets as a monopolist under trade for \( \epsilon > a - c + s \). However, if an antidumping policy is imposed, it can act as a monopolist only if \( \epsilon > a - c + 3s / 2 \). According to Wang (1998), royalty licensing is always a dominant strategy when the innovation of the high-tech firm is non-drastic. Thus, Firm F is more likely to transfer its advanced technology to Firm H via licensing under price undertakings. Based the above discussions, we can arrive at the following proposition:

**Proposition 3**

The foreign high-tech firm is less likely to become a monopolist under price undertakings than free trade. This implies price undertakings could encourage technology transfer.

The intuition of the above proposition is as follows. As the price undertaking policy is initiated, Firm F can no longer take international price discrimination and the profit of Firm H is, therefore, enhanced. In other words, it is more difficult for Firm F to
drive its rival out of the market when it faces an antidumping policy. In this circumstance, Firm F is more likely to extract Firm H’s profit via licensing its innovation instead of competing with Firm H directly.

As in the conventional wisdom, antidumping policies are usually initiated by rich (developed) countries that protect their markets against cheap labor-intensive imports. In this paper, we argue that antidumping policy could be a means of absorbing advanced technology for the developing countries. This finding also gives an explanation to the rapidly increasing antidumping investigations initiated by the developing countries after 1990.

In this Section, we explore and explain the effect of price undertakings on Firm F’s technology transfer behavior. In the next Section, we will further incorporate Firm F’s licensing stage and explore the domestic welfare in the presence of technology transfer via licensing. Then, we shall compare it to the literature in which licensing are ignored.

4 Extensions

By adding a licensing stage to models a la previous Sections, in this Section, we shall first investigate and compare the optimal royalty rate under free trade and under antidumping policy, and then we tend to study the effects of an antidumping policy on domestic consumer surplus, producer surplus and social welfare in the presence of technology transfer via licensing.

Note that all of the assumptions in this Section are the same as that in the previous Sections, but the game structure is now refined to a two-stage game. In the first stage, Firm F decides whether to transfer its innovation and choose its optimal royalty rate if the licensing occurs. In the second stage, the two firms compete in quantity terms in the domestic country, whereas Firm F acts as a monopolist in the foreign country. In what follows, we begin our analysis with the free trade regime, followed by the price undertaking regime.

4.1 The Free Trade Regime

When Firm F can engage in transferring its advanced technology via a royalty

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13 It is quiet obviously the foreign welfare is necessarily increases under price undertakings, as in this regime the foreign market price is lower than the monopoly price. Therefore, we ignore the welfare analysis on the foreign country.

14 According to Wang (1998) royalty licensing is always better than fee licensing as the patent holder is an insider. Moreover, among the empirical studies, Rostoker (1984) finds that there are 39% of royalty licensing alone was used. Thus, we shall focus on the royalty licensing cases throughout this paper.
licensing, it licensing its innovation to Firm H at a fixed royalty rate, \( r \). In addition, this rate is necessarily no greater than the magnitude of the innovation, i.e. \( r \leq \varepsilon \). Otherwise, Firm H will not accept the licensing contract. The total amount of the licensing fee of which Firm H pays will depend on the quantity its will produce using the innovation. Thus, the profit functions of Firm H and firm F in the presence of royalty licensing can be expressed as follows:

\[
\Pi = (P - (c - \varepsilon) - r)y, \quad (26)
\]

\[
\Pi^* = (P^* - (c - \varepsilon)x^* + (P - (c - \varepsilon) - s)x + ry, \quad (27)
\]

As usual, the sub-game perfect Nash equilibrium is solved through backward induction by first considering the second stage, followed by the first stage. Differentiating (26) with respect to \( y \) and (27) with respect to \( x \) and \( x^* \), and solving the first order conditions for profit maximization simultaneously, we can derive the sales and the resulting profits of the two firms and the price of the two markets as follows:

\[
y = \frac{1}{3}(a - c + \varepsilon - 2r + s), \quad (28)
\]

\[
x = \frac{1}{3}(a - c + \varepsilon + r - 2s), \quad (29)
\]

\[
x^* = \frac{1}{2}(a - c + \varepsilon), \quad (30)
\]

\[
P = \frac{1}{3}(a + 2c - 2\varepsilon + r + s), \quad (31)
\]

\[
P^* = \frac{1}{2}(a + c - \varepsilon). \quad (32)
\]

\[
\Pi = \left(\frac{a - c + \varepsilon - 2r + s}{3}\right)^2, \quad (33)
\]

\[
\Pi^* = \left(\frac{a - c + \varepsilon}{2}\right)^2 + \left(\frac{a - c + \varepsilon + r - 2s}{3}\right)^2 + \frac{r}{3}(a - c + \varepsilon - 2r + s). \quad (34)
\]

As mentioned, the technology transfer occurs if the innovation is not too large (i.e. \( \varepsilon < a - c + s \)). We assume this is the case and begin our analysis on the first stage (Firm F makes its decision on the royalty rate).

Differentiating (34) with respect to \( r \), we can derive the first-order condition for
profit maximization as follows:

$$\frac{d\Pi^*}{dr} = \frac{1}{9}(5a - 5c + 5e - 10r - s) \geq 0.$$  (35)

According to (35), the optimal royalty rate for profit maximization charged by Firm F is derivable as follows:

$$r = \begin{cases} 
\epsilon, & \epsilon < a - c - \frac{s}{5} \\
\frac{1}{2}(a-c+\epsilon)-\frac{s}{10}, & \text{if} \quad \epsilon \geq a - c - \frac{s}{5} 
\end{cases}.$$  (36)

Note that the innovation is drastic and licensing shall not occur for $\epsilon \geq a - c + s$. Equation (36) implies that Firm F shall licensing its advanced technology at a rate less than the magnitude of its innovation when $a - c - s / 5 \leq \epsilon < a - c + s$. This result is in contrast to the findings in Wang (1998) which concludes that the optimal royalty rate is necessarily a corner solution (i.e. $r = \epsilon$) when a royalty licensing is adopted by the patentee. This difference is mainly because the existence of transportation cost. As $y(x)$ increases (decreases) with the transport cost, Firm F is more like to use royalty licensing to extract the rent for Firm H rather than export and compete with Firm H head to head. A lower royalty can stimulate Firm H to produce more, as therefore increases Firm F’s profit. Therefore, we can make the following proposition:

*Proposition 4*

*When the trade costs are incorporated, the optimal royalty rate charged by the patent holder is possibly less than the magnitude of its innovation.*

In the next Subsection, we shall examine whether this result is robust under price undertakings. The domestic welfare effect under an antidumping policy with licensing will also be investigated and compared to the literature.

**4.2 The Price Undertaking Regime**

Again, the model assumptions here are the same as those in Section 3 except a licensing stage is added. The profit functions of Firm H and F can be specified as follows:

$$\Pi = (\bar{P} - (c - \epsilon) - R)\bar{y},$$  (37)

15 If the trade cost is set to be zero, the solution shall degenerate to Wang (1998).
\[ \Pi^* = (\bar{P}^* - (c - \varepsilon))\bar{x}^* + (\bar{P} - (c - \varepsilon) - s)\bar{x} + \bar{r} y, \]  
\text{s.t.} \quad \bar{P}^*(\bar{x}^*) = \bar{P}(\bar{x}, \bar{y}) - s \]

Utilizing the same approach in Section 3 and differentiating (37) with respect to \(\bar{y}\) and (38) with respect to \(\bar{x}^*\), and solving the first order conditions for profit maximization simultaneously, we can derive the outputs and the resulting profits of the two firms, and the price of the two markets in the second stage as follows:

\[ \bar{y} = \frac{1}{5}(2a - 2c + 2\varepsilon - 4\bar{r} + 3s), \]  
\[ \bar{x} = \frac{1}{5}(a - c + \varepsilon + 3\bar{r} - 6s), \]  
\[ \bar{x}^* = \frac{1}{5}(3a - c + 3\varepsilon - \bar{r} + 2s), \]  
\[ \bar{P} = \frac{1}{5}(2a + 3c - 3\varepsilon + \bar{r} + 3s), \]  
\[ \bar{P}^* = \frac{1}{5}(2a + 3c - 3\varepsilon + \bar{r} - 2s). \]

\[ \Pi = \left(\frac{2a - 2c + 2\varepsilon - 4\bar{r} + 3s}{5}\right)^2, \]

\[ \Pi^* = \frac{2}{25}(2a - 2c + 2\varepsilon + \bar{r} - 2s)(2a - c + 2\varepsilon + \bar{r} - 2s) + \frac{\bar{r}}{5}(2a - 2c + 2\varepsilon - 4\bar{r} + 3s). \]

The first-order condition for profit maximization in the first stage is derivable by differentiating (45) with respect to \(\bar{r}\), which can be expressed as follows:

\[ \frac{d\Pi^*}{d\bar{r}} = \frac{1}{25}(18a - 18c + 18\varepsilon - 36\bar{r} + 7s) \geq 0. \]

Therefore, the optimal royalty rate for profit maximization charged by Firm F is derivable as follows:

\[ \bar{r} = \begin{cases} 
\varepsilon, & \varepsilon < a - c + \frac{7s}{18} \\
\frac{1}{2}(a - c + \varepsilon) + \frac{7s}{36}, & \varepsilon \geq a - c + \frac{7s}{18}
\end{cases} \]
As the innovation is of drastic when \( \varepsilon \geq a - c + 3s / 2 \) under a price undertaking policy, Equation (47) also exhibits the possibility of the interior solution on the royalty rate. In addition, by (47) with (36), we can compare the optimal royalty rate under the two regimes with respect to the magnitude of the innovation as follows:

\[
\begin{cases} 
  r = \bar{r} & \text{if } \varepsilon < a - c - \frac{s}{5} \\
  r < \bar{r} & \text{if } \varepsilon \geq a - c - \frac{s}{5} 
\end{cases}
\]  

(48)

The intuition behind this result is straightforward. Firm F cannot implement the so-called international price discrimination, when it is constrained by the price undertaking policy. A lower market price in the home country suffers Firm F as it has to under-pricing in the foreign monopolistic market. Therefore, Firm F has an incentive to raise the domestic market price via charging a higher royalty fee. Accordingly, we can arrive at the following proposition:

**Proposition 5**

*The royalty rate under free trade is no greater than that under a price undertaking policy.*

Figure 3 demonstrates the royalty rate under two regimes. In Figure 3, the dark solid line portrays the optimal royalty rate under free trade whilst the light solid line depicts the optimal royalty rate under price undertakings. As shown in Figure 3, technology licensing necessarily occurs in both free trade and AD regimes when \( \varepsilon < a - c + s \) (Regions I to III). Region IV indicates the magnitude of the innovation in which the technology licensing occurs only if Firm F is constrained by price undertaking. Region V is where Firm F will never engage in technology licensing. It is worth noting that, in Region IV, the foreign market is monopolized by Firm F under free trade while it is of duopoly under the antidumping policy. This implies that domestic total output and domestic consumer surplus are higher under the price undertakings than that under free trade. This result goes against the standard conclusion in which antidumping policies usually worsen domestic consumer surplus.\(^{16}\) Furthermore, Firm H’s profit is zero before the antidumping policy; whereas it is positive under antidumping policy as the royalty rate is less than the innovation

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\(^{16}\) Setting up a fixed fee licensing model, Kabiraj and Marjit (2003) also find that an import tariff can enhance domestic consumer surplus. However, our paper is the first study which proposes that consumer surplus could be better off under a royalty licensing.
level. Based on the above discussions, we can establish the following proposition.

**Proposition 6**

*When the magnitude of foreign firm's innovation is large enough\( (a - c + s \leq \varepsilon < a - c + 3s/2) \), consumer surplus, producer surplus as well as social welfare of the developing country are necessarily enhanced by price undertakings.*

This result is in parallel to the finding in Reitzes (1993). He constructs a two-period model and concludes that, in a Cournot model, the commitment of imposing an antidumping duty increases the welfare of the home country if the market share of the foreign constrained firm is small. Different from him, we argue that the welfare enhancing effect comes from the technology transfer between the two countries. The finding may give an explanation on the increasing antidumping investigations initiated in the developed countries in the past decade.

The most striking result of this paper is that, in certain circumstances, a trade policy benefits both domestic producers and consumers. That is, there is a Pareto improvement in the domestic country due to the antidumping policy.

![Figure 3: The Optimal Royalty Rate under Free Trade and Price Undertaking](image-url)
5 Concluding Remarks

In the past decades, licensing agreements and antidumping policies are both important phenomena and have been studied extensively by two separate branches of the economics literature. This paper constructs a theoretical model to examine whether an antidumping policy may induce high-tech firms to alter their strategies on technology transfer (strategic licensing). We also investigate the welfare effect of antidumping on the developing countries, and then compare our findings to those without (i.e., no technology transfer).

This paper makes several contributions. Firstly, the previous studies mainly focus on the behavior of technology adoption of the low-tech firms. Our work differs from then as we examine the technology via licensing from the perspective of high-tech firms. Secondly, different from Kabiraj and Marjit (2003), we look at the effects of a different protection, namely price undertakings. Thirdly, the results of this paper suggest that price undertakings could be employed by developing countries as a means of technology upgrading.

We have found that firms with advanced technology are more likely to engage in technology transfer as the trade cost increases. Moreover, the foreign high-tech firm is less likely to drive out its low-tech rivals under price undertaking than under free trade. This implies that a price undertaking policy encourages high-tech firm to transfer its advanced technology to the inefficient firms via licensing.

By adding a licensing stage to our model, some interesting results are found. First of all, the optimal royalty rate charged by the patent holder is possibly less than the magnitude of its innovation if the trade costs are incorporated. This finding runs against the standard result in Wang (1998) which concludes the royalty rate is always equal to the non-drastic innovation level. This difference is, of course, due to the presence of the trade cost. Moreover, our result can be degenerated to Wang (1998) as the trade cost is zero. Secondly, the royalty rate under free trade is no greater than that under price undertakings. The reason is as follows. The so-called international price discrimination is prohibited when the high-tech firm is constrained by the price undertaking policy. The market price in the foreign market is lower than the monopolistic pricing. To maximize its profit, it has an incentive to increase the market price in the home country by means of the royalty rate.

As for the welfare effect, we have found that, given the magnitude of foreign firm’s innovation is large enough; consumer surplus, producer surplus as well as social welfare of the developing country are necessarily enhanced if an antidumping policy is imposed on the high-tech foreign firm. This result is in parallel to the finding in
Reitzes (1993). In addition, this result provides a theoretical explanation on the boost of the antidumping investigations initiated by developing countries in the past decades.

We have assumed that the domestic firm can only sale its output to the domestic market. If instead the domestic firm is allowed to export, there will be an additional competition effect from the foreign market which gives the foreign firm more incentive to engage in licensing.

There are a number of ways in which this work could be extended. First, our model could be extended to the Bertrand case. Second, we can also explore the bilateral antidumping case as there are more and more countries engage in tax retaliation. Third, we can incorporate different licensing modes and study the different effect among them under antidumping policies. It is hoped that this study will go some way toward stimulating these lines of research.
References


