# The patterns of contingent protection when innovation is at stake

Kaz Miyagiwa [(a)]
Huasheng Song[(b)]
Hylke Vandenbussche[(c)]

(a) Emory University, U.S.A.
(b) CRPE and College of Economics, Zhejiang University, China
(c) IRES-CORE, Université Catholique de Louvain, LICOS-KULeuven

*Abstract*

This paper concerns three recent empirical findings about contingent protection. First, protection actions are mostly between the North and the South. Second, the South uses contingent protection to retaliate against the Northern users. Third, protection actions are concentrated in R&D-intensive industries. In this paper we develop a model consistent with these findings, and explore the model's implications. We find that industrial countries are more likely to impose contingent protection against developing countries that improve R&D capability. One surprising conclusion is that improved IPR protection in developing countries has no effect on industrial countries' incentive to administer contingent protection.

JEL codes; F12, F13, L13
Keywords: R&D, contingent protection, intellectual property rights, reciprocal dumping

Address for correspondence: Kaz Miyagiwa, Department of Economics, Emory University, 1603 Fishburne Dr., Atlanta, GA 30322, U.S. A. E-mail: kmiyagiwa@gmail.com

We thank Jacques Thisse, Eric Bond, Paul Belleflamme, Claude d'Aspremont, Jim Hartigan, Maurizio Zanardi, Florian Mayneris and participants of seminars and conferences for useful comments on earlier drafts. Miyagiwa and Song express their gratitude to CORE (Universite catholique de Louvain) for the hospitality during their visits. Vandenbussche is grateful to ARC-UCL and PAI-BELSPO for financial support.

## 1. Introduction

Today, although overt protectionism is waning, national governments are still free to administer contingent protection policy such as antidumping, countervailing duties and safeguard measures in the event of adverse shocks, as in the wake of the recent financial crisis in 2008 (Baldwin and Evenett 2009). Contingent protection actions are clearly on the rise in recent years, as illustrated in Figure 1, most of which reflects increased use by developing and semi-industrialized countries.[1]

Since this period also witnessed the conclusion of international trade agreements, it is tempting to interpret the rapid spread of contingent protection as countries' attempt to substitute contingent policy for the tariffs and quotas they eliminated as part of trade agreements. Recent empirical work however contradicts this hypothesis, indicating retaliation instead of substitution as the primary motive for the spread of AD use.[2]

Empirical research has also found that protection actions are concentrated in R&D-intensive industries (Niels 2000). Despite the high volumes of trade in R&D-intensive goods among them, however, industrial countries do not impose contingent protection against each other. Use of contingent protection is primarily between developed and developing countries (Prusa and Skeath, 2002).

In this paper we develop a model that accounts for these observed patterns of contingent protection use in recent years; namely, the majority of actions and retaliations occur

[1] For example, Mexico, China, India, Turkey, Egypt, and Brazil.

[2] Studies arguing that retaliation is the main determinant of AD filings include Martin and Vergote (2008), Feinberg and Reynolds (2006) and Moore and Zanardi (2008). Thus far, the substitution hypothesis has only been confirmed for India. Bown and Tovar (2008) show that Indian liberalization efforts have resulted in higher probability of antidumping filings.

between the developed North and the developing South. To address this issue, we first develop a model that aims to go a step further than the existing models while retaining key ingredients from them. We thus first extend the Brander-Krugman (1983) model of reciprocal dumping to a multi-country framework, in which national markets vary in *size*. For simplicity, we retain the assumption in that model that each country has only one national firm, and that firms compete in quantity competition. Extensions to price competition and to the multi-firm case are straightforward but are not pursued in the present work to keep the analysis simple.

Secondly, reflecting the fact that contingent protection is aimed mostly at the R&D-intensive sectors, we examine the relationship between contingent protection and protection of intellectual property rights (IPRs) in developing countries when firms have the opportunity to improve technology through R&D.

Despite simple set-ups, our analysis yields novel and surprising results. First, while taking protectionist actions against all foreign firms is the dominant strategy, both firms are harmed by reciprocal protection if their home markets are similar in size. Thus, in the long run, when firms interact over time repeatedly, the desire to avoid such prisoners' dilemma outcomes restrains use of contingent protection among countries having similar-sized home markets. By contrast, firms having *larger* home markets can protection war against smaller countries, even if the latter retaliate. This result implies that contingent protection will be initiated against only a subset of countries, and is consistent with the fact that protection activity is mostly between the North and the South, where market size differences can be substantial.

Further, in the context of North-South trade, we find that the North is more likely to initiate protection actions in R&D-intensive industries than in industries with little R&D

activities. This result is consistent with recent empirical findings that contingent protection actions are concentrated in R&D-intensive industries. Surprisingly, this result does not depend on the strength of IPR protection in the South. Thus, our model casts some doubt to the rhetoric in advanced countries that contingent protection is necessary to counter the lack of IPR enforcement in developing countries. Our finding thus contrasts with the earlier findings by Qui and Lai (2004) that trade policy by the North can be used to supplement weak IPR enforcement in the South. Lastly, we find that, if the South's R&D technology improves, the South is more likely to be targeted by the North's contingent protection policy.

The remainder of the paper is organized in 4 sections. The next section examines the possibility of reciprocal protection in a multi-country setting without R&D. Section 3 considers a North-South model with R&D competition, where the Northern firm is more efficient in R&D than its Southern counterpart but the latter can appropriate part of the North's R&D. The final section concludes.

## 2. Model

### *2.1 Environment*

Consider an industry spanning M ($\geq 2$) national markets. Country m's inverse demand is given by $p_m = 1 - Q_m/b_m$, where the common demand intercept is normalized to unity, $Q_m$ denotes total sales in country m, and $b_m \in (0, 1]$ measures the size of market m. Markets are enumerated in the descending order, with the size of market one normalized to unity:

$$b_1 = 1 > b_2 > \ldots . > b_M.$$

Turning to the production side of the model, assume that each country has a single firm producing a homogeneous good at constant marginal cost and playing a quantity-setting (Cournot) game with all other firms in each market.[3] Marginal costs are identical across firms and constant at c. Let $t_{i,j}$ denote a specific duty under contingent protection country i imposes on imports from country j, and let

$$T_i = t_{i,1} + t_{i,2} + \ldots + t_{i,i-1} + t_{i,\,i+1} + \ldots + t_{i,M}$$

be the sum of duties country i imposes on imports from all other countries. We assume these duties are not chosen to maximize national welfare but are set exogenously. This is a reflection of reflecting recent findings; for example, Hartigan (2000) and Blonigen (2006) convincingly argue that dumping margin determination by national authorities is discretionary and completely divorced from actual dumping margins.[4]

Firms consider all national markets as segmented and maximize the profit in each market independently. Given Cournot competition, it is straightforward to show that firm m's profit from domestic sales equals:

$$\pi_{m,m} = b_m[1 - c + (M - 1)\tau + T_m]^2/(1 + M)^2, \tag{1}$$

where $\tau$ is the unit transport cost. Its profit from exporting to country e ($\neq$ m) equals

$$\pi_{m,e} = b_e[1 - c - 2\tau - (M + 1)t_{e,m} + T_e]^2/(1 + M)^2. \tag{2}$$

The total profit to firm m is the sum of these profits from all the M markets:

---

[3] A price-setting game (played by differentiated-goods oligopolists) yields similar results without additional insight.

[4] The arbitrariness of margin determination also motivates the signaling model of dumping of Miyagiwa and Ohno (2007), where the rate of the antidumping duty is treated as a random variable drawn from some distribution function.

$$\pi_{m,1} + \pi_{m,2} + \ldots + \pi_{m,M}.$$

In the analysis to follow, assume that the transport cost $\tau$ is arbitrarily small and there are no tariffs initially. In such an environment the profits from domestic sales in (1) and the profit from exports in (2) differ only in terms of market size:

$$\pi_{m,m} = b_m(1 - c)^2/(1 + M)^2$$

$$\pi_{m,e} = b_e(1 - c)^2/(1 + M)^2.$$

*2.2. Reciprocal contingent protection*

We turn next to the effect of contingent protection and retaliation. Assume that, when deviating from free trade, each country imposes an exogenously given small AD duty; i.e.,

$$dt_{m,j} = dt > 0$$

for all m and all j ($\neq$ m). It is easy to show that a unilateral action is a dominant strategy for any firm, independently of its home market size. Thus, in a one-shot game the unique equilibrium has all firms demanding protection from its government against each other.

However, when country e retaliates, firm m's profit from exports to that country falls. With transport costs arbitrarily small and free trade initially, the above two effects can be approximated by

$$\partial\pi_{m,m}/\partial t_{m,e} \approx 2b_m(1 - c)/(1 + M)^2$$

$$\partial\pi_{m,e}/\partial t_{e,m} \approx -2Mb_e(1 - c)/(1 + M)^2$$

so reciprocal protection between firm m and firm e changes firm m’s profit from the two markets by

$$\partial\pi_{m,m}/\partial t_{m,e} + \partial\pi_{m,e}/\partial t_{e,m} = 2(b_m - Mb_e)(1 - c)/(1 + M)^2.$$

Thus, the change in firm m’s profit from reciprocal protection depends on the sign of

$$b_m - Mb_e.$$

**Lemma 1**: Firm m is harmed by reciprocal protection with country e if and only if

$$b_e M > b_m.$$

This gives two important results. First, if m is the smaller market i.e., $b_m < b_e$,

$$b_m - Mb_e < b_e - Mb_e = b_e(1 - M) < 0,$$

since $M \geq 2$. Therefore, *a firm from a smaller home market never benefits from engaging in reciprocal protection with a firm based in a larger home market.* By contrast, it is possible that $b_m - Mb_e > 0$, if $b_e$ is substantially smaller than $b_m$. That is, *a firm from a larger home market can benefit from reciprocal protection with a firm located in a much smaller home market.* Second, the above condition becomes more difficult to satisfy as the number of countries M increases. With only two countries, Lemma 1 says that *the large country can benefit from reciprocal production if and only if it is at least twice as large as the small country (i.e., b < 1/2).*

In a one-shot game, all countries impose import duties against all others and end up in prisoners’ dilemmas. However, if firms interact repeatedly over time as they do in the real world, they can avoid the prisoners' dilemma outcomes. In contrast, larger countries are willing to use contingent protection against much smaller countries despite retaliation by the latter.

*2.4. Multi-country contingent protection*

So far we have only considered reciprocal protection between two countries. In this section we extend the analysis to a multi-country setting. Consider the following scenario. Firm 1 takes actions against all firms domiciled in sufficiently small countries, which then retaliate against firm 1. What is new in the multi-country case is that there may be a snowball or cumulative effect; that is, a large country may use protection against a wider range of countries than is implied by lemma 1. To see this, suppose there is market $n < M$ such that

$$1 - Mb_n < 0 \text{ and } 1 - Mb_{n+1} > 0.$$

Then firm 1 benefits from reciprocal protection against each firm in smaller countries $\{n + 1,\ldots,M\}$, when each case is considered individually[5]. However, protection against all those markets can make protection against the marginal country n profitable to firm 1. That is because the cumulative duties on imports from firms n + 1 through M increase firm 1's profit from domestic sales, making contingent protection on imports from the marginal firm n more profitable. To illustrate, with duties against firms $\{n + 1,\ldots,M\}$ in effect, firm 1's profit from home sales is

$$[1 - c + t_{m,n} + \ldots + t_{m,M}]^2/(1 + M)^2,$$

so the effect of a small duty is given by

[5] Antidumping duties in contrast to safeguards (Crowley, 2007) are trade defense instruments that can be used in a discriminatory way.

$$2[1 - c + t_{m,n} + \ldots + t_{m,M}]/(1 + M)^2,$$

which exceeds the corresponding effect

$$2[1 - c + t_{m,n}]/(1 + M)^2$$

resulting when there are no other duties. This shows that the firm domiciled in the largest home market demands contingent protection against more firms collectively than when each firm is targeted singly.

Firm 2 targets a smaller set of countries than firm 1 for two reasons. One is obvious: firm 2 has a smaller home market than firm 1 ($b_2 < 1$). The other reason is subtler. When there is already reciprocal protection going on between firm 1 and, say, firm e, firm 2 has less of an incentive to seek contingent protection against the latter, even if $Mb_e < b_2$. This is because firm e's retaliatory action against firm 1 has caused trade diversion, expanding market share of firm 2 (and all other firms) in country e at the expense of firm 1. With exports to country e more profitable, retaliation by country e is more damaging to firm 2. Thus, firm 2 has less of an incentive to engage firm e in reciprocal protection. From country e's perspective, retaliation against firm 1 can prevent being targeted by others.

To summarize this section, there is reciprocal protection only between countries having markets substantially different in size. This result is consistent with the findings that contingent protection actions are mostly between the industrial North and the developing South. Our model is also consistent with the empirical findings that developing countries use contingent protection to retaliate against industrial countries as only the North faces winnable reciprocal protection against the South.

## 3. Innovation and contingent protection

The preceding section has shown why there is more reciprocal protection between the North and the South than within each region. In this section we explore this case further, with new focus on R&D-intensive industries. We represent such industries by endowing them with the opportunities to invest in cost-reducing R&D. In the present section, in addition to the market size difference, we introduce two new features of the South: One is that the South's R&D capability is inferior to the North's in the sense defined below. The other is that the Southern firm can appropriate Northern innovation thanks to the South's weak IPR protection.

### *3.1. Environment*

As before, inverse demands are given by $p_i = 1 - Q_i/b_i$, where $p_i$ is price and $Q_i$ is total sale in market i. We assume that the North has the market size of one and let $b \in (0, 1)$ denote the relative size of the Southern market. The firms play a two-stage game, first investing in cost-reducing R&D and then competing in both markets as described in the preceding sections. Marginal production costs are assumed constant with respect to output but can be reduced by R&D. The R&D cost is assumed quadratic and is given by $\gamma_i k^2/2$, where i = n, s and k is the level of investment in R&D. The Southern firm faces a higher R&D cost in that $\gamma_s > \gamma_n$.

In the North, firm N's ex-post marginal cost depends only on its own investment level in R&D, $k_n$, and is written as

$$c_n = c_o - k_n,$$

where $c_o$ denotes the ex ante marginal cost. In contrast, firm S's ex post marginal cost is given by

$$c_s = c_o - k_s - \alpha k_n$$

As the last term on the right indicates, firm S benefits from firm N's innovation in proportion to the parameter $\alpha \in (0, 1]$, which reflects the laxity in IPR protection in the South.[6]

*3.2. Equilibrium Profits*

We solve the two-stage model backward. With ex post marginal costs given, the second-stage game equilibrium (Cournot) profits are straightforward to calculate. In market N, firm N faces the unit cost $c_n$ while firm S incurs the unit cost $c_s + \tau + t_n$, where $\tau$ is international transport cost and $t_n$ is an AD duty by country N. Thus, firm N's equilibrium profit from domestic sales equals

$$[(1 - 2(c_o - k_n) + (c_o - k_s - \alpha k_n) + (\tau + t_n)]^2/9$$

$$= [W + (2 - \alpha)k_n - k_s + t_n]^2/9,$$

where

$$W \equiv 1 - c_o + \tau.$$

[6] This aspect of the model is drawn on d'Aspremont and Jacquemin (1988), who first discussed R&D competition with technology spillovers.

In market S, the firms' positions are reversed as firm N now incurs transport cost $\tau$ and possibly country S's AD duty, $t_s$. We can write firm N's equilibrium profit from exporting to the South as

$$b[w + (2 - \alpha)k_n - k_s - 2t_s]^2/9,$$

where

$$w \equiv 1 - c_o - 2\tau.$$

We assume that all the parameter values are such that there is an interior solution to the Cournot game; i.e., each firm always produces strictly positive output for all relevant parameter values.

Collecting terms and subtracting the cost of R&D, we obtain firm N's first-stage profit:

$$\pi_n = [W + (2 - \alpha)k_n - k_s + t_n]^2/9 + b[w + (2 - \alpha)k_n - k_s - 2t_s]^2/9 - (\gamma_n/2)k_n^2,$$

Likewise, the first-stage profit to firm S is expressed as

$$\pi_s = [w + 2k_s - (1 - 2\alpha)k_n - 2t_n]^2/9 + b[W + 2k_s - (1 - 2\alpha)k_n + t_s]^2/9$$
$$- (\gamma_s/2)k_s^2.$$

In the analysis to follow we assume that transport costs are arbitrarily low so that W = w = 1 and there is free trade initially. That is, we evaluate all derivatives at $\tau = t_n = t_s = 0$.

*3.3. Optimal R&D investments*

Firms choose R&D investment levels simultaneously to maximize the respective profits, given the rival's investment in R&D. The first-order conditions can be arranged to yield the best-response functions:

(3) $$k_n = [A_n - 2(2-\alpha)(1+b)k_s]/Z_n$$

(4) $$k_s = [A_s - 4(1-2\alpha)(1+b)k_n]/Z_s$$

where

$$A_n \equiv 2(2-\alpha)(W + bw) + 2(2-\alpha)(t_n - 2bt_s) > 0$$

$$A_s \equiv 4(w + bW) + 4(bt_s - 2t_n) > 0$$

$$Z_n \equiv 9\gamma_n - 2(2-\alpha)^2(1+b) > 0$$

$$Z_s \equiv 9\gamma_s - 8(1+b) > 0.$$

Differentiating (3) yields

$$dk_n/dk_s = -2(2-\alpha)(1+b)/Z_n < 0,$$

so $k_n$ is a strategic substitute to $k_s$. Differentiating (4) we obtain

$$dk_s/dk_n = -4(1-2\alpha)(1+b)/Z_s.$$

$dk_s/dk_n$ is negative if and only if $\alpha < 1/2$. In other words, $k_s$ is a strategic substitute to $k_n$ only if IP protection in the South is strict enough so that $\alpha < 1/2$; otherwise $k_s$ is a strategic complement to $k_n$. Intuitively, if $\alpha < ½$ and firm S increases investment in R&D, firm N's Cournot profits fall in both markets, prompting firm N to reduce investment in R&D. On the other hand, if $\alpha > 1/2$, an increase in R&D investment by firm N increases firm S's Cournot profit due to spillovers, inducing firm S to invest more in R&D.

The Nash equilibrium $(k_n^*, k_s^*)$ is given by:

$$(5) \qquad k_n^* = \{A_n Z_s - 2(2-\alpha)(1+b)A_s\}/\Delta$$

$$(6) \qquad k_s^* = \{A_s Z_n - 4(1-2\alpha)(1+b)A_n\}/\Delta$$

where

$$\Delta \equiv Z_n Z_s - 8(2-\alpha)(1-2\alpha)(1+b)^2$$

is positive by the Hahn stability condition, which we assume throughout. In the absence of import duties and arbitrarily small transport costs, we can write

$$A_n = 2(2-\alpha)(1+b) > 0, \text{ and } A_s = 4(1+b) > 0.$$

Substituting these into (5) and (6), we obtain the following necessary and sufficient conditions for $k_n^*$ and $k_s^*$ to be positive:

$$(7) \qquad \gamma_s > 4(1+b)/3.$$ [7]

*3.4. Reciprocal protection*

In this subsection we examine the effect of reciprocal protection on investment. We first study how it affect firms' investment in R&D. Differentiating (5) and (6) with respect to $dt_n = dt_s = dt$ yields the desired results:

---

[7] This is for $k_n^* > 0$. The condition for $k_s^* > 0$ is $\gamma_n > 2(2-\alpha)(1+\alpha)(1+b)/9$, which always holds if (15) does, since $\gamma_n > \gamma_s$.

$dk_n^*/dt = \{Z_s dA_n/dt - 2(2 - \alpha)(1 + b)dA_s/dt\}/\Delta$

$dk_s^*/dt = \{Z_n dA_s/dt - 4(1 - 2\alpha)(1 + b)dA_n/dt\}/\Delta$

To evaluate these derivatives, we differentiate $A_n$ and $A_s$:

$dA_n/dt = 2(2 - \alpha)(1- 2b),$

$dA_s/dt \equiv 4(b - 2) < 0.$

Substituting these expressions yields

(8) $dk_n^*/dt = 2(2 - \alpha)\{(1- 2b)Z_s + 4(1 + b)(2 - b)\}/\Delta,$

(9) $dk_s^*/dt = 4\{(b - 2)Z_n - 2(2 - \alpha)(1 - 2\alpha)(1 + b)(1- 2b)\}/\Delta.$

We now examine each expression closely. On the right-hand side of (8) the expression in braces in the denominator simplifies to the quadratic in b:

(10) $12b^2 - 2(9\gamma_s - 6)b + 9\gamma_s.$

This is positive at b = 0. At b = 1, it is negative, given the condition (7): $\gamma_s > 4(1 + b)/3$. Thus, there is the unique $\tilde{b} \in (0, 1)$ as given below, at which the expression in (10) vanishes:

$$\tilde{b} = \frac{3\gamma_s - 2 - \sqrt{(3\gamma_s - 2)^2 - 12\gamma_s}}{4} \quad .$$

Since $\Delta > 0$, we conclude that contingent protection raises R&D investment for firm N, $dk^*_n/dt > 0$, if and only if the South's market size is less than $\tilde{b}$, or $b \in (0, \tilde{b})$. Calculation shows that this cutoff value $\tilde{b} > 1/2$.

The right-hand side of (9) is more complicated, but it is shown in Appendix A that it is negative for all relevant values of $\alpha$ and b so that $dk_s^*/dt < 0$. The next proposition summarizes the effect of reciprocal protection on investment in R&D.

**Proposition 1**:

(A) If $b < \tilde{b}$, $dk_n^*/dt > 0$ and if $b > \tilde{b}$, $dk_n^*/dt < 0$.

(B) $dk_s^*/dt < 0$.

In words, reciprocal protection always reduces the incentive to invest in R&D in the South. In the North, the same conclusion holds if and only if the South's market size b exceeds the critical value $\tilde{b}$.

Note that the signs of derivatives in (8) and (9) are independent of the appropriation parameter $\alpha$. Regardless of how lax IPR protection is in the South, reciprocal protection always discourages firm S's R&D effort. By the same token, the effect on firm N's investment in R&D depends only on the South's market size but not on the value of $\alpha$.

Although having no qualitative effect on R&D, the value of $\alpha$ affects the magnitudes of changes in R&D investment from reciprocal protection. It is easy to show that $\partial^2 k_n^*/\partial t \partial \alpha < 0$, implying that weaker IPR protection in the South reduces firm N's investment in R&D. In contrast, $\partial^2 k_s^*/\partial t \partial \alpha > 0$ implies that weaker IPR protection results in a less marked decline in R&D in the South. We collect these findings in

**Proposition 2.** (A) The weakness of the South's IPR policy has no qualitative effect on R&D investment from reciprocal protection.

(B) Weaker IPR protection in the South reduces the North's R&D incentive. Thus, if b < $\tilde{b}$, reciprocal protection raises firm N's investment in R&D by a lesser extent than when IPR protection is stricter. If b > $\tilde{b}$, reciprocal protection decreases firm N's investment in R&D more than when IPR protection is stricter.

(C) When the South's IPR protection becomes weaker, reciprocal protection lowers firm S's investment in R&D by a lesser amount.

Now we turn to the effect on the profits from reciprocal protection. The total effect for firm N is, by the envelope theorem, given by

$$d\pi_n/dt = \partial\pi_n/\partial t + (\partial\pi_n/\partial k_s^*)(\partial k_s^*/\partial t).$$

There are two effects from reciprocal protection. The direct effect, captured by the first term on the right, is the pure effect from reciprocal protection, while the indirect effect, represented bythe second term on the right, affects the profits through changes in R&D investment of firm S. Calculations yields the direct effect

$$\partial\pi_n/\partial t = \partial\pi_n/\partial t = 2(1 - 2b)[w + (2 - \alpha)k_n - k_s],$$

and the indirect effect

$$\partial\pi_n/\partial k_s = - 2(1 + b)[w + (2 - \alpha)k_n - k_s],$$

both evaluated at initial zero duties and arbitrarily low transport costs, so the total effect on the profit to firm N is

$$d\pi_n/dt = 2[w + (2 - \alpha)k_n - k_s]\{(1 - 2b) - (1+b)\partial k_s^*/\partial t\}.$$

Since the term in brackets is positive due to positive output, we conclude that

$$\text{sgn}\ \{d\pi_n/dt\} = \text{sgn}\ \{(1 - 2b) - (1+b)\partial k_s^*/\partial t\}.$$

Substituting from (9), we can rewrite the expression on the right-hand side above, after manipulation, as

(11) $$Z_n\{(1 - 2b)Z_s + 4(1 + b)(2 - b)\}/\Delta.$$

A comparison with (8) shows that (11) is positive only if $dk_n^*/dt > 0$. We prove a similar result for firm S, in Appendix B. The next proposition summarizes the findings.

**Proposition 3**:

(A) $\text{sgn}\ \{d\pi_n/dt\} = \text{sgn}\ \{dk_n^*/dt\}$

(B) $\text{sgn}\{d\pi_s/dt\} = \text{sgn}\ \{dk_s^*/dt\}$

The positive linkage between the changes in profits and investment in R&D implies the following observations. First, Proposition 2, firm S never benefits from reciprocal protection, no matter how much it infringes firm N's IPRs. In contrast, reciprocal protection benefits firm N if and only if the Southern market is small enough ($b < \tilde{b}$). As mentioned before, South's IPR enforcement policy plays no role.

Second, lemma 1 implies that without R&D firm N benefits from reciprocal protection if and only if b < 1/2. When firms can invest in cost-reducing R&D, this cutoff condition is replaced by b < $\tilde{b}$ < 1/2. Thus, if the South has the market size b $\in [1/2, \tilde{b})$, then reciprocal protection is harmful to firm N without R&D but beneficial with R&D opportunities. This implies that R&D-intensive industries are more likely to resort to contingent protection.

**Proposition 4**: Without R&D, reciprocal protection benefits the Northern firm if the Southern market is less than half as large as the Northern market (b < ½). When firms can invest in R&D, this cutoff point increases to $\tilde{b} \in (1/2, 1)$.

Finally, calculations show that $\partial \tilde{b}/\partial\gamma_s < 0$ and $\partial \tilde{b}/\partial\gamma_n = 0$. Thus, if firm S becomes more efficient in conducting R&D, the cutoff point $\tilde{b}$ rises, making firm S a more likely target of AD actions by firm N. This leads to the next proposition.

**Proposition 5**: Improvement of the South's R&D technology is more likely to trigger reciprocal protection.

In contrast, an increase in firm N's R&D capability has no effect on the likelihood of reciprocal protection.

## 4. Concluding remarks

During the last two decades, use of contingent protection has spread to a large number of developing and semi-developed nations. Recent empirical evidence shows that those countries are retaliating against industrial countries that have used import duties against them before, rather than substituting contingent policy for the traditional protectionist policy which they had abolished as part of WTO-sponsored trade liberalization agreements. Evidence also shows that most protection actions today occur between the industrial North and the developing South.

Our multi-country analysis shows that firms want to avoid protectionist actions against foreign firms having larger home markets. However, firms with large home markets (North) prey on firms having sufficiently small home markets. The model's prediction thus corresponds to the stylized facts that most of today's contingent protection is between the North and the South.

Our analysis also shows that industries facing R&D opportunities are more likely to engage in reciprocal protection, a result consistent with the fact that contingent protection is concentrated in R&D-intensive industries. Another finding is that whether the North benefits or is harmed by reciprocal protection has little to do with the weakness of enforcement of IPRs in the South. This runs counter to the conventional view that trade protection is necessary to penalize foreign firms appropriating technologies invented in industrial nations.

To conclude, the North can benefit from reciprocal protection with the South if the South has a substantially smaller home market. Our model predicts that over time, as some countries in the South grow, the North's incentives to engage them in contingent protection will abate, but that some will always be targeted due to the smallness of their home markets.

**Appendix A:** Proof that

(A1) $$dk_s^*/dt = 4\{ (b-2)Z_n - 2(2-\alpha)(1-2\alpha)(1+b)(1-2b)\}/\Delta < 0.$$

Given

$$Z_n - 2(2-\alpha)(1-2\alpha)(1+b) > 0$$

by the second-order condition, we have, for $1 - 2b \leq 0$, that

$$-(1-2b)Z_n + 2(2-\alpha)(1-2\alpha)(1+b)(1-2b) > 0.$$

Adding this to the expression in braces in (B.1) yields $3(b-1)Z_n < 0$. Therefore, for any $b \geq 1/2$, that expression in braces in (A1) must be negative and hence $dk_s^*/dt < 0$. For $b < 1/2$, differentiate the numerator of $dk_s^*/dt$ with respect to $\alpha$ to get

$$4\{4(b-2)(2-\alpha)(1+b) - 2(-5+4\alpha)(1+b)(1-2b)\}$$

$$= 8(1+b)\{2(b-2)(2-\alpha) - (-5+4\alpha)(1-2b)\} = -24(1+b)[1+2b(1-\alpha)] < 0$$

and the denominator to get

$$d\Delta/d\alpha \equiv 4(2-\alpha)(1+b)Z_s - 8(-5+4\alpha)(1+b)^2 > 0.$$

Thus, $dk_s^*/dt$ is decreasing in $\alpha$ and hence takes the maximum value at $\alpha = 0$, which is

$$dk_s^*/dt = 4\{ (b-2)Z_n - 4(1+b)(1-2b)\}/\Delta < 0.$$

Thus, for any $b < 1/2$, $dk_s^*/dt < 0$ for any $\alpha$. We have shown that for any value of b and $\alpha$ $dk_s^*/dt < 0$. QED

**Appendix B (Not for publication)**:

The total profit to firm S is

$$\pi_s = [w + 2k_s - (1 - 2\alpha)k_n - 2t_n]^2$$

$$+ b[W + 2k_s - (1 - 2\alpha)k_n + t_s]^2 - (\gamma_s/2)k_s,$$

where $k_n$ and $k_s$ are evaluated at the Nash equilibrium values. The direct effect is

$$\partial\pi_s/\partial t = - 4[w + 2k_s - (1 - 2\alpha)k_n - 2t_n] + 2b[W + 2k_s - (1 - 2\alpha)k_n + t_s].$$

We also have

$$\partial\pi_s/\partial k_n = - 2(1 - 2\alpha)[w + 2k_s - (1 - 2\alpha)k_n - 2t_n]$$

$$- 2b(1 - 2\alpha)[W + 2k_s - (1 - 2\alpha)k_n + t_s].$$

As in the text if transport costs are arbitrarily small and free trade initially, these are written as

$$\partial\pi_s/\partial t = (b - 2)H.$$

$$\partial\pi_s/\partial k_n = - (1 - 2\alpha)(1 - b)H$$

where

$$H \equiv 2[w + 2k_s - (1 - 2\alpha)k_n - 2t_n] > 0.$$

Therefore,

$$d\pi_s/dt = \{(b - 2) - (1 - 2\alpha)(1 + b)(dk_n/dt)\}H.$$

The term in braces is written as

$$(b - 2) - (1 - 2\alpha)(1 + b)dk_n/dt$$

$$= (b - 2) - (1 - 2\alpha)(1 + b)2(2 - \alpha)\{(1 - 2b)Z_s + 4(1 + b)(2 - b)\}/\Delta$$

$$= (b-2)\{Z_n Z_s + 8(2-\alpha)(1-2\alpha)(1+b)^2\}/\Delta$$

$$-\ 2(1-2\alpha)(1+b)(2-\alpha)\{(1-2b)Z_s + 4(1+b)(2-b)\}/\Delta$$

$$= Z_s\{(b-2)Z_n - 2(1-2\alpha)(2-\alpha)(1+b)(1-2b)\}/\Delta,$$

which has the sign of $\{dk_s^*/dt\}$ found in the text. Therefore,

$$\mathrm{sgn}\{d\pi_s/dt\} = \mathrm{sgn}\ \{dk_s^*/dt\}.$$

**References**

Anderson, S. P, N. Schmitt and J. F. Thisse, 1995, Who benefits from antidumping legislation?, *Journal of International Economics* 38, 321-337.

Baldwin, R. and S. Evenett (eds.) 2009, *The collapse of global trade, murky protectionism and the crisis*, a VoxEU.org publication, CEPR- London.

Blonigen, B. A., 2006, Evolving discretionary practices of U.S. antidumping activity, *Canadian Journal of Economics* 39, 874-900.

Bown, C P. and P. Tovar, 2011, Trade liberalization, antidumping, and safeguards: evidence from India's tariff reform, *Journal of Development Economics*, forthcoming.

Brander, J., and P. Krugman, 1983, A 'reciprocal dumping' model of international trade, *Journal of International Economics* 15, 313-321.

Crowley, M. A., 2006, Do safeguard tariffs and antidumping duties open or close technology gaps? *Journal of International Economics* 68, 469-484.

d'Aspremont, C., and A. Jacquemin, 1988, Cooperative and non-cooperative R&D in duopoly with spillover, *American Economic Review* 78, 1133-1137.

Feinberg, R.M and K. Reynolds, 2006, The spread of antidumping regimes and the role of retaliation in filing, *Southern Economic Journal* 72, 877-890.

Gao, X., and K. Miyagiwa, 2005, Antidumping protection and R&D competition, *Canadian Journal of Economics* 38, 211-227.

J.C. Hartigan, 2000, The design of an antidumping law, *Journal of Economic Integration* 15, 655-668.

E.L-C. Lai, R. Riezman and P. Wang, 2009, Outsourcing of innovation, *Economic Theory* 38, 485-515.

Martin, A. and W. Vergote, 2008, On the role of retaliation in trade agreements, *Journal of International Economics* 76, 61-77**.**

Miyagiwa, K., and Y. Ohno, 2007, Dumping as a signal of innovation, *Journal of International Economics* 71, 221-240.

Moore, M.O. and M. Zanardi, 2009, Does antidumping use contribute to trade liberalization in developing countries?, *Canadian journal of Economics* 42, 469-495.

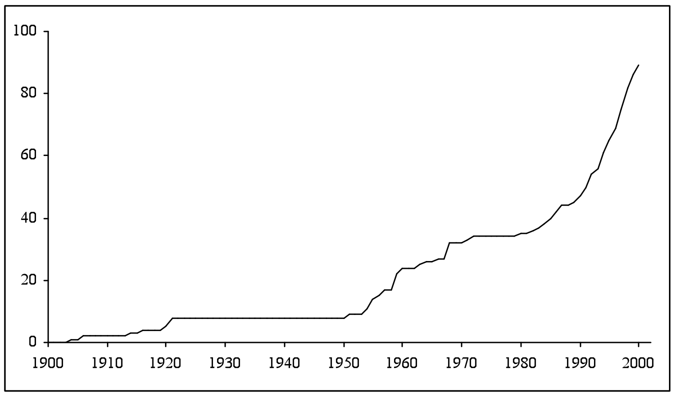
Niels, G., 2000, What is antidumping really about? *Journal of Economic Surveys* 14, 465-492.

Prusa, T.J. and S. Skeath, 2002, Retaliation as an explanation for the proliferation of anti-dumping: the economic and strategic motives for antidumping filings, *Weltwirfschafflines Archives* 138, 389–413.

L.D. Qui and E.L-C. Lai, 2004, Protection of trade for innovation: the roles of Northern and Southern tariffs", *Japan and the World Economy* 16, 449-470.

Vandenbussche, H., and M. Zanardi, 2010, The chilling effects of antidumping law proliferation, *European Economic Review* 54, 760-777.

Figure 1: The number of countries with Antidumping Laws




Source: Vandenbussche and Zanardi, 2010