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# Regulatory protection when firms move first

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## Regulatory Protection When Firms Move First

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# Regulatory Protection When Firms Move First

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**Abstract**

I investigate the imposition of a horizontal technical barrier to trade (HTBT) in a symmetric, cross-hauling duopoly. Tariffs and subsidies are ruled out, but, in the absence of a mutual recognition agreement, it is possible for governments to impose HTBTs, so long as firms apply different technologies. If firms are first movers, this possibility may induce them to avoid technical collaboration, in order to tempt governments into creating local monopolies, except where spillovers and R&D effects are high. This exacerbates the costs of regulatory protection, compared to standard models without R&D or spillovers.

Keywords: Research and development, spillovers, trade, protection

JEL codes: F10, F19, L13, L50.

## 1 Introduction

The issue of alleged regulatory protection has become a contentious one, particularly as other forms of protection have been reduced by trade liberalisation. The World Trade Organization, in 1995, states that

> *'Members shall ensure that technical regulations are not prepared, adopted or applied with a view to or with the effect of creating unnecessary obstacles to international trade. For this purpose, technical regulations shall not be more trade-restrictive than necessary to fulfil a legitimate objective....'*

While, in principle, this outlaws explicit regulatory protection, the problem is the acknowledgement that technical regulations - on product quality, on environmental, health or safety standards, on network

standards or on labelling and warranty conditions - are legitimate, and often unavoidable. Reasons for this include limitation of externalities[1], avoidance of market failure due to informational problems, ensuring that network externalities are efficiently exploited, and controlling for monopolistic distortions.[2]

The problem is that any of these reasons can, in practice, be misused to justify what is, in practice, regulatory protection.[3] Hence, while standard protection, such as tariffs and quotas, can easily be ruled out by the WTO and other trade agreements, technical barriers to trade (TBTs) are less visible and harder, in practice, to control.

The starting-point of this paper is that the existing literature on TBTs assumes that governments - or national bodies, such as standards councils - act first, and that firms respond.[4] The problem with this view is that, in practice, the choice of technologies is not exogenous. Technology develops by a process of research and development (R&D), which can be either carried out individually by firms, or in collaboration, at a national or a cross-border level. Collaboration is usually in order to reduce the costs of developing new technology - the decision to establish a collaborative relationship between firms allows for partial internalisation and exploitation of spillovers.[5] Moreover, it may make it possible for firms to share suppliers, yielding scale economies. However, in the presence of national borders, there may be other motivations: a collaboration essentially means that firms' products share a technological base, which means that it is very difficult for regulatory authorities to exclude one firm's product, or to impose high adaptation costs to a nationally-specified technology - a process which we could summarise as a horizontal technical barrier to trade (HTBT).

This raises an interesting question - in a situation where governments feel able to exploit technological rules and regulations for protectionist purposes, but are constrained from using more obvious trade instruments, such as tariffs, will firms prefer to set up their technological collaborations in order to minimise protection, or will they deliberately attempt to trigger protection? In other words, does allowing firms to move first make the issue of regulatory protection more or less serious?

[1] Costinot, 2008.

[2] Crampes and Hollander (1995), Lutz (1996) and (2000), Edwards (2009).

[3] Maskus and Wilson (eds 2001). Sturm (2006).

[4] Strictly speaking, standards are agreed by firms, often with support from governments, while regulations are compulsory. See Sykes (1995).

[5] Gil-Molto *et al* (2005).

Interesting examples of this dilemma include the past history of development of television network standards (with the American NTSC system, the German PAL and French SECAM), which created difficulties for Japanese TV manufacturers (whose home country adopted NTSC) to enter European markets. Another interesting example is the choice of different technological routes for aviation, with Boeing pulling out of a potential collaboration with Airbus on wide-bodied planes,[6] which may lead to potential issues over the planning of future airport expansions in the USA, suitable for the wider A380.

The structure of the paper is as follows. I start in *Section 2* by setting up a theoretical model of a Cournot duopoly, where one firm is foreign. The local regulator chooses the level of a pure, horizontal technical barrier to trade (HTBT). It is shown that, when firms are symmetric, a totally exclusionary barrier will be set. *Section 3* then introduces R&D expenditure into the model, with or without spillovers between companies. It is shown that firms will prefer to trigger protection, except where both the effect of R&D on costs and the potential spillovers between collaborating firms are large. *Section 4* shows that, where firms choose to trigger protection, the welfare costs are higher than in a model with constant marginal costs. *Section 5* concludes.

## 2 Regulatory protection in a duopoly without R&D

Consider first the situation ignoring R&D and technical collaboration. The broad framework is an extension of Brander (1980) and Brander and Spencer's (1985) work. As in Edwards (2009), there is a symmetric, cross-hauling duopoly, with firms 1 and 2 based in countries 1 and 2 respectively. I assume there are no transport costs involved, and tariffs are ruled out.

The inverse demand function is assumed to be linear in form, products are homogeneous from the standpoint of customers (even though they may be produced with different technology), and without loss of generality we can choose scale such that

$$P = 1 - Q_1 - Q_2, \tag{1}$$

[6] Irwin and Pavcnik (2004). Pavcnik (2002).

I set marginal revenue equal to marginal cost, $C$, which is constant and equal for the two firms, so that profit-maximising output

$$Q_1 = \frac{1 - C - Q_2}{2}; \tag{2}$$

$$Q_2 = \frac{1 - C - \tau - Q_1}{2}. \tag{2a}$$

Solving the first-order conditions to maximise profits, Cournot-Nash equilibrium sales of the two firms in country 1 are:

$$Q_1 = \frac{1 - C + \tau}{3}; \tag{3a}$$

$$Q_2 = \frac{1 - C - 2\tau}{3}. \tag{3b}$$

Hence we can derive

$$\text{Profit } \Pi_1 = (P - C)Q_1 = \frac{(1 - C + \tau)^2}{9}. \tag{4}$$

$$\text{Consumer Surplus } V = \frac{(2(1 - C) - \tau)^2}{18}. \tag{5}$$

If the national regulator in country 1 is assumed to maximise $W_1 = \Pi_1 + V$, then we can derive

$$W_1 = \frac{1}{6}[2(1 - C)^2 + \tau^2]. \tag{6}$$

It follows that the profit-shifting effect outweighs the loss of consumer surplus. Hence

**Proposition 1:** *Where tariffs are ruled out, in the presence of a cross-hauling, Cournot duopoly, a country will choose to impose a HTBT to exclude the foreign firm, unless the foreign firm can produce significantly more cheaply than the domestic firm.*

**Proof.** Differentiating (6), $\frac{\partial W_1}{\partial \tau} = \frac{\tau}{3}$, which shows that the marginal returns to increasing $\tau$ are positive and

increasing. ■

Where the firms are asymmetric, it is possible to show (Edwards, 2009) that country 1 will cease to exclude firm 2 if

$$C_1 > \frac{1}{3} + \frac{2C_2}{3}, \tag{7}$$

in other words, if firm 2 is substantially cheaper than firm 1. In this case, no HTBT will be applied.

# 3 The game with R&D and/or spillovers

## 3.1 The game without spillovers

We assume now that firms can alter technology, and consider first the case where R&D affects costs, but there are no spillovers. This may reflect the situation where the firms choose not to collaborate.

The game sequence is as follows:

| **Sequential setup of game** | **Sequence 1** |
|---|---|
| **1.** | Tariffs are banned; |
| **2.** | Firms decide on collaboration; |
| **3.** | Firms set R&D; |
| **4.** | Each country decides on HTBT; |
| **5.** | Firms set output levels. |

Marginal costs if firms do not collaborate are assumed to decline with respect to the firm's R&D activity:

$$C_1 = \overline{C} - bR_1, \tag{8a}$$

$$C_2 = \overline{C} - bR_2. \tag{8b}$$

In this case, $\overline{C}$ represents marginal cost with no R&D expenditure, and $b$ is the R&D sensitivity of marginal cost.

The assumption that firms set R&D expenditure before governments decide on setting HTBTs is impor-

tant. This means that marginal costs, $C_1$ and $C_2$, are constant as far as the governments are concerned: consequently, we have

**Lemma 1** *If firms do not collaborate, and costs are symmetric, then governments will choose to impose an HTBT to exclude the foreign firm. Each firm will, consequently, have a monopoly in its own local market.*

**Proof.** See above. This follows from *Proposition 1,* which indicates, *inter alia*, that $C_1$ and $C_2$ will be exogenous from the point-of-view of the national regulators. ■

It is now possible to solve for country 1's market, on the basis that firm 2 will be excluded (so that $Q_2 = 0$). I also assume that there are diminishing marginal returns to R&D expenditure, such that, if $R$ is the level of effective R&D activity, it costs $R^2$. Hence, solving for the first order condition for maximising profit, we obtain the following estimates of optimum R&D activity and marginal cost:

$$R^* = \frac{b}{4-b^2}(1-\overline{C}); \tag{9}$$

$$C^* = \overline{C} - \frac{b^2}{4-b^2}(1-\overline{C}). \tag{10}$$

## 3.2 Parameter restrictions

Note that this model requires restrictions on $b$ and $\overline{C}$:

1. For positive $b$, $C^*$ is declining with respect to $b$, and reaches 0 when

$$b = 2\sqrt{\overline{C}}. \tag{11}$$

2. For nonnegative demand we also require $C^* < 1$.This happens when

$$b = \sqrt{2}. \tag{12}$$

Consequently, we can deduce that profit

$$\frac{\Pi}{(1-\overline{C})^2} = \frac{1}{4-b^2} \leqslant \frac{1}{2}. \tag{13}$$

### 3.3 The game with a positive R&D spillover

Let us now assume that firms decide to collaborate over research, developing their product on a common standard. This creates a spillover, $\lambda$, from R&D effort, where $\lambda \in \{0, 1\}$, such that

$$C_1 = \overline{C} - bR_1 - \lambda bR_2, \tag{14a}$$

$$C_2 = \overline{C} - bR_2 - \lambda bR_1. \tag{14b}$$

The higher $\lambda$ is, the greater the potential benefits to firms from collaborating, as opposed to going it alone.

Firm 1's profit

$$\Pi_1 = \frac{2}{9}(1 - \overline{C} + (2-\lambda)bR_1 - (1-2\lambda)bR_2))^2 - R_1^2. \tag{15}$$

Maximisation in a symmetric equilibrium gives R&D activity

$$R' = \frac{2(2-\lambda)b}{9 - 2(2-\lambda)(1+\lambda)b^2}(1-\overline{C}), \tag{16}$$

marginal cost,

$$C' = \overline{C} - \frac{2(2-\lambda)(1+\lambda)b^2}{9 - 2(2-\lambda)(1+\lambda)b^2}(1-\overline{C}), \tag{17}$$

and profit,

$$\frac{\Pi_1}{(1-\overline{C})^2} = \frac{18 - 4(2-\lambda)^2 b^2}{(9 - 2(2-\lambda)(1+\lambda)b^2)^2}. \tag{18}$$

### 3.4 Will firms collaborate?

We can now solve for firms' decision on whether to collaborate, and save costs, or alternatively develop separate technology, gaining a local monopoly. This depends upon whether $\Pi_1$ in equation (18) is greater than $\Pi$ in equation (13). First of all, we can derive

**Proposition 2:** *In the absence of spillovers ($\lambda = 0$) firms will always prefer a local monopoly to a crosshauling duopoly.*

**Proof.** This follows by setting $\lambda = 0$ in (18). The condition for whether a local monopoly is preferred becomes

$$\frac{\Pi}{(1-\overline{C})^2} = \frac{1}{4-B} > \frac{\Pi_1}{(1-\overline{C})^2} = \frac{18-16B}{(9-4B)^2}, \tag{19}$$

substituting $B = b^2$ for simplicity

$$\begin{aligned} (9-4B)^2 - (4-B)(18-16B) &> 0; \\ 10B + 9 &> 0, \end{aligned} \tag{20}$$

which is definitely true, given $B$ is positive. ■

Looking at the opposite extreme, where there are maximum possible spillovers ($\lambda = 1$), we find that

**Proposition 3:** *In a symmetric, cross-hauling, Cournot duopoly, with maximum possible spillovers, if firms set R&D levels before governments decide on protection, then they will choose to collaborate if and only if $\overline{C} > 0.064$ and $b > 0.51$.*

**Proof.** When $\lambda = 1$, (19) becomes

$$\begin{aligned} (9-4B)^2 - (4-B)(18-4B) &> 0; \\ 81 - 72B + 16B^2 - 72 + 34B - 4B^2 &> 0; \\ 12B^2 - 38B + 9 &> 0. \end{aligned} \tag{21}$$

(21) would be an equality when

$$B = \frac{38}{24} \pm \frac{\sqrt{(38x38) - (48x9)}}{24} = 0.26 \text{ or } 2.91. \tag{22}$$

Given the positive sign on $B^2$ in (22), the function first declines and then increases, so it will be negative between the two roots. Also note that the upper root lies above the upper feasible value in (12). Consequently

$$0.26 < b^2 < 2 \text{ or } 4\overline{C} ==> 0.51 < b < \sqrt{2} \text{ or } 2\sqrt{\overline{C}}. \tag{23}$$

The second constraint implies that, if

$$4\overline{C} < 0.26 ==> \overline{C} < 0.064, \tag{24}$$

then there will be no value of $b$ for which the firms will prefer to collaborate. Taking (23)-(24) together, we can conclude that the firms will choose to collaborate rather than trigger protection if and only if there are sufficient pre-R&D costs and if the responsiveness of those costs to R&D is sufficiently large to make collaboration more profitable than protection. ■

For intermediate cases of $\lambda$, equation (19) is rather complicated, so I apply numerical analysis. The results are summarised in *Figure 1*, below:

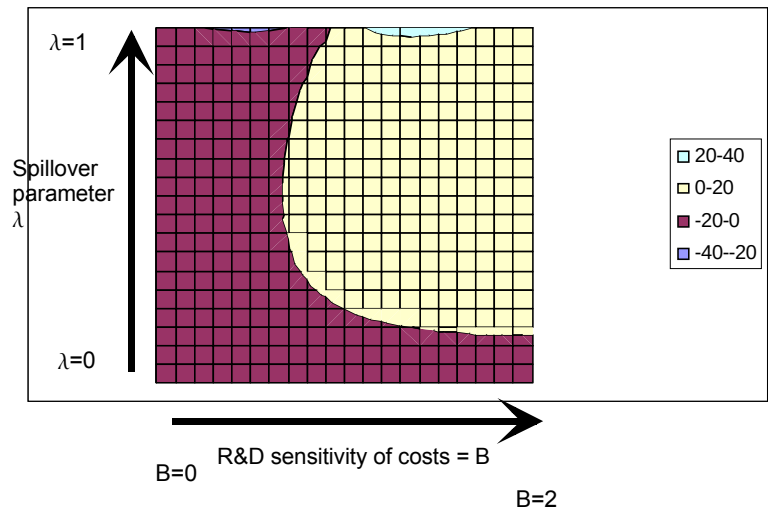


Figure 1: Effects of R&D sensitivity and spillovers on firms' gain from not cooperating and enforcing a local monopoly.

*Figure 1:*

### 3.5 Parameter restrictions

The upper restrictions upon $B$ are somewhat tighter in the case of a duopoly with spillovers than with a monopoly. This is because costs in equilibrium fall to zero faster than in the monopoly case, setting an upper limit on profits. Taking equation (17), and setting a lower limit of $C' = 0$, we find

$$\begin{aligned} C' &= 0 = \overline{C} - \frac{2(2-\lambda)(1+\lambda)b^2}{9-2(2-\lambda)(1+\lambda)b^2}(1-\overline{C}); \\ \frac{9\overline{C}}{2(2-\lambda)(1+\lambda)} &= b^2. \end{aligned} \tag{17a}$$

This corresponds to a limit of

$$B \leqslant \frac{9\overline{C}}{2(2-\lambda)(1+\lambda)}. \tag{25}$$

When $\lambda = 0$, this corresponds to $B \leqslant \frac{9}{4}\overline{C}$. Likewise, when $\lambda = 1$, $B \leqslant \frac{9}{4}\overline{C}$. For intermediate values of $\lambda$, the upper limit of $B$ is somewhat lower still, being at its lowest when $\lambda = \frac{1}{2}$, where $B \leqslant 2\overline{C}$.

# 4 Welfare effects

National welfare is taken to be

$$W_c = V_c + \Pi_{i=c}, \tag{26}$$

where $V_c$ is consumer surplus and $\Pi_{i=c}$ is the profit made by the local firm in both markets (if it is allowed to sell there). Consumer surplus is

$$V_c = \frac{1-P}{2}Q = \frac{(Q_1+Q_2)^2}{2}. \tag{27}$$

In the case of a monopoly,

$$\frac{V^*}{(1-\overline{C})^2} = \frac{(\frac{4}{4-B})^2}{8} = \frac{2}{(4-B)^2}, \tag{28}$$

and so

$$\frac{W_1^*}{(1-\overline{C})^2} = \frac{V^*+\Pi}{(1-\overline{C})^2} = \frac{6-B}{(4-B)^2}. \tag{29}$$

In the case of a cross-hauling duopoly,

$$\frac{V'}{(1-\overline{C})^2} = \frac{18}{(9-2(2-\lambda)(1+\lambda)B)^2}. \tag{30}$$

Noting that the firm makes profits in both markets,

$$\frac{W_1'}{(1-\overline{C})^2} = \frac{V'+\Pi'}{(1-\overline{C})^2} = \frac{36-4(2-\lambda)^2B}{(9-2(2-\lambda)(1+\lambda)B)^2}. \tag{31}$$

From comparing (29) and (31), welfare will be better off with non-collaboration and local monopolies if and only if

$$\frac{6-B}{(4-B)^2} > \frac{36-4(2-\lambda)^2B}{(9-2(2-\lambda)(1+\lambda)B)^2}. \tag{32}$$

**Lemma 2** *In the absence of spillovers between firms, in a symmetric, Cournot model of competition between two firms in different countries, national welfare is higher with a crosshauling duopoly than with two local monopolies.*

**Proof.** Set $\lambda - 0$ in (32) The condition becomes

$$\frac{6-B}{(4-B)^2} > \frac{36-16B}{(9-4B)^2}; \tag{32a}$$

.

$$(6-B)(9-4B) > 4(4-B)^2, \tag{33}$$

given $0 < B < 2$ (so $9 - 4B$ is positive). Multiplying out, this becomes

$$\begin{aligned} 54 - 33B + 4B^2 &> 64 - 32B + 4B^2; \\ -10 - B &> 0, \end{aligned} \tag{33a}$$

which is clearly never true for $B > 0$. ■

This can be related to Brander and Krugman's (1983) results on reciprocal dumping, in the case where there are no transport costs or tariffs. Note that, defining the net welfare loss from a monopoly,

$$L = \frac{6-B}{(4-B)^2} - \frac{36-16B}{(9-4B)^2}; \tag{34}$$

numerical analysis shows that, over the range $0 < B < 2$, both $L$ and $\frac{L}{W'}$ are monotonically declining with respect to $B$. Hence, the gains from reciprocal dumping are increasing the more R&D can affect costs. This is shown in *Figure 2*, below:

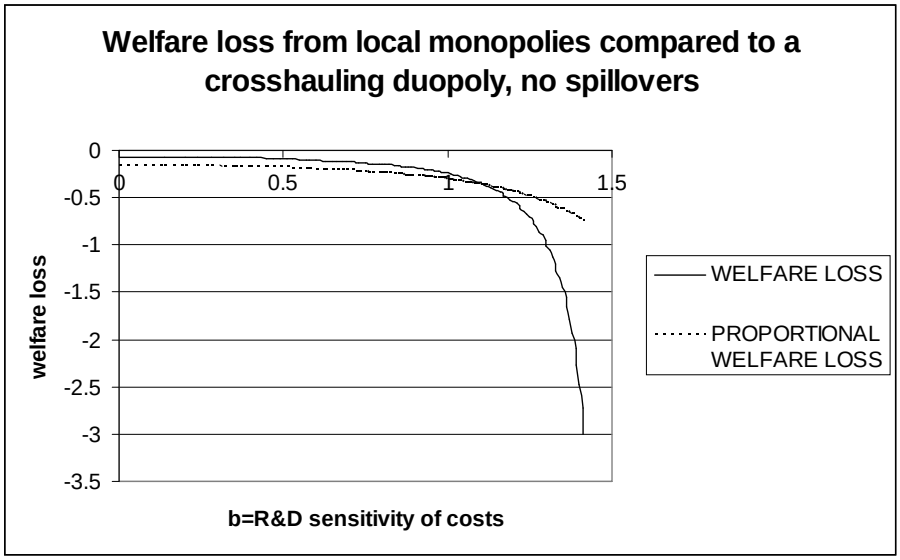


*Figure 2:*

We turn now to the case where there are maximum potential spillovers between firms ($\lambda = 1$). In this case, (33) becomes

$$(6 - B)(9 - 4B)^2 > 4(9 - B)(4 - B)^2. \tag{35}$$

Note that the only terms changed are on the RHS, and that this is now smaller than in (34). Consequently, the finding that welfare is improved in a crosshauling duopoly compared to a monopoly is even stronger than where there are no spillovers. Equation (34) becomes

$$L = \frac{6 - B}{(4 - B)^2} - \frac{36 - 4B}{(9 - 4B)^2}; \tag{36}$$

which shows that $L$ is greater than without spillovers.

This can be summarised as

**Proposition 4:** *In a symmetric, Cournot model of competition between two firms in different countries, national welfare is higher with a crosshauling duopoly than with two local monopolies, and this effect is more marked with full spillovers than with no spillovers.*

**Proof.** See above. ■

A numerical simulation shows the welfare effects of a monopoly compared to a collaborating duopoly -

this is shown in *Figure 3*, below.

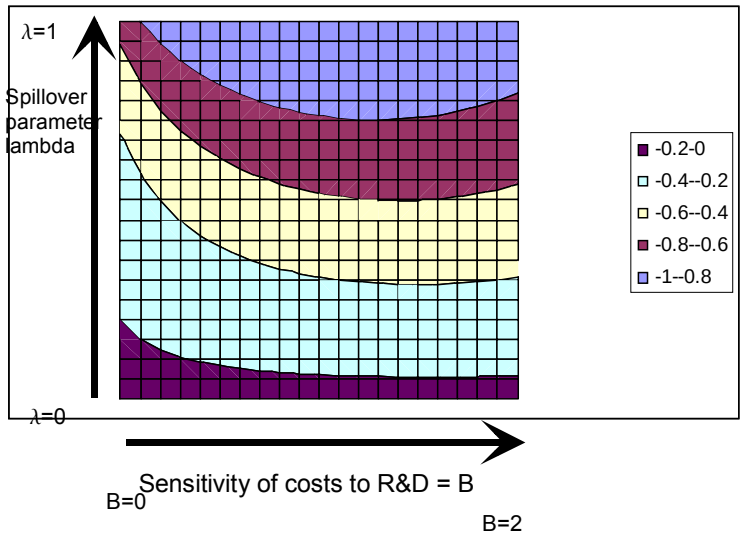


Figure 3: Proportional loss of welfare from moving from a collaborating duopoly to a protected monopoly

*Figure 3:*

However, we have already shown in *Figure 1* that there are cases where firms opt to collaborate, rather than trigger protection. Hence, in *Figure 4*, I superimpose onto *Figure 3* the dividing line for firms' behaviour. Towards the top right hand corner, firms will not act to trigger protection: this includes most of the cases where the potential loss of national welfare is greatest. However, to the left of/below the dividing line, there are still areas with considerable welfare loss, particularly where $\lambda$ is high.

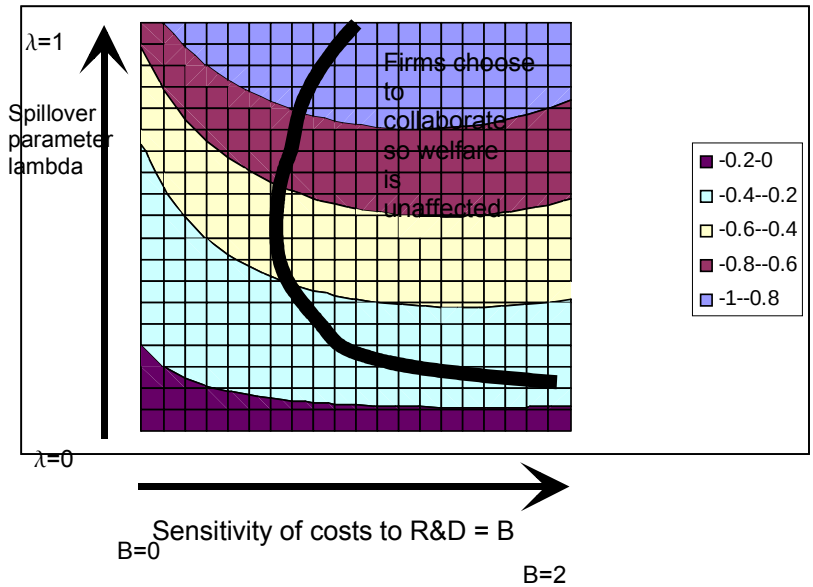


Figure 4: Welfare loss from the HTBT game

*Figure 4: welfare losses from the regulatory protection game*

In addition, from the parameter restrictions in equation (25), the areas towards the right hand side are ruled out when $\overline{C}$ is relatively low.

# 5 Conclusion: when firms move first

The aim of this paper was to see the effects of regulatory protection upon welfare, in a game where firms can move first, in the sense that they can either collaborate (making regulatory protection impracticable) or avoid collaboration (raising costs, but triggering regulatory protection). The question was whether firms would act to encourage protection, or to forestall it, and a secondary question was the effects upon welfare.

It is worth noting that the inclusion of R&D and of spillovers between firms potentially increases the cost of regulatory protection, compared to a model without these features. Moreover, in many cases, firms will choose to trigger such protection, leading to significant welfare losses. However, in potentially the very worst cases (high initial costs, high spillovers and a high R&D-sensitivity of costs), the effect on costs from not collaborating is such that firms will choose to collaborate, and protection will not occur.

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