RIVALRY IN UNCERTAIN EXPORT MARKETS: COMMITMENT VERSUS FLEXIBILITY

by

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Abstract:
This paper examines optimal trade policy in a two-period oligopoly model in which a home and a foreign firm choose capital and output. Demand uncertainty which is resolved in period two gives rise to a trade-off between strategic commitment and flexibility in the firms' investment decision. When the government can commit to an export subsidy it may choose to over- or under-subsidise to deter private-sector capital commitment. It is shown that when the government cannot commit to its trade policy the value of commitment to the unsubsidised foreign firm is greater than that of the subsidised home firm.
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1. Introduction

In international markets with fluctuating demand, strategically motivated investment commitment by rival firms implies the loss of the flexibility required for adjusting to unexpected demand changes. Recent occurrences of destabilising shocks in major economic zones quite naturally motivate policy questions involving a trade-off between commitment and flexibility. This paper focuses on issues of investment flexibility on the one hand and policy commitment on the other hand. In particular the policy discussion addresses how government commitment or lack of commitment affects competing firms' strategic investment decisions for export markets where demand uncertainty prevails.

To study these issues we use a strategic trade model in which a home and a foreign firm export to a third market. The key early papers in the strategic trade literature are Brander and Spencer (1985) and Spencer and Brander (1983) in which they show that an export subsidy can be used to shift rents from a foreign to a home firm.[1] As in Grossman and Maggi (1997) our model is an international duopoly in which firms choose capital and output and the government chooses an export subsidy[2]. In the model we examine here there are two periods, during the first of which players face uncertainty about future demand in the export market. In period two, in which the actual output is chosen, uncertainty disappears[3].

A firm that undertakes a large capital investment so as to manipulate the future output or price choice of its rival may find itself overextended if the demand for the good turns out to be less than anticipated. In contrast a firm that delays its capital choice until after the demand until it knows more about demand retains the flexibility to cope with demand fluctuations. Retention of flexibility however, may imply the surrender a first mover advantage. This choice of when to invest gives rise to endogenous timing in the investment game. Since the 1980s there has been considerable interest in the question of endogenous timing in the choice of strategic variables in oligopolistic markets[4].

[1] Eaton and Grossman (1986) showed that this result was sensitive to the assumption that firms chooses quantities. Dixit (1984) showed that it was sensitive to the number of firms. Neary and Leahy (1998) provide a general framework in which optimal strategic trade and industrial policy can be analysed.

[2] See also Karp and Perloff (1995) and Goldberg (1995) for a similar approach. In Neary and O' Sullivan (1998) the firms choose R&D and output while the government chooses an export subsidy.

[3] This structure is similar to that in Cooper and Reizman (1989) and Arvan (1991).

[4] See for instance Gal-Or (1985), Dowrick (1986), Boyer and Moreaux (1987), Hamilton and Slutsky (1990) and Brander and Spencer (1992).

Governments can alter the relative advantages of investment flexibility. We examine the case where export subsidies set by the home government influence the nature of the investment chosen by the home firm and its foreign opponent. If the government cannot credibly commit to its trade policy, it determines its export subsidy *after* uncertainty has disappeared. Capital flexibility makes the foreign firm more vulnerable to manipulation by the rival's government export subsidy, hence leaving it more likely to commit, even at relatively high levels of uncertainty. Conversely, even at low levels of uncertainty, the domestic firm prefers to keep its capital flexible, thereby maximising the benefits from a flexible subsidy.

The game is more complicated if the government commits to its trade policy *before* the firms choose their capital levels and the timing of their investments. Government commitment implies a loss of subsidy flexibility in the sense that the subsidy chosen cannot be adjusted to take account of *actual* demand in period two. However, the options of the government are wider in the sense that it may choose a policy of *Commitment Deterrence* with respect to its own firm or the foreign rival. This involves using its export subsidy to strategically manipulate the timing of home or foreign investment The government can force the foreign firm to remain flexible by over-subsidising or persuade the home firm to avoid commitment by under-subsidising relative to the *Commitment Accommodation* benchmark.

In section two we describe the basic model in which a home and a foreign firm export to a third market characterised by demand uncertainty. In section three we examine the case in which the government cannot commit in advance to its export subsidy. In this case it is forced to set its trade policy in period two after uncertainty has been resolved. Our discussion turns to the case of credible government commitment in section four where we derive the optimal policy under different levels of uncertainty and discuss the possibility of strategic commitment deterrence. Section five concludes and suggests future research directions.

2. The model

A home and a foreign firm are competing in a Cournot fashion in a third market, facing demand uncertainty. The stochastic demand component is denoted by α, defined over the

closed interval $[\underline{u},\bar{u}]$ and characterised by zero mean ($Eu = 0$) and variance of s^2. Demand is given by

$$p = a - Q + u \qquad (1)$$

where p is the price prevailing in the export market , $Q = x + y$ is total output, and x and y denote output of the home and foreign firm, respectively. Firms also invest in capital, symbolised by k and k^*. Henceforth, starred variables refer to the foreign firm. We assume the firms' cost functions are

$$C = \left(c_0 - k\right)x + \frac{k^2}{2h} \qquad (2a)$$

$$C^* = \left(c_0^* - k^*\right)y + \frac{k^{*2}}{2h} \qquad (2b)$$

where c_0 and c_0^* stand for the constant home and foreign marginal costs of production and $1/h$ is the marginal capital cost (which we assume to be identical for the two firms).

There are two periods, during the first of which players face uncertainty about future demand in the export market. At the start of period two, in which the actual output is chosen, uncertainty disappears. Firms have the option to commit strategically to investment in period one. However, since this choice implies foregoing capital flexibility in the second period, commitment is less appealing for high levels of uncertainty. If investment is delayed to period two, capital is chosen simultaneously with output and optimally for the demand then prevailing.

Governments can alter the relative advantages of investment flexibility. We examine the case where export subsidies set by the home government (s) influence the nature of the investment chosen by the home firm and its foreign opponent. Depending on whether the government can commit to the subsidy or not, the subsidy is set under uncertainty (i.e., in period one) or after demand is known (i.e., in period two). As we will discuss in sections three and four, this will crucially determine the investment decisions of both firms. Summarising, respective profits for the home and foreign firm are equal to

$$p = \left(p - s_i\right)x - C \qquad i = 1,2 \qquad (3a)$$

$$p^* = py - C^* \qquad (3b)$$

where subscript i refers to the period in which the subsidy is set.

For simplicity, players are assumed to be risk neutral. Risk aversion complicates the analysis significantly but does not change the qualitative nature of our results. Compared to their risk neutral counterparts, risk averse players would generally only prefer commitment to flexibility at lower levels of uncertainty.

Firms always choose outputs in the last stage of the game. Maximising second period profits amounts to expressions (4a) and (4b) for optimal outputs

$$x = \left[2A - A^* + 2s_i + 2k - k^* + u\right]/3 \qquad \text{with } A \equiv a - c_0 \text{ and } A^* \equiv a - c_0^* \qquad (4a)$$

$$y = \left[2A^* - A - s_i + 2k^* - k + u\right]/3 \qquad (4b)$$

3. Government non-commitment

If the government cannot commit in advance to its trade policy, it is forced to set its export subsidy in period two, *after* uncertainty has disappeared (i.e., in period 2, hence $s_i = s_2$). Before solving the actual game, we first determine the actions of the players in each branch of the game tree.

3.1. The alternatives under government non-commitment

Four outcomes are possible, each of which will be discussed.

3.1.1. Both firms commit

First, both the home and foreign firms may choose to commit to capital in period one. In that case, firms determine capacity before the home government sets the export subsidy, effectively implying a three-stage game. Outputs, set in the third stage, are given by expressions (4a) and (4b) where k and k^* are the capital levels chosen in period one. In the second stage the government chooses the optimal subsidy, given firms' investment decisions. It maximises second period welfare, which is equal to profit of the home firm corrected for the subsidy cost.

$$\max_{s_2} \; W = p - s_2 x \qquad (5)$$

The optimal non-commitment subsidy implied by expression (5) is equal to

$$s_2 = x/2 \qquad (6)$$

In the first stage, firms commit to capital. Since firms are confronted with demand uncertainty in period one, they maximise *expected* profits[5], or

$$\max_{k_1} Ep = E\left(x^2\right) - \frac{k_1^2}{2h} \tag{7a}$$

$$\max_{k_1^*} Ep^* = E\left(y^2\right) - \frac{k_1^{*2}}{2h} \tag{7b}$$

The respective first order conditions for the home and foreign capital choice are

$$\frac{dEp}{dk_1} = 2E\left(x\frac{dx}{dk_1}\right) - \frac{k_1}{h} = 0 \tag{8a}$$

$$\frac{dEp^*}{dk_1^*} = 2E\left(y\frac{dy}{dk_1^*}\right) - \frac{k_1^*}{h} = 0 \tag{8b}$$

After substituting (6) into (4a) and (4b), we know $\frac{dx}{dk_1} = 1$ and $\frac{dy}{dk_1^*} = \frac{3}{4}$, reducing (8a) and (8b) to

$$k_1 = 2hEx \tag{9a}$$

$$k_1^* = \frac{3}{2}hEy \tag{9b}$$

The foreign competitor clearly invest less in capital per unit of expected output than the home firm. This is the result of the subsidy by the home government to its national exporter in the second stage of the game. Still, it retains a first mover advantage over the home government, but not over the home firm.

3.1.2. Home firm flexibility and foreign commitment

Second, we derive the players' optimal decisions when the foreign rival commits to capital in period one while the home firm delays investment to the last period. In this case the home firm decides simultaneously on output and capital investment. Optimal output is given by expression (4a), while maximising profits in period two with respect to capital implies

$$k_2 = hx \tag{10a}$$

Unlike in the previous case, capital is now flexibly chosen by the home firm. The optimal subsidy is, also in this case, determined as in expression (7). On average the home firm invest less in capital than in the previous case. Conversely, its rival commits to a higher level of capital per unit of expected output, with

[5] Risk averse firms would maximise expected utility of profits in period one.

$$k_1^* = \frac{3-h}{2(1-h)} hEy \qquad (10b)$$

This is not surprising since the foreign firm now has a first mover advantage both over the home government and its rival. Still, this strategic advantage implies a lack of flexibility to unexpected demand shocks.

3.1.3. Home firm commitment and foreign flexibility

In the third case firms' capital investment decisions are opposite to those in case two. Now the home firm strategically commits while the foreign rival delays investment. Hence, the latter's capital adjusts to actual output and is equal to

$$k_2^* = hy \qquad (11)$$

The subsidy set by the home government in stage two, is higher than in the previous two cases since now $\frac{dy}{dx} = -1/(2-h)$ and $h < 1$. Hence, from expression (6) we obtain

$$s_2 = x/(2-h) \qquad (12)$$

The foreign firm has lost its first mover advantage to the government, which can now manipulate the former's investment given that its capital is adjustable. In the first stage, the home firm maximises expected profits, requiring

$$k_1 = \frac{2-h}{1-h} hEx \qquad (13)$$

In this case the home firm has a first-mover advantage over the foreign firm, which explains its larger investment compared to either of the previous cases[6].

3.1.4. Both firms remain flexible

The final case under government non-commitment involves both firms delaying investment until the second period. Thus, this branch of the game has two stages and is characterised by both firms simultaneously deciding on output (given by expressions (4a) and (4b)) and capital (given by expressions (10a) and (11)). The subsidy is determined by expression (12) since, like in the previous case, the government can strategically influence the foreign firm's capital.

3.2. The game under government non-commitment

We now solve the game in which the government chooses its subsidy in period two. The outcome depends on the level of uncertainty and the marginal capital cost ($1/h$). Solving the game thus requires calculating the level of uncertainty at which firms are indifferent between committing to capital and delaying investment, given each of the rival's choices. Indifference refers to the fact that investing in period one and two yields the same level of expected profits, given the investment choice of the competitor. This implies that a pair of indifference loci exists for each firm. For the home firm, indifference between capital commitment and flexibility given foreign flexibility is defined by the locus $Ep\{s_2, k_1, k_2^*\} = Ep\{s_2, k_2, k_2^*\}$, while indifference given foreign commitment is given by the locus $Ep\{s_2, k_1, k_1^*\} = Ep\{s_2, k_2, k_1^*\}$. An equivalent pair of indifference loci exists for the foreign competitor. Even without any cost asymmetry between firms, the foreign rival is indifferent between capital commitment and flexibility at a higher level of uncertainty than the home firm, both given rival commitment and delay. This indicates that the foreign firm values commitment relatively more than the home firm. Flexibility by the foreign firm increases the home government's scope for manipulating foreign output in the last stage. In other words, to the foreign firm the value of the first-mover advantage at committing to capital in the first stage is magnified by limiting its vulnerability to the home government's flexible subsidy policy. Moreover, if the home firm delays investment, foreign commitment is associated with a first-mover advantage over both the home firm and the government, implying that the foreign indifference locus given rival delay lies above the one given rival flexibility. The opposite is true for the home exporter. The latter gains relatively more from remaining flexible than from commitment since capital flexibility will increase the strategic effects of the government's flexible subsidy. Hence, the home firm will only prefer commitment to flexibility at relatively low levels of uncertainty.

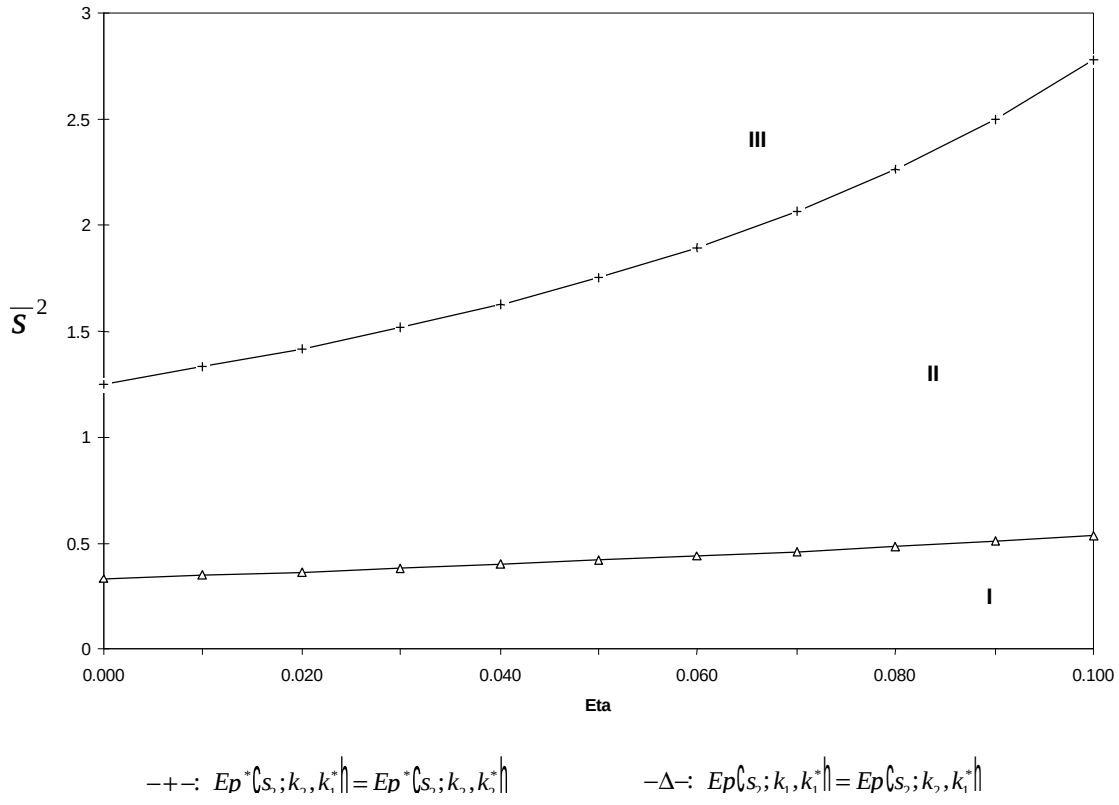
Figure 1 presents the relevant indifference loci, dividing the $\bar{s}^2, h$-diagram (where $\bar{s}^2 = s^2 / A^2$ is the normalisation of the variance) into three areas. In area I, both firms commit to capital (s_2, k_1, k_1^*). In area III where uncertainty is relatively high, both firms choose to keep capital flexible. For intermediate levels of uncertainty (area II), the foreign

[6] When the foreign rival also commits to capital, the home firm invest less per unit of output since capital investment is a strategic substitute. In the case where the home firm stays flexible while its rival commits, it

firm commits whereas the home firm remains flexible (s_2, k_2, k_1^*). This result contrast sharply with the choice made by firms with identical marginal costs of production under free trade at similar levels of uncertainty. In a way, the subsidy gives the home firm a cost advantage, even if actual marginal production costs of the competing firms are the same. The crucial difference between the game with trade policy and under free trade lies in the fact that the former allows for the possibility that the government helps its national exporter to establish Stackelberg leadership in the export market. Hence, the foreign firm has an incentive to limit the government induced leadership of the home firm by pre-empting the home government by committing to capital. This issue does not arise in the non-policy game.

Note that the intermediate area in figure 1 will widen if the foreign firm has a relative cost advantage. Conversely, if the home firm has a sufficiently large real cost advantage over its rival, multiple equilibria may emerge for intermediate levels of uncertainty[7].

Figure 1: Firms' indifference loci for non-commitment by the home government (A=A*)



has a second-mover disadvantage and hence its expected investment is lower.

4. Government commitment

Suppose that the government can credibly commit to an export subsidy in period one. Here we consider the case in which the government always has to determine the export subsidy at the beginning of the game, without being able to change it in period two when the uncertainty has been resolved (hence, now $s_i = s_1$). Like in the non-commitment case, considered in the previous section, we derive the alternative payoffs for the players and then solve the game.

4.1. The alternatives under government commitment

The expressions for outputs chosen in the last stage of the game are still given by (4a) and (4b). The export subsidy is always chosen in period one, before capital investment by either firm. So we only need to distinguish between the four capital commitment/delay combinations.

First, consider the case in which both firms choose to commit to capital, *after* the government has set its subsidy but *before* period two starts. The game the consists of three stages with capital chosen in the second stage of the game. Now, since $dx / dk_1 = dy / dk_1^* = 2/3$, capital investment by the home and foreign firm is given by

$$k_1 = (4/3)hEx \qquad (14a)$$

$$k_1^* = (4/3)hEy \qquad (14b)$$

Expressions (14a) and (14b) are symmetric (although the values of the expected home and foreign output will differ) because, unlike in the case of subsidy non-commitment discussed in section three, neither firm can influence the government by committing to capital.

Second, we derive the values of the players' decision variables if the home firm delays investment and the foreign firm commits to capital. Now, not only outputs are determined in period two (expressions (4a) and (4b)), but in addition the home firm chooses capital investment in this period, given by expression (10a). The foreign rival commits to its capital

[7] For an extensive discussion of this issue, we refer to Dewit and Leahy (1999).

investment one stage earlier (i.e., stage two in period one). Maximising its expected profit requires an investment equal to[8]

$$k_1^* = \frac{2(2-h)}{3-2h} hEy \qquad (15)$$

In the third case, the home firm commits to capital while the foreign firm keeps its capital adjustable to any unexpected demand shock. Not surprisingly, the expression for optimal home capital is symmetric to expression (15), or, since $\frac{dx}{dk_1} = \frac{2-h}{3-2h}$,

$$k_1 = \frac{2(2-h)}{3-2h} hEx \qquad (16)$$

and the expression for k_2^* is given in (11).

In the final case, firms simultaneously choose capital flexibly in the last stage. Optimal capital investment for firms is then given by expressions (10a) and (11), respectively. Like in the equivalent case under non-commitment by the government, this branch of the game tree is reduced to two stages only, but now the first stage occurs in period one.

In the first stage, government maximises *expected* welfare;

$$\max_{s_1} EW = Ep - s_1 Ex \qquad \text{with } Ep = E\left(x^2 - \frac{k^2}{2h}\right) - s_1 Ex \qquad (17)$$

The solution to this maximisation problem depends on h, A, A^* and the level of uncertainty. This is discussed in the next subsection and illustrated in figures 2 and 3 below. As an intermediate step in obtaining this solution it proves useful to calculate the optimal subsidies for *given* capital commitment/flexibility combinations. The values of these constrained optimal subsidies are reported in the appendix.

[8] Here too, investment is now larger than when home firm commits too ($\frac{4}{3} > \frac{2h(2-h)}{3-2h}$), because capital investment is a strategic substitute.

4.2. The game under government commitment

Under government commitment the trade policy is always set before any firm moves, whether the latter commits to its capital or chooses it flexibly. Government commitment to its trade policy implies a loss of flexibility in the sense that the subsidy chosen can not be adjusted in line with *actual* demand in period two[9].

The fact that the government always moves first complicates the nature of the game significantly. Most importantly, it widens the government's options. In particular, it implies that, if the government wants to prevent strategic investment by firms, it can, as we will discuss below, deter capital commitment by choosing the appropriate subsidy. We refer to this strategy as *Commitment Deterrence.* The reason for using commitment deterrence against the foreign firm differ from that from deterring home commitment. By keeping the foreign firm flexible the government guarantees that the foreign rival will not have a first-mover advantage over the domestic firm, whereas home firm flexibility avoids the domestic social costs associated with overinvestment. Since commitment deterrence implies deviating from the optimal subsidies *given* firms' capital commitment or flexibility (as calculated in section 4.1), it entails a cost for the government. The government's optimal policy will involve commitment deterrence if the costs are outweighed by the welfare gains from firm flexibility.

Lower subsidy levels increase the relative attractiveness of flexibility to the home firm by reducing the firms relative cost advantage. Likewise a higher export subsidy to the home firm raises the relative value of flexibility to the foreign firm. Hence deterring home capital commitment requires lowering the export subsidy while deterring foreign commitment involves increasing the export subsidy relative to the *Commitment Accommodation* level. The actual type of commitment deterrence and the subsidy levels needed to achieve it depend crucially on the level of uncertainty prevailing and the relative cost difference between competing firms. To illustrate this, we present two cases. First, the game is solved in the case when firms have symmetric costs. The second case involves a cost asymmetry, where the foreign rival has a cost advantage over the domestic firm.

4.2.1. Government commitment with initial cost symmetry

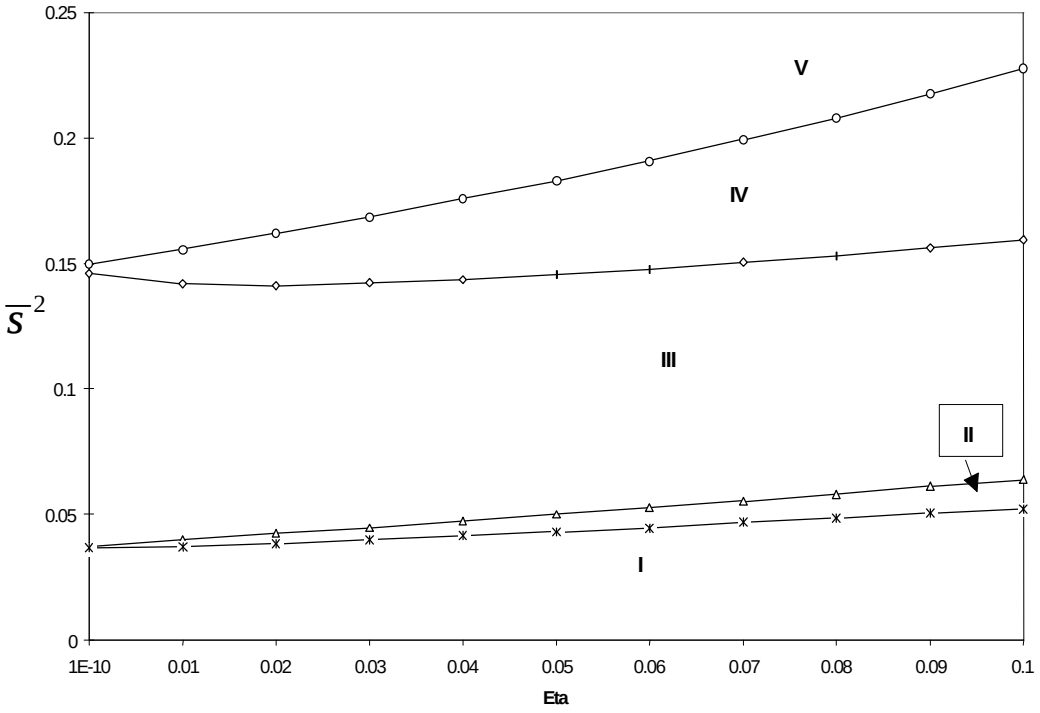
By initial cost symmetry we mean the case in which $A=A^*$. The outcome of the game under government commitment with cost symmetry between firms is presented in figures 2a and 2b. While figure 2a shows the outcome of the game for different levels of uncertainty and varying capital costs, figure 2b illustrates how the subsidy under government commitment (s_1 is normalised as $\bar{s}_1 = s_1 / A$) changes for various ranges of uncertainty, keeping capital costs constant (i.e., given h).

In area I in figure 2a, both firms commit since uncertainty is very low and the firm thus finds it optimal to invest strategically. The welfare gains from firm flexibility are very small implying that commitment deterrence is very costly in this region[10]. So, the government accommodates the firms' strategic investment decisions by setting the optimal subsidy given firms' commitment ($s_1^{cc^*}$). Foreign firm flexibility can only be enforced by raising the subsidy beyond $s_1^{cc^*}$, whereas deviating in the opposite direction is required to ensure home firm flexibility. The first subsidy switch point is determined by the level of uncertainty at which the cost of commitment deterrence is sufficiently low. The government chooses to tailor its subsidy to the least costly type of commitment deterrence. With symmetric costs and subsidisation by the home government, enforcing foreign firm flexibility is the cheaper option because commitment has lower value for the foreign rival than it has for the home firm. Hence, moving from area I to area II in figure 2a implies that the government will switch from commitment accommodation ($s_1^{cc^*}, k_1, k_1^*$) to *foreign* commitment deterrence while allowing the home firm to commit (($s_1^{ct^*}, k_1, k_2^*$), where $s_1^{ct^*}$ refers to the lowest possible subsidy that deters foreign commitment).

[9] This also means that, compared to the previous scenario of government non-commitment, capital flexibility is now relatively more attractive to the foreign firm.

[10] Foreign commitment deterrence in this region requires a huge subsidy while home commitment deterrence implies taxing the domestic firm. The welfare costs involved in either alternative form of commitment deterrence outweigh the small welfare gains from firm flexibility.

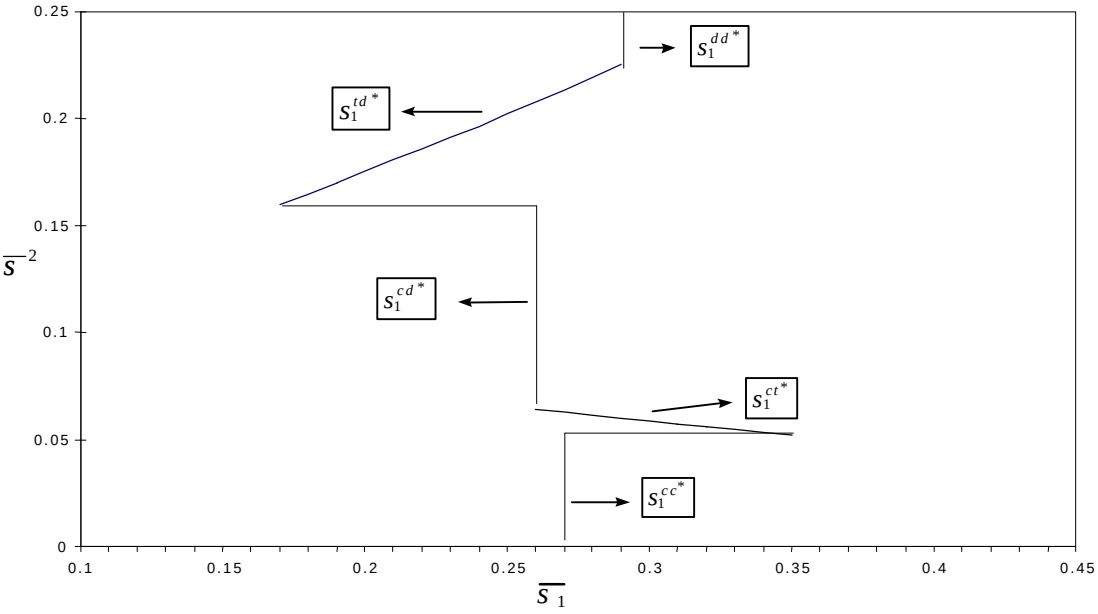
Figure 2a: Firms' indifference loci for commitment by the home government (A=A*)



$-\circ-: Ep(s_1^{dd*}; k_1, k_2^*) = Ep(s_1^{dd*}; k_2, k_2^*)$ $-\Diamond-: EW(s_1^{cd*}; k_1, k_2^*) = EW(s_1^{td*}; k_2, k_2^*)$

$-\Delta-: Ep^*(s_1^{cd*}; k_1, k_1^*) = Ep^*(s_1^{cd*}; k_1, k_2^*)$ $-x-: EW(s_1^{cc*}; k_1, k_1^*) = EW(s_1^{ct*}; k_1, k_2^*)$

Figure 2b: Subsidy under commitment by home government as a function of (A=A*; eta=0.1)



More precisely, this switch point is indicated by the locus on which the government is indifferent between these two policies because they yield the same expected welfare (i.e., $EW(s_1^{cc*}, k_1, k_1^*) = EW(s_1^{ct*}, k_1, k_2^*)$). Figure 2b shows that at that point the subsidy jumps discretely to a higher level (s_1^{ct*}) implying that the deviation from the commitment accommodating subsidy (s_1^{cc*}) has to be quite large to ensure that the foreign firm prefers to stay flexible. At higher levels of uncertainty a smaller deviation is sufficient to attain that objective, thus, s_1^{ct*} decreases as uncertainty rises.

When uncertainty is sufficiently high, the foreign firm automatically decides to maintain flexibility, thereby rendering the policy of commitment deterrence obsolete. This second switch point occurs when $s_1^{ct*} = s_1^{cd*}$ in figure 2b and is indicated by locus $Ep^*(s_1^{cd*}, k_1, k_1^*) = Ep^*(s_1^{cd*}, k_1, k_2^*)$ in figure 2a. Hence, in area III the foreign firm remains flexible and the government subsidy accommodates home firm commitment and foreign firm flexibility. At this level of uncertainty, deterring the home firm from commitment still proves too costly[11].

Home commitment deterrence becomes sufficiently attractive to the government when the maximum subsidy that enforces home firm flexibility (s_1^{td*}) is sufficiently high (indicated in figure 2a by locus $EW(s_1^{cd*}, k_1, k_2^*) = EW(s_1^{td*}, k_2, k_2^*)$). Hence, home commitment considerations shape the subsidy policy prevailing in area IV. In figure 2b, the switch point from s_1^{cd*} to s_1^{td*} is characterised by a discrete drop in the subsidy level, which is the minimum subsidy deviation necessary to enforce flexibility of the home firm. For higher levels of uncertainty, this policy involves a subsidy closer to the unconstrained subsidy with firm flexibility (s_1^{dd*}), which is reflected in the upwards sloping s_1^{td*}-segment in figure 2b.

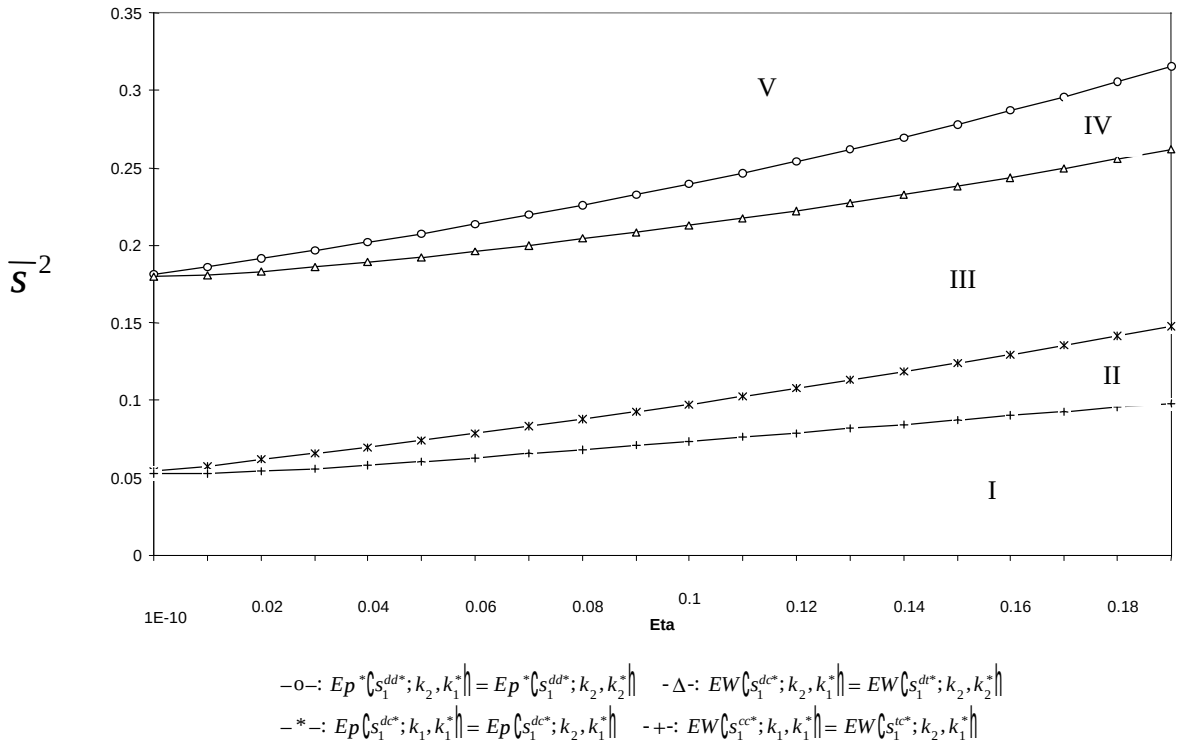
Here too commitment deterrence only prevails until uncertainty is so high that such a policy becomes unnecessary ($s_1^{td*} = s_1^{dd*}$, implying $Ep(s_1^{dd*}, k_1, k_2^*) = Ep(s_1^{dd*}, k_2, k_2^*)$). From this point on, the home firm optimally prefers to remain flexible (area V) given s_1^{dd*}. As a result,

the government simply accommodates firms' choices, setting the optimal subsidy given capital flexibility by both firms.

4.2.2. Government commitment and cost asymmetry

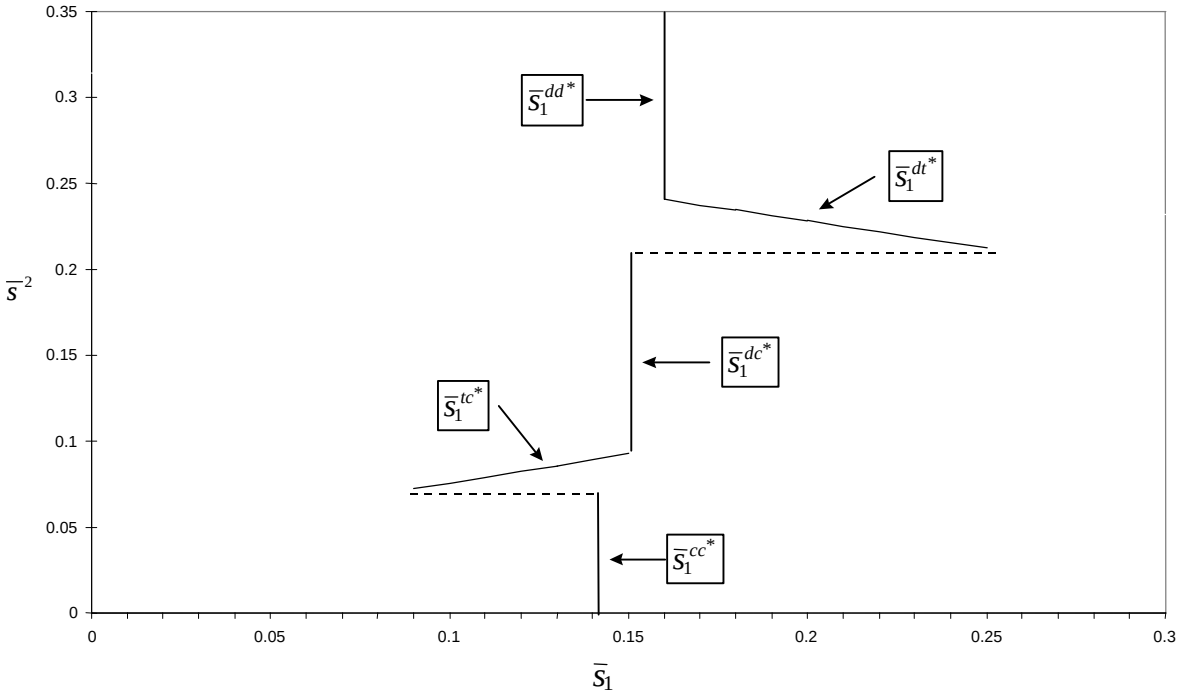
Suppose the foreign rival has a relatively large cost advantage over the home firm (e.g., such that $A^* = 1.4A$). For this case, the game is illustrated in figures 3a and 3b. Similarly to the symmetric case, five areas are demarcated in the $\bar{s}^{-2}, h$ -diagram, now given by figure 3a. For extremely low and high levels of uncertainty, the government accommodates the investment choices of both firms, involving double commitment in area I (s_1^{cc*}) and double flexibility in area V (s_1^{dd*}).

Figure 3a: Firms' indifference loci for commitment by home government (A*=1.4 A)



[11] Note that in figure 2b area III begins below $\bar{s}^{-2} = 0.1$. At this level of uncertainty, an export tax would be required to guarantee home firm flexibility.

Figure 3b: Subsidy under commitment by the home government (A*=1.4 A ; eta=0.1)



Although the game is similar in nature to the cost symmetry case, the actual outcomes of both games are different for less extreme levels of uncertainty. Due to the cost asymmetry, commitment is now relatively more valuable to the *foreign* firm than to its home competitor. As a result, deterring commitment by the home firm will be relatively cheaper, implying that the ranking of the commitment deterrence policy prevailing under symmetry is reversed. Here, home firm flexibility (s_1^{tc*}) is enforced for relatively low uncertainty (area II), while commitment by the foreign firm is deterred (s_1^{dt*}) at high levels of uncertainty (area IV). In area III, the government prefers to accommodate foreign commitment and home flexibility. Figure 3b shows the actual subsidy levels for varying levels of uncertainty and is, to a large extent, the mirror image of figure 2b.

5. Concluding remarks

In this paper we have taken the first steps in examining optimal trade policy when the timing of competitors' investment decisions is endogenous and demand is uncertain. We have considered a scenario in which firms face a trade-off between remaining flexible in order to adjust their capital stock appropriately in the face of uncertain demand or moving earlier in order to strategically manipulate their rival's future output.

We have shown that endogenous timing of investment creates a new motive for government intervention. This arises because the relative value of commitment to flexibility for a firm depends on its marginal costs relative to that of its rival. When the government sets its subsidy at the beginning of the game before firms decide when and how much to invest, it may find it optimal to over- or under-subsidise to deter private-sector capital commitment. If it chooses to deter foreign commitment this involves a larger export subsidy which reduces the relative advantage of commitment to the foreign firm. To deter home commitment and thus prevent socially wasteful over-investment by the home firm, the government may find it optimal to under-subsidise in order to "persuade" the home firm to remain flexible.

In the case in which the government sets it subsidy in period two we have shown that the relative value of commitment to the foreign firm rises sharply, so much so that even when it has an initial cost disadvantage (which is compounded by the subsidy received by the domestic firm) it will remain committed at higher levels of uncertainty than its domestic rival.

Before concluding we wish to discuss briefly some possible extensions of the analysis. An immediate extension involves comparing welfare under government commitment and non-commitment. Initial results show that, together with uncertainty, capital costs are crucial in determining which of these two policy regimes is superior. Another interesting way to extend the analysis would be to compare government non-commitment with commitment to free trade. In this case, the discussion would naturally focus on endogenising the move order of the government. This approach is closely related to work by Grossman and Maggi (1997). Allowing for asymmetric information in the analysis would lead to yet another interesting line of research. We could for instance consider a case in which one firm (with local knowledge) has better information about the market demand. These issues are left as topics for future research.

Appendix

The subsidies under government commitment for different investment choices are presented in Table 1.

Table 1: Subsidies under government commitment for given investment choices by firms

s_1^{cc*}	$\frac{1-(4/9)\theta(2-(4/3)\theta)}{(2-(4/3)\theta)} Ex^{cc*}$
s_1^{dc*}	$\frac{3-2\theta}{2\left[3-4\theta+\theta^2\right]} Ex^{dc*}$
s_1^{cd*}	$\frac{(3-2\theta)^2-2\theta(2-\theta)^2}{(3-2\theta)^2(2-\theta)} Ex^{cd*}$
s_1^{dd*}	$\frac{Ex^{dd*}}{(2-\theta)}$

Note:	$s_1^{dc*} > s_1^{dd*} > s_1^{cc*} > s_1^{cd*}$ if $A^* = A$
	$s_1^{dd*} > s_1^{dc*} > s_1^{cc*} > s_1^{cd*}$ if $A^* = 1.4A$

References

Arvan L. (1991), "Flexibility versus commitment in strategic trade under uncertainty", *Journal of International Economics*, 31, 341-355.

Boyer, M and M. Moreaux (1987), "Being a leader or a follower: Reflections on the Distribution of roles in duopoly" *International Journal of Industrial Organization*, 5, 175-192.

Brander J. and B. Spencer (1985), "Export subsidies and international market share rivalry" *Journal of International Economics*, 18, 83-100.

Brander, J and B. Spencer (1992), "Pre-commitment and flexibility: Applications to oligopoly theory", *European Economic Review*, 36, 1601-1626.

Cooper, R and R. Riezman (1989) "Uncertainty and the choice of trade policy in oligopolistic industries", *Review of Economic Studies*, 56, 129-140.

Dixit, A. (1984), "International trade policy for oligopolistic industries", *Economic Journal Conference Papers*, 1-15.

Dowrick, S. (1986), "Von Stackelberg and Cournot duopoly: Choosing roles", *Rand Journal of Economics*, 17, 251-260.

Eaton J. and G. Grossman (1986), "Optimal trade and industrial policy under oligopoly", *Quarterly Journal of Economics*, 383-406.

Gal-Or, E. (1985), "First-mover and second-mover advantages", *International Economic Review*, 26, 649-653.

Goldberg, P. (1995), "Strategic export promotion in the absence of government commitment", *International Economic Review*, 36, 407-426.

Grossman, G. and G. Maggi (1997), "Free trade vs strategic trade: A peek into Pandora's box" Mimeo., Princeton University.

Hamilton J. and S Slutsky (1990), "Endogenous timing in duopoly games Stackelberg or Cournot equilibria", *Games and Economic Behaviour*, 2, 29-46.

Karp, L. S. and J.M. Perloff (1995), "The failure of strategic industrial policy due to manipulation by firms", *International Review of Economics and Finance*, 4, 1-16.

Neary J. P, and D. Leahy (1998), "Strategic trade and industrial policy towards dynamic oligoplies", CEPR Discussion Paper.

Neary J. P, and P. O' Sullivan (1998), "Beat em or join em?: Export subsidies versus international research joint ventures in oligopolistic markets", University College Dublin Working Paper.

Spencer B., and J. Brander (1983), "International R&D rivalry and industrial strategy", *Review of Economic Studies*, 50, 707-722.