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A Note on the Time Consistency of Strategic Trade Policy

by

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1. Introduction

The concept of strategic trade policy to shift rents in imperfectly competitive markets has been widely discussed in the trade literature since the middle of the 1980s. The basic idea of rent-shifting in international oligopolies which was first modeled in SPENCER/BRANDER (1983) and BRANDER/SPENCER (1985) has now become an integral part of thinking about trade policy under imperfect competition. Note, however, that trade policy to extract rents from foreign producers had already been examined earlier by BHAGWATI (1965, 1969), KATRAK (1977) and DE MEZA (1979) for the case of a foreign monopolist. Work had also been done by AUQUIER/CAVES (1979), KATRAK (1980), RIEBER (1982) and DAVIES/McGUINESS (1982) on domestic monopolies which at the same time cause allocative inefficiency in the domestic market and extract rents from foreign consumers. Nevertheless, it took the incorporation of theoretical tools from industrial organization into trade theory to spread the word of rent-shifting among economists.

Among the various forms of rent-shifting that are possible under imperfect competition (cf. NORMAN, 1989) the one that has attracted most attention is the BRANDER/SPENCER story of a transfer of rents from foreign to domestic firms in international COURNOT duopololies without domestic consumption: If a government can credibly commit itself to policy measures before firms in an international duopoly make their production decisions, it can use trade policy instruments in a broad sense, like export or R&D subsidies, to alter the duopolistic interaction in favor of its domestic producer and thereby shift duopoly

rents from the foreign to the domestic firm. This idea has been met with many caveats and criticisms. As a policy prescription it remains of dubious value since it is highly non-robust with respect to changes in the specification of the model. A different kind of duopolistic interaction, modeled by the use of conjectural variations (cf. DIXIT, 1986a), can turn the case for a subsidy into a case for a tax (cf. EATON/GROSSMAN, 1986). Similar conclusions can arise with more than one domestic producer (EATON/GROSSMAN, 1986), with free entry for domestic firms (HORSTMAN/MARKUSEN, 1986), or with the order of moves between firms and government reversed (GRUENSPECHT, 1988, NEARY, 1989). If the product under consideration is also consumed domestically, changes in the consumer rent have to be taken into account (cf. DIXIT, 1984, BRANDER/SPENCER, 1985, EATON/GROSSMAN, 1986). In addition, spill-over effects in general equilibrium can change the conclusions for optimal policy (cf. DIXIT/GROSSMAN, 1986). Given this lack of robustness, detailed empirical information would be needed to determine welfare improving policies for specific industries. Whether recent work with calibrated models, as in DIXIT (1987, 1988), BALDWIN/KRUGMAN (1988), LAUSSEL et al. (1988) and SMITH/VENABLES (1988), can provide this information appears questionable. Further critics noted the political economy aspects of rent-shifting: Rent-shifting by government will probably induce rent-seeking activities by private agents (SIEBERT, 1988, BHAGWATI, 1989). Furthermore, it is not obvious that governments are superior to firms in their ability to precommit themselves to a particular course of action (CAVES, 1987).

This paper deals with one more critical remark about the feasibility of rent-shifting. Among others, DIXIT (1986b) and GROSSMAN (1986) noted that what appear to be super-normal profits in oligopoly might in reality be normal, risk-adjusted returns for the winners from previous rounds of competition, e.g. the winners of a patent race. If, however, firms in these previous stages anticipate policies to extract rents from the winners, they will be less inclined to participate in these early activities. This in turn could cause welfare losses, e.g. through less innovations. MOHR (1988) addressed a similar issue in a very simple framework of a multi-market monopolist which decides whether or not to enter the domestic market. Once it has paid a fixed entry cost and entered the market, the domestic government can use an optimum tariff to extract some of the monopoly rent. If the cost of entry is sufficiently high compared to

the monopoly rent under the optimum tariff, the monopolist will stay out of the domestic market. For domestic welfare, however, this outcome is inferior to the situation with entry and no tariff, since now both consumer rent and tariff revenue are zero.

In MOHR's example the government could think of announcing a policy of no policy intervention to induce entry. However, once entry has occurred the government has an incentive to recalculate its optimal policy and come up with an optimum tariff. Ex ante free trade is optimal for the domestic government, whereas ex post, after entry, the optimum tariff is the welfare maximizing policy. If the firm anticipates this, it will not enter, no matter what the government announces. The issue at hand is nothing else but the question of time consistency of economic policy (cf. KYDLAND/PRESCOTT, 1977, WOHLTMANN/KRÖMER, 1989). A free trade policy is time inconsistent because there is an incentive to impose a tariff in a later stage of the game.[1] The consequences can be summarized as in PERSSON (1988): The mere possibility that the government will move from a second-best (monopoly without a tariff) to a first-best situation (monopoly with optimum tariff) leads to a third-best outcome (no entry).

In the present paper the time consistency of strategic trade policy is examined in a model which is closer to the recent work on rent-shifting than the approach used by MOHR (1988). The specification used builds on D'ASPREMONT/JACQUEMIN (1988). In a three-stage game with an international COURNOT duopoly and no domestic consumption the domestic government first decides on an export subsidy for the domestic producer. The duopolists then commit ressources to R&D, and finally they play their quantity game. It will be shown that a strategic trade policy of subsidizing exports is not time consistent, since after the firms made their R&D decisions there is an incentive for the government to change its policy.

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1 The term "time inconsistency" is used here as in ALESINA/TABELLINI (1988) or LAPAN (1988). For a discussion of the confusion about the terminology cf. WOHLMANN/KRÖMER (1989).

The paper is organized as follows: In section 2 the ex ante optimal policy is derived. Section 3 shows that this policy will be revised ex post by a welfare maximizing government. Concluding remarks are contained in section 4.

2. Optimum Output Subsidy in a Three-Stage Game

Consider an industry with two firms producing a homogeneous good. One is located in the domestic country, the other in the foreign country. To isolate rent-shifting from other effects, we follow the original literature on strategic trade policy in assuming that all production is sold in a third country. The duopolists face an inverse linear demand

$$p = a - b(x + X) \qquad a,b > 0 \qquad x+X \leq a/b$$

Capital letters are used to denote foreign variables. Each producer has to make two decisions: First, an R&D level f (F) is determined, and then the decision for an output quantity x (X) is made.[2] In both stages the firms act simultaneously as COURNOT competitors.[3] R&D is supposed to reduce production costs in a non-stochastic way, i.e. by spending money on R&D a firm buys with certainty a more efficient technology for the output game. This is clearly a very simple setup which neglects the rich theoretical literature on R&D and innovation. It is nevertheless used since the principal goal of the paper is not to model innovation processes but to point out time (in-)consistency problems of strategic trade policy.

The firms' cost functions are given by

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2 SPENCER/BRANDER (1983) considered this type of decision problem in a more general model. However, they did not examine the time consistency of the policies derived.

3 The consequences of using conjectural variations in oligopoly models with commitments in earlier stages are well-known from the work of EATON/GROSSMAN (1986) and DIXIT (1986a). This issue will not be addressed here.

$$c(x,f) = (A - f)x + r(f^2/2)$$

and

$$C(X,F) = (A - F)X + r(F^2/2)$$

respectively.[4] r denotes the cost of one unit of R&D activity which is assumed to be identical in both countries.

In the following $0 < A < a$ and $f,F < A$ is assumed to hold. The profit functions are

$$g = [a - b(x+X)]x - (A - f)x - r(f^2/2)$$

and

$$G = [a - b(x+X)]X - (A - F)X - r(F^2/2)$$

Consider first the case where no policy intervention takes place. Solving backwards to ensure subgame perfectness of the equilibrium, we first examine the optimal output choice given R&D decisions f and F. Maximization leads to reaction functions

$$x = [a - bX - (A-f)]/2b \qquad X = [a - bx - (A-F)]/2b$$

for the output game. An increase in R&D shifts a firm's reaction curve in (x,X)-space to the right, i.e. spending money on R&D amounts to a credible commitment to a more aggressive behavior in the output game. The COURNOT-NASH equilibrium values for output are

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4 D'ASPREMONT/JACQUEMIN (1988) used the model to analyze cooperative and noncooperative R&D in a duopoly with spillovers. Since the focus of the present paper is different, spillovers are not included in the specification used here.

$$x = (a - A + 2f - F)/3b \qquad X = (a - A + 2F - f)/3b$$

Inserting these values into the profit function of the domestic firm yields

$$g = \frac{1}{9b} \cdot (a - A + 2f - F)^2 - r(f^2/2)$$

There are three ways in which R&D influences the domestic firm's profits:

- directly through R&D costs rf
- directly through production costs A-f
- indirectly through shifting its reaction curve in the output game

Maximization of g and G with respect to R&D levels f and F leads to the following reaction functions for the domestic and the foreign firm, respectively, in the R&D game:

$$f = \frac{2(a - A - F)}{4.5br - 4} := R(F)$$

$$F = \frac{2(a - A - f)}{4.5br - 4} := R(f)$$

The second-order conditions imply that the denominators are positive. The numerators are also positive.[5] Both reaction curves are downward sloping in (f,F)-space. The HAHN stability conditions (HAHN, 1962, DIXIT, 1986a) imply that the domestic firm's reaction curve is steeper. Equilibrium is given by

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5 This is equivalent to assuming that firms would still produce a positive output, even if they did not invest in R&D.

$$f = \frac{2(a - A)}{4.5br - 4} = F$$

Suppose now the domestic government credibly announces a per unit production subsidy s for the domestic firm before the producers take any decisions. Clearly enough, other instruments, like an R&D subsidy for example, could be used for rent-shifting in the present model (cf. SPENCER/BRANDER, 1983). However, production or export subsidies were the first instruments of economic policy analyzed in the literature on strategic trade policy and will be considered here. To concentrate on domestic policy incentives and time consistency and to avoid the well-known prisoners' dilemma results (cf. BRANDER/SPENCER, 1985), the foreign government is assumed to take no trade policy measures. The domestic firm's profit function can now be written as

$$g = [a - b(x+X)]x - (A - s - f)x - r(f^2/2)$$

Maximization for the output game changes the domestic reaction function to

$$x = [a - bX - (A-s-f)]/2b$$

and leads to equilibrium outputs

$$x = (a - A + 2f + 2s - F)/3b$$

$$X = (a - A + 2F - f - s)/3b$$

A positive subsidy s shifts the domestic producer's reaction curve to the right and increases its output more than the foreign firm's output is decreased.

Inserting equilibrium outputs into the profit functions yields

$$g = \frac{1}{9b} \cdot (a - A + 2f + 2s - F)^2 - r(f^2/2)$$

and

$$G = \frac{1}{9b} \cdot (a - A + 2F - f - s)^2 - r(F^2/2)$$

The announcement of a subsidy for the output game therefore influences the behavior of both firms in the R&D game. Maximization with respect to f and F, respectively, yields reaction functions

$$f = \frac{2(a - A - F + 2s)}{4.5br - 4} := R(F,s)$$

$$F = \frac{2(a - A - f - s)}{4.5br - 4} := R(f,s)$$

The production subsidy induces the domestic firm to do more R&D and the foreign firm to do less. Using f^N and F^N to denote R&D in the equilibrium with no policy intervention and writing θ for 4.5br-4, equilibrium R&D choices are now given by

$$f = f^N - 4s \cdot \frac{1 + \theta}{4 - \theta^2} \qquad F = F^N + 2s \cdot \frac{4 + \theta}{4 - \theta^2}$$

To determine the effect of the production subsidy on R&D activity note that the stability conditions imply $4 - \theta^2 < 0$. Since θ is positive from the second-order condition, we can conclude that an output subsidy $s > 0$ from the domestic government increases domestic and decreases foreign R&D activity compared to the no intervention case. Note that the total amount of R&D increases by $2s/[2+\theta]$.

Turning to the question of which value of s the domestic government should choose, consider the government's decision problem as

$$\max_s w(s) = \max_s g(s) - sx$$

Using subscripts to denote partial derivatives the first-order condition is

$$\frac{dw}{ds} = g_f \cdot \frac{df}{ds} + g_F \cdot \frac{dF}{ds} + g_s - s \cdot \frac{dx}{ds} - x = 0$$

$g_f = 0$ follows from maximizing behavior in the R&D game. Using previous results and defining

$$J := a - A + 2f - F \qquad K := \frac{4 + \theta}{4 - \theta^2}$$

we get

$$-(2/9b) \cdot (J + 2s) \cdot 2 \cdot K + (2/9b) \cdot (J + 2s) \cdot 2 -$$

$$- (2/3b) \cdot s - (1/3b) \cdot (J + 2s) = 0$$

This implies an optimum subsidy

$$s^* = \frac{J \cdot (1 - 4K)}{4 + 8K}$$

J is positive and K is, due to the stability conditions, negative. Therefore, the numerator is positive. For the denominator to be positive, we need a value of $K \in]-1/2,0[$. This holds, because the second-order condition for welfare maximization implies $K > -1/2$.

Since s depends via K on f and F, the three-stage decision process of the model is not yet fully solved. However, as will be shown in the next section, the results derived so far are sufficient to conclude that the domestic government has an incentive to change its production subsidy once the firms committed themselves to $f(s^*)$ and $F(s^*)$.

3. Time Consistency of the Optimum Subsidy

To check whether the optimum subsidy s^* is time consistent, assume that the duopolists irreversibly chose their optimal R&D levels $f(s^*)$ and $F(s^*)$. Before the output game is going to be played the domestic government gives its subsidy program a second thought. By initially announcing s^* it induced the domestic firm to do more R&D and the foreign firm to do less R&D than in the case of no policy intervention. This in turn caused a rightward shift of the domestic producer's reaction function for the output game. Its competitor's reaction curve, on the other hand, was moved to the left. If the government reduces or cancels the subsidy before outputs are chosen, the domestic reaction curve moves to the left wheras the foreign curve remains unchanged by this revision of domestic policy. Compared to an equilibrium without an announced subsidy program the domestic firm is still committed to a more aggressive reaction curve, since it invested more in R&D. By the same token, the foreign duopolist's curve is still a more cautious one.

Why should the government consider reducing or even canceling the subsidy program ? Two effects on domestic welfare, working in opposite directions, have to be considered:

- The government has to spend less on the subsidy program.
- The domestic firm's profit is reduced.

To calculate an optimal policy at this stage note that

$$\frac{df^*}{ds} = \frac{dF^*}{ds} = 0$$

This reduces the first-order condition for welfare maximization to

$$\frac{dw}{ds} = g_s - s \cdot \frac{dx}{ds} - x = 0$$

which leads to an optimal subsidy

$$s^{**} = \frac{J}{4} > 0$$

Note that J is still the same value as in the expression for s^* since f and F remained unchanged by assumption on the timing of decisions. To compare s^{**} to the subsidy s^* initially announced we calculate

$$\frac{s^*}{s^{**}} = \frac{1 - 4K}{1 + 2K}$$

which is larger than 1 for the values $K \in]-1/2,0[$ that are relevant in this model. The optimal subsidy ex ante, i.e. before R&D decisions are taken, is larger than the optimal subsidy ex post.

We therefore arrive at the following

Proposition: A welfare maximizing government will reduce the subsidy it initially announced once the firms have made their R&D decisions.[6]

To find the effect of this policy revision on the domestic firm's profits, note first that profits can not fall below the level of the two-stage game with no policy intervention. If they did, policy would reduce welfare. In fact, profits have to be higher than in the no policy case, since s^{**} is still positive. To see that profits will be lower compared to the case when s^* had actually been paid, calculate dg/ds for given f and F which yields

$$\frac{dg}{ds} = \frac{4}{9b} \cdot (J + 2s) > 0$$

The following proposition holds:

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6 Note that the incentive to reduce the subsidy is increased, if there are costs of raising funds as in GRUENSPECHT (1988) and NEARY (1989).

Proposition: A reduction of the production subsidy after the R&D game reduces the domestic duopolist's profits below the level that would have been reached had the initially announced subsidy program been carried out. Profits, however, do not fall below the level reached in the equilibrium without policy intervention.

It might appear odd that a leftward shift of the domestic producer's reaction curve in output space can be welfare improving. The results in the literature on strategic trade policy for COURNOT duopolies recommend a shift to the right to increase welfare (cf. BRANDER/SPENCER, 1985, EATON/GROSSMAN, 1986). For given $f(s^*)$, $F(s^*)$, however, s^{**} has the usual property of inducing the domestic firm to behave as if it were a STACKELBERG leader in an output game without a subsidy. To see this, consider such a STACKELBERG leader's profit function

$$g = [a - b(x+R(x))]x - (A - f)x - r(f^2/2)$$

where R(x) is used to denote the other firm's COURNOT reaction in the output game. Maximization leads to

$$x = (a - A + 2f - F)/2b$$

On the other hand, inserting $s^{**} = J/4$ into the domestic producer's COURNOT reaction function for the output game also yields

$$x = (a - A + 2f + 2s^{**} - F)/3b =$$

$$= (a - A + 2f - F)/2b$$

which confirms that the domestic producer acts as an "as-if"-STACKELBERG leader.

The intuition of these results is that the ex ante optimal subsidy s^* induces the domestic firm to behave more aggressively in the output game than is optimal

once R&D activities have taken place. From an ex post perspective, the reaction curve of the domestic producer has been shifted too far to the right. By reducing its subsidy to an ex post optimal value of s^{**} the government pushes its firm into the welfare maximizing position of "as-if"-STACKELBERG leadership.

4. Conclusions

In the last section an optimum domestic production subsidy for an international two-stage duopoly was shown to be time inconsistent: There is an incentive for government to revise its subsidy downward once the firms committed themselves irreversibly to R&D levels in the first stage of their game. Rational producers will anticipate this re-optimization. Therefore, policy announcements which are only optimal ex ante will not be credible, i.e. they will not lead to the desired reactions in terms of R&D levels.

The additional constraint on strategic trade policy which could guarantee credibility became apparent at the end of the last section: As long as the subsidy implies a behavior of the domestic firm in the output game which is more aggressive than the behavior of a STACKELBERG leader in the same game without subsidization, government will want to increase welfare and reduce the firm's profits by cutting back the subsidy. For a subsidy to be credible, therefore, the constraint of "as-if"-STACKELBERG leadership in the output game has to be imposed.

Imposing an additional constraint on policy making, however, can only reduce welfare compared to a situation in which the government announces its ex ante optimal subsidy and does not revise it later. PERSSON's (1988) dictum on time inconsistent economic policy is confirmed for strategic trade policy: The mere fact that a benevolent government will try to reach a first-best outcome after private agents have committed themselves makes the second-best result impossible to achieve and leads to a third-best situation. This insight limits the scope for strategic trade policy to shift rents in international oligopolies in addi-

tion to the numerous caveats and criticisms mentioned in the introduction of this paper.[7]

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7 An issue which has not been raised here concerns the possibility that a government can acquire credibility in a sequence of policy decisions and can thereby achieve the second-best outcome. Questions of reputation and credibility in repeated games have been examined extensively in the recent literature on macroeconomic policy (cf. PERSSON, 1988, DRIFFILL, 1988).

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