E C O N O M I C S B U L L E T I N

A note on Research and Development and Voluntary Export Restrictions".

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Abstract

This note qualifies the statement made in Bouët (2001), European Economic Review 45, 323−336, by showing that within the model proposed by the author the effect of a VER on research and development does depend on the mode of competition

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1 Introduction

In a recent issue of the European Economic Review, Bouët (2001) offers yet a new contribution to the strategic trade policy literature. The main result of his paper is that under Cournot competition, a VER decreases R-D expenses while a tariff increases innovation. Then, this result is generalized to Bertrand competition. Quoting the paper's abstract, we are indeed told that *"When the R-D investment has uncertain consequences on marginal cost, a voluntary export restriction (VER) decreases innovation by the domestic producer as compared to the free trade level. This result holds both under Cournot and Bertrand competition"* (p.323).

The aim of the present note is to qualify the above claim: *contrary to the above statement, the qualitative impact of the VER on R-D investment does depend on the mode of market competition in Bouët's model.* To support our claim, we shall proceed in three steps. First, we briefly recall of the argument underlying Bouët's result. Then we consider two examples in which the presence of the VER increases R-D investment, instead of decreasing it. Last, we briefly sketch the economic intuition which underlies our result.

2 Bouët (2001)

The part of Bouët's paper that is relevant for the present comment can be summarized as follows.

- Think of a domestic firm (denoted N, for Northern) being challenged in its domestic market by a foreign one (denoted S, for Southern). Firm S produces at low marginal cost. Before entry takes place, firm N may invest in R-D. If the R-D program is successful, N produces at low marginal cost whereas if it is not successful, the domestic firm produces at a higher marginal cost. R-D expenses therefore results from a willingness to remain competitive against a low cost entrant.

- Firm N may thus engage in R-D. However, the outcome of the R-D activity is uncertain and by investing more, firm N increases the probability of success for its R-D program. In equilibrium, the optimal R-D investment level reflects the trade-off between higher R-D expenses sunk in stage one and the increased prospects for high profits that are associated with producing at low cost in stage 2.

- Suppose now that the game is altered in a way such that *firm N's payoffs increase in the case of an unsuccessful R-D activity but are not affected in the case of a successful program.* Since the domestic payoff in case of ex post wasteful R-D expenses has increased while remaining unchanged in case of successful R-D, the marginal benefit of R-D investment has decreased in this modified game, so that firm N invests less in equilibrium.

Bouët (2001) shows that, under Cournot competition, any VER which is binding in case of unsuccessful program and not binding otherwise, alters the game precisely in the way alluded to here above. So that the VER induces less R-D.

Then, the author claims that a similar result obtains under Bertrand competition. In order to make his point, he replicates the argument developed under Cournot competition.

The argument runs as follows. Suppose the quota is set exactly at the equilibrium level of foreign's sales in the unsuccessful R-D price subgame. This quota is not binding at the equilibrium of the price subgame that follows a successfull R-D program. Relying on the analysis of Krishna (1989), we know that the quota set at the free trade level will increase firm N's profit (more precisely both firms' profits) in the unsuccessful R-D price game. If it leaves firm N's equilibrium profits in the successful R-D game untouched, this quota will induce less R-D in equilibrium, exactly as under Cournot competition. Bouët argues that if the VER is set at the free trade level of the unsuccessful R-D price subgame, this last condition is satisfied.

We provide hereafter two examples which show that the last part of the above argument is not correct in general. In fact, Krishna (1989)'s main contribution is to show that under price competition a VER tends to be effective *even if set above the free trade equilibrium level*, i.e. in the two subgames. In other words, *we may expect that a quota set at a level corresponding to the free trade equilibrium sales of the foreign firm in the unsuccessful R-D game will increase domestic profits whatever the outcome of the R-D program.* Accordingly, nothing can be said in general about the effect of the VER on R-D investment under price competition. In the nest two examples, the presence of the quota increases the R-D investment of the domestic firm.

3 Example 1

Let us first consider the linear example developed in Bouët (2001), section 5, when illustrating Cournot competition. We apply it to Bertrand competition, so that the only difference between our treatment of the example and his is the mode of competition.

Market demand is given by $p = a - (q_N + q_S)$ and we assume that $a = 24$. Firm S faces a marginal cost $c_N = 3$. Firm N faces a marginal cost $c_h = 9$ if the R-D activity is not successful and a marginal cost $c_l = 3$ if it is successful. The probability of a successful R-D activity is equal to $\sqrt{r}$ where $r \in [0, 1]$ is the amount of R-D investment. We assume that firms compete in prices.

In order to study the R-D investment decision, we solve first the two possible price subgames: the "unsuccessful R-D game" (denoted UG) and the"successful R-D game" (denoted SG), and then we go backward to address the R-D decision.

- In UG, the foreign firm benefits from an absolute cost advantage. Under Bertrand competition, the Nash equilibrium sees the low cost firm either playing its monopoly strategy or naming a price that just undercuts the high cost firm. Under our particular parametrization, the monopoly solution is not feasible: the foreign firm thus names $p_S = 9-\epsilon$ while the domestic firm names $p_N = 9$. The domestic firm therefore nets zero profits in UG.

- In the SG, the two firms enjoy identical constant marginal costs. The unique Nash equilibrium in this case is $(3, 3)$. The two firms share the market evenly and both make zero profits.

- Having solved the two possible price subgames, we note that the domestic firm nets zero profits in both cases. R-D investment is therefore purposeless and the optimal decision is $r = 0$ under free trade.

Consider now the introduction of a VER, that is set exactly at the level of demand faced by the foreign firm in UG, i.e. VER=15+ϵ, as proposed in Bouët (2001, section 7).

- Even though this VER is apparently not binding in the SG, it alters the whole game, so that a new equilibrium emerges. Under Bertrand competition with homogeneous goods, a quantity restriction, imposed on one firm only, and set below the competitive aggregate demand level ensures positive equilibrium payoffs to both firms (see Levitan and Shubik (1972) for a theoretical treatment particularily well-suited for the present analysis). By way of consequence, the introduction of the VER at a level of 15+ϵ will for sure yield positive payoffs for the domestic firm in SG. The particular form of the (mixed strategy) equilibrium and the level of the payoffs will depend on the exact specification of the rationing rule at work in the market. Note that a closed-form solution of such games is not necessary for our present purpose (see Levitan and Shubik (1972)). We only need to know that $\pi_N^{SG} > 0$.

- UG is formally equivalent to a pricing game where one firm faces a capacity constraint and where unit costs differ. Again, obtaining closed-form solutions for such games is far from being trivial (see Deneckere and Kovenock (1996) for a detailed analysis of such pricing games). However, it the present case, the cost differential is so large that as long as we consider VER at or sufficiently close to 15, the free trade equilibrium remains feasible. The intuition for this runs as follows: supppose firm S is a monopolist facing a capacity constraint k, its monopoly payoff is defined by $\pi^m = p.\min\{k, 24-p\}$. The maximum of this function is obviously $p^m = 9-\epsilon$. Since this price is below firm N's marginal cost, it cannot be undercut by firm N, and therefore defines the optimal strategy of firm S Accordingly, the domestic firm's payoffs in UG is not affected by the presence of the VER.

- Having solved the two subgames we can now go backward in the game tree. Since the domestic firm's payoff in SG has increased, relative to free trade, whereas it is unaffected in UG, firm N is more prone to invest in R-D than under free trade.

It is not necessary to compute the optimal R-D investment level to see that the presence of the VER alters the domestic firm's incentives in a direction that is exactly opposite to what happens under Cournot competition: *In this example, the introduction of the VER tends to increase R-D expenses!*

4 Example 2

The previous example looks rather extreme because under free trade the domestic firm never finds it optimal to invest in R-D. Note however that it should not be viewed as "pathological": after all, it is an exact counterpart to the example considered in Bouët (2001) to illustrate his result under Cournot competition. Notice however that, when dealing with price competition, Bouët's switches from an homogeneous example to markets for differentiated products. Could it be then that our previous example owes too much to the presence of homogeneous goods? The following example shows that the conclusion of example 1 carries over to differentiated industries.

Let us consider a textbook version of the Hotelling model with linear transportation costs.[1] We assume that firms are located at both ends of the unit line. The utility derived by a consumer located at a distance d of firm i is defined as $S-d-p_i$. Refraining from consuming yields a utility of zero. In the pricing games, firm S produce at zero marginal cost while firm N produces at marginal cost $a > 0$ in UG pricing games and at zero marginal cost otherwise. The R-D investment stage is modelled as in the previous example.

It is a straighforward exercice to obtain the following equilibrium characterization under free trade.

- The price equilibrium in SG is given by $p_N^{SG} = p_S^{SG} = 1$, with $D_N^{SG} = D_S^{SG} = \frac{1}{2}$ and $\pi_N^{SG} = \pi_S^{SG} = \frac{1}{2}$
- The price equilibrium in UG is given by $p_N^{UG} = 1+\frac{2a}{3}$, $p_S^{UG} = 1+\frac{a}{3}$, with $D_N^{UG} = \frac{1}{2}-\frac{a}{6}$, $D_S^{UG} = \frac{1}{2} + \frac{a}{6}$ and $\pi_N^{UG} = \frac{1}{2}(1 - \frac{a}{3})^2$.

Suppose now that we impose a quota on firm S at the level $D_S^{UG} = \frac{1}{2}+\frac{a}{6} = \overline{q}$. Applying the method laid out in Krishna (1989) it is relatively straighforward to show that no pure strategy equilibrium will exist, neither in subgames UG, nor in SG. Instead a mixed strategy equilibrium exists, in which firm N randomizes between a high price $S - \frac{1}{2} + \frac{a}{6}$ at which it sells $\frac{1}{2} - \frac{a}{6}$ and some lower price, while firm S plays a pure strategy.[2] Since firm N faces a pure strategy, its equilibrium payoffs can be computed at one of its atom. Accordingly, we may state the following:

- In the presence of a quota $\overline{q}$, firm N's equilibrium payoffs in subgames UG is given by $\pi_S^{UG}(\overline{q}) = (S - \frac{1}{2} - \frac{5a}{6})(\frac{1}{2} - \frac{a}{6})$.
- In the presence of a quota $\overline{q}$, firm N's equilibrium payoffs in subgames SG is given by $\pi_S^{SG}(\overline{q}) = (S - \frac{1}{2} + \frac{a}{6})(\frac{1}{2} - \frac{a}{6})$.

It is then straightforward to show that firm N's payoffs increase in UG and SG because of the quota. Moreover, it turns out that the increase in payoffs tends to be sytematically larger in SG than in UG. Therefore, in relative terms, the presence of the quota makes the R-D investment more attractive. As in the previous example, we are thus lead to conclude that the presence of the VER *increases* the marginal benefit of R-D investment, instead of decreasing it.

5 Comments

The reason why our two examples yield to a conclusion that runs against Bouët's one is that the domestic firm payoffs increases due to the presence of the quota, whatever the outcome of the R-D program. Whenever this is the case, the argument used in Bouët for establishing his main result (the fact that a marginal value of R-D investment decreases because domestic payoff in SG is not affected by the VER) cannot be invoked. Obviously,

[1] The reader is referred to Tirole (1988) for the exposition of the model

[2] Boccard and Wauthy (1997) provide a detailed analysis for such pricing subgames. The present characterization can be directly inferred from their model.

we cannot claim either that a VER will never lead to a decrease in R-D effort under price competition. In order to apply the argument of Bouët, one basically needs the quota to be "sufficiently" above the free trade equilibrium level of the SG pricing game in order to preserve the corresponding prices as a pure strategy equilibrium. What "sufficently" means exactly will essentially depend on the degree of product differentiation and the costs differential. Given some cost differential, the larger the degree of differentiation, the more likely it is that the R-D will decrease because of the quota. However, no general conclusion should be expected to hold here.

Because we are considering a VER, the case of price competition is intrinsically different from the case of quantity competition: *the basic feature of the VER in a Cournot game is that it is not effective if set above the Free Trade equilibrium level whereas the basic feature of a VER under Bertrand competition is that it is effective even if set above the Free Trade equilibrium level.* Accordingly, if some result obtained under Cournot competition crucially depends on whether the VER is binding or not relative to the Free Trade benchmark, we should not expect that it naturally extends to Bertrand competition. Stated differently, what makes Bouët's argument fully compelling under Cournot competition is also what makes it not under Bertrand.

This conclusion is not too surprising since it captures in fact the essence of Krishna (1989)'s paper: in oligopolistic markets, a quota has very different implications depending on the mode of competition. Fairly enough however, very few papers elaborated on Krishna's original idea by dealing explicitely with price competition in the presence of export restrictions. In particular, almost all papers dealing with the possible impact of quotas in early stages of oligopoly games (where firms commit to strategic variables such as products' characteristics, or R-D) retained a Cournot framework for the analysis of the market competition stage. Accordingly, the key issue raised by Krishna has been progressively overlooked. New material aimed at improving our understanding of price competition in the presence of quantitative restrictions and product differentiation seems to be called for.

References

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