Research and development, voluntary export restriction and tariffs: a comment

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1 Introduction

In a recent issue of this journal, Bouët (2001) offers a contribution to the literature dealing with the implication of quantitative restrictions in international oligopolies. The main result of the paper is 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 show that, contrary to the author's claim, the qualitative impact of the VER on R-D investment does depend on the mode of market competition in his model. In order to show this, we provide a counter-example that makes use of the linear example developed by Bouët (2001) and solve it for Bertrand competition (instead of Cournot). In this case, a VER *increases* R-D expenses (instead of decreasing it under Cournot), i.e. depending on the mode of competition, the implication of the VER on the R-D investment are reversed.

Before we proceed to the analysis of the example, let us summarize the main intuition underlying Bouët's original result.

- 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 and is therefore less competitive than the foreign entrant. The motivation for R-D expenses results from its impact on the profits at the competition stage: domestic profits are larger if its marginal cost is lower.

- The outcome of the R-D activity is uncertain but by investing more, firm N increases the probability of a success. In equilibrium, the optimal R-D investment level reflects the trade-off between higher R-D sunk costs and increased prospects for the high profits that are associated with the market game with low cost.

- Suppose now that the game is altered in a way such that *N payoffs increases in the case of an unsuccessful R-D activity but is not affected in the case of a successful program.* Since the domestic payoff in case of failure has increased while being unaffected in case of success, the marginal value of R-D investment has decreased, so that firm N invests less in equilibrium.

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Bouët shows first that, under Cournot competition, a VER which is binding in case of unsuccesfull program and not binding otherwise, has precisely the implication alluded to here above. Accordingly *"Sourthern firm's VER may be exchanged against less Research and Development from the Northern firm"*(p.324) He then claims that a similar result obtains under Bertrand. We show hereafter that this last conclusion is certainly not true in general, precisely because, a quota set above the Free Trade level is very likely to be effective (as shown by Krishna (1989)).

2 The Counterexample

Let us consider the linear example developed in Bouët (2001). Market demand is given by $p = a - (q_N + q_S)$. We assume herafter that $a = 10$. 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 is the investment decision. 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 go backward.

- 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 feasible: the foreign firm names $p_S = 5$ 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. $VER = 5$, 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 market 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 5 yields 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. 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 a pricing game where one firm faces a capacity constraint and where unit costs differ. Again, obtaining closed-form solutions for such game is not trivial (see Deneckere and Kovenock (1996)). However, it the present case, the cost differential is so large that as long as we consider VER at or sufficiently close to 5, the monopoly equilibrium (possibly constrained) remains feasible. Accordingly, the domestic firm's payoffs is not affected.

- 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 the opposite to what happens under Cournot competition: *In our example, the introduction of the VER tends to increases R-D expenses!*

3 Comments

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 cannot be viewed as "pathological" since it is a counterpart to the example considered in Bouët (2001) to illustrate his result under Cournot. The assumption of homogeneous goods greatly simplifies the analysis. The natural question then is: should we expect a similar result to hold under product differentiation? The answer is clearly yes.

The keypoint for obtaining our result is indeed that the domestic firm payoffs in case of a successful innovation increases due to the presence of the quota. 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. This is not to say that a VER will never lead to a decrease in R-D effort under price competition. It is very likely in fact that this is so for many parameters constellations involving differentiated products. What should be stressed however is that *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 the fact that 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 is deeply rooted in the very nature of VER, i.e. **the fact that it acts like a capacity constraint**.

This conclusion is not too surprising since it is a direct implication of Krishna (1989)'s paper. Her main contribution in this paper is to show why 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

[1] Bouët A. (2001), Research and development, voluntary export restriction and Tariffs, European Economic Review, 45, 323-336.

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[4] Levitan R and M. Shubik (1972), Price duopoly and capacity constraints, International Economic Review, 13, 111-122.