



The prisoner's dilemma in Cournot models: when endogenizing the level of competition leads to competitive behaviors.

EPRG Working Paper 1619

Cambridge Working Paper in Economics 1641

Ibrahim Abada and Andreas Ehrenmann*

In a resource based industry, the regulation of exports is crucial. Most oil or gas producing countries, like Saudi Arabia, United Arab Emirates or Russia, export via regulated monopolies. Other countries, like Norway and Canada, have decided to open their export activity to competition. In these countries, many firms can produce oil and directly export it to international spot markets where they are in competition. Some oil producing countries have recently experienced an economic shift toward export nationalization: The government of Argentina decided in 2012 to expropriate Repsol YPF and acquired more than 51% of the company. Other countries have carried out a shift in the other direction. As an example, Norway and the United Kingdom have increased competition in the production and export activity in the previous decades.

From the producing country's point of view, deciding the level of competition among its exporting firms ends up to arbitrating between price and volume. If market power is exerted by the exporters, increasing the number of exporting firms reduces the price, but increases the total sale of the country. The impact on the total payoff is not obvious and clearly depends on the number of exporters from the other producing countries and their strategic decisions. In an imperfect competition context, it is not straightforward that an export monopoly is optimal for a country. The intuition behind this assertion is the possibility of the other producers to free-ride: if country A is an export monopoly, country B can increase its export competition to a certain extent, in order to exploit a high price situation created by country A. Therefore, country A might not be willing to remain an export monopoly and might want to increase its sales too.

As explained above, the oil industry provides many examples of different behaviors of the producing countries in the selling activity in terms of market concentration. The gas industry is another interesting field: as an example, Russia only authorizes Gazporm Export to sell gas to Europe. Algeria does the same with Sonatrach. On the contrary, Norway has opened its export market to firms other than Statoil. The main objective of this paper is to analyze the economic incentives that can lead a country to open or close its production/commercialization activity to different firms, at the risk of potentially reducing its market power exercise. Our analysis will focus on strategic interactions between different players and will study the robustness of the results with respect to the upstream cost structure. In our paper, we start by constructing a set of classical game theoretical models that differ in their representation of strategic interaction between the countries. We model a two-stage oligopoly *a la Cournot* providing a homogeneous good to a market where the price is set via an inverse-demand function and the production cost is quadratic. The players decide



endogenously the level of competition they exert in the market. To do so, we assume that two big entities (we will consider them as countries) have many exporting firms and each country chooses in the first stage the number of firms it owns that can sell in the market. The market is solved in the second stage by analyzing the interaction between the firms that have been allowed to sell. These are in an imperfect competition and we will assume that they can all exert market power *a la Cournot*. Each firm allowed to sell will therefore be in competition with the other firms active in the market, whether they belong to its country or to the other one. This setting will be referred to as *the standard model*. Like Baye et al. (1996) and Corchon (1991), the *standard model* is solved using backward induction in closed loop: we first solve the market interaction between the firms allowed to sell in second stage (assuming that the countries have already chosen the firms to enter the market) and then, given this outcome, the Nash equilibrium of the game between the countries is calculated in first stage. Our main finding is that this setting leads to the prisoner's dilemma outcome: the Nash equilibrium is not Pareto-optimal and occurs when the countries have a competitive exporting behavior. In other words, if the countries were to choose the level of competition they want to exert the market, the equilibrium is reached when all the firms are allowed to enter. This finding is not new and is similar to what Baye et al. (1996) and Corchon (1991) have shown, but extended to the convex cost function case (both Baye et al. (1996) and Corchon (1991) consider a constant marginal production cost). We argue that this seemingly counter-intuitive result is due to the inconsistency of conjectural variations of the Nash equilibrium in the game between the countries. To challenge this explanation, we have extended our setting to three benchmarks for the interaction between the countries. The first is the situation, where the countries coordinate the number of firms in the market to optimize their payoff. This is not a classical cartel solution since the firms still compete with each other and there is no transfer between countries. The second situation models the same interaction between the countries as the standard model but the game is solved in open loop: the countries decide at the same time the number of firms to enter the market and how these should operate. The last benchmark represents a Stackelberg interaction, when one country plays before the other and anticipates its reaction function (bi-level game). Our results suggest that in the coordination between the countries and Stackelberg cases (which are consistent conjectural variations approaches), the counter-intuitive effect disappears: the market becomes very concentrated and market power is fully exerted by the countries. The open loop model gives more subtle results: the market is not concentrated but market power is still exerted by the countries. In summary, it turns out that the closed loop setting leads to the most competitive outcome among the different approaches to model a competitive environment where players choose their level of competition. Both closed and open loops representations lead to extreme market structures that are not observed in practice. The Stackelberg outcome is more realistic but contradicts the basic set up of symmetric players. Indeed by choosing a leader and a follower, the game is clearly not symmetric anymore.

As a final step we expand our setting to a new game theoretical design by giving the countries the additional possibility to choose if they want to be leader or follower and hence re-introduce symmetry. We find a mixed strategy equilibrium between the countries where the number of exporters will be very small and market power quite important, with a very high probability.

Contact andreas.ehrenmann@engie.com; ibrahim.abada@engie.com
Publication July 2016
Financial Support ENGIE

* The opinions expressed in this paper are those of the authors alone and might not represent the views of Engie.