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# RECONCILING COURNOT AND BERTRAND OUTCOMES: A REVIEW

By

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FIRST DRAFT

## ABSTRACT

This paper reconciles the Cournot and Bertrand Models of oligopolistic competition, highlighting its weaknesses and giving an opinion thereafter. The pertinent question in this paper is why Cournot (1838) ignored the price and Bertrand (1883) ignored the quantity? From the review, the main conclusion of this paper is that oligopoly competition is guided in the long run by production capacity competition, as advocated by Cournot, equilibrated through price competition in the short run, as advocated by Bertrand.

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<sup>1</sup> *This paper was written when Kirui was a student at The University of Dar es Salaam.*

# INTRODUCTION

## Oligopolistic Market Models

An oligopoly is a market or industry dominated by a small number of firms. A characteristic of an oligopoly is that the firms in the markets are interdependent – when making decisions they have to take into considerations action or reactions of the other firms in the industry. Oligopoly markets, in its simplest form, consist of two firms selling homogenous products. Two products are homogeneous for a consumer if their characteristics, as perceived, are such that this consumer is indifferent between them (Buccirossi, 2001). There are several models of oligopolistic markets. A central element of many models is the careful consideration of how firms respond to each other and to opportunities in the market. Two of the oldest and most important oligopoly models are Cournot quantity competition and Bertrand price competition. This paper reconciles these two models. The pertinent question in this paper is why Cournot (1838) ignored the price and Bertrand (1883) ignored the quantity? This question was addressed by a review of the existing theoretical and empirical literature. The next section, while highlighting the weaknesses of each model, reviews and summarizes the peculiar features of each of the two models. Thereafter, a reconciliation of the two models is presented. The last section concludes the paper.

### Cournot Model

Under the Cournot model, firms simultaneously and independently make production quantity decisions, and then bring what they have produced to the market, with the market price being the price that equates the total supply to the total demand. The sole strategic choice of each firm is the amount they choose to produce. Each firm cares about the market price when it selects its production level. Because market price depends on the total production of the firms, the amount one firm produces depends on how much it expects the other to produce. Thus, each firm's optimal level of production is the best response to the level it expects its rival to choose.

One of the main weaknesses inherent in the assumption of this model is that firms will simultaneously select the best response to each others' choices, which is often hard to accept as an accurate depiction of how real firms behave. It seems to impose unrealistic omniscience on each firm. Each firm somehow expects that its rival will choose its Cournot equilibrium output, and in response, each firm actually chooses its Cournot equilibrium output. Secondly, Cournot model implies that the equilibrium industry output does not maximize industry profit. By independently maximizing their own profits, firms produce more output than they would if they collusively maximized industry profits. The pursuit of individual self-interest does not maximize the well-being of the group as a whole. The main drawback of quantity setting models is that no explicit price mechanism is stipulated. The latter motivated the development of the Bertrand model.

## **Bertrand Model**

On the other hand, the Bertrand model concerns firms who simultaneously and independently name prices. Firms are allocated demand depending on the price they set: demand is allocated to the low-price firm, who then produces (up to) the demand they encounter. Any unsatisfied demand goes to the second lowest price firm (s) and so on (if there are more than two firms).

Bertrand believed that "two is enough for competitive outcomes". In Bertrand's model, rivalry between two firms is enough to achieve the perfectly competitive outcome. This conclusion is known to rely on the premise of constant marginal cost and for this reason lacks any generality (Boccard and Wauthy, 2000).

In Bertrand model, each firm selects a price and stands ready to meet all the demand for its product at that price. Each firm selects a price to maximize its own profits, given the price that it believes the other firm will select. Each firm also believes that its pricing practices will not affect the pricing of its rival; each firm views its rival's price as fixed. The main limitation of the Bertrand model is that, allowing firms to set prices leads to the Bertrand result, if and only if firms face constant marginal costs. As shown by Edgeworth (1925) (cited by Boccard and Wauthy, 1997) no pure strategy equilibrium exists in the Bertrand model with increasing marginal costs.

## **RECONCILIATIONS OF COURNOT AND BERTRAND MODELS**

Reconciling the Cournot and Bertrand Model has been the aim of many papers, the most remarkable being Kreps and Scheinkman (1983). In their analysis, two firms invest in capacities and then compete in prices with constant marginal cost up to capacity and an arbitrarily large marginal cost above capacity. Investing in limited capacity has a strategic value because it amounts to committing not to be aggressive in the pricing game (Boccard and Wauthy, 2000).

Kreps and Scheinkman (1983) showed that the Cournot competitors can be thought of as choosing capacities and then competing as price setters given the capacities chosen earlier. The results of this "two-stage" competition (first choose capacities and then choose prices) can be shown to be identical to the Cournot equilibrium in quantities. They also found out that Cournot outcome is the unique subgame perfect equilibrium of their game. In addition to reconciling Bertrand and Cournot competition into a single framework, this result essentially suggests that quantity pre-commitment is a natural way out of a too fierce price competition (Boccard and Wauthy, 1997). This result has been criticised, in particular, because of the particular rationing rule. Still, the fact that capacity commitment relaxes price competition and drives equilibrium outcomes towards Cournotian ones is much less controversial (Boccard and Wauthy, 2000).

Apart from the foregoing reconciliation, the major difference between the two models is that consumers' behaviour changes completely in the Cournot and Bertrand settings. In a quantity game consumers decide how much they are willing to pay in order to buy the total output produced by firms. In a price game consumers decide how much they are willing to buy given the prices charged by the firms and where to buy it given the same vector of prices. Deciding how much one is willing to buy, given a price, or how much one is willing to pay, given a quantity, are two aspects of the same decision summed up in the demand function. What is missing in the Cournot game is the second decision made by consumers: where to buy. Of course this decision is missing on both sides of the market. The Cournot model does not describe how consumers perform it and does not give to firms a means to influence it. Prices constitute one of these means. But do prices always perform their job extraordinarily well as in the pure Bertrand model? The intuitive answer is that they do not if consumers are not sensitive to any tiny price difference as in the Bertrand case (Buccirossi, 2001).

Secondly, in Bertrand model homogeneous product results in zero profits, whereas homogeneous product results in positive profits for the Cournot model. This comes about due to the fact, at equilibrium; price equals marginal cost under Bertrand competition, while price is above marginal cost under Cournot competition. Empirical evidence supporting this theoretical results include; Singh and Vives (1984) who showed that firms earn higher profits under Cournot competition than under Bertrand competition, while welfare is higher under Bertrand competition. Hence, the firms are better off in a less competitive market, whereas the society prefers a more competitive environment. Nevertheless, most results are in no way clear-cut as they tend to be highly dependent on modelling assumptions. For vertically integrated firms, Mukherjee, Broll and Mukherjee (2012) showed that if the upstream firm charges a uniform price, the profit in the downstream market can be higher under Bertrand competition if the downstream firms are sufficiently asymmetric. However, the profits of the downstream firms are always higher under Cournot competition if there is price discrimination by the upstream firm.

Thirdly, the best response functions in the Cournot model slope downward. This implies that the more aggressive a rival in terms of output, the more passive the Cournot firm's response. For instance suppose firm  $j$  raises its output the price at which firm  $i$  can sell output falls. This means that the incentive to increase output falls, under Cournot model, as the output of the competitor rises. On the other hand, the best response functions in the Bertrand model slope upward, which means that the more aggressive a rival in terms of price, the more aggressive the Bertrand firm's response. For example, suppose firm  $j$  reduce price, the price at which firm  $i$  can sell output has to fall. As long as firm  $j$  price is less than firm  $i$  price, the incentive to reduce price rise, subject to firm's marginal cost. Otherwise firm  $i$  is likely to sell zero output in the market, if firm  $j$  can supply the total market demand.

The Cournot model applies most naturally to markets in which firms must make production decisions in advance and are committed to selling all of their output. This might occur because the majority of production costs are sunk, or because it is costly to hold inventories. In such settings, prices will adjust more quickly than quantities, and each firm will set a price that lets it sell all that it produces. The Bertrand model, on the other hand, pertains to markets in which capacity is sufficiently flexible that firms can meet all of the demand that arises at the prices they announce. This distinction helps to explain the pro-cyclicality of airline industry profits. During business downturns, the airlines have substantial excess capacity on virtually every route. Because many consumers perceive the airlines as selling undifferentiated products, and search costs are low, each airline can fill empty seats by undercutting rivals' prices and stealing their customers. The resulting competition resembles Bertrand's model and can lead to substantial losses for the industry. During boom times, airlines operate near capacity. Because they have few empty seats, they are unable to increase business even if they cut prices. Competition in each route is based on capacity, not price, resembles Cournot's model, and allows the airlines to reap substantial profits.

In summary, Cournot and Bertrand model seems to coexist, although at different time horizons, despite the differences between them. Earlier attempt to reconcile the two (such as Kreps and Scheinkman, 1983) has been criticized, therefore there is no clear cut results reconciling the two models.

## **CONCLUSION**

Whether Cournot or Bertrand was correct is a question that can be resolved only by looking at the details of the context within which the competitive interaction takes place. One way to reconcile the two models is to recognize that Cournot and Bertrand competition may take place over different time frames. An important view point, which was discussed in this paper, is that firms do set prices, as expected in the Bertrand model, but they set capacities for production, as expected in the Cournot model, before announcing prices. If we take setting of capacities for production as a long run phenomena and setting of prices as a short run competitive strategy, when capacity is fixed, then, it has been shown by Kreps and Scheinkman (1983) that this Bertrand equilibrium outcome of price competition results in Cournot quantities and prices. Thus, we can conclude that, oligopoly competition is guided in the long run by production capacity competition, as advocated by Cournot, equilibrated through price competition, as advocated by Bertrand, in the short run when capacities are fixed. This way, each model seems to fit into its place well, and both play important roles in oligopoly competition.

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