Cournot bertrand and stackelberg models of oligopoly economics essay

Generally in oligopoly competition, it is assumed that there are a fixed number of firms and no new entry; all firms produce homogenous product in a single period and have constant marginal cost c. In the Cournot model, firms choose the quantities to produce and prices adjusted along to clear the market. In Bertrand model, firms set different prices for the same product so the firm that has the lowest price can sell to the whole market.

Consider a duopoly case where there are two firms in the market. Suppose that Firm 1 sets p1 and Firm 2 sets p2 above the marginal cost (MC). For given p1, if p2 is slightly lower than p1, all consumers will buy from Firm 2 and Firm 1 sells 0 as two firms produce identical products. If p2 is higher than p1, no one will buy from Firm 2. If p2 = p1, consumer’s preference is indifferent between two firms.

Market Demand

Residual Demand

p2

p1

MC

q2

P

Q

Figure 1: A Bertrand Firm's Residual Demand

As shown in Figure 1, Firm 2's residual demand curve equals to 0 if p2> p1, coincides with the market demand curve when p2

Since MC is constant and total cost equals average cost (AC) times quantities produced, therefore MC = AC = c. Suppose Firm 1 sets p1 > p2 > c then it will sells 0. So Firm 1 is better off deviating and charging p1 below p2. When Firm 1 charge p1 = p2 = p > c, demand is divided equally between two firms, both firms earn profit π1 = π2 = (p-c)*1/2Q(p). But if Firm 1 lowers p1 to slightly below p then it will sell to the whole market and earn almost double profit π1 = (p-c)*Q(p). So it will do better by deviating. There is a possibility where Firm 1 charges p2 > p1 = c and earns zero profit since it produces where price equals AC. Then it will earn positive by raising p1 to just below p2 but above c. The same case goes to Firm 2. In these situations, both firms can be better off deviating and changing its price level. Thus none of them can be the Nash Equilibrium. This is illustrated in Figure 2 below.

Figure 2: Bertrand Best-Response Functions

Source: http://users. ox. ac. uk/~scat3104/oligopolynotes. doc

Given p1, Firm 2 will choose p2 slightly below p1 but above MC, therefore, Firm 2's best-response function lies slightly below the 45° line, where price equals MC. If Firm 1 set p1 below MC, then Firm 2's best-response is to do nothing to prevent losses. Similarly, Firm 1's best-response function lies just above the 45° line. The intersection of the two functions is where both firms charge p1 = p2 = c and neither of them would want to deviate because if one wants to lower its price, it will gain losses but if it tries to higher the

price, it will earn zero sales. Hence, no firm can do better by changing price. This is the unique Bertrand Equilibrium where firms set prices equal to MC and all firms gain zero profit, similar to the social optimum. The outcome is equivalent to the outcome in competitive market where there’s no market power. This is called the Bertrand Paradox. It is hold regardless the number of firms

However, the assumptions of Bertrand’s model ignored some important facts in real world market. As assumed, products are homogenous and MC is constant, one firm can fill the market demand if its price is slightly below rival’s price. But in real market, this is unrealistic since firms have limited capacities. In 1897, Francis Edgeworth showed that if there are capacity constraints, the Bertrand Paradox may not hold. His model was based on Bertrand duopoly model excepting that both firms are capacity constrained. Suppose that firms can only produce a certain level of output qc and it is very costly to produce beyond that level. So up to qc, MC is constant but it becomes infinite at qc.

MC

P(Q)

qc

qc

Q

P

p1

c

Figure 3: Bertrand Residual Demand with Capacity Constraints

Suppose that Firm 2 sets p2 equal MC: p2 = c. Believing that Firm 2 charges p2, Firm 1 will not respond because it will make losses by lowering p1. And if it sets p1 > p2, then all consumers will by from Firm 2. Since Firm 2's capacity is constrained, it can only sell the amount qc. There will be consumers who are turned away by Firm 2. These consumers may be willing to buy from Firm 1 at higher price p1. Therefore, Firm 1 will sell the amount equals market demand minus qc, which means Firm 1's residual demand curve is the market demand curve shifted left-ward by qc. Thus, Firm 1 can maximise profit by acting as a monopolist and charges p1 where MR = MC. At this price, Firm 1 can make positive profit. Hence, the Bertrand equilibrium is not hold in this case.

If two firms charge the monopolist price p1, one firm would want to lower its price to slightly below p1. This way, although it can't fulfil the market demand, it still gets higher demand than its rival, thus, earns higher profit compared to setting price equal MC. Consequently, setting price equals monopoly level is not a Nash Equilibrium.

Consider the case where the total capacity of two firms, q1 + q2, is comparatively small to the market demand. And suppose that p is the price where market demand is equal to the total capacity, Q = q1+q2, and Firm 2 charges p. If Firm 1 also charges p1= p, its profit will be π1 = q1*p. If it

charges p1 < p, then it will still earn the same profit due to the limited capacity. However, if Firm 1 chooses p1 > p, its residual demand will equal the market demand minus Firm 2's residual demand, Q – q2, similar to the case above. Since the total capacity is small, Firm 1 can do better by not raising p1 above p. So Firm 1's best-response when Firm 2 charges p2 = p is to charge p1 = p and vice versa. In this case, p1 = p2 = p is the Bertrand-Edgeworth Equilibrium. On the contrary, when the total capacity is large compared to market demand, if firms try to set price equals to MC and share half of the market demand, their capacities will not be fully consumed. So firms would try to deviate to gain more consumers. The situation goes back to the Bertrand outcome.

Generally, if capacity constraints exist, there is no static equilibrium i. e. no equilibrium in pure strategies since prices may fluctuate or firms may choose to use mixed strategies. Apart from that, the size of capacity influences the competitiveness of the industry, the smaller capacity constraints, the higher market power.

Up until now, capacity constraints have been considered exogenous. Assume that firms endogenously choose capacities before setting price. This is a two-stage game which firms simultaneously choose a capacity in first stage, then choose prices in second stage. This means that firms engage in Bertrand-Edgeworth competition, and therefore can avoid the Bertrand Paradox. According to Kreps and Schienkman (1983) and Deneckere and Kovanock (1996), under some conditions, the firms' capacity choice in Edgeworh's model leads to equilibrium prices which are similar to those arise in Cournot

model. If the capacity and production cost are relatively high, the unique Cournot equilibrium occurs.