

## CHAPTER 3

### METHODOLOGY AND MODEL

This study focuses on the expansion competition between two players who produce the same type of product with the various qualities. These two firms have the same cost of production function where the factor influences this cost of production is the level of product's quality. The higher level of product's quality, the higher production cost. In this study, I will assume that the firms need to make a decision for pricing, location and also product's quality.

In order to picture the competition mentioned above, the concept of Hotelling's model of location game is adopted. However, there will be some modification to make the model fit the objective of this study. The model in this study will be three-stages location game, where the axes is location. There will be two players in the game. Both players are rational and want to maximize their profit. Therefore, the objective of these firms is to maximize their profit while considering the other's action. As mentioned before, the higher level of product's quality leads to the higher production cost. Thus, the firm that has higher value of product quality level will face the higher production cost. I will assume that the product's price set by the firm has to be nonnegative. Also, the prices have to be higher than or equal to the production cost and both firms are assumed to have no fixed cost.

This model will be different from Tabuchi (1994) because the location of the firms in term of  $y$ -axis will determine the cost of production of those firms while, in Tabuchi (1994), the cost of production are assumed to be equal for both firms. Therefore, we can view this study as the expansion of Tabuchi (1994).

For consumer side, the simple rules of location game are applied. The number of consumer is normalized to be 1 and the population density is jointly uniformly distributed. Each consumer will buy at most one unit of product and they will buy the product from the firm that gives them highest utility. Consumers' utility will be determined by price, location of each firm, consumers' location, and transportation

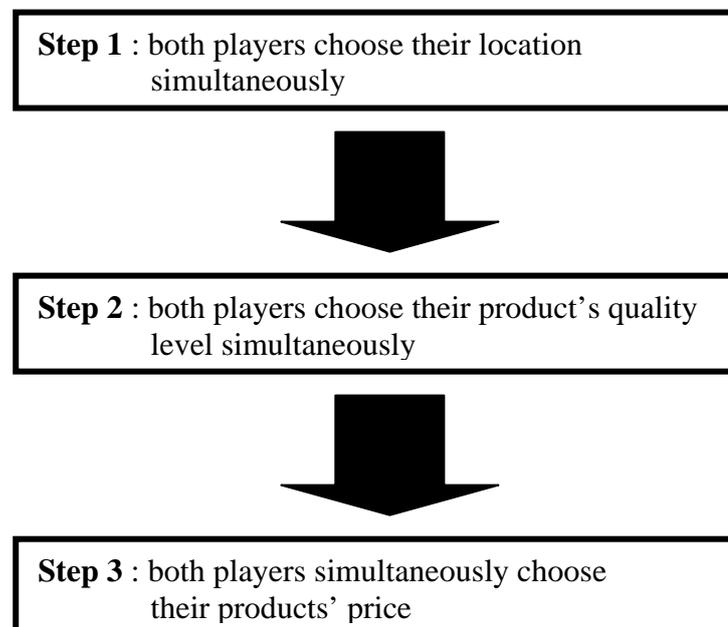
cost from the point where consumers are located to the point where the firms are located.

At the beginning, each player already has one branch at the optimal location and product quality level from the “first competition”, where this optimal and product quality level is assumed to be chosen without knowing that this “second competition” will occur and their decision is to add another branch into the two-dimension platform.

The game in this study will be divided into three stages. In the first stage, players will choose their location simultaneously. After that, players will choose their product quality level concerning that the production cost is the function of product’s quality. In the third stage, both players will, again simultaneously set their price of their product. Then, consumers will determine the utility from each firm and choose to buy the product from the firm that provides them the highest utility. The flow of this game is presented in the figure below.

Figure 3.1

The flow of the game



Although this study mainly focus on the “second competition” between two players, we still need to consider the “first competition” as the optimal location from

this competition will become the original branch for each firm in the “second competition”. Therefore, firstly, we are going to analyze the “first competition” and, after that, we will analyze the “second competition”.

### 3.1 The Model: First Competition

There are two players competing with each other in this game. Both players have to choose the location, level of product’s quality, and price, which represented by  $x_i$ ,  $y_i$ , and  $p_i$ , respectively, where  $x_1 \leq x_2$ . The value of  $x_i$  and  $y_i$  are assumed to be in the interval  $[0,1]$ .

The products from both firms are of the same types, however, the product’s quality between these two firms might not be the same depended on the value of  $y_i$  of these two firms. The cost of production for firm 1 and firm 2,  $c_1$  and  $c_2$ , are as follow:

$$c_i = y_i^2 \quad i = 1,2$$

Both players are rational and maximizing their profit. The profit functions for each firm are:

$$\begin{aligned} \pi_1 &= (p_1 - c_1)q_1 \\ \pi_2 &= (p_2 - c_2)(1 - q_1) \end{aligned}$$

Where  $p_1, p_2$  are the product’s price of player 1 and 2, respectively;  $q_1$  is the market share of player 1;

In the first stage, the players will choose the value of  $x_i$  within the range  $[0,1]$ . In the second stage, both players will choose the value of  $y_i$  within the range  $[0,1]$ . This decision will affect their production cost as statement earlier. The higher level of quality, the higher level of production cost. In the third stage, both players will have to set the price for their product, which cannot be less than their production cost. After

that, the consumers will determine the utility they will get from buying the goods from player 1 or 2.

The number of consumer in this market is assumed to be 1, which are uniformly distributed over the square  $[0,1]^2$  and have a unit demand. Each of consumers will buy the product from the firm that gives them the highest utility. If the utilities from player 1 and player 2 are equal, the consumers will randomly choose the product from both players. The utility that each consumer will receive from consuming any product equal to  $V$ . The value of  $V$  is assumed to be sufficiently high such that the consumers will always buy at least one unit of product. The quadratic transportation cost is assumed for simplicity, the unit transportation cost is assumed to be unity. Therefore, the net utility of consumer located at the point  $x$  buying product from each firm will be

$$\text{Buying from player 1:} \quad u_1 = V - p_1 - (x - x_1)^2 + y_1$$

$$\text{Buying from player 2:} \quad u_2 = V - p_2 - (x - x_2)^2 + y_2$$

### 3.2 The Model: Second Competition

There are two players competing with each other in this game. At the beginning, each firm will already have one branch at the optimal location and product quality level from the “first competition”. Both players have to choose the location, level of product’s quality, and price for their new branches, which represented by  $m_i, n_i$ , and  $p_i$  for player  $i$ , respectively. The value of  $m_i$  and  $n_i$  are assumed to be in the interval  $[0,1]$ . Both players also need to choose the price for their product,  $p_i$ , which will assumed to be used for both branches owned by the same player.

The products from both firms are of the same type, however the product’s quality between these two firms might not be the same depended on the value of  $n_i$  of these two firms. The cost of production for firm 1 and firm 2,  $c_1$  and  $c_2$ , are as follow:

$$c_i = \frac{y_i^2 + n_i^2}{2} \quad i = 1, 2$$

Both players are rational and maximizing their profit. The profit functions for each firm are:

$$\begin{aligned} \pi_1 &= (p_1 - c_1)q_1 \\ \pi_2 &= (p_2 - c_2)(1 - q_1) \end{aligned}$$

Where  $p_1, p_2$  are the product's price of player 1 and 2, respectively;  $q_1$  is the market share of player 1;

In the first stage, the players will choose the value of  $m_i$  within the interval  $[0,1]$ . In the second stage, both players will choose the value of  $n_i$  simultaneously within the interval  $[0,1]$ . This decision will affect their production cost as statement earlier. The higher level of quality, the higher level of production cost. In the third stage, both players will have to set the price for their product. I will assume that this price set by each firm will be applied to both branches under the same player. After that, the consumers will determine the utility they will get from buying the goods from player 1 or 2.

The number of consumer in this market is assumed to be 1, which are uniformly distributed over the square  $[0,1]^2$  and have a unit demand. Each of consumers will buy the product from the firm that gives them the highest utility. If the utilities from player 1 and player 2 are equal, the consumers will randomly choose the product from both players. The utility that each consumer will receive from consuming any product equal to  $V$ . The value of  $V$  is assumed to be sufficiently high such that the consumers will always buy at least one unit of product. The quadratic transportation cost is assumed. For simplicity, the unit transportation cost is assumed to be unity. Therefore, the net utility of consumer located at the point  $x$  buying product from each firm will be

$$\begin{aligned} \text{Buying from original branch of player 1: } & u_1 = V - p_1 - (x - x_1^*)^2 + y_1^* \\ \text{Buying from new branch of player 1: } & u_2 = V - p_1 - (x - m_1)^2 + n_1 \\ \text{Buying from original branch of player 2: } & u_3 = V - p_2 - (x - x_2^*)^2 + y_2^* \\ \text{Buying from new branch of player 2: } & u_4 = V - p_2 - (x - m_2)^2 + n_2 \end{aligned}$$