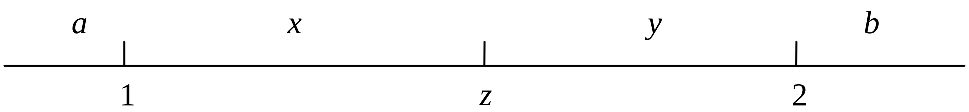
CHAPTER 2

LITERATURE REVIEWS

There are many literatures studied oligopoly competition about location and product variety in the past. Hotelling (1929) is one of the interesting examples. Hotelling studied the situation that location is included in firms' decision. This study captures the concept of transportation cost of consumer, which he assumes it as a linear transportation cost. He assumes that the consumers are uniformly distributed along the line of length *L*. Firm 1 is assumed to be at a distance "*a*" from one end and firm 2 is assumed to be at a distance "*b*" from another end of line segment as shown in figure 1.

Figure 2.1

Hotelling's market line



Each consumer transports his purchases home at a cost *c* per unit distance. Let firm 1 and firm 2 set their mill prices equal to p_1 and p_2, respectively. If the consumer located at "*z*" purchases the product from firm 1, his cost will be $p_1 + cx$. If he purchase from firm 2, his cost will be $p_2 + cy$. Point "*z*" is assumed to be the point that consumer is indifferent buying from firm 1 and firm 2. In other word, the utility that consumer located at point "*z*" will receive from both firm are equal. This means that the market demand in this model will be divided into two segment, $a + x$ and $b + y$, which are the market demand form firm 1 and 2 respectively. By equating the delivered price, we have

$$p_1 + cx \quad = \quad p_2 + cy \qquad (2.1)$$

And, from the assumption that the line segment's length is equal to L, we have

$$L \quad = \quad a + b + x + y \qquad (2.2)$$

From equations (2.1) and (2.2), we can solve for the value of "*x*" and "*y*", which will be equal to

$$x = \frac{1}{2}\left(L - a - b - \frac{p_1 - p_2}{c}\right)$$

$$y = \frac{1}{2}\left(L - a - b - \frac{p_2 - p_1}{c}\right)$$

As we obtained the value of "*x*" and "*y*", the total profit of each firms are as follow

$$\pi_1 = \frac{1}{2}(L + a - b)p_1 - \frac{p_1^2}{2c} + \frac{p_1 p_2}{2c} \qquad (2.3)$$

$$\pi_2 = \frac{1}{2}(L - a + b)p_2 - \frac{p_2^2}{2c} + \frac{p_1 p_2}{2c} \qquad (2.4)$$

From equations (2.3) and (2.4), we can see that each firm's profit is the function of p_1 and p_2. By using first-order condition with respect to its own price, the optimal pricing of each firm and the optimal profit of each firm are obtained, which are

$$p_1^* = c\left[L + \frac{a-b}{3}\right]$$

$$p_2^* = c\left[L - \frac{a-b}{3}\right]$$

$$\pi_1 = \frac{c}{2}\left(L + \frac{a-b}{3}\right)^2$$

$$\pi_2 = \frac{c}{2}\left(L - \frac{a-b}{3}\right)^2$$

The further discussion is that if both firms are free to move their position, changing the value of *a* and *b*. If firm 1's location has been fixed and firm 2's location is freely to move. Firm 2 will choose to locate just as close to firm 1's location to increase its profit or to make π_2 as large as possible. Vice versa, firm 1 will also try to move its location to make π_1 as large as possible. At equilibrium, both firms will locate at the middle of market line, which is later called minimum differentiation.

However, from d'Aspremont (1979), the principle of minimum differentiation is shown to be invalid. He proposed the necessary condition about the value of "*a*" and "*b*" in order to guarantee the existence of the price equilibrium, which are

For $a+b=L$, the unique equilibrium point is given by $p_1^* = p_2^* = 0$. For $a+b<L$, there is an equilibrium point if, and only if,

(1) $$\left(L+\frac{a-b}{3}\right)^2 \geq \frac{4}{3}L(a+2b)$$

(2) $$\left(L+\frac{b-a}{3}\right)^2 \geq \frac{4}{3}L(b+2a)$$

And, whenever it exists, an equilibrium point is uniquely determined by

(3) $$p_1^* = c\left[L+\frac{a-b}{3}\right]$$

(4) $$p_2^* = c\left[L-\frac{a-b}{3}\right]$$

He also proposes a change in Hotelling's assumption to solve the problem of price equilibrium. With the same model as Hotelling, he changed the assumption about transportation cost from linear to be quadratic or cx^2 instead of cx. This change of transportation cost assumption lead to the new optimal price of each firm, which are defined by

$$p_1^* = c[L-a-b]\left[L+\frac{a-b}{3}\right]$$

$$p_2^* = c[L-a-b]\left[L-\frac{a-b}{3}\right]$$

He concludes that the principle of maximum differentiation will apply instead. As the extension of the previous spatial competition, Economides (1989) propose another competition. The model is as follow. Firm will choose their locations in the first stage, which represented by x and y for firm 1 and 2, respectively. In the second stage, firm will choose their quality of their product, given by a_1 and a_2. And, in the third stage, firms choose the price for their product. By focusing on symmetric location, $x+y=1$, Economides has proven that firm will not undercut its opponent and drive him out of business because, by doing so, that firm will gain zero profit. Thus, in his analysis, first order condition can be employed. The conclusion is that the perfect equilibrium is at maximal variety differentiation $x^* = 0$, $y^* = 1$, minimal quality differentiation, $a_1^* = a_2^* = 1/(2\lambda)$, and equal price, $p_1^* = p_2^* = 1$, for $\lambda \in (1/4, 1/3)$.

Since these three studies base on one-dimensional space, the question comes to whether these studies can be apply to the real world situation where location is not in one-dimensional space. This question is answered by Tabuchi (1994). He extended the model from one-dimension to two-dimension in order to find the feasibility of Hotelling's model. All of his assumptions are the same as Hotelling's model except a quadratic transportation cost, the unit transportation cost is unity, and firms are in a rectangular area C where $\int_C dxdy = 1$ and its length equals to c and height equals to $1/c$. Therefore, the point that the consumer will be indifferent between both firms will be changed to be a straight line or

$$p_1 + (x_1 - x)^2 + (y_1 - y)^2 \quad = \quad p_2 + (x_2 - x)^2 + (y_2 - y)^2$$

And firm 1's market demand is equal to $\int_{C_1} dxdy$, where $C_1 = \{(x, y) \in C \mid p_1 + (x_1 - x)^2$
$+ (y_1 - y)^2 \le p_2 + (x_2 - x)^2 + (y_2 - y)^2\}$. From his study, he proposed a set of lemmas and proposition.

Lemma 1 Given firm j's location of $(x_j, y_j) \in C$, firm $i (\neq j)$ locates either at a corner or at a midpoint of one side.

Lemma 2 If one firm locates at a corner, then the other firm locates at a midpoint of one side which is farthest from the corner.

Lemma 3 If one firm locates at a midpoint of one side, then the other firm locates at one of three other midpoints.

Proposition If C is a rectangle close to a square, then firms locate at the opposite midpoints of short or long sides. Otherwise, firms locate at the opposite midpoints of the short sides.

Therefore, from lemmas and proposition, he proved that two firms will maximize their distance in one dimension and minimize their distance in another dimension. Therefore, this study support that Hotelling's model is applicable in the real world two-dimensional space.

Hotelling's model is widely used as a base assumption nowadays. Adachi (2000) used Hotelling's model of spatial competition to cover product varieties and consumer loyalty in transition market. He modeled his idea by employing Hotelling's model. He extended it into two periods game where, in the first stage consumers are uniformly distributed along the interval [0,1], which is a characteristic space. Once consumers decide which variety to purchase in period 1, they develop a loyalty to that variety in period 2 or they move halfway toward the producer from which they have bought in the stage 1. This means that the distribution of consumers in the second stage is not uniform anymore. The consumers' distribution will depend on the location and price of each player in the first stage. In his literature, he studied the result of competition with and without brand loyalty and also the effect of brand loyalty in this type of competition. Brekke (2003) is another example that use Hotelling's model as a base assumption. This study analyzed how equilibrium locations in location-price games are affected when firms acquire inputs through bilateral monopoly relations with supplier. He employed standard assumptions of unit demand, uniformly distributed consumers and quadratic transportation cost. The difference is that both players will also have to consider about the price of input which will be varied upon the location they choose or, in other word, input's price is endogenous. For this model, the consumer located at point *z* who is indifferent between buying from both firms must have the following condition.

$$p_1 + t(z - x_1)^2 \qquad = \qquad p_2 + t(x_2 - z)^2$$

Solving for the value of *z*, we get

$$z = \frac{1}{2}\left(\frac{p_2 - p_1}{t(x_2 - x_1)} + x_1 + x_2\right) \qquad (2.5)$$

In the price competition stage, given the locations of the firms, x_1 and x_2, and the input prices, w_1 and w_2, the firms simultaneously set prices to maximize profits. The first-order condition for firm *i* is gi

$$z + (p_i - w_i)\frac{\partial z}{\partial p_i} = 0 \qquad i = 1,2 \qquad (2.6)$$

By substitute equation (2.5) into equation (2.6), we get

$$p_1 = \frac{t}{3}(2 + x_1 + x_2)(x_2 - x_1) + \frac{1}{3}(2w_1 + w_2) \qquad (2.7)$$

$$p_2 = \frac{t}{3}(4 - x_1 - x_2)(x_2 - x_1) + \frac{1}{3}(2w_2 + w_1) \qquad (2.8)$$

In the stage of bargaining, he adopted Nash bargaining model in a simultaneous bargaining system. However, for simplicity, he assumed that the threat point of bargaining party is zero. Using the optimal pricing or equation (2.7) and (2.8) the equilibrium input prices are as follow.

$$w_1 = \alpha_1 t(x_2 - x_1)\left[\frac{2(2 + x_1 + x_2) + \alpha_2(4 - x_1 - x_2)}{4 - \alpha_1\alpha_2}\right]$$

$$w_2 = \alpha_2 t(x_1 - x_2)\left[\frac{2(4 - x_1 - x_2) + \alpha_1(2 + x_1 + x_2)}{4 - \alpha_1\alpha_2}\right]$$

Where $\alpha_i \in [0,1]$ is a measure of the relative bargaining strength of the input supplier of firm *i*. And, in the location stage, first-order condition is employed. The equilibrium location are given by

$$x_1^* = \frac{-4 + 8\alpha_1 - 16\alpha_2 + 5\alpha_1\alpha_2}{4(2 - \alpha_2)(2 - \alpha_1)}$$

$$x_2^* = \frac{20 + 8\alpha_1 - 16\alpha_2 - \alpha_1\alpha_2}{4(2 - \alpha_2)(2 - \alpha_1)}$$

They have shown in this study that the firm will locate further apart from each other. An interesting implication is that downstream firms would prefer having bilateral monopoly relations with input supplier rather than facing a competitive upstream market. Unlike two literatures stated above, Narajabad and Watson (2008) extended the model into dynamic concept. They studied about a dynamic duopoly with location, quality, and price as decisions of the firms. This study's model will be a little different with original Hotelling's model as firms can choose to locate only either end of the line instead of any point along the line and also can choose to improve level of product quality. However, there are also the probabilities that changing location and product's quality improvement are successful, which are given by

$$A(h_i(t)) = \frac{\exp(-\gamma)h_i(t)}{1+\exp(-\gamma)h_i(t)} \quad \text{for changing location}$$

$$Q(v_i(t)) = \frac{\exp(-\phi)v_i(t)}{1+\exp(-\phi)v_i(t)} \quad \text{for quality improvement}$$

Where $h_i(t) \geq 0$ and $v_i(t) \geq 0$ denote the dollar value of investment of location changing and quality improvement, respectively, by firm *i* in period *t* and γ and ϕ are the cost parameter. As this model is dynamic, Bellman's equation is employed to find best response strategy of each firm. Harter (1996) focused on the decision of the firms about product's variety in a differentiation product model where the demand is unknown. In his model, consumers are uniformly distributed over interval $[\Theta, \Theta+1]$ where firms do not know the value of Θ and know only that Θ is drawn form a uniform distribution [0,1]. The firms enter the market sequentially and choose a single location (product variety) on real line. If firms choose a product variety that is outside the interval $[\Theta, \Theta+1]$, their profit will be zero. Since, in Lane (1980), the existence of equilibrium in the complete location pricing game cannot be proven, simulation is used in order to get the results.

As we can see, all of the above stated literatures are in theoretical manner. None of them apply their study to explain market characteristic in the real world. There are also several literatures using spatial competition that try to explain the characteristic in a specific market both foreign and Thai. Schmalensee (1978) did the study of the ready-to-eat breakfast cereal industry in USA. He attempted to test that evidence in RTE cereal industry is consistent with the model. He employed the model that consumers are distributed on the perimeter of a circle and there are already N established brands (firms) located distances $1/N$ apart around the circle. Firms have to make a decision about price and advertising. Firms also can collude with each other to prevent the new entry in to the market. As a result, he concludes that products in this industry have to be differentiated as the established firm can not duplicate other product. In the case of Thailand, Kesavayuth (2001) did the analysis about non-price competition using instant noodle as a case study. She employed the model from Koutsoyianis (1983), Ludwick (1992), and Fehr and Stevik (1998). She extend Hotelling model in such a way that each firm strategy is to set the level of advertising and product-variety. However, some assumptions are also added such as each firm is located at each end of the line segment. At first she used the generalized model from Koutsoyianis (1983) to solve for the optimal quantity of advertising and product-variety. As a result, the optimal level of advertising and product-variety are given by

$$a_i^* = \left(\frac{p-MC}{p}\right)\left(\eta_{Q_i a_i} + \eta_{Q_i a_j}\eta_{a_i a_j}\right)\left(\frac{R_i}{k}\right)$$

$$v_i^* = \left(\frac{p-MC}{p}\right)\left(\eta_{Q_i v_i} + \eta_{Q_i v_j}\eta_{v_i v_j}\right)\left(\frac{R_i}{h}\right)$$

$$i = 1,2 \quad j = 1,2 \text{ and } i \neq j$$

Where $Q_i, a_i, v_i, R_i, h,$ and k are firm i's sale, amount of firm i's advertising, number of flavour offered by firm i, revenue of firm i, average expenditure to produce a different variety, and average price of advertising, respectively. After that, she employed the idea of Ludwick (1992), and Fehr and Stevik (1998), which say that advertising will affect market size, market share, consumer's wiliness to pay, consumer preference, and perceived product difference. She obtained the market share after the changes of advertising and product variety. She divided her study into three cases. The market shares for each case are as follow.

Case 1: advertising affects through willingness to pay

$$x_1^* \quad = \quad \frac{1}{2} + \left[\frac{1}{2\overline{\theta}} \left(\gamma_1^1 - \gamma_2^1 \right) a_1 + \frac{1}{2\overline{\theta}} \left(\gamma_1^2 - \gamma_2^2 \right) a_2 \right]$$

$$x_2^* \quad = \quad 1 - x_1^*$$

Case 2: product variety affects through product different index

$$x_1^* \quad = \quad \frac{\overline{\theta} + \beta_2^2 v_2 + \beta_2^1 v_1}{2\overline{\theta} + \left(\beta_2^2 - \beta_1^2 \right) v_2 + \left(\beta_2^1 - \beta_1^1 \right) v_1}$$

$$x_2^* \quad = \quad 1 - x_1^*$$

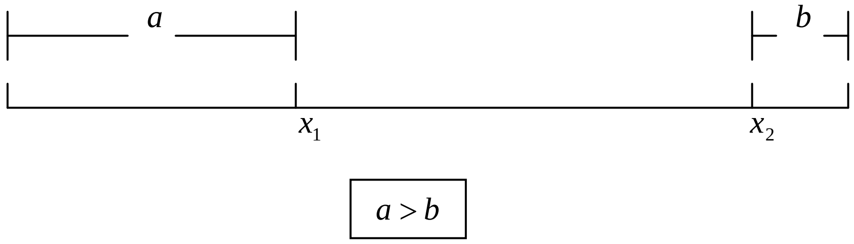
Case 3: advertising affect through consumer's most preferred product location

$$x_i^* \quad = \quad \overline{x} - \left(a_i^{\alpha_i^i} \right) \left(a_j^{-\alpha_i^j} \right)$$

Where $\gamma, \alpha, \beta, \overline{\theta}$, and $\overline{x}$ are coefficient of advertising in one function so called function *S*, coefficient of firm *i* and firm *j*'s advertising in another function so called function *X*, coefficient of product variety of firm *i* and firm *j*, a inherit product different index, and the original consumer location, respectively. From this study, although the data are insufficient, she can explain the effect of non-price strategy such as advertising, product variety, and etc. in Thailand's instant noodle industry. Another literature related to the case of Thailand is Limpong (2003). She employed spatial competition to analyze the case of retail oil market in Thailand. By considering the effect of brand of existed oil company, she can explain the past behavior of four major oil companies such as introducing gas station's store. Her model is that consumers are uniformly distributed along the interval [0,1]. Firms have to make the decisions about price and product variety in their oil station. However, firms cannot choose their location, but they are given in the first place as a level of brand loyalty. She set that the major oil companies will locate at the point such that the distance from the end of interval is higher than minor oil companies' location. Figure 2 illustrates the idea.

Figure 2.2

Limpong's market line



The inequality $a > b$ represents the degree of brand loyalty that major oil company will have higher level of brand loyalty than the minor one. After doing the calculation, she obtained the optimal level of price and variety offer to the consumers, which are given by

$$v_1^* = \frac{3\theta c_2(3+a-b)-2}{27\theta^2 c_1 c_2 - 3\theta(c_1+c_2)}$$

$$v_2^* = \frac{3\theta c_2(3-a+b)-2}{27\theta^2 c_1 c_2 - 3\theta(c_1+c_2)}$$

$$p_1^* = \frac{3\theta c_1 c_2(3+a-b)-2c_1}{9\theta^2 c_1 c_2 - \theta(c_1+c_2)}$$

$$p_2^* = \frac{3\theta c_1 c_2(3-a+b)-2c_1}{9\theta^2 c_1 c_2 - \theta(c_1+c_2)}$$

From her study, she concluded that both major and minor brand try to relax price competition by launching more varieties to their station.

From many reviewed literatures, we can see that spatial competition theory is widely used in many oligopoly competitions and suitable in the non-price competition analysis. As this study focus on location and product's quality or non-price strategy in oligopoly competition, spatial competition theory should be an appropriate model in this case.