

## The effects of product innovation on product life cycle patterns in Taiwanese motors: views of consumer preferences

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### Keyword

Consumer Preference, Product Innovation, the Product Life-Cycle Pattern

### Abstract

*Despite much research on the product life cycle (PLC), little research was done on the determinants of the PLC patterns from the point of view of customer behavior and product innovation. Therefore, this study extends previous research on the product life cycle to answer the following question what are the effects of consumer preferences and product innovation on the product life-cycle patterns? In order to answer this question, this study surveys a convenience sample of 627 subjects in Taiwan by a self-developed questionnaire and adopts the multinomial logit model to analyze the sample data. The empirical results are showed as below : (1) The higher the level of customers' preferences for functions of product was, the more probability the shape of product life cycle was "the innovation-ripe pattern". (2)The higher the level of product innovation was, the more probability the shape of product life cycle was "the classical-pattern". (3)The higher the level of interaction between product innovation and customers' preferences for economy of product, the more probability the shape of product life cycle was "the cycle-recycle pattern".*

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### 1. Introduction

Past studies on product life cycle are mostly conducted from the angle of product features, less are from the perspective of consumers' preferences. In essence, while product life cycle becomes shorter and businesses continue to strive for survival and growth, a thorough understanding of the market circumstances and the preferences of the consumers will enable businesses to design new products that meet the market need and to satisfy the need of the customers (Kotler, 2000). This is especially true for the motor industry that is customer need oriented. Since Taiwan joined the WTO in 2002, Taiwan's mobile industry has been facing the competition of globalization; the circulation of product life cycle is short and rapid while there is greater pressure and challenge for businesses. Hence, to research and develop new products and to create new needs from the perspective of customer preferences and to master the pattern of product life cycle have become the management strategy for today's businesses to increase their competitiveness (Ewing, 2000).

Therefore, this research aims to discuss the impact of product innovation on the product life cycle of Taiwan's mobile industry from the perspective of consumer preferences. The main research questions are: (1) Do consumer preferences influence the pattern of product life cycle? (2) Does product innovation influence the pattern of product life cycle? (3) Do the interaction of consumer preferences and product innovation influence the pattern of product life cycle?

## 2. Literature Discussion and Hypotheses Development

### 2.1 Product life-cycle and its pattern

Product life-cycle refers to the changes in sales from the time of its introduction and withdrawal in the market; the process includes rapid growth, reaching peak sales, and the decrease in sales volume (Rink and Swan, 1979; Potts, 2010). Potts (2010) pointed out that most PLC demonstrate bell-shaped curve. With the horizontal axis representing time and longitudinal axis representing sales volume, the curve in the chart represents the change of sales volume through time. The curve can usually be divided into four stages, which, in sequence, are: introduction stage, growth stage, maturity stage, and decline stage.

According to the research and discovery of Swan and Rink (1979), there are approximately six to seventeen PLC pattern. In addition to the commonly seen (1) classical pattern, there are also (2) cycle-recycle pattern, (3) growth-decline-plateau pattern, and (4) innovative maturity pattern as shown in Figure 1.

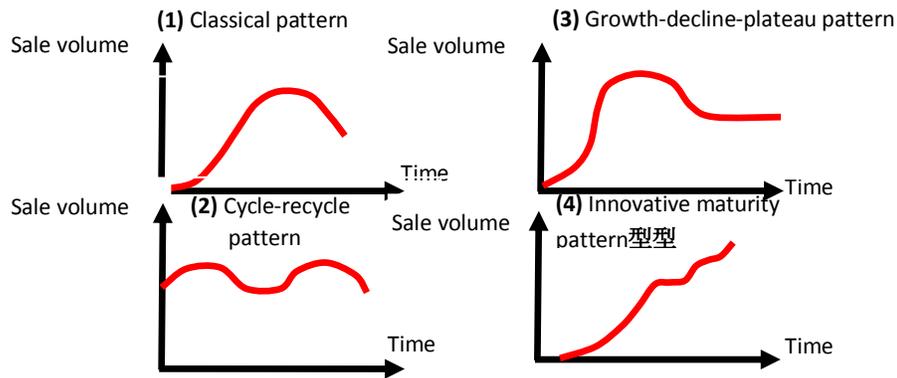


Figure 1: Four commonly seen product life-cycle curves

Notes: (1) Classical pattern: Potts's bell-shaped curve

(2) Cycle-recycle pattern: the first cycle peak created by the active promotion of the new product by the company; the sales of volume will start to decline until the company provide other promotion method to create the peak of the second cycle (usually the range is smaller and the duration is shorter).

(3) Growth-decline-plateau pattern: When a product is introduced to the market, the sales volume increases rapidly and declines to a stable state. The stable state of sales volume is created because of the initial purchase of the later adopters and the replacement purchase of the earlier adopters.

(4) Innovative maturity pattern: the sales volume experiences a continuous life-cycle due to the discovery of new product feature, new uses, or new users.

The concept of PLC is mainly to assist businesses in the marking of products and the planning of product development (David, Dianne, and Harold, 1999). Kotler (2000) pointed out that the concept of PLC can be used as a tool for planning and control. The concept of PLC describes the characteristics of the marketing challenges in each stage and specifies the main marketing strategy that can be adopted by the company. It helps the company to evaluate the performance of the products that they want to put in the market by a comparison with similar products that has been

produced before. However, the concept of PLC provides limited support in sales prediction since sales history is diversified and there is a greater level of variations in the duration of each stage.

## 2.2 The relationship between consumer preferences and product life-cycle pattern

Understanding consumer preferences is beneficial for the business to find out the most popular products and to predict market share and possible profit (Kotler, 2000). Preferences are subjective judgment from the mind of the consumers toward the products. The standard of measurement came from the feature of the products themselves, the customers' condition and experience in using the products, as well as the experience of self-feedback that is generated after a good deal of external stimulation and internal transformation. These factors contribute to the development of a personalized measurement system (Norton, 1987).

The core of the systematic stages of EKB Model proposed by Engel, Blackwell, and Kollat (2001) lies in the decision process, including the five stages of problem recognition, information research, alternative measurement, choice, and outcome. In this model, the assessment of consumer preferences refers to the stages of product research, alternative measurement, and choice when consumers face the decision of purchase. Schiffman and Kanuk (2000) believe that a consumer's measurement standard in making a purchase is an important factor in the purchase decision. When attitude assessment becomes the standard of measurement, a low measurement of a single item can be balanced by high measurement from other items. On the other hand, changes in measurement standard, the importance of standard, and level of trust will all lead to changes in the overall attitude of the consumers toward a certain product.

Since the number of people purchasing a product will be decided by the product price and service (Cohen and Whang, 1997; Herrmann et al., 2007), the decrease of production and marketing cost will create a growth stage for the product. Next, the market will soon decline and enter the maturity stage because of the mass expansion of the overall capacities, unless the new product developers who first entered the market have exclusive product technology patents; the sales rate after the decline stage will be maintained by the initial purchase of later adopters and the re-purchase of early adopters (Rogers, 1983).

This research infers that if economical concern is more important for consumers when they purchase automobiles, the PLC should be closer to the pattern of growth-decline-maturity, possibly the growth-decline-plateau pattern; hypothesis H<sub>1a</sub> is therefore proposed. Jordan (1964) believes that the sales volume will continue to grow due to the constant discovery of product feature, function, and new usage, or the increase of new users. This research thus infers that if the consumers are influenced by specific functionalities and their desire of purchase is thus increased, the PLC may display an innovative maturity pattern due to new product feature, new usage, and a continuous life-cycle experienced by the sales volume. Hypothesis H<sub>1b</sub> is thus proposed. If the focus of consideration is on external product attributes such as brand, style, and model (for example make, vehicle design, and color), the PLC pattern might show growth after a decline, possibly the "cycle-recycle pattern". As a result, H<sub>1c</sub> is proposed.

H<sub>1a</sub> : When a consumer demonstrates a greater preference in finance while purchasing an automobile, the pattern of the product life-cycle could be a "growth-decline-plateau pattern".

H<sub>1a</sub> : When a consumer demonstrates a greater preference in functionality while purchasing an automobile, the pattern of the product life-cycle could be an “innovation-maturity pattern”.

H<sub>1a</sub> : When a consumer demonstrates a greater preference in external look while purchasing an automobile, the pattern of the product life-cycle could be a “cycle-recycle pattern”.

### **2.3 The relationship between product innovation and product life-cycle pattern**

Rochford and Linda (1991) discussed product innovation from the various perspectives of consumers, businesses, and market. From the perspective of the consumer, product innovation refers to providing new products that are more effective for the consumers (Benner and Tushman, 2003; Zheng, Yim and Tse, 2005); from the perspective of the business, product innovation refers to greater novelty of a product's related market, technology, and production method; from the perspective of the market, product innovation is evaluated from the fact if the new product contains functions that are not seen in the existing products. David (2005) believes that product innovation is the incremental changes and improvements in product, service, and process. It includes creative response and solution to meet the need and expectation of the consumers and the market, the driving force of the business circumstances, and requirement of the organization strategy.

Rogers (1983) defines innovation diffusion process as the process of the diffusion of an innovation from its source of invention or creation to the last adopter. Based on the mean and standard deviation of time when each adopter accepts the innovation, the adopters are divided into five categories: innovators, early adopters, early majority, late majority, and laggards. Time is shown in the horizontal axis and the number of adopters in the longitudinal axis due to the fact that there are fewer adopters in the beginning and with the increase of people; the number of adopters gradually rises to the climax. The curve gradually declines and is similar to a normal distribution chart. The curve for product life-cycle pattern is the most commonly seen classical or bell-shaped curve. Hole (1998) believes that the feature of innovation and level of acceptability are based on product attributes. However, the continuity and maintenance of the adoption of innovativeness will be based on the categorization of the consumers; in other words, the continuous adoption of innovation by the innovators to the laggards. Therefore, he proposed a new product adoption model which pointed out that perceived product attribute, consumer trait, and environmental variables have an influence on the consumers' purchase intention and later product adoption.

Base on the above description, this research infers that product innovation will lead to diversified and differentiated product attributes; although there are few adopters in the initial stage, with the dissemination of the innovation, the number of adopters will gradually increase and reach the peak. The number of adopters will gradually decrease and finally the product will be adopted by the laggards. As the product demonstrates an innovative development, PLC might demonstrate a classical pattern through the dissemination process of innovation. Hypothesis H<sub>2</sub> is thus proposed.

H<sub>2</sub> : The higher the level of innovation of a product, the greater the possibility for the product life-cycle to demonstrate a “classical pattern”

### **2.4 The influence of consumer preferences and product innovation on product life-cycle pattern**

Day (1994) pointed out that in an environment characterized by ever-changing technology and rapid changes of consumer preferences, businesses can no longer develop new products based on their own thoughts and have to consider the need of the consumers and the strategies adopted by competitors. Cooper (1994) mentioned that businesses would be able to fully understand customer needs, the competition of the market, and the characteristics of the market if they develop new products that are market-oriented (Brentani, 2001; Bisbe and Otley, 2004). Therefore, "market-oriented" has become a key factor in the success of product development.

Based on the above discussion, this research infers that there are mutual influence between consumer preferences and product innovation. Considering product innovation as a moderator, it is inferred that it would cause a moderating effect on the relationship between consumer preferences and product life-cycle patterns. Hypothesis  $H_{3a} \sim H_{3c}$  are thus proposed. When the product demonstrates a higher level of innovation and when the consumer has a greater emphasis on finance preferences, the first cycle peak will be formed by the active promotion of the new product by the company. Afterwards, the sales volume will start to decline until the company provides other promotions to create the second cycle peak. The PLC pattern might demonstrate a "cycle-recycle pattern." Hypothesis  $H_{3a}$  is thus proposed.

When the product demonstrates a higher level of innovation and when the consumer has a greater emphasis on functionality preferences, there will be few adopters in the initial stage and the number will gradually increase to reach its peak, similar to the dissemination process of innovation. The number of adopters will then decline and finally the product will be adopted by the laggards. The PLC pattern might demonstrate a "classical pattern." Hypothesis  $H_{3b}$  is thus proposed. When the product demonstrates a higher level of innovation and when the consumer has a greater emphasis on external look, sales volume will experience a continuous life-cycle due to the new style and look of the new product. The PLC pattern might demonstrate an "innovative maturity pattern". Hypothesis  $H_{3c}$  is thus proposed.

$H_{3a}$  : When the product demonstrates a higher level of innovation and when a consumer demonstrates a greater emphasis on finance preference, the pattern of the product life-cycle could be a "cycle-recycle pattern".

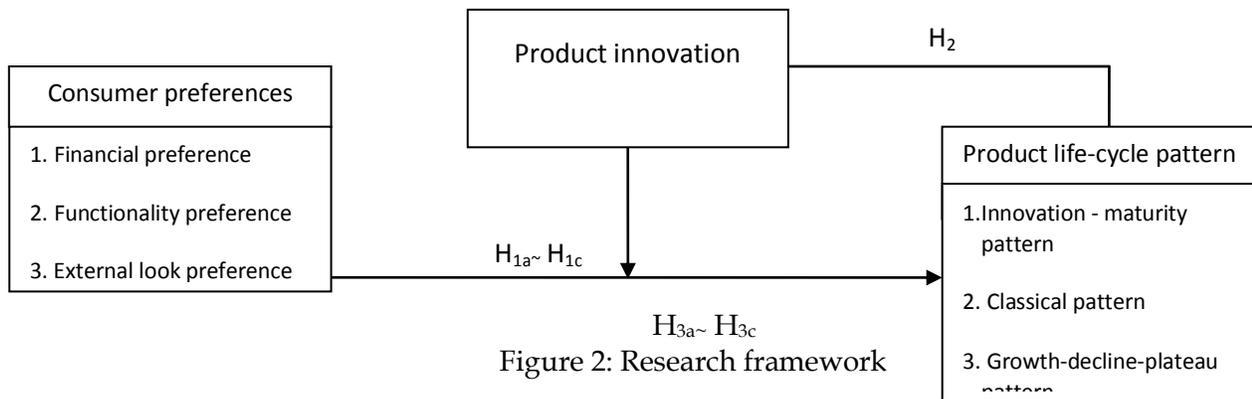
$H_{3b}$  : When the product demonstrates a higher level of innovation and when a consumer demonstrates a greater emphasis on functionality preference, the pattern of the product life-cycle could be a "classical pattern".

$H_{3c}$  : When the product demonstrates a higher level of innovation and when a consumer demonstrates a greater emphasis on external look, the pattern of the product life-cycle could be an "innovation-maturity pattern".

### 3. Method

#### 3.1 Research framework

The structure of concept of the research is shown in Figure 2 with a summarizing analysis of the above discussion and various hypotheses.



### 3.2 Definitions and measurements of research variables

#### 3.2.1 Consumer preferences

Through a summary of the perspectives of the scholars in the literature discussion, this research defines consumer preference variable as: the consumers' measurement and degree in valuing the product attributes of automobiles. The preferences for product attributes are classified into three dimensions: (1) Financial preferences: referring to the degree in valuing the related cost benefit for purchasing an automobile (for example price, maintenance cost, fuel economy, cost of parts, quality, payment terms, resale price, and durability); (2) Functionality preference: referring to the degree of valuing the needed functions in using a car (for example easy operation, shock performance, safety features, internal features, service network and quality, performance, and riding comfort); (3) External look preference: referring to the degree of valuing the brand, style, model in purchasing an automobile (for example make, vehicle design, and color)

This research adopts single-rating (Kotler, 2000) in the measurement of consumer preference variables, requiring consumers to rate every item based on their degree of preference. Five-point Likert items is adopted in this research, asking the interviewees to answer the degree of important for each item, rating one to five from "strong indifference", "indifference", "neutral", "value", and "greatly value". A higher rating signifies a higher degree of preference of the consumer toward that dimension.

#### 3.2.2 Product innovation

In order to have a concrete measurement of the degree of product innovation, this research defines product innovation as the number of facelift of an automobile of the same brand and model (or make) in its product life-cycle (Calantone et al., 2006). This research sorts out the type and model of sedans produced by all automobile factories over the years, the number of facelift is calculated for each model (or make); each facelift counts as one and the number increases by one with a new facelift until the product retires (Gallouj and Weinstein, 1997; Gruner and Homburg, 2000).

#### 3.2.3 Product life-cycle pattern

The dependent variables discussed in this research are the product life-cycle patterns of domestic sedans. According to the statistics of the Taiwan Transportation Vehicle Manufacturers Association over the years (Industrial Economics and Knowledge Research center and Mechanical and Systems Research Laboratories, Industrial Technology Research Institute, 2003), Taiwan's automobile market demonstrates a high density in the sale of sedans; the sales volume from the top five automobile manufacturing companies (China Motor, Kuozui Motor, Yulon Motor, Ford, and

Sanyang) consists more than 90% of the total market. Hence, this research organizes the model and sales volume of sedans in Taiwan from recent years to create the PLC curves for all kinds of model, with the horizontal axis presenting time and the longitudinal axis representing the sales volume. The PLC curves of all models are further classified based on the four commonly seen PLCS patterns mentioned in the literature of this research (Rink and Swan, 1979). If the PLC pattern is indistinct, it will be classified as a pattern that is most similar to it.

### 3.2.4 Control variables

This research adopts two control variables: product lifetime and consumer purchase motivation. Since product lifetime varies, the life-cycle patterns will be different as well. The consumer purchase motivation can be seen as their purchase need; when the motivation changes, the need will change as well and so will the product life-cycle. Therefore, this research utilizes these two factors as control variables to examine the net relations between product life-cycle patterns and consumer preferences as well as product innovation.

The product survival time is defined as: the time of introduction and retirement of all kinds of automobiles in the market; a continuity variable. The consumer purchase motivation is defined as what kinds of need the consumer wants to fulfill: a categorical variable allowing multiple choices.

### 3.2.5 Research subject and source of samples

The research subjects of this study are the domestic consumers who have bought sedans. For the information accuracy and efficiency in return rate, convenience sampling is adopted in the collection of the sample information since traditional survey mailing tend to have a low return rate, moreover, the person filling out the survey might not be the person who bought the car or the driver him/herself. Surveys were handed out at major parking lots in the greater Taipei metropolitan area; a small percentage of the surveys were filled out by families and friends through social network.

In this study, the surveys were collected for data compilation and coding; SPSS software was used to conduct statistical analysis according to the research hypotheses. The process of the information analysis is as follows: First, descriptive statistical analysis is conducted to calculate the mean and standard deviation of the continuous variables; the information is collated, described and interpreted. The vehicle type and brand of the subjects were properly classified to the closest product life-cycle pattern; frequency distribution and percentage analysis were conducted to understand the distribution of PLC patterns. The next step is reliability analysis and Cronbach  $\alpha$  value is calculated based on the individual's preference dimension to examine the consistency or stability of the test results. Finally, the hypotheses proposed in this research were validated with multiple variables Logit model

### 3.2.6 Survey design and data collection

The research tool adopted in this research is self-developed surveys that are designed base on related literature, established hypothesis, operational definition and measurement of various variables. Scholars in related fields and senior staff with practical experience were invited to fill out the first draft before the formal launch of the surveys. Revisions were done based on their suggestion and the final draft is set after constant testing and revision.

This research survey is divided into two sections: the first section is about the basic information of the respondent, to understand the respondent's gender, age, marital status, car type and brand; the second section is to evaluate consumer preference variables, in other words to measure the consumer's measurement and how much he/she values the automobile product attributes. Likert scale is adopted. Surveys were handed out and collected at major parking lots in the greater Taipei metropolitan area; surveys were collected after the drivers have completed the form. A small percentage of the surveys were filled out through social network .by families and friends who own cars. The time frame of the survey is January to May, 2012; a total of 1,200 surveys were handed out and 1,142 were collected. There were 627 valid surveys, resulting in a response rate of 54.9%.

## 4. Analysis and Discussion

### 4.1 Reliability and validity analysis

The reliability analysis of the empirical data in this research is calculating the Cronbach  $\alpha$  values of the survey questions based on the three dimensions of consumer preferences. The result of analysis is shown in Chart 1. The Cronbach's  $\alpha$  value for each measurement dimension is between 0.73~0.74. Generally, Cronbach's  $\alpha$  values above 0.70 are considered as high reliability values, showing that the internal consistency of the scale is acceptable. Arguments in past related literatures were consulted for the measurement of all variables and the survey contents of this research; discussions with academic scholars and experts with practical experiences were held to develop and modify the surveys. In addition, revisions were done after several friends who owned cars fill out the tryout surveys and provided their opinions. Therefore, the surveys demonstrate a certain degree of content validity.

Table 1: The reliability values of the measurement dimensions of the consumer preferences

| Measurement dimension | Reliability values (Cronbach's $\alpha$ ) |
|-----------------------|---|
| Finance               | 0.73                                      |
| External look         | 0.74                                      |
| Functionality         | 0.73                                      |

### 4.2 Descriptive statistical analysis of the variables

Descriptive statistics of the variables of the research is shown in Table 2; it can be seen from the table that among the dimensions of consumer preferences, the functionality preference has the highest average score, followed by financial preferences and external look preference, showing the order of emphasis for these three types of preferences in the minds of the consumers. On the other hand, the distribution of the PLC patterns indicates a highest percentage in "classical" pattern, matching most common pattern identified by research theory.

Table 2 Descriptive statistics of variables (N = 627)

| Research variables       | Mean   | Standard deviation | Minimum | Maximum |
|--------------------------|--------|--------------------|---------|---------|
| Financial Preference     | 3.4422 | 0.7921             | 1.00    | 5.00    |
| Functionality Preference | 3.4994 | 0.8038             | 1.00    | 4.50    |
| External Look Preference | 3.3647 | 0.9810             | 1.00    | 5.00    |

|                                |         |                         |      |       |
|--------------------------------|---------|-------------------------|------|-------|
| Product Innovation             | 3.3100  | 1.6700                  | 1.00 | 7.00  |
| Product lifetime               | 10.5300 | 5.9200                  | 2.00 | 22.00 |
| Product life-cycle pattern     |         | Percentage (total 100%) |      |       |
| Classical pattern              |         | 34.6 %                  |      |       |
| growth-Decline-Plateau pattern |         | 17.9 %                  |      |       |
| Cycle-recycle pattern          |         | 26.0 %                  |      |       |
| Innovative maturity pattern    |         | 21.5 %                  |      |       |

In this research, the continuous variable linear correlation condition of each variable is observed by calculating the coefficient of correlation; the analytical result is shown in Table 3. Table 3 shows that there is a high degree of positive correlation between the variables of "product innovation" and "product lifetime" (Pearson coefficient of correlation = 0.789,  $P < 0.01$ ). However, since "product lifetime" is a control variable in this research, one does not have to worry about its impact on the research. In addition, the research discovers negative correlation between "variables of consumer preferences" and "product lifetime", although it is not significant.

Table 3: Coefficient of correlation between each continuous variable

| Research variables          | 1.        | 2.        | 3.        | 4.        | 5.        |
|-----------------------------|-----------|-----------|-----------|-----------|-----------|
| 1. Financial Preference     | 1.000 *** |           |           |           |           |
| 2. Functionality Preference | 0.694 *** | 1.000 *** |           |           |           |
| 3. External Look Preference | 0.433 *** | 0.455 *** | 1.000 *** |           |           |
| 4. Product Innovation       | 0.017     | 0.007     | 0.023     | 1.000 *** |           |
| 5. Product lifetime         | -0.059    | -0.057    | -0.038    | 0.789 *** | 1.000 *** |

Note:  $N=627$  ; \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$  (2-tailed)

### 4.3 Validation of hypotheses

#### 4.3.1 The relationship between consumer preferences and product life-cycle patterns

This study adopts Multi-Logit model to validate hypotheses  $H_{1a} \sim H_{1c}$ ; when the consumer has a greater emphasis on financial preference, functionality preference, and external look preference, the corresponding PLC patterns are "growth-decline-plateau pattern", "innovative maturity pattern", and "cycle-recycle" respectively. The analytical result is shown in Table 4.

It is shown in Table 4 that among the three variables of consumer preferences, only functionality preference has a significance to  $\beta$  value and it is a negative number ( $\beta_4 = -0.446$ ,  $p < 0.05$ ). According to the explanation of the analysis method for empirical models, when the consumer has a greater emphasis on the functionality of the vehicle while purchasing the car, the product life-cycle pattern of the vehicle is more likely to be a reference type; it is thus inferred that a consumer's functionality preference for the automobile has an impact on the product life-cycle and the corresponding product life-cycle may be the innovative maturity pattern, supporting hypothesis  $H_{1b}$  in this research. As of the two variables financial preference and external look preference, since they do not have significance toward the  $\beta$  value of the product life-cycle patterns, hypotheses  $H_{1a}$  and  $H_{1c}$  are not supported.

Table 4: Result of the Multi-Logit model analysis on the impact of consumer preferences on PLC patterns

| Research variables       | Classical Pattern | Growth-Decline-Plateau Pattern | Cycle-recycle Pattern |
|--------------------------|-------------------|--------------------------------|-----------------------|
| Control variables        |                   |                                |                       |
| Product lifetime         | -0.216 ***        | 0.016                          | 0.005                 |
| Motivation of purchase   | -0.037            | -0.096                         | -0.069                |
| Consumer Preferences     |                   |                                |                       |
| Financial preference     | 0.243             | 0.380                          | 0.024                 |
| Functionality preference | -0.243            | -0.174                         | -0.446 **             |
| External look            | 0.123             | 0.137                          | 0.018                 |
| Constant term            | 2.233 **          | -1.162                         | 1.068                 |

Note: a:  $N=627$ ,  $\chi^2(15)=168.325$ ,  $\text{Sig } \chi^2=.000$ ,  $\text{Pseudo } R^2=.235$ ;

b: \* $p<0.1$ , \*\* $p<0.05$ , \*\*\* $p<0.01$

c: This table is an analysis of the impact of the independent variable on the dependent variable with product lifetime and purchase motivation as the control variables.

d: Reference type ( $k=1$ ) innovative maturity pattern

#### 4.3.2 The relationship between product innovation and product life-cycle patterns

This studies adopts Multi-Logit model to validate hypothesis  $H_2$ , which presumes that the greater the degree of product innovation, the greater the possibility of a corresponding "classical" PLC pattern. The analytical result is shown in Table 5. One can discover from Table 5 that the variable of product innovation has a significant influence to  $\beta$  value and the figures are all positive numbers ( $\beta_{j2}=2.011$ ,  $\beta_{j3}=1.803$ ,  $\beta_{j4}=2.013$ ,  $p<0.01$ ). According to the explanation of the analysis method for empirical patterns, the higher the degree of product innovation, the more likely that it will demonstrate a "cycle-recycle" product life-cycle pattern, followed by "classical pattern" and then "growth-decline-plateau pattern." Therefore, it is inferred that product innovation will have an influence on product life-cycle pattern, although "classical" falls to be the second possible corresponding PLC pattern, yet the chances of possibility of these two patterns are very similar; as a result, it is appropriate to say that hypothesis  $H_2$  in this research is supported.

Table 5: Result of the Multi-Logit model analysis on the impact of product innovation on PLC patterns

| Research variables     | Classical Pattern | Growth-Decline-Plateau Pattern | Cycle-recycle Pattern |
|------------------------|-------------------|--------------------------------|-----------------------|
| Control variables      |                   |                                |                       |
| Product lifetime       | -0.633 ***        | -0.340 ***                     | -0.393 ***            |
| Motivation of purchase | -0.041            | -0.137 **                      | -0.011                |
| Product innovation     |                   |                                |                       |
| Number of facelift     | 2.011 ***         | 1.803 ***                      | 2.013 ***             |
| Constant term          | 1.027 **          | -1.330 ***                     | -1.636 ***            |

Note: a:  $N=627$ ,  $\chi^2(9)=280.964$ ,  $\text{Sig } \chi^2=0.000$ ,  $\text{Pseudo } R^2=0.361$

b: \* $p<0.1$ , \*\* $p<0.05$ , \*\*\* $p<0.01$

c: This table is an analysis of the impact of the independent variable on the dependent variable with product lifetime and purchase motivation as the control variables.

d: Reference type ( $k=1$ ) innovative maturity pattern

### 4.3.3 The influence on product life-cycle patterns caused by the interaction between consumer preferences and product innovation

This research adopts Multi-Logit model to validate hypothesis  $H_{3a} \sim H_{3c}$ , which presumes the greater the degree of product innovation and the greater the degree of emphasis on the three variables of consumer preferences, the greater the possibility that the corresponding PLC patterns will be, in the respective order, "cycle-recycle", "classical", and "innovative maturity." In other words, verifying whether "product innovation" will cause a moderating effect on "the relationship between consumer preferences and PLC patterns." The analytical result is shown in Table 6.

One can discover from Table 6 that the interaction between the variables of consumer financial preference and product innovation has a significance toward  $\beta$  value and the figures are positive ( $\beta_{j4}=0.264$ ,  $p<0.1$ ). The result illustrates that the corresponding product life-cycle pattern for the interaction between the two variables might be "cycle-recycle", supporting hypothesis  $H_{3a}$  in this research. As of the interaction between the variables of production innovation and functionality preference as well as external look preference of the consumers, it did not demonstrate a significant degree of impact on the  $\beta$  value in all PLC patterns. Hypotheses  $H_{3b}$  and  $H_{3c}$  in this research are not supported.

A comparison of Table 4 and 6 shows that when product innovation is included as a moderator in the empirical model, the degree of significant in the corresponding relationship between the variable of consumer functional preference and innovative maturity pattern will decrease. Furthermore, the corresponding PLC pattern for the variable of consumer financial preference will alter to "innovative maturity pattern" ( $\beta_{jk}$  values all turn to negative from positive) without demonstrating significance. Moreover, after the interaction with the variable of product innovation, the possible PLC pattern might not be "innovative maturity" but "cycle-recycle" (as the support for  $H_{3a}$  stated above). It is thus inferred that product innovation has a moderating effect on the relationship between consumer preference and product life-cycle patterns.

Table 6: Result of the Multi-Logit model analysis on the impact of consumer preferences and product innovation on PLC patterns

| Research variables (j)      | Classical Pattern | Growth-Divide-Plateau Pattern | Cycle-recycle Pattern |
|-----------------------------|-------------------|-------------------------------|-----------------------|
| <b>Control variables</b>    |                   |                               |                       |
| Product lifetime            | -0.629 ***        | -0.327 ***                    | -0.378 ***            |
| Motivation of purchase      | -0.051            | -0.109                        | -0.079                |
| <b>Product innovation</b>   |                   |                               |                       |
| Number of facelift          | 1.372 **          | 0.834                         | 0.560                 |
| <b>Consumer preferences</b> |                   |                               |                       |
| Financial preference        | -0.375            | -0.155                        | -0.721                |
| Functionality preference    | -0.254            | -0.656                        | -1.020 *              |
| External look preference    | 0.137             | 0.268                         | 0.003                 |

**The influence of consumer****preferences and product innovation :**

|                                     |         |        |          |
|-------------------------------------|---------|--------|----------|
| Financial preference×innovation     | 0.188   | 0.151  | 0.264 *  |
| Functionality preference×innovation | -0.012  | -0.038 | -0.005   |
| External look×innovation            | 0.007   | 0.156  | 0.158    |
| Constant item                       | 2.781 * | 0.438  | 4.530 ** |

Note : a :  $N=627$ ,  $\chi^2(27)=304.116$ ,  $\text{Sig } \chi^2=0.000$ ,  $\text{Pseudo } R^2=0.384$

b : \* $p<0.1$ , \*\* $p<0.05$ , \*\*\* $p<0.01$

c : This table is an analysis of the impact of the independent variable on the dependent variable with product lifetime and purchase motivation as the control variables.

d : Reference type ( $k=1$ ) innovative maturity pattern

## 5. Conclusions and managerial implications

### 5.1 Conclusions

The result of this research, based on the sample data collected and the sales data of domestic sedan with a multinomial Logit model analysis, has three major conclusions:

First, for the relationship between “consumer preferences and product life-cycle patterns”, only the variable of functionality preference demonstrates a significant relationship with product life-cycle patterns. In other words, the more the consumers value the functionality preference while purchasing a car, the higher possibility for the product life-cycle to be “innovative maturity.”

Second, there is a significant relationship between product innovation and product life-cycle pattern. The greater the degree of automobile product innovation, the greater possibility that the product life-cycle pattern to show as “cycle-recycle”, followed by “classical.” However, the chances of possibility of these two patterns are very similar.

Third, the level of product innovation has a moderating effect on the relationship between consumer preference and product life-cycle patterns.” The relationship between consumer financial preference and product life-cycle patterns was not significant in the beginning; however, when product innovation is included as a moderator, it is discovered that the greater the degree of product innovation and when the consumers place greater emphasis on financial preferences, the greater the possibility that the automobile product will demonstrate “cycle-recycle” life-cycle pattern.

### 5.2 Managerial implications

Since significant positive correlation exists between product innovation and product lifetime, and since product innovation as well as its interaction with financial preference both have major influence on product life-cycle patterns, businesses should consider product innovation as a crucial competition strategy for creating value and seeking market opportunity.

Product innovation can extend product lifetime, but it needs to demonstrate certain uniqueness, if it shows high homogeneity with the competitors' products, the priority of consumer preferences, under crowding out effect, will shift to financial considerations. This may dilute part of the company profit and will not be able to maintain long-term market share. It is also known from the research conclusion that among the dimensions of consumer preferences, functionality preference has an impact on product life-cycle. The denotation is that when the automobile

industry is developing automobile product attributes, the main consideration should be the unique functions of the product so that the product sales volume might enjoy a continuous life-cycle.

### 5.3 Research restrictions

Certain blind spots exist in the research on product life-cycle (Kotler, 2000) due to the following reasons: (1) there are many other factors that cause the cycle, for example promotion or other major external events, therefore it is really difficult to ascribe the cause of the cycle to certain factors; (2) product life-cycle lacks a predetermined procedure and set length, therefore there are many variations in the patterns; (3) with the product sales record and the profit information derived from historical information, sometimes it is hard to discern which stage the product is at or how long a certain stage will last; (4) product sales volume is often a dependant variable decided by promotion activities (independent variables) and the cause and effect relationship is hard to judge.

Moreover, since the vehicle model of the respondent is properly classified by the researcher based on the four common PLC patterns raised by Swan and Rink (1979), the result is restricted within these four patterns. Even if the model does not demonstrate a clear PLC pattern, it will still be classified into the most similar category. Therefore, the analytical result of this research might be influenced by the subjective elements and over-simplification of the PLC pattern classification.

### 5.4 Suggestion for further studies

As stated in the research restrictions, there are many factors that would influence product life-cycle; for the hypotheses in this research that were not be able to be supported by empirical evidence, further study is needed to explore the real reason. Future research can collect important factors through factor analysis from the many variables including company strategy, resource, technique, condition or brand. LISREL can be adopted to explore the influence of multiple independent variables on product life-cycle. A more comprehensive conclusion might be derived from these studies.

Future studies can also explore the sequence of consumer preferences and the effect on product life-cycle. This research assumes that there is no sequence in the dimensions of consumer preferences and measures each preference separately in the degree of importance to the consumers. Yet in reality, consumer preferences in product attributes often have their priority and order. Therefore, future study can adopt conjoint analysis to measure the influence of the order of the preference dimensions on product life-cycle in order to provide a richer marketing strategy. With three preference dimension variables, this research categorizes the many different kinds of preferences a consumer has toward automobile product attributes; this research can't thoroughly comprehend the individual effects of each product attribute preference under each preference dimension. Therefore, future study can directly explore the impact of each product attribute preferences on the product life-cycle and pattern, which will help businesses conduct new product development and product positioning strategy. This research collected sample data through convenience sampling, the effective sample size is 627, which is minimal considering the mass automobile consumer group. Therefore, if future studies can expand the number of samples, a more effective generalization could be achieved. In addition, there is great variation in the form and duration of product life-cycle patterns, since this research adopts only four patterns, it can't encompass the variety of automobile life-cycle patterns. Hence, if future study can increase, with appropriate consideration, the category of product life-cycle patterns, the analysis results can be more comprehensive.

Finally, although quantitative empirical analysis can lead to objective conclusions, it's often not easy to understand the real factors behind the empirical results. Therefore, in addition to quantitative analysis, if in-depth interviews can be conducted with consumers and business owners in the relevant industries in future studies, it should be beneficial to creating a deeper understanding of the background factors or practices about the research conclusions in this study.

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