CHAPTER 3 RESEARCH METHODOLOGY

This research uses fundamental analysis and Bass model as tools to study pattern of innovation diffusion.

3.1 Conceptual Framework

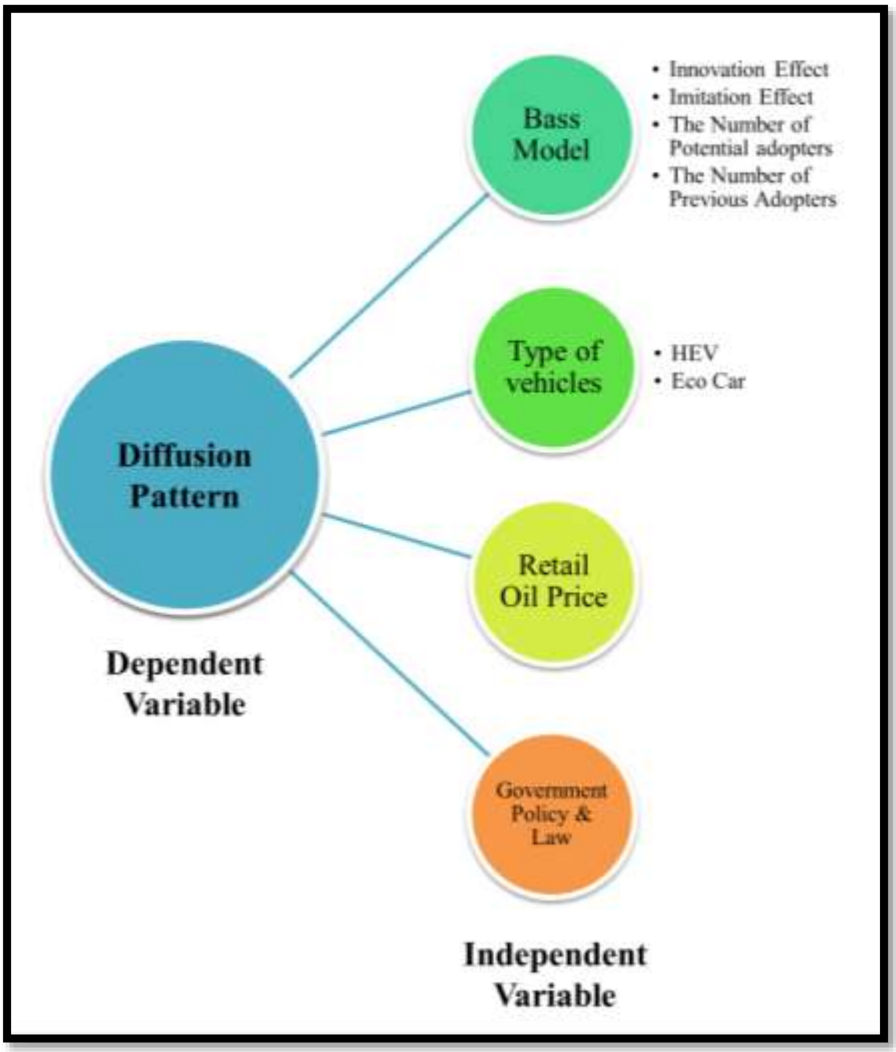

Figure 3.1 Conceptual Framework

From literature review, diffusion of innovation is depended on 4 factors.

1) The number of sales in each quarter which is function of innovation effect, imitation effect, the number of potential adopters and the number of previous adopters
2) Type of vehicles
3) Retail oil prices
4) Government policy and related law

3.2 Data

3.2.1 HEV

This research uses new registered vehicle data at the state-quarter level obtained mainly from Transport Statistics Sub-Division, Planning Division, and Department of Land Transport as a proxy of sales to analyze by statistical analysis method as well as estimate a diffusion model. The data covered the period January, 2007 – December, 2012. The main data used in this study are shown in the Appendix C.

3.2.2 Eco Car

This research uses annually new registered vehicle data classified by Brand and engine capacity from Transport Statistics Sub-Division, Planning Division, and Department of Land Transport as a proxy of sales to be analyzed by statistical analysis method and estimated a diffusion model. The data covered the period April 2011 – March 2013. The main data used in this study are shown in the Appendix D.

3.3 Data Analysis

In this research, data were analyzed by Microsoft Excel 2010 and presented into fundamental mathematic formula such as percentage and growth.

3.3.1 Percentage

$$P = \frac{n}{N} \times 100$$

Meaning of the symbols

P = Percentage of n relative to N
n = The number of subset (Part)
N = The number of full set (Whole)

3.3.2 Percent Change

$$\triangle P = \frac{N(t) - N(t-1)}{N(t-1)} \times 100$$

Meaning of the symbols

$\triangle$P = Percentage change
N(t) = Value of N at period t
N(t-1) = Value of N at period t-1

3.4 Bass Model

From the aforementioned concept of Bass model in chapter 2, the equation must be altered into proper form to be used for solving its parameter.

$$L(t) = \frac{f(t)}{[1 - F(t)]} \quad \text{-- (1)}$$

$$L(t) = p + \left(\frac{q}{m}\right)N(t) \quad \text{-- (2)}$$

Equating (1) and (2) :

$$\frac{f(t)}{[1-F(t)]} = p + (\frac{q}{m})N(t) \qquad \text{-- (3)}$$

Rearrange the equation

$$f(t) = \{p + (\frac{q}{m})N(t)\}[1 - F(t)] \qquad \text{-- (4)}$$

Defining the number of adopters at particular time t as n(t) (f(t) = n(t)/m) and total number of adopters up to time t as N(t) : (F(t) = N(t)/m)

$$n(t) = p(m - N(t)) + (\frac{q}{m})\, N(t)\, (m - N(t)) \qquad \text{-- (5)}$$

Both terms reflect type of diffusion (Innovator/Imitator) in their meaning as follows.

- "*p(m-N(t))*" represents adopters who are not influenced by the number of people who have already bought the product in the timing of their adoption
- "$(\frac{q}{m})N(t)(m\text{-}N(t))$" represents adopters who are influenced by the number of previous buyers. (Mahajan et al., 1993)

Rearrange equation (5)

$$n(t) = pm + (q - p)N(t) - (\frac{q}{m})\, N^2(t) \qquad \text{-- (6)}$$

Define $\alpha 1$, $\alpha 2$, $\alpha 3$ as following

$\alpha_1 = pm$

$\alpha_2 = q - p$

$\alpha_3 = -\frac{q}{m}$

The equation (6) changes its form into

$$n(t) = \alpha_1 + \alpha_2\, N(t) + \alpha_3\, N^2(t) \qquad \text{-- (7)}$$

3.5 Quadratic Formula

Obtaining coefficient by using regression technique, it is able to find *p, q* and *m* by using the quadratic formula.

Substitute p and q in the equation (8) with $\alpha 1$ and $\alpha 3$

$$\alpha_2 = -(\alpha_3\, m) - (\frac{\alpha 1}{m}) \qquad \text{-- (8)}$$

Multiply both side by m

$$\alpha_2\, m = -(\alpha_3\, m^2) - \alpha_1 \qquad \text{-- (9)}$$

Rearrange the equation (8)

$$\alpha_3\, m^2 + \alpha_2\, m + \alpha_1 = 0 \qquad \text{-- (10)}$$

Considering equation in a standard form $ax^2 + bx + c = 0$ with real or complex coefficient, there will be two solutions (roots) which may or may not be distinct as well as may or may not be real number.

$$ax^2 + bx + c = a\left(x - \frac{-b+\sqrt{b^2-4ac}}{2a}\right)\left(x - \frac{-b-\sqrt{b^2-4ac}}{2a}\right)$$

$$0 = a\left(x - \frac{-b+\sqrt{b^2-4ac}}{2a}\right)\left(x - \frac{-b-\sqrt{b^2-4ac}}{2a}\right)$$

$$0 = \left(x - \frac{-b+\sqrt{b^2-4ac}}{2a}\right)\left(x - \frac{-b-\sqrt{b^2-4ac}}{2a}\right)$$

Thus, the roots are able to written in the form like this.

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Using aforementioned quadratic equation, coefficients of Bass model such as p, q and m can be solved as follows.

Find *m* in term of $\alpha 1$, $\alpha 2$ and $\alpha 3$

$$m = \frac{-(\alpha 2) \pm \sqrt{(\alpha 2)^2 - 4(\alpha 1)(\alpha 3)}}{2(\alpha 3)} \qquad \textbf{-- (11)}$$

Substitute *m* by $-\frac{q}{\alpha 3}$

$$-\frac{q}{\alpha 3} = \frac{-(\alpha 2) \pm \sqrt{(\alpha 2)^2 - 4(\alpha 1)(\alpha 3)}}{2(\alpha 3)} \qquad \text{-- (12)}$$

Find *q* in term of $\alpha 1$, $\alpha 2$ and $\alpha 3$

$$q = \frac{(\alpha 2) \pm \sqrt{(\alpha 2)^2 - 4(\alpha 1)(\alpha 3)}}{2} \qquad \textbf{-- (13)}$$

Substitute *q* by $\alpha_2 + p$

$$\alpha_2 + p = \frac{(\alpha 2) \pm \sqrt{(\alpha 2)^2 - 4(\alpha 1)(\alpha 3)}}{2} \qquad \text{-- (14)}$$

Find *p* in term of $\alpha 1$, $\alpha 2$ and $\alpha 3$

$$p = \frac{(\alpha 2) \pm \sqrt{(\alpha 2)^2 - 4(\alpha 1)(\alpha 3)}}{2} - \alpha_2 \qquad \text{-- (15)}$$

$$p = \frac{(\alpha 2) \pm \sqrt{(\alpha 2)^2 - 4(\alpha 1)(\alpha 3)}}{2} - \frac{2(\alpha 2)}{2} \qquad \text{-- (16)}$$

$$p = \frac{-(\alpha 2) \pm \sqrt{(\alpha 2)^2 - 4(\alpha 1)(\alpha 3)}}{2} \qquad \textbf{-- (17)}$$