CHAPTER III

METHODOLOGY

This chapter was organized into 3 sections. The first section gave detail of all variables and their measurement used in this study. Data sources and data collection including all data sources used in this study, collected data fields and involved processes were described in the second section. The third section outlined data analysis.

3.1 Variables and Measurement

3.1.1 Price Discrimination was the focal dependent variable in this study. It was theoretically categorized into 3 types as mentioned in chapter 2. However, the limitation of data format did not allow quantification of the theoretical-defined second degree price discrimination. This study then characterized and quantified only the first and the third degree price discrimination. Their operationalizations and measurements were portrayed as following.

- **First Degree Price Discrimination**

Operationalization: The first degree price discrimination was operationalized in this study as price discrimination of a particular product among hospitals under the same level of care. For example, price discrimination of the Brand A drug among primary hospitals was defined as first degree price discrimination. The first degree price discrimination of the same drug was calculated for all level of care where applicable. If there were enough data records, first degree price discrimination of a particular branded drug should be quantified for every level of care, i.e., primary, secondary, and tertiary hospitals.

Measurement: Gini-coefficient and Theil index were chosen to assess the extent of this price discrimination type. The former is the famous and widely used inequality measurement in various settings (Xu, 2004), but sensitive to the middle part of distribution. The latter, Theil index, was

additionally employed, since the entropy class index that it was belonged to had been sensitive to the extreme value of distribution (Jenkins & Jantti, 2005). By applying both measurements according to equations (1) and (2), this study could capture price discrimination or unusual pricing inequality happened anywhere along the studied price ranges. The first degree price discrimination was calculated for each particular branded product, the unit of analysis was thus using each hospital purchased price and quantity.

Gini coefficient is computed by the following working formula

$$G = \left| 1 - \sum_{i=1}^{N} (\sigma P_{i-1} + \sigma P_i)(\sigma Q_{i+1} - \sigma Q_i) \right| \quad \text{................................ (1)}$$

Where   N   = the number of observations

σP_i = cumulative proportion of price/unit

σQ_i = cumulative proportion of quantity

G ranges from 0 to 1. The closer the index to 1 means the bigger extent of inequality or price discrimination.

Theil index working formula

$$T = \ln\left[\frac{\sum_{i=1}^{n} Q_i}{\sum_{i=1}^{n} P_i}\right] + \left[\frac{\sum_{i=1}^{n}(P_i \times \ln(P_i / Q_i))}{\sum_{i=1}^{n} P_i}\right] \quad \text{............................ (2)}$$

Where P_i = price hospital i purchased the product

Q_i = quantities hospital i purchased

Theil index ranges from 0 to ∞, the higher the index the bigger extent of first degree price discrimination. Numerically, it seems like Theil index contains a wider range of scale than Gini. However, the natural logarithm scale of Theil index designates the unequal interval of its scale with the larger interval toward the lower end; the large extent of inequality or price discrimination could therefore be determined by a modest figure of Theil. In

general, the inequality of the same set of data could be reflected by the comparatively similar range of number on Gini and Theil scales.

The study has decided that the first degree price discrimination should be on the alert when Gini or Theil index was greater than 0.5 (Haidich & Ioannidis, 2004).

- **Third Degree Price Discrimination**

Operationalization: The third degree price discrimination was operationalized in this study as price discrimination across the comparative markets. There were 3 comparative markets in this study according to level of care. Those are primary hospital, secondary hospital, and tertiary hospital markets. While the first degree price discrimination reflected within the market inequality, the third degree suggested discrimination between the studied markets.

Measurement: The inequality between markets was estimated using the same measurements as the first degree, Gini-coefficient and Theil index. The unit of analysis was this time shifted from each hospital for the first degree to each level of care for the third degree price discrimination. The same calculations, equations (3) and (4), were then applied. The weight average price and total quantity of the particular product purchased by all hospitals under each level of care were used for each level of care. Since there were only 3 markets, the third degree price discrimination of a product could be estimated only when this product was purchased by all 3 levels of care.

$$G_b = \left| 1 - \sum_{j=1}^{k} (\sigma WAP_{j-1} + \sigma WAP_j)(\sigma Q_{j+1} - \sigma Q_j) \right| \qquad \text{...........................(3)}$$

Where G_b = Gini coefficient indicating inequality between markets

σWAP = Cumulative proportion of weight average price in a market

σQ = Cumulative proportion of quantities purchased in a market

$$T_b = \ln\left[\frac{\sum\limits_{j=1}^{k} Q_j}{\sum\limits_{j=1}^{k} WAP_j}\right] + \left[\frac{\sum\limits_{j=1}^{k}\left[WAP_j \times \ln(WAP_j / Q_j)\right]}{\sum\limits_{j=1}^{k} WAP_j}\right] \quad \dots\dots\dots\dots\dots (4)$$

Where T_b = Theil index indicating inequality between markets

                 WAP_j = Weight average price of market j

                 Q_j = Quantities purchased by market j

The extent of third degree price discrimination was identified by magnitudes of Gini-coefficient and Theil index between markets (G_b, T_b). The same standard as the first degree price discrimination had been applied to the third degree price discrimination, i.e., the extent of third degree price discrimination was critical when G_b and T_b was bigger than 0.5.

To get the whole picture of price discrimination and at the same time to weight the concern between the first and the third degree price discrimination, decomposition analysis had been conducted. From the relationship, inequality between markets (I_b) + inequality within market (I_w) = total inequality (I), percent contribution of each type of price discrimination to overall discrimination could be decomposition analyzed with level of care as a partition variable. The result would indicate that x % of total discrimination was contributed by the third degree, and (100-x) % was accounted for by the first degree. Higher percent contribution within the market would raise the concern that the particular product selectively discriminated within the markets and vice versa if higher percent contribution between the markets was found.

Since there were 3 within market inequality estimates for each particular product going into the decomposition analysis, these within market inequalities had to be transformed into one estimate using the following formula, equation (5), for both Gini-coefficient and Theil index.

$$I_w = \sum_{j=1}^{k} \left(\frac{N_j}{\sum_{j=1}^{k} N_j} \right) \times I_j \qquad \dots (5)$$

Where I_w = Index indicating inequality within the markets

N_j = Number of hospital in market j

I_j = Index indicating inequality within market j

3.1.2 Potential Factors to Be Explored

To answer which factors explained the price discrimination or Gini-coefficient, each product was analyzed as a unit of analysis. Most of potential factors included in this study were market-structure variables. These variables depicted market conditions of the pharmaceutical market which were hypothesized to explain the price discrimination or Gini-coefficient of the market. In addition, some variables, specific to drug market context, were also examined. The operationalization and measurement of each variable were described as following.

- **Intensity of Competition Variables** were represented by 2 variables, number of competitors and market concentration.

Number of competitors was operationalized as number of available brands which belonged to the same item (identical generic name, strength, dosage form, package size) in a particular market. It was measured by simple counting number of available brands which belonged to the same item in each market.

Market concentration was operationalized as average market size per brand belonging to the same item sold in a particular market. The Herfindahl index, the total market volume in baht divided by number of competitors in a particular market of an identical item, was employed as market concentration indicator.

- **Market Share** was the market size of a particular brand compared with the others of the identical item. It was a continuous measure calculated by percentage of a particular product purchased value in baht divided by total purchased value of all brands in a particular market with the same generic, strength, and dosage form.

- **Popularity** was another market size indicator determined using number of the product buyers instead of purchased value. The same calculation as market share was applied. Popularity was then estimated in percentage of the number of product buyers divided by the number of the same generic buyers.

- **Market Power** was power to reside in the market by charging a higher price over other products which belonged to the same item. When cost indifference was assumed, the more expensive products hold bigger market power than the cheaper substitutable products. It could be assessed by the proportion of a particular product price above the lowest price of substitutable product.

- **Pharmaceutical Supplier Type** was the type of the manufacturer categorized according to owner nationality. There are 3 attributes of firm type: foreign R&D based firm, foreign generic, and local generic.

- **Essential Drug List Status** indicated whether each particular item was listed in Thai National Essential Drug List. It could be categorized into 2 groups; listed item (ED) or not on the list item (Non-ED).

All of variables together with their measurements, attributes and essential data(s) for a variable derivation were summarized in the table 3.1 below.

Table 3.1   Variables summary

Variables	Measurment	Attributes	Data Fields Needed
Price discrimination - First degree - Third degree	Gini coeffincient Theil index Gini between(G_b) Theilbetween(T_b)	Range from 0->1 Range from 0->∞	Generic name Brand name/Firm name Purchased price Quantity bought Hospital type
Potential factors to be explored			
Number of Competitors	Number of brands belong to an identical item in each market	Discrete number of competitors	Generic name Brand name/Firm's name
Market Concentration	Product's market size(฿) / number of competitors in particular market	Continuous number	Quantity bought Purchased price Generic name Brand name/Firm name
Market share	% product's market size(฿)/ total market size(฿)of an identical item in particular market	Percentage	Quantity bought Purchased price Generic name Brand name/Firm name Hospital Type
Popularity	% number of product buyers / total buyers of the identical item in a particular market	Percentage	Generic name Brand name/Firm name Hospital Type Hospital name
Market power	Proportion of product price / the lowest price of substitutable product	Continuous number	Quantity bought Purchased price Generic name Brand name/Firm name Hospital Type
Supplier types	Categorize according to owner's nationality	- Foreign-R&D - Foreign-generic - Local-generic	Firm's name of the particular product
ED status	Categorize by whether the particular generic name was included in ED or not	- ED drug - Non-ED drug	Generic name Strength Dosage form

3.2 Data Sources and Data Collection

3.2.1 Data Source

DMSIC (Drug and Medical Supply Information Center) was the crucial source of data in this study. It is a bureau under Ministry of Public Health (MOPH) compiling a national database of quantities and prices of drugs purchased by all public hospitals under the administration of MOPH. The

study has received a permission to use 2003 data of purchased quantities and prices of the selected drugs.

3.2.2 Data Collection

The study data set was defined as a main theme to track out the data from the main database. The defined data set for this study was detailed in table 3.2.

Table 3.2   Defined data set for collecting data

Data fields	Description
Hospital name	Name of hospital
Province	Province that hospital is located
Level of care	Level of care that the hospital provide; tertiary, secondary or primary care
Number of beds	Total beds that hospital has
Generic name of drug	The name of active ingredient of purchased product
Strength	Active ingredient's concentration in purchased product.
Data fields	Description
Package size	Number of smallest unit/each purchased unit of the product
Manufacturer	Manufacturer name producing the product.
Brand name	The specific name of the product
Purchased quantity	Number of the smallest unit of the product that was purchased.
Price/package size	Purchased price per package size
Price/smallest unit	Package price divided by package size

3.3 Data Analysis

3.3.1 Data Preparation

The raw data was received in the format reported by hospitals. The number of records of a hospital represented the number of times the hospital reported to DMSIC. If a hospital reported twice a year, then there were 2 records of purchase for this hospital. The study primarily prepared the data by aggregating a number of records of an identical product purchased by the same hospital so that each hospital had one record of annual purchase for a

particular item. The unit of analysis was thus each product purchased by each hospital.

- **Inclusion Criteria**

Purchasing a product, the hospital could be done by either self purchasing or group purchasing which might result in price differentiation. In order to control price differentiation caused from different purchasing methods, this study thus included only self purchasing records to the analysis.

- **Exclusion Criteria**

1. A drug item with only one reported record and if the particular record represented very small purchasing size, it was hypothesized that it could be an incomplete report by the hospital. One raw record meant one hospital report of a particular product purchasing data. In a year, a particular product purchasing data might be reported many times by some hospitals, while some might reported only one time. Since the purchasing size per year of hospital was very important data in analysis, the one reported observation with doubted small purchasing size than generally found in other hospitals was then excluded from analysis.

2. Observations of the same product were secondly classified by hospital type (level of care). Within a particular hospital type, the product bought by less than 4 buyers was also excluded. Using less than 4 points of data to quantify the extent of price discrimination within the market by inequality index was less reliable.

3.3.2 Quantify the extent of price discrimination

There were 2 types of price discrimination quantified in this study. In addition, for informative explanation of market pricing behavior, the analysis was done in 2 levels of aggregation. Those were brand and generic levels of aggregation.

- **Brand Level of aggregation**

First degree price discrimination

Because claiming for discrimination needed to ensure cost indifference, the analysis had to be done separately brand by brand in each market (level of care). In quantifying price dispersion among buyers of the identical brand, production cost indifference was the prerequisite and needed to be established. The marketing cost of the same brand was reasonably assumed indifference among buyers in the same level of care.

Gini-coefficient and Theil index were calculated for quantifying the extent of first degree price discrimination of each brand for each level of care. The greater than 0.5 of Gini or Theil indicated the existence of first degree price discrimination of a brand in a particular market.

Third degree price discrimination

The analysis was still strictly done brand by brand for ensuring production cost indifference. First order stochastic approach was employed to preliminary compare price among comparative markets. Plotting of price/unit on y-axis against cumulative proportion of quantities on x-axis was facilitated comparison of ceiling price dealt with majority of purchased quantities in each market. For example, 80% of purchased quantities in primary hospital market were bought at lower than x baht.

Decomposition analysis was consequently done after first degree price discrimination in each market. The index reflecting first degree price discrimination were plug in the equation (5) to calculate I_w. Purchased quantities of hospitals in each market were summed up, while prices were weighted averaged to be a market price (WAP). Overall purchased quantities and WAP were put in equation (3), (4) to calculate index between markets. Third degree price discrimination was indicated when I_b greater than 0.5.

Percent contribution of I_w and I_b from decomposition analysis was used to indicate which type of price discrimination had made more contribution to overall discrimination a particular brand.

- **Generic level of aggregation**

All brands which belonged to the same item (identical generic name, strength, dosage form, and package size) were brought up together in first order stochastic approach. Pricing behavior among brands was basically described.

Decomposition analysis was once more employed, but brands of the same item were used as a partition instead to the market. I_w was the magnitude of first degree price discrimination within brands in a particular market. I_b determined the extent price dispersion among brands. I_b in this level of aggregation was not able to claim for discrimination because of cost difference among brands. However, it could be an indicator of price competition among brands under the same generic item.

3.3.3 Multiple Regression Analysis

Multiple regression analysis was employed to examine the influence of potential factors on the extent of price discrimination. The Gini-coefficient was the dependent variable while variables in table 3.1 as well as level of care were independent variables.