HOW DOES THE AVAILABILITY OF GENERIC DRUG AFFECT THE PRICE OF ESSENTIAL MEDICINE IN THAILAND DURING YEAR 2014-2015

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ABSTRACT

The purpose of this thematic paper thematic paper is to investigate the relationship between the availability of generic drugs and the price of essential medicine in Thailand during year 2014-2015. To that end, the author constructed two separate datasets which draw on year 2014 and 2015 cross sectional data retrieved from the Thai ministry of health and Government Pharmaceutical Organization (GPO) and estimated multiple and log-level regression models designed to test for a statistically significant decrease in the average price of essential medicine for every positive change in the number of generic drugs or substitutions. The two datasets consisted of five variables which include; price of medicine, patent status, brands, number of generic drugs or substitutes and quantity of sales. The findings revealed that the price level of the essential medicines were negatively related to the number of generic drugs or substitutions available. On top of that, it was also shown that patent, brand and quantity of sales all have different but meaningful implications on the average price of essential medicines in Thailand.

KEY WORDS: Generic drugs/ Essential medicine/ Price of medicine/ Substitutions/ Thailand

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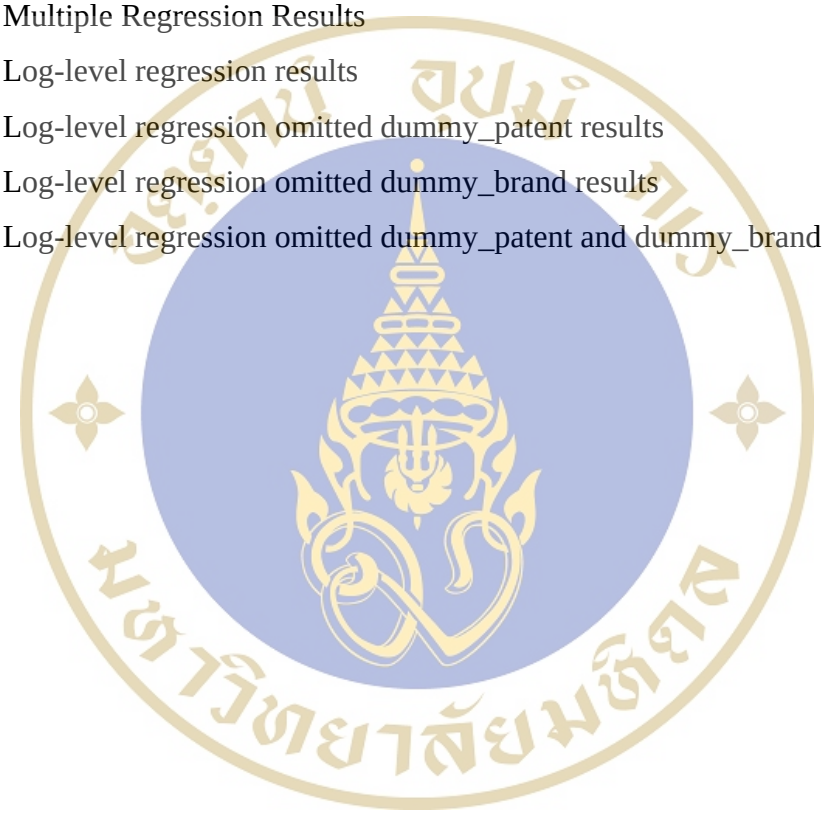

CHAPTER I
INTRODUCTION

As a member state of the Word Trade Organization (WTO), Thailand has an obligation to follow Trade-Related Aspects of Intellectual Property Rights or TRIPS agreement, which is an international agreement administered by WTO, (Supakankunti et al. 2001). Under the agreement, Thailand is required to provide strong protection for intellectual property rights, particularly the amendment of patent law. This certainly effect Thai pharmaceutical industry as a whole, which Thailand had long been excluded from patent law, specifically in the area of generic drug. The impact of TRIPS agreement on Thailand has not been limited to pharmaceutical industry only, but it also carries over to the area of public health. Hauray & Urfalino (2009), as the availability of generic drug becomes limited, original producers have gained more bargaining power and control of the market. In other words, Thailand has to rely more on imported drugs, which are being priced significantly higher than the locally produced one.

Ever since TRIPS agreement went into effect, the average price of medicine in Thailand, especially those for life threatening diseases such as cardiovascular, cancer, HIV/AIDS, etc., has risen resulting in a poorer health standard for Thai people. Basically, the agreement prohibit all Thai pharmaceutical producers from attempting to develop or formulate a drug that is identical to the patented medicine and distribute them at a lower price. In effects, multinational pharmaceutical companies, who hold a patent for any given drugs, automatically compete in Thai market as a monopoly throughout the patent life. Krugman & Wells (2012), as a monopoly, original producers have become a price maker, thus charging the price above their average total cost and supplying the medicine at profit maximizing quantity. Consequently, the price of essential medicine in Thailand has continued to rise over the years making it more difficult for people to access.

Although, under the agreement, local producers are allowed to develop the generic medicine and distribute them once the patent has already been expired, the development and commercialization of such drug is not as simple. In practice, Thai producers must go through series of regulation and lengthy registration process, which can take up to five years to complete, mandated by Thai authority before they could obtain the trading license for a generic drug. Therefore, often times, the expiration of patent does not cause the monopolist to lose all its market power because of the lack of substitution.

In response to worsen healthcare situation, the government of Thailand has come up with free healthcare scheme in an attempt to provide Thai people a better access to medication and reduce the bargaining power of the original producer. Unfortunately, due to the flaw design of the scheme, it has failed to satisfy the ultimate goal on both fronts. Because of the insufficient budget allocation, the scheme barely offer a medicine that is a direct remedy for the diseases. Original and patented medicine are mostly being omitted from the scheme because of the high market price. Furthermore, due to the tough regulation imposed on Thai pharmaceutical companies, insufficient amount of high quality generic medicine are being produced over the years. The limited availability of generic drug caused the government no option but to opt for obsolete drugs, which has a high resistance and treatment failure rate, as a treatment for some diseases. In other words, the government has underestimated the impact of the availability of generic drug on Thai healthcare in general. As a consequence, not only does the shortage of high quality generic drug causing the flop of the free healthcare scheme but it also allowing the original producer to continue dominating the market and charging the price according to its will.

In consequence to the lack of effectiveness of the healthcare scheme, Thai government in recent years has issued several compulsory licenses allowing Government Pharmaceutical Organization to produce generic copies of some of the essential medicine. Hauray & Urfalino (2009), according to WTO, compulsory licensing can be defined as an act when a government allows someone else to produce the patented product or process without the consent of the patent owner. It is considered to be one of the flexibilities on patent protection included in the WTO's agreement on intellectual property. However, under compulsory license, medicines shall only be produced for domestic uses, not for

export. In addition to the usage, the provision of generic drug under compulsory license is limited to a certain amount for each license.

Thus far, the most notable compulsory license issued by the Thai government is for Merck's HIV/AIDS drug Efavirenz, in an attempt to cut growing healthcare costs by encouraging the production and import of generic versions of the patented medicine. The granting of the license has been seen as a success according to many public health advocates. Thailand is able to provide Efavirenz, a 'second-generation' antiretroviral drug at one of the lowest prices available in the world. Furthermore, due to this success, Merck, the patented holder for Efavirenz has been in negotiations with Thai government to either seek voluntary license or offer the drug at a lower price.

Despite the success of compulsory license for HIV/AIDS drug, Thailand has been facing with a difficulty in expanding this policy to other essential drugs that are expensive and in short supply. The case for Merck's HIV/AIDS drug Efavirenz is rare. Not only does the Thai government allows a longer duration for compulsory license but also the fact that it opens the door to competitive imports of generics from India. Roder, Heinrich, Gehrig, & Mikus, (2007), according to published reports, the drug is not patented in India, thus the Indian government has no problem exporting the drug. Both of these factors have contributed to a tremendous downward pressure on the drug price.

Using compulsory licensing of Efavirenz as a reference case, Thailand has been trying to duplicate and expand this success to as many essential medicines as possible. More specifically, the Thai government has been given the Government Pharmaceutical Organization a longer compulsory license duration to facilitate the development, production and provision of locally made generic drugs. Additionally, Thailand has been seeking a trade partner to import generic copies of essential medicines. Despite the success in extending compulsory license life, Thailand has been facing with a severe difficulty in finding a trade partner for generic drugs which drastically hampered its ability to duplicate the success. Roder, Heinrich, Gehrig, & Mikus, (2007), other than Efavirenz, more than 80 percent of other essential drug produced abroad are subjected to compulsory license, hence the import of such generics to the country is not possible. Without the availability of generic drugs, the downward pressure put forth on the drug price is dramatically less

significant, as a consequence, the price of medicine, especially essential medicines, in Thailand still sit on a level that is inaccessible for the public.

1.1 Problem Statement

Public health issue in Thailand has been put on a national agenda ever since the amendment of Trade-Related Aspects of Intellectual Property Rights or TRIPS agreement. There is no denying that the provision of copyright protection has created a positive investment atmosphere for the research and development of new medication. On the surface, the agreement seems to benefit the entire humanity as more cure for life threatening diseases has been discovered and made available (Musungu, & Cecilia, 2005). However, these drugs are almost always being price expensively thus making them virtually inaccessible for the general Thai people.

In addition to patent law, Thailand's own tough regulation on local pharmaceutical manufacturer has contribute to worsen healthcare problem as it caused a shortage of high quality generic drug, which can be used as a substitute to original drug. In other words, the government has underestimated the importance of generic drug to the price of medicine; especially for those of the non-patented medicine. According to the report from Thai ministry of health, on average there are less than 5 generics available for each non-patented medicine currently being sold in Thailand. As for some patented essential medicine such as Merck's HIV/AIDS drug Efavirenz, Thailand has been able to bring the drug price down by the issuance of compulsory license and imports of generics. Reichman, (2009) obviously, compulsory license increased downward pressure on drug prices; however, there were also strong evidence for the case of generics copies. Evidently, researcher has found that there are some correlation between the availability of generic medicine and the price of medicine; however, the sample size is too small to conclude that it would have as strong of an effect on the average price of all essential medicine. The case for Merck's HIV/AIDS drug Efavirenz should serve as a guideline for future government policy related to public health, particularly on compulsory license as well as generic drug.

To make a clear statement, this research intends to investigate the relationship between the availability of generic drug and the price of medicine in Thailand using

simple OLS regression as a tool. The conceptual framework behind this research the availability of substitute, which is one of the application from Microeconomic theory. Krugman & Wells (2012) generally, the market price for a particular product or service should fall if more substitutes or alternatives are available for that particular product or service.

1.2 Research Objectives

This research aims to apply a simple concept of the availability of substitute from Microeconomics theory to deteriorating healthcare problem in Thailand with the two main objectives.

1. To examine the relationship between the availability of generic drug and price of essential medicine in Thailand during year 2014-2015.
2. To study the determinant variables (patent, brand and quantity of sales) of essential medicine price in Thailand during year 2014-2015.

1.3 Research Question

"How does the availability of generic drugs affect the price of essential medicine in Thailand during year 2014-2015?" In order to complete the research, there are sub questions required as shown the following part.

1. How does a change in a number of generic drugs or substitutes available affect the average price of essential medicine in Thailand in year 2014?
2. How does a change in a number of generic drugs or substitutes available affect the average price of essential medicine in Thailand in year 2015?
3. What are the key differences or similarities between the results from sub question 1 and 2?

CHAPTER II
LITERATURE REVIEW

This chapter presents a review of literature pertaining to the key areas of the research. It starts off by shedding lights on the background of TRIPS agreement and how it's been impacting the price of medicine through patent law. Later, the concept of compulsory license and the use of generic drugs as a mean to cope with rising cost of medication from previous studies are being introduced and reviewed. Also, an emphasis has been put on the concept of the availability of substitute, which is a conceptual framework for this study and one of the application from Microeconomic theory. Furthermore, the studies of brand-name drug and its influence on price after the expiration of patent is reviewed. Lastly, this chapter touches on how quantity of sales influence the price of medicine under the elasticity demand theory.

2.1 Patent

Limited access to essential pharmaceuticals is a serious issue confronting developing countries ever since the ratification of the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) by the World Trade Organization (WTO). Wainright & Amaral (2005) a large chunk of populations have been affected by the increased in drug price caused by the agreement agreed upon during the Uruguay Round relating to the "patentability" of pharmaceutical products. Undeniably, patent creates incentives for both revolutionary and evolutionary innovations allowing mankind to take a leap forward into the future; however, it is imperative to recognize that such protection contains a cost represented by the possible abusive of monopoly power. According to La Croix & Kawaura (2000), under patent protection, local pharmaceutical producers are prohibited from producing and distributing a generic copy of the patented drug, thus originator pharmaceutical firms effectively become a monopoly with the ability to control the price of the medicine.

Recent study on Post TRIPS options for access to patented medicine in developing country by Scherer & Watal (2002) has concluded that on average most of the patented medicines have been sold for more than double the price of their generics counterpart, as a result, the right to health was seriously affected since various social groups could not have access to the medicine they need. This result was in consistent with Economics theory on Monopoly. According to Mankiw (2011), during the life of patent, the monopoly firm maximizes profit by producing the quantity at which marginal revenue equals marginal cost and charging the price well above the marginal cost. In other words, the granting of patent rights motivates monopolistic pricing. Rose (2003), both social and consumer welfare are expected to be reduces drastically from the ratification of the TRIPS agreement as patent holders are expected to engage in profit increasing move, where they cut output and raise price. Her idea was seemingly supported by previous research on Product Patent Reform and its Impact on Korea's Pharmaceutical by La Croix & Kawaura (2000). Post product patent reform, the amendment of patent law along with Korean pharmaceutical producer incapability to produce internationally marketable drugs have fueled originator firm to raise the price of medicine in Korea resulting in a loss of wealth in the pharmaceutical industry as well as worsen public health standard (La Croix & Kawaura, 2000).

2.2 Compulsory License and Generic Drugs

Carsten, (2001) post TRIPS, in order to improve customer access to medication, government across developing world have imposed price control on patent medicine sold by major pharmaceutical companies. However, according to several researchers, the measure seems to be ineffective. Bond & Saggi (2012) argued that a major drawback for using pricing control system as a leverage to upgrade consumer access to medication is that originator firms with patented medicines may simply opt not to participate in markets where they find such controls to be too strict.

Due to the ineffectiveness of price control system, many developing countries have turned to compulsory license. Rose (2003) interpreted that one of the possible ways in which the government may increase the affordability and accessibility of essential medicines is through the use of compulsory licensing. Hauray & Urfalino (2009), according

to WTO, compulsory licensing can be defined as an act when a government allows someone else to produce the patented product or process without the consent of the patent owner. Rose (2003) interpretation of compulsory license was supported by recent study on compulsory licensing of pharmaceutical products & access to essential medicines in developing countries by Niesporek (2005). In her study she pointed out that compulsory license promote production and distribution of cheaper generic medicine in developing countries, thus putting downward pressure on originator patent medicine. Other than these two researches, there are couples of notable study on in the field of compulsory licensing and the use of generics drug worth mentioning.

For instance, Lybecker & Fowler (2009), in a rigorous academically research, they examined the impact of recent example of compulsory in Thailand and Canada. For the case of Thailand, they studied the licensing granted by the Thai government for Kaletra, an AIDS to the Government Pharmaceutical Organization (GPO), which is a government owned Thai producer of medicines. Using qualitative research, they found that in order to develop a generic copies of patent medicine; especially lifesaving medicine, a huge research and development funding are required. More importantly, a country must also have a fundamentally and technically sound domestic industry to support the production of such advance medicine. Unfortunately for Thailand, back then, it didn't have adequate capability to produce generic copy of Kaletra that is of the quality standard of the World Health Organization (WHO). More specifically, in 2003, the GPO has received $133 million from Global Fund to Fight HIV/AIDS. The purpose of this grant was to help the GPO improve its plant to meet international quality standards; however, the fund has been withdrew since 2006 after the GPO failed to meet the World Health Organization (WHO) quality standards.

Lybecker & Fowler (2009), although, Thailand's attempt to produce a generic version of Kaletra has met with substantial delayed but the policy serve as an imminent threat to originator producer of patent medicine to lower the prices. As a result, patent holder for Kaletra drug finally comes to terms with the Thai government to reduce the drug price. In addition, the researcher added that aside from the grating of compulsory license for Kaletra, the Thai government also planned to expand its reach to issue compulsory licenses for other essential medicines. The result from the study can clearly be linked with the theory of the availability of substitute. According to Mankiw (2011),

generally, the market price for a particular product or service should fall if more substitutes or alternatives are available for that particular product or service. Despite the clear linkage between the findings and theory, the sample size of the study is too small as the researcher only focused on one particular medicine. Therefore, it is fair to say that the result obtain from this study although meaningful but shouldn't be use to explain the entire industry as it lacks comprehensiveness, hence could cause misinterpretation.

Coriat, Orsi & d'Almeida (2006), by way of contrast, focused on how the production of generic copies of non-patented medicine help the Brazilian government response to HIV/AIDS. They used a situation analysis based on a literature review of relevant research, data and statistical analyses, impact assessments, and surveys to evaluate the impact of such production on the price of HIV/AIDS drug. Their findings showed that in 2001, 56% of all ARVs drugs for HIV/AIDS consumed were produced domestically, resulting in a price reduction of 82% over the period from 1996 to 2001. The substantial reduction in drug price was in consequence to the action took by the Brazilian government to assist local manufacturers in producing 10 low-cost generic versions of the non-patented ARVs for HIV/AIDS comprised within the national therapeutic guidelines. In addition to therapeutic guidelines, the authors believed that the early work exception has also played a vital role in influencing the production of generic drug in Brazil. Oliveira et al. (2004), early working exception can generally be defined as a length of time given to local pharmaceutical manufactures to complete all the procedures necessary to register a generic drug before the original patents expire. Apart from generic versions of the non-patented ARVs for HIV/AIDS, they also find that numbers of generic drugs for other life threatening diseases are also widely available in Brazil. Consequently, they are convincing that the price for other lifesaving medicine in Brazil should follow the similar trend.

The results suggest a significant negative correlation between the price of medicine and the availability of generic drug. Given the fact that the research was conducted on a generic versions of a non-patented drug, the results is more applicable to the countries in the developing world context. Although, undeniably access to patent medicine is subject of interest in today's research in medical field but the access to non-patent medicine is a topic of equally if not more important as non-patent drugs are the main source of medication for people in developing countries. According to Bate

(2007), non-patent medicine on average account for more than 80 percent of the total lifesaving medicine being sold in every developing country; however, there hasn't been as much research devoted to this field. At the end of the day, a conclusion from this research, to the very least, showed that the applicability of the availability of substitute concept is not only limited to patented-drug but also non-patented drug as well. However, similar to the research conducted by Lybecker & Fowler (2009), it's only focused on one particular medicine, thus the result is best serve as a guideline rather than a forgone conclusion on the correlation of generic drugs and the drug prices.

2.3 Brand

Supakankunti et al. (2001), in developing countries, the implementation of the TRIPS agreement is expected to have a long lasting impact on public health; especially the access to medication. In their study on impact of the World Trade Organization TRIPS Agreement on the pharmaceutical industry in Thailand, they predicted that monopolist are likely to maintain their high level of market or bargaining power even after the expiration of patent. Additionally, some consumers might perceive that locally made generic drugs are not of the same quality standard of the brand-name drugs, thus they remain royal to the brand. Effectively, in many cases, the former patent holder or monopolist are able to charge additional price for their products.

Hoen (2003) major pharmaceutical company's ability to charge a high price for its brand-name drug even after the expiration of patent can be partially blamed on the amendment of patent law, which distorted local manufacturing capacity and wealth. His idea was supported by an early research conducted on product patent reform and its impact on Korea's pharmaceutical industry by La Croix & Kawaura (2000). The authors used the data obtained from Korea Stock Exchange (KSE) to construct a pharmaceutical industry portfolio from January 1980 to December 1989; and calculated monthly rate of return for the portfolio. They found that pharmaceuticals stocks and the market were moving in the opposite direction; that is while there was a substantial declined in the weighted index of pharmaceutical stocks, the value of the market portfolio rapidly surged. Evidently, the resultant loss of wealth in the pharmaceutical industry was reflected in the performance of the drug industry stock portfolio. In the research conclusion, La

Croix & Kawaura (2000) concluded that the loss of wealth in Korean pharmaceutical industry has hindered its capacity to produce high quality generic drugs.

2.4 Quantity of sales

Krugman & Wells (2012), in Microeconomics, one of the main determinant of price is quantity of sales. However, in a practical sense the degree of influence that quantity of sales have on the price also depend on the elasticity of demand and supply. According to Mankiw (2014), a good is said to have an elastic demand when the quantity demand responds substantially to changes in price; however, if the quantity demand tiny responds to a change in prices, then a good is said to have inelastic demand. Medicine is considered to be a necessity goods, thus implying an inelastic demand. Necessities tends to have inelastic demand, whereas luxuries have elastic demands (Mankiw, 2011). These economic concepts are supported by recent study on the effect of price on pharmaceutical R&D by Civan & Maloney (2009). Although there is a strong relationship between the price of existing drugs and the number of drugs under development, but there seems to be no correlation with the yearly quantity of sales (Civan & Maloney, 2009).

CHAPTER III
RESEARCH METHODOLOGY

In this research, quantitative methodology is used to collect the data. The data are being retrieved from the Thai ministry of health and Government Pharmaceutical Organization (GPO). Secondary data analysis is chosen over primary data analysis mainly because it can provide larger and higher quality database, which better fits the nature of this study. Furthermore, since this research focuses on how the availability of generic drugs effect the average price of essential medicine in Thailand, researcher first construct an econometric model. Then, a regression analysis is being applied to investigate the correlation between the two variables. Dataset used in this study contains 150 observations of essential medicine, which are all being chosen based on the usage and demand of the Thai people, in Thailand. Therefore, the results from this study can be used to generalize the impact that the availability of generic drugs have on the average price of essential medicine in Thailand.

3.1 Regression Model

$$Y = \beta 0 + \beta 1 Dummy\_Patent + \beta 2 Dummy\_Brand + \beta 3 Generic\ Drug + \beta 4 Quantity + \varepsilon t$$

Where:

Y	=	Price of medicine
Dummy_Patent	=	Dummy variable which has a value of 1 or 0.
If dummy	=	1, patent drug. If dummy = 0, otherwise
Dummy_Brand	=	dummy variable which has a value of 1 or 0.
If dummy	=	1, brand-name drug. If dummy = 0, otherwise
Generic Drug	=	Number of generic drugs or substitution available
Quantity	=	Quantity of Sales
εt	=	Random error term

Hypothesis for each coefficient (β)

1. $\beta 0$: In this regression $\beta 0$ is a parameter for a constant term. The result value of this parameter should always be positive as no commercial product is sold for a negative price.

2. $\beta 1$: In this regression $\beta 1$ is a coefficient of Dummy_Patent. Y (Price of medicine) and Dummy_Patent should have a strong positive correlation. Since the production and distribution of generic copies of a patent medicine is prohibited under the ratification of patent law, patent holder of the medicine automatically compete in Thai market as a monopoly; expect for some rare occasion where the government grants compulsory license to local manufacturer. Effectively, they most of the time use their monopoly power to charge a higher price for their product. As a consequence, the result value for $\beta 1$ should be positive.

3. $\beta 2$: In this regression $\beta 2$ is a coefficient of Dummy_Brand. Y (price of medicine) and Dummy_Brand should have a somewhat strong positive correlation. Generally, omitting the patent status, brand-name drugs is often price higher than their generic version because of the higher research and development cost. After the expiration of patent, manufacture of the brand-name drug is expected to remain a certain degree of market power due to consumer loyalty, perhaps because of fear that generic drug might not be as effective as the brand-name drug. Thus, regardless of patent status, brand-name drug should have a higher price than generic copies. Consequently, the result value for $\beta 2$ should be positive.

4. $\beta 3$: In this regression $\beta 3$ is a coefficient of generic drugs. Y (price of medicine) and the availability of generic drug should have a negative correlation. Referring to the concept of the availability of substitute, the market price for a particular product or service should fall if more close substitutes or alternatives are being made available for that particular product or service. In this case, the availability of generic drugs is an equivalent to close substitute. In theory, a goods with close substitutes tend to have more elastic demand because it is easier for consumers to switch from that particular goods to other. Hence, a small increase in price would cause quantity of medicine to fall by a large amount. Consequently, to maintain total revenue and profit, the price shall be reduced. In the end, the result value for $\beta 3$ is predicted be negative. The assumption

should hold true for all kind of medicine, whether it's patent, non-patent, brand-name or generic drug.

5. $\beta 4$: In this regression $\beta 4$ is a coefficient for quantity of sales. The relationship between quantity of sales and Y (price of medicine) could either be positive or negative. Since medicine is considered to be a necessity goods, which imply an inelastic demand, a change in price shouldn't have much impact on the quantity of sales or vice versa. Although, the theory seem to imply that there is a weak relationship between the two variables but researcher can't assume the value of zero for $\beta 4$. In econometrics, it is impossible to obtain a coefficient value of zero. Therefore, the result value of $\beta 4$ is assumed to be either positive or negative; however, it is fair to also predict that regardless of the sign, coefficient value of quantity of sales should be very close to zero. In addition, although quantity of sales is unlikely to have much weight on the price of medicine, but it is imperative that this regression model must include this variable. According to Krugman & Wells (2012), quantity of sales is one of the main determinant of price.

3.2 Research Design

Since the main focus of this research is to examine the relationship between the availability of generic drugs and the average price of essential medicine, simple OLS regression is used as a tool for research analysis. Regression analysis has been widely used among statisticians, economists and researchers as a process for estimating the relationships among variables. It includes many techniques for modeling and analyzing several variables, when the focus is on the relationship between a dependent variable and one or more independent variables. Specifically, for this research, price of medicine is dependent variable, whereas patent status, brand, number of generic drug available, and quantity of sales are independent variable.

One of the major advantage for using regression analysis or statistical modelling is that the results obtained from the analysis are supported by beta significance and time trend; therefore, the results can be easily explained to the public. Precisely, regression analysis helps one understand how the typical value of the dependent variable changes when any one of the independent variables is varied, while the other independent variables are held fixed. Moreover, all regression analysis software including GRETL,

which is the software used in this study, offer numbers of significant statistic within the package that help prove the legitimacy, reliability and accuracy of the result such as r-squared, adjusted r-squared, heteroscedasticity, log-likelihood, etc. Additionally, there are various kind of techniques which can be applied to multiple regression analysis so as to achieve the most accurate results, such as adding logarithmic function into both side of the equation, or dropping some independent variable.

Specifically, this research took cross sectional regression approach rather than time series regression approach due to limited time and data availability. Undeniably, time-series regression can provide a more comprehensive results comparing to cross sectional regression; that is it can help one understand and predict the behavior of dynamic systems from experimental or observational data. However, according to Greene (2012), in order to build an accurate and reliable multiple time series regression model, at least 20 time period of historical data must be collected. This is impractical because neither public nor private agency in Thailand is able to provide such data. The Thai ministry of health and Government Pharmaceutical Organization (GPO), the two agencies whom keep all data related to medicine available in Thailand, only store them for as far back as 10 years. Therefore, given the mentioned shortfall in data, researcher found that the best way to investigate the relationship between the average price of essential medicine and the availability of generic medicine in Thailand is to separately multiple regression analysis on year 2014 and 2015 cross sectional data, where drug price is a dependent variable, while patent status, brand, number of generic drugs and quantity of sales are an independent variables.

Last but not least, the analysis of year 2014 cross sectional regression is being added into the study to make up for the shortfall in the data collection. The regression results of year 2014 will be compared with the results from year 2015 to determine the differences, similarities and trends of the results. In other words, by adding year 2014 regression model into the finding, the results obtain from this study will become more comprehensive and unbiased.

3.3 Data Collection

This research focuses on how the availability of generic drugs effect the average price of essential medicine in Thailand. In order to examine the relationship, researcher construct two different datasets using year 2014 and 2015 cross sectional data retrieved from the Thai ministry of health and Government Pharmaceutical Organization (GPO). Both datasets are being separated into five parts in accordance to the observatory variables; (1) price of medicine, (2) patent status, (3) brand, (4) number of generic drug available, and (5) quantity of sales. The two government agencies have been serving as a main source of database for almost all research ever conducted in this field in Thailand as they keep all relevant data for all medicine available in the country. Cross sectional data is chosen over a time series data due to limited data availability. Greene (2012), in order to perform an accurate multiple time series regression analysis, at least 20 time period of historical data is required. Unfortunately, despite keeping all data related to medicine, the ministry of health and government pharmaceutical organization (GPO) only store most of them for as far back as 10 years. Consequently, there will be a lot of incompletion samples if time-series approach were to be taken, thus leading to the misinterpretation of the results.

Furthermore, in order to construct two datasets which truly reflect Thai people's usage and demand for essential medicine, researcher set out three specific criteria when creating both datasets. First of all, both data sets used in this study contain 150 observations of essential medicine in Thailand. According to Greene (2012), most statisticians agree that the minimum sample size to get any kind of meaningful result is 100. Hence, by having 150 observations for each dataset, it would cover all meaningful essential medicines used in Thailand. Second of all, all medicine included in both datasets is selected based upon its usage; that is only a treatment for fatally diseases commonly found in Thailand are being included in the dataset such as HIV/AIDS, cancer, cardiovascular, malaria, plague, diabetes, etc. This is done to ensure that the dataset truly reflect essential medicines that are in needed for Thai people. Finally, quantity of sales has also been taken into consideration when selecting a medicine into the two dataset in order to reflect Thai people's demand for essential medicine. Specifically, each medicine for each diseases is ranked based upon the quantity of sales before being included into each of the dataset.

3.4 Data Analysis

Following data collection, all data would be entering into datasets in preparation for analysis. In this study, the analysis is being conducted in GRETL, which is an open source regression software. GRETL is being chosen due to its flexibility, accuracy and credibility as it provides large numbers of significant statistic within the package such as R-squared, heteroscedasticity, log-likelihood, etc. The analysis commences by performing a separate multiple regression analysis on year 2014 and 2015 model, respectively, and compared them side by side. Later, logarithmic function is being applied on dependent variable (price of medicine) for both model. Log-level regression is being incorporated into the analysis so that the interpretation of dependent variable will be in terms of percentage change, which is easier to interpret and explain. In addition, since some predictor/independent variables could be highly correlated, both model will be analyze again using drop technique. This is done mainly to test and collect for multicollinearity which could cause the results to be misinterpreted. Finally, the results from both model will be compared side by side to see how the availability of generic drugs affect the average price of essential medicine in Thailand during year 2014-2015.

CHAPTER IV
RESEARCH FINDINGS

In this research, the author have conducted multiple statistical analyses in order to determine whether the availability of medicine substitutes negatively impact the average price of essential medicines in Thailand. Each of these analyses are variants of multiple regression that derive from year 2014 and 2015 cross sectional price level of essential medicine in Thailand in order to identify any statistically significant decrease in price for every increase in numbers of generic drugs or substitutions.

The initial set of regression analyses are variants of the following regression model that accounts for the influence of variety factors on the average price of essential medicine in Thailand during year 2014-2015:

$$\text{Price of Medince} = \beta 0 + \beta 1\text{Dummy\_Patent} + \beta 2\text{Dummy\_Brand} + \beta 3\text{Generic Drug} + \beta 4\text{Quantity} + \varepsilon t$$

Specifically, dependent variable, price of medicine, is the market price per unit of medicine being sold on Thailand during the studied period. The explanatory variable, Dummy_Patent is a dummy variable captures the patentability of the observed drugs, equals one for patented medicine and zero for non-patented medicine. The explanatory variable, Dummy_Brand equals one for brand-name drug and zero for the generic versions. The explanatory variable, Generic Drug captures the numbers of generic drugs or substitutes available for the observed drugs. Lastly, the explanatory variable, Quantity records the yearly quantity of sales for the observed drugs.

In this chapter, the findings and results of the research are presented in Section 4.1. Precisely, this section is being divided into three sub-sections. First, it begins with the presentation of summary statistics of year 2015 and 2016 datasets (Section 4.1.1). The next section presents the findings and interpretations of the multiple regression analysis (Section 4.1.2). The third section demonstrates the results of log-level regression along

with the testing for multicollinearity (Section 4.1.3). These include the findings and interpretations of the log-level regression analysis (Section 4.1.3.1), and the test for multicollinearity on log-level regression analysis together with its correction and interpretation (Section 4.1.3.2). Finally, the results of the study are discussed and analyzed with the literature presented in Chapter 2 (Section 4.2).

4.1 Findings and Results

4.1.1 Summary statistics

This section provides the summary statistics for both year 2014 and 2015 dataset which are being presented below in table 4.1 and 4.2, respectively. Both tables display mean, minimum, maximum and S.D. for all observed variables.

Table 4.1 Year 2014 Summary Statistics

(n = 150)

	Mean	Minimum	Maximum	S.D.
Price	181.85	0.65	2,790	357.03
Dummy_Patent	0.25	0	1	0.43
Dummy_Brand	0.39	0	1	0.49
Generic drugs	7.72	0	25	7.61
Quantity of sales	337,322	8,000	5,895,000	756,520

Notes: - Dummy_patent and Dummy_brand are dummy variables which has a value of either 1 or 0.

- All prices are recorded in THB, unit is THB/Tablet
- Quantity of sales represents number of tablets sold.

Year 2014 dataset contains 150 medicine samples for the top 15 fatally diseases most commonly found among Thai people in year 2014 which includes (1) Coronary Artery Disease, (2) Stroke, (3) Chronic Obstructive Pulmonary Disease, (4) Lower Respiratory Infections, (5) Trachea, Bronchus, and Lung Cancers, (6) HIV/AIDS, (7) Diarrheal Diseases, (8) Diabetes Mellitus, (9) Preterm Birth Complications, (10)

Tuberculosis (TB), (11) Liver Cancer, (12) Alzheimer's Disease, (13) Chronic Liver Disease, (14) Kidney Disease and (15) Septicemia. In this dataset, 10 medicine samples are being collected for each disease. The average, minimum and maximum price for the medicine is 181.85, 0.65 and 2,790 THB/Tablet, respectively. In addition, this dataset contains 37 patented drugs and 58 brand-name drugs. As for the availability of generic drugs, on average there are 7.72 generics available per each medicine, while the minimum and maximum number of generic drugs or substitute available for each medicine are 0 and 25, respectively. Finally, the average quantity of sales is 337,322 tablets, while the minimum and maximum are 8,000 and 5,895,000 tablets, respectively.

Table 4.2 Year 2015 Summary Statistics

(n = 150)

	Mean	Minimum	Maximum	S.D.
Price	190.46	0.64	2,790	367.56
Dummy_Patent	0.25	0	1	0.44
Dummy_Brand	0.40	0	1	0.50
Generic drugs	7.46	0	26	7.62
Quantity of sales	326,550	8,040	5,891,400	747,120

Notes: - Dummy_patent and Dummy_brand are dummy variables which has a value of either 1 or 0.
- All prices are recorded in THB, unit is THB/Tablet
- Quantity of sales represents number of tablets sold.

Year 2015 dataset contains 150 medicine samples for the top 15 fatally diseases most commonly found among Thai people in year 2015 which includes (1) Coronary Artery Disease, (2) Stroke, (3) Chronic Obstructive Pulmonary Disease, (4) Lower Respiratory Infections, (5) Trachea, Bronchus, and Lung Cancers, (6) HIV/AIDS, (7) Diarrheal Diseases, (8) Diabetes Mellitus, (9) Preterm Birth Complications, (10) Tuberculosis (TB), (11) Liver Cancer, (12) Alzheimer's Disease, (13) Chronic Liver Disease, (14) Kidney Disease and (15) Primary Hypertension Disease. In this dataset, 10 medicine samples are being collected for each disease. The average, minimum and maximum price for the medicine is 190.46, 0.64 and 2,790 THB/Tablet, respectively. In addition, this

dataset contains 38 patented drugs and 60 brand-name drugs. As for the availability of generic drugs, on average there are 7.46 generics available per each medicine, while the minimum and maximum number of generic drugs or substitute available for each medicine are 0 and 26, respectively. Finally, the average quantity of sales is 326,550 tablets, while the minimum and maximum are 8,040 and 5,891,400 tablets, respectively.

4.1.2 Multiple linear regression analysis

The first set of regression results are presented below in table 4.3, and show that the availability of generic drugs negatively effects the average price of essential medicine in Thailand for both year 2014 and 2015. Additionally, this econometric framework also shows that this results holds after controlling for patent, brand and quantity of sales. The adjusted R-squared for both models are roughly 0.48. This suggests that 48 percent of variance in the price of essential of medicine can be explained through variance in patentability status, brand, the availability of generic drug and substitution and quantity of sales. Thus, both models do offer proof for the expected relationships.

Table 4.3 Multiple Regression Results

Independent Variables	Year 2014 Model		Year 2015 Model	
	Coefficient	P-Value	Coefficient	P-Value
Constant	58.7835	0.0004***	55.5501	0.0003***
Dummy_Patent	481.852	1.21e-07***	507.046	1.95e-08***
Dummy_Brand	73.7171	0.0343**	70.2602	0.0262**
Generic drugs	-3.1134	0.0114**	-2.82075	0.0119**
Quantity of sales	-7.71271e-07	0.8399	-1.86205e-06	0.6210
n	150		150	
Adjusted r-squared	0.4770		0.4868	

Notes:- Dependent variable: Price of essential medicines.

- Dummy_patent and Dummy_brand are dummy variables which has a value of either 1 or 0.
- *** indicates significance at a 1 percent level, ** indicates significance at a 5 percent level and * indicates significance at a 10 percent level.

More specifically, the constant term $\beta 0$ = 58.7835 and 55.5501 for year 2014 and 2015 model, respectively, are an estimate that the average price of essential medicine being sold in Thailand is equal to 58.7835 Baht per tablet in 2014 and 55.5501 Baht per tablet in 2015, when holding other variables constant. In a plain sight, these numbers might appear to be small; however, it must be stressed that 58.7835 and 55.5501 Baht are the price per tablet not the unit sales. To get the exact price per unit, one must multiple these prices with the number of tablets per unit. For example, if one unit of X medicine contains 10 tablets, then its price in Year 2014 and 2015 was equal to 587.835 and 555.501 baht per unit. Evidently, these results clearly reflect the high cost of medication in Thailand. Additionally, the constant term $\beta 0$ has the expected positive sign and the standard error for these models are statistically significant at 99 percent confidence level. Hence, these outcomes allow the acceptance of $\beta 0$ hypothesis.

Moreover, the coefficient $\beta 1$ = 481.852 and 507.046 on $Dummy\_Patent$ for year 2014 and 2015 model, respectively, are an estimate that patented drug was being sold for 481.852 and 507.046 Baht more than other kind of drugs in year 2014 and 2015. The standard error of $\beta 1$ for both model indicates that they are statistically significant at 99 percent confidence level. These findings not only confirmed the stated hypothesis but also clearly reflected monopoly practice in Thai pharmaceutical market by the patent holders. In addition, the results clearly indicates a rising trend in price for the patented medicine during year 2014-2015.

Furthermore, the coefficient $\beta 2$ = 73.7171 on $Dummy\_Brand$ for year 2014 model is an estimate that brand-name drug was being sold for 73.7171 Baht more than its generic versions. As for year 2015, it can be interpreted that brand-name drug was being sold for an estimate of 70.2602 Baht more than its counterpart. Comparing the results from both model, it can clearly be seen that brand-name drug despite being less costly in year 2015, they were still on average being priced at a significantly higher price than its generic versions. The standard error of $\beta 2$ for both model indicates that they are statistically significant at 99 percent confidence level. Hence, these outcomes allow the acceptance of $\beta 2$ hypothesis.

As a further matter, the coefficient $\beta 3$ = -3.1134 on *Generic Drug* for year 2014 model is an estimate that for every unit increased in number of generic drug or medicine substitute, the price of that particular medicine would fall by 3.1134 Baht in year 2014. For example, if patent for medicine X has expired, and two local manufacturers have decided to produce the generic versions of X medicine, then it price would fall by 6.2268 Baht per tablet. As for year 2015, the interpretation should follow that of year 2014; however, the impact of the availability of generics drug on the price of essential medicine is a bit lower. Precisely, in 2015, for every unit increased in number of generic drug or medicine substitute, the price of that particular medicine would fall by 2.82075. The lower impact in year 2015 model might be due to the fact that year 2015 dataset consists of more patent and brand name drugs than year 2014 dataset. Both of these variables have strong positive correlation with the price.

Last but not least, the outcomes conclusively showed that for both models, quantity of sales have very little to none impact on the average price of essential medicine. Precisely, the coefficient for $\beta 4$ for both year 2014 and 2015 model have a value of less than 0.0000. This findings is in line with the stated hypothesis that a change in price shouldn't have much impact on the quantity of sales or vice versa.

4.1.3 Log-level regression analysis

Despite having correct sign and statistically significant, both multiple regression models can moderately explain the variance of price of essential medicine through variance of independent variables at approximately 48 percent. Multiple regression models are unable to completely do so because the residuals have a skewed distribution and the spread of the residuals changes systematically with the values of the dependent variable. Therefore, logarithmic function shall be applied to normalize the residuals and linearize the relationship. More importantly, the outcome of logged-level regression analysis can be explained in terms of percentage change, which is more understandable to the public. Precisely, the interpretation of the model should read as follow: $\%\Delta y = 100 \cdot \beta 1 \cdot \Delta x$, if X changes by 1 (unit), Y would changes by 100 times $\beta 1$ percent. Thus, the log-level regression model can be describe as follows:

$$\ln(\text{price of medicine}) = \beta 0 + \beta 1 \text{Dummy\_Patent} + \beta 2 \text{Dummy\_Brand} + \beta 3 \text{Generic Drug} + \beta 4 \text{Quantity} + \varepsilon t$$

4.1.3.1 Log-level regression

The log-level regression results are presented below in table 4.4, and show that the availability of generic drugs significantly effects the average price of essential medicine in Thailand for both year 2014 and 2015. As shown in column 2 and 4 of table 4.4, all coefficients on these independent variables have the expected sign and statistically significant at 99 percent confidence level. The adjusted r-squared for both models are roughly 0.90. This suggests that for both models 90 percent of variance in the price of essential of medicine can be explained through variance in patentability status, brand, the availability of generic drug and substitution and quantity of sales. Hence, both models do legitimately or completely offer proof for the expected relationship.

Table 4.4 Log-level regression results

Independent Variables	Year 2014 Model		Year 2015 Model	
	Coefficient	P-Value	Coefficient	P-Value
Constant	4.37301	6.70e-063***	4.32636	2.14e-064***
Dummy_Patent	1.17002	3.96e-08***	1.24258	2.80e-09***
Dummy_Brand	0.642811	0.0018***	0.642819	0.0012***
Generic drugs	-0.175842	8.49e-30***	-0.171003	2.05e-029***
Quantity of sales	-2.14586e-07	0.0042***	-2.08891e-07	0.0032***
n	150		150	
Adjusted r-squared	0.9069		0.9043	

Notes: - Dependent variable: Log of price of essential medicines.

- Dummy_patent and Dummy_brand are dummy variables which has a value of either 1 or 0.
- *** indicates significance at a 1 percent level, ** indicates significance at a 5 percent level and * indicates significance at a 10 percent level.

The results from the log-level regression analysis indicated that in year 2014, the price of patented drug was approximately 117 percent higher than other kind of medicines. As shown in row 3 column 2 of table 4.4, the coefficient $\beta 1$ = 1.17002 is an estimate that patented drug sold in Thailand in year 2014 was being sold at 117 percent, the price of other drugs. As for year 2015, the coefficient $\beta 1$= 1.24258 is an indication that the patented drug sold in Thailand in year 2015 was 124.25 percent, the price of other drugs. The standard error of $\beta 1$ for both models indicates that they are statistically significant at 99 percent confidence level. Additionally, since the test of this study has been conducted on different dataset from different year, the outcomes of the test are unlikely to be a rare occurrence rather a trend. In other words, based on the results, the author expect the increasing trend in price of patented medicine in Thailand in the future. In the end, the findings are in agreement with the stated hypothesis that there would be a strong correlation between these two variables, which to a certain degrees imply the abusive of monopoly power in Thai pharmaceutical market.

On top of that, the coefficient $\beta 2$ = 0.64281 on Dummy_Brand for both year 2014 and 2015 model is an estimate that brand-name drug being sold in Thailand during year 2014-2015 was 64.28 percent than its generic versions. The standard error of $\beta 2$ for both model indicates that they are statistically significant at 99 percent confidence level. Combining the impact of $\beta 1$ and $\beta 2$, it can be interpreted that a patented brand-name medicine was sold for approximately 181.28 and 188.53 percent, the price of its generic versions in year 2014 and 2015, respectively. These outcomes legitimately proof that brand is also another factor that have a huge impact on the price of essential medicine in Thailand. Moreover, the sum of the estimation of $\beta 1$ and $\beta 2$ solidly indicate a rising trend in patented brand-name drug price level.

In addition, the results from table 4.4 also suggests that in year 2014, for every 1 (unit) increase in number of generic drugs or substitution, the price of essential medicine would fall by 17.58 percent as indicated in row 5 column 2, $\beta 3$ = -0.175842. As for year 2015, the coefficient of $Generic\ Drug$ also yield the expected negative relationship. Precisely, the coefficient $\beta 3$ = -0.171003 on Generic Drug for year 2015 model is an estimate that for every unit increased in number of generic drug or medicine substitute, the price of that particular medicine would fall by 17.10 percent. The standard error of $\beta 3$ for both models indicates that they are statistically significant

at 99 percent confidence level. In a plain sight, a 17 percent reduction in medicine price for every unit increase in number of generics drug or substitution might not appear to be substantial. However, it must be noted that once the patent has expired or compulsory license has been issued, multiple number of generic drugs can be produce; as a consequence, the impact on the price would be exponential. Evidently, these results displayed that there is a strong negative correlation between generic drugs and essential medicine price for both models.

Lastly, the outcomes conclusively showed that for both models, quantity of sales have very little to none impact on the average price of essential medicine. Precisely, the coefficient for $\beta 4$ for both year 2014 and 2015 model have a value of less than -0.00000. In other words, the results can be interpreted that for every unit change in quantity of sales, the price would change by less than -0.00000 percent. The standard error of $\beta 4$ for both models indicates that they are statistically significant at 99 percent confidence level.

4.1.3.2 Multicollinearity Testing

Greene (2012), Multicollinearity exists whenever an independent variable is highly correlated with one or more of the other independent variables in a multiple regression equation. This problem could undermines the statistical significance of an independent variable. In this case, patent status and brand could be highly correlated with one another and also generic drugs. In order to test and collect for multicollinearity, drop technique is applied. More specifically, three additional log-level egression are performed with the omission of patent and brand variable; (1) log-level regression omitted patent, (2) log-level regression omitted brand, and (3) log-level regression omitted patent and brand.

Table 4.5 Log-level regression omitted dummy_patent results

Independent Variables	Year 2014 Model		Year 2015 Model	
	Coefficient	P-Value	Coefficient	P-Value
Constant	4.52098	1.09e-054***	4.47939	8.85e-056***
Dummy_Brand	1.22917	2.95e-08***	1.26467	7.33e-09***
Generic drugs	-0.188419	3.66e-027***	-0.184129	3.22e-027***

Table 4.5 Log-level regression omitted dummy_patent results (cont.)

Independent Variables	Year 2014 Model		Year 2015 Model	
	Coefficient	**P-Value**	**Coefficient**	**P-Value**
Quantity of sales	-1.81956e-07	0.0125**	-1.75418e-07	0.0112**
n	150		150	
Adjusted r-squared	0.8776		0.8695	

Notes: - Dependent variable: Log of price of essential medicines.

- Dummy_patent and Dummy_brand are dummy variables which has a value of either 1 or 0.
- *** indicates significance at a 1 percent level, ** indicates significance at a 5 percent level and * indicates significance at a 10 percent level.

The results from table 4.5 indicate that the log-level regression model described in the above section contains no multicollinearity as all coefficients for independent variables have the expected sign despite the omission of Dummy_Patent. Moreover, they are all statistically significant at a 99 percent confidence level except for quantity of sales, which drop to 95 percent confidence level. This deviation from the initial results is unlikely to cause any misinterpretation as quantity of sales is predicted to have no meaningful impact on the price level. In addition, the adjusted r-squared for both model are approximately 0.87 suggesting that 87 percent of the variance of the dependent variable can be explain through variance of independent variables. Also, the magnitude and significance of the availability of generic drug remains identical to the outcomes from table 4.4 at negative 18 percent.

Table 4.6 Log-level regression omitted dummy_brand results

Independent Variables	Year 2014 Model		Year 2015 Model	
	Coefficient	P-Value	Coefficient	P-Value
Constant	4.70914	9.11e-077***	4.66173	1.02e-078***
Dummy_Patent	1.46019	2.47e-013***	1.53410	7.41e-015***
Generic drugs	-0.197964	5.32e-040***	-0.192778	4.80e-040***
Quantity of sales	-1.80099e-07	0.0114**	-1.77220e-07	0.0095***
n	150		150	
Adjusted r-squared	0.8994		0.8963	

Notes: - Dependent variable: Log of price of essential medicines.

- Dummy_patent and Dummy_brand are dummy variables which has a value of either 1 or 0.
- *** indicates significance at a 1 percent level, ** indicates significance at a 5 percent level and * indicates significance at a 10 percent level.

The findings from table 4.6 suggest that all coefficients for independent variables have the expected sign and are all statistically significant at a 99 percent confidence level. Moreover, the adjusted r-squared for both models are approximately 0.89. This suggested that 89 percent of the variance of the dependent variable can be explain through variance of independent variables. Although, the size of the coefficient for each independent variable is relatively larger compared to the results from table 4.4, but they do not alter the significance of the outcome. The change in magnitude of impact for all parameters are mainly due to the model compensating for the influence of an omitted variable. Evidently, these results all pointed to a conclusion that Dummy_Brand is not a cause for multicollinearity.

Table 4.7 Log-level regression omitted dummy_patent and dummy_brand results

Independent Variables	Year 2014 Model		Year 2015 Model	
	Coefficient	P-Value	Coefficient	P-Value
Constant	5.44231	1.21e-089***	5.42429	3.07e-089***
Generic drugs	-0.250795	2.67e-051***	-0.247384	4.46e-051***
Quantity of sales	-7.67355e-08	0.2850	-7.48292e-08	0.3065
n	150		150	
Adjusted r-squared	0.8402		0.8277	

Notes: - Dependent variable: Log of price of essential medicines.
- Dummy_patent and Dummy_brand are dummy variables which has a value of either 1 or 0.
- *** indicates significance at a 1 percent level, ** indicates significance at a 5 percent level and * indicates significance at a 10 percent level.

The outcomes from table 4.7 suggest that Dummy_Patent and Dummy_Brand are not the cause for multicollinearity. The coefficient $\beta 1$ for both year 2014 and 2015 model has the expected negative sign and is statistically significant at a 99 percent confidence level. Besides, the adjusted r-squared for both models remain relatively high at 0.83 on average.

In a nutshell, the results from table 4.5, 4.6 and 4.7 indicate that the log-level regression model contains no multicollinearity. The outcome of these tests allows for the acceptance of all hypotheses. Hence, the findings obtained from the log-level regression model in section 4.1.3.1 can be used as a conclusive evidence for the expected relationship.

4.2 Discussion

In the previous section, it was determined that an increase in number of generic drugs or substitutions available would lead to a reduction in essential medicine price in Thailand. It was also shown that patent and brand do have a significant positive relationship to the price of essential medicine in Thailand. On top of that, it was also suggested that quantity of sales although statistically significant but has close to zero

impact on the price level of the essential drugs. These findings are compared to the literature review in this section.

4.2.1 Patent

The results of log-level regression analysis displayed that during the observed period, there was a rising trend in the price level of patented medicine. More specifically, the findings of year 2014 and 2015 model indicated that patented drugs were being sold for 117 and 124.25 percent, the price of other medicines in Thailand. In addition to a consistent increase in price of patented drugs, the study also provided a convincing evidence that the impact of patent is broaden across different medicine categories. These findings provide supportive evidence to the previous study of Scherer & Watal (2002) that on average most of the patented medicines have been sold for more than double the price of their generics counterpart. The outcomes of this research in conjunction to the research findings of Scherer & Watal (2002), clearly demonstrate the abusive of monopoly power by the patent holders. They are expected to take advantage of the patent protection law by cutting output and raising prices, a profit increasing move, which reduces both consumer and social welfare.

While the evidences for the case of the abusive of monopoly power are clear, the remedies to the problem are perplexing as originator patent medicines are protected by patent law. The best solution for this problem could come in a form of compulsory license as suggested in the previous research of Niesporek (2005) that compulsory license promote production and distribution of cheaper generic medicine in poor countries, thus putting downward pressure on originator patent medicines.

4.2.2 Brand

Referring to the log-level regression results in the previous section, brand is another important variable which significantly influence the price of essential medicine in Thailand. The results showed that during the period of 2014-2015, brand-name drugs were being sold at the price which were approximately 64.28 percent higher than those of generic drugs. These results ultimately suggested that manufacturers of the brand-name medicines hold substantial degree of market power over the local producers. These findings provided a supportive evidence to the previous research of Supakankunti et al. (2001)

that the expiration of a patent is unlikely to cause the monopolist to lose all its market power as some customers remain loyal to brand-name drugs partly due to a fear that the new generic drugs are not of the same quality standard. Consequently, this allow the originator producers to continue charging the price for their medicines above the price charged by local pharmaceutical producers.

To solve this problem, a national effort is required; that is the government must enforce leading public hospitals such as Siriraj, Ramathibodi and Chulalongkorn hospital to always prioritize the prescription and usage of locally made generic over brand-name drugs if available. Also, local pharmaceutical producers must invest more on their research and development, lab testing, facilities, etc. so as to ensure that the production of their medicines are of the World Health Organization (WHO) quality standard. By doing so, not only does it put a downward pressure on the price of brand-name drug but also help the public to access high quality medication.

4.2.3 Generic drugs

The relationship that was at the heart of this study was the relationship between the price of essential medicine and the availability of generic drugs or substitutions. As discussed above the log-level regression analysis indicated that there is a strong negative correlation between generic drugs available and the price of essential medicine. More specifically, in year 2014, the findings suggested that for every unit increase in number of generic drug available, the price of that medicine would fall by 17 percent. The analysis of year 2015 sample set also yield the same results. A reduction of 17 percent in price for every unit increase in substitution is considered to be highly substantial because multiple number of generic drugs can produced at once. For example, if there were 3 generics or substitutions available for X medicine, then its price would expected to fall by more than 50 percent. These findings or phenomenon can be theoretically explained by the application of the availability of substitute, which is one of the major application from Microeconomics theory; and the backbone theory behind this study. According to Mankiw (2011), generally, the market price for a particular product or service should fall if more substitutes or alternatives are available for that particular product or service. Hence, the outcomes of this study have confirmed that such theory or prediction hold true for the case of essential medicine in Thailand.

On top of that, the results of this research, to a certain degree, help bridges the gap for the applicability of the availability of substitutes in pharmaceutical market. Previous research have shown that the granting of compulsory licenses and the production of generic drugs have led to a decrease in price of HIV/AIDS medicine in Thailand and Brazil (Coriat, Orsi & d'Almeida, 2006 and Lybecker & Fowler, 2009). Despite showing consistent outcomes, these two researches lack comprehensiveness as they only focused on HIV/AIDS medicine. Meanwhile, this study extent the scope of the study so that it cover a majority number of essential medicines in Thailand; and found similar results. The outcomes of this research along with previous literature have led to a conclusion that the availability of generic drugs and substitutions strongly effects the price of essential medicine in a negative fashion.

While the evidence clearly indicates a negative relationship between the availability of generic drugs and the price of essential medicine, it may be tricky to put this concept into work. First, the government must consider reviewing and loosening many of its tough and out of date regulations put forward local manufacturers and distributors regarding the licensing and commercialization processes of the locally made generic drugs. According to the Thai ministry of health, it could take up to five years for local producers to obtain a license for their generic drugs. The majority of the processes were all about validating a paper work. Thus, if the government can somehow find a way to loosen up its regulations, it would encourage the production of generic drugs on a larger scale. Second, a comprehensive research must be conducted to evaluate Thai people's usage of essential medicine and identify the type of medicine that they lack access the most. By doing so, it can be ensure that the investment made in the development of generic drugs is appropriate and most importantly offer the highest potential to reduce the cost of medication.

4.2.4 Quantity of sales

As discussed above quantity of sales among all the other independent variables has the least impact on the price level of essential medicine in Thailand. Precisely, the findings showed that during the observed period, for every unit change in quantity of sales, the price would change by less than -0.0000 percent. This leads to a conclusion that quantity of sales has no impact on the price level. These phenomenon can be explained

through previous literature of (Mankiw, 2011) that necessity goods such as medicine tends to have inelastic demand, thus a change in price is unlikely to have much impact on the quantity demanded or vice versa.

CHAPTER V
CONCLUSION

This is a final chapter of the study that gives conclusion of the findings. The results of data collected and analyzed are summarized in relation to the research aims and objectives. This chapter includes four sections which are conclusion, recommendations of the research, research limitations and recommendations for future research.

5.1 Conclusions

This research set out to examine the effect of a change in generic drugs available on the average price of medicine in Thailand by analyzing the relationship of the availability of generic drug and the average price of essential medicine in Thailand during year 2014-2015. The objectives of the study were to (1) examine the relationship between the availability of generic drug and price of essential medicine in Thailand during year 2014-2015 and (2) study the determinant variables (patent, brand and quantity of sales) of essential medicine price in Thailand during year 2014-2015. To that end, the author constructed two separate datasets which draw on year 2014 and 2015 cross sectional data retrieved from the Thai ministry of health and Government Pharmaceutical Organization (GPO) and estimated multiple and log-level regression models designed to test for a statistically significant decrease in the average price of essential medicine for every positive change in the number of generic drugs or substitutions.

The findings essentially suggested that the number of generic drugs or substitutions available have a significant impact on the price level of the essential medicines being sold in Thailand during the period of 2014-2015. The author have tested a number of models and consistently found that the increasing number of generic drugs have led to a dramatic drop in essential medicine price. As discussed in the previous chapter, estimates of decreased in the price of essential medicine for every unit increase in a number of substitutes from log-level regression models range from approximately 17 to 25 percent,

with an average of 19 percent. Without the influence of generic drugs, the average price of essential medicine being sold in Thailand is expected to be substantially more expensive as the log-level regression models exhibited a strong positive correlation for other explanatory variables such as brand and patent.

In conclusion, the availability of substitute theory is applicable to the price of essential medicine in Thailand. In this context, the availability of generic drugs is highly pivotal to Thai people's access to medication; that is the higher the availability of generics drugs, the better the access to medication. The increasing number of substitutes significantly lower the price of essential medicine as it provides consumers more choices as well as reduces incumbent's bargaining power. More specifically, the increasing number of generics drugs have caused the demand of essential drugs to become more elastic; as a consequence, the producers are forced to lower their price so as to maintain the same level of revenue. In addition to that, wider use of generic drugs would dramatically improve the effectiveness of the government's free healthcare scheme as it represents a more cost effective source of medication. Thus, the government can spend the saved budget to enhance the quality of the scheme on other aspects. At the end of the day, it can be concluded that in order to improve health standard in Thailand, both the government and private sector must collaborate and continue to develop and expand the production and usage of generic drugs.

5.2 Recommendations of the Research

There are several practical recommendations of the research that can be made. These recommendations are mainly aimed to encourage the public and private sector to work together toward a dynamic solutions for the lack of access to medication.

First of all, this research along with other studies by Lybecker & Fowler (2009) and Coriat, Orsi & Almeida (2006) have demonstrated that there is a strong negative correlation between the availability of generic drugs and the price of essential medicine, which can be applied not just to the price of non-patented drug, but actually to the price of patented drug as well. In a simple contexts, the price of a medicine is likely to fall once more of its generic versions are being made. These results must serve as a wake up calls to the Thai government. From the past up until now, the government has been

overlooking the importance of the availability of generic drugs and its influences on life threatening medicine price. The government's inability to identify the correlation between the two variables has led to a significant fall in the production of generic drugs. Effectively, the shortage of high quality locally made generic drugs has allowed original producers to maintain their high bargaining power and continue charging high price for their drugs, resulting in a deteriorating health standard for Thai people. Therefore, to effectively tackle this issue, the government must seriously invest more in the research and development as well as the production of locally made generic medicines.

For patented drugs, the government should consider issue more compulsory licenses to public or private agencies to produce the generic copies of some of the essential medicine. Doing so would not just give Thai people better access to medication, but actually put pressure on the patent holder to either lower the price of medicine or negotiate for voluntary license. On the other hand, for non-patented drugs, the government could either invest on the production of such medicines directly or encourage local manufacturers to do so by enforcing both public and private hospitals to prioritize the usage of locally made generic over brand-name drug. Such actions would guarantee that there will be a feasible market for locally made generic drugs, hence stimulating the investment and production of such drugs. All in all, an investment in the development and production of generic drugs by the government would give Thai people a better access to high quality medication at a much cheaper cost, thus raising the standard of living. The benefit of having a large numbers of high quality but affordable medicines available are not limited only to healthcare sector but also expanded to national level in a sense that it indirectly help raise national output. According to Mankiw (2011), a stronger agents can contribute more to the economy resulting in a higher output per capita and GDP growth. In other words, once peoples have a better health standard, they will have more time and energy to work resulting in higher output.

Another recommendation is Thai government should consider wide scale revision of the tough regulations put forth local pharmaceutical manufacturers and distributors regarding the licensing and commercialization processes of the locally made generic medicines. According to the published report by the Thai ministry of health, the entire processes could take up to five years resulting in a shortage of high quality generic drugs. By revamping the rules and regulations, Thai healthcare sector

would gain several different benefits. Firstly, not only does a larger number of high quality generic drugs would be produced and served to Thai people, it would also reduce the originator producer's bargaining power. As discussed above, this study as well as other studies by Coriat, Orsi & d'Almeida (2006), Lybecker & Fowler (2009), Niesporek (2005) and Rose (2003) agree that there is an inverse relationship between the availability of generic drug and its price. Secondly, doing so would allow the Thai government to make substantial improvement on the efficiency and effectiveness of its free healthcare scheme. Locally made generic drugs represent a cost effective and high quality source of medication, thus the scheme could finally offer high quality medicines to the public. More importantly, since the wide availability of generic drugs help reduce medication cost, which represents the majority cost of running the scheme, the government can allocate these spare budgets to improve on other areas of the scheme. In the end, a wide scale production of generic drugs would enhance the government healthcare scheme's ability to fulfill its ultimate goals of providing Thai people a better access to medication and reducing the original producer's bargaining power.

The other recommendation is that Thai local pharmaceutical producers should form a committee to push forward the deregulation of the licensing and commercialization of locally made generic drugs in Thailand. Such moves by Thai producers would put tremendous pressure on the Thai ministry of health to speed up the revision of the rules and regulations concerning the issues. As a consequence, it would pave the ways for more production and commercialization of the locally made generic drugs. In the end, Thai local pharmaceutical manufacturers, Thailand and Thai people would all benefit from such actions. For Thai people, their standard of living will be raise as generic drugs represent them a low cost but high quality source of medication. In other words, they would gain a better access to medication. As for Thai producers, the deregulations simply means higher revenues and profits. The extra profit can be used to improve on research and development so as to compete against multi-national firms more competitively. Finally, as a country, Thailand is stand to benefit from a wider production of generic drugs in a form of higher GDP growth. Directly, it benefits from the investments, job creations and higher output produced across the pharmaceutical sector. Indirectly, it provides a solid foundation for Thai healthcare giving Thai peoples a better health standard, thus they can contribute more to the economy.

5.3 Limitations

Although the research has successfully reached its aims, there were some unavoidable limitations. First and foremost, due to limited time and data availability, the research was conducted using cross-sectional analysis, with data collection taking place over a limited period and only reflecting one point in time. This means that can't be used to analyze behavior over a period of time. Precisely, if there is a sudden and significant change in patent law, the perceived relationships between the average price of essential medicines and number of generic drugs could also change. Second of all, due to limited time and budget, this research only took quantitative method. Therefore, the findings may lack some in-depth information regarding the healthcare situation in general; and the practical understanding of how the availability of generic drugs affects the average price of essential medicines in Thailand. Consequently, although the study is more than useful in understanding the tested relationships conceptually, but might not have been comprehensive enough to be perceived as a new norm. A final limitation is that due to time limitation, the research conducted on a relatively small sample size (150 medicine samples per dataset). As a consequence, even though the findings represents a generalize conclusion for the price of essential medicine for fatally diseases but the results might not hold true for other kind of medicine.

5.4 Recommendations for Future Research

There are several recommendations for future research in this field. First of all, without any time and data constraint, future research should take time-series approach to explore the relationship between the examined variables. Time series analysis would help research understand the behavior of the examined variables overtime more discretely as the data are being collected over a period of time rather than a point in time. Additionally, such approach also provide a good basis for establishing causality and confounding factors. Second of all, future research should incorporate qualitative interview into the study so as to make the findings more dynamic and comprehensive. Specifically, doctors, health officials, local pharmaceutical producers, consumers and pharmacists should be contacted for interview as they are the representatives of the five main parties concerning the topic, who can provide different views and opinions regarding the study. For example,

local producers could give an in depth information on why they choose to produce a generic versions of one particular drug but not for the other. On the other hand, consumer could provide researchers with different opinions regarding their choices and perspectives toward the use of generic drugs. More specifically, they would give researchers a better understanding on how consumer feel toward the quality of generic versus brand-name drug and more importantly, whether they would choose to consume it over its counterpart given a lower price point and perceived quality. Later on, all the additional information collected from the interview can be used to support or reject the findings. In other words, the analysis of the interview shall be meshed together with the regression results in order to get the most accurate results and the best practical understanding of the subject. Third of all, the sample size should be expanded so as to include more medicine categories. For example, instead of including just lifesaving medicine, common-medicine should also be included in the sample set. By doing so, the results can be used to generalize all medicine being sold in Thailand. Conversely, future research can opt to study different category of medicine independently and compare the results as well. Finally, additional variable such the cost of production could be added into the regression model. Undeniably, the information on such variable is highly difficult to obtain; however, if future research can manage to collect such data, it will surely make a case for a breakthrough research in this field.

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APPENDICES

Appendix A: Year 2014 Dataset

Price	Dummy_ Patent	Dummy_ Brand	Generic drugs	Quantity of Sales	Disease
30.00	0	0	6	565,820	Coronary Artery
20.00	0	0	13	485,195	Coronary Artery
18.00	0	0	13	459,225	Coronary Artery
1.04	0	0	23	259,855	Coronary Artery
115.60	0	1	6	168,400	Coronary Artery
19.00	0	0	13	155,985	Coronary Artery
22.00	0	0	13	78,560	Coronary Artery
577.00	1	1	0	21,065	Coronary Artery
1578.00	1	1	0	20,520	Coronary Artery
395.00	0	1	2	9,365	Coronary Artery
38.00	0	0	7	399,050	Chronic Obstructive Pulmonary
13.00	0	0	8	378,200	Chronic Obstructive Pulmonary
40.00	0	0	7	245,420	Chronic Obstructive Pulmonary
45.00	0	0	7	201,540	Chronic Obstructive Pulmonary
12.00	0	0	8	121,560	Chronic Obstructive Pulmonary
360.00	1	1	0	140,030	Chronic Obstructive Pulmonary
15.00	0	0	9	98,245	Chronic Obstructive Pulmonary
21.00	0	0	10	90,760	Chronic Obstructive Pulmonary
57.00	1	1	3	81,375	Chronic Obstructive Pulmonary
285.00	1	1	0	52,130	Chronic Obstructive Pulmonary
14.00	0	0	9	209,455	Stroke
293.00	1	1	0	126,725	Stroke
122.00	0	1	3	125,830	Stroke
514.00	1	1	0	91,785	Stroke
470.00	1	1	0	90,545	Stroke
419.00	1	1	0	79,950	Stroke
6.25	0	0	12	75,875	Stroke
6.35	0	0	12	63,540	Stroke
6.15	0	0	12	58,900	Stroke
6.30	0	0	12	57,035	Stroke
52.00	0	1	2	230,810	Lower Respiratory Infections

Price	Dummy_ Patent	Dummy_ Brand	Generic drugs	Quantity of Sales	Disease
43.00	0	0	6	160,000	Lower Respiratory Infections
75.00	0	0	6	150,195	Lower Respiratory Infections
5.50	0	0	12	108,000	Lower Respiratory Infections
35.00	0	0	3	79,800	Lower Respiratory Infections
39.00	0	0	3	79,700	Lower Respiratory Infections
44.00	0	0	6	76,505	Lower Respiratory Infections
350.00	1	1	0	59,500	Lower Respiratory Infections
6.00	0	0	16	52,730	Lower Respiratory Infections
35.00	0	0	6	19,600	Lower Respiratory Infections
4.50	0	0	16	288,500	Trachea, Bronchus, and Lung Cancers
4.55	0	0	16	284,885	Trachea, Bronchus, and Lung Cancers
210.00	1	1	0	165,500	Trachea, Bronchus, and Lung Cancers
4.65	0	0	16	162,335	Trachea, Bronchus, and Lung Cancers
40.00	0	0	2	118,930	Trachea, Bronchus, and Lung Cancers
0.80	0	0	23	103,755	Trachea, Bronchus, and Lung Cancers
35.50	0	0	6	101,800	Trachea, Bronchus, and Lung Cancers
31.50	0	0	6	62,200	Trachea, Bronchus, and Lung Cancers
886.00	1	1	0	53,500	Trachea, Bronchus, and Lung Cancers
950.00	1	1	0	21,350	Trachea, Bronchus, and Lung Cancers
6.00	0	0	3	506,560	Diarrheal
75.00	0	1	4	324,100	Diarrheal
12.00	0	0	14	184,670	Diarrheal
11.50	0	0	14	120,560	Diarrheal
5.50	0	0	23	143,600	Diarrheal
66.00	0	1	3	110,885	Diarrheal
4.00	0	0	15	90,560	Diarrheal
49.00	0	1	1	89,995	Diarrheal
951.00	1	1	0	82,085	Diarrheal
870.00	1	0	0	79,520	Diarrheal
100.00	0	1	1	269,325	Diabetes Mellitus
10.00	0	0	11	189,800	Diabetes Mellitus
13.50	0	0	11	98,465	Diabetes Mellitus
15.00	0	0	11	94,200	Diabetes Mellitus
650.00	1	1	0	90,655	Diabetes Mellitus
12.50	0	0	11	82,450	Diabetes Mellitus

Price	Dummy_ Patent	Dummy_ Brand	Generic drugs	Quantity of Sales	Disease
13.00	0	0	11	74,950	Diabetes Mellitus
65.00	0	0	3	58,970	Diabetes Mellitus
54.50	0	0	3	40,550	Diabetes Mellitus
55.00	0	1	3	23,200	Diabetes Mellitus
9.00	0	0	9	449,875	Tuberculosis
8.00	0	0	9	395,595	Tuberculosis
8.50	0	0	9	369,125	Tuberculosis
413.00	1	1	0	122,250	Tuberculosis
8.75	0	0	9	118,055	Tuberculosis
144.00	0	1	2	90,360	Tuberculosis
341.00	1	1	0	66,875	Tuberculosis
44.00	0	1	2	58,080	Tuberculosis
20.00	0	0	10	54,795	Tuberculosis
107.00	0	1	3	41,850	Tuberculosis
5.00	0	0	14	989,875	Liver Cancer
4.50	0	0	14	889,000	Liver Cancer
4.00	0	0	14	875,225	Liver Cancer
9.00	0	0	13	175,420	Liver Cancer
8.00	0	0	13	161,590	Liver Cancer
89.00	0	1	2	97,980	Liver Cancer
879.00	1	1	0	79,450	Liver Cancer
664.00	1	1	0	68,590	Liver Cancer
468.00	1	1	0	33,750	Liver Cancer
129.00	1	1	0	25,065	Liver Cancer
40.00	0	0	4	100,260	HIV/AIDS
35.00	0	0	4	71,150	HIV/AIDS
31.00	0	0	4	70,515	HIV/AIDS
39.00	0	0	4	69,030	HIV/AIDS
2790.00	1	1	0	45,000	HIV/AIDS
1262.00	1	1	2	32,275	HIV/AIDS
1190.00	1	1	0	20,845	HIV/AIDS
120.00	0	1	1	10,035	HIV/AIDS
235.00	0	1	1	9,575	HIV/AIDS
305.00	0	1	0	8,000	HIV/AIDS
0.95	0	0	24	1,008,065	Preterm Birth Complications

Price	Dummy_ Patent	Dummy_ Brand	Generic drugs	Quantity of Sales	Disease
0.90	0	0	24	299,500	Preterm Birth Complications
0.85	0	0	24	280,070	Preterm Birth Complications
0.92	0	0	24	149,000	Preterm Birth Complications
300.00	1	1	0	99,085	Preterm Birth Complications
29.00	0	0	8	90,025	Preterm Birth Complications
739.00	1	1	0	84,405	Preterm Birth Complications
25.00	0	0	8	62,745	Preterm Birth Complications
748.00	1	1	0	58,405	Preterm Birth Complications
65.00	0	1	1	13,540	Preterm Birth Complications
0.68	0	0	25	3,058,565	Alzheimer's
0.65	0	0	25	2,998,760	Alzheimer's
0.70	0	0	25	2,854,600	Alzheimer's
60.00	0	0	3	365,200	Alzheimer's
58.00	0	0	3	88,025	Alzheimer's
348.00	1	1	0	51,955	Alzheimer's
272.00	1	1	0	30,780	Alzheimer's
205.00	0	1	3	22,405	Alzheimer's
54.00	0	0	3	13,045	Alzheimer's
265.00	1	1	0	9,700	Alzheimer's
4.50	0	0	15	597,500	Chronic Liver disease
5.00	0	0	15	157,300	Chronic Liver disease
70.00	0	1	0	73,650	Chronic Liver disease
3.00	0	0	18	66,200	Chronic Liver disease
21.00	0	0	1	65,755	Chronic Liver disease
62.50	0	1	1	59,055	Chronic Liver disease
3.50	0	0	18	55,575	Chronic Liver disease
860.00	1	1	0	16,540	Chronic Liver disease
251.00	1	1	0	11,305	Chronic Liver disease
265.00	1	1	0	10,540	Chronic Liver disease
1.06	0	0	21	5,895,000	Kidney Disease
1.05	0	0	21	3,503,400	Kidney Disease
1.09	0	0	21	3,080,540	Kidney Disease
1.03	0	0	21	1,007,650	Kidney Disease
1.00	0	0	21	900,960	Kidney Disease
18.00	0	0	14	270,085	Kidney Disease

Price	Dummy_ Patent	Dummy_ Brand	Generic drugs	Quantity of Sales	Disease
15.00	0	0	14	222,650	Kidney Disease
89.00	1	1	0	107,815	Kidney Disease
192.00	1	1	0	29,800	Kidney Disease
198.00	0	1	1	16,540	Kidney Disease
1.22	0	0	17	2,000,185	Septicemia
1.25	0	0	17	1,899,850	Septicemia
1.65	0	0	17	995,605	Septicemia
1.15	0	0	17	836,425	Septicemia
20.50	0	0	1	568,755	Septicemia
2.00	0	0	16	498,005	Septicemia
2.05	0	0	16	100,055	Septicemia
2.10	0	0	16	99,875	Septicemia
435.00	0	1	1	40,015	Septicemia
755.00	1	1	0	27,605	Septicemia

Appendix B: Year 2015 Dataset

Price	Dummy_ Patent	Dummy_ Brand	Generic drugs	Quantity of Sales	Disease
30.00	0	0	6	565,410	Coronary Artery
18.00	0	0	13	478,610	Coronary Artery
20.00	0	0	13	452,120	Coronary Artery
1.04	0	0	23	265,985	Coronary Artery
19.00	0	0	13	152,620	Coronary Artery
115.60	0	1	6	125,550	Coronary Artery
23.00	0	0	13	76,050	Coronary Artery
395.00	0	1	2	21,980	Coronary Artery
1578.00	1	1	0	20,420	Coronary Artery
577.00	1	1	0	9,030	Coronary Artery
38.00	0	0	7	378,950	Chronic Obstructive Pulmonary
13.00	0	0	8	345,210	Chronic Obstructive Pulmonary
40.00	0	0	7	235,490	Chronic Obstructive Pulmonary
45.00	0	0	7	200,070	Chronic Obstructive Pulmonary
360.00	1	1	0	140,030	Chronic Obstructive Pulmonary
12.00	0	0	8	111,265	Chronic Obstructive Pulmonary
21.00	0	0	10	98,760	Chronic Obstructive Pulmonary
57.00	1	1	3	80,370	Chronic Obstructive Pulmonary
15.00	0	0	9	60,245	Chronic Obstructive Pulmonary
285.00	1	1	0	52,135	Chronic Obstructive Pulmonary
14.00	0	0	9	198,450	Stroke
293.00	1	1	0	128,025	Stroke
122.00	0	1	3	120,450	Stroke
470.00	1	1	0	91,875	Stroke
514.00	1	1	0	90,730	Stroke
419.00	1	1	0	79,450	Stroke
6.25	0	0	12	74,440	Stroke
6.35	0	0	12	62,310	Stroke
6.15	0	0	12	58,900	Stroke
68.00	0	1	3	24,035	Stroke
52.00	0	1	2	240,810	Lower Respiratory Infections

Price	Dummy_ Patent	Dummy_ Brand	Generic drugs	Quantity of Sales	Disease
43.00	0	0	6	154,200	Lower Respiratory Infections
75.00	0	0	6	140,295	Lower Respiratory Infections
5.50	0	0	12	98,520	Lower Respiratory Infections
44.00	0	0	6	78,825	Lower Respiratory Infections
35.00	0	0	3	78,800	Lower Respiratory Infections
39.00	0	0	3	69,695	Lower Respiratory Infections
350.00	1	1	0	58,030	Lower Respiratory Infections
6.00	0	0	16	42,780	Lower Respiratory Infections
35.00	0	0	6	25,600	Lower Respiratory Infections
4.50	0	0	16	298,500	Trachea, Bronchus, and Lung Cancers
4.55	0	0	16	264,335	Trachea, Bronchus, and Lung Cancers
4.65	0	0	16	164,805	Trachea, Bronchus, and Lung Cancers
210.00	1	1	0	164,500	Trachea, Bronchus, and Lung Cancers
40.00	0	0	2	123,600	Trachea, Bronchus, and Lung Cancers
0.80	0	0	23	106,505	Trachea, Bronchus, and Lung Cancers
35.50	0	0	6	84,590	Trachea, Bronchus, and Lung Cancers
31.50	0	0	6	59,200	Trachea, Bronchus, and Lung Cancers
886.00	1	1	0	53,600	Trachea, Bronchus, and Lung Cancers
950.00	1	1	0	20,340	Trachea, Bronchus, and Lung Cancers
6.00	0	0	3	497,560	Diarrheal
75.00	0	1	4	364,100	Diarrheal
12.00	0	0	14	154,605	Diarrheal
11.50	0	0	14	134,560	Diarrheal
5.50	0	0	23	123,650	Diarrheal
66.00	0	1	3	111,785	Diarrheal
4.00	0	0	15	89,520	Diarrheal
49.00	0	1	1	89,425	Diarrheal
951.00	1	1	0	82,085	Diarrheal
870.00	1	0	0	78,520	Diarrheal
100.00	0	1	1	278,325	Diabetes Mellitus
10.00	0	0	11	149,800	Diabetes Mellitus
13.50	0	0	11	105,655	Diabetes Mellitus
15.00	0	0	11	98,560	Diabetes Mellitus
12.50	0	0	11	90,450	Diabetes Mellitus
650.00	1	1	0	87,655	Diabetes Mellitus

Price	Dummy_ Patent	Dummy_ Brand	Generic drugs	Quantity of Sales	Disease
13.00	0	0	11	73,650	Diabetes Mellitus
65.00	0	0	3	56,420	Diabetes Mellitus
52.50	0	0	3	46,550	Diabetes Mellitus
55.00	0	1	3	20,050	Diabetes Mellitus
9.00	0	0	9	456,980	Tuberculosis
8.00	0	0	9	385,455	Tuberculosis
8.50	0	0	9	300,125	Tuberculosis
8.75	0	0	9	120,055	Tuberculosis
413.00	1	1	0	111,250	Tuberculosis
144.00	0	1	2	100,360	Tuberculosis
341.00	1	1	0	64,045	Tuberculosis
20.00	0	0	10	56,895	Tuberculosis
44.00	0	1	2	55,980	Tuberculosis
107.00	0	1	3	41,850	Tuberculosis
5.00	0	0	14	987,560	Liver Cancer
4.50	0	0	14	888,590	Liver Cancer
4.00	0	0	14	856,425	Liver Cancer
8.00	0	0	13	160,050	Liver Cancer
89.00	0	1	2	98,540	Liver Cancer
9.00	0	0	13	85,490	Liver Cancer
879.00	1	1	0	79,450	Liver Cancer
664.00	1	1	0	65,085	Liver Cancer
468.00	1	1	0	32,105	Liver Cancer
129.00	1	1	0	25,985	Liver Cancer
40.00	0	0	4	98,760	HIV/AIDS
31.00	0	0	4	79,860	HIV/AIDS
35.00	0	0	4	69,150	HIV/AIDS
39.00	0	0	4	59,850	HIV/AIDS
2790.00	1	1	0	45,255	HIV/AIDS
1262.00	1	1	2	31,295	HIV/AIDS
1190.00	1	1	0	21,455	HIV/AIDS
116.00	0	1	0	10,455	HIV/AIDS
225.00	0	1	0	9,050	HIV/AIDS
276.00	0	1	0	8,040	HIV/AIDS
0.95	0	0	24	1,004,785	Preterm Birth Complications

Price	Dummy_ Patent	Dummy_ Brand	Generic drugs	Quantity of Sales	Disease
0.85	0	0	24	298,560	Preterm Birth Complications
0.90	0	0	24	248,905	Preterm Birth Complications
0.92	0	0	24	152,005	Preterm Birth Complications
300.00	1	1	0	98,080	Preterm Birth Complications
29.00	0	0	8	89,025	Preterm Birth Complications
739.00	1	1	0	80,405	Preterm Birth Complications
748.00	1	1	0	58,095	Preterm Birth Complications
25.00	0	0	8	52,645	Preterm Birth Complications
55.00	0	1	1	14,950	Preterm Birth Complications
0.64	0	0	26	3,015,485	Alzheimer's
0.66	0	0	26	3,001,455	Alzheimer's
0.69	0	0	26	2,649,850	Alzheimer's
60.00	0	0	3	364,520	Alzheimer's
58.00	0	0	3	87,905	Alzheimer's
348.00	1	1	0	52,345	Alzheimer's
272.00	1	1	0	30,055	Alzheimer's
206.00	0	1	3	21,560	Alzheimer's
54.00	0	0	3	12,645	Alzheimer's
265.00	1	1	0	9,500	Alzheimer's
4.50	0	0	15	598,620	Chronic Liver disease
5.00	0	0	15	152,600	Chronic Liver disease
70.00	0	1	0	73,890	Chronic Liver disease
21.00	0	0	1	65,425	Chronic Liver disease
3.00	0	0	18	65,420	Chronic Liver disease
3.50	0	0	18	58,975	Chronic Liver disease
65.00	0	1	1	54,765	Chronic Liver disease
860.00	1	1	0	16,550	Chronic Liver disease
251.00	1	1	0	10,900	Chronic Liver disease
265.00	1	1	0	10,850	Chronic Liver disease
1.06	0	0	21	5,891,350	Kidney Disease
1.05	0	0	21	3,489,500	Kidney Disease
1.09	0	0	21	3,000,255	Kidney Disease
1.00	0	0	21	1,005,000	Kidney Disease
1.03	0	0	21	900,265	Kidney Disease
18.00	0	0	14	300,985	Kidney Disease

Price	Dummy_ Patent	Dummy_ Brand	Generic drugs	Quantity of Sales	Disease
15.00	0	0	14	236,500	Kidney Disease
89.00	1	1	0	106,015	Kidney Disease
192.00	1	1	0	28,975	Kidney Disease
198.00	0	1	1	15,200	Kidney Disease
2.05	0	0	15	2,095,750	Primary Hypertension
2.12	0	0	15	1,802,365	Primary Hypertension
2.08	0	0	15	835,670	Primary Hypertension
20.15	0	0	2	489,500	Primary Hypertension
20.35	0	0	2	476,125	Primary Hypertension
1.00	0	0	18	248,950	Primary Hypertension
1.03	0	0	18	248,005	Primary Hypertension
378.00	0	1	2	60,540	Primary Hypertension
815.00	1	1	0	22,530	Primary Hypertension
1260.00	1	1	0	13,500	Primary Hypertension