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PRICE DISCRIMINATION AMONG DIFFERENT STRENGTHS OF THE SAME DRUGS

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ABSTRACT

This thesis studies the price discrimination through the drug's market. Using the data from the USA and Chinese drugs' markets, we are looking for the factors what might affect the price discrimination. Counting the price per mg/ml and classifying the drugs by the diseases, we find that the price discrimination of the anti-infective drugs is the smallest in both countries, the drugs' prices are positively related to the price discrimination, and the standard deviation of the American drug's prices is smaller than the standard deviation of the Chinese drug's prices.

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CHAPTER ONE

INTRODUCTION

When you go to the drug store, you will find the same drugs with different strengths. But most of us do not pay attention to the price difference among therm. After counting the price per mg/ml, we find that the higher the strength every pill, the cheaper the price per mg/ml, and we assume this is the price discrimination.

The manufacture could use many ways to increase the profits, such as the bundling, and so on. Price discrimination is one of these ways, and many economists write many papers about this topic. In this thesis, we are going to use the medicine industry to analyze the price discrimination. This thesis just studies the price discrimination among the drugs with different strengths, ignoring other potential factors.

The price discrimination is that the producers use the price difference to increase the profits. The price discrimination contains the first-degree, the second-degree and the third-degree price discrimination. The first degree price discrimination is making the prices different as to different customer. In this degree, the producers should have all the information of the customers, which does not exist in the real life. The second degree price discrimination is varying the prices according to the sales. If you buy more, you will get the lower unit price. This price discrimination is very widespread. The third degree price discrimination is that make the price different based on the location and the customer segment. For example, there is one hair salon set two different prices to the students and the non-students, and the salon offers the lower price to the students, because the student has the more elastic price elasticity of the demand.

Not all the markets could take the price discrimination. It must satisfy three conditions to take the price discrimination. First, the information of this industry should be asymmetric. The customer should know less information than the sellers, such as the drug store, and the hospital. Second, classifying the customer of this market should not be too hard. The last one is that the price elasticity of this market is best to be very small. So the limiting the trades and the regional blockade are helpful to the price discrimination.

The drugs market satisfies the above conditions. The drug's market has the patent to limit the entry. Unlike the rice, not everyone could enter this market. And the people who could know the real function of the drugs are just the doctors and some other workers in the health system. So the information of this market is asymmetric. Then the patients could be classified by the diseases easily. Moreover, every drug related to the specific disease, so the replacement of the drugs is very small. Even the producers increase the price, the customers have to keep health, and accept the price.

On the other side, the drug's price is also another hot topic of the economists. The price of the medicine is one of the most important factors that influence the health and the security of the people, and the health level in the whole country. People always complain that the drug's price is too high, while the drug's producer and dealers always want to earn more profits. As to the government, it not only wants to reduce the price of the drugs, but also does not want to hurt the profits of the drug's producers and dealers. Only if the producers get the money, they could have the funds and the motive to create the new drugs.

We are trying to figure out that which factors will affect the price discrimination. This thesis includes some factors, such as the existing number of the same drugs, the mean price of the drugs, and the policy of the government and so on. In order to test these factors, we use the price per mg/ml as the basic data to count the mean and the standard deviation and build the linear regression model.

The thesis is organized as follows. Chapter Two is the literature review, which is about the price discrimination in every field, and the analysis about drug's prices. The methodology & hypothesis are concluded in the Chapter Three. Chapter Four and Five are about the data and the results of the application. And the final part is the conclusion.

CHAPTER TWO

LITERATURE REVIEW

There are many papers about the price discrimination or related to the price differential.

In this paper, we use the price per mg/ml to analyze data. And this idea comes from the Chorniy and Maloney (2010)'s paper. In this paper, the authors use the price discrimination to explain the phenomenon that some drugs are priced by pills and some drugs are priced by milligram of the active ingredient.

The data used in this paper covers 171 unique drugs, and the prices of these drugs come from <Medco.com>. Used these data, the authors build one model to test the correlations between the likelihood of pricing per pill and four factors. And they are the drug divisibility, the disease severity, the degree of competition of the market and the drug popularity.

Finally, the results of the experiment shows that the positive relationship between the indivisibility property of a drug and the likelihood of pricing per pill, and the positive relationship between the price per daily dose and the likelihood of pricing per pill.

The papers studying the price discrimination in the drug industry are very few, but the papers about the price discrimination in other industry are very many. Borenstein and Rose (1994) analyze price dispersion in the U.S. airline industry. The data of this thesis are the 10 percent random sample of U.S. airline (11 major U.S. airlines) tickets sold in the second quarter of 1986.

The tool of measuring price dispersion or inequality is the Gini coefficient (GINI) of fares paid on. The Gini coefficient of .10 implies the expected absolute price difference of 20 percent of the mean fare. They conclude that the expected difference in prices paid by two passengers selected at random on a route is about 36 percent of the airline's mean ticket price on the route. Meanwhile, the dispersion of the ticket price may are not only from variations in the serving different passengers’ costs, but also from discriminatory pricing.

One interesting discovery of this paper is that the price dispersion is positively related to the competition. The limitation of this paper is that the data of this paper could not test all the cost-based explanations of price dispersion, such as the most notably peak-load pricing under stochastic demand.

Leslie (2004) writes a model containing the second-degree and third-degree price discrimination. Using the example of Broadway Theater, the author builds the model of individual consumer behavior and monopoly price discrimination to analyze the welfare implications of price discrimination.

The data of this paper contain the price and quantity of the play sold for all 17 different ticket categories for all 199 performances of Seven Guitars in 1996. In this paper, the author builds various experiments to test the pricing policies, and conclude that the tested price discrimination increases the profit by 5%, compared to a policy of optimal uniform pricing.

Borzekowski, Thomadsen and Taragin (2005) also build one model to analyze the second-degree and the third-degree price discrimination. In this paper, the authors use the mailing lists' market to test the relationship between competition and price discrimination. The advantage, using the mailing list industry to analyze the model, is that that lists are zero marginal-cost goods. In other word, the different prices come from the different demand, and have nothing to do with the cost.

They test the sellers would prefer to classify consumers by providing a menu of choices (second-degree price discrimination) or providing different prices to different groups of consumers (third-degree price discrimination) in more competitive markets.

This paper concludes that mailing list industry increases the price discrimination as the market becomes more competitive, for both the second- and third-degree price discrimination. Specifically, as to the second-degree price discrimination, when the market becomes more competitive, the producer will offer more options on the menus to the customers. And the authors offer two reasons to support the conclusion.

Dhar and Hoch (1996) compare the effectiveness of in-store coupons (promote buys) and straight off-the-shelf price discounts (bonus buys), in generating incremental sales and profits for the retailer.

This thesis focuses on two different retailer in-store mechanisms to attract the customers. One is the off-the-shelf price discounts that offering the customers price discounts at check-out as the form of the point-of-purchase; the other is that offering the customers the in-store discount, and the coupon directly put in the front of the product.

The dataset of this thesis is that the results of five field tests in an 86 outlet supermarket chain. In the results of the five tests, coupons increase the profits by 35%, and the promoted items have a 108% greater increase in retailer profits than do the bonus buys with the same level of discount. The profits with coupons are greater than that with discounts, because of the redemption rate of 55%.

Finally, the authors conclude that unit category sales and dollar category profits are higher with coupons. Meanwhile, the findings are generalizable and hold over a wide range of parameter values.

However, the paper has some limits. The authors could not tell the difference between the theory-based explanations for the higher sales effect observed for coupons. And the author did not explain clearly the reasons why coupons generate the greater sales in the tests.

Locay and Rodriguez (1992) present the models that in the perfectly competitive market, the choice of the consumers are constrained by their groups' choices, and the price discrimination of a two-part price exists in such competitive market because of the constrains of the groups.

What is the extra content of the two-part price? The authors explain that the two-part price is composed of an entrance fee and the price of the rides. Take a movie theater as an example, the two-part price contains the entrance fee and the price of the popcorn. The entrance fee gives the consumers to have the right to watch a movie and purchase the popcorn.

After analyzing the data, the authors point out that the entry fee is less than the marginal cost, and the popcorn fee is above the marginal cost. Making the prices of the popcorn above the marginal cost, the movie theater will get more profits from the customer with large surplus than it will lose in the entrance fee. So the movie theater make the popcorn above the marginal cost is the optimal choice.

In sum, this paper has successfully shown that the group purchasing could constrain the individuals to allow price discrimination even in competitive industry.

Clemens (1951) states that the price discrimination and multiple product production are the essence of customary action. Unless the firm discriminate the pricing policy, or differentiate the product line, or invade new markets, he predicts that the firm will die in the market.

Using a spatial model of monopolistic competition, Borenstein (1985) examine third-degree price discrimination in free-entry, zero-profit markets.

Firstly, this paper eliminates the misunderstanding, and points out that the price discrimination exists in the free entry market.

Secondly, the paper introduces that classifying the reservation price and the strength of brand preference differentiates the price of the same product. In this part, the author provides that the consumers are different in the utility they get from the product, and in the strength of the preference on the different brands.

Thirdly, the author also conclude that, as to the same kind of product in the competitive market, sorting the products based on the strength of brand preference is more effective than selecting the products based on the reservation price of the consumers.

Stavins (2001) tests that the price discrimination is positively related to the competition of the airline market. More specifically, the author uses the marginal implicit prices of ticket restrictions (Saturday-night stayover requirements and advanced-purchase discounts) as a example for price discrimination and compares those marginal effects across routes to test the relationship between the airlines discrimination and the competition in that market.

The dataset contains the information about 5,804 tickets of the twelve routes' flights on a day: Thursday, September 28, 1995. Based on the information, the author concludes that price dispersion leads to ticket restrictions increases when market becomes more competitive, and that price discrimination decreases when the market concentrates.

Shepard (1991) analyzes the microdata on gasoline retailing to demonstrate the price discrimination based on willingness to pay for quality exists in multifirm markets.

This paper builds a experiment in which firms have same cost of production, but have different ability to discriminate the prices. And the different price structures of firms are the evidence of price discrimination.

The author compares the price difference of the gasoline between the multiproduct stations offering both full-service and self-service gasoline and the single-product stations offering only one of these two kinds of service. Obviously, a multiproduct station could price discriminate because it can set two prices, while a single-product station cannot because it has only one price.

The data used to test the price discrimination hypothesis are the retail prices and characteristics for all 1,527 stations in a four-county area in eastern Massachusetts. Finally, the data demonstrate that price discrimination at the retail level adds at least 9 cents a gallon to the average price of full-service gasoline.

Although the data supports the price discrimination hypothesis, the test is built on a single geographic area and has two limits. First, the distribution of retail configurations is not common. Second, these data pertain to a densely stationed area.

Besanko, Dube, and Gupta (2003) was trying to study whether a retailer could just base on the weekly store level aggregate sales and marketing-mix information to make targeted pricing.

The dataset of this thesis is the aggregate retail data, which is a novel approach relative to other papers. The retailers could access to these data. The authors estimate a discrete choice demand system with latent consumer segments, with a structural model of uniform pricing by manufacturers and the retailer.

Moreover, the authors point out that the taste heterogeneity of the customers makes it is possible for the retails to price discriminate by setting different prices across consumer segments.

Busse and Rysman (2005) study the association between competition and price discrimination in the market for Yellow Pages advertising.

The dataset of this paper is cross-sectional and contain the price for all advertisement sold at every directory published in1997 whose publisher is a member of the YPPA (YPPA is an industry trade group that represents 95% of the sales in the industry).

The authors conclude that the increased competition between directories leads to the decrease in prices. While the competition increases in this market, the rate of discounting increases. And the purchasers of the largest ads pay less per ad size relative to purchasers of small ads in more-competitive directories. In other words, an increase in the competition measure is that one additional competitor is associated with a more than 12% lower full-page ad price, but only a 6% lower price for a quarter-column ad.

Khan and Jain (2005) analyze that the retailers usually use different kinds of price discrimination to increase profits. In this paper, the authors compare the results of the two price discrimination mechanism: quantity discounts based on package size (second-degree price discrimination) and store-level pricing or micromarketing (third-degree price discrimination).

The dataset of this paper come from a large supermarket in the Chicago area. Comparing the profits from quantity discounts based on package size to store-level pricing, the author conclude that the quantity discount set on the package size contributes more to profits than setting the store-level pricing. And the reason is that quantity discounts could catch a larger part of the heterogeneity in demand than the store-level pricing does.

Cohen (2006) builds a structural model of consumer demand and firm pricing behavior to test the effects of multiple package sizes in the paper towel industry. And this model is based on two assumptions: (1) each brand may only offer its small size; (2) each brand must charge a uniform unit-price for all its sizes.

The data are collected from 64 cities and 8 quarters (1997- 1998) by Information Resources Incorporated (IRI). The sample contains the price and volume measures for each of the paper towels, and almost 512 potential observations on each product.

Basing on the data and the model, the author indicates that competition in the multi-roll package size segment increases the consumer surplus and reduces the retail prices. Meanwhile, the measure indicates that 34 - 46% of the price discounts comes from the price discrimination, with the rest being cost-driven. Finally, the author states that consumers purchasing multi-roll packages could get more options and lower prices, and consumers purchasing one-roll packages could get the lower prices because the multi-roll segment make the market more competitive.

In this thesis, we collect the medicine prices of America and China, and compare them together. Some economists already worked on many papers about the cross-national differences in pharmaceutical prices. Danzon and Furukawa (2003) has compared average price levels for pharmaceuticals in eight countries—Canada, Chile, France, Germany, Italy, Japan, Mexico, and the United Kingdom—relative to the United States.

The dataset of this paper are about the manufacturer-price levels, from the IMS Health Midas. The unit of analysis in the dataset is the molecule-indication, and they are the active ingredient and the IMS three-digit anatomical therapeutic class. Meanwhile all these data are the represents of the originator products, not the small numbers of some products. So the dataset of this paper is more accurate.

And the result of the comparison is that the Japan's prices are higher than U.S. prices, other countries' prices are from 6% to33% lower than U.S. prices, and Canadian prices to be the lowest.

CHAPTER THREE

METHODOLOGY & HYPOTHESIS

In order to study the price discrimination among the different strengths, we choose the drugs with different strengths, and calculate the price per mg/ml and the price per pill/capsule/bottle. The formula to calculate the price per mg/ml and the price per pill/capsule/bottle:

$$\text{Price per mg/ml} = \frac{\text{price per package}}{\text{number of the drugs in package} \times \text{strength of each drug}}$$

$$\text{Price per pill/capsule/bottle} = \frac{\text{price per package}}{\text{number of the bottle/pill/capsule in package}}$$

All the calculation is based on the price per mg/ml. We calculate the mean and the standard deviation of the price per mg/ml. Regard to a drug with different strengths, the mean expresses the average price of price per mg/ml, and the standard deviation denotes the discrete degree of the prices per mg/ml. More specifically, the mean of the prices per mg/ml shows the price of this drug, and the standard deviation means the degree of the price discrimination among different strengths.

We classify the drugs based on the diseases that the drugs are used to heal. The drugs are classified to 8 categories. And they are Anti-infective, Cardiovascular system drugs, and so on (for details see Appendix).

Basing on the data, we use the mortality of diseases, the number of the strengths, the nations of the drugs, the mean of the price per mg/ml, and the different kinds of drugs to analyze the price discrimination.

Then we list the presumptions of our models.

Firstly, the number of the existing unique drugs in one category is one of the factors affect the price discrimination. Compared to other drugs, the number of the existing anti-infective drugs is the largest. So the replacement of the anti-infective is higher than any other drugs. The replacement of the products is positively related to the price elasticity of demand (absolute value).

Thus, the productions of the anti-infective could not increase too much price. If the price of the anti-infective is higher than other anti-infective drugs, the customer may choose other anti-infective drugs. So we conclude that the price elasticity of the anti-infective is the highest and the price discrimination of the anti-infective drugs is the lowest.

The drug's price is the second factor affecting the price discrimination. In this situation, the producer classifies the customer by the purchase ability. Different group of customer will choose different drugs with the different prices. The customers with the high purchase ability prefer to buy the best drugs in this field. Sometimes the high prices imply the high quality. So if the producers increase the price discrimination among the kind of drugs, the sales of the drugs with high prices could not change and the profits of these drugs increase. We conclude that the price of the drugs is positively related to the price discrimination.

Another factor is the mortality rate of the disease. The mortality rate is higher, which means the scale of the consumers is large. If the customers of the drug spread widely, the producer needs to produce too many different kinds of strengths to satisfy the demand. In other words, this kinds of drugs should have more different strengths than other drugs healing the high mortality rate disease. Thus, compared to the drugs healing the low-mortality rate disease, the drugs healing the high-mortality rate disease have the higher price discrimination among the different strengths.

Meanwhile, the fourth factor is the number of the different strengths among any unique drugs. The producers provide much different strengths of one unique drug to increase the price discrimination. Based on the different demand of the drug, the produce classify the drugs into different strengths every pills. They try to sell the drug to different groups of consumer to earn the largest profits. The policy that the producer makes one drug into different strengths helps the producer to take the price discrimination. In other word, the larger number of the different strengths among one unique drug means the higher price discrimination among different strengths. Thus, we assume that the number of different strengths is positively related to the price discrimination within the different strengths.

The last factor is the different health system among different countries. We use the drug's prices from the USA and China. The price discrimination of these two countries must be different. In the USA, the foundation and the development of the drug's market are based on the rules of the market, not the control of the government. On the other hand, 90 percentage of the Chinese health care market is still owned by the public hospitals. This market has not really turned into the "privacy". In order to increase the profits, these hospitals take the rule that "using the drugs to supply the doctors". Then chief aim of the hospitals is not to serve the patient, but rather selling the drugs. Usually after the hospital has bought from the drug's producers, the drug's price has been increase by 15%. But the reality is more than that ratio, because of that rule. So we could think the price discrimination of different strengths in China is higher than that in the USA.

CHAPTER FOUR

DATA

We choose 118 unique drugs from two countries' markets, China and the USA. Among these unique drugs, 58 are the USA drugs, and 60 are Chinese drugs. And every unique drug contains different strengths with different prices.

The prices of the Chinese drugs come from the Panwan hospital and <yy.jspn.net>. Panwan is my hometown, and the whole town just has one hospital; and website is the official website to public the prices of drugs in the whole province. The prices of the USA drugs come from <Medco.com> (Pricing Strategies in Pharmaceuticals Retail, Chorniy & Maloney, 2010).

On the other hand, we get the mortality rate of different drugs from the WHO. We use the report of the global burden disease (2008) (website: http://apps.who.int/ghodata/?vid=10012#). We use the mortality rate of the region of the Americas denotes the mortality rate of the USA, and the mortality rate of the Western Pacific Region denotes the mortality rate of the China. The formula for the mortality rate of the disease:

$$Mortality\ \text{Rate} = \frac{The\ \text{number of the dead people}}{The\ \text{number of the total population of this region}} \times 1000‰$$

How to find the diseases that the drugs are used to heal? The standard of classifying is from the Chinese website <souhu.com>. In this website, it has a medicine and health channel, where you could check which diseases that drug is used to treat. And the Appendix already has the categories of diseases. Then we get the categories of the drugs, based on the Appendix. We give an example to express how we related the drugs to these 8 categories. Just take the central nervous system drugs as an example (see table 4.1).

Basing on the prices per mg/ml of every drug, we count the means and standard deviations of the prices per mg/ml. Then we count the means and the standard deviations of the mean of the price per mg/ml, the standard deviation of the price per mg/ml, and the number of different strengths in every specified category.

Finally, the table 4.2 is the results. And in this table, the number of the observation is the totally number of drugs, not just the unique drugs.

From that table, the means of the price per mg/ml of the anti-infective drugs in two countries have the least standard deviations among all drugs, and the standard deviations of the price per mg/ml of the anti-infective drugs have the smallest standard deviation among all drugs of two countries.

Table 4.1 : Central Nervous System Drugs

disease		the USA drugs	China drugs
Epilepsy	→	Keppra Trileptal Zonegran	Clonazepam
Insomnia (primary)		Lunesta	Nitrazepam Hydrochloride
Parkinson disease		-------	Levodopa
Alzheimer and other dementias	→	Exelon Namenda	Piracetam

Schizophrenia →	Abilify Geodon	Clozapine
Alcohol use disorders →	Campral Cancidas	-------
Migraine	Axert	--------
Unipolar depressive disorders	Cymbalta	--------

Table 4.2 – Summary

		the USA				China			
			price				price		
Disease		number of different strengths	mean ($)	standard deviation	obs	number of different strengths	mean($)	standard deviation	obs
Anti-infective	mean	2.875	0.072	0.038	23	3.214	0.003	0.001	90
	sd	(1.458)	(0.116)	(0.092)		(1.101)	(0.004)	(0.001)	
Cardiovascular System	mean	4.250	3.644	2.402	17	5.200	0.021	0.014	24
	sd	(1.258)	(6.881)	(4.494)		(2.387)	(0.039)	(0.029)	

Antineoplastic	mean	2.500	12.418	3.638	14	2.800	0.267	0.081	14
	sd	(0.837)	(12.844)	(8.695)		(0.447)	(0.516)	(0.128)	
Gastointestinal Tract	mean	3.000	13.16	4.171	15	3.800	0.007	0.001	18
	sd	(1.732)	(19.064)	(6.388)		(2.168)	(0.009)	(0.001)	
Central Nervous system	mean	4.833	1.406	0.687	58	4.800	0.003	0.001	24
	sd	(3.099)	(1.915)	(0.779)		(1.304)	(0.006)	(0.001)	
Hematologic	mean	3.667	6.238	1.802	11	5.000	0.234	0.349	20
	sd	(0.577)	(10.676)	(3.109)		(3.162)	(0.439)	(0.698)	
Hormonal	mean	2.643	30.065	17.002	37	3.000	0.003	0.003	6
	sd	(0.633)	(90.616)	(53.668)		(1.414)	(0.003)	(0.004)	
Immunologic	mean	3.000	6.250	0.058	6	6.500	1.645	0.986	13
	sd	(0.000)	(5.194)	(0.056)		(2.121)	(2.256)	(1.369)	
Genitourinary System	mean	2.5	0.296	0.138	10	3.250	1.078	0.040	13
	sd	(1.000)	(0.297)	(0.141)		(0.957)	(1.933)	(0.075)	

CHAPTER FIVE

RUSULTS

Because we could not find the mortality rates of some drugs or the mortality rates of all drugs in the same category are the same, we firstly analyze the price discrimination of five categories' drugs, such as the anti-infective drugs, gastrointestinal tract drugs, cardiovascular system drugs, Central nervous System drugs and Antineoplastic drugs with mean, number of different strengths, mortality and so on. Then, we analyze the price discrimination of all drugs we collected without the mortality variables.

Firstly, we analyze the regression model of five different categories' drugs. We suppose that the mean, the number of different strengths, the mortality rate, and the mean of the price per mg/ml are the independent variables, and the standard deviation is the predicted value of the dependent variable.

$$\text{Standard Deviation} = \hat{\beta}_o + \hat{\beta}_1 \textit{Mean}\ \text{Price} + \hat{\beta}_2 \textit{Number of Different Strengths} + \hat{\beta}_3 \textit{Mortality} \quad \text{(Model I)}$$

And the results of the Model I are in the Table 5.1. In the Table 5.1, the values of most R-squares are very close to the 1. As we all know that the closer the R-square is to one, the better our model is. If the R-square equals to one, the linear regression provides the perfect predictions. So the linear regressions we used in this thesis could explain how the factors affect the prices discrimination.

From Table 5.1, all the mean's the parameter estimates are positive, which is the same as we predict. As to the mortality rate of the diseases and the numbers of different strengths, we could not get the unique conclusion for all these different categories' drugs.

Then we put all the data of these five categories' drugs together to build the Mortality Sample Model. We set the mean, the number of different strengths, the mortality rate, and the mean of the price per mg/ml to be the independent variables, and the standard deviation of the price per mg/ml to be the dependent variable.

$$\text{Standard Deviation} = \hat{\beta}_o + \hat{\beta}_1 \textit{Mean}\ \text{Price} + \hat{\beta}_2 \textit{Number of Different Strengths} + \hat{\beta}_3 \textit{Mortality} + \hat{\delta} T_i + \hat{\alpha}_1 D_{1i} + \hat{\alpha}_2 D_{2i} + \hat{\alpha}_3 D_{3i} + \hat{\alpha}_4 D_{4i}$$

（Mortality Sample Model）

We use the T_i to stand for the nations, and the D_i to stand for the standard deviation of different kinds of drugs. When T_i=1, the equation stands for the standard deviation of USA drugs; when T_i=0, the equation stands for the standard deviation of the China drugs. When D_{1i}=1, the equation stands for the standard deviation of the anti-infective drugs; when D_{1i}=0, the equation stands for the standard deviation of the other drugs. When D_{2i}=1, the equation stands for the standard deviation of the anti-neoplastic drugs; when D_{2i}=0, the equation stands for the standard deviation of the other drugs. When D_{3i}=1, the equation stands for the standard deviation of the cardiovascular drugs; when D_{3i}=0, the equation stands for the standard deviation of the other drugs. When D_{4i}=1, the equation stands for the standard deviation of the central nervous system drugs; when D_{4i}=0, the equation stands for the standard deviation of the other drugs. When $D_{1i}=D_{2i}=D_{3i}=D_{4i}=0$, the equation stands for the standard deviation of the gastrointestinal tract drugs.

The results of this Mortality Sample Model are in Table 5.3. The price discrimination of the antineoplastic drugs is the smallest. And the parameter estimator of α_5 is -0.269, which means the standard deviation of the antineoplastic drugs is lower 0.269 than that of the gastrointestinal tract drugs, which is lowest compared to other 3 drugs. Because we use the standard deviation to test the degree of the price discrimination, the price discrimination of the central nervous system drugs is the smallest, which is not the same as we predict.

The price of the drugs is positively related to the price discrimination among the drugs with different strengths. The parameter estimator of the β_1 is 0.398, which is same as our assumption. And the mortality rate is negatively related to the price discrimination, and the parameter estimator of the β_3 is 601.109, the same as our assumption. On the other hand, the numbers of different strengths' parameter estimates is 0.099, which is the same as our prediction.

The last discover is that the standard deviation of the American drug's prices is smaller than the standard deviation of the Chinese drug's prices. From table 5.3, the parameter estimator of δ is -0.107, which proves the standard deviation of the Chinese drugs is higher 0.107 than that of the USA drugs. So we could conclude that the price discrimination of the USA drugs is smaller than that of the Chinese drugs.

Basing on this Mortality Sample Model, we eliminate one variable, the mean of the price per mg/ml, to check whether the results might change or not. And the results are still in table 5.3. The Mortality and the number of different strengths are still positively related to the standard deviation. But the price discrimination of the USA drugs is higher, and the price discrimination of the central nervous drugs is the lowest.

Thirdly, we analyze the regression model including all the drugs we collected. Compared to the Mortality Sample Model, the Full Sample Model eliminates one dependent variable, the mortality rate of the disease, and adds the data of the hematologic drugs, the hormonal drugs, the immunologic drugs, and the genitourinary system drugs.

$$\text{Standard Deviation} = \hat{\beta}_o + \hat{\beta}_1 Mean\ \text{Price} + \hat{\beta}_2 Number\ of\ \ Different\ Strengths + \hat{\delta}T_i$$
$$+\hat{\alpha}_1 D_{1i} + \hat{\alpha}_2 D_{2i} + \hat{\alpha}_3 D_{3i} + \hat{\alpha}_4 D_{4i} + \hat{\alpha}_5 D_{5i} + \hat{\alpha}_6 D_{6i} + \hat{\alpha}_7 D_{7i} + \hat{\alpha}_8 D_{8i}$$
(Full Sample Model)

In this model, we still use the T_i to stand for the nations, and the D_i to stand for the standard deviation of different kinds of drugs. Compared to the Mortality Sample Model, this model just includes four new letters. When D_{5i}=1, the equation stands for the standard deviation of gastrointestinal tract drugs; when D_{5i}=0, the equation stands for the standard deviation of the other drugs. When D_{6i}=1, the equation stands for the standard deviation of the hematologic drugs; when D_{6i}=0, the equation stands for the standard deviation of the other drugs. When D_{7i}=1, the equation stands for the standard deviation of the hormonal drugs; when D_{7i}=0, the equation stands for the standard deviation of the other drugs. When D_{8i}=1, the equation stands for the standard deviation of the immunologic drugs; when D_{8i}=0, the equation stands for the standard deviation of the other drugs. When $D_{1i}=D_{2i}=D_{3i}=D_{4i}= D_{5i}=D_{6i}=D_{7i}=D_{8i}= 0$, the equation stands for the standard deviation of the genitourinary system drugs. Other letters have the same mean as the same letters of the Mortality Sample Model have.

The results of the Full Sample Model are in table 5.3. The mean, the mean of the price per mg/ml and the number of the different strengths are still positively related to the price discrimination. Meanwhile, the price discrimination among the USA drugs is still lower 0.967 point than the price discrimination among the Chinese drugs. And the price discrimination of the immunologic is the smallest. The parameter estimates of α_8 is -1.796.

Meanwhile, we eliminate the variable, the mean of the price per mg/ml. All the results are in table 5.3. The mortality rate of the diseases is negatively related to the price discrimination, the price discrimination of the USA drugs is higher, and the price discrimination of the central nervous drugs is the lowest.

Moreover, we have discovered one situation that the differences of some drugs' prices with the different strengths are very small. We count the price per pill/bottle/capsule and find that most of them do not have too much difference. And the situation is common in the USA and the Chinese drugs. Such as the cefadroxil (Chinese drugs), 0.039 dollars/pill with 250mg, and 0.037 dollars/pill with 125mg. Among the USA drugs, some of the same drugs with different strengths have almost the same price per pill/bottle/capsule. For instance, Vesicare has the same price, 4.38 dollars, with the 5mg and 10mg. Basing on that situation, we could conclude that the pricing of the drug is almost like the flat pricing. Because the pricing of the drugs is not based on the marginal cost of the materials, is based on the technology of developing the drugs. So whatever how much mg/ml you bought, you just need to pay for almost the same price.

Finally, in this whole thesis, we exchange the yuan to dollar, and the exchange rate of one renminbi is 0.1547 dollars.

Table 5.1-Results of the Model I

	Parameter Estimate									
	Anti-infective		Antineoplastic		Cardiovascular System		Central Nervous System		Gastrointestinal Tract	
	the USA	China	the USA	China	the USA	China	the USA	China	the USA	China
Intercept	0.062	-4.574e-05	-15.133	-0.017	-0.161	9.4e-04	0.032	-1.64e-03	1.279	-4.71e-06
	(0.053)	(4.548e-04)	(5.960)	(0.117)		(0.006)	(0.411)	(0.002)	(2.100)	(6.443e-04)
Mortality	-86.488	2.256	-14520	-31.631	-5152.197	2.373	277.968	-16.620	-40778	0.3946
	(82.838)	(1.333)	(20841)	(63.923)		(7.799)	(2021.215)	(31.776)	(36176)	(6.978)
Number of different strengths	-0.031	-1.241e-04	7.312	0.016	0.027	-7.375e-04	0.038	4.203e-04	-0.071	8.48e-06
	(0.020)	(1.303e-04)	(2.623)	(0.036)		(0.002)	(0.061)	(4.132e-04)	(0.371)	1.190e-04
Mean Price	1.105	0.254	0.208	0.265	1.015	0.741	0.325	0.217	0.318	0.090
	(0.206)	(0.031)	(0.196)	(0.054)		(0.061)	(0.099)	(0.063)	(0.032)	(0.030)
R-square	0.984	0.741	0.923	0.996	1	0.995	0.579	0.926	0.993	0.917
Obs	8	28	6	5	4	5	12	5	5	5

Table 5.2-Summary Statistics for the Mortality Sample Model and the Full Sample Model

Variables:	Mortality Sample	Full Sample
Mean Price	2.1	5.388
	(6.955)	(32.13)
Standard Deviation Price	0.739	2.618
	(3.041)	(18.838)
Mortality	1.717e-04	-------
	(2.472e-04)	
Number of Different Strengths	3.627	3.534
	(1.859)	(1.791)
Anti-infective	0.434	0.305
	(0.499)	(0.462)
Antineoplastic	0.133	0.093
	(0.341)	(0.292)
Cardiovascular System	0.108	0.076
	(0.312)	(0.267)
Central Nervous System	0.205	0.144
	(0.406)	(0.353)
Gastrointestinal Tract	-----	0.085
		(0.28)
Hematologic	------	0.059
		(0.237)
Hormonal	------	0.136
		(0.344)
Immunologic	------	0.034
		(0.182)
the USA (Yes=1)	0.422	0.492
	(0.497)	(0.502)

Table 5.3-Results of the Mortality Sample Model and Full Sample Model

	Mean Price Including		Mean Price Not Including	
	Mortality Sample	Full Sample	Mortality Sample	Full Sample
	Parameter Estimate	Parameter Estimate	Parameter Estimate	Parameter Estimate
Intercept	-0.848	-0.322	1.122	0.001
	(0.671)	(0.960)	(1.226)	(7.855)
Mortality	601.109	-------	606.699	-------
	(825.339)		(1544.824)	
Number of different strengths	0.099	0.172	0.025	-0.367
	(0.106)	(0.138)	(0.199)	(1.128)
Mean Price	0.398	0.585	-------	-------
	(0.029)	(0.007)		
the USA(yes=1)	-0.107	-0.967	1.704	2.288
	(0.412)	(0.486)	(0.730)	(3.962)
Anti-infective	0.458	-0.003	-1.675	0.652
	(0.602)	(0.915)	(1.089)	(7.493)
Antineoplastic	-0.269	-1.614	-0.286	1.74
	(0.733)	1.078	(1.372)	(8.818)
Cardiovascular System	0.612	0.054	-1.160	1.812
	(0.794)	(1.155)	(1.466)	(9.456)
Central Nervous System	0.511	0.082	-1.983	0.641
	(0.678)	(1.039)	(1.222)	(8.501)
Gastrointestinal Tract	------	-1.542	------	2.189
		(1.102)		(9.016)

Hematologic	-------	-0.693 (1.218)	-------	1.617 (9.966)
Hormonal	-------	0.2 (1.031)	-------	13.861 (8.342)
Immunologic	--------	-1.796 (1.443)	-------	1.121 (11.805)
R-square	0.757	0.986	0.138	0.073
Observations	83	118	83	118

Figure 5.1- The Standard Deviation VS the Mean of Price per mg/ml

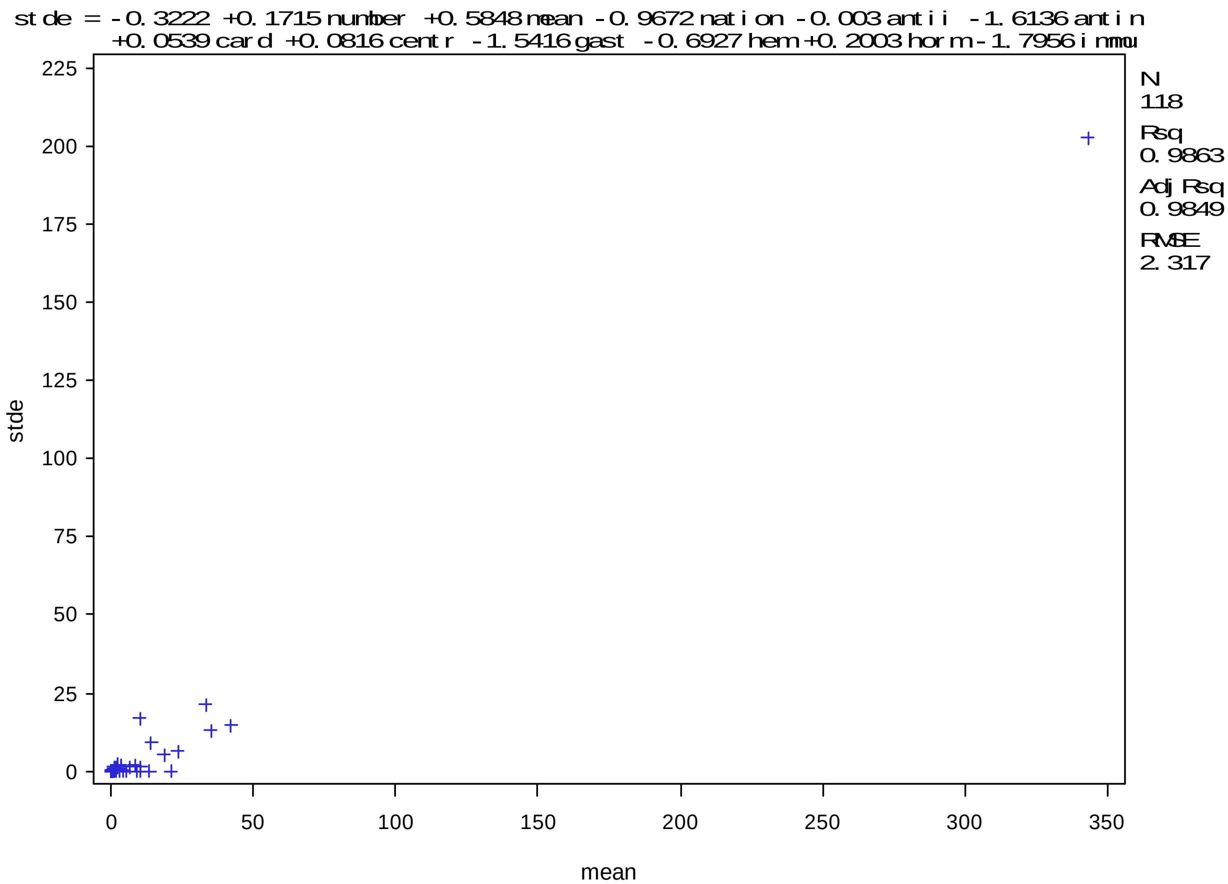
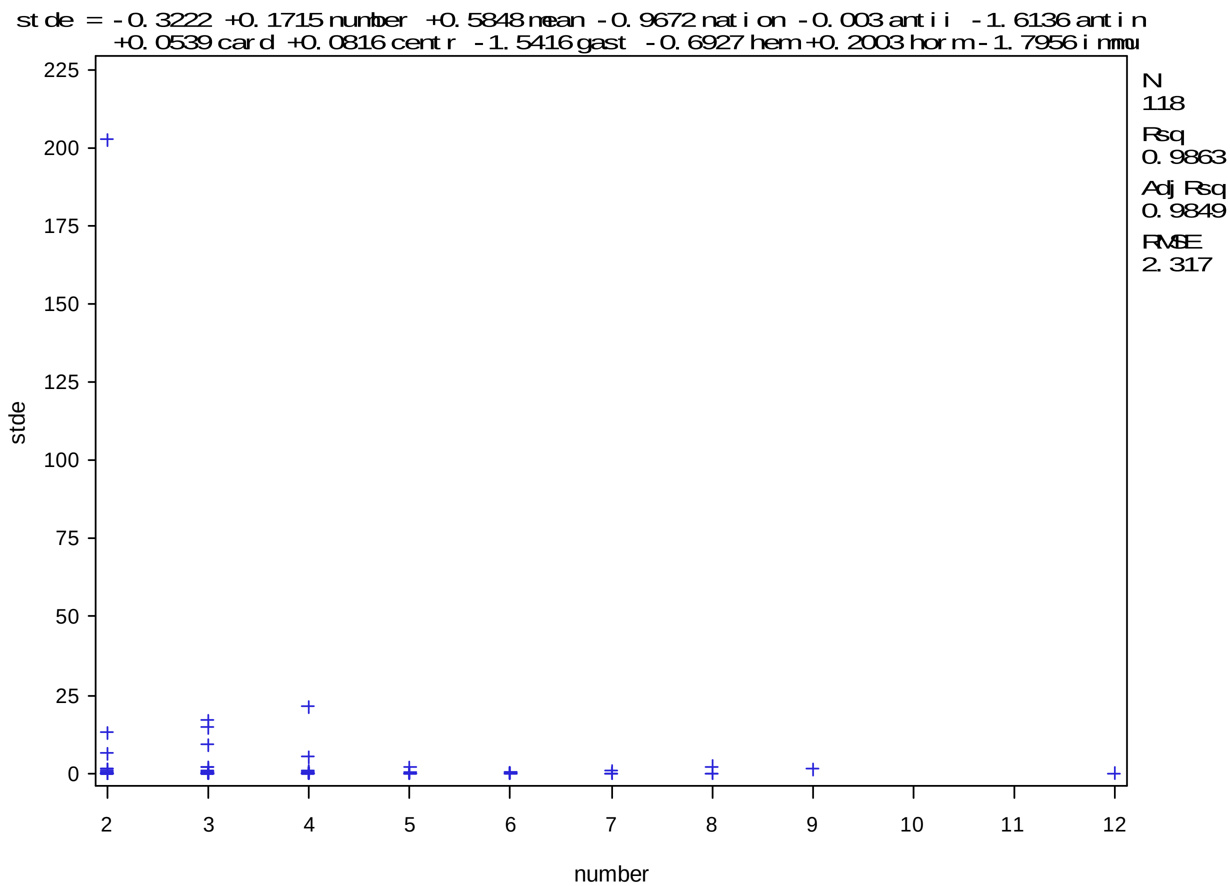


Figure 5.2- The Standard Deviation VS the Number of Different Strengths



CHAPTER SIX

CONCLUSION

The topic of the price discrimination is not very new topic, and many economists have study this topics in many field. However, just few papers discuss the price discrimination among the drugs with different strengths. Because usually we do not pay attention to that the price per mg/ml of the same drug is different among different strengths.

Meanwhile, the drug market is one of the perfect examples to study the price discrimination. Price discrimination means the producers offer same product or service to different customer with different prices. Not every producer has the power of carrying out the price discrimination. And the drug market satisfies these two conditions.

The assumption of this thesis is that five factors may affect the degree of price discrimination. They are the existing number of the unique drugs in each category, the prices of the drugs, the number of the different strengths among one unique drug, the mortality rate of the diseases and the policies of the different governments. In order to demonstrate the assumption, we have observed the two countries' drug markets. We just choose the drugs with different strengths, and sort them out, based on the diseases that they are used to treat. The mean and the standard deviation of the price per mg/ml are two parameters to testify the hypothesis.

Finally, the data set supports most hypotheses. We could conclude that the degree of price discrimination is positively relative to the price of drugs, the number of the different strengths and the number of the different strengths in any unique drug, and the degree of the price discrimination in the USA drug's market is lower than the Chinese drug's market. Based on what we have found, customer could reduce the cost by choosing the drugs with high strengths, if there is no special strength limits.

APPENDIX

Table A1. Broad class categories as in Nursing Drug Handbook, 2011

	Anti- infective (163)	
amebicides, antiprotozoals,	aminoglycosides	tetracyclines
and anthelmintics	penicillins	antivirals
antituberculotics	sulfonamides	local anti-infectives
antifungals	scabicides and	fluoroquinolones
antimalarials	pediculicides	antiretrovirals
macrolide anti-infectives	cephalosporins	miscellaneous
	Cardiovascular system drugs (139)	
	vasodilators	miscellaneous
antianginals	antiarrhythmics	antihypertensives
antilipemics	vasopressors	
diuretics	inotropics	
	Hematologic drugs (50)	
	platelet drugs	antianemics
thrombolytic enzymes	anticoagulants	
blood derivatives	neutropenia drugs	
	Central nervous system drugs (178)	
alzheimer's disease drugs	sedative-hypnotics	antipsychotics
antiparkinsonians	CNS stimulants	antidepressants
anxiolytics	anticonvulsants	attention deficit
antimigraine drugs	nonsteroidal anti-	hyperactivity disorder
nonopioid analgesics and	inflammatories	drugs
antipyretics	opioid analgesics	
	Musculoskeletal system drugs (30)	
skeletal muscle relaxants	antirheumatics	neuromuscular blockers
parathyroid-like drugs	antiresorptive drugs	antigout drugs
	Respiratory tract drugs (47)	
antihistamines	bronchodilators	miscellaneous
	Gastrointestinal tract drugs (77)	

- antacids, absorbents, and antiflatulents
- bowel disorder drugs
- antiemetics
- miscellaneous
- antiulceratives and reflux drugs
- antidiarrheals
- laxatives

Genitourinary system drugs (17)

- benign prostatic hyperplasia drugs
- erectile dysfunction drugs
- incontinence drugs
- miscellaneous

Hormonal drugs (103)

- androgens and anabolic steroids
- estrogens and progestins
- fertility drugs
- thyroid hormones
- parenteral antidiabetics and glucagon
- steroidal anti-inflammatories
- oxytocics
- pituitary hormones
- thyroid hormone antagonists
- topical anti-inflammatories
- oral antidiabetics

Antineoplastic (85)

- Antineoplastic that alter hormone balance
- antimetabolites
- alkylating drugs
- antibiotic Antineoplastic
- antimitotic drugs
- miscellaneous

Immunologic drugs (37)

- immunosuppressants
- immunomodulators
- immune serums

Ophthalmic and nasal drugs (52)

- ophthalmic anti-inflammatories
- miotics and mydriatics
- antiglaucoma drugs
- ophthalmic vasoconstrictors and antihistamines
- ophthalmic anti-infectives
- nasal drugs

Miscellaneous categories* (68)

- antagonists and antidotes
- electrolyte balancing drugs
- nutritional drugs
- uncategorized drugs

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* includes the categories created by me in addition to NDH

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