ISCTE Business School
Instituto Universitário de Lisboa

The Relationship between China's Population Aging and Growing Antihypertensive Drug Market

Lin Jianning

Thesis submitted as partial requirement for the conferral of the degree of

Doctor of Management

Supervisor:

Prof. Elizabeth Réis, Full Professor, ISCTE University Institute of Lisbon

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Declaration

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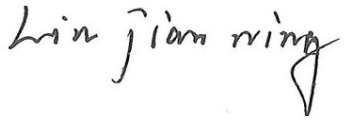
Signed:  Date: 2014-11-24

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Abstract

China has become an aging society with the largest aging population in the world. As in any developed country that has become an aging society, population aging has an influence on almost all aspects of economic and social development. Among the disease problems, common diseases among the middle-aged and old and drugs for chronic diseases are important because they will directly influence the development of the antihypertensive drug market.

Based on research carried out both for China and for foreign countries, this thesis discusses the problems facing the development of the antihypertensive drug market in the context of population aging. The main body of this thesis attempts to answer the following questions: firstly, what's the relationship between the increasingly severe aging problem and the growing antihypertensive drug market? Secondly, what are the features of the antihypertensive drug market in the context of population aging? And thirdly, as the aging problem becomes more and more severe, what is the trend in the development of the antihypertensive drug market and how to cope with it?

This thesis, starting with the world's and China's population aging problem, tries to shed light on influencing factors of the population aging problem in China on the antihypertensive drug market. Through regression analysis, this thesis constructs a model to estimate the relationship between population aging in China and the growth of the antihypertensive drug market. The model shows that, in the context of an aging society, the growth of the antihypertensive drug market is affected by the increases in government's health care expenditure, by the population aged 65 and above and by the amount of health care costs. These results allow answering the first question above.

A regression model is applied to sort out the influencing factors of the population aging on the antihypertensive drug market. To learn more about the features of use of antihypertensive drugs in practice, this thesis analyzes the features of the two main actors involved in the antihypertensive drug market in reality, namely, the practitioner and the patient. According to the results, in the context of population aging, the population of those seeking medical advice increases at a slower rate than the population of patients, the cost

for receiving treatment increases relatively fast, drugs produced by foreign invested enterprises and joint ventures are more often used than those produced by domestic enterprises, and improper use of drugs as a usual practice, are all features of the antihypertensive drug market. These results allow answering the second question above.

As for the third question, through the regression model, the antihypertensive drug market is estimated to grow more rapidly as population aging intensifies, assuming that current policies and economic environment will not change. To address this problem, it is suggested that management of chronic diseases among old people should be improved, that government's health care expenditure be rationally allocated and that the development of national pharmaceutical enterprises be promoted.

Key Words: Population Aging, Antihypertensive Drug Market, Regression Model
JEL Classification: J14, I11, C20

Resumo

A China transformou-se numa sociedade envelhecida com a maior população de idosos no mundo. Tal como em qualquer outra sociedade desenvolvida que envelheceu, na China o precesso de envelhecimento populacional influencia quase todos os fatores de desenvolvimento económico e social. Entre os mais importantes problemas de saúde da população encontram-se as doenças que afetam a população de meia idade e os idosos e os medicamentos para doenças crónicas, pelo efeito direto que têm sobre o mercado dos medicamentos antihipertensores.

Esta tese analisa os problemas com o desenvolvimento do mercados de medicamentos antihipertensores, num ambiente de envelhecimento populacional, com base em investigação realizada, quer para o mercado Chinês, quer para outros países, e que tenta responder às seguintes três questões: primeira, qual a relação entre o crescente envelhecimento populacional e o crescimento do mercado de medicamentos antihipertensores? Segunda, quais as características do mercado de medicamentos antihipertensores num ambiente de envelhecimento populacional? E terceira, à medida que o problema do envelhecimento populacional se agrava, qual a tendência prevista pera o desenvolvimento desse mercado e como adaptar-se a essa tendência?

Esta tese, começando por analisar o problema do envelhecimento populacional no mundo e na China, procura salientar os fatores relacionados com esse envelhecimento que influenciam o mercado de medicamentos antihipertensores. Através da análise de regressão, esta tese estima um modelo explicativo do crescimento do mercado de medicamentos antihipertensores a partir de variáveis relacionadas com o envelhecimento populacional. As estimativas encontradas mostram que, num ambiente de envelhecimento populacional, o crescimento do mercado de medicamentos antihipertensores é explicado sobretudo pelo aumento da despesa governamental em serviços de saúde, pela população com 65 ou mais anos, e pelos custos de serviços de saúde. Estes resultados permitem responder à primeira questão anteriormente colocada.

Para compreender como são utilizados e prescritos os medicamentos antihipertensores na prática, foram analisados os resultados de um inquérito aos dois principais atores do

Mercado de medicamentos antihipertensores, nomeadamente os medicos e os doentes. De acordo com esses resultados, e num contexto de envelhecimento populacional, a população que procura aconselhamento médico cresce a uma taxa inferior à da população de doentes, o custo de tratamento cresce relativamente rápido, é maior a prescrição e utilização dos medicamentos produzidos por empresas com investimento estrangeiro e joint ventures do que os que são produzidos por empresas nacionais, e a utilização imprópria dos medicamentos como prática corrente, são as principais características do mercado de medicamentos antihipertensores. A partir destes resultados é possível responder à segunda questão de investigação.

A resposta à terceira questão é dada com auxílio a previsões encontradas a partir dos modelos de regressão estimados: estas previsões apontam para um rápido crescimento do mercado de medicamentos antihipertensores à medida que o envelhecimento populacional se acentua, pressupondo-se que não existirão mudanças ao nível dos ambientes políticos e económicos. Para minimizar este problema, sugerem-se mudanças a três níveis: melhoria na gestão de doenças crónicas da população idosa, alocação mais racional das despesas governamentais em saúde e promoção das empresas farmacêuticas nacionais.

Palavras Chave: Envelhecimento populacional, Mercado Medicamentos Antihipertensores, Modelos de Regressão

Classificação JEL: J14, I11, C20

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Chapter 1: Introduction

1.1 Research Background

1.1.1 Acceleration of Population Aging

Population aging refers to the process of social development in which the proportion of the aged population against the total population increases because the life expectancy in a country or a region prolongs gradually. As provided by the general international standard, a society will be deemed an aging society when people aged 60 or above in this country or region takes up more than 10% of the total population or when people aged 65 and above accounts for more than 7% of its total population (Li, 2010). In the academic circles, population aging is usually assessed by such indicators as the total population of people aged 60 or 65 and above, the percentage of such population and the age dependency ratio (Chen, & Hu 2012).

China has actually become an aging society. In 2000, people aged 65 and above took up more than 7% of China' total population (Chen, & Hu 2012). According to the *World Population Prospects* issued by the United Nation, the aging population in China will grow very fast in the first half of the twenty-first century and then stay large on the second half. The trend will be noticed in terms of the size of the aging population, the proportion of aging population against the total population and the dependency ratio. Firstly, from 2000 to 2050, the size of the aging population will expand quickly and remain large in the second half of the twenty-first century. Statistics from the UN shows that, in 2000, there are 130 million people aged more than 60 and 13.62 million people aged more than 80 in China. Based on the demographic transition of medium fertility, the size of the population of the same ages is estimated to be 440 million and 98.39 million respectively, equal to 3.4 times and 7.2 times of that in 2000 (Population Reference Bureau, 2001). Secondly, the percentage of aging population in China will increase substantially and remains large for a long time, which is consistent with the trend in the size of the aging population. The

population aged more than 60 will reach its peak in 2055, taking up approximately 36.5% of the total population. Thirdly, the dependency ratio of the aging population in China will markedly increase and stay at a high level. The dependency ratio is an age-population ratio of those typically not in the labor force to those in the labor force, showing how many elderly people 100 working people support. China's age dependency ratio changed slowly before 2000. However, it grew fast when the twenty-first century came, reaching its peak of 50% in 2058 and after that remaining steady. The fast growing aging population is an important fact and the most obvious feature of China's population aging (Xu, 2011).

Table 1-1 The proportions of population aged more than 60 in China's total population of 2007 to 2014

Year	Population aged more than 60 (million)	Proportion in China's total population (%)
2007	153.40	11.6
2008	159.89	12
2009	167.14	12.5
2010	177.65	13.26
2011	184.99	13.7
2012	193.90	14.3
2013	202.43	14.9
2014	212.42	15.5

Source: Ministry of Civil Affairs of the PRC (2015)

1.1.2 Higher Incidence of Hypertension among the Elderly

The increasing aging population must have a significant influence on the disease map. As one ages, his health condition will change, which means a higher incidence of disease. In other word, more elderly people will suffer from typical diseases such as hypertension, stroke and coronary diseases. Among them, hypertension is one of the most common cardiovascular diseases and a main contributor to the increasing incidence of all kinds of cardiovascular diseases and death rate (Wang, Sun, & Gu, 2004).

Now, hypertension has become a key public health field attracting attention from the world. In 2003, hypertension is set by the World Health Organization as the theme of the

World Health Day, aiming to appeal to the international society and governments in all countries to attach importance to hypertension and show the importance of hypertension prevention and control.

Hypertension is the most common type of geriatric disease. According to the analysis of the report of the 4thNational Health Interview Survey in 2008, hypertension ranks first in terms of residents' incidence of the disease every two weeks in China, up to 31.4‰, while the incidence of hypertension every two weeks among people aged 65 and above reaches 127.5‰, which is the highest among other age groups (Wang, Sun, & Gu, 2004). In addition, surveys and research on incidence of hypertension among the elderly carried out in different periods shows that as population aging intensifies, the prevalence of hypertension among the elderly in China is increasing, which will directly and indirectly influence health care expenditure in this country (Wang & Zhao, 2005).

1.1.3 Continuous Growth of the Antihypertensive Drug Market

Viewed from the current medical technology level, since hypertension cannot be thoroughly cured, active early intervention and reasonable prevention appear to be of great significance. Now, drug intervention is the main means to prevent and treat hypertension. We can learn from the above information that population aging leads to the increase of incidence of hypertension and thereby the population of elderly patients with hypertension continues to increase, which further increases the need for antihypertensive drugs and facilitates the growth of the antihypertensive drug market. Statistics show that the size of hospital market of antihypertensive drug in China grew to RMB 15.155 billion in 2011 from RMB 4.709 billion in 2001 with an annual average compound growth rate of 12.4%.The size of hospital market of antihypertensive drug between 2001 and 2011 is as shown in Table 1-2.

Table 1-2 Size of Hospital Market of Antihypertensive Drug between 2001 and 2011

(Multiplied by RMB 100 Million)

Year	Market Size
2001	47.09
2002	50.12
2003	54.20
2004	64.86
2005	74.08
2006	76.30
2007	84.50
2008	96.40
2009	113.57
2010	135.80
2011	151.55

Data source: Guangzhou Biaodian Medical Information Co., Ltd. *Research Report of Antihypertensive Drug Market*

Along with the intensified population aging, the increase in the number of elderly hypertensive patients will bring a heavy burden of disease and economic burden. Consequently, active early intervention and reasonable prevention of hypertension appear to be increasingly important. Since drug therapy is now the main means to prevent and treat hypertension, there is no doubt that the increase of the elderly patient with hypertension will bring more health care demand and promote the continuous increase of antihypertensive drug consumption. This research attempts to measure the factors influencing the relationship between population aging and the change of antihypertensive drug market, to determine the degree of association between them through a correlation analysis and to predict the trend in the antihypertensive drug market in China's process of population aging in the future. Based upon this research, suggestions on China's antihypertensive drug market and health care policy can be offered to provide references and theoretical supports to hypertension prevention and control in China.

1.2 Definition of Basic Concepts

"Population aging" and "antihypertensive drug market" in this thesis are defined as

follows.

Population aging is an indicator that measures the extent to which a society ages. It is mainly measured by percentage of aged population, or the aging coefficient, which means the proportion of people aged 60 or 65 and above against the total population. As provided by the general international standard, a society will be deemed an aging society when people aged 60 or above in this country or region takes up more than 10% of the total population or people aged 65 and above accounts for more than 7% of its total population (Guangzhou Pharmaceutical Information Ltd., 2013).This study selected the aged 65 and above in China as the research object.

In addition, the population aging rate, namely, the ratio of growth rate of the elderly population against the growth rate of the total population, is another important index. When the ratio is greater than one, it means that elderly population increases more rapidly than the total population and population aging intensifies; when the ratio is less than one, it means that population aging slows down (Liu, 2008).

According to marketing theory, market size or capacity, means the number of units of certain product or service that the market can obtain, or in other words, the total market demand including demand capacity and potential demand capacity that already achieved, which is a cumulative value. In short, the market size of anti-hypertensive drug stands for the market's demand on anti-hypertensive drug. The achieved demand volume is equal to actual sales volume if anti-hypertensive drug market and the potential demand is the sales volume that not yet achieved. In a general way, the achieved demand is equal to actual sales volume and the potential demand is sales volume that not yet achieved. The sum of these two variables is the value of market size within a given time.

Generally, two approaches for measuring the quantity demanded of medical services or products are: 1. Conducting from the perspective of supply, working out the total scale of medical products by calculating the business volume of the supply side; 2. Conducting from the perspective of demand, estimating the quantity demanded of medical services or products through investigating actual consumption level of consumers on medical services

or products (Xue & Cui ,2003).

The former approach is applied for calculating the market size of anti-hypertensive drug by figuring out the actual sales volume of anti-hypertensive drugs supplying terminal in China over a period of time. In general, market supplying terminal of China are urban hospitals, county hospitals and sell-through pharmacies. Among them, drugs supplying of those urban hospitals accounts for over 60% of the market sales volume. In some extent, that is because county hospitals and sell-through pharmacies distribute, and it is difficult to figure out the sales volume of anti-hypertensive drugs within these two kinds of terminal (China Food and Drug Administration Southern Medical Institute, 2013). Therefore, this research takes the actual sales volume of anti-hypertensive drugs in the urban hospital market as the size of anti-hypertensive drug market.

The potential impacts that the market demand may encounter are the policy, law and population structure. These factors are often measured by tendency method and indirect calculating method (Guo, 1997).The developing tendency of the anti-hypertensive drug market affected by the population aging is studied under the conditions of constant health policies, population policies and anti-hypertensive drug pricing policies. Actually, what it studies is the potential demand variation of anti-hypertensive drug market. In the later chapters, this research would conduct through indirect calculation method.

In short, the narrow definition of the anti-hypertensive drug market in this research is the actual demand of the whole market, which is measured through the total sales volume of anti-hypertensive drugs in the hospital market in China.

1.3 Research Objectives

Hypertension is a chronic disease which requires patients to take drugs for a long period of time in order to control it. Besides, hypertension and its complications exert a threat to people's health and life, bringing a heavy economic burden to the patients and their families or even to the whole society. Currently, research on hypertension is mostly confined to rules on the use of drug, comparison of drug efficacy and health maintenance,

and few research has discussed the influence of population aging. However, elderly patients account for more than half of those who tend to have hypertension. Considering the rapid population aging in the Chinese society, it is reasonable to regard population aging as an increasingly important influencing factor in the analysis of the antihypertensive drug market in China.

Since this research discusses the influence of population aging on the development of the antihypertensive drug market, it is innovative among the current analysis of the antihypertensive drug market in China. The analysis and research on the relationship between population aging and the growth of the antihypertensive drug market will give important instructions to real practice and provide theoretical basis and reference to the management of hypertension among elderly people in China and to the formulation of medical care policies.

Now, Chinese and foreign research about hypertension among the elderly is limited to certain aspects and there is little systematic and comprehensive research, but this research discusses relevant factors of population aging and the antihypertensive drug market systematically, so as to analyze the relationship between population aging and the change of antihypertensive drug market comprehensively; secondly, this research uses a multi-method approach through mathematical reasoning, quantitative analysis, qualitative analysis and questionnaire survey; a multivariate linear regression model is constructed to discuss the relationship between population aging and the growth of the antihypertensive drug market, so the research design becomes more normative and precise and the research result will be more scientific and reasonable. The results from this research will also seek to attract more attention from the government and the medical circle to the influence imposed by population aging on the antihypertensive drug market.

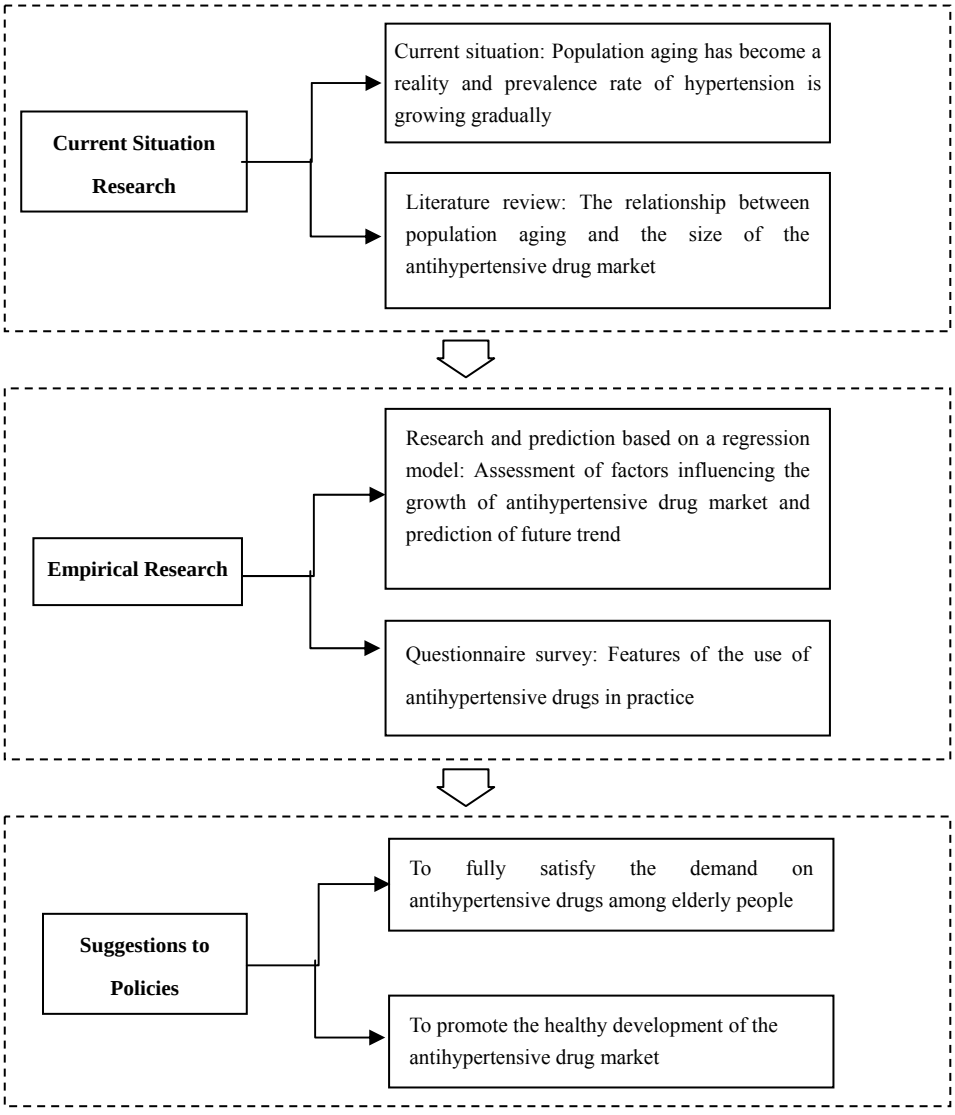
1.4 Research Approach and Research Method

1.4.1 Research Approach

This thesis, starting with literature review, analyzes the relationship between

population aging and the antihypertensive drug market and identifies the influencing mechanism of population aging on the growth of size of the antihypertensive drug market. Then a regression model is constructed to analyze and predict the trend on the size of the antihypertensive drug market in the future in the context of an aging society. Additionally, a questionnaire survey is carried out to identify the features of use of antihypertensive drugs in practice. At last, some suggestions to policies are raised based on the model and empirical findings. See Figure 1-1 for the detailed framework.

Figure 1-1 Framework of the Research Approach



Source: The author

1.4.2 Research Method

In terms of research method, the relationship between population aging and the growth of the antihypertensive drug market is discussed through mathematical reasoning, quantitative analysis, qualitative analysis and a questionnaire survey.

Quantitative Analysis

There are several influencing factors between population aging and the antihypertensive drug market. Different factors have different degrees of influence and different correlation levels might exist between the different factors. A linear regression model is built in this thesis and the research approach is as follows:

(a) Collecting all relevant indicators;

(b) Linear regression analysis is applied to study and explore the relationship between certain indicators and the market size of anti-hypertensive drug. By using linear regression model (simple and multiple linear regression model), the equation reflecting the quantitative relationship between population aging and the market size of anti-hypertensive drug can be work out and applied to explore the magnitude and direction of the main factors' effects on market size of anti-hypertensive drug.

(c) Predicting the evolution of the main factors in the following five years through grey sequence[a] and estimating the trend toward the development of the size of the antihypertensive drug market in the following five years.

Questionnaire Survey

One objective of this research is to find out the choice of drugs, to what extent the drugs are used according to the severity of disease and whether the drugs used by the patients follow the doctors' prescription. Therefore, based on a questionnaire survey, this research attempts to learn the way of prescribing treatment and its trend of the physicians at

[a]The grey prediction of this research would adopt the time series prediction approach. By using the observed time series which reflects the characteristics of the predictive object, a grey prediction model could be built for predicting the characteristic quantity at a specific time in future, or the time should be spend for reach a certain characteristic quantity. The grey prediction is an analyzing predictive approach which is basing on the Chaos Theory(Wei,2011; Wei, & Kong,2010).

hospitals in Guangzhou and Raoping through random sampling so that factors discussed in this research will be more comprehensive and the research system will be more scientific.

1.5 Thesis Structure

This thesis is divided into six parts. Part one is an introduction, stating the background, objective and significance, and method of this research.

Part Two shows the theoretical framework and literature review, mainly giving literature reviews on Chinese and foreign research about population aging's influence on economic and social development and questions about the antihypertensive drug market.

Part Three (Linear Regression Model on the Relation between Population Aging and the Antihypertensive Drug Market) presents an analysis of the correlation between population aging and the antihypertensive drug market in China. A linear regression model is estimated to discuss the factors that influence the growth of the antihypertensive drug market in the context of population aging.

Part Four presents the results of an empirical survey on the use of antihypertensive drugs in the context of population aging. The features of use of antihypertensive drugs in practice are revealed through a survey applied to doctors and elderly hypertensive patients.

Part Five (Prediction and Analysis of the Trends in the Development of Antihypertensive Drug Market) analyzes the expected change in the antihypertensive drug market in the future context of population aging. This part includes the research on the features of use of antihypertensive drugs in the context of population aging, pointing out the problems in health care management based on the results from the questionnaire survey and the analysis of available data.

Part Six contains predictions and suggestions for future policies, using models to predict the trend in the growth of the antihypertensive drug market in the future and offering suggestions and methods to solve problems of health care management and the development of antihypertensive drug market.

Chapter 2: Theory and Literature Review

2.1 Review of Research about Population Aging

China is now facing the challenges of population aging. Data from the United Nations Population Division shows that in 2011, among the world's countries which has a population of over one million, the following countries rank top ten in terms of the percentage of people aged over 60: Japan (31%), Italy (27%), Germany (26%), Finland (25%), Sweden (25%), Bulgaria (25%), Greece (25%), Portugal (25%), Belgium (24%) and Croatia (24%) (Zhang & Wu, 2013). Although China is not in the list, is one of the countries whose aging population increases at a highest rate. Since the middle of the 20th century, developed countries in the west have entered an era of aging society and Sweden is, among them, the country with the oldest population, with people aged 65 and above accounting for 17.9% of its population. Japan is the country in Asia with the oldest population, where people aged 65 and above accounts for 15% of its population. Although the percentage of old people in developing countries is not high, it is increasing rapidly. Therefore, population aging has become a hot issue that attracts attention from scholars all over the world.

2.1.1 Overview of Research on Population Aging in China

Li (2010) carried out a review of relevant research on population aging in China, in which he pointed out that before the 90s of the 20th century, when talking about population problems, the academic circles and government departments mainly focused on the large size, fast growth of China's population and its pressure on social and economic development. Less attention was paid to population aging and change in age structure (Li, 2010). After China became an aging society in the 90s of the 20th century, importance began to be attached to them. Research on population aging is mainly centered on the system to support the old, develop the aging industry and protect the rights and interests of

the elderly; while little research as discussed the influence of population aging on economy. Up to now, the research only involved simple qualitative analysis, prediction of relevant trends and discussion about policies, but lacked in-depth examination.

Scholars at home realize the severity of China's population aging and their further research mainly covers the following aspects:

First, the description of population aging based on statistics. Chen, Cheng & Dai (2012) analyzed the trend in the population aging development in China from the perspective of the expansion speed of the aging population size, the aging population's percentage to the total population and the age dependency ratio. They then came to a conclusion that China's aging population markedly increased in the early stage of the 21st century and it will remain steady at a high percentage in the second half of the 21st century . Xu (2011) discovered that the speed of population aging in China is alarming compared with that of other countries. It only took China 18 years to change from a middle-aged society into an old-aged society while France used 115 years, Switzerland85 years, the United States 60 years and the UK 45 years for the same process. Even Japan, the former country that spent least time to finish the process, spent 25 years (Chen & Hu, 2012). According to the research carried out by Wu, Wang & Miao (2004), now China's average life expectancy is relatively low compared with that of the developed countries. Although the population aging in China is still in an immature stage, when the era of mature population aging comes in the future, China will have to shoulder a bigger burden.

Second, the causes of population aging. Zhang (2008) suggested that death rate and birth rate were the most direct factors that cause population aging. Du (1992) pointed out that the decrease in birth rate is the decisive factor that caused population aging.

Lastly, the implications and social problems caused by population aging. Research on the overall aging of the age structure should not be limited to the elderly because it is related to all the age groups and will influence the entire society's development and economic operation. Fu (2006) suggested that population aging would affect the amount and structure of labor force and result in certain influences on economic development. Xie

(2008) indicated that population aging may promote the adjustment of industry structure through increasing social demand. As the aging population increases, the market demand on products and service for the elderly will rise correspondingly. Tang (2012) pointed out that the large aging population and their various special needs may form a considerable consumer market. The emergence and development of the aging industry will inject new vitality into the market and it may be a new economic growth point. Huang & Pang's (2011) research shows that the limited medical resources have failed to meet the needs of the old in medical care, which will exert heavier pressure on China's social security system.

2.1.2 Overview of Foreign Research on Population Aging

Most of the foreign research on population aging began after the Second World War. In 1956, the *Population Aging and Its Social and Economic Consequences* published by the UN summarized the results of former research on population aging, symbolizing that the research about population aging has enter a new era. After that, as population aging became increasingly severe in the West, plus the development of demographic theories and progress in research methods, research on the population aging became more profound and literature concerning the problem was enriched. In 1994, the World Bank issued a report *Averting the Old Age Crisis: Policies to Protect the Old and Promote Growth*, the first research report discussing population aging, a complex yet pressing problem, worldwide. Since the mid-1980s, along with the aggravation of population aging, the challenges of developed countries on labor market, social insurance and social welfare had become larger and larger. Researches of population aging impacts on economic development were carried out on labor supply (Senesi, 2003), savings (Nakagawa, 1999), investment (Disney, 1996) and social insurance (Bonatii,2003), etc. (Gonzalez & Niepelt, 2011; Yuan & Guo, 2009).

Blondal & Scarpetta (1998) found that the design of social pension insurance system had great influences on the retirement policy; the social insurance policy may impel elderly people to quit labor market in advance. Bloom & Canning (2011) found that population age structure variations had a significant impact on the economy growth: average life spans can improve saving rates and capital stock and increase physical capital and human resource

investment, thereby restraint the negative effects of population aging on economy growth. In one hand, population aging can directly reduce the productive working-age population proportion of a country, and compress the labor supply scale in a long-time basis. Take the west Europe and Japan as examples, in which the degree of population aging is relatively high, the shortage of labor supply had become the longtime puzzle of productive enterprises, which seriously restrict their dynamism of economy growth. On the other hand, the proportion of elderly people can increase the burden of support in a country and thus increase the burden of physical capital accumulation and the endowment insurance on working-age people. That could negatively affect the economy growth simultaneously. In order to make certain that the population aging would have a potential impact on the relationship between the government finance and the economy, lots of experts and academics from OECD member states had done mass researches on this issue. Auerbach Kotlikoff, Jagemann, & Nicoletti (1989) from America applied a general equilibrium model with OLG algorithm to investigate the economic dynamics problems raised from population aging. These researchers found that the population aging had the greatest impacts on the saving rates, take-home pay and the total saving amount. Hviding & Merette (1998) from Canada indicated that the population aging could bring negative growth to the per capita gross Chinese product. Fougere & Merette (2000) explained that a series of social welfare policies aiming at population aging could stimulate capital investment and accelerate the economy growth.

There is a huge difference between developing and developed countries on economy developing level, economic structure and the policy environment. Therefore, when studying the population aging influences on the market economy growth, processes like model assumption, variable selection and parameter setting should be conducted with incredible care. That is because economy duality commonly exists in those developing countries. Economy duality refers to economy growth level differences between cities and countryside, which results in pension system differences and low health care coverage and these facts

should have significant impacts on the economic effects of the population aging (Roncada, 2000). Though most of the researches showed that the population aging had disastrous impacts on the social economy growth, some other academics indicates that the negative effects from population aging problems could be recovered by the inner drive of human capital and the progress of scientific technology.

2.2 Overview of Research Relating to Hypertension Treatment and Hypertensive Drug Market

Hypertension is the most common chronic disease and the major dangerous cause for cardiovascular diseases. The complications of hypertension, such as stroke, myocardial infarction, heart failure and chronic kidney diseases, can cause disability or death and at the same time consume a lot of medical and social resources, which will bring heavy burdens to families and the society. Research at home and abroad show that hypertension is a disease that can be prevented and controlled. If the blood pressure level of a patient with hypertension is decreased, then the incident of stroke and heart diseases can be lowered markedly, the life quality of the patients is improved obviously and thereby the burden caused by the disease is also decreased effectively. Now there are more than a billion people with hypertension in the world. Therefore, it is not only a health problem but also a problem that exerts a significant influence on the society. Accordingly, the prevention and control of hypertension has become a focus of the world.

2.2.1 Overview of Research on Hypertension Treatment and the Use of Antihypertensive Drugs in China

In the recent 20 years, China has made progress in detection, treatment and control of hypertension. Comparing the national sampling survey of 1991 and the statistics of the National Nutrition Survey of 2002, the hypertension awareness rate among the patients has increased from 26.3% to 30.2%, the rate of outpatient treatment from 12.1% to 24.7% and the control rate from 2.8% to 6.1%.

As the Chinese Guidelines for the Management of Hypertension (2001) points out, the main purpose of hypertension treatment is to stabilize blood pressure and reduce the

incidence of complications such as various cerebrovascular diseases and the overall risk of death. Methods to treat hypertension include drug therapy and non-drug therapy. Non-drug therapy mainly refers to intervention to one's lifestyle, such as taking healthful diets and reducing weight. Non-drug therapy is only an adjuvant therapy while drug therapy is the primary treatment measure for hypertension. The drug therapy given to hypertensive patients, through reducing blood pressure, aims to effectively prevent or delay the occurrence of such complications as stroke, myocardial infarction, heart failure and chronic kidney diseases and to effectively control the course of hypertension and prevent the occurrence of hypertensive urgencies and hypertensive emergencies. New antihypertensive drugs and preparations had appeared in the market since the 1960s, offering abundant choices for the patients to control hypertension and improve their life quality. Applying antihypertensive drugs in a correct and rational way has practical significance, because it allows patients to achieve the best efficacy at the lowest cost and health care resources to be used rationally. Researchers have developed several types of drugs to treat hypertension, including diuretics in the 1960s, beta receptor blockers (BRB) in the 1970s and calcium channel blockers (CCB) and angiotensin-converting-enzyme inhibitor (ACEI) in the 1980s. After years of application, the efficiency of these drugs has been recognized by clinicians and patients (Writing Group of 2010 (Chinese Guidelines for the Management of Hypertension, 2011).

As people's understanding of the pathogenesis of hypertension deepens, a series of targeted drugs have been developed and allowed to enter the market. Captopril, the first ACEI came into the market in the 1980s, followed by other drugs including Enalapril, Lisinopril and Fosinopril. Now, ACEI has been treated as a kind of drugs in the clinical treatment of hypertension. Angiotensin II receptor antagonist (ARB) developed after the appearance of ACEIs can overcome the side effect of ACEI such as dry cough. Such type of drug has a special effect and therefore can be a new competitive category of antihypertensive drug.

The increase in the incidence of hypertension and hypertension treatment rate has

increased the demand on antihypertensive drugs. Currently, drugs used to treat hypertension in China mainly include diuretics, BRBs, ACEIs, long-acting CCBs and ARBs. The sales volume of the antihypertensive drugs has been on the rise since 2003. Statistics from the *Research Report of Antihypertensive Drug Market* released by Guangzhou Biaodian Medical Information Co., Ltd. shows that the size of hospital market of antihypertensive drug in China grew to RMB 15.155 billion in 2011 from RMB 4.709 billion in 2001 with an annual average compound growth rate of 12.4% **(**Guangzhou Pharmaceutical Information Ltd., 2013).

2.2.2 Overview of Foreign Research on Hypertension Treatment and the Use of Antihypertensive Drugs

The incidence of hypertension in many countries all over the world is up to 10% to 20%. Therefore, the WHO and ISFC decided that the 17th of May of each year would be the World Hypertension Day, aiming to increase people's awareness of the importance of hypertension. In 2013, the WHO decides that the theme of the World Health Day would be hypertension, a hidden yet globe public health problem, and asked countries all over the world to make efforts to prevent and control hypertension effectively so that an environment of health promotion can be created. The WHO emphasized that hypertension is preventable and controllable, so it is essential to discover it early and involve hypertension into a nation's preliminary health care plan. Hence, as more attention is attached to hypertension, the work of hypertension prevention and control will be furthered promoted and thereby the use of antihypertensive drugs will be affected. WHO issued the report *A Global Brief on Hypertension: Silent Killer, Global Public Health Crisis*on April 3, 2013.The statistics cited by this report shows that, thanks to sound public policies and wider health care, developed countries have a lower incidence of hypertension (35%) than that of developing countries (49%) (Liu & Wu, 2013).

Due to the importance and large market demand of antihypertensive drugs, the structure of antihypertensive drugs in the world also improves as the market develops. Among the listed drugs, many of the biggest blockbusters on a global scale are

antihypertensive drugs. Anti-hypertensive drug is a category that attracted much more number of drug manufacturers than other drug categories in the worldwide. IMS reported that annual sales of cardiovascular drugs have continued to increase steadily since it exceeded the sales of any anti-inflammatory drugs for the first time. Now it takes the lead in the drug market and takes up 16% to 17% of the total sales in the international market. The sales of antihypertensive drugs is USD 32.462 million among the top 500 bestselling drugs in the world's seven largest pharmaceutical markets in 2009, taking up to 51% of the cardiovascular drugs. In 2011, sales of ARB antihypertensive drugs reached USD 27.4 billion, increasing by 3.01% on a yearly basis and ARB drugs constitute the most of the shares of the antihypertensive drug market. Antihypertensive drugs are among the bestsellers and have a potential market.

2.3 Research on the Correlation between Population Aging and Drug Demand

Research has been carried out on the correlation between population aging and drug demand, focusing on the following main aspects:

Incidence and outpatient treatment of hypertension.

Health care costs and expenses.

Medical expenses per capita.

Medical security.

Use of antihypertensive drugs in practice.

Each of these aspects will be analyzed in the following sections.

2.3.1 Population Aging and the Incidence of Hypertension and Outpatient Treatment Rate of Hypertension

The incidence of hypertension among the elderly is increasing. Now China has a large population of patients with hypertension, and the incidence among the elderly to the total patients is 60% to 70%. And the elderly patients who have systolic pressure of over140mmHg and diastolic pressure of less than 90mmHg represent 62.2% of the patients

aged between 65 and 85 years. Additionally, the epidemiologic study of hypertension within 14 provinces in China in 2006 shows that the incidence of hypertension among people aged between 65 and 75 is 51.5%, and among people aged between 75 and 85 is 60.25%. It is also widely believed that, as population aging intensifies and the absolute aging population increases, the incidence of hypertension will also increase and the higher the age, the higher the incidence will be.

The prevalence of hypertension among the elderly is increasing. Zhou (2007) analyzed the results of three general surveys carried out since the 1950s, concluded that incidence of hypertension (defined as systolic pressure of 140mmHg or above and/or diastolic pressure of 90mmHg or above) was obviously on the rise, rising from 5.11%in 1959, 7.73% in 1979, to 11.88% in 1991 and the incidence of hypertension among the elderly was 40.4%; results of the sampling survey of hypertension within 12 provinces and cities in China between 2000 and 2001 showed that the incidence of hypertension among people aged 64to 74 was 48.8%. Hui (2010) pointed out that, according to latest epidemiologic data, the incidence of hypertension among the elderly is high, with an incidence of 38.2% to 57.0% among people aged over 60 and over 70% among people aged over 80.

The risk of complications of hypertension is relatively high. Results of an epidemiologic study show that hypertension is closely related to a series of diseases, especially coronary heart disease, stroke, congestive heart failure and impairment of renal function. Gao & Lv's (2008) research proved that the risk of heart, brain and kidney complications would increase as blood pressure rises and there exists no specific threshold value; if hypertension patients with blood pressure of the same level are affected by other dangerous factors (such as smoking, hyperlipidemia and diabetes), they will have a higher incidence of complications. Therefore, it seems to be urgent to strengthen prevention and treatment to elderly hypertensive patients, which will increase the demand on the antihypertensive drug market.

According to the Report of the National Health Services Survey in 2008, people aged over 60 has a stronger awareness of hypertension prevention when compared with other age

groups. For example, the percentage of people aged over 60 who have had their blood pressure measured is 63% and those who have received health instructions concerning hypertension prevention and treatment account for 73.9%, the highest among all age groups. This will increase the rate of outpatient treatment of old hypertensive patients (Ministry of Health of The People's Republic of China, 2008).

2.3.2 Population Aging and Health Care Costs and Expenses

As for the relationship between population aging and health care expenses, according to Breyer's analysis in 2011 of Germany's medical expenses between 1997 and 2008, population aging, falling death rate and increased life expectancy will promote the increase of medical expenses. This author predicted, through modeling, that by the year 2060, the medical expenses of Germany will be 1.7 to 3 times the current level.[24] Based on the data about the impairment of people aged 65 and above of the Portugal's national health surveys between 1987 and 2005, Nogueira and Reis (2012), estimated a multiple regression model including as independent variables age, sex, educational background, income, daily routine, treatment frequency and self-awareness of health condition, to predict public expenditure between 2012 and 2060; they concluded that the change of residents' health condition and incidence of diseases will lead to a remarkable change in the growth rate of public expenditure.

In 2004, the Chinese scholar Huang carried out an empirical survey on the relationship between health care expenses and population aging based on the "growth factor". Results show that the population aging is necessarily accompanied by the growth of health care expenses, although the correlation between the two variables will gradually become weaker. It was predicted that the level of population aging will reach the peak between 2030 and 2040, while its influence on the increase of health care expenses will weaken and have a negative effect between the years 2040 to 2050.

With regard to the relationship between population aging and government's health care expenditure, Liu (2012) indicated that medical expenses would increase with the rise of medical insurance coverage rate among elderly people. Cheng and Zhao (2010) analyzed

the features and laws of medical and health care expenses during the progress of population aging based on the statistics of country members of WHO. With population aging, the percentage of health care expenses, especially government's health care expenditure, against the GDP is on the increase. They found a strong positive correlation between population aging and medical and health care expenses.

2.3.3 Population Aging and Medical Expenses per Capita

Foreign research shows that medical cost of elderly people is also higher than that of other age groups. According to the research conducted by Grant & Teasdale (1999), the average medical cost of people aged 65 and above is three to five times as that of the people aged less than 65. Besides, since the incidence of chronic diseases among old people is two to three times that among other people, old people's demand for medical service is higher than other people (Nogueira & Reis , 2012). Nogueira (2011) indicated that the incidence and prevalence of disease will obviously increase because of weak physiological function and immunity, which will inevitably lead to greater demand for medical service. According to the American Medical Service Survey, the average medical service cost of general population is USD 3,366 in 2005 while that of the people aged over 65 is nearly USD 15,000, more than four times the former.

The development of the Chinese medical service market differs from that of foreign countries, although more medical services are provided to elderly people than to other groups. Feng & Wang (1999) found that medical service costs and expenses among elderly people are only 1.6 times as that among other age groups. The literature published by Liu ,Cai & Li (2011) noted that average outpatient treatment cost for people aged 65 in China is RMB1,811 while that for other group is RMB958. There is a significant difference between the statistics of China and the United States, yet little research literature has illustrated the reasons for such difference. Generally speaking, population aging, insurance scheme and new technology are all major determinants of medical demand. Qiu (2005) pointed out that according to the predictive trend of population aging in China, the medical cost incurred by the population aging will increase by 1.54% yearly and, therefore, the

medical cost will be 26.4% up compared with the current cost. Deng & Song (2008) indicated that with the growth of inelastic demand among elderly people on medical services, it will be essential to conduct more research on the health conditions of the elderly in China and medical service demand and to formulate feasible medical policies and development strategies(Deng & Song, 2008).

2.3.4 Population Aging and Medical Security

China Research Center on Aging (2003) conducted a research on the status of medical security among the elderly on the basis of a sampling survey about the status of elderly population in urban and rural areas in 2000, in which they found that medical and health care resources available to the elderly are quite limited and that there is a significant gap between the situation in the urban and rural areas. Wu (1999) conducted an analysis of the increase in medical security demand caused by population aging and the influence of such increase on the medical security system. Qiu (2005) pointed out that the reformed urban medical insurance scheme was unable to meet the pensioners' needs for medical security. Supplementary insurance measures should be established to satisfy their needs since they are a group of people easily affected by medical risks (Jiang & Wang, 2004). Jia & Li (2006), focusing their research on urban medical insurance, suggested that population aging led to a fall in the contributions to basic medical insurance while the total basic medical insurance expenses increased, which did harm the fairness of the basic medical insurance system. Such a phenomenon is exactly the negative influences population aging in urban areas imposed on the basic medical insurance system. Therefore, further measures should be taken to improve the medical care system for the elderly. Other researchers such as Deng & Song (2008) studied population aging's influence on medical demand and security, problems concerning medical security and nursing services for the elderly brought about by population aging. By using the population covered by medical insurance as an indicator to reflect the potential medical needs in the course of population aging, they found that population aging would result in the growth of medical insurance expenses. Accordingly, emphasis should be put on constructing a reasonable medical security system and nursing

services system for the elderly. Liu (2012) pointed out that population aging would influencing the structure of insured population, in which the insurance coverage rate among the elderly would continue increasing.

2.3.5 The China National Health System

The medical service system in China consists of two separate parts: urban medical and health service system and rural medical and health service system. Medical institutions can be divided into hospitals, primary health service institutions (community health services institutions and rural township health care institutions) and professional public health institutions. After years of development and revolution, health institutions in China grew rapidly. At the end of 2013, the total number of health service institutions in China was 974398, much higher than that of 2008. Among them, the number of hospitals, primary health service institutions and professional public health institutions were 24709, 915368 and 31155, respectively (China Health and Family Planning Commission, 2013).

The universal health care policies carried out in China are divided into three categories: medical insurance for urban workers, medical insurance for urban residents and the new rural cooperative medical insurance. The insuring and government subsidy standards of these three kinds of medical insurance are different from each other (Cao, 2014). Through years of development, medical insurance business in China has made great progress. The new rural cooperative medical insurance has already covered most of the rural areas. The coverage of medical insurance for urban residents also grew significantly. Meanwhile, private health insurance, which was a supplement of the basic public medical insurance system, is also rapidly developing. Besides, safeguard of serious diseases and chronic disease had been strengthen gradually over these years. Physical examination fees were also included in the claims scale of medical insurance (Yang, 2010).

There are still significant differences between urban and rural medical and health service system. The three-level health service system in rural areas includes county hospitals, professional health institutions (such as disease centers, maternity and child care institutions) and health clinics in townships. The professional competence of medical staff,

the numbers of beds and the medical service quality of these institutions are far below those of the urban areas (China Health and Family Planning Commission, 2013). In what concerns insurance, the new rural cooperative medical insurance system, which has covered most of the rural areas, presents differences with the urban medical insurance both on the reimbursement ratio and the catalog (Cao, 2014).

2.3.6 Application of Antihypertensive Drugs in Practice

Doctor's way of prescribing treatment will exert influence so on the use of drugs. In practice, doctors will choose different drugs according to specific conditions of the elderly patients. Therefore, it is essential to choose the most suitable treatment for elderly hypertensive patients. According to the features of the elderly patient, a treatment plan shall be made after a comprehensive assessment of the patient by taking both the patient's condition and the drug characteristic into consideration. As the Chinese Guidelines for the Management of Hypertension suggests, calcium channel blockers, diuretics, beta receptor blockers and fixed-dose compound preparations can be used for preliminary or long-term treatment (Zhao, Chen, Cui, Wu & Hu, 2006).

Results of the investigation by Wang, Sun & Gu (2004) on the use of antihypertensive drugs of a hospital in Shanghai between 2002 and 2003 showed that the use of drug in the hospital's dispensary for outpatients and for inpatients are quite similar. The most common drugs used to treat hypertension are suppressants and calcium channel blockers. Ma Li & Liu's (2011) research revealed that hypertension of 60% to 70% of the elderly patients is isolated systolic hypertension, which features complications such as various cerebrovascular diseases. Therefore, diuretics and calcium channel blockers have better effects than other types of antihypertensive drugs. As for research on use of drugs, in practice, scholars often base their research on pharmacology while little research has been carried out on the choice and use of Chinese or imported drugs.

In addition, some scholars pointed out that two and more antihypertensive drugs which are long-acting and release-controlled should be used to treat hypertension, and the initial dosage of each drug should be low so that blood pressure can be reduced slowly. The

recommended combined treatment is the use of diuretics with CCB, ACEI and ARB or the use of CCB with ACEI, ARB and beta receptor blockers. Fixed-dose compound preparations containing diuretics can also be used. In such case, the amount of potassium in the blood shall be monitored (Chinese Guidelines for the Management of Hypertension, 2010). Trial results of a certain combined treatment are different. As a result, the use of antihypertensive drugs shall adhere to four principles as follows: the initial dosage should be small, give preference to long-acting preparations, choose combined treatment and use the drugs according to different conditions of the patients. Therefore, treatments according to the guidelines for hypertension treatment and the doctors' different ways of prescribing treatment will influence the structure of the use of antihypertensive drugs and then further influence the market demand.

Chapter 3: Research Method

This chapter looks at the research method used to conduct the research. It is composed of the research design, the study populations, data, sample dimension, sampling techniques, instrument used and data analysis methods.

3.1 Research design

There are several influencing factors between population aging and the antihypertensive drug market. Different factors have different degrees of influence and different correlation levels might exist between the different factors. A linear regression model is built in this thesis and the research approach is as follows:

(a) Collecting all relevant indicators;

(b) Testing the correlation between all indicators and the response variable, i.e. the antihypertensive drug market. To be specific, it means studying the relationship between the size of the antihypertensive drug market and each influencing factor through simple linear regression and then analyzing to what degree and to what extent each factor will influence the antihypertensive drug market;

(c) Deciding the quantitative equation of the relationship between population aging and the antihypertensive drug market through multivariate regression analysis and discussing to what degree and to what extent each main factor will influence the size of the antihypertensive drug market;

(d) Predicting the evolution of the main factors in the following five years through grey sequence and estimating the trend toward the development of the size of the antihypertensive drug market in the following five years.

Another objective of this research is to find out the choice of drugs, to what extent the drugs are used according to the severity of disease and whether the drugs used by the

patients follow the doctors' prescription. Therefore, based on a questionnaire survey, this research attempts to learn the way of prescribing treatment and its trend of the physicians at hospitals in Guangzhou and Raoping through random sampling so that factors discussed in this research will be more comprehensive and the research system will be more scientific.

3.2 Study populations and samples

There are three populations under study:

Population aging in China is studied using national statistics on those aged over 65 years; incidence and prevalence of hypertension was analyzed for those aged 65 or over, for the period 1998 to 2012, based on the National Health Services Survey (2008, 2012).

To find out to what extent the antihypertensive drugs are used according to severity of the disease and according to the physicians' prescription, two populations were surveyed: the population of general physicians at hospitals in Guangzhou and Raoping and the population of patients from the same hospitals aged 60 and above.

Because this survey mainly intends to provide empirical evidence to the models mentioned above, subjective sampling (i.e. the investigator chooses and determines the subject of the survey according to the objectives and subjective analysis) is adopted to collect the overall information.

Cardiovascular and cerebrovascular physicians and hypertensive patients in a level A grade three hospitals in the urban area of Guangzhou and a hospital in Raoping County.

Qualification standard to be included in the sample: People aged over 60 who have lived in Guangzhou or Raoping for more than a year, diagnosed as having hypertension for five years or above and have taken drug therapy (including comprehensive therapy).

In this survey, 90 questionnaires were sent out and all of them were collected, that is, the collection rate is 100%. Among all the questionnaires, 96.67% of the questionnaires (for instance 87 questionnaires) are valid. 48 out of the 50 questionnaires sent out to the patients are valid, i.e., the effective response rate is 96.0%; 39 out of the 40 questionnaires handed out to the physicians are valid, so the effective response rate is 97.5 %.

3.3 Data collection instruments

Two questionnaires were designed to collect information about antihypertensive drug prescription and use. The questionnaire to physicians is presented in Appendix 1. It starts with an introduction explaining the objective of the survey followed by two screening questions:

How long have you been working on hypertension treatment?

Do you prescribe drug therapy for major treatment of hypertension?

Only those physicians working on hypertension for more than five years and prescribing drug therapy would be included in the sample.

The questionnaire main body is divided into two parts: the first part comprises 9 questions about the treatment status of hypertensive patients and the second part includes 3 questions about the purchase of drugs by patients.

The questionnaire applied to patients is presented in Appendix 2. It also starts with an introduction explaining the objective of the survey followed by four screening questions:

How long have you been living in this area?

How old are you?

Have you been diagnosed as having hypertension?

Have you been prescribed a drug therapy after being diagnosed with hypertension?

Only those patients living in the area for more than one year, 60 years or more, sure about the hypertension diagnosis and prescribed with drug therapy would be included in the sample.

The questionnaire main body is divided into three parts: the first part comprises 5 questions about the hypertensive patients drug use habits, the second part includes 4 questions about the economic burden to patients due to the use of antihypertensive drugs and the last part is about the patient demographics: age group, gender and the average monthly income, as well as information for further contact (name and phone number).

3.4 Regression Analysis

Since China is undergoing population aging process, the changes in disease map and the structure of the drug market will become obvious with the coming of an aging society. Linear regression modeling will be applied to evaluate the strength of the cause-effect relationship between the two variables.

3.4.1 Linear Regression Model

Regression analysis is a statistical method to analyze if a set of influencing factors (independent variables) have an effect on the predicted object (dependent variable) and how strong and significant is this effect. Only when there is a certain relationship between the independent variable and dependent variables will the regression equation be meaningful. Therefore, whether there is any relationship between the influencing factors, independent variable, and the predicted object, dependent variable, how are they correlated and how difficult it is to judge the correlation between them are all problems shall be solved before the regression analysis. Additionally, based on my experience in this industry and observation of statistics, I consider that there may be a linear relationship between population aging and the hypertensive drug market. Due to the above reasons, this research focuses on exploring a linear regression model appropriate for describing the relationship between population aging and the size of the antihypertensive drug market.

$$\mathbf{Y=f\ (X_i)\quad (1=1,2,\ldots,\mathit{p})} \tag{3.1}$$

Among them, X_i represents different influencing factors, i identifying the explanatory variables. For each observation j, the regression model takes the following form:

Where β_i (i=1,2,…,*p*) is a regression parameter showing the degree of influence of X_i on the size of population antihypertensive drug market; the β_i's are also called the partial slope coefficients and represent the change in the dependent variable Y associated with a one unit increase in X_i when all other independent variables in the model are held constant, while β_0 is a constant term or intercept, meaning the value of the dependent variable when all the independent variables equal zero. ε_j is the random error, which may be conceived as representing (1) the effects on Y of variables not explicitly included in the model and (2) a

residual random element in the dependent variable.

The goal of linear regression modeling is to fit a line through the points, i.e., to predict a perfect linear relationship between the dependent and the independent variables:

Where represents the estimator of the population coefficients (i=0,1,2,…,p), known as the nonstandardized coefficients showing the estimated contribution of each independent variable to explain the dependent variable, when the effects of the other variables in the model are controlled. Their standardized forms allow the comparison of effects on Y of variables defined in different measuring units.

Different estimation methods can be used to find the estimates for the parameters, the most common way being the Ordinary Least Squares (OLS) method: the adjusted line is found in such way that the sum of the squared deviations of the observed points from that line is minimized.

Estimates found with the OLS method are the best is the sense they are unbiased and efficient. The least square estimators are said to be BLUE: Best Linear Unbiased estimators, but only if the model assumptions are met. In practice, one or more of these assumptions are likely to be violated. If this occurs, the application of regression analysis may produce misleading or problematic coefficient estimates and the least squares estimators of the intercept and the partial slope coefficients are no longer BLUE, no longer the estimators with minimum variance among the class of unbiased estimators (McGarr, Barry, Dedieu, Perricaudet & Isner, 1995).

3.4.2 Assumptions of the Linear Regression Model

It is implicit in the way the regression model is defined that

i The relationships between Y and each X_i is linear, and that the effects of the independent variables are additive.

Other assumptions should be met to allow for appropriate estimates of the population coefficients and tests of statistical significance:

ii For each set of values of the p independent variables, the error term is normally distributed with zero mean and constant variance (homoscedasticity);

iii For each set of values of the p independent variables the error terms are uncorrelated;

iv Each independent variable is uncorrelated with the error term;

v Relative independence between independent variables (only applicable in a multiple linear regression model), meaning that there is no perfect collinearity between the X_i.

The checking of the linear regression model assumptions is conducted from five different aspects, namely, (a) linearity between each X_i and Y, (b) normality of random errors, (c) homoscedasticity of random errors, (d) independence between the random errors, and (e) collinearity between the independent variables.

The application of multiple linear regression models should satisfy the model assumption, which including 7 items, they are:

i Random sampling

ii Existence of linear relationship between the independent and dependent variables

iii Normal distribution of random errors

iv Average standard error equals zero

v Variance of random errors is a constant

vi Random errors of independent observations are independent

vii No collinearity between independent variables (only applicable in a multiple linear regression model)

SPSS17.0 is used to carry out all the statistical analyses in this thesis.

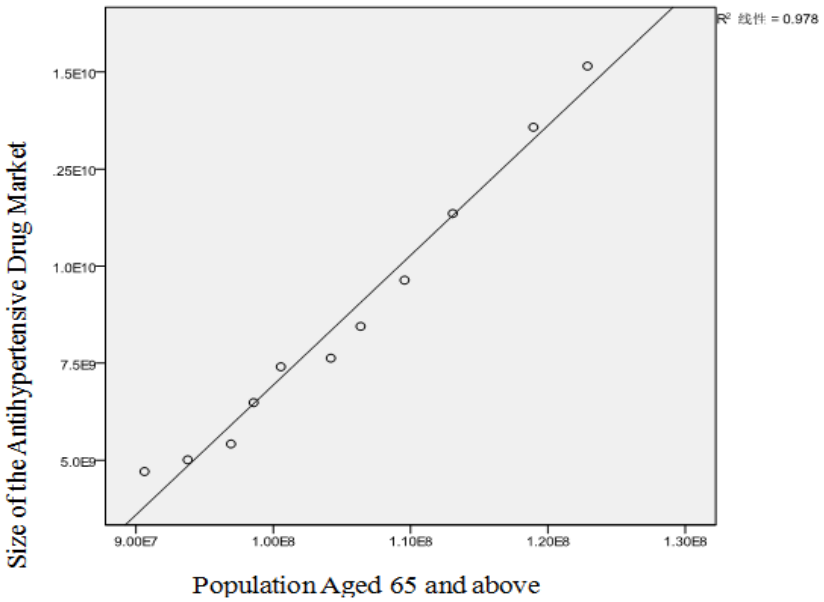
(a) Linear relations between the dependent and the independent variables

To check for linear relationships between the dependent variable and the independent variables, both the scatter plot and the linear correlation coefficient can be used.

By plotting the X_i and the Y scores for each observation in the sample, a scatter plot is created to check for the assumption of linear relationship and providing a visual sense of how two variables are related. When the dots in a scatter plot approximate a line, there is a linear relationship between the two variables. See, for example, Figure 3-1 where the Size of the antihypertensive drug market (Y) is plotted against the Population aged 65 and above

(X). The dots resemble a line, even if not perfect, with a positive slope, showing that the variable "Population of aged 65 and above" and the variable "Size of the antihypertensive drug market" have a linear relation, even if not perfect, and as "Population of those aged 65 and above" increases, the "Size of the antihypertensive drug market" also grows.

Figure 3-1 Scatter plot



The Pearson linear correlation coefficient (r) can confirm the impression given by the scatter plot. The formula to calculate the correlation coefficient of the samples is as follows and can take values between -1 and +1. Values of r near zero show a lack of linear association between the two variables, while values near -1 or +1 show very strong linear association, negative or positive, respectively.

$$r = \frac{\sum_{i=1}^{n} (X_i - \overline{X})(Y_i - \overline{Y})}{\sqrt{\sum_{i=1}^{n} (X_i - \overline{X})^2 \sum_{i=1}^{n} (Y_i - \overline{Y})^2}} \quad \textbf{(3.2)}$$

The value of the Pearson linear correlation between the "Population of people aged 65 and above" and the "Size of the antihypertensive drug market" is $r = 0.989$, confirming the strong linear and positive association between the two variables in the sample.

To conclude about the population linear association it is possible to test for the statistical significance of *r*. The null hypothesis for a correlation is that no linear association exists between the two variables in the population (H_0: $\rho = 0$), where ρ is the population linear correlation coefficient. The hypothesis is tested against the alternative of a nonnulllinear relation between the two variables in the population (H_1: $\rho \neq 0$). The null hypothesis should be rejected if *r* has a low probability of occurring when H_0 is true, i.e., when this probability is lower than a fixed significance level α. By convention a low probability is defined as 0.05 or lower.

For example, the test for the correlation between the "Population of people aged 65 and above" and the "Size of the antihypertensive drug market" shows a probability near zero (p-value≈0.000), allowing for the conclusion that, in the population, the correlation between the two variables is significantly different from zero.

(b)Normality of random errors

A residual is a deviation of an observed Y score from its estimated value from the equation line. Residuals are conceived as measures of the error component. It is assumed in regression modeling that the residuals are distributed normally. Again, even though most statistical tests are quite robust with regard to violations of this assumption, it is advisable, before making decisions, to review the distribution of the residual values with normal probability plots (Q-Q normal and detrended normal) or tests for normality (Kolmogorov-Smirnov or Shapiro-Wilks tests). In the standard Q-Q plot (Figure 3-2), almost all dots scattered near the line and in the detrended standard Q-Q plot (Figure 3-3), dots scattered randomly on both sides of the zero axis showing no specific pattern; both allowing the conclusion that, in the sample, the residuals distribution is not far from normality. The Shapiro-Wilk normality test (Table 3-1), better than the Kolmogorov-Smirnov test for sample dimensions up to 50, shows a *p*-value=0.543, clearly over 0.05. Therefore, it is acknowledged that, in the population the random error distribution does not differ significantly from normality.

Figure 3-2 Standard Q-Q Plot of Standardized Residual

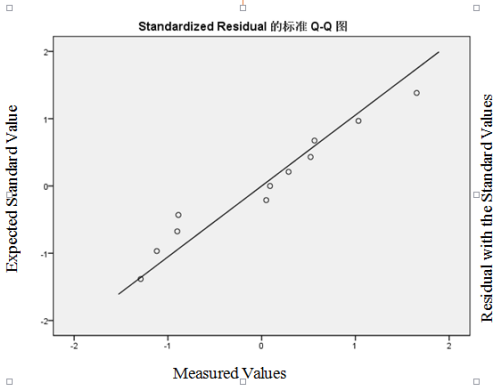


Figure 3-3 Detrended Standard Q-Q Plot of Standardized Residual

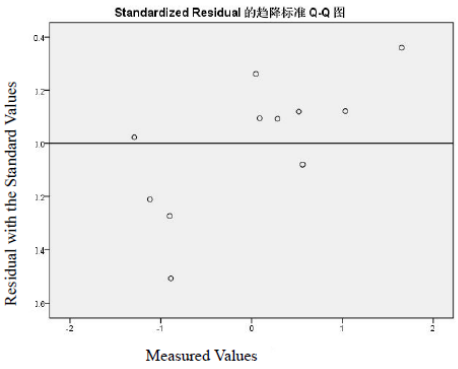


Table 3-1 Normality Tests for the standardized residuals

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistics	df	Sig.	Statistics	df	Sig.
Standardized Residual	.189	11	.200*	.942	11	.543

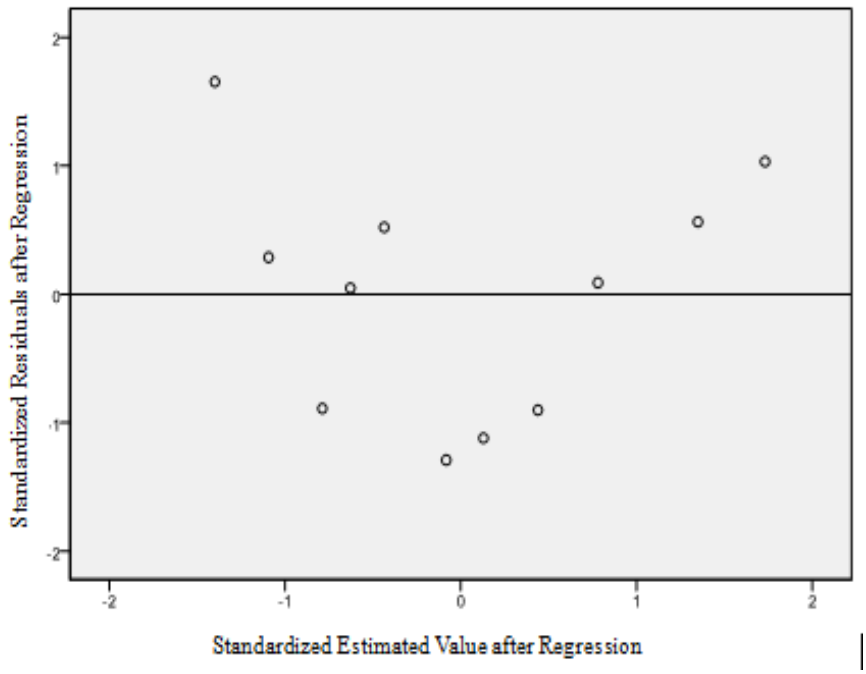
a. Adjustment of Level of Significance byLilliefors

*. This is the lower limit of the real level.

(c) The Variance of the Random Errors is Constant

Heteroscedasticity, opposite to the assumption of homocedasticity, happens when the error tem in a regression model does not have constant variance and can be detected by the visual inspection of the plot of the standardized regression residuals against the standardized adjusted values of Y. It is generally safe to assume that heteroscedasticity is not present when the dispersion of the dots do not increase or decrease consistently as the values of adjusted Y increase. In Figure 3-4 the configuration of points fall in an approximately horizontal band with no apparent systematic features, meaning the variance of the residuals does not departure very much from constancy.

Figure 3-4 Scatter Diagram Dependent value: Size of the Antihypertensive Drug Market



(d) No Correlation between Random Errors

The decision about the assumption of no correlation of adjacent error terms can be based either on the Durbin–Watson (DW) statistic or on the statistical test. The empirical decision based on the DW statistic follows the next rule:

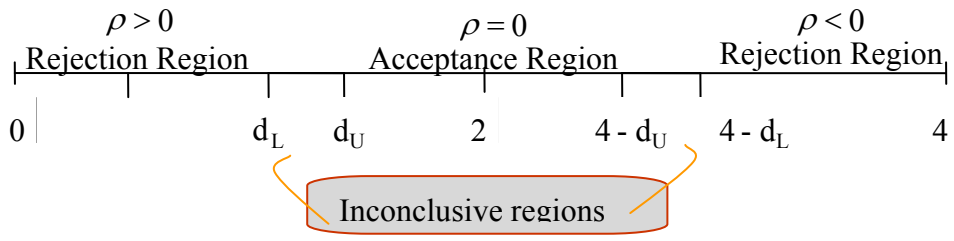
If the errors are not correlated the value of the DW statistic ≅ 2 (±0,2)

If the errors are positively correlated, then DW≅ 0

If the errors are negatively correlated, then DW≅ 4

To test the null hypothesis of no correlation between the random errors, the value of the test statistic is compared to the Rejection and Acceptance Regions, defined after two values, d_L and d_U. For example, a value for DW bellow leads to the rejection of the null hypothesis of no serial correlation (Figure 3-5); a value for DW greater than leads to the no rejection of the null hypothesis; the range between and leads to an inconclusive result because it is possible that the correlation in errors are due to the autocorrelation of the independent variables rather than to the autocorrelation of the error terms.

Figure 3-5 Rejection and acceptance regions for the Durbin-Watson test



The values of d_L and d_U for a significance level of 5% are obtained from the following table (Table 3-2), where *n* is the sample dimension and *p* is the number of independent variables:

Table 3-2 Critical values for the Durbin-Watson Test (α=0.05)

p	1		2		3		4	
n	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U
9	0.824	1.320	0.629	1.699	0.455	2.128	0.296	2.588
10	0.879	1.320	0.697	1.641	0.525	2.016	0.376	2.414
11	0.927	1.324	0.758	1.604	0.595	1.928	0.444	2.283
12	0.971	1.331	0.812	1.579	0.658	1.864	0.512	2.177
13	1.010	1.340	0.861	1.562	0.715	1.816	0.574	2.094
14	1.045	1.350	0.905	1.551	0.767	1.779	0.632	2.030
15	1.077	1.361	0.946	1.543	0.814	1.750	0.685	1.977
16	1.106	1.371	0.982	1.539	0.857	1.728	0.734	1.935
17	1.133	1.381	1.015	1.536	0.897	1.710	0.779	1.900

Note:parts highlighted with grey are the test critical values involved in our study.

For the previously mentioned model of the "Size of the antihypertensive drug market" regressed on the "Population aged 65 and above" the DW statistic equals1.015, which does not fall in the range [d_U=1.324, 4-d_U=2.676]; but it does not fall either in the rejection region [0 , 0.927], meaning the sample data does not allow a conclusive decision about the assumption of no autocorrelation between the error terms.

(e) No Collinearity between Independent Variables

Independence of explanatory variables is one of the assumptions of the multiple linear regression models. Perfect collinearity exists when one of the independent variables is

perfectly linearly related to one or more of the other independent variables. When the independent variables are highly correlated, it becomes difficult to separate out the effect of one, with all the others holding constant. One warning signal that multicollinearity is present is all individual partial slope coefficients failing to be significant although the overall model shows a good measure of fit. One common way of checking for multicollinearity is to examine he matrix of bivariate correlations; this will not be a problem if no individual correlation exceeds some predefined cutoff value, usually around 0.70. But this rule is unsatisfactory for two main reasons: first, it is possible the presence of multicollinearity not reflected in high bivariate correlations; second, it is difficult to define what the appropriate cutoff value is.

Two statistics can also be used to evaluate the multicollinearity present in the data: the Tolerance level and the Variance Inflation Factor. For each independent variable I, its Tolerance is, where is the squared multiple correlation of that variable with the other independent variables. The VIF is the reciprocal of Tolerance. So, variables with high multicollinearity have small values of TOL and large values of VIF. In practice, values of the TOL< 0,1 or VIF>10 allow the conclusion of multicollinearity[b] between the independent variables.

3.4.3 Goodness of Fit and Validity of the Linear Regression Model

The Goodness of Fit means the explanatory power of the regression equation, symbolized by , and it is interpreted as the proportion of variation in Y explained by the presence of the variables *X's* in the model (or the adjusted regression line). Its values vary between zero and one: a high value for is associated with a good fit; and, a low value of with a poor fit. When is equal to one, that means that the independent variables explain entirely the total variations in *Y* variable. When is equal to or around zero, it means that 0% of the variation in *Y* is explained by variations in *X*. Several causes might explain that value:

[b]For some authors values of TOL < 0,2 or VIF > 5 indicate the existence of multicollinearity.

The *X*'s variables are independent from *Y* variable;

The *X*'s variables are "poor" in explaining variations in *Y*;

The linear function is not adequate to formalize the relationship between them., known as the coefficient of determination, is the ratio between the Regression Sum of Squares (RSS) or variation explained by the regression model and the Total Sum of Squares (TSS) or total variation of the dependent variable. The Error Sum of Squares (ESS) is the variation unexplained by the model. So, is a measure of the variation of the dependent variable explained by the regression models.

The independent variable "Population Aged 65 and above" explains 97.8% of the variation of the "Size of the Antihypertensive Drug Market", meaning a very good fit for the observed data (Table 3-3).

Table 3-3 Summary of Model Goodness of Fit[b]

Model	r	R^2	Adjusted R^2	Standardized estimated error
1	.989[a]	.978	.975	5.49E8

a. Predicative variable: (constant value), Population Aged 65 and above.

b. Dependent variable: Size of the Antihypertensive Drug Market

As more independent variables are included in a regression model, the determination coefficient tends to increase, even if some variables are irrelevant, i.e., have no effects on the dependent variable. Because tends to be an overestimate of the population parameter, the adjusted determination coefficient is designed to compensate for the number of independent variables (p) in the model and the sample dimension (n).

$$\bar{R}^2 = R^2 - \frac{p(1-R^2)}{n-p-1} \quad \textbf{(3.3)}$$

Other things being equal, a strong relationship between X and Y is expected to result

in a large ratio of explained to unexplained variance, a large value for F, and to the rejection of the null hypothesis that the population is equal to zero:

$$\frac{\text{Explained variance}}{\text{Unexplained variance}} = \frac{\text{RSS}/p}{\text{ESS}/(n-p-1)} \cap F_{(p,n-p-1)} \quad \textbf{(3.4)}$$

On the contrary, a very weak relationship between X and Y is expected to result in small values of F, and on a population significantly different from zero. So, the F test is very useful for testing the validity of the multiple regression model.

Testing that the model has no power to explain the variation of the dependent variable is comparable to test that all independent variables have coefficients equal to zero or that their joint effects are zero:

$$\beta_1 = \beta_2 = \cdots = \beta_p = 0 \quad \textbf{(3.5)}$$

It is also possible to test separately the significance of each independent variable (with the following t-Student statistic:

$$\frac{b_i - \beta_{i0}}{S_{b_i}} \cap t_{(n-1)} \quad \textbf{(3.6)}$$

where is the sample coefficient, the estimate of the standard error of and the value of the population coefficient under the null hypothesis.

Chapter 4: The Relationship between Population Aging and the Antihypertensive Drug Market

4.1 Analysis of the Influencing Factors

4.1.1 Population and Disease Map

(1) Prevalence of Hypertension Every Two Weeks among People Aged 65 and above

In China, the prevalence of hypertension every two weeks of people aged 65 and above was only 30.1‰ in 1998. As the aging population increases, the standard of living improves and the life style changes, the prevalence of hypertension increases quickly. In recent years, the prevalence of hypertension grew quickly in China. Among Chinese people aged 65 and above, the prevalence of hypertension has reached about 50%. In 2008, the prevalence of hypertension every two weeks among Chinese people aged 65 and above was up to 127.5‰.

Table 4-1 Prevalence of Hypertension Every Two Weeks of People Aged 65 and above (‰)

Year	Aged 65 and above	Year	Aged 65 and above
1998	30.10	2006	91.35
1999	34.01	2007	107.92
2000	38.42	2008	127.50
2001	43.40	2009	150.63
2002	49.04	2010	177.96
2003	55.40	2011	210.24
2004	65.45	2012	248.38
2005	77.32		

Data Source: An Analysis Report of the National Health Services Survey

According to the Analysis Report of the National Health Services Survey in 2008, people aged over 60 in China has a stronger awareness of hypertension prevention, compared with other age groups. For example, the percentage of people aged over 60 who

have had their blood pressure measured is 63% and who have received health instructions concerning hypertension prevention and treatment is 73.9%, the highest among all age groups. This will increase the rate of outpatient treatment of old hypertensive patients.

(2) Outpatient Hypertension Treatment Rate Every Two Weeks of People Aged 65 and above

Outpatient hypertension treatment rate every two weeks refers to the proportion of the number of people involved in the survey who receive outpatient treatment within two weeks against the total number of the survey sample. Hypertension is a chronic disease that tends to be ignored by people. In 1998, the outpatient hypertension treatment rate of people aged 65 and above in China was only 21.3‰, but with the popularization of medical knowledge, it increased to 51.7‰ in 2008.

Table 4-2 Outpatient Hypertension Treatment Rate Every Two Weeks of People Aged 65 and above (‰)

Year	Outpatient Hypertension Treatment Rate Every Two Weeks	Year	Outpatient Hypertension Treatment Rate Every Two Weeks
1998	21.30	2004	41.01
1999	24.00	2005	43.45
2000	27.05	2006	46.04
2001	30.48	2007	48.79
2002	34.34	2008	51.70
2003	38.70		

Data Source: An Analysis Report of the National Health Services Survey

4.1.2 Medical Insurance Coverage and Affordability

(1) Average Level of Drugs Use

The average level of use of drugs, also called the average cost of use of drugs, refers to the per capita cost use of drugs in China on an annual basis (the formula is: the average level of use of drugs = the total sales volume of the drug market in China of the year/the total population in China of the year). The aging population is the largest consumer group,

so population aging will inevitably lead to the increase in the use of drug. By 2011, the average level of use of drug in China is RMB 706 per person, up 24.25% from that in 2010. In 2001, it was only RMB 139.7 per person. Average annual growth rate of the demand for drug may be up to 17.7%.

Table 4-3 Average Level of Use of Drugs

Year	Average Level of Use of Drugs (RMB per Person)
2001	139.7
2002	161.9
2003	183.2
2004	206.7
2005	239.6
2006	271.1
2007	311.4
2008	377.8
2009	457.0
2010	568.2
2011	706.0

Data Source: Annual Report of Health Statistics

(2) Average Cost of Hypertension Outpatient Treatment Every Two Weeks

The increase of elderly hypertensive patients leads to the increase in demand for drugs. Due to the shortage in health care resources supply in China, the increased demand for drugs will result in price rise and further affect the treatment cost (without strict regulation policies)(Wang & Liu , 2012). Besides, the level of hypertension treatment cost affects the prevention and treatment of hypertension among people. In this research, the cost of outpatient hypertension treatment every two weeks is chosen as the main indicator to assess the hypertension treatment cost, because the percentage of inpatient hypertension treatment is relatively low and inpatients usually have other diseases apart from hypertension.

Table 4-4 Average Cost of Outpatient Hypertension Treatment Every Two Weeks (RMB)

Year	Average Cost of Outpatient Hypertension Treatment Every Two Weeks	Year	Average Cost of Outpatient Hypertension Treatment Every Two Weeks
1998	81.90	2004	104.15
1999	84.21	2005	115.28
2000	86.58	2006	127.59
2001	89.02	2007	141.22
2002	91.52	2008	156.30
2003	94.10		…

(3) Medical Insurance Coverage Rate among People Aged over 60

Insurance expenses will increase mainly due to the elderly patients. As the medical insurance policy covering all the people is implemented, the medical insurance coverage rate will expand gradually, meaning that patients, who cannot afford to receive medical treatment now, will also have the ability to pay treatment cost and thus the demand for drug consumption will also rise markedly. In 2011, 1.304 billion people in China have been covered by basic medical insurance. Obviously, the medical insurance coverage rate among elderly people also increases. The implementation of new rural cooperation medical insurance and the medical insurance for urban residents will fill the gap of medical insurance for elderly people, helping release the pressure to receive medical treatment and increase the demand for drugs from this group.

Table 4-5 Medical Insurance Coverage Rate among People Aged over 60

Year	Medical Insurance Coverage Rate among People Aged over 60	Year	Medical Insurance Coverage Rate among People Aged over 60
1998	12.07	2004	40.64
1999	14.78	2005	49.76
2000	18.09	2006	60.92
2001	22.15	2007	74.58
2002	27.11	2008	91.30
2003	33.20		

Data source: An Analysis Report of the National Health Services Survey

(4) Government Expenditure in Health Care

Government expenditure on health care refers to the fiscal appropriation by governments of all levels to be used in public health care, which constitutes, together with social expenditure on health care and residents' personal health care expense, the source of the overall expenditure on health care. Government's intervention in health care is an important measure to promote equality among the population to realize their right of health care. As shown in the research review, the government expenditure on health care will grow increasingly with the aggravation of the population aging.

With the increase of population aging, the population's demand for medical care also increases and people will become more eager to have a fair and equal right to health care. Government, as the provider of public health products and services, plays an essential role in promoting the development of the medical industry. Government investment in health care will increase the supply of health care products and promote the development of the medical industry. In recent years, the Chinese government continuously increased its investment in health care: in 2000, government expenditure on health care represented 15.47% of total health care cost; in 2011, this percentage doubled to 30.4%.

Table 4-6 Government Expenditure on Health Care over Years

Year	Annual Total Expenditure on Health Care (Multiplied by RMB 100 Million)	Percentage in Total Health Care Cost (%)
2000	709.52	15.47
2001	800.61	15.93
2002	908.51	15.69
2003	1116.94	16.96
2004	1293.58	17.04
2005	1552.53	17.93
2006	1778.86	18.07
2007	2581.58	22.31
2008	3593.94	24.73
2009	4816.30	27.50
2010	5732.50	28.70
2011	7377.78	30.40

Data source: Annual Report of Health Statistics

(5) Health Care Cost

Population aging is one of the causes of health care cost. The total health care cost refers to the total amount of money consumed for medical services by the whole society in a country or region within a certain period (usually a year). The total health care cost in China has been on the increase over the past years, but its proportion in GDP doesn't change distinctly. The increase in average health cost can well reflect the rise of demand for health care. The elderly people have a higher incidence of disease, longer treatment period and higher outpatient treatment rate, so the health care cost for them increases accordingly. In 2000, the average health care cost was RMB 361.88, taking up 5.96% of the average consumption expense. By 2011, the average health care cost in China was six times as that in 2000, up to RMB 1,820, accounting for 12.00% of the average consumption expense.

Table 4-7 Average Health Care Cost and Its Percentage to Average Consumption Expense

Year	Total Health Care Cost (Multiplied by RMB 100 Million)	Percentage of Total Health Care Cost to GDP (%)	Average Health Care Cost (RMB)	Percentage of Average Health Care Cost to Average Consumption Expense (%)
2000	4586.6	4.62	361.88	5.96
2001	5025.9	4.58	393.80	6.21
2002	5790.0	4.81	450.75	6.48
2003	6584.1	4.85	509.50	7.07
2004	7590.3	4.75	583.92	7.49
2005	8659.9	4.68	662.30	8.04
2006	9843.3	4.55	748.84	8.16
2007	11574.0	4.35	875.96	8.46
2008	14535.4	4.63	1094.52	9.49
2009	17541.9	5.15	1314.30	9.72
2010	19980.4	4.98	1490.10	11.06
2011	24269.0	5.15	1820.00	12.00

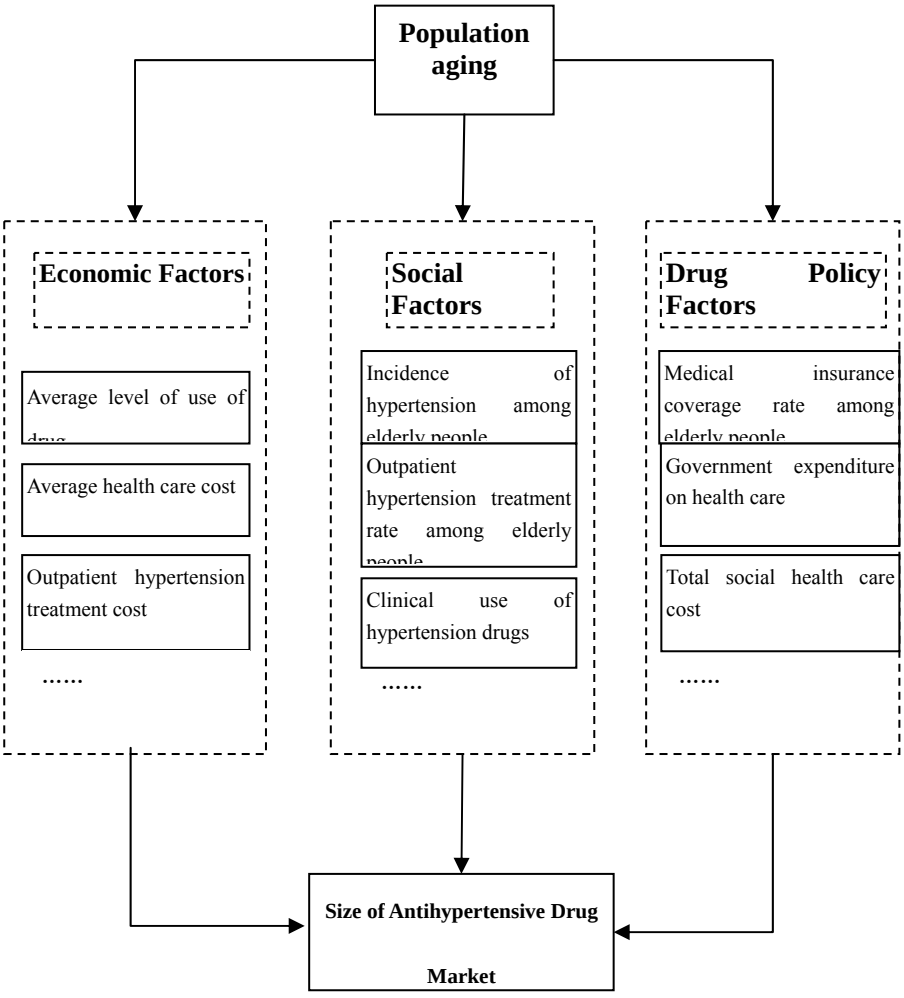
Statistics Source: Annual Report of Health Statistics

4.1.3 The Relationship between Population Aging and the Level of Use of Antihypertensive Drugs

Population aging is an inexorable trend of social development. Population, as the subject and endogenous variable of social and economic development, the change of

population structure will have a significant influence on social economic development.[55] From the perspective of public health care, population aging will inevitably lead to the change in the map of disease, especially chronic diseases. Hypertension is one of the chronic diseases of highest incidence and it will bring new challenges to the health care for the aging population. Drug therapy is the main treatment for hypertension, and the level of use of antihypertensive drugs among the elderly patients will increase as the incidence of hypertension is getting higher. The process of population aging is associated with social security and economic development, while the development of social economy and the construction of social medical system affect people's demand for drugs.

Figure 4-1 The Relationship between Population Aging and the Size of Antihypertensive Drug Market



According to the previous literature review, the author concluded that the antihypertensive drug market under a population aging society had the following characteristics: population of elderly above 65 increasing, two-week prevalence rate of hypertension of elderly above 65 rising, per capita drug use rising, average two-week clinic expense increasing, two-week outpatient rate of elderly above 65 rising, rate of joining insurance of elderly above 60 rising, total health expenditure and per capita health expenditure increasing and government health expenditure increasing. The previous Figure 4-1 summarizes several key characteristics of the antihypertensive drug market under the influence of population aging: increase in the population of people aged 65 and above, higher incidence of hypertension every two weeks among people aged 65 and above, increase in average level of use of drugs, increase of outpatient hypertension treatment cost every two weeks, higher outpatient treatment of hypertension every two weeks among those aged 65 and above, larger medical insurance coverage rate among people aged 60 and above, increase in total health care cost and per-capita health care cost, and increase in government expenditure on health care.

Therefore, the following hypotheses have been defined concerning the different factors influencing the size of antihypertensive drug market:

i. The total elderly population (in this thesis the author chose the total population of people aged 65 and above as its representative),
ii. prevalence of hypertension every two weeks among those aged 65 and above,
iii. outpatient hypertension treatment rate every two weeks among people aged 65 and above,
iv. average cost of hypertension outpatient treatment every two weeks
v. total health care cost,
vi. per-capita health care cost,
vii. medical insurance coverage rate among people aged 60 and above, and
viii. government expenditure on health care.

The objective of this chapter is to present the results of a multiple linear regression model to explain the variation of the size of antihypertensive drug market with the previously defined independent variables. But first, it was necessary to test the different assumptions of the model, namely: linear relationship between the independent and dependent variables, normality, homoscedasticity and independence of the random errors respectively and multicollinearity between independent variables. A summary of these results is presented in Table 4-8. The assumption of normality of random errors is violated for two of the independent variables: Two week morbidity rate among people aged 65 and above and Medical insurance coverage rate increase among people aged 60 and above; DW test rejects that the random errors are not correlated for variables Outpatient hypertension treatment rate every two weeks among people aged 65 and above, Total health care cost and Per-capita health care cost, being inconclusive for all the remaining variables. But the main problem concerns the assumption of no multicollinearity between the independent variables.

Table 4-8 Test Results for Each Independent Variable

Indicators	Test requirements				
	N	Linear relation with the Independent variable	Whether Standardized Residuals After Regression Normally Distribute	Shapiro-Wilktest p-value	Durbin-Watson
Population of people aged 65 and above	11	Yes	Yes	0.543	1.015
Two week morbidity rate among people aged 65 and above	11	Yes	Yes	0.021*	1.414
Medical insurance coverage rate increase among people aged 60 and above	9	Yes	Yes	0.017	1.214
Outpatient hypertension treatment cost every two weeks	9	Yes	Yes	0.208	1.002
Outpatient hypertension treatment rate every two weeks among people aged 65 and above	9	Yes	Yes	0.765	1.452
Average level of use of drugs	10	Yes	Yes	0.298	1.240
Total health care cost	11	Yes	Yes	0.135	1.801
Per-capita health care cost	11	Yes	Yes	0.094	1.881
Government expenditure on health care	11	Yes	Yes	0.362	0.970

Note:The parts highlighted with grey are indicators suitable for linear regression

Numbers with* correspond to Kolmogorov-Smirnov test p-values

(1) Multiple Linear Regression Model

This research aims to explore the relationship between the size of the antihypertensive drug market and the influencing factors and construct a model based on linear regression.

Model 1A: All independent variables

The first model to be estimated includes all the independent variables. The model is good since the F value is 691.353, and p-value is 0.000. There are no problems with the

assumptions of normality of the residuals (p-value of the Shapiro-Wilk test equals 0.481) and no autocorrelation of residuals (Durbin-Watson statistic equals 2.314 and falls in the interval of [1.322, 2.668]). But there is multicollinearity between the independent variables since the TOL values are all smaller than 0.1 and the VIF larger than 10. Also, none of the independent variables is significant to explain the dependent variable at the 0.05 significance level, pointing to the lack validity of the estimated model.

The results of the multiple regression model with all independent variables including the values of Tolerance and VIF to test for multicollinearity are presented in Table 4-9.

Table 4-9 Test Results for Each Independent Variable in the Multiple Regression Model

		Test requirements				
		Indicators	t	p	TOL	VIF
F	691.354	Aged 65 and above	-0.479	0.643	0.001	683.113
p	0.000	Prevalence of Hypertension Every Two Weeks among People Aged 65 and above	1.127	0.289	0.000	7280.455
n	18	Medical Insurance Coverage Rate among People Aged 60 and above	-0.831	0.428	0.000	2385.298
Linear or not (Independent)	yes	Average Cost of Hypertension Outpatient Treatment Every Two Weeks	-0.445	0.667	0.001	911.746
Normal distribution or not (Standardized residuals)	no	Outpatient hypertension treatment rate every two weeks among people aged 65 and above	1.246	0.244	0.003	308.649
p-value of Shapiro-Wilk test (>0.05)	0.481	Average level of use of drugs	0.872	0.406	0.001	1934.057
Durbin-Watson statistic	2.134	per-capita health care cost	0.112	0.913	0.000	2359.309
		Government Expenditure in Health Care	-0.575	0.579	0.001	1366.380

Model 2A: Only those independent variables that do not violate assumptions

We found from the previous discussion that regression equation cannot be applied to describe the relationship between all the indicators and the size of the hypertensive drug

market. However, considering the complexity of the hypertensive drug market and the association between the indicators, a multiple linear regression model concerning the relationship between the size of the antihypertensive drug market and a small number of independent factors is established for further exploration.

The nine independent variables were screened via the normality test, autocorrelation test, t-test and dependence of the random errors of the coefficients figured out through the model. Finally, we could find that the regression model where the size of the hypertensive drug market is explained by "population aged 65 and above" and the "government expenditure on health care" does not violate the assumption of no multicollinearity. The testing process concerning the hypothesis in this model is as follows.

(2) Testing the Assumptions of the Multiple Linear Regression Model

The testing of the assumptions of the multiple linear regression model is carried out based on five aspects, including the linear relationship between the independent and dependent variables, normality, homoscedasticity and independence of the random errors respectively and no multicollinearity between the independent variables.

(a) Linearity between Independent Variables and the Dependent Variables

The scatter diagrams for the relationship between the dependent variable and "population aged 65 and above" and between the dependent variable and "government expenditure on health care" were drawn, from which we could find that both two independent variables have a linear relationship with the dependent variable. (See Appendix 3, Figure 4-1 and Figure 4-2)

(b) Normality of the residuals

After a normality test was conducted against the random errors of this model, it was found that p(Kolmogorov-Smirnov)=0.188 and p(Shapiro-Wilk)=0.244. Because both of them are larger than 0.05, the random errors of this model could be deemed normally distributed.

Table 4-10 Normality Tests

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistics	df	Sig.	Statistics	df	Sig.
Standardized Residual	.169	18	.188	.936	18	.244

a.Adjustment of the Level of Significance by Lilliefors Correction

(c) The variance of the random errors is constant

The distribution of the residual values on the '0 line' is random, meaning that the variance of the random errors is homogeneous. (See Appendix 3 ,Figure 4-3)

(d No correlation between the random errors

From the Durbin-Watson statistics, we could see that d_U=1.536. The scope of the random errors for independence assumption is [1.536, 2.464]. Therefore, the Durbin-Watson value of this model is 1.8585. According to the original hypothesis, the random errors are considered relatively independent and there is no autocorrelation between the errors. Therefore, the indications will not affect the interpretation of the model.

(e) Independence of explanatory variables

The linear independence of explanatory variables was judged with tolerance and VIF and it was figured out that the tolerance of this linear model=0.144>0.1 and its VIF=6.954<10, which means that the two indicators in the equation are not significantly associated in a linear way.

Testing the Validity and Goodness of Fit of the Multiple Linear Regression Model

T-tests for the regression coefficients and the ANOVA test were used to test for the validity of the regression model. The model goodness of fit was evaluated with the adjusted determination coefficient (R^2).

Table 4-11Estimated Regression Coefficients[a]

Model		Non-standardized Coefficients		Standardized Coefficients	t	Sig.	Independence Statistics	
		B	Standard Errors				Tolerance	VIF
2A	(Constant Value)	-1.22E10	1.07E9		-11.447	.000		
	Population Aged 65 and above	177.548	12.193	.563	14.561	.000	.144	6.954
	Government Expenditure on Health care	.008	.001	.454	11.744	.000	.144	6.954

a. Dependent value: Size of the Antihypertensive Drug Market

The ANOVA test of the regression equation showed that p=0.000<0.01. Therefore, it has statistical significance. The null hypothesis that both regression coefficients are equal to 0 was also rejected. The size of the antihypertensive drug market can be explained by the two independent variables, namely, government expenditure on health care and population aged 65 and above.

The results shows that adjusted R^2=0.996, meaning that the variation of the variables Government Expenditure on Health care and Population Aged 65 and above explain 99.8% of the variation of the Size of the Antihypertensive Drug Market.

Table 4-12 Summary of the Model[e]

Model	R	R^2	Adjusted R^2	Standard estimated error	Durbin-Watson
2A	.998[a]	.997	.996	2.76E8	1..8585

a. Predictive variables: (constant values), Government Expenditure on Health care, Population Aged 65 and above.

b. Dependent value: Size of the Antihypertensive Drug Market

The test of the regression equation showed that p=0.000<0.01. Therefore, it has statistical significance. The null hypothesis that both regression coefficients are equal to 0

was refused. The size of the antihypertensive drug market can be explained by the two independent variables, namely, government expenditure on health care and population aged 65 and above.

The result in the tests for slope and intercepts showed that $p<0.01$. Therefore, the model is good and valid, slope and intercepts can be generalized to the population and they are shown in the following multiple linear regression equation:

$$\mathbf{Y = 177.548\ X_1 + 0.008X_2 - 1.22*10^{10}} \qquad \mathbf{(4.1)}$$

with Y = Size of the Antihypertensive Drug Market

X_1 = Population Aged 65 and over

X_2 = Government Expenditure on Health care

.In the Standardized Residue Column Diagram (see the Appendix III, Figure 4-5), a probability distribution shows a similarity to normal distribution.

Standardized Residue Cumulative Probability Diagram (see the Appendix III, Figure 4-6), is also similar to normal distribution.

Stardardized Residue Scatter Diagram, (see the Appendix III，Figure 4-7) just shows scatter plot without any obvious pattern. It states that this model is the most suitable one.

(3) Simple Linear Regression Models

Then several simple regression models were built, in which the aforesaid factors were set as explanatory variables and discussed their relations with the dependent variable (the size of the antihypertensive drug market).

According to the above mentioned model, simple linear regression equations can be estimated between the "size of the antihypertensive drug market" and three independent factors, "outpatient hypertension treatment rate every two weeks among people aged 65 and above", "total health care cost" and "per-capita health care cost".

(a) Model1B: "outpatient hypertension treatment rate every two weeks among people aged 65 and above" and "size of antihypertensive drug market"

"Outpatient hypertension treatment rate every two weeks among people aged 65 and above" was set as the independent variable and a simple linear regression equation was

estimated between this variable and "size of the antihypertensive drug market".

Y: Size of the antihypertensive drug market

X_1: Outpatient hypertension treatment rate every two weeks among people aged 65 and above

R^2 equals 0.949, meaning that the variation of the variable Outpatient Hypertension Treatment Rate Every Two Weeks among People Aged 65 and above. Explains 94.9% of the variation of' the Size of the Antihypertensive Drug Market'.

Table 4-13 Summary of the Model[b]

Model	R	R^2	Adjusted R^2	Standard estimated error	Durbin-Watson
1B	.974[a]	.949	.941	4.26E8	1.452

a. Predicative value: (constant value), Outpatient Hypertension Treatment Rate Every Two Weeks among People Aged 65 and above.

b. Dependent variable: Size of the Antihypertensive Drug Market

The test of the regression equation showed that p=0.000<0.01. Therefore, it has statistical significance. The null hypothesis that the regression coefficient is 0 was rejected. Therefore, the result that the dependent variable "Size of the antihypertensive drug market" can be explained by independent variable "Outpatient hypertension treatment rate every two weeks among people aged 65 and above" can be generalized to the population. It can be concluded that the model is good and valid.

Table 4-14 Anova[b]

	Model	Sum of Squares	df	Mean Square	F	Sig.
1B	Regression	2.03E19	1	2.03E19	111.700	.000
	Residual	1.09E18	6	1.82E17		
	Total	2.14E19	7			

a. Predictive variable: (constant value), Outpatient Hypertension Treatment Rate Every Two Weeks among People Aged 65 and Above.

b. Dependent variable: Size of the Antihypertensive Drug Market

Tests for the slope and the intercept show that $p<0.01$. Therefore, slope and intercept are significantly different from zero in this regression equation. The equation can be expressed as follows:

$$\mathbf{Y = 2.37*10^8 X_1 - 3.07*10^9} \quad \textbf{(4.2)}$$

Table 4-15 Regression Coefficients

Model 1B	Non-standardized Coefficient		Standardized Coefficient	t	Sig.
	B	Standard error			
(Constant Value)	-3.07E9	9.50E8		-3.228	.018
Outpatient hypertension treatment rate every two weeks among people aged 65 and above	2.37E8	2.24E7	.974	10.569	.000

a. Dependent variable:Size of the Antihypertensive Drug Market

(b) Model 2B: Total Health Care Cost and Size of the Antihypertensive Drug Market

"Total health care cost" as set as the independent variable and a simple linear regression equation was estimated to explain the "size of the antihypertensive drug market".

Y-Size of the antihypertensive drug market

X_2- Total health care cost

R^2 equals 0.990, which means that the model's ability in interpretation (prediction) is up to 99.0%. The independent variable in this regression equation can well explain the dependent variable.

Table 4-16 Summary of the Model[b]

Model	R	R^2	Adjusted R^2	Standardized Estimation Error	Durbin-Watson
2B	.995[a]	.990	.989	3.65E8	1.801

a. Predictive variable: (constant value), Total Health Care Cost

b. Dependent variable: Size of the Antihypertensive Drug Market

The ANOVA test of the regression equation showed that p=0.000<0.01. Therefore, it has statistical significance. The null hypothesis that the overall regression coefficient is 0 was rejected. Therefore, the dependent variable "size of the antihypertensive drug market" can be explained by independent variable "total health care cost".

Table 4-17 Anova[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
2B	Regression	1.20E20	1	1.20E20	901.901	.000[a]
	Residual	1.20E18	9	1.33E17		
	Total	1.21E20	10			

a. Predictive variable: (constant value) Total Health Care Cost

b. Dependent variable: Size of the antihypertensive drug market

The result in the tests for slope and intercept showed that p<0.01. Therefore, slope and intercept are significant in this regression equation. The equation can be expressed as follows in the linear regression equation:

$$\mathbf{Y = 0.005\ X_2 + 2.10*10^9} \qquad \mathbf{(4.3)}$$

Table 4-18 Coefficienta

Model		Non-standardized Coefficient		Standardized	t	Sig.
		B	Standard error	Coefficient		
2B	(Constant Value)	2.10E9	2.43E8		8.628	.000
	Total Health Care Cost	.005	.000	.995	30.032	.000

a. Dependent variable:Size of the Antihypertensive Drug Market

In the Standardized Residue Column Diagram (see the Appendix III, Figure 4-8), a probability distribution shows a similarity to normal distribution.

Standardized Residue Cumulative Probability Diagram (see the Appendix III, Figure 4-9), is also similar to normal distribution.

Stardardized Residue Scatter Diagram, (see the Appendix III，Figure 4-10) just shows scatter plot without any obvious pattern. It states that this model is the most suitable one.

(c) Model 3B: "Per-capita Health Care Cost and Size of the Antihypertensive Drug Market"

Set "per-capita health care cost" as the independent variable and estimate a simple linear regression equation between this variable and "size of the antihypertensive drug market"

Y-Size of the antihypertensive drug market

X_3- Per-capita health care cost

R^2 equals 0.990, which means that the model's ability in interpretation (prediction) is up to 99.0%. The independent variable in this regression equation can well explain the dependent variable.

Table 4-19 Summary of the Model

Model 3B	R	R^2	Adjusted R^2	Standardized Estimated Error	Durbin-Watson
1	.995[a]	.990	.988	3.75E8	1.881

a. Predicative variable: (constant value), Per-Capita Medical Cost

b. Dependent variable: Size of the Antihypertensive Drug Market

The ANOVA test of the regression equation showed that p=0.000<0.01. Therefore, it has statistical significance. The null hypothesis that the overall regression coefficient is 0 was rejected. Therefore, the dependent variable "size of the antihypertensive drug market" can be explained by independent variable "per-capita health care cost".

Table 4-20 Anova[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
3B	Regression	1.20E20	1	1.20E20	855.438	.000[a]
	Residual	1.26E18	9	1.40E17		
	Total	1.21E20	10			

a. Predictive variable: (constant value), Per-Capita Health Care Cost.

b. Dependent variable: Size of the Antihypertensive Drug Market

The result of the tests for the slope and intercept showed that $p<0.01$. Therefore, slope and intercept are significant in this regression equation. The equation can be expressed as follows:

$$\mathbf{Y = 7.40*10^6 X_3 + 1.93*10^9} \qquad \mathbf{(4.4)}$$

Table 4-21 Regression Coefficients[a]

Model		Non-standardized Coefficient		Standard Coefficient	t	Sig.
		B	Standard error			
3B	(Constant Value)	1.93E9	2.55E8		7.576	.000
	Per-capita Health Care Cost	7.40E6	2.53E5	.995	29.248	.000

a. Dependent variable: Size of the Antihypertensive Drug Market

In the Standardized Residue Column Diagram (see the Appendix III, Figure 4-11), a probability distribution shows a similarity to normal distribution.

Standardized Residue Cumulative Probability Diagram (see the Appendix III, Figure 4-12), is also similar to normal distribution.

Stardardized Residue Scatter Diagram, (see the Appendix III，Figure 4-13) just shows scatter plot without any obvious pattern. It states that this model is the most suitable one.

4.2 Discussion of results

4.2.1 Results of the Simple Linear Regression Models

Model 1B:

Y(size of antihypertensive drug market)=$2.37*10^8X_1$(outpatient hypertension treatment rate every two weeks among people aged 65 and above)–$3.07*10^9$ (4.5)

Relationship between outpatient hypertension treatment rate every two weeks and the size of the antihypertensive drug market: there is a positive correlation between the two. As outpatient hypertension treatment rate every two weeks increases, the size of the antihypertensive drug market will also increase. From the above equation, when outpatient hypertension treatment rate every two weeks increases by 1‰, the size of the antihypertensive drug market will increase by RMB 0.237 billion.

Model 2B:

Y(size of antihypertensive drug market)=$0.005X_2$(total health care cost)+$2.10*10^9$ (4.6)

Relationship between total health care cost and the size of the antihypertensive drug market: there is also a positive correlation between the two; the size of the antihypertensive drug market will increase with the increase in total health care cost. As seen from the regression model, when total cost of health care increases by RMB 200, the size of the antihypertensive drug market will increase by RMB 1.

Model 3B:

Y(size of antihypertensive drug market)=$7.40*10^6X_3$(percapita health care cost)+$1.93*10^9$ (4.7)

Relationship between per-capital health care cost and the size of the antihypertensive drug market: as seen from the regression model, when the average cost of health care increases by RMB 1, the size of the antihypertensive drug market will increase by RMB 7.4 million.

Outpatient hypertension treatment rate directly impacts both the chance of drug use in the antihypertensive drug market and the size of this market. As shown by the data, every increase by 1‰ in outpatient hypertension treatment rate among the population has a huge

influence on the size of the antihypertensive drug market. Since hypertension is a chronic disease, hypertensive patients need to be on long-term medication; once someone suffers from hypertension, he has to receive lifetime medication until he passes away. When more hypertensive patients receive outpatient treatment, the use of hypertensive drugs will increase and the size of the antihypertensive drug market will expand. From another perspective, the size of the antihypertensive drug market is also influenced by health care cost, both total health care cost and per-capita health care cost. Hypertension, as a chronic disease, only takes up quite a small proportion of the total health care cost, so the size of the antihypertensive drug market does not increase as rapidly as total health care cost. But the case is different for per-capita health care cost. Due to the large population base in China, the increase in per-capita health care cost will exert a large influence on the antihypertensive drug market.

Among the three equations, the independent variable of equation 2 is total health care cost. From the perspective of statistics, there is a relatively small gap between total health care cost and the size of the antihypertensive drug market in terms of dimension and thus the response is comparatively good.

In the Standardized Residue Column Diagram (see the Appendix III, Figure 4-11), a probability distribution shows a similarity to normal distribution.

Standardized Residue Cumulative Probability Diagram (see the Appendix III, Figure 4-12), is also similar to normal distribution.

Stardardized Residue Scatter Diagram, (see the Appendix III， Figure 4-13) just shows scatter plot without any obvious pattern. It states that this model is the most suitable one.

4.2.2 Results of the Multiple Linear Regression Models

Model 2A:

$$\textbf{Y(size of the antihypertensive drug market)}=177.548X_4\textbf{(population of people aged 65 and above)}+0.008X_5\textbf{(government expenditure on health care)}-1.22*10^{10} \quad \textbf{(4.8)}$$

(a) Relationship between population aging and the size of the antihypertensive drug market: there is a positive correlation between the two: the size of the antihypertensive drug market will increase with the increase in the elderly population (population aged 65 and above). As seen from the regression model, under the prerequisite of constant government expenditure on health care, when population aged 65 and above increases by 1 person, the size of the antihypertensive drug market will increase by RMB 177.548. According to previous researches, the relative risk for elderly people to suffer from hypertension is significantly higher than that for young people. Consequently, the increasing elderly population increases the possibility for elderly people to suffer from hypertension and, from this point of view, indirectly affects the size of the antihypertensive drug market. As the population aging process speeds up in China, its impact on the size of the antihypertensive drug market will become more evident.

(b) Relationship between government expenditure on health care and the size of the antihypertensive drug market: there is a positive correlation between government expenditure on health care and the size of the antihypertensive drug market, that is, as government expenditure on health care increases, the size of the antihypertensive drug market will increase accordingly. In light of the model, under the condition of fixed elderly population, when government expenditure on health care increases by RMB 125, the size of the antihypertensive drug market will increase by RMB 1. Actually, only part of government expenditure on health care is used for antihypertensive drugs and as seen from the regression equation, the coefficient is only 0.008, which shows a small influence of this indicator on the size of the antihypertensive drug market, but this indicator and the indicator "population of people aged 65 and above" jointly explain the size of the antihypertensive drug market. With the continuous increase in government expenditure on health care, the size of the antihypertensive drug market will increase to some extent. As the data of the research shows, both the population aged 65 and above, and government expenditure on health care are on the increase trend. However, there is certain saturation for

population growth. When population aging reaches a saturation point, the model may demonstrate some deviation. Yet under current circumstances, population aging in China is still on the rise, so this model remains a valuable reference.

4.3 Empirical Survey on the Use of Antihypertensive Drugs in the Context of Population Aging

The previous paragraphs discussed the factors that influence the growth of antihypertensive drug market based on regression models. Since information about the drug market can be significantly asymmetric, what follow the paragraphs will further explore the features of the antihypertensive drug market of elderly people in practice, through investigating doctors' behavior regarding the prescription of antihypertensive drugs and elderly people's use of drugs, serving as references for specific suggestions that will be presented later in this thesis.

4.3.1 Survey Objectives and Design

The questionnaire, with the purpose to further understand antihypertensive treatment and use of antihypertensive drugs among elderly people and the doctors' prescription behavior survey, analyzes the features of elderly people's use of drug in practice to provide a realistic basis for prediction in the next chapter and to serve as references for specific suggestions on the management of hypertension that will be presented later in this thesis (For the questionnaire, see Appendix 1-2)

Take the urban areas of Guangzhou and Raoping County as examples. The survey will investigate the antihypertensive treatment and use of antihypertensive drugs among elderly people and the prices of the drugs they take and, at the same time, compare their awareness of the prices of the drugs within the last five years; investigate doctors' awareness of hypertensive treatment in the last five years, the percentage of elderly patients and the patients' choice of drugs.

4.3.2 Results of the Survey

(1) The Growth of Hypertension Outpatient Treatment Rate among Elderly People is

Relatively Low

Firstly, hypertension treatment rate increased to some extent in recent years. Most physicians consider that hypertension outpatient treatment rate is between 71% and 90% now while that of five years ago was about 61% to 80%. The surveyed physicians assessed that the treatment rate has risen compared to that of five years ago.

Secondly, the percentage of elderly hypertensive people who receive treatment did not change much. According to 75% of the interviewed doctors, this percentage is between 71% and 90% now, roughly the same as that of five years ago. The hypertension treatment rate shown in the survey is higher than the average outpatient treatment rate every two weeks over the past years. The possible reasons behind the result may be that the sample was taken in Guangdong, a place with a high incidence of hypertension since 2008. From another perspective, the questionnaire survey proves that the statistics of the past years are reliable and reflect reality.

(2) Hypertension Treatment Cost is Relatively High

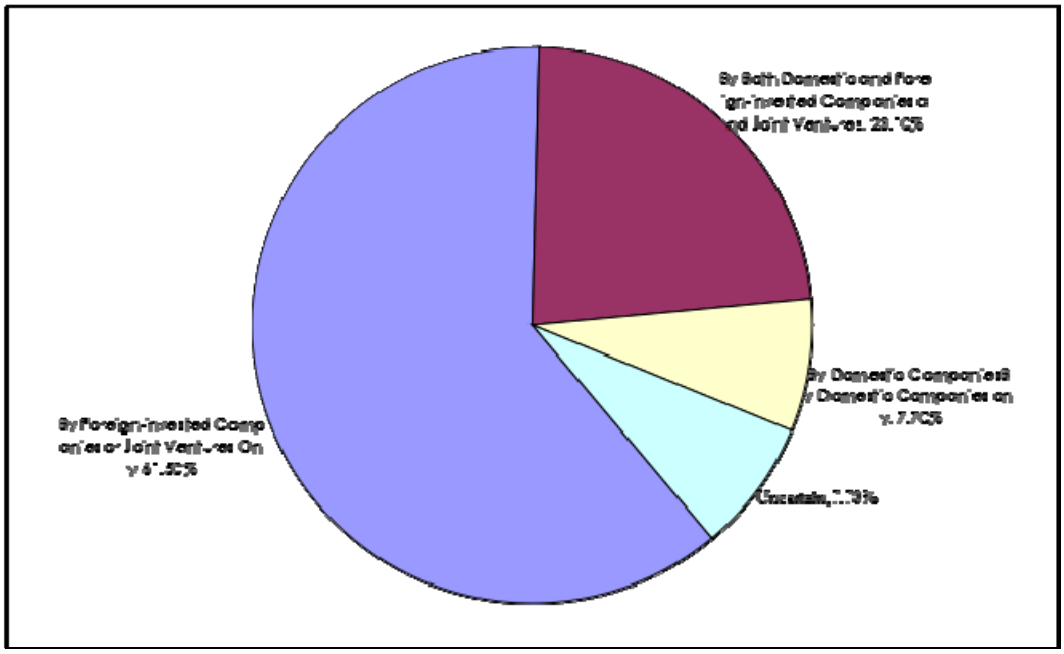
According to the survey, both the hypertension treatment cost (including the cost of diagnosis and drug cost) and the actual burden of hypertension (including hypertensive drug cost deducting the cost that can be covered by medical insurance)are on the rise. The average hypertension treatment cost of the respondents is RMB 235.96, higher than the actual burden, being RMB 120.77. This result means that 51.18% of the cost is paid by the interviewed elderly antihypertensive patients. Such cost is lower than the medical expenses expected by them.

It is worth mentioning that the cost of diagnosis and drug cost involved in this survey is the cost covering a treatment period which lasts for one month. As a chronic disease, hypertension's treatment period is long. Considering that the respondents' average monthly income is RMB 2,312.85, we can conclude that, if the proportion of the cost than can be covered by medical insurance and the drug price remain unchanged, the average actual burden takes up 5.22% of the patients' average income since the cost will cover a long-term treatment.

(3) Features of Use of Drug among Elderly People

(a) Preference to drugs produced by foreign-invested companies or joint ventures. When asked which type of drugs they prefer to buy, 61.5% of the patients choose to take drugs produced by foreign-invested companies and joint ventures only, 23.1% of them use both drugs produced by both Chinese companies and foreign-invested companies or joint ventures, while only 7.7% choose to take drugs produced by Chinese companies (see Figure 4-14).

Figure 4-14 Respondents' Choice of Drugs Produced by Foreign-invested Companies



The Patients' monthly income only has a modest influence on the Patients' choice of drugs. Respondents tend to take drugs produced by foreign-invested companies or joint ventures. The distribution of patients' income in this survey is as follows: 57.7% of the patients have a low monthly income (less than RMB 1,000), 26.9% is in the middle income level (between RMB 1,001 to 2,500) while only 11.5% has a high income (more than RMB 2,500).

(b) Improper use of drugs in self-made therapy. The average percentage of improper use of drugs among elderly hypertensive patients is 24%. Among improper use of drugs,

excessive use of drugs takes for 36.63% while drug reduction accounts for 35.21%, which shows that the two percentages are similar. In addition, there are some improper drug use habits: 75% of the patients do not know the contraindications for the drugs; 58.3% of the patients choose the wrong drugs; 58.3% of the patients do not pay attention to the change of blood pressure; 45.8% of the patients have prejudice against β receptor blockers; 45.8% of the patients are too eager to reduce their blood pressure; 58.3% of the patients take improper dosage of drugs or use the same drugs repeatedly; 79.2% of the patients ignore other risk factors; and 8.3% of the patients have other improper drug use habits.

Table 4-22 Improper Drug Use Habits

	Percentage (%)	Improper Drug Use Habits	Yes (%)	No (%)
Percentage of improper use of drugs	24.00	Lack of knowledge of contraindications	75.0	25.0
		Choice of wrong drugs	58.3	41.7
		Ignoring change of blood pressure	58.3	41.7
Excessive use of drugs	36.63	Prejudice against diuretics and β receptor blockers	45.8	54.2
		Too eager to reduce blood pressure	45.8	54.2
		Taking improper dosage of drugs or using the same drugs repeatedly	58.3	41.7
Drug reduction	35.21	Ignoring other risk factors	79.2	20.8
		Others	8.3	91.7

(4) Physician's Preference of Antihypertensive Drugs Produced by Foreign-Invested Companies and Joint Ventures

83.3% of the interviewed physicians advise the elderly patients to take a certain kind of drug. 12.5% of the physicians usually induce the patients to take drugs produced by foreign-invested companies and joint ventures, but none of the interviewed physicians advise the patients to use drugs produced by Chinese companies only. Most physicians think that they should give relatively reasonable suggestions considering the control of

hypertension and treatment cost when they prescribe the patients.

In the survey on combined treatment, 56.67% of the physicians prescribe only one type of drugs, 28.13% of them prescribe two types of drugs and 15.2% of the physicians advise the patients to take three or more types of drugs.

Table 4-23 Physicians' Preference of Drugs

Drug Preference	Percentage (%)	Types of Drugs	Average Percentage
By foreign-invested companies and joint ventures	12.5	One type of drug	56.67
Combined	83.3	Two types of drugs	28.13
Total	95.8	Three types of drugs	15.21

Notes: A few respondents did not write down their preference of drugs

Through this survey, the features of use of hypertensive drugs in practice are as follows: treatment rate among elderly hypertensive patients keeps increasing steadily over the recent years; the interviewed elderly hypertensive patients considered that the hypertensive treatment cost is relatively high; in terms of the structure of use of hypertensive drugs, physicians tend to advise patients to take drugs produced by foreign-invested companies and joint ventures and thus such drugs are also favored by most elderly hypertensive patients, which indicates that drugs produced by Chinese companies are not competitive in the drug market; from the perspective of the drug use habits of the interviewed elderly hypertensive patients, some improper drug use habits occur during self-medication, increasing the drug use risk.

This chapter discusses the features of use of hypertensive drugs in practice and probing into the rule of the antihypertensive drug market, lays the foundation for suggestions regarding the development of antihypertensive drugs produced by Chinese companies, management of chronic diseases such as hypertension among the elderly, and the improvement of reasonable drug use.

Chapter 5: Prediction and Analysis of the Future Trend of the Antihypertensive Drug Market

Based on the explorative research stated in previous chapters, this chapter will further predict and evaluate the trend of the influencing factors of the antihypertensive drug market and thereby forecast the expansion of the future antihypertensive drug market.

5.1 Quantitative Forecasting

5.1.1 The Application of Regression Equation

On the basis of the four regression models obtained in the research stated in previous Chapters, the grey sequence operation is conducted on the independent variables of the four models; the values for the size of the antihypertensive drug market from 2012 to 2020 are estimated for the period 2012-2020 for each particular model. The results are shown in the Table 5-1.

Table 5-1 Prediction of the Size of Antihypertensive Drug Market 2012-2020

(Multiplied by RMB 100 Million)

Year	Model1B	Model2B	Model 3B	Model 2A
2012	139.63	177.16	176.02	171.92
2013	153.33	205.94	204.13	198.46
2014	168.14	240.04	237.27	232.23
2015	184.14	280.42	276.37	273.97
2016	201.42	328.24	322.47	325.95
2017	220.10	384.88	376.84	391.07
2018	240.27	451.97	440.97	473.07
2019	262.07	531.42	516.59	576.77
2020	285.63	625.51	605.79	708.38

Independent variable of Model1B: outpatient hypertension treatment rate every two weeks among people aged 65 and above;

Independent variable of Model 2B: Total health care cost;

Independent variable of equation 3B: Per capita health care cost;

Independent variables of Model 2A: Population aged 65 and above and government expenditure on health care.

The comparison of the predicted results shows a relatively large gap between the result of model1B and the results of the other three equations. Given that the prediction difference between models and the other models increase as the year goes on, the discussion will be based on the results of the other models.

As shown by the predicted outcomes of models 2B, 3B and 2A, the predicted sizes of the antihypertensive drug market from 2012 to 2020 are close. The predicted size of the antihypertensive drug market will reach between RMB 27.397 and RMB 28.042 billion in 2015. As the population aging grows, there will be a dramatic increase in the antihypertensive drug market from 2015 to 2020. By 2020, the size of the antihypertensive drug market will be up between RMB 60.579-70.838 billion.

To better determine the efficiency of the model prediction outcome, the increase rates of the predicted values and the actual values are compared for the period 2002-2011, as shown in Table 5-2. The average increase rates of all equation results are basically close to the original data and the predicted outcomes of models 2B, 3B and 2A are all very similar. Using horizontal comparison, certain difference can be found among the increasing rates of these equations. The means of relative residual between the equation results and the increasing rates of original data are 0.32, 0.23, 0.22 and 0.42 respectively. That proves a difference of 20%-40% between the predicted values and the actual values. According to the vertical comparison, the increase rate of the original data in 2006 decreased distinctly to merely 3%; the relatively serious external influencing factors of the year (due to the national combat against commercial bribery in pharmaceutical market in 2006, a variety of pharmaceutical market indicators obviously went down) resulted in the abnormal data. Therefore, only the means of relative residuals from 2007 to 2011 are compared; it is found that their values decrease distinctly (except model 1B) and the mean of relative residuals of model 2A is only 0.05 which demonstrates a good effect of prediction.

Table 5-2 Prediction of the Increase Rate of the Size of the Antihypertensive Drug Market 2002-2011

Year	Observed Data	Model 1B	Model2B	Model3B	Model 2A
2002	6.43%	8.61%	8.69%	22.00%	14.36%
2003	8.14%	8.24%	8.25%	20.37%	14.05%
2004	19.67%	9.65%	9.66%	8.97%	7.33%
2005	14.22%	9.35%	9.27%	8.69%	8.77%
2006	3.00%	9.46%	9.37%	8.49%	12.03%
2007	10.75%	12.64%	12.59%	8.31%	13.05%
2008	14.08%	19.20%	19.22%	8.12%	15.51%
2009	17.81%	16.36%	16.21%	13.57%	15.59%
2010	19.57%	11.40%	11.16%	10.40%	15.11%
2011	11.60%	18.00%	18.84%	10.20%	14.71%
Average Increase Rate	12.53%	12.29%	12.33%	11.91%	13.05%
Mean of Relative Residuals		0.33	0.23	0.22	0.42
Mean of Relative Residuals 2007-2011		-0.30	0.13	0.12	0.05

5.1.2 Discussion on Future Development Trends

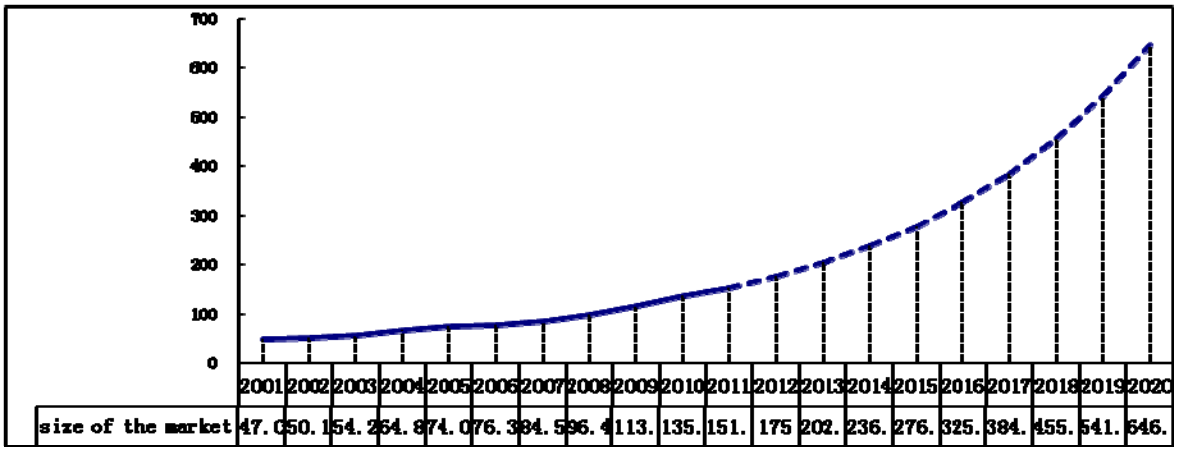
There are prerequisites for predicting the future trend of the antihypertensive drug market. Compared with other periodic industries, drug markets, due to the peculiarity of drugs, are influenced less by economic fluctuations, but more by policy intervention and regulations. Consequently, the trend of the antihypertensive drug market is predicted and discussed under the prerequisite that the existing environment of the pharmaceutical industry and policy of pharmaceutical health care remain unchanged or change mildly, namely the political and economic environments are stable.

Based on the above-mentioned prerequisite, the Chinese population aged 65 and above will rise in 2020, while the total health care cost and government's health care expenditure

will keep the present increasing trend. Both the risk of incidence of hypertension and the outpatient hypertension treatment rate every two weeks among elderly people will increase (given the relatively strong will of patients to receive outpatient treatment),which will trigger the expansion of the size of the antihypertensive drug market. In 2020, the size of the antihypertensive drug market will rise to RMB 64.656 billion (adopting the mean of the predicted values of the three models), and compared with the value of RMB 17.503 billion in 2012, the compound growth rate is 17.74%.

Figure 5-1 The Trend of the Size of the Antihypertensive Drug Market 2012-2020

(Predicted Mean: Multiplied by RMB 100 Million)



However, the model prediction under fixed conditions might differ from the real development. Characterized by the high information asymmetry and market failure, the drug market is under strong government regulation, so the trend of the future antihypertensive drug market is oriented, to some extent, by pharmaceutical policy and economic environment. Some characteristics of the current related policies and industry environment will be analyzed to lay a good foundation for putting forward suggestions.

5.2 Characteristics of the Chinese Antihypertensive Drug Market

The previous models allow a quantitative study of the influencing factors on the size of the antihypertensive drug market, namely factors such as the population aged 65 and

above, government's health care expenditure and health care cost; these models show a linear growth of the market, with hypertensive patients highly willing to receive treatment; but, in reality, there may be some difference from the predictions due to the fact that the market might be affected by uncertainties such as government policy. Here, centering on these influencing factors and combining the conclusion of Chapter 4, this thesis summarizes a few characteristics and some prominent problems that currently exist in the Chinese antihypertensive drug market.

5.2.1 Outpatient Hypertension Treatment Rate Increases Relatively Slowly and People Lack Awareness of Prevention and Treatment

The population aging is intensifying (as shown in Figure 5-2), and in recent years the outpatient hypertension treatment rate every two weeks has increased continuously. In 1998, the outpatient hypertension treatment rate among Chinese people 65 and above was 21.3‰ and it rose to 51.7‰ in 2008 (Figure 5-3). Compared with the outpatient hypertension treatment rate among elderly people, the prevalence of hypertension among elderly people increases more rapidly. The prevalence of hypertension among people aged 65 and above in China increased markedly from 30.1‰ in 1998 to 127.5‰ in 2008[7], which means that people have relatively weak awareness of preventing and treating hypertension.

Figure 5-2 The Change and Trend Prediction of Population of People Aged 65 and above in China over the Years (Unit: 10 Thousand)

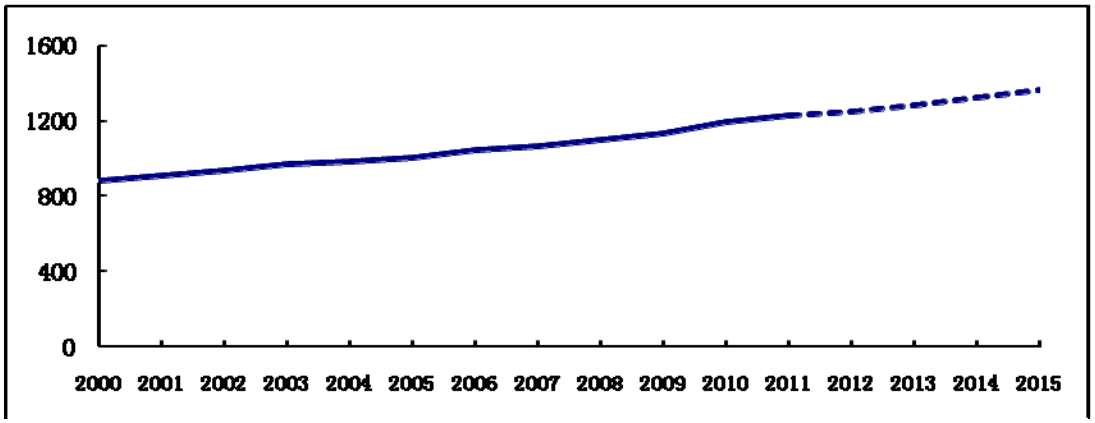
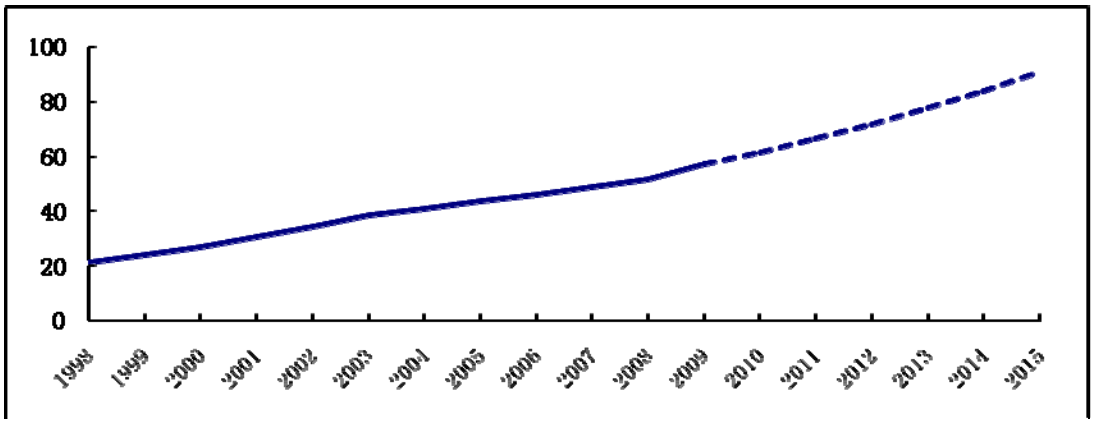


Figure 5-3 The Change and Trend Prediction of Outpatient Treatment Rate Every Two Weeks among People Aged 65 and above in China over the Years (‰)



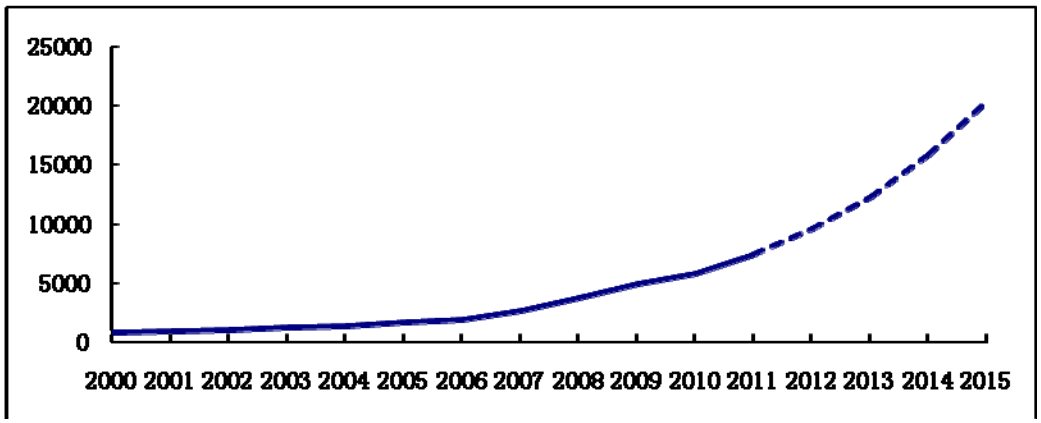
From the current situation of outpatient treatment of hypertension among the elderly people in China, there is still a gap between the rural area and urban area in terms of awareness of preventing and treating hypertension. In 1998, the outpatient hypertension treatment rate every two weeks among the people aged 65 and above in urban areas was 33.6‰ and 13.7‰ in rural areas; the same rate increased to 46.3‰ in urban areas and 42.2‰ in rural areas in 2008. As the standards of health care and medical treatment in Chinese rural areas improve gradually, the outpatient hypertension treatment rate in rural areas keeps rising, but still lags behind that in urban areas. The difference between the urban and rural areas concerning awareness of health care prevention and treatment is associated with the uneven distribution of medical resources and different medical security systems as well as lifestyles in urban and rural areas in China. In the 2008 survey, in terms of the proportion of the hypertension patients aged over 60 who had their blood pressure measured within 3 months, the proportion of the urban areas was 82.2% and that of the rural areas was 52.8% (Ministry of Health of The People's Republic of China,2008).

5.2.2 Government Expenditure on Health Care Influences the Size of the Antihypertensive Drug Market, but the Fairness and Efficiency Are Not High

The population aging has a positive influence on the government's health care

expenditure and the increase in government's health care expenditure enlarges the size of the antihypertensive drug market (Chen, 2013). In the context of intensified population aging and increased incidence of hypertension, patients' demand for health care services will further increase and the health care cost will also expand, which will inevitably add to the burden on families and even the entire society. The good news is that government expenditure on health care has increased sharply in the past five years, which helps release patients' pressure and the demand for health care services. The increased government expenditure on health care reflects governments' attention and support to health care, which will further ensure elderly people's demand for antihypertensive drugs.

Figure 5-4 The Change and Trend Prediction of Chinese Government's Health Care Expenditure over the Years (RMB 100 Million)



Although the amount of government expenditure on health care has increased, the measures are still inefficient. Now, government's expenditure on health care mainly goes to the general medical service sector while that goes into the public health care sector is relatively small. Besides, there is a large gap between the basic-level medical clinics and medical institutions, between the urban areas and rural areas. As for the structure of government health care expenditure, there is an imbalance between the responsibilities born by the central government and local governments, while local governments differ distinctly from each other regarding their health care expenditure. Take the case of the year 2008 as an example, the average government health care expenditure of Beijing (the highest, RMB

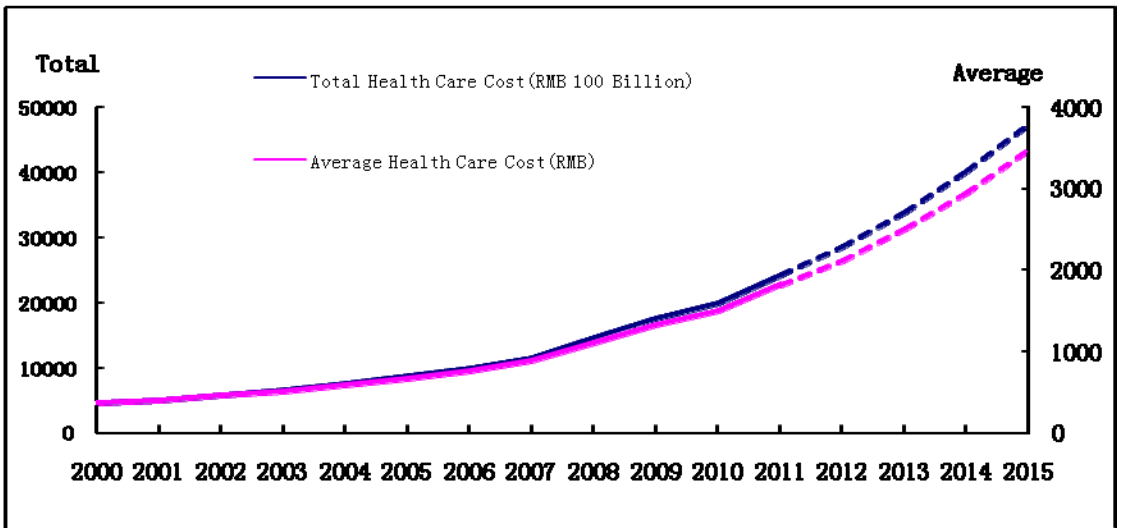
855.76) is 6 times as that of Hunan (the lowest, RMB 137.30).[56] The distribution between the urban and rural areas is not reasonable. Such imbalance has a strong impact on the development of medical and health services in rural areas and leads to the inequality between the medical and health services in rural and urban areas in terms of quantity and quality.

As for the regional fairness of government's health care expenditure, the low average government's health care expenditure in some central and western provinces (the average government's health care expenditure in the central and western regions is RMB 4.66 and 7.85 respectively) is the important cause of the regional unfairness of Chinese government's health care expenditure (Song, 2009).

5.2.3 Hypertension Treatment Cost Grows Rapidly, Medical Security Catches up Gradually

There is a long term influence of population aging on the increase in medical treatment cost(He, 2006). The influence of population aging on the increase in Chinese health care cost cannot be ignored (Huang,2004). From the long term perspective, as the population aging intensifies, the average hypertension outpatient treatment cost every two weeks has increased gradually from RMB 81.9 since 1998, but it grew sharply (with an annual growth rate of 10.68%) after 2004 and reached RMB 156.3 in 2008. The cost in 2008 is twice as much as that of 1998. In the future, Chinese health care cost will be on a rapid increase and the average health care cost will also rise, which will affect the size of the antihypertensive drug market. It's worth mentioning that, the improvement of the medical security system plays an especially important role in releasing the burden of patients and the society under the situation of population aging where the demand for medical treatment grows and the medical treatment cost increases.

Figure 5-5 The Changes and Trend Prediction of Total Chinese Health Care Cost and Average Health Care Cost over the Years



Through great efforts, the social medical insurance coverage rate in China increased from 22.1% in 2003 to 87.1% in 2008 and, by 2011, 1.304 billion people have been covered. The social medical insurance coverage rate for people aged over 60 also increased from 33.2% in 2003 to 91.3% in 2008. Obviously, the medical insurance policy has undoubtedly reduce the cost burden on patients and the intense social pressure caused by health care cost increase.

5.2.4 Percentage of Taking Drugs Produced by Foreign-Invested Companies and Joint Ventures Is Higher Than Those Produced by Chinese Companies

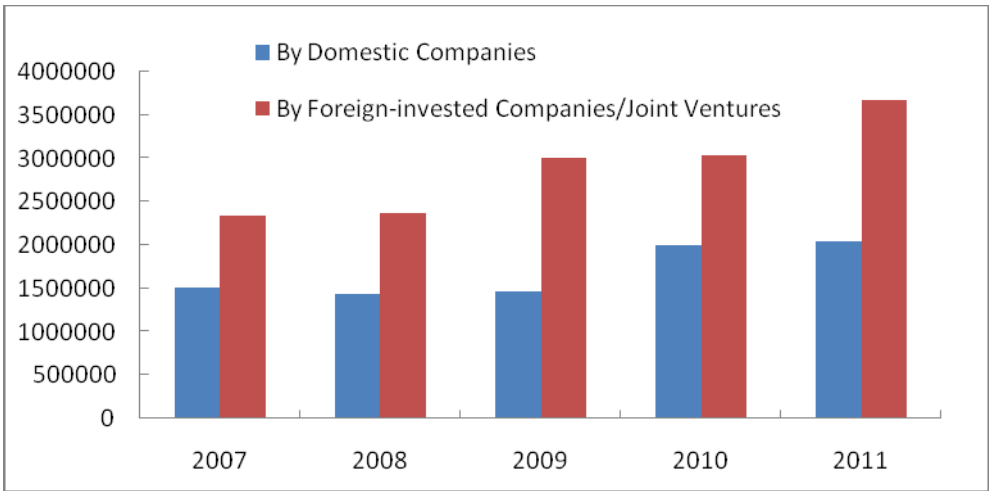
Empirical research shows that more drugs produced by foreign-invested companies and joint ventures are taken than drugs produced by Chinese companies, which is not just limited to the use of drugs among elderly people, but is also seen in the entire antihypertensive drug market, as shown in Figure 5-6. Between 2007 and 2012, mean usage amount of drugs produced by Chinese companies (drug amount and sales*package*weight of each grain of drug) kept falling and the use of Chinese drugs in hospital was decreasing.

Table 5-3 Mean Usage Quantity of Drugs Produced by Chinese Companies for the Year 2007 to 2012

	Mean Quantity (g)					
	2007	2008	2009	2010	2011	2012
China	8353448.95	1985345.41	1354906.36	1250528.28	1099721.99	409669.07

Data source: Statistic Analysis System of South Medicine Economic Research Institute

Figure 5-6 Comparison of Composition of Antihypertensive Drug Usage Amount for the Year 2007 to 2011



Data source: Statistic Analysis System of South Medicine Economic Research Institute

Hypertensive drugs produced by Chinese companies are used far less frequently than those produced by foreign-invested companies and joint ventures. Take doxazosin as an example, according to the statistics of drug use by hospital, the overall drug use frequency of drugs produced by foreign-invested companies and joint ventures (drug use amount/defined daily dose) is 20 times more than that of Chinese drugs, as shown in Table 5-4. Therefore, the clinic use of Chinese drugs is less competitive than that of drugs produced by foreign-invested companies and joint ventures, mainly due to the relatively

low quality of and large quantity of duplication production of Chinese generic drugs.

Table 5-4 Doxazosin Use Frequency for the Year 2007 to 2011 DDDs

(Multiplied by 1 Million Units)

Doxazosin	Drug use frequency (DDDs)					
	2007	2008	2009	2010	2011	2012
China	1.974	2.960	3.992	4.676	4.646	1.767
Foreign-invested/Joint Venture	29.306	54.669	64.937	63.541	86.157	43.185

Data source: Statistic Analysis System of South Medicine Economic Research Institute

5.2.5 Usual Improper Use of Drugs

The survey shows that, in practice, improper use of drugs can be perceived among the elderly people. Firstly, improper use of drugs exists with self-medication, especially among elderly patients. For instance, renin-dependent hypertension and salt-sensitive hypertension take up a large percentage of hypertension among elderly people, so it is effective to use CCB and diuretics to reduce blood pressure. Secondly, there exist some improper drug use habits, such as ignoring other risk factors, lack of knowledge of contraindications, wrong choice of drugs and paying no attention to change of blood pressure. The main reasons behind this phenomenon are that the hypertensive patients learn little of contraindications for hypertensive drugs; that they improperly combine the drugs and ignore other risk factors that will affect hypertensive patients. According to the Guidelines for Prevention and Treatment of Hypertension in Canada in 2009, unless there are strong indications, β receptor blockers shall not be the first choice for hypertension treatment among people aged over 60 (Mai, Li & Liu, 2011). However, in the empirical research, some elderly hypertensive patients did not know this and used it improperly during their self-medication.

Chapter 6: Conclusions and Suggestions to Policies

6.1 Conclusions

The estimated models in Chapter 4 show that, along with the increasing aging population in China (population aged 65 and above), the progress of population aging in China has been speeded up and the government's expenditure on health care has risen. The scale of anti-hypertensive drug market also increased substantially. The progress of population aging in China is still speeding up and its impact on the anti-hypertensive market has become more and more obvious. Besides, the increases of two-week outpatient rate of hypertension, total health expenditure and per capita health expenditure had great impacts on the expansion of the anti-hypertensive drug market size.

The future prediction (Chapter 5) based on the previous modelsindicates that, if the present policy does not change, along with the developing of population aging, in the period 2015~2020, the speeding of population aging will be faster (population of elderly in 65 and above would increase rapidly), the market size of anti-hypertensive drug will display a rapid growth trend. In other words, the demand for anti-hypertensive drug is expected to have an incredible climbing pace.

In order to accomplish the objectives of this research which can offer more decision-making directions for the hypertensive disease management and the market development in China, the empirical investigation (Chapter 4) demonstrates that the anti-hypertensive drugs in China has several specific characteristics such as; a) relatively high clinic expense, b) preference for high-price drugs from foreign or joint venture pharmaceutical enterprises (some doctors would induce patient choosing these drug, as they can get more drug price addition from them), and c) unreasonable amount of self-medication.

Supplementary research on the growth of anti-hypertensive drug market in China can be carried out on the aforesaid aspects.

6.2. Suggestion to Policies

6.2.1 To Improve the Management of Chronic Diseases and Strengthen Prevention and Treatment Awareness

There are many clinic features for elderly hypertension. For example, hypertension is accompanied by various cardiovascular diseases and non-cardiovascular diseases; the blood pressure fluctuates widely and orthostatic hypotension often occurs. These features make it difficult to prevent and treat hypertension among elderly people. Improve the prevention of hypertension among elderly people is significant for improving the health condition of elderly people and reducing the consumption of medical resources in China.

The achievements of hypertension management reflect a country's ability to manage a chronic disease(Guo,2011). Chronic disease management (CDM) refers to a scientific management mode where physicians on chronic diseases, pharmacists and nurses provide patients with chronic diseases with comprehensive, continuous and active measures in order to promote health, delay the process of chronic diseases, reduce complications and lower injury and disability rate, prolong life expectancy, improve life quality and reduce medicine cost (Li, 2009). Hence, the ability to manage chronic diseases should be improved in China and different actions can be proposed to improve the management of chronic diseases and strengthen prevention and treatment awareness.

(a) Conduct research on chronic diseases. Now, China has issued some policies and regulations concerning CDM. Many community health care service institutions have also carried out various chronic disease management tasks to manage the patients with hypertension and diabetes. However, chronic disease management in China is still insufficient (He, 2012).For instance, the CDM network is not yet sound, and the staff in community health service institutions is insufficient. CDM in community lacks policy and resources support. In addition, the CDM mode is unsound and there is little theoretical research regarding the management subject and standardization of the management mode. Since these problems will determine whether CDM can be carried out scientifically and effectively , it is suggested that in-depth research on the chronic disease management mode

shall be conducted to give support for further improvement of CDM in China(Liu, 2009).

(b) Carry out chronic diseases prevention and treatment. CDM not only involves the management of patients with chronic diseases, but also include publicity and education on chronic diseases prevention and treatment among high risk groups; should not be limited to evaluation of disease treatment schemes, but should also include intervention to health diets, behaviors and psychology; not be limited to management of different diseases, but should also include the publicity of correct ideas, knowledge and skills of CDM; not be limited to the patients' medical service condition, but should also include attention to the social environment they are in.

(c) Create a new chronic disease management mode. The development of chronic diseases will only be controlled when the former chronic disease management mode, which is fruitful, continues to be enforced and comprehensive measures are taken to manage patients with chronic diseases based on with the community as a center and an innovative mode. Community health service institutions should work hard to improve their management level, expand the scope of their service subject and enrich the contents of management so that the quality of chronic disease management can be promoted to a new level. The relatively mature community based CDM system in Chengdu, Sichuan can serve as a successful example for other provinces and municipalities. The community based CDM system is a management mode combining grading management system and management system based on a contract with responsible physicians. The grading system divides the hypertensive patients into three groups based on the extent to which their blood pressure increase and establishes a record for each patient. The management system based on a contract with responsible physicians requires a responsible physician to sign a cooperative agreement with the patients to specify the obligations and rights of both parties. Awards and punishment will be received by the patients based on their performance of the medical advice. In this way, the hypertension awareness rate and controlling rate will be improved. The combination of these two management modes makes it possible to manage patients with different degrees of hypertensive urgency in a targeted manner and optimize

the utilization of medical resources. Via the reward and punishment mechanism, patients are also encouraged to develop healthful habits, which will be conductive to managing the chronic disease from its origin.

6.2.2 To Enhance the Efficiency of Government's Health Care Expenditure

According to the result of the models previously presented, an increase in government's health care expenditure will influence the expansion of antihypertensive drug market. While the government increases its investment in health care, it should also enhance the efficiency of the investment. With this purpose:

(a) The leading role of government in providing public health care and basic medical services shall be established (Liu, 2012). The central government and local governments' responsibilities of health care investment should be properly divided and a government health care expenditure system in which the responsibilities are clearly defined, burdens are born by governments of all levels, and finance and competence are coherent, should be established. The growth rate of government's health care expenditure should be higher than that of other regular financial expenditure to raise the proportion of government investment in health care in the regular financial expenditure and in total health care expenditure, so that residents' basic medical care cost will be effectively released (Lan, Wang, Xu, & Chen, 2012). Besides, the percentage of government's health care expenditure against the total health care expenditure shall be further enhanced. In 2011, government's health care expenditure in Thailand, a country whose level of economic development is similar to that of China, took up 75.5% of the total medical expenditure while that in Mexico reached 49.4%. Even in the United States, a country whose medical care service is highly market-oriented, government's health care expenditure took up 45.9% of the total medical expenditure (The World Bank). The leading role of central government in providing health care expenditure shall be strengthened and the transfer and payment from the ministry of finance shall be mobilized. At present, government's health care expenditure is mainly paid by local governments, the reason why gaps between health care expenditure in different areas occur (Liu & Shi, 2013). Therefore, the leading role of central government

in providing health care expenditure shall be reinforced and more transfer and payment should be made to underdeveloped areas and to areas with a larger aging population (Yu, 2012).

(b) More health care investment should be put into rural areas. Since there is a gap between economic development of different regions, governments shall raising their awareness of promoting the development of health care in rural areas and call for further developing health care in rural areas through different forms and different channels, and from different aspects. It can be noticed from the prediction in Chapter 6, more government's health care investment and medical care resources will be spent in services for the elderly. Accordingly, government's health care expenditure should be used to fulfill the needs of medical and health care services by elderly people in rural areas and to provide more medical and health care resources for them.

(c) The medical security system shall be further developed. To increase the medical insurance coverage rate and enhance the efficiency of health care investment, the medical security system shall also be improved. A social security system is essential for connecting health care investment with practical needs. According to the *Twelfth Five-year Plan for the Development of Human Resources and Social Security*, the coverage rate of China's social security will be further enhanced so that the population covered by the basic urban or rural medical insurance will reach 1.32 billion. The expansion of medical insurance coverage will satisfy the orderly's needs for medical and health care services.

The medical security system shall also be improved so that the resources will be handed out to each individual more fairly and equally (Huang, 2011). A social security network in which the government plays a leading role, while other social forces, such as NGOs, charity institutions, enterprises and individuals working together, should be established. Meanwhile, the contribution to medical insurance shall be increased. The contribution to the urban employee basic medical insurance is relatively high while that to new rural cooperative medical insurance and urban residents' basic medical insurance is relatively low. Since the contribution to new rural cooperative medical insurance and urban

residents' basic medical insurance is jointly paid by the central budget, local budget and individuals,[56] the central government and local governments should offer greater support to these insurance schemes. Through establishment of the security system, the increasingly heavier pressure of medical care expenditure will be released and the efficiency of government's health care expenditure will be enhanced by reasonably, with the support of the government, the society and individuals.

6.2.3 To Encourage the Development of National Industry and Improve the Quality of Antihypertensive Drugs

In the context of population aging, the demand for hypertensive drugs increases gradually and Chinese companies will be the main force to release the demand pressure. Developing national industries, especially promoting the development of small and medium enterprises will be beneficial for providing cheap drugs.

More antihypertensive drugs produced by foreign-invested companies and joint ventures are used than that produced by Chinese companies for several reasons.

The first reason is that drugs produced by foreign-invested companies and joint ventures are more reliable than Chinese ones in terms of quality and treatment effect. On the contrast, drugs produced by Chinese companies are replications. Original drugs have advantages in terms of quality and treatment effect.(Zhang, 2013) For instance, they can occupy the entire market shares and have fewer opponents than other drug manufacturers. However, most of the drugs produced by Chinese companies are imitations. Drugs produced by Chinese companies are weak in both technology and quality compared with original drugs. Although with similar application, Chinese drugs lose advantage for their technology and quality. In the process of drug circulation, a physician's preference has a significant influence on patients' choice of drugs. It is hard for a patient to know the drugs' quality and treatment effect based on his own knowledge, yet a physician can learn their quality and treatment effect from a professional perspective. Physicians give instruction to patients through their advice. Although the survey shows that most doctors has no obvious preference to certain drugs, in most cases, patients will ask physicians the difference

between imported and Chinese drugs. Hence, the most basic reason is that imported drugs are more effective than Chinese drugs. The second reason is that most imported antihypertensive drugs are intermediate-acting and long-acting antihypertensive drugs. Compared with short-acting ones, intermediate-acting and long-acting antihypertensive drugs can take effect in the blood for a longer time. Although it takes longer for them to begin to make effect and their competence to cure and control hypertension is delayed, intermediate-acting and long-acting antihypertensive drugs can control blood pressure in a safer and more effective way. Hypertension requires taking drugs for a long period and often with many complications, and although short-acting drugs can reduce blood pressure in time, sudden blood pressure reduction will cause burden and injury on the body, which, to some extent, will lead more people to choose imported drugs. The third reason is that, although there are a lot of drug brands and manufacturers, there are no leading brands. What enable drugs produced by Chinese companies to get a share of the antihypertensive drug market are not antihypertensive drugs, but drugs that are used to prevent and treat complications from hypertension. Many manufacturers produce this type of drugs with a lot of brands, but there are no leading brands among them.

To sum up, as a chronic disease, hypertensive patients need to take drugs for a long period. Therefore, the drugs' quality and treatment effect are important to the patients' health. This is the major reason why imported drugs have been dominating the market for a long period. Few Chinese drugs are original and most of them are imitations. They lack technical support and guarantee for quality, is the reason why they are not competitive enough in the market. Although there are a lot of drug brands and manufacturers, there are no leading brands. In most cases, they are unable to combine their strength and pose effective pressure on imported drugs.

Some suggestions can be put forward to encourage the development of the national industry and improve the quality of antihypertensive drugs:

Firstly, guidance should be provided through policies. Study and improve the policies of the medical industry and strengthen the coordination and cooperation between the

policies of the medical industry and other economic policies to promote the development of national industry. Government should strengthen and improve the management of medical industry, encourage industries with key products to develop and apply both economic and legal measures to restrict repeated construction with low level; study and make policies that are consistent with the characteristics of the industry and speed up the consolidation and reorganization of small and medium drug enterprises; promote protection of medical intellectual property, such as patents, trademarks and know-how and crack down on stealing know-how according to law (Zhao,2013).

Secondly, drug innovation capacity should be improved. Government should promote research and development of innovative drugs, stick to original innovation, integrated innovation and combine drug introduction, absorption with drug innovation, and encourage national medical industry to research and develop cardiovascular and cerebrovascular diseases, digestive system diseases and drugs for children; speed up the development and industrialization of innovative drugs and make efforts to enhance the scientific and technological content and quality of drugs; support Chinese enterprises in carrying out clinical research of innovative drugs and their registration in foreign countries; materialize the development and production of a large amount of drugs whose patents have expired and begin the research on this field in China. In terms of system innovation, government should help ensure the enterprises' leading role in the technology innovation system, allow enterprises to undertake more national technical projects and strengthen the ability to develop new drugs and transform scientific research achievement; guide and support the development of small and medium enterprises that are active in innovation and have unique technological features and cultivate them so that they can become important forces to drug innovation; improve the support service system of drug innovation and pay attention to the construction of public resources platforms for drug safety evaluation, clinical evaluation of new drugs and new drug development.

Lastly, enterprise investors should be diversified. Now, the development of China's drug manufacturers suffers setbacks and many small and medium enterprises are in

predicament (Tang & Zhang, 2008). They are short of capital, incapable of seeking capital financing and have difficulty in creating a large investment environment. Government shall give better play to its leading role in the development of China's drug manufacturers; guide social capital investment properly and broaden fields of capital investment, making best use of market mechanism, improve competitive investment mechanism, encourage and guide non-governmental and social capital to invest in Chinese drug manufacture and provide policies to supply them if necessary.

6.2.4 To Manage Drug Price Effectively and Control the Drug Use Cost

The ultimate aim of policies of drug price management is to control drug costs. One of the measures to control health care costs and ease social conflicts is to prevent drug price to increase excessively. In recent years, China has issued a variety of drug price management policies successively, which aims to control drug price and guide doctors' behaviors. Doctors tend to increase the amount of prescriptions in order to gain higher prescription subsidies and avoid the drug price limitation set by the governments. For example, they can prescribe both cheap Chinese drugs and relatively expensive imported drugs. If use of drug is not constrained through relevant measures, the drug cost cannot be controlled just through controlling drug price. It can be concluded from previous research that price is not the only influencing factor of the size of the antihypertensive drug market. Drug prices cannot be controlled alone because of some implicit factors such as doctor's guidance due to information asymmetry.

The balance point between price control and innovation should be found. When the drug price is reduced, a company's profit margins will shrink, which will lead to the increase of generic drugs and the reduction of innovative drugs, on both production and consumption. It will affect the development of the medicine industry. Therefore, when defining drug price management policies, China should also consider their effect on the medicine industry and find a balance point where drug cost can be controlled while drug innovation can also be promoted.

Firstly, various policies should be combined to control drug price. There is no lack of

cases of successful drug price control. The EU nations control drug price by controlling the behaviors of suppliers, purchasers and doctors' prescriptions through different means and measures, and form a systematic management and control system. From the experience of the EU nations, controlling drug costs through one solely method seems unlikely to be effective (Yu, He & Liu, 2009). The consumption of drugs is influenced by the supplier, purchaser and doctors' prescription and each of them are affected by different factors, so different means and measures should be taken to intervene and control drug cost and make drug cost management become a management project focusing on different factors. The emphasis of the drug cost management in the EU nations is the market supplier. Policies targeted at the purchaser (such as encouraging proper use of drugs, policies of non-patented drugs and sharing costs) plays an indispensable role in people's choosing cheaper drugs and control the total amount of drugs.[70] Therefore, the combination of different policies becomes the best choice for all nations. But which policies to choose depend on each nation's history, politics (medical and industrial policies and election motivations), economics (level of national income), medical cultures (people's beliefs and attitudes and doctors' prescription behaviors) and other factors. These factors are independent from each other while, at the same time influence each other. For example, the policy of non-patented drugs contains many other policies, including replacement of non-patented drugs, supplier intervention (such as convenient channel for drug registration and low registration fee), graded cost shares, drug information disclosure and education, guideline for prescription, reference price and incentive system for doctors. Secondly, the drug price system should be improved. A scientific and suitable drug price model shall be established, pharmacoeconomics should be introduced to evaluate the value of drugs and the drug price monitoring and management system shall be strengthened. The government shall also issue standard disease diagnosis guidelines to control the amount of drug used and the drug use structure and regulate the prescription behaviors in the process of diagnosis and treatment. As supplementation, government shall also improve the compensation mechanism of medical institutions and medical security mechanism. Only when they are all managed

comprehensively can we prevent drug cost from growing too fast.

A price system of cheap drugs should be established to ensure the production enthusiasm among enterprises, end the practice of using pharmacy profits to subsidize medical services and encourage doctors to choose cheap Chinese drugs. The government shall speed up the management of the system for basic drugs and establish a uniform price mechanism so as to give play to the leading role of price. The uniform procurement mechanism shall be improved and a feasible comprehensive assessment index system should be established. The government shall support innovative drugs which are indispensable in practice and safe, have obvious treatment effect and a reasonable price to be covered by medical insurance.

In addition, government should launch wide publicity on the implementation of a basic drug system to change ideas of the medical staff and the public, consolidate a uniform awareness and actively guide the doctors to change their drug choice behavior so that the practice of using pharmacy profits to subsidize medical services will be transformed fundamentally.

6.2.5 To Guide People to Take Drugs Properly

Hypertensive patients need to take drugs for their life and proper use of drug is the key to effective treatment of hypertension, so the change of drug use habit has a positive effect on preventing and treating hypertension among elderly people. Since elderly hypertensive patients are more dependent on physicians, to prevent and treat hypertension among them, not only elderly people's knowledge of hypertension prevention and treatment should be broaden and they should be helped to learn the correct way of drugs use, but there is also a need to promote rational utilization of health care resources through proper choice of drugs by doctors.

Hypertensive patients should be actively guided to take drugs properly, according to their own physical conditions, so as to achieve high treatment effects at a lower cost. What's more, it should be noticed that hypertension is caused by various factors. Apart from taking drugs properly, hypertensive patients also need to follow a healthy and

balanced diet, improve their tastes and exercise regularly, so as to better control blood pressure and emotion, and achieve the best treatment effect of drugs (Bi , Tao & He, 1999).

Currently, some communities in China have begun to explore a management mode in which health care staff is responsible for instructing the use of drugs for chronic diseases. Most of the health care staff comes from families with patients, who then receives a series of professional training in the management of hypertension and other chronic diseases and instruct patients on the proper use of drugs, diet and lifestyle. Results of a survey carried out among different communities by the Xiaolan Hospital of Zhongshan shows that proper use of drug and self-test of blood pressure by patients are more frequent when health care staff participates in the direct management of patients' life (Gong, Wang, & Qi,2003) .Since patients with chronic diseases have to endure a long course of disease, allowing their well-trained families to help them will undoubtedly be a more direct, time-saving, free, and sustainable way to manage hypertensive patients.

6.3 Discussion

6.3.1 Limitations of the Research

Prediction is the process of making statements about events whose real values have not yet been observed. A usual example might be to estimate the values of some dependent variable of interest at some specified future date. Quantitative prediction models such as regression models are used to forecast future data as a function of past data; they are appropriate when past data are available. Predictive modeling is a research method that has been widely used but their results are associated with risk and uncertainty, so there is always some danger of relying blindly on models that are essentially back forward looking in nature.

These methods are usually applied to short or intermediate range decisions. The regression equation's degree of fitting would possibly be higher than that in the real situation.

In addition, the sample dimension used in the regression model is relatively small. Research based on a small sample is hard to be applied to other cases and the model's significance is limited. Therefore, the probability to make type I error may increase. The regression model is constructed based on the linear relationship between independent variables and dependent variables, which means that this model can only be used to study the general relationship between independent variables and dependent variables and cannot be used to predict fluctuation in data in emergent events.

Despite of the above mentioned limitations, this research has its importance. As an exploratory study, the regression models in this research aim to take most of the factors that influence the antihypertensive drug market and understand the influencing factors under the general rules of the antihypertensive drug market. Therefore, despite the limitation in the data, this model can serve as a reference and example for an extensive data analysis of the whole antihypertensive drug market in China.

6.3.2 Future Research Direction

Although population aging brings China the heavy burden of supporting the old, it also creates a wealth of opportunities for the service industry and drug market for elderly people. In the current antihypertensive drug market, drugs produced by foreign invested enterprises and joint ventures are more often used than those produced by Chinese enterprises. The main reasons are that imported drugs are mainly medium-acting and long-acting drugs that will be effective during a longer period and safer. Most of imported drugs are original drugs whole drugs produced by Chinese companies are mainly replications.

Further research could be carried out on the following two aspects:

Firstly, study the type and efficiency of antihypertensive drugs produced by Chinese companies with a large sample and analyze their advantages and disadvantages.

Following such analysis, draw some successful policies concerning the management of the production of drugs for chronic diseases and assessment and approval procedures, in order (1) to explore and encourage the innovative research and development of antihypertensive drugs in China and the improvement of the quality of imitations, and (2) to

stipulate scientific and reasonable policies and regulations regarding the management of antihypertensive drugs and drugs for other chronic diseases.

Finally, analyze the antihypertensive drug market and the successful chronic disease management mode in different Chinese provinces and cities, and continue exploring an effective and sustainable management scheme that keeps with the increasing trend of elderly hypertension in China.

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Appendix Ⅰ

Questionnaire on Antihypertensive Drugs (For Doctors)

Questionnaire number:

First review:

Second review:

Final review:

Cities:

Guangzhou	**01**
Raoping	**02**

Excuse me. I'm an interviewer from South Medical Economics Research Institute of China Food and Drug Administration. Now we are carrying out a study on the use of drug among elderly hypertensive patients (aged 60 and above). We will appreciate it if you can take your time to answer the questions for us to learn about your views. The answers are open-ended and you only need to answer the questions based on your experiences. We undertake to keep your answers in secret.

Thanks for your support and cooperation.

Pledge of the interviewer: I hereby undertake that all the contents in this questionnaire are prepared by me according to the standard procedures for an interview and all of them are truthful. If any of them is false, all of them shall be invalid.

Signature of the interviewer:

[For sample screening]

S1: How long have you worked on hypertension treatment?

Within five years (after April 2009)……01 (Stop here)

Over five years (before April 2009)……02 (continue)

S2: Do you take drug therapy for major treatment forhypertension?

Yes, I take drug therapy for major treatment for hypertension…..01 (continue)

No, I usually apply non-drug therapy…….02 (Stop here)

[Main Body of the Interview]

I. Treatment Status of Hypertensive Patients

Q1. What level do you think the current outpatient treatment rate is?

1-10%	01	51-60%	06
11-20%	02	61-70%	07
21-30%	03	71-80%	08
31-40%	04	81-90%	09
41-50%	05	91-100%	10

Q2. What level do you think the current outpatient treatment rate is five years ago (2009)?

1-10%	01	51-60%	06
11-20%	02	61-70%	07
21-30%	03	71-80%	08
31-40%	04	81-90%	09
41-50%	05	91-100%	10

Q3. What do you think the current percentage of elderly hypertensive patients among all hypertensive patients?

1-10%	01	51-60%	06
11-20%	02	61-70%	07
21-30%	03	71-80%	08
31-40%	04	81-90%	09
41-50%	05	91-100%	10

Q4. What do you think the percentage of elderly hypertensive patients among all hypertensive patients five years ago (2009)?

1-10%	01	51-60%	06
11-20%	02	61-70%	07
21-30%	03	71-80%	08
31-40%	04	81-90%	09
41-50%	05	91-100%	10

Q5.You think that currently,among all elderly hypertensive patients, (note that the sum of the following three figures shall be 100%)

%of them only use one type of drugs for hypertension treatment;

%of them use two types of drugs for hypertension treatment; and

%of them use three and more types of drugs for hypertension treatment.

Q6.You think that five years ago (2009),among all elderly hypertensive patients, (note that the sum of the following three figures shall be 100%)

%of them only use one type of drugs for hypertension treatment;

%of them use two types of drugs for hypertension treatment; and

%of them use three and more types of drugs for hypertension treatment.

Q7. Do the elderly hypertensive patients take the doctor's advice?(note that the sum of the

following three figures shall be 100%)

%of them fully take medical advice;

%of them take the medical advice when they are in in serious condition;

%of them take the drugs as they want.

Q8-1. You think that, compared with that in five years ago (2009), currently the population of people who use drugs improperly

significantly increases	01
are basically the same	02
obviously falls	03

Q8-2. You think that currently% of the elderly hypertensive patients use drugs improperly.

Q8-3.You think that, among the elderly hypertensive patients use drugs improperly, (note that the sum of the following two figures shall be 100% or less)

excessive use of drugs takes up %;

drug reduction accounts for%

Q9.Improper use of drugs commonly seen among elderly hypertensive patients mainly include:

Inadequate knowledge about the indications and contraindications for antihypertensive drug	01
Choose the wrong drug(s)	02
Have prejudice against diuretics and beta receptor blocker	03
Take improper dosage of drugs or use the same drugs repeatedly	04
Do not pay attention to the change of blood pressure	05
Eager to reduce their blood pressure	06
Ignore other risk factors (such as hyperlipidemia,hyperglycemia and hyperuricemia)	07
Others, such as	08

II. Purchase of Drug by the Patients

Q10.What's the monthly hypertensive drug expenses do you think a patient have to spend currently?

Less than RMB 20	01
RMB 21-50	02
RMB 51-80	03
RMB 81-110	04
RMB 111-140	05
RMB 141-170	06
RMB 171-200	07
Over RMB 200, about RMB	08

Q11. You think that currently a patient's hypertensive drug expenses increase by % compared

with that in five years ago (2009).

Q12.Which type(s) of antihypertensive drug did you mainly prescribe for elderly hypertensive patients over the last year? (multiple choice)

Norvasc	01	Lotensin	11	Hyzaar	21
Adalat	02	Nifedipine	12	Landi Amlodipine Besylate Tablets	22
Plendil	03	Enalapril	13	Monopril	23
Diovan	04	Avapro	14	Trastal	24
LevamlodipineBesylateTablets	05	Micardis	15	Indapamide	25
Metoprolol	06	AnneizhenAmlodipineBesylate Tablets	16	Clonidine HydrochlorideTablets	26
Irbesartan	07	Acertil	17	Candesartan Cilexetil Tablets	27
Amlodipine Benzenesulfonate Tablets	08	Vasorel	18	Neifedpine Sustained-release Tablets	28
Compound Reserpine and Hydrochlorthiazide Tablets	09	YiaiqingIrbesartan Tablets	19	BosuBisoprololFumarate	29
Cozaar	10	KangxinBisoprololFumarate	20	Nimodipine	30

Other antihypertensive drugs you prescribe? Name of the drug:

[please give us your information for contract]

Name:

Contact number:

Thank you again for your cooperation!

Time of the interview: from:to :

Location of the interview:

Appendix Ⅱ

Questionnaire on Antihypertensive Drugs (For Patients)

Questionnaire number:

First review:

Second review:

Final review:

Cities:

Guangzhou	**01**
Raoping	**02**

Excuse me. I'm an interviewer from South Medical Economics Research Institute of China Food and Drug Administration. Now we are carrying out a study on the use of drug among elderly hypertensive patients (aged 60 and above). We will appreciate it if you can take your time to answer the questions for us to learn about your views. The answers are open-ended and you only need to answer the questions based on your experiences. We undertake to keep your answers in secret.

Thanks for your support and cooperation.

Pledge of the interviewer: I hereby undertake that all the contents in this questionnaire are prepared by me according to the standard procedures for an interview and all of them are truthful. If any of them is false, all of them shall be invalid.

Signature of the interviewer:

[For sample screening]

S1: How long have you lived in this area?

Within one year…….01 (Stop here)

More than one year……02 (Continue)

S2: How old are you?

Under sixty years old……01 (Stop here)

Sixty years old or above……..…..02 (Continue)

S3: Are youdiagnosed as having hypertension?

Not sure/No……...……01 (Stop here)

Yes……..……02(Continue)

S4: Did you receive a drug therapy after youarediagnosed as having hypertension?

Yes……01 (Stop here)

No/No, I receive non-drug therapy……..02(Continue)

[Main Body of the Interview]

I. Drug use habit

Q1.How many years have passed since you were diagnosed as having hypertension?(According to the date on which you were diagnosed.)

One year	01	Six years	06
Two years	02	Seven years	07
Three years	03	Eight years	08
Four years	04	Nine years	09
Five years	05	Ten years or above	10

Q2. Do your take the drugs on a daily base according to the drug instruction or prescription offered by the doctor?

Yes……01

No, I take the drug based on my health condition ……02

Q3.Please specify your use of drug.

<u>One</u> time each day, <u>one</u> type of drug a time and <u>one</u> tablet/piece for each type of drugs

Q4.Please specify your use of drug.

Drug instruction or medical advice offered by the doctor: time(s) each day, type(s) of drug a time and tablet(s)/piece(s) for each type of drugs

Your use of drug:

time(s) every day, type(s) of drug a time and tablet(s)/piece(s) for each type of drugs……01

Take drugs as prescribed by the doctor every days…….02

time(s)every days, type(s) of drug a time and tablet(s)/piece(s) for each type of drugs……03

Other, do not take drugs if the blood pressure is under control…….04

Q5.Which type(s) of antihypertensive drug did you often use over the last year? (Multiple choice)06

Norvasc,(long-acting) imported	01	Lotensin,imported	11	Hyzaar,imported	21
Adalat CC,(long-acting) imported	02	Nifedipine, (long-acting) domestic	12	Landi Amlodipine Besylate Tablets, (long-acting)imported	22
Plendil,(long-acting) imported	03	Enalapril,domestic	13	Monopril,imported	23

Diovan,domestic	04	Avapro,imported	14	Trastal,imported	24
ShihuidaLevamlodipineBesylateTablets,domestic	05	Micardis,domestic	15	IndapamideTablets,domestic	25
BetalocTablets,domestic	06	AnneizhenAmlodipineBesylate Tablets (long-acting) imported	16	Clonidine HydrochlorideTablets, domestic	26
Aprovel,domestic	07	Acertil,imported	17	Candesartan CilexetilTablets,domestic	27
Amlodipine Benzenesulfonate Tablets, (long-acting) domestic	08	Vasorel, imported	18	Neifedpine Sustained-release Tablets, domestic	28
Compound Reserpine and Hydrochlorthiazide Tablets, domestic	09	YiaiqingIrbesartan Tablets, domestic	19	BosuBisoprololFumarate, domestic	29
Cozaar, imported	10	KangxinBisoprololFumarate, imported	20	Nimodipine, imported	30

Other antihypertensive drugs you used. **Name of the drug:**

II.Economic Burden due to Use of Drugs

Q5.How much do you expend on hypertensive treatment currently? (Including the part that can be covered by medical insurance)

Less than RMB 20	01	RMB 111-120	11
RMB 21-30	02	RMB 121-130	12
RMB 31-40	03	RMB 131-140	13
RMB 41-50	04	RMB 141-150	14
RMB 51-60	05	RMB 151-160	15
RMB 61-70	06	RMB 161-170	16
RMB 71-80	07	RMB 171-180	17
RMB 81-90	08	RMB 181-190	18
RMB 91-100	09	RMB 191-200	19
RMB 110-110	10	More than RMB 210, RMB	20

Q6.To what extent do you think the drug cost increases compared with that in five years ago(2009)? (Including the part that can be covered by medical insurance)

Does not increase	01	51-75%	04
1-25%	02	76-100%	05

26-50%	03	Increased by more than on time: by ( ) times	06

Q7. What's the actual amount you pay for the drugs currently?(Deducting the part that can be covered by medical insurance)

Less than RMB 20	01	RMB 111-120	11
RMB21-30	02	RMB121-130	12
RMB31-40	03	RMB131-140	13
RMB41-50	04	RMB141-150	14
RMB51-60	05	RMB151-160	15
RMB61-70	06	RMB161-170	16
RMB71-80	07	RMB171-180	17
RMB81-90	08	RMB181-190	18
RMB91-100	09	RMB191-200	19
RMB110-110	10	More than RMB210, RMB	20

Q8.To what extent do you think the drug cost increases compared with that in five years ago(2009)? (Deducting the part that can be covered by medical insurance)

Does not increase	01	51-75%	04
1-25%	02	76-100%	05
26-50%	03	Increased by more than on time: by () times	06

[Basic Information of the Consumer]

[Read by the interviewer: at last, we want to know some personal information. such information are only used for reference and we undertake to keep your information in secret.]

Q9. How old are you? (Single choice)

61-65 years old……1 66-70years old……2

71-75years old……3 76-80years old……4

80years old or above……..5

Q10.What's your average monthly income (including salary, bonus and other incomes) (Single choice)

RMB 500or less……1

RMB 501-1000…… 2

RMB1001-2500……3

RMB2501-4000……4

RMB 4001-5500……5

RMB5501-7000……6

RMB7001-10000…….7

RMB10000 or above……8

[please give us your information for contract]

Name:

Contact number:

Gender of the interviewee:□ Male□ Female

Thank you again for your cooperation!

Time of the interview: from:to :

Location of the interview:

Appendix Ⅲ

Figure 4-2 Scatter Diagram of 'Population of people aged 65 and above' and 'Market size of anti-hypertensive drug'

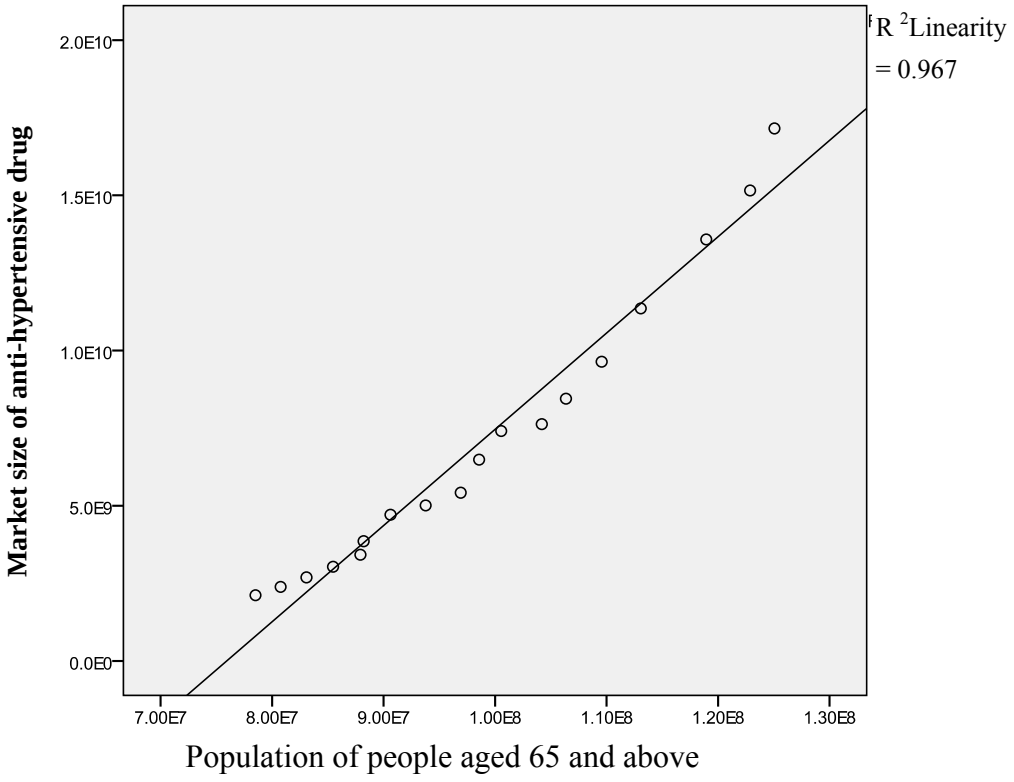

Figure 4-3 Scatter Diagram of 'Government Expenditure in Health Care' and 'Market size of anti-hypertensive drug'

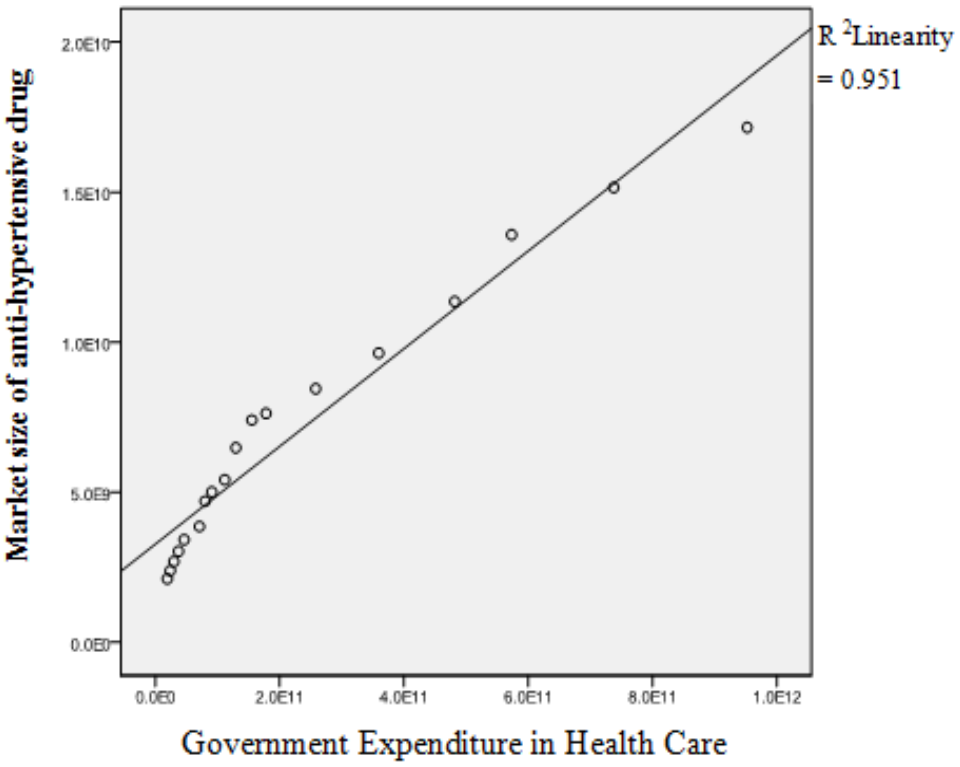

Figure 4-4 Detrended Q-Q Plot of Standardized Residual

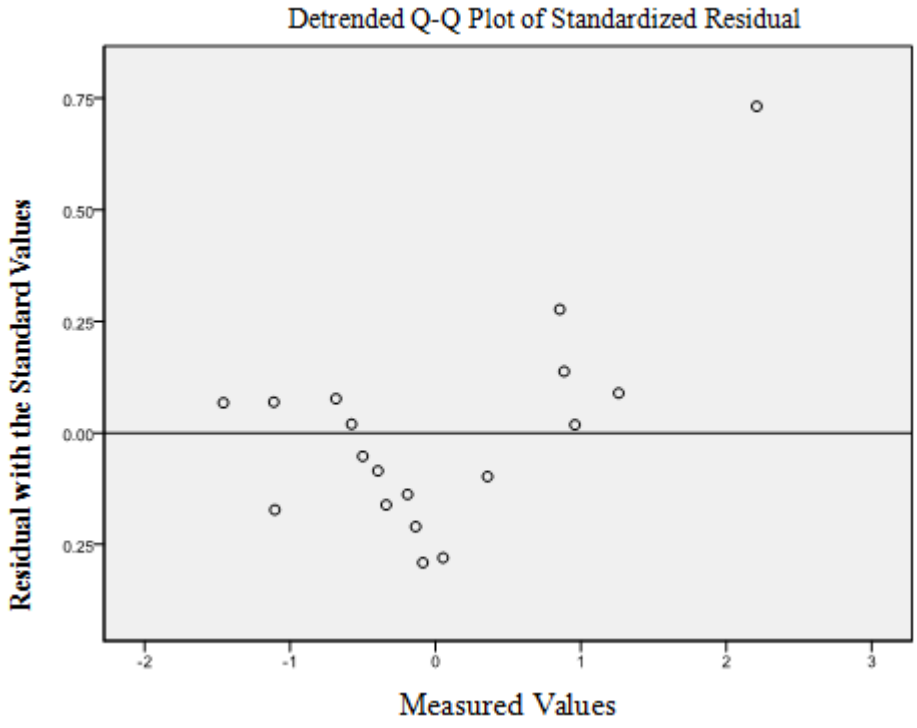

Figure 4-5 Standardized residuals histogram

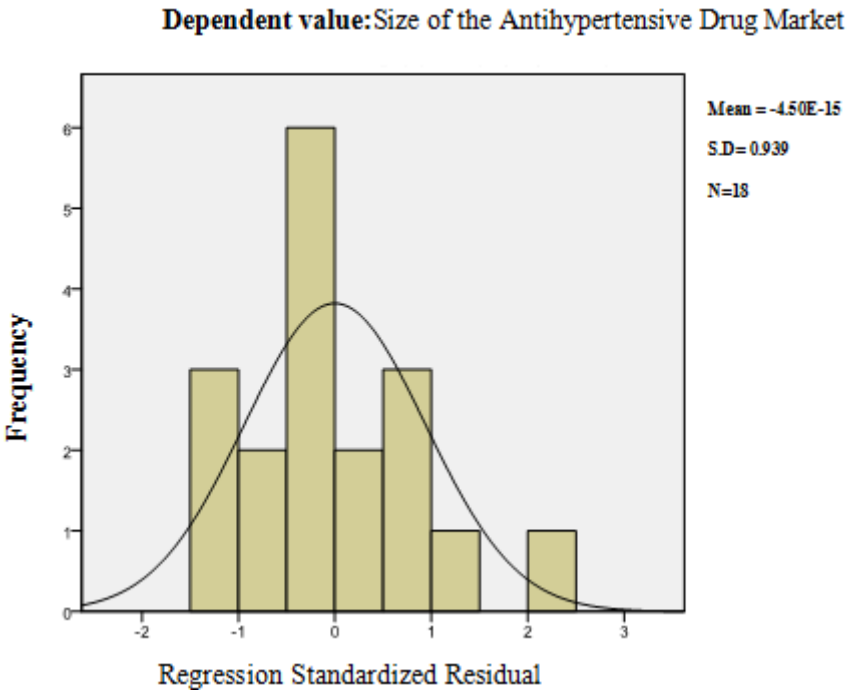

Figure 4-6 P-P plot of standardized residuals

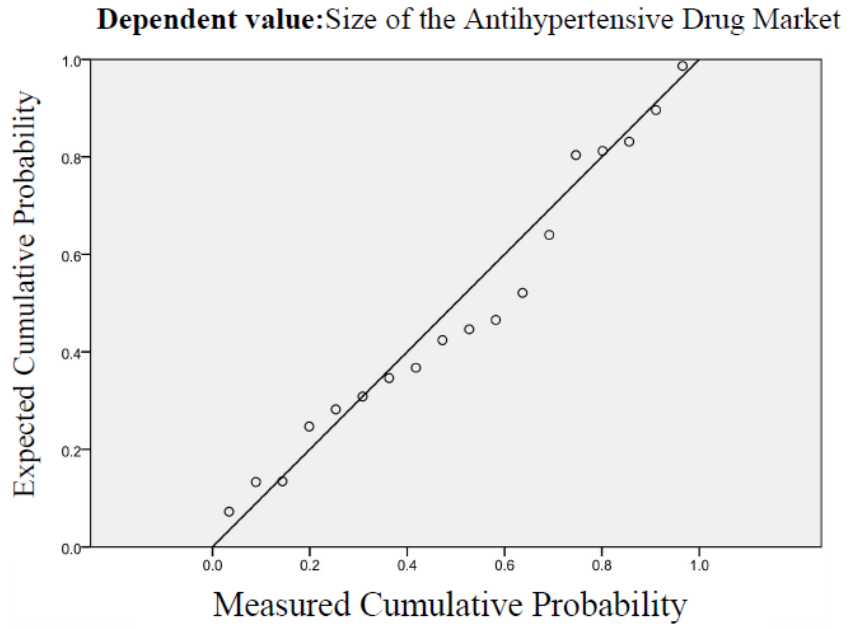

Figure 4-7 Scatter Diagram of Standardized residuals

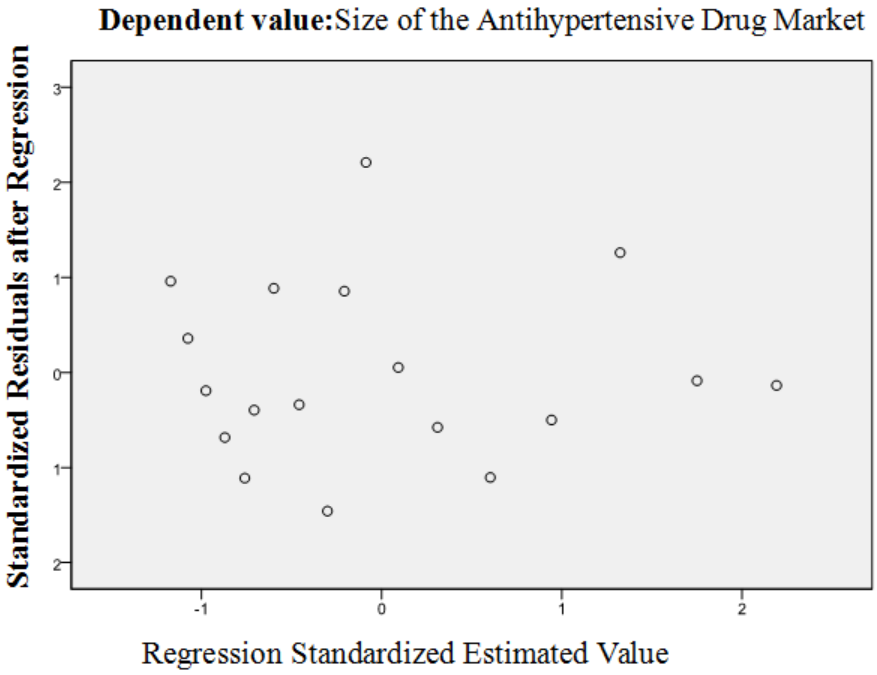

Figure 4-8 Standardized residuals histogram

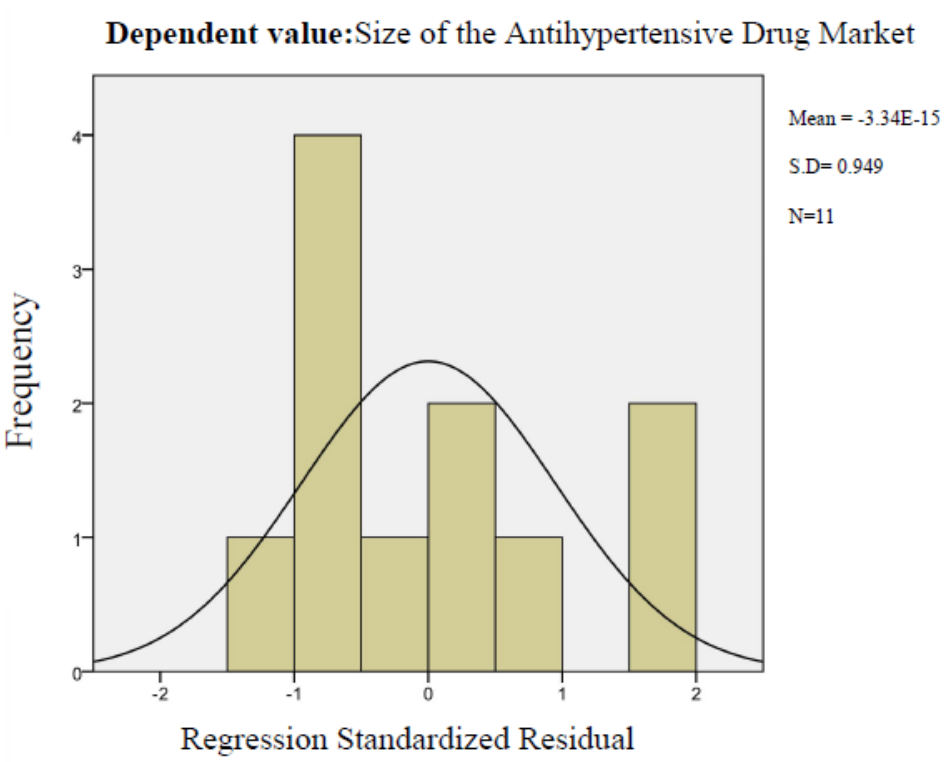

Figure 4-9 P-P plot of standardized residuals

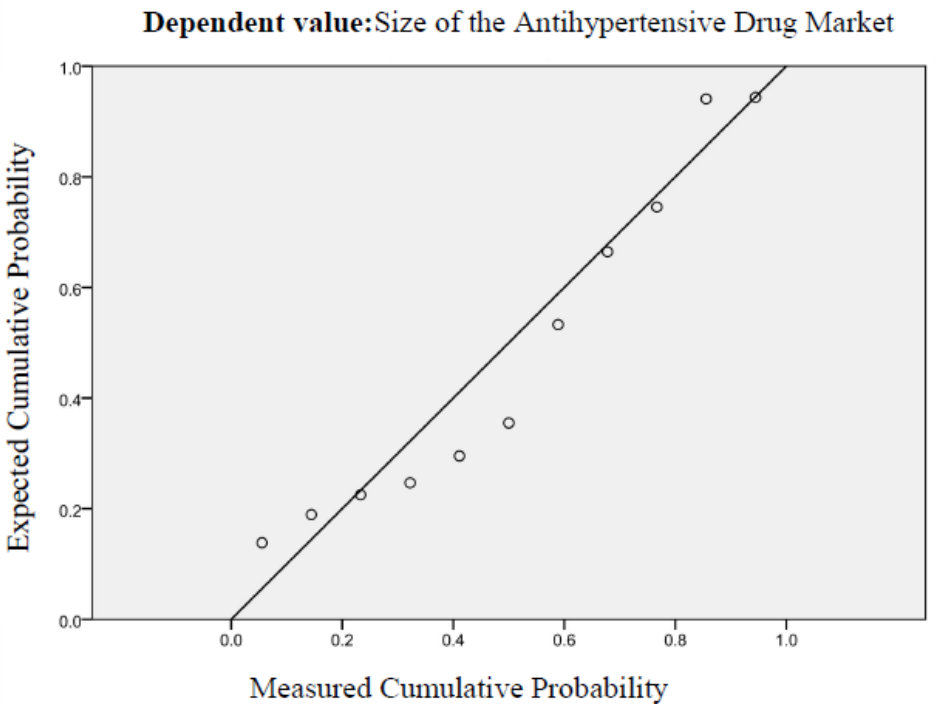

Figure 4-10 Scatter Diagram of Standardized residuals

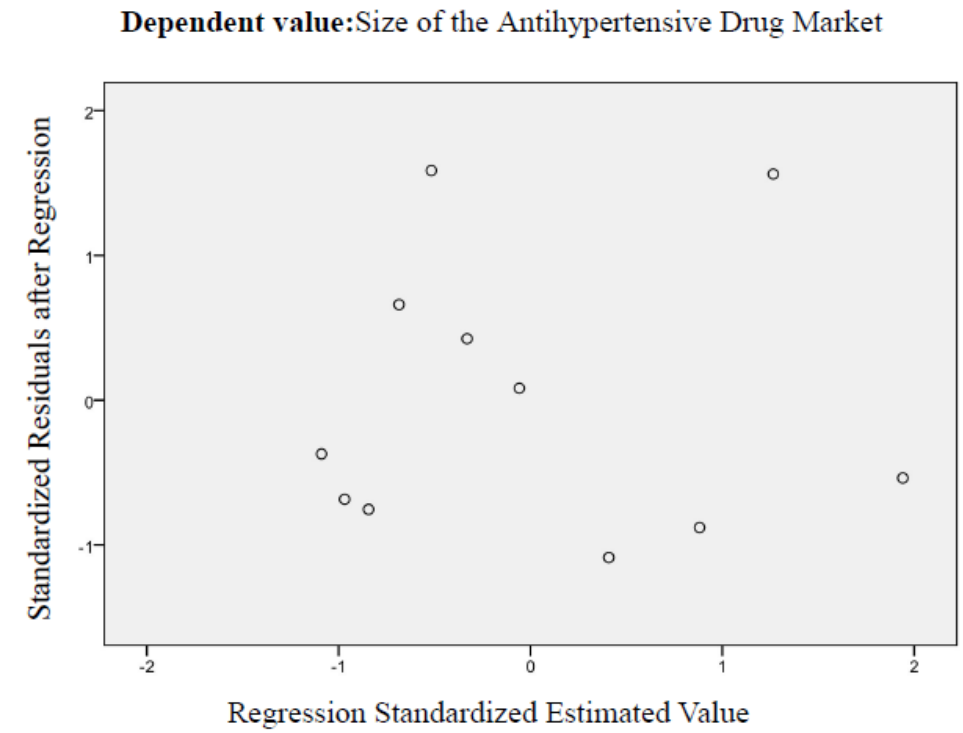

Figure 4-11 Standardized residuals histogram

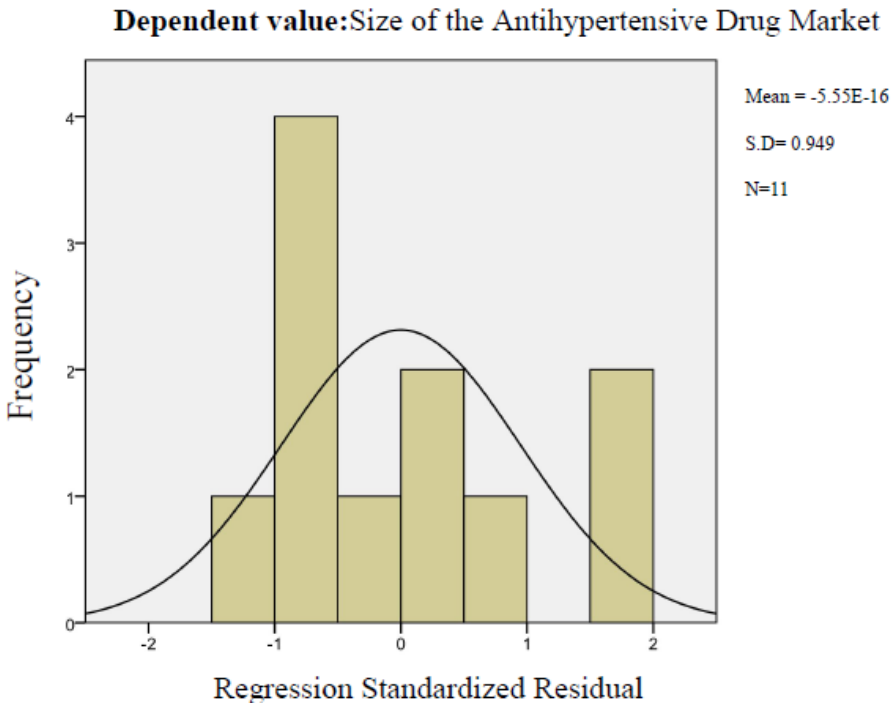

Figure 4-12 P-P plot of standardized residuals

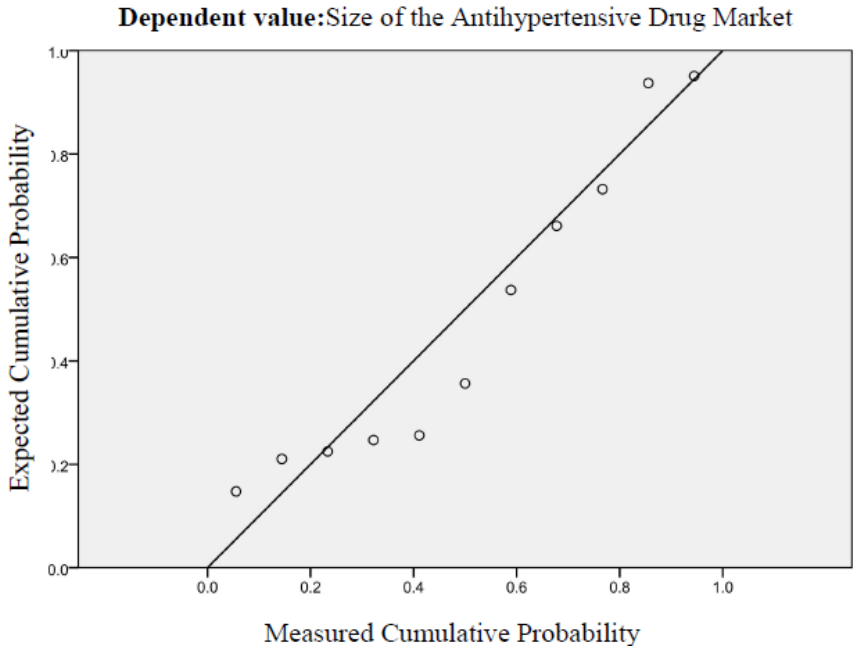

Figure 4-13 Scatter Diagram of Standardized residuals