# THE EFFECT OF FOOD SAFETY AND QUALITY ON THE CONSUMPTION AND PRICE OF MEAT IN BEIJING, CHINA

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**Title**

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

**MASTER OF SCIENCE**

# ABSTRACT

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China's economic success has helped it become one of the largest markets in the world. As a result, the demand for agricultural commodities in China has experienced a significant increase. Increasingly affluent Chinese people are paying increasing attention to food safety and quality instead of just quantity. Understanding how meat demands and prices are related to food safety and quality in Beijing will provide guidance for industry and policymakers interested in the Chinese meat market.

The purpose of this study is to develop two models to analyze meat demand and prices associated with food safety and quality respectively. First, An Almost Ideal Demand System (AIDS) is used to investigate the effects of food safety on meat consumption. To address the potential bias of zero consumption in the estimation procedures, a simulated maximum likelihood (SML) estimation is applied in the regression. Second, we analyze the implicit price of meat with the intrinsic and extrinsic attributes using a hedonic price model. Five meat categories are regressed on several intrinsic and extrinsic attributes in the model using household survey data collected in Beijing in 2007.

The key results of this research have two major outcomes. First, food safety has a significant and positive influence on meat consumption for Beijing residents. Second, the quality-related attributes or characteristics such as meat appearance, supermarket, meat brand, and processed meat as well as demographic variables such as household head's income have a significantly positive influence on the price of meat, which suggest that the

consumers in Beijing are willing to pay a price premium to guarantee the quality and safety of meat.

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# TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

# CHAPTER 1. INTRODUCTION

## Problem Statement

For a country of more than 1.3 billion people, how to feed this huge population is one of central problems for the Chinese government, and this problem has attracted world-wide attention. Research about the food consumption habits of increasingly affluent Chinese consumers has become an important focus in development literature. Changes in food consumption may influence Chinese food supply policy since providing an adequate food supply for more than 22 percent of the world's population has always been an essential and challenging goal of the Government of China (Liu and Deblitz, 2009). Additionally, given the massive potential purchasing power of its large population, understanding Chinese food consumption patterns is not only of interest to domestic producers, marketers, consumer and policy makers, but also essential to the continuing growth of international trade, particularly for exporter nations with significant agricultural surpluses (Halbrendt *et al.*, 1994). In particular, the accession of China to the World Trade Organization (WTO) in 2001 has accelerated the openness of China's agricultural trade and allowed more imports. More specifically, China has become a large market and a great opportunity for most of countries in the world, especially the U.S. and European Union (Guan, 1996). The following section will begin to discuss these changes. In addition, this thesis will develop some empirical analyses to assess the new preference of Chinese consumer on food consumption.

### Structural Change of Chinese Food Consumption

During the last two decades, a prosperous economy had resulted from market-oriented economic reforms and made the Chinese economy one of world's most rapidly

developing economic systems (Zheng and Henneberry, 2010). In less than a generation, China has made great advances in its socioeconomic development (Guo *et al.*, 1999). The World Bank has noted that China's average annual gross domestic product (GDP) from 1990 to 2008 was 10 percent (Figure 1.1). Additionally, the country also has successfully reduced the number of absolute poor people and made a huge of increase on urbanization (US Department of Agriculture-Foreign Agricultural Service, 2001), and improved the living standards of the Chinese people as a whole (Zheng and Henneberry, 2010).

Undoubtedly, China's rapid economic development has boosted Chinese people's income level dramatically. For example, per capita annual disposable income of urban Chinese households increased from 1,510 Yuan in 1990 to 5,850 Yuan in 1999 and jumped to 13,786 in 2007 (China Statistical Yearbook, 2008), which represent a nearly tenfold growth in the income of urban households over the last two decades. In response to the economic reforms, over 90 percent of retail prices and over 80 percent of agricultural prices have been set by markets since the early 1990s (Ortega *et al.*, 2009).

One of the most direct measures of income growth, the Engel Coefficient[1] for urban Chinese residents, showed a considerable decline (Figure 1.2). Also, the structure of Chinese households' food consumption has experienced a large change, especially for urban Chinese households. This structural change has manifested itself in several ways.

First, Chinese consumers have been experiencing a transition in food consumption from subsistence (grains, wheat) to a more balanced diet with great variety of food and more income elastic commodities, such as meat, fresh fruit, and dairy products. For

[1] Engel's law is an observation in economics stating that, with a given set of tastes and preferences, as income rises, the proportion of income spent on food falls, even if actual expenditure on food rises.

instance, the annual per capita grain consumption of Chinese residents dropped from 130.71 kilograms in 1990 to 77.60 kilograms in 2007, whereas, during the same period, the consumption of meat, fruits, and dairy products increased from 38.25 kilograms, 41.11 kilograms, and 4.63 kilograms, to 46 kilograms, 59.54 kilograms, and 10.33 kilograms, respectively (Figure 1.3).

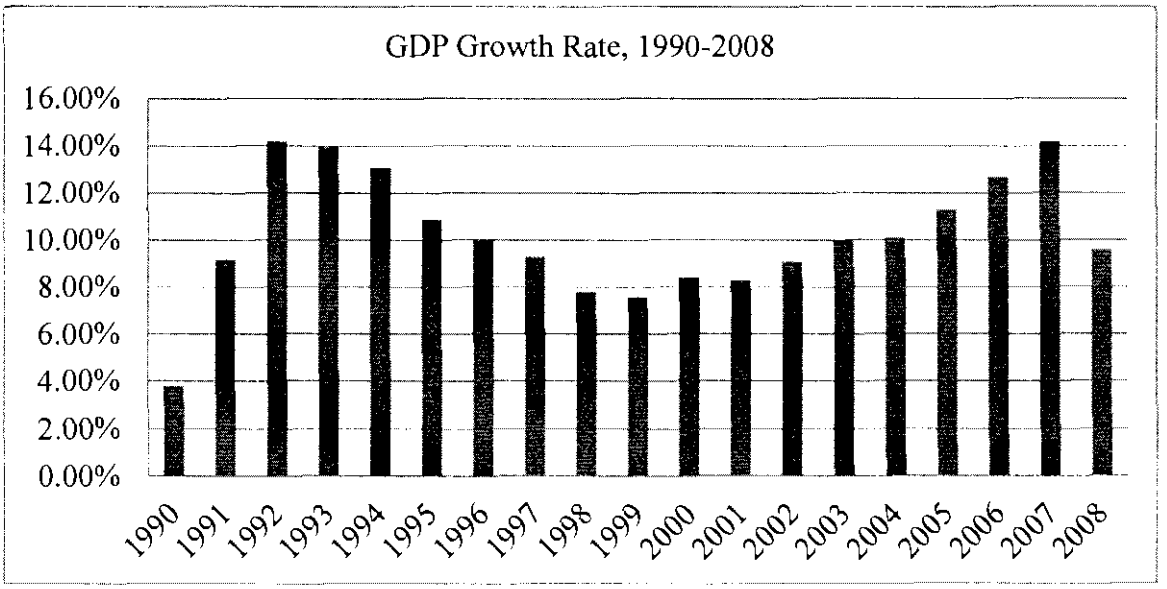


Figure 1.1 The GDP Growth Rate in China, 1990-2008.
Source: World Databank. The World Bank. http://databank.worldbank.org

Second, while Chinese consumers structurally increased their annual income level and meat products consumption, their preference of meat consumption also has been altered, especially in recent years. Traditionally, pork was considered as the dominant meat for Chinese urban and rural residents and accounted for a very large share in total consumption of meats (pork, beef, mutton, poultry, and aquatic products). But such preference has been changing with the growth of income. For instance, the consumption share of pork in urban China fell from 56 percent in 1990 to 40 percent in 2007. In contrast, the consumption for other meat products increases substantially. For example, the consumption share for poultry in urban areas increased from 10 percent in 1990 to 21

percent in 2007 (China Statistical Yearbook, 2008). Although the consumption shares for beef and mutton still remain low, their consumption shares in urban China have also increased significantly (Figure 1.4).

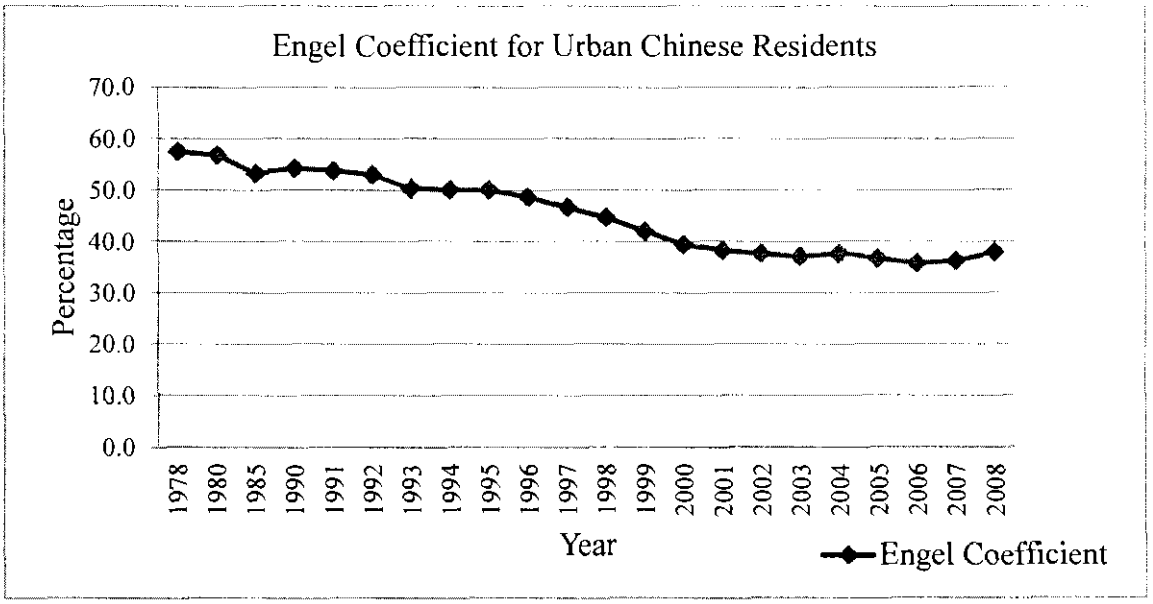


Figure 1.2 Engel Coefficient for Urban Chinese Residents, 1978-2008.
Source: China Statistical Yearbook, 2009. The National Bureau of Statistics, P. R. China

Third, the changing pattern of Chinese meat consumption also can be presented as increasingly affluent consumers increase their spending on not just in quantity but also in quality (Gale and Huang, 2007). Despite the fact that some Chinese consumers are still price sensitive in their food purchasing decisions, an increasing numbers now are willing to pay premium prices for food, especially after a number of seriously incidents concerning food quality and safety in China. Huang and Gale (2009) also point out that consumers purchase higher quality foods are reflected in paying a higher unit value for safety certified, brand, better cuts of meat or other premium quality. In addition, there is an increase in expenditures on processed foods, products certified as free of harmful

chemicals, foods with potential health benefits, or other foods with desirable attributes (Gale and Huang, 2007).

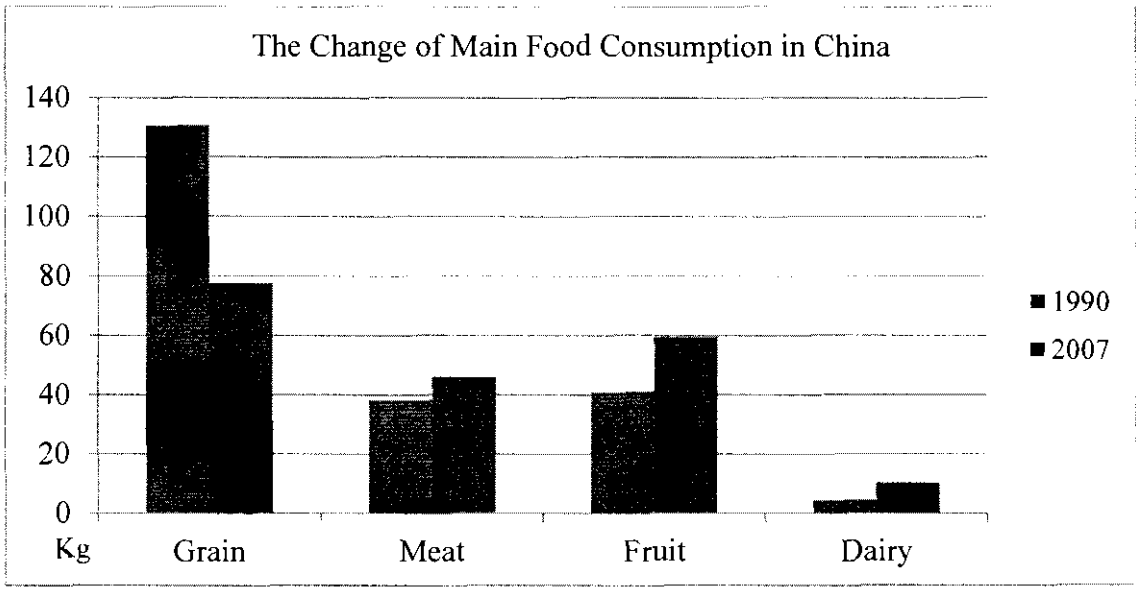


Figure 1.3 The Changes of Food Consumption in Urban China
Source: China Statistical Yearbook, 2008. The National Bureau of Statistics, P. R. China

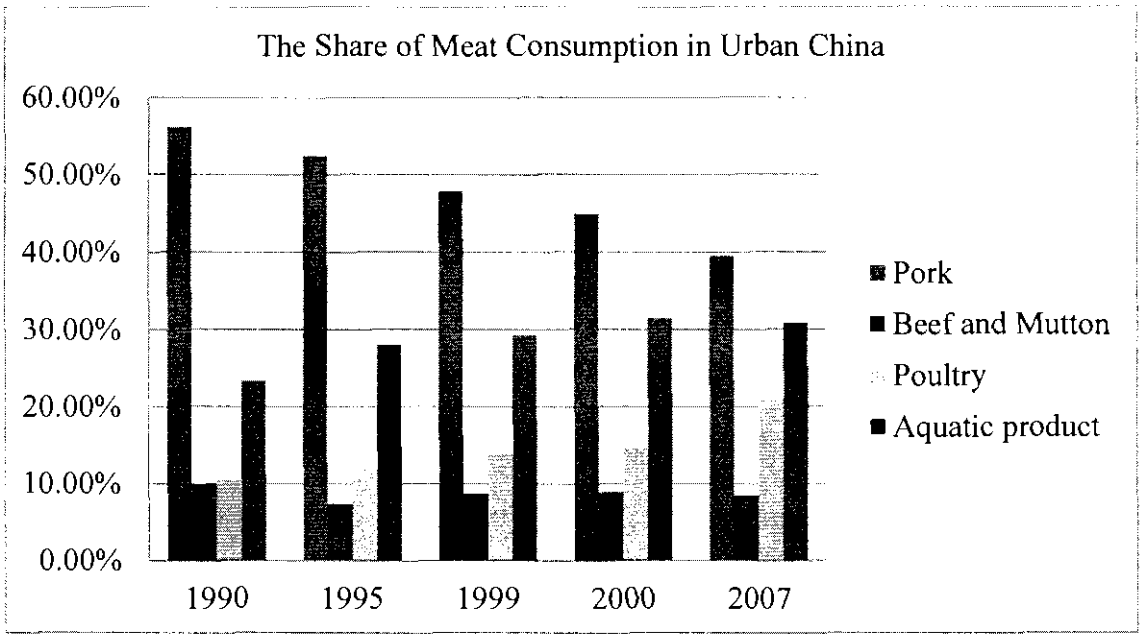


Figure 1.4 The Shift of Meat Consumption Share of China.
Source: China Statistical Yearbook, 2008. The National Bureau of Statistics, P. R. China

China's Current Food Safety and Quality

The main goal of this research is to investigate the effect of food safety and quality on the demand for meat and its price, respectively. Food safety issues are becoming increasingly important and have attracted the attention of billions of consumers, especially after several serious and nationwide food safety incidents in China. Numerous incidents involving food safety in China have been exposed by the media in recent years, including the unconventional use of pesticides and other dangerous chemical additives as food preservatives or additives as well as the use of unhygienic raw materials as food ingredients. Understanding the effect of food safety and quality on meat consumption and meat price has a great implication for both policy makers and agricultural commodity exports.

Food safety incidents emerged in China as a trade issue in the early 2000s (Wang *et al.*, 2008). In the 1990s, China was a low-cost exporter of food products such as vegetables, apples, seafood, and poultry in the world's market (Calvin *et al.*, 2006). However, China's food exports declined when its shipments failed to meet stringent safety and quality standards in Europe, Japan, and other countries, because of excessive antibiotic and pesticide residues. The "Chinese pesticide contaminated dumpling incident" in Japan in 2008 caused distrust of Chinese food exports and more than 75 percent of Japanese stated that they would no longer purchase food that was imported from China (Ning, 2008). This incident has had a serious and negative impact on China's food export industry.

These incidents did not only affect China's food export industry, but also made a negative impact on domestic Chinese consumers. Increasingly affluent Chinese are also

not optimistic about food safety in China (Thompson and Ying, 2007). In recent years, with reports of the media, many scandals related to domestic food safety were exposed to the public such as "the Three Deer milk powder scandal" in 2008 that resulted in the death of six infants from kidney stones and other kidney damage due to melamine being added to infants' milk formulas. Thus, in response to these food safety issues, Chinese consumers today are willing to pay at least a modest premium for food that meets safety standards or is free of dangerous contaminants (Gould, 2004; Calvin *et al.*, 2006; Wang *et al.*, 2008).

The Chinese government now has recognized the impact of food safety issues and has developed of food safety and quality systems for both export and domestic food agricultural commodities. Food Safety in China is regulated by several governments entitles, including the Department of Agriculture, the State Administration of Quality Supervision, and Food and Drug Administration (Calvin *et al.*, 2006). The food safety and quality systems include a series of national standards, a certification system, and requirements for use of quality and safety management systems (Calvin *et al.*, 2006). Today, most Chinese foods carry logos showing that the products have met safety-related certifications, such as "Quality Safe" or "Green Food" (Figure 1.5). Such logos have been an important cue for consumers to make a purchasing decision. In addition, Chinese publicity about food poisonous additives and dangerous chemical residues has given rise to great demand for "green foods" and organic foods (Marks and Bean, 2005). According to the China Green Food Development Center, domestic sales of organic and green food were in excess of 200 billion Yuan in 2007. However, up to 2007, markets for organic

food have mainly been located in China's booming regions of Beijing, Shanghai and Guangzhou, where living standards are higher than elsewhere in China.

More Chinese food manufacturers have started to apply Hazard Analysis Critical Control Point (HACCP) management in the food manufacturing process; HACCP is a quality management system used to reduce food safety risks (Wang *et al.*, 2008). A major component of China's efforts to improve food safety and quality, HACCP certification is generally accepted by Chinese consumers who are willing to pay a modest premium for food produced under HACCP procedures (Wang *et al.*, 2008; Zhang *et al.*, 2010).


Figure 1.5 An Example of "Quality Safe" and "Green Food" Labels of China
Source: China Green Food Development Center

The Changes in China's International Meat Trade

The surge in demand for quality food caused a change in agricultural trade behavior recently, especially for the meat trade. And these changes have important implications for U.S. agricultural exports (Wang *et al.*, 1998). Two or three decades ago, pre-reform Chinese trade was highly controlled by the government through monopoly trading corporations where import volumes were determined by a government plan and the demand for particular goods (Ianchovichina and Martin, 2001). In addition, in order to

protecting domestic agriculture and food security of China, the government imposed significant tariff and nontariff barriers that hamper the international trades of agricultural commodities. Consequently, the U.S. food and agricultural trade with China had been constrained for a long time.

However, since the economic reforms and the "open-door" policies of the 1970s, China's agricultural trade has experienced rapid expansion (Wailes *et al.*, 1998). Today, China is the fourth-largest market for U.S. agricultural commodity and Sino-American bilateral agricultural trade in 2008 consisted of US$12.2 billion in U.S. exports to China (USDA-ERS, 2010). China imports a great volume of agricultural commodities from the U.S. such as soybeans, cotton, wheat, and meat, which experienced a significant boost from 1989 to 2008. During this period, imported poultry from the U.S. has dominated the imported meat category with import volume increased from 308 metric tons in 1989 to 333 thousand metric tons in 2008. Similarly pork imports grew from 215 metric ton in 1989 reaching at 164 thousand metric ton in 2008 (USDA-ERS) (Figure 1.6). The main reasons for this tremendous increase of China's meat imports are the combination of economic growth, low barriers to imports after China's accession to WTO in 2001, and a tightening of domestic commodity supplies (Gale, 2005). The following paragraphs discuss these factors driving the change of China's agricultural trade directly in recent years.

China's accession to the World Trade Organization (WTO) in December 2001 played an important part for the growth of meat imports. As a WTO member, China had to cut tariffs, and opened tariff rate quotas (TRQs) for imports of agricultural commodities at low tariffs (Huang *et al.*, 1999).

A broad-based increase in food demand is suggested by the rapid growth in domestic food sales (Gale, 2005). Consumers and food service industry demands caused a sharp increase in imported food items. On the one hand, China's food retail and restaurant industries are developing rapidly, and these sectors are likely to be important sources of demand for food imports, such as meat and milk. Furthermore, Supermarkets such as Wal-Mart and restaurants (KFC and McDonald's) created a new market for imported food among Chinese consumers in order to cater to their desire for exotic fare (Gale, 2005). On the other hand, it seems that the increase quantity of fatal food safety and quality scandals in China heavily damaged the confidence of Chinese consumers in domestic food products. They are willing to pay a premium price for imported meat that has guaranteed safety and quality. Chinese consumers' demand for imported food will likely continue to increase in the long run.

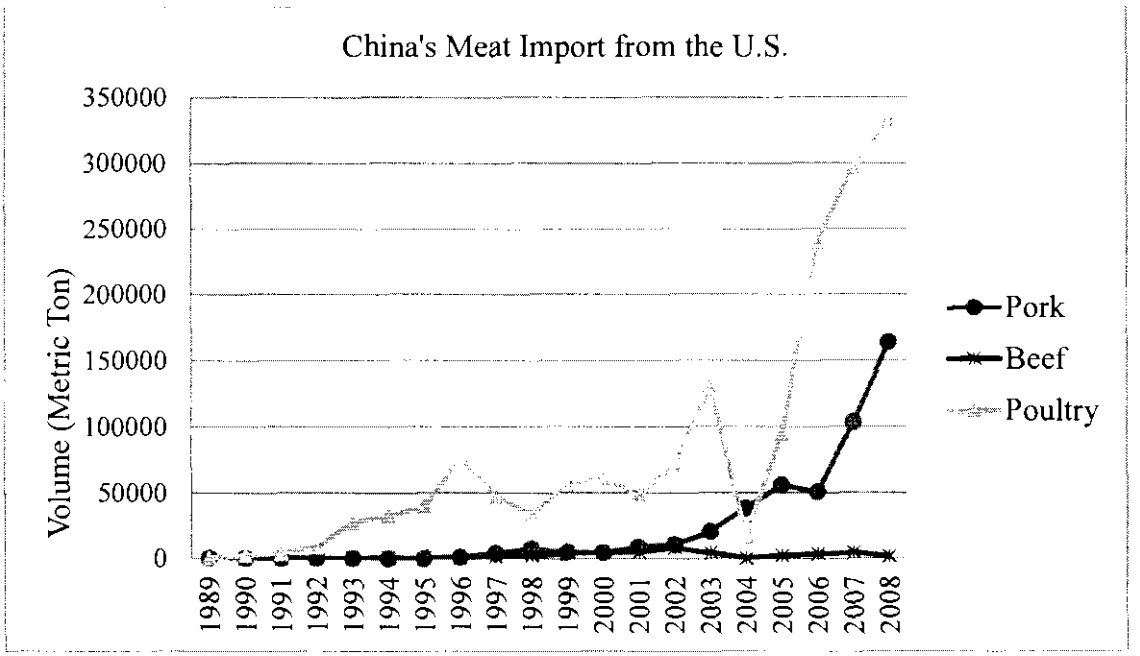


Figure 1.6 China's Meat Imports from the U.S. (1989-2008)
Source: US Department of Agriculture-Economic Research Service.

China's imports of meat are also driven by the limited domestic production capability and resources. For example, about half of Chinese pork comes from "backyard" production. These hogs are fed with household and farm waste, which are low in some essential amino acids (Wang *el al.*, 1998). Consequently, animal growth rates are slow and cannot meet the increasing demand of Chinese consumers and generally China has become a larger buyer of U.S. food products.

The Social Structure Changes in Urban China

China's rapid economic growth also results in social and demographic changes. It is obvious to understand that these social and demographic changes work together and play an important role in the changes in urban household meat consumption, since the different meat preferences and different consumption patterns for Chinese urban households with different social demographic profiles. These social structure changes are not only reflected by the growth of annual disposable income, but also by other factors. Additionally, these factors also affect food and specifically meat consumption.

One of the great changes in social and demographic characteristic is the increase in the education level of Chinese people. One reason for this growth is the dramatic development of education, especially the increasing enrollment rate of higher education in China since 1999. Accounting to the China Ministry of Education, total enrollment at the beginning of 1998 was about 3.4 million, while this number in 2008 was nearly 20.3 million (China Ministry of Education, 2009). This increase represents approximately a 600 percent increase in the enrollment in higher education over the last ten years. This increase in education levels affects food consumption in two ways. First, the rapid development of education has contributed substantially to the shift of Chinese consumers'

meat purchasing decisions. For example, highly educated people may focus more on nutrition and healthy foods in their food purchases, because they are more aware of nutrient value. Second, generally, a head of household or wife with a higher educational level may be more aware of food safety and the ability to distinguish the quality of food. Based on these reasons, this study will take the educational level of Chinese consumers into account in its analysis.

Another social and demographic change in China is led by the population control policy which has decreased the population growth rate since 1980s. By adopting this policy, urban household size dropped from 3.89 in 1985 to 2.91 in 2007 (China Statistical Yearbook, 2008). The "One couple, one child" regulation has caused the distribution of household size to be centered on the integer three and the number of large households decreased (Guan, 1996). As a result, the single-child policy has increased parents' focus on child nutrition. The children in each family are undoubtedly the center of every family, especially when each family only has one child. The diet for children (younger than 18 years old) is likely to affect household food consumption, particularly in the consumption of meat and dairy products. Furthermore, the number of children in the family is likely to have a positive effect on the evaluation and consumption of meat.

In summary, China is experiencing great changes in the key areas of its society. This study is intended to investigate the effects of food safety and quality in details, associating with such changes by applying empirical methods. This will be the representative of a new concept about food consumption embodied in the mind of urban Chinese people and have several implications for policy makers, food producers, and food exporters.

## Objectives

The overall objective of this research is to examine the impact of food safety and quality on meat consumption and meat price, respectively, in Beijing, China, today. This study is divided into two major parts: the first part estimates the effect of food safety on meat consumption; the second investigates the influence of quality-related attributes on meat prices. The specific objectives of this study are to do following works:

1) Apply an econometric framework, especially a nonlinear Almost Ideal Demand System (AIDS) incorporating a food safety variable and social-demographic variables, to detect the effects on meat consumption in Beijing, China.
2) Assess the effects of social-demographic variables on meat consumption by calculating price and expenditure elasticities. Determine and explain the elasticities between expenditure share and meat consumption.
3) Evaluate the effects of quality-related attributes on meat prices by using a Hedonic Price Analysis in the empirical study and identify the important quality-related attributes which significantly affect meat price.

## Methods

Two empirical models are developed for this study to analyze both the factors affecting meat consumption and those affecting meat prices separately to Beijing, China. The first model employs a non-linear AIDS model to analyze the effects of food safety issues on the consumption of meat. In addition to the food safety variables, the number of children in a household and the household educational levels are included in the model. Since there is the existence of zero-consumption in the data, this study uses a simulated

maximum likelihood (SML) and Reordered GHK (Geweke, Börsch-Supan and Hajivassiliou, Keane) simulator to deal with the potential bias of zero meat consumption econometrically.

The second model analyzes the influence of quality-related attributes on meat price and investigates the premium price that Chinese consumers are willing to pay. Following Rosen's approach (1974), several intrinsic and extrinsic quality-related attributes are added to the Hedonic Price Model, including meat appearance, meat brand, meat certification, purchasing venues, and processed form.

This study uses household level survey data which was jointly conducted in 2007 by the Center for Chinese Agricultural Policy (CCAP) at the Chinese Academy of Sciences, and the Beijing Branch of National Bureau of Statistics of China (NBSC). The non-linear AIDS model is estimated using Gauss, and the Hedonic Model is analyzed by STATA software.

## Organization

This thesis is divided into five chapters. Related studies about food safety and quality will be discussed in Chapter 2 along with the review of this study's theoretical framework and empirical modeling approach. Chapter 3 is an independent chapter to investigate the effect of food safety on meat consumption. Chapter 4 is another individual part which discusses the effect of quality-related attributes on consumer's evaluation of meat prices. Finally, Chapter 5 provides the overall summary, conclusions, as well as implication for the further study.

# CHAPTER 2. LITERATURE AND METHODLOGY REVIEW

## Summary

In recent twenty years, a great number of researches and quantitative methods have been introduced and applied for Chinese food consumption issues. And in recent one decade, Chinese food quality and safety issues open a new domain for researchers to investigate. In this chapter, the studies of Chinese food and meat consumption will be reviewed at first. Then the previously literatures about food quality and food safety contribute the second part of this chapter. Finally, the review of demand and price analysis models also makes up another important part in this chapter. In all, this chapter will be devoted to understanding meat consumption patterns of urban Chinese households and food safety and quality issues in China.

## Literature Review

### Review of Chinese Food Consumption and Demand

*Staple Foods*

Several studies have focused on grains or staple foods consumption in both urban and rural China and investigated the main factors that influence Chinese grain consumption. Lewis and Andrews (1989) develop a Linear Expenditures System (LES) and an Extended Linear Expenditure System (ELES) separately to analyze rural and urban household demand in China respectively. They apply the data which are obtained from the surveys of Chinese people and National Statistical Bureau and argue that Chinese household devotes a large proportion of the income to meeting the basic needs. They conclude that urban household increases in income will result in a reducing proportion of expenditure on food and within the food category a lower proportion expenditure on staple

foods. And for rural household, they have the similar results but more sensitive than urban household.

Huang and David (1993) analyze the effect of urbanization on demand for cereal grains (rice, wheat, and coarse grains) in nine Asian countries, including China. These nine Asian countries account for about 85 percent of the world's rice consumption and production. LA/AIDS has been used as a fundamental model and extended to include urbanization rate as an independent variable. They conclude that the urbanization rate has an insignificant effect on Chinese cereal consumption firstly due to the slow rate of urbanization over the period of study, and secondly to the system of grain rationing that limited consumer choice.

Fan *et al.* (1994) also attempt to model the food demand in China. In their study, dynamic Almost Idea Demand System (AIDS) model is introduced to estimate various food demand parameters for Chinese rural households using rural household survey data in 1994. The reason employing dynamic AIDS model is because it can be able to capture the dynamic nature of the consumption parameter for Chinese rural households. This model successful reflects the change in consumption pattern and the expenditure elasticities can be calculated from the model estimation. From the estimation results, they point out that rural reform in China has a significant impact on the food consumption patterns of Chinese rural households. For example, all important food commodities such as rice, wheat, grains, vegetables, and meat, have positive expenditure elasticities. Rice, wheat, and other staple foods are necessities, while meat and vegetable are luxuries. They suggest that China must continue to increase its food production by a greater rate in order to avoid food shortage.

Wu and Wu (1997) present direct and indirect grain consumption into AIDS model to detect the household grain consumption in China. The direct grain refers to food grain, such as rice, flour, and corn, while the indirect grain is foodstuffs or the grain for alcohol. The main issue of this paper is to focus on the application of demand models, examination of consumption parameters, and estimation of the effects of price, income and urbanization on grain demand. They also pay attention on the regional grain demand in China. The empirical results indicate that grain is a normal good in China, but the food grain tends to be inferior in the southern and Yangtze River region. They also argue that the effect of urbanization plays a negative role on the food grain consumption. The reason is that more rural people move to urban area, and they adopt an urban consumption pattern and tend to consume less food grains. However, as the continuing depth of urbanization, indirect grain consumption becomes the main source of grain demand.

*Vegetables and Fruits*

Ahmadi-Esfahani and Stanmore (1997) allow a LA/AIDS model to quantify the vegetables demand for market in a Chinese wholesale market. In their analysis, they divide data set into two periods, the period of regulated market (1988-1990) and competitive market (1991-1994), to detect and compare how Chinese consumers respond to the demand for vegetables. Besides, they also estimate the elasiticites of vegetables. From the results of empirical model, they conclude that the own price elasticities for vegetables are all low in the period of regulated market, indicating the necessity of vegetables to the Chinese diet. Furthermore, some vegetables such as cabbage, ginger, and garlic are price sensitive which shows that these are less essential vegetables for Chinese people during that period. In terms of competitive market (1991-1994), the market in

China is less regulated. The own-price elasticities for vegetables are smaller than the former period, which shows that with the growth of income, Chinese consumers become fewer prices sensitive toward vegetable than before.

Han and Wahl (1998) examine the food consumption patterns, which special emphasis on fruits and vegetables, of China's rural households across different income groups and regions. In their study, they also investigate whether the demand for fruits and vegetables share a common demand function and provide estimates of price and expenditure elasiticities for fruits and vegetables. Han and Wahl apply a two-stage budgeting model to estimate a complete demand, where the first stage allocates total expenditure across broad group of commodities by using a linear expenditure system (LES), and the second stage allocates group expenditure across individual commodities through utilizing the LA/AIDS model. The key results for this study indicate that different geographical location, household type, and education level affect household consumption behavior. The consumption of vegetable can be affected by household size, when household size increased vegetable consumption increase, and meat and grain consumption decrease. Han and Wahl also conclude that lower value vegetables are the most price elastic in the vegetable group. Fruit are more price elastic than vegetables. Furthermore, the larger expenditure elasticities for fruits and vegetables indicate that a growth in income will increase demand for fruits and vegetables and consequently will increase the fruits and vegetables production.

Liu *et al.* (2008) study the changes in fruit and vegetable consumption over time and across region in China. They point out that a better understanding the changes of fruit and vegetable consumption in China would be useful in assessing Chinese dietary quality

and implication for future agricultural trade. In the empirical study, they use the urban household survey data of Guangdong, Jiangsu, and Shandong in 1993 and 2001, and first examine how the economic factors may influence a household's demands for fruits and vegetables. Then, they identify the factors that cause the changes in the consumption of fruit and vegetable between 1993 and 2001 among different regions through applying the difference-in-differences (DID) method to rule out the unobserved effects. From the empirical study results, Liu *et al.* point out that there is a significant evidence to prove that the vegetable consumption among households in different provinces are disparate. Meanwhile, the income coefficients have a positive and significant effect on the consumption of vegetables and fruits and the family with larger size may reduce the quantity of available for each member. Finally, Liu *et al.* also suggest some policy implication for China. For example, the policy should be designed differently for households with different level of fruit and vegetable consumption, and the policy should take regional disparities into account, especially for the fruit consumption.

*Meat and Animal Products*

Wang *et al.* (1998) examine urban Chinese consumer preference for major animal products and estimate the potential impacts of a reduction in China's import tariff on its pork and poultry demand. AIDS model and the translog model are employed as the main demand system to estimate the demand elasticites for animal products, including pork, beef, mutton, and fish. They suggests that Chinese urban household are likely to allocate 39.1 percent of their additional expenditures on animal products to pork, 7.3 percent to beef and mutton, 17.1 percents to poultry, and 20 percent to fish. And pork still is the major animal product in urban China, for the reason that pork has been the most

commonly meat product with a relatively low price. Wang *et al.* also argue that the accession to WTO will continue the process of liberalization of China's meat market and make China become the potential largest market in the world. Thus, U.S. exports of poultry and pork will increase dramatically. At the same time, due to market liberalization, the price impact in U.S. and Chinese markets will be relatively decreasing.

Cai *et al.* (1998) detect the meat demand in urban China within different income strata. In their study, L/A AIDS method is also applied as the main empirical modal to investigate the meat consumption pattern in the developing Chinese society. They analyze the effects of income and price on meat demand by segment households according to income levels. And the households are categorized as low, medium and high income based on urban households' income. Therefore, the hypothesis in this research is that consumers from different income strata respond differently to changes in prices and income when purchasing meats. From the estimation results, Cai *et al.* conclude that pork enjoy the position of dominant and traditional meat in the diet of most Chinese people. Poultry has higher income elasticites of low-income group compared with that of middle and high income classes. Besides, the income elasiticities of beef and mutton are luxury goods for all urban households irrespective of their income level. The price changes of meat can bring a significant change in meat consumption patterns. Finally, they also make some policy implication for the policy maker in China. For instance, the Chinese government should design some appropriate policies in order to enhance the purchasing powers of low-income group.

Fuller *et al.* (2002) study the rising demand of meat in China and discuss the problems which are derived by such increase. In their study, they point out that per capita

meat and egg consumptions in both rural and urban China are enjoying a dramatic change, and such change is caused by the continued income growth and urbanization. Consequently, how to balance China's growing need of livestock products and the limitation of resource and inefficient way of rising will be an important issue in the future. Fuller *et al.* mention two ways to solve this problem. The first is to import feed grain, and the second one is the meat imports. Meanwhile, the increasing demand for high-value cut in urban China and the growth of super market may boost the meat import. They also make an implication that if China did not impose stringent labeling on the biotechnology that apply to feed grains, the raise feed costs to China's livestock will be lower and increase the sector's growth.

Ma *et al.* (2004) also focus on Chinese animal products consumption, especially in the period of 1990s. They also consider the effects of food away from home on the consumption of meat in China, which is the novel point in this study. Ma *et al.* first argue that accounting for consumption away from home is an important data improvement, for the reason that consumption of animal products away from home has increased dramatically in China in the period of 1990s. Omitting consumption away from home can also lead to a misunderstanding of animal consumption. To have the best estimation results, L/A AIDS model is employed in this study again, and Seemingly Unrelated Regression (SUR) is used for the main estimation technique. In the conclusion, Ma *et al.* point out that Chinese consumer will continue to increase the consumption of animal products, but the preference is generally shifting from pork to chicken and aquatic products. Besides, the results also show the significant differences in animal product consumption preferences across regions in China. Meanwhile, if without considering

food-away-from-home animal consumption in the analysis, the expenditure share and elasticities are likely to be biased and underestimated.

Review of Food Safety and Quality Demand in China

Chinese food safety and quality issues have attracted increasing concerns from public and media recently. However, limited numbers of previous studies focus on these two points in China except the following literatures, especially for meat safety and quality issues.

Brown *et al.* (2002) discuss food safety and the development of the beef industry in China. They mention that the increasing concerns about the safety of beef have coincided with increased consciousness of the safety of all foods, especially in urban areas. Food safety in relation to meats, and in particular, has attracted increasing attention following several pork and chicken-related human disease outbreaks on the mainland China and in Hong Kong since 1997. They conclude that because household slaughtering and wet markets dominated beef processing and distribution in China, the willingness or capacity of Chinese consumers to pay the added cost of better inspection and other services to guarantee food safety are strong. They also claim that although some Chinese consumers exhibit a willingness and capacity to pay the premium for safe beef, the mass market for beef is still low-value and low-price market. So based on these conclusions, Brown *et al.* figure out that there is an increasing market opportunity for high-quality and safe beef in China, and domestic and imported "Green Beef" will be accept by more and more consumers.

Gale and Huang (2007) discuss the demand for food quantity and quality in China, and they find demand for food quantity diminishes as income rises. High-income

consumers spend more on higher quality food which indicates an increasing attention on food with high quality in China.

Wang *et al.* (2008) investigate the Chinese consumer awareness, willingness to pay, and price premiums for milk products manufactured using Hazard Analysis Critical Control Point (HACCP) management, which is a quality management system to reduce food safety risks. They report that HACCP is a major component of China's effort to improve food safety, but the analysis of their study indicates that most of Chinese consumers are not familiar with system. In the empirical study, hedonic price model is applied as the main methodology, and data come from a survey held in Beijing in 2007. From the empirical results, Wang *et al.* conclude that urban Chinese consumer are willing to pay a modest price premium for milk products certified with HACCP. Although these studies have contributed to understanding food safety issues in China, there is a significant need to understand the way that Chinese consumers search for safe foods and the implications of this behavior for food safety policies and food markets (Zhang *et al.*, 2010).

Zhang *et al.* (2010) analyze how Beijing Consumers determined milk safety when they purchased liquid milk using survey data, which is collected before the melamine-contaminated infant formula event was disclosed. In their study, they point that consumers often rely on certain extrinsic indicators to evaluate the safety of food products in asymmetric information markets. In the survey, consumers were asked to rank the important factor which may be related to milk safety. Thus, rank ordered logistic regression model (ROLM) is introduced to fit the ranking data. The key finding in this research indicates that purchase venues and brand are ranked as the first two important

milk safety indicators. The implication for the results is that China's milk safety regulators should put more monitoring resources toward supervising the safety of milk in China. Besides, Zhang *et al.* also make some comments toward the Chinese certification system. They argue that current milk safety certification system in China might be significantly inefficient, which means potential waste of regulatory resources.

## Review of Methodology

In this study, the nonlinear Almost Ideal Demand System (AIDS) model and Hedonic Price Analysis are employed as the main methodology to estimate the effects of food safety and quality on the meat demand and price, respectively.

### AIDS Model

Deaton and Muellbauer (1980) firstly introduce the Almost Ideal Demand System (AIDS) which is now the widely applied demand analysis in analytical researches. According to Deaton and Muellbauer, the AIDS model is derived from the PIGLOG (expenditure) function. The PIGLOG model defines the minimum cost or expenditure $c$ necessary to attain a specific utility level $u$ at a given price $p$ (Guan, 1996). Following Deaton and Muellbauer, the cost function is:

$$lnc(u,p) = a(p) + ub(p) \tag{2.1}$$

where $a(p)$ and $b(p)$ are functions of price, which can be defined as:

$$a(p) = \alpha_0 + \sum_{i=1}^{n} \alpha_i \, lnp_i + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij}^{*} \, lnp_i lnp_j \tag{2.2}$$

$$b(p) = \beta_0 \prod_{i=1}^{n} p_i^{\beta_i} \tag{2.3}$$

where $\alpha, \beta$, and $\gamma^*$are parameters, and $n$ is the number of commodities. Therefore, the AIDS cost function can be represented as:

$$lnc(u,p) = \alpha_0 + \sum_{i=1}^{n} \alpha_i \, lnp_i + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij}^{*} \, lnp_i lnp_j + u\beta_0 \prod_{i=1}^{n} p_i^{\beta_i} \quad (2.4)$$

The basic form of AIDS demand function is derived directly from Equation (2.4) by using Shephard's Lemma, which is $\partial c(u,p)/\partial p_i = q_i$. Then we multiply both sides by $p_i/c(u,p)$, so the AIDS budget share can be expressed in terms of expenditure (Guan, 1996):

$$w_i = \frac{\partial lnc(u,p)}{\partial Lnp_i} = \frac{p_i q_i}{c(u,p)} \quad (2.5)$$

Furthermore, incorporating function (2.4) and (2.5), the budget shares can be further expressed as a function of price and utility, which is:

$$w_i = \alpha_i + \sum_{k=1}^{m} \gamma_{ij} ln \, p_j + \beta_i u\beta_0 \prod_{i=1}^{n} p_i^{\beta_i} \quad (2.6)$$

where $\gamma_{ij} = \gamma_{ji} = \frac{1}{2}(\gamma_{ij}^{*} + \gamma_{ji}^{*})$.

The indirect utility function in Equation (2.4) also can be represented as a function of price and expenditure. Through substituting $u$ in Equation (2.6), the budge shares can be finally defined in a basic specification, which is:

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ji} ln \, p_j + \beta_i \, ln\left(\frac{y_i}{P_i}\right) + \varepsilon_{ji} \quad (2.7)$$

where

$w_i$ = the budget share of commodities

$y_i$ = the total expenditure

$n$ = the total number of commodities

$p_j$ = the price of commodity $j$

$P_i$ is a price index which can be expressed as:

$$ln\, P_i = \alpha_0 + \sum_{i=1}^{n} \alpha_i \; lnp_i + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ji} \, lnp_i lnp_j \tag{2.8}$$

and $\alpha_i$ is defined such formation that it includes the socio-demographic variables effects in the model

$$\alpha_i = \delta_i + \sum_{r=1}^{R} \delta_{ir} \, d_r \tag{2.9}$$

$$j = 1, 2, \dots, N$$

where $d_r$ is vectors of socio-demographic variables with the total number of R, which indicates the $r$th measures the influence on the expenditure share of group $i$.

The parameters $\beta$ of the AIDS model determine whether the goods are luxuries or necessaries (Deaton and Muellbauer, 1980). If $\beta_i > 0$, $w_i$ increases with expenditure so that the good $i$ is a luxury. In the contrast, $\beta_i < 0$ if good $i$ is necessary. At the same time, the $\gamma_{ji}$ parameters explain the change in the $i$th budget share following one unit change in price $i$ with $(y_i/P)$ held constant.

What we have to notice is that if the price index is replaced by Stone Price Index, which is $logP^* = \sum w_k \, log\, p_k$, the nonlinear AIDS model becomes the Linear Approximate AIDS (LA/AIDS) model. This reduces the AIDS to a linear model.

The adding up restriction must be imposed in the model in order to guarantee the sum of estimated budget shares equal to one. Incorporating the demographic variables in this manner ensures that the symmetry restriction is not violated (Ramezani *et al.*, 1995). The adding up restriction for the AIDS model can be written as follows:

$$\sum_{i}^{n} a_i = 1; \quad \sum_{r=1}^{R} \delta_{ji} = 0; \quad \sum_{k=1}^{M} \gamma_{ji} = 0$$

The homogeneous condition is

$$\sum_{j}^{n} \beta_j = 0$$

and the symmetrical condition for the nonlinear AIDS model is $\gamma_{jk} = \gamma_{kj}$, for any $k \neq j$.

In general, the AIDS model has several advantages compared with other demand models. It is derived from utility maximization, which has the ideal property of ensuring that the demand system is theoretically consistent (Guan, 1996). Moreover, it is easy to be estimated by some statistical software, such as GAUSS and SAS. Besides, it is unnecessary to impose any restriction on the degree of substitutions among commodities (Deaton and Muellbauer, 1980).

The uncompensated (Marshallian) price elasticities $e_{ji}$ of the AIDS model can be derived by the following equations (Green and Alston, 1990):

$$e_{ij} = \frac{\partial lnq_i}{\partial lnp_i} = -\epsilon_{ij} + \frac{\partial lnw_i}{\partial lnp_i} = -\epsilon_{jk} + \frac{\gamma_{ij}}{w_i} - \frac{\beta_j}{w_i}(\alpha_j + \sum_{j}^{N} \gamma_{ij} ln\, p_j) \qquad (2.10)$$

where $\epsilon_{jk}$ is the Kronecker delta, $\epsilon_{jk} = 1$ for $i = j$ , and $\epsilon_{jk} = 0$ for $i \neq j$. The uncompenstate price elasticities present the percent change in quantitiy consumed of commoditiy $i$ with respect to a percent change in the price of commodity $j$, houlding constant total expenditure, y, and the price of other commodities.

The expenditure elasticities $\eta_i$ are represented by the following equation:

$$\eta_j = 1 + \frac{\beta_j}{w_j} \qquad (2.11)$$

Furthermore, the compensated elasticities (Hicksan) price elasticites $\epsilon_{ij}$ can be driven by using the Slutsky Symmetry condition:

$$\xi_{ij} = \epsilon_{ij} + w_j(1 + \frac{\beta_i}{w_i}) \tag{2.12}$$

Hedonic Price Analysis

The Hedonic Price Analysis is used to estimate the economic value of commodities that directly affect market prices. Empirical work on quality of products is mostly based on a procedure referred to as the hedonic technique, and this is usually justified in terms of household production theory (Deaton and Muellbauer, 1980). The presupposition of hedonic price model is that the price of commodity in market is related to its characteristics or attributes embodied in the value of such commodity itself.

The formal deviation of the hedonic price model is driven by Rosen (1974) from a market-determined approach. Briefly, Rosen's model can be described to demonstrate how people objectively evaluate the price of the products in which some attributes embodied by consumers' perceptions, and both the producer and consumer's optimal behavior can be represented by this approach (Rosen, 1974; Wahl *et al.*, 1995).

Based on Rosen's approach, a market equilibrium hedonic price model is driven from the tangency point between the consumer's optimal bid curve and the producer's selling curve (Rosen, 1974). On the demand side of the market, consumers purchase one unit of *j*th commodities, which consists of *n* kind of attributes: $z_i = \{z_1, z_2, z_3, \dots, z_n\}$. Under this situation, the consumer's utility function is

$$f(x) = U\ (x, z_1, z_2, \dots z_n), i = 1, 2, \dots, n \tag{2.13}$$

where $x$ is all of the commodities. The budget constraint, which is

$$m = x + p(z) \tag{2.14}$$

where $m$ is the income, and $p(z)$ is the price of commodity which consists of various attributes. We take the first-order conditions to maximize consumer's utility subject to the budget constraint, and then yield the following equation:

$$\frac{\partial u/\partial z_i}{\partial u/\partial x} = \frac{\partial p}{\partial z_i}, i = 1, 2, \dots, n \tag{2.15}$$

The individual consumer achieves the optimal utility when the marginal rate of substitution between an attribute of commodity, $z_i$, and other meat consumed is equal to the marginal price of that attribute. In another words, the consumer will choose a unit of commodity with attributes at an optimal price in order to maximize the utility.

On the supply side of the market, the goal of meat suppliers or producers is to maximize their profits by producing the meat which contains component attributes $z_i = \{z_1, z_2, z_3, \dots, z_n\}$. Suppose the producer produces F units of commodity, and the costs of production are $c$(F, $z_i$). Therefore, the profit function is

$$\pi = Fp(z) - c(F, z_i) \tag{2.16}$$

and the commodity producer can have the maximal profits when holding the following condition:

$$\frac{\partial p}{\partial z_i} = \frac{\partial C/\partial z_i}{F}, i = 1, 2, \dots, n \tag{2.17}$$

In an equilibrium market, $\frac{\partial p}{\partial z_i} = \frac{\partial C/\partial z_i}{F} = \frac{\partial u/\partial z_i}{\partial u/\partial x}$, which indicates that both commodity producers and consumers could achieve the optimal behavior under the price of attributes $z_i$. Under this condition, the market equilibrium hedonic price model can be estimated through regress the equilibrium prices of commodities on their characteristics or attributes. A general hedonic model can be described in equation (2.18):

$$p_j = h(C_{ij}, D_i), j = 1, \dots, J, \text{and } i = 1, \dots, n \tag{2.18}$$

where $p_j$ is the price of $j$th commodity, $C_{ij}$ is a vector of the characteristics or attributes for $j$th commodity, and $D_i$ is the social demographic information of consumers.

# CHAPTER 3. ESTIMATING THE EFFECT OF FOOD SAFETY ON MEAT CONSUM PTION IN BEIJING, CHINA, USING A SML APPROACH

## Summary

Chapter 3 is an individual part which investigates the effect of food safety on meat consumption in Beijing, China. A nonlinear Almost Ideal Demand System is estimated with a simulated maximum likelihood (SML) and Reordered GHK (Geweke, Börsch-Supan and Hajivassiliou, Keane) simulator that deals with zero meat consumption in the survey. The key results suggest that food safety has a significant and positive influence on meat consumption. Meanwhile, the empirical results indicate changing demand of meat consumption in Beijing, China.

## Background

China's increasing wealth has contributed to a structural change in its food consumption (Gale and Huang, 2007). Since the market-oriented economic reforms in the late of 1970s, the average annual growth of China's economy has exceeded 8 percent. Over the last three decades, annual income in urban households increased from I,510 Yuan in 1990 to 6,278 Yuan in 2000 and reached 15,781 Yuan in 2008 (Figure 3.1). The rapid growth in income has prompted significant changes in food demand including a shift away from staple grains and starches toward animal proteins (meat and seafood) (Gould and Dong, 2004; Yen *et al.*, 2004; Gale and Huang, 2007). For example, per capita annual consumption by urban households of traditional staple foods (grains) fell from 130.72 kilograms in 1990 to 77.60 kilograms in 2007 as disposable income rose. Per

capita meat and seafood consumption increased from 32.85 kilograms in 1990 to 46 kilograms in 2007 (Figure 3.1).

With the considerable growth of income, consumption of meat and seafood has increased. Obviously, Chinese consumers are increasing the demand for food quality and safety. As a result, the demand for food with a safety guarantee has become an increasingly crucial component of the food purchase process (Hsu *et al.*, 2001). This is especially true in most of China's urban areas, which have been dramatically emerged and developed in recent decades. These changes in food demand for food quantity and quality (including safety) have important implications for China's agriculture and world food markets (Liu and Chern, 2004; Yen *et al.,* 2004).

However, increasingly affluent Chinese are not optimistic about food safety in China (Thompson and Ying, 2007). In recent years, many cases of food-related illness and death are frequently reported by the Chinese media, such as the blue-ear disease and the melamine-contaminated infant formula scandal. In 2008, the globally publicized melamine-contaminated baby formula scandal, which resulted in the death of six infants from kidney stones and other kidney damage, had put food safety issues in China at the center of criticize and become the top concern of Chinese consumers in recent years (China Daily, 2009).

The seemingly unstoppable food safety incidents have scared both domestic and international consumers for consuming food produced in China. Food safety incidents emerged in China as a trade issue in the early 2000s (Wang *et al.*, 2008). In the 1990s, China was a low-cost exporter of food products such as vegetables, apples, seafood, and poultry in the world's market (Calvin *et al.*, 2006). However, China's food exports

declined when shipments failed to meet stringent safety and quality standards in Europe, Japan, and other countries, because of excessive antibiotic and pesticide residues. The "Chinese pesticide contaminated dumpling incident" in Japan in 2008 caused distrust of Chinese food exports, and more than 75 percent of Japanese expressed that they would no longer purchase food that was imported from China (Ning, 2008). This incident now has a seriously negative impact on China's food export industry.

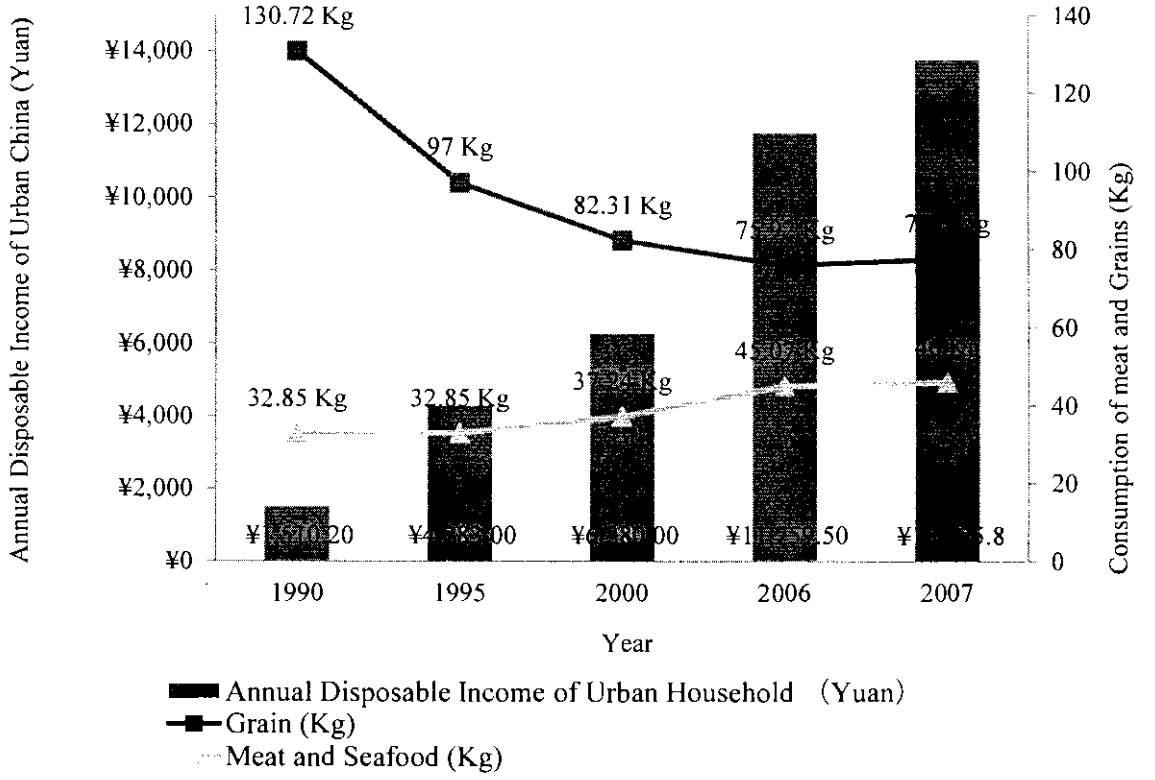


Figure 3.1 Consumption of Grain, Meat and Seafood, and Per Capita Annual Disposable Income of Urban Households in China

Note: meat include pork, beef, mutton, and poultry

Source: China Statistical Yearbook (2008), National Bureau of Statistics of China

More importantly, the frequently occurred food incidents have damaged Chinese consumers' confidence in domestic food products, even non-food products. According to the General Administration of Customs of China, imported baby formula has increased by

83 percent in 2010 compared with 2009 since the disclosure of the melamine-contaminated infant formula in 2008, and the price of imported milk powder also increased by approximately 34 percent. Food safety as a determinant of purchasing decision has become more important than ever for most Chinese households when they purchase food. Studies show that Chinese consumers are willing to pay at least a modest premium for food that meets safety standards or is free of dangerous contaminants (Gould, 2004; Calvin et al., 2006; Wang *et al.*, 2008). Obviously, Chinese consumers have been forced to change their food shopping and consumption behavior due to food safety worries. Then, a question is whether consumer's preference for food safety has impacts on their demand for meat products?

Many studies have done in literature, but answers to this question are mixed. For example, Flake and Patterson (1999) use USDA price and quantity data to estimate a Linear Approximate Almost Ideal Demand System model (LA/AIDS) to evaluate how information, disseminated through the media, on food safety issues related to beef has affected the demand for beef and other meats (poultry and pork). Their research is the first study incorporating a specific variable measuring health information as a measure on food safety. The results of this study indicate that beef safety information would provide a modest impact on beef consumption in the U.S. and that food safety concerns are dominated by the effects of increased health information on cholesterol. Piggott and Marsh (2004) construct food safety indices to investigate the relationship between publicized food safety concerns surrounding beef, pork, and poultry and meat consumption. They find that the adverse publicity concerning food safety has statistically important own- and cross-commodity impacts on demand for meat in the U.S. but the

average impact of these effects had been economically small over the last several decades. Several studies have also analyzed food safety demand in China. For example, Brown *et al.* (2002) discuss food safety and the development of the beef industry in China. They point out that, because household slaughtering and wet markets dominated beef processing and distribution in China, the willingness or capacity of Chinese consumers to pay the added cost of better inspection and other services to guarantee food safety are strong. Gale and Huang (2007) discuss the demand for food quantity and quality in China, and they find demand for food quantity diminishes as income rises. High-income consumers spend more on higher quality food which indicates an increasing attention on food safety in China. Wang *et al.* (2008) investigate the Chinese consumer awareness, willingness to pay, and price premiums for milk products manufactured using Hazard Analysis Critical Control Point (HACCP) management, which is a quality management system to reduce food safety risks. They report that HACCP is a major component of China's effort to improve food safety, but the analysis of their study indicates that most of Chinese consumers are not familiar with system. Yu and Abler (2009) estimate the determinants of changes in the quality of food demanded in rural China, and their econometric results state that households in rural China tend to consume higher quality food as income increases. However, none of these studies can directly measure the effects of consumer's preferences for food safety on meat demand specifically.

In this paper, we use a unique dataset collected from Beijing, China, to estimate a meat demand system. We particularly focus on assessing the effects of respondent's preferences for the safety of meat on their household meat demand. Five meats (pork, beef, poultry, mutton, and aquatic products) are considered in the analysis. In order to capture

the effects of health awareness and household composition on meat demand, respondent's education achievement and household size are incorporated in the system. To deal with zero consumption problems, we follow the suggestion of Hasan and Mittelhammer (2001), to estimate a Multivariate Tobit Model (MVT) as a nonlinear Almost Ideal Demand.

## Econometric Approach

Nonlinear AIDS model

Deaton and Muellbauer (1980) developed the Almost Ideal Demand System (AIDS) from the PIGLOG model, and the AIDS specification is a popular framework for estimating price and expenditure elasticities when expenditure or budget data are available (Halbrendt *et al.* 1994). The AIDS model represents a flexible complete demand system, and it does not require the additively of the utility function. It satisfies the axioms of choice exactly and under certain conditions, aggregates perfectly over consumers (Deaton and Muellbauer, 1980). A number of previous studies on China's household food demand have employed AIDS as the theoretical model (Chern and Wang, 1994; Fan *et al.*, 1994; Halbrendt *et al.*, 1994; Wu *et al.*, 1995; Gao *et al.*, 1996; Han and Wahl, 1998; Huang and Rozelle, 1998; Ma *et al.*, 2004; Gould and Villarreal, 2006; Jiang and Davis, 2007; Liu et al., 2009; Zhang and Henneberry, 2010). Thus, for the theoretical and practical considerations, the nonlinear form of AIDS model has been chosen for estimating the effects of food safety on meat consumption in urban China.

In a basic specification, the share equation for the AIDS model for consumer $i$ is defined as:

$$w_{ji} = \alpha_j + \sum_{k=1}^{M} \gamma_{jk} ln\, p_{ki} + \beta_j\, ln\left(\frac{y_i}{P_i}\right) + \varepsilon_{ji} \tag{3.1}$$

where

$w_{ji}$ = the budget share of meat $j$ chosen by household $i$

$y_i$ = the total expenditure by household $i$

$M$ = the total number of meat

$p_{ki}$ = the price of meat $k$ for household $i$

$P_i$ is a price index which can be expressed as:

$$ln\, P_i = \alpha_0 + \sum_{k=1}^{M} \alpha_k\ lnp_{ki} + \frac{1}{2} \sum_{j=1}^{M} \sum_{k=1}^{M} \gamma_{jk}\, lnp_{ji} lnp_{ki} \tag{3.2}$$

and $\alpha_j$ is defined such that it includes the socio-demographic variables effects in the model

$$\alpha_j = \delta_j + \sum_{r=1}^{R} \delta_{jr}\, d_r \tag{3.3}$$

$$j = 1, 2, \ldots, M$$

where $d_r$ is the socio-demographic variables with the total number of R, which measures the influence on the expenditure share of group $j$.

The adding up restriction must be imposed in the model in order to guarantee the sum of estimated budget shares equal to one. Incorporating the demographic variables in this manner ensures that the symmetry restriction is not violated (Ramezani *et al.*, 1995).

The adding up restriction for the AIDS model can be written as follows equation 3.4:

$$\sum_{j}^{n} a_j = 1; \quad \sum_{r=1}^{R} \delta_{jr} = 0; \quad \sum_{k=1}^{M} \gamma_{jk} = 0 \tag{3.4}$$

The homogeneous condition is

$$\sum_{j}^{n} \beta_j = 0 \tag{3.5}$$

and the symmetrical condition for the nonlinear AIDS model is $\gamma_{jk} = \gamma_{kj}$, for any $k \neq j$.

The expenditure elasticities and uncompensated price elasticities in the AIDS model are given by

$$\eta_j = 1 + \frac{\beta_j}{w_j} \tag{3.6}$$

$$e_{jk} = -\epsilon_{jk} + \frac{\gamma_{jk}}{w_j} - \frac{\beta_j w_k}{w_j} \tag{3.7}$$

The Multivariate Tobit Model (MVT)

Because the data used in this analysis are collected using household surveys, further discussed next, it is very common to observe zero values in consumptions. In empirical studies, zero consumption has important econometric and economic implications. The presence of zero consumption observations can be demonstrated as a positive probability that the choice happens at the kink or boundary points in choice sets of consumers (Lee and Pitt, 1986). Statistical estimation procedures that do not account for non-negative in the dependent variable could lead to biased and inconsistent parameter estimates. Excluding the observations with zero consumption does not mitigate the problem, but the sample selection bias will result (Lee and Pitt, 1987).

In order to solve the potential bias and inconsistency of non-negative parameters estimation, researchers commonly use some sort of corrections through estimation approach. Wales and Woodland (1983) first introduce the Kuhn-Tucker approach to estimate micro-level censored demand system. The Kuhn-Tucker approach derives demand (share) equations from maximizing an explicitly specified random utility function after incorporating non-negativity and budget constraints. But for some widely used demand systems such as the AIDS model, it is impossible to obtain an estimable empirical format accounting for non-negativity from utility functions (Dong and Kaiser, 2003). Heien and Wessells (1990) apply a two-step estimation procedure based on the Amemiya-Tobit approach to include all of the observations at both steps to estimate the equation. The Univariable Probit model is estimated for each equation in the demand system in the first stage, and in the second stage the inverse Mills Ratio is employed as an instrumented variable in a multivariable regression. However, statistical efficiency is compromised when the demand system is estimated with this procedure (Yen *et al.*, 2004). Therefore in this study, we follow Hasan and Mittelhanmmer (2001) and apply the Multivariate Tobit Model (MVT) to evaluate the data generating process under the demand system, which includes binding non-negative constraints, where both positive and zero consumption of meat are observed. At the same time, due to the Kuhn-Tucker conditions determining the set of non-consumed commodities (Lee and Pitt, 1986), the individual household's consumption for a given commodity is represented by $x = 0$ or $x > 0$. The probability distribution for $x > 0$ exhibits continuous components, whereas the probability distribution for $x = 0$ shows discrete components.

Based on Hasan and Mittelhanmmer's work, in this MVT approach, the quantity of consumption, denoted as $x_j$, with the latent variable $x_j^*$, can be represented as $x_j = \max\{0, x_j^*\}$. Because the price of good $j$, $p_j$ is positive, the share of consumption, $w_j = \frac{p_j x_j}{y}$, is also positive. So the observed shares of $w_j$ can be expressed as:

$$w_j = \max\{0, w_j^*\} = \max\{0, \frac{p_j x_j^*}{y}\} \tag{3.8}$$

where $w_j^*$ is a latent variable, which represents that a household purchase or consume this specific kind of meat. Thus, the original nonlinear AIDS model with the non-negative constraint can be demonstrated in the following:

$$w_{ji}^* = \alpha_j + \sum_{k=1}^{M} \gamma_{jk} ln\, p_{ki} + \beta_j\, ln\left(\frac{y_i}{P_i}\right) + \varepsilon_{ji} \tag{3.9}$$

The residual term $\varepsilon_{ji}$ in the above expenditure share function can account for the error from measurement and information about the consumers that is unobservable to the analyst, because this error is assumed to be independent from the consumer error (Hasan *et al.*, 2001a). If we assume that $\varepsilon \sim N(0, \sum)$ and $\sum = \begin{bmatrix} \sigma_{11} & \cdots & \sigma_{1M} \\ \vdots & \ddots & \vdots \\ \sigma_{M1} & \cdots & \sigma_{MM} \end{bmatrix}$, where $\sum$ is a [$M$ x $M$] error variance and covariance matrix. Thus, the MVT format for AIDS model can be represented as the following form:

$$w_{ji} = \begin{cases} w_{ji}^* & if\ w_{ji}^* > 0 \\ 0 & otherwise \end{cases} \tag{3.10}$$

The equation (3.9) can be rewritten as

$$w_i^* = \mu + \varepsilon \tag{3.11}$$

where $\varepsilon \sim N(0, \sum)$ and $w_i^* \sim N(\mu, \sum)$.

Furthermore, equation (3.11) can be converted into the following format:

$$w_i^* = \begin{matrix} w_{1i}^* \\ w_{2i}^* \\ . \\ . \\ w_{Mi}^* \end{matrix}, \quad \mu_i = \begin{matrix} \mu_{1i} \\ \mu_{2i} \\ . \\ . \\ \mu_{Mi} \end{matrix} \quad \text{and } \mu_{ji} = \alpha_j + \sum_{k=1}^{M} \gamma_{jk} ln\, p_{ki} + \beta_j\, ln\left(\frac{y_i}{P_i}\right) \quad (3.12)$$

For every single household observation $i$ of M meats, the latent variable $w_i^*$ can be divided in

$$w_i^* = \begin{vmatrix} w_{id}^* \\ \dots \\ w_{ic}^* \end{vmatrix} = \begin{vmatrix} \mu_{id} \\ \dots \\ \mu_{ic} \end{vmatrix} + \begin{vmatrix} \varepsilon_{id} \\ \dots \\ \varepsilon_{ic} \end{vmatrix} \quad (3.13)$$

where $w_{id}^*$ represents the latent variable, which is associated with discrete shares of $w_i$. In other words, $w_{id}^*$ implies the zero consumption for a single household observation. And $w_{ic}^*$ is the continuous element of $w_i$, which represents the positive shares of meat consumptions. The vectors $\mu_{id}$ and $\mu_{ic}$ denote the mean vector of the latent elements, which are associated with discontinuous and continuous parts, respectively. The covariance matrix of error terms is a block form which is

$$\Sigma = \begin{bmatrix} \Sigma_{dd} & \Sigma_{dc} \\ \Sigma_{cd} & \Sigma_{cc} \end{bmatrix} \quad (3.14)$$

So the joint probability density function (PDF) of $w_{id}$ and $w_{ic}$ are equal to

$$P\,(w_{id}, w_{ic};\, \mu_i, \Sigma) = P\,(w_{ic};\, \mu_{ic}, \Sigma_c) \times P(\, w_{id} \mid w_{ic}\, ;\, \mu_i, \Sigma) \quad (3.15)$$

where $P\,(w_{ic};\, \mu_{ic}, \Sigma_c)$ is the probability density function for the continuous variables, and $P(\, w_{id} \mid w_{ic}\, ;\, \mu_i, \Sigma)$ is the conditional probability of the continuous variables $w_{ic}$. Therefore, the general form of likelihood function for the demand system of $i$th household observation will be

$$\ell(w_{id}, w_{ic};\, \mu_i, \Sigma) = \ell_c(w_{ic};\, \mu_{ic}, \Sigma_c) \times \ell_{d|c}(\, w_{id} \mid w_{ic}\, ;\, \mu_i, \Sigma) \quad (3.16)$$

After taking the log form of the likelihood function in (14), we can obtain

$$Ln\, \ell(w_{id}, w_{ic};\, \mu_i, \Sigma) = ln\, \ell_c(w_{ic};\, \mu_{ic}, \Sigma_c) + ln\, \ell_{d|c}(\, w_{id} \mid w_{ic}\, ;\, \mu_i, \Sigma) \quad (3.17)$$

where

$$ln\,\ell_c = -\frac{1}{2}M_c ln(2\pi) - \frac{1}{2}ln(|\sum_c|) - \frac{1}{2}(w_{ic} - \mu_{ic})'\sum_c^{-1}(w_{ic} - \mu_{ic}) \qquad (3.18)$$

and

$$ln\,\ell_{d|c} = Ln\left(\int_{-\infty}^{-\mu_{id|c},M_d} \cdots \int_{-\infty}^{-\mu_{id|c},1} \frac{1}{(2\pi)^{0.5M_d}|\sum_{d|c}|^{\frac{1}{2}}} exp\left[-\frac{1}{2}(u-\mu_{id|c})'\sum_{d|c}^{-1}(u-\mu_{id|c})du\right]\right) \qquad (3.19)$$

.

## The Survey and Data

The Survey

To improve the specific and reliable household census data about meat consumption and food safety issues, a survey in Beijing is jointly conducted by the Center for Chinese Agricultural Policy (CCAP) at the Chinese Academy of Sciences, and the Beijing Branch of National Bureau of Statistics of China (NBSC). Because of the absence, the data used in this study are collected in Beijing in July 2007, from households which are a sub-set of the panel used for the Urban Household Income and Expenditure (UHIE) survey conducted by the NBSC. In this study, the households are selected from four districts (Chaoyang, Haidian, Fengtai, and Dongcheng) using random sampling approaches (Bai *et al.*, 2010). 100, 100, 60 and 60 households are randomly selected as the sample of observations, respectively. The total number of useful household observations is 315.

Overall, this survey includes two parts. The first includes socioeconomic and demographic information, which are collected in face-to-face interviews by enumerators. The second part includes food consumption information collected using a diary record

method in which the selected households are asked to record the expenditures and consumption of food every day in a week (Bai *et al.*, 2010). In this part, enumerators select the person who is familiar with the household's food consumption to record food consumption information for a week to provide detailed information on all food purchasing behavior for the household including weekly meat expenditures and meat consumption.

In order to evaluate the effects of food safety issues on meat consumption, the respondents are asked to rank from 1 to 5 (1 least, 5 most) the importance of food safety on fresh meat purchasing decisions. Estimating the effects of food safety issues on meat purchasing decisions and consumption is an important goal in our analysis.

The Data

In order to economize the parameters in the nonlinear AIDS model, selecting and describing the socio-demographic variables are important issues for the empirical study. The three demographic variables selected are the importance of food safety (Safety), the head of household's educational level (Edu), and household size (HHsize). In the model, food safety, education, and household reflect the influences of changing consumption and preferences of meat in Beijing, China (Table 3.1).

Head of household is included because higher levels of education can be associated with a better awareness of healthy and nutritional information. For meat consumption, households may prefer meats which contain less fat and calories such as chicken and fish. Household size is related to the number of children in a family, which can also account for how notable the impact would be on the consumption of a particular meat.

Table 3.1 Description of Socio-demographic Variables

| Variable | Definition |
|---|---|
| Safety | = 1 if the head of household ranked food safety issue as an important factor for the meat purchasing (the score above 3 is considered as an important factor)<br>= 0 otherwise |
| Education | = 1 if the educational level of the head of household is above junior high school<br>= 0 otherwise |
| Household Size | Household size (number of individuals) |

We estimate the nonlinear AIDS model with the following meat categories: beef, pork, poultry, mutton, and aquatic products. The proportions of consuming households are only high for pork (93.66 percent) and aquatic products (84.51 percent). The proportions of the rest of the meat categories are less than 70 percent, as shown in table 3.2, which is 44.37 percent for beef, 65.14 percent for poultry, and 23.24 percent for mutton.

Table 3.2 The Proportions of Households Consuming Each Meat

| Meat | Beef | Pork | Poultry | Mutton | Aquatic Products |
|---|---|---|---|---|---|
| Percentage | 44.37% | 93.66% | 65.14% | 23.24% | 84.51% |

Before estimation, extremely low or high price outliers are detected and deleted for accuracy and unbiased estimates using the Studentized Residual Test in SPSS with a criterion number of three. After deleting the outliers, 284 observations are used to estimate the final model.

Since the survey recorded the daily prices of meat items for a week and includes instances of zero consumption, the weighted average prices of meat categories are calculated for the week. The average price is used as the price of meat for households which did not consume meat in the survey period. The sample statistics for the prices, quantities and demographic variables are present in table 3.3.

## Estimation Procedure

In this study, maximum likelihood (ML) estimation cannot be applied in the model because the estimation of the parameters of the demand system would involve an integration problem at each iteration of a likelihood maximization algorithm (Hasan *et al.*, 2001a). Although this method is unbiased, consistent and fast in two or three dimensions, the estimation speed and accuracy will decrease when the dimension of integration increases (Hasan and Mittelhammer, 2001b).

Table 3.3 Sample Statistics

| Variables | Mean | Std.dev | Min | Max |
|---|---|---|---|---|
| Prices of meat categories | | | | |
| (Yuan per gram) | | | | |
| Price of Beef | 0.032 | 0.009 | 0.01 | 0.089 |
| Price of Pork | 0.024 | 0.005 | 0.009 | 0.048 |
| Price of Poultry | 0.024 | 0.009 | 0.002 | 0.083 |
| Price of Mutton | 0.027 | 0.004 | 0.001 | 0.061 |
| Price of Aquatic products | 0.022 | 0.012 | 0.002 | 0.120 |
| Quantities (gram per household) | | | | |
| Quantity of Beef | 379.543 | 656.04 | 0 | 3980 |
| Quantity of Pork | 1191.306 | 979.523 | 0 | 6030.234 |
| Quantity of Poultry | 602.165 | 655.956 | 0 | 4300 |
| Quantity of Mutton | 149.824 | 380.434 | 0 | 3000 |
| Quantity of Aquatic Products | 1046.109 | 965.116 | 0 | 6000 |
| Socio-demographic variables | | | | |
| Safety | 0.859 | 0.384 | 0 | 1 |
| EDU | 0.782 | 0.414 | 0 | 1 |
| HHSIZE | 3 | 0.64 | 2 | 6 |

The parameters of the nonlinear AIDS model associated with MVT model are estimated using the Simulated Maximum Likelihood (SML) procedure. The advantages of the SML approach are simplicity, speed in censored demand systems and superior small samples properties (Hajivassiliou and Ruud, 1994). In previous literature, a GHK simulator (Geweke, Börsch-Supan and Hajivassiliou, Keane) has been employed for SML estimation studies (Cheng and Cosslett, 1998; Yen *et al.*, 2003; Dong *et al.*, 2004). For a small number of households having zero expenditure, estimation is slow using conventional methods. The GHK simulator can provide accurate simulation results when compared with other simulators, but with a higher variance. Hasan and Mittelhammer (2001a) suggest a reordered GHK simulator (ORDGHK) based on the concepts of reordering and reflection of integration (Hasan and Mittelhammer, 2001a). Implementing ORDGHK will decrease the variance of the GHK simulators and therefore reduce the bias and inefficiency of SML estimations.

At the same time, since the existence of adding up restrictions in the AIDS model and the summing of all meat expenditure shares to one, a demand system composed of five individual expenditure share equation would be singular matrix (Heien and Wessells, 1990; Liu *et al.*, 2009). Therefore, the expenditure share equation for aquatic products was not included in the estimation due to singularity.

## Estimation Results and Discussion

All the results of parameter estimates and socio-demographic variables are based on SML using ORDGHK for the meat categories of beef, pork, poultry and mutton. Most of the parameter estimates are significant at the 1 percent confidence level (Table 3.4).

Table 3.4 also presents the parameter estimates of socio-demographic variables, and it indicates that the model works well for explaining meat consumption behavior and the effects of food safety on the consumption of meat in Beijing, China. Most of the parameters are statistically significant and have the expected signs. The coefficients of safety on beef, pork, and mutton have positive signs, and they are both statistically significant at 95 percent confidence interval, which indicates that the food safety variable has positive and statistically significant effects on beef, pork, and mutton. In other words, the safer they are perceived to be, the more beef, pork and mutton that consumers are willing to consume. This result also indirectly reflects the tendency that modern and standardized slaughterhouses can provide safe and well-packaged meat, which will take the place of traditional household slaughtering or slaughtering in wet markets in China. The effects of food safety on meat consumption suggest that food safety is an important concern for Chinese consumers in purchasing decisions. The coefficients of household educational levels associated with beef and poultry are positive and statistically significant, but the sign for pork is negative. These results suggest that well educated consumers may choose to consume meat which contains less fat and calories and more protein (beef [2] and poultry). The educational level of household head is a significant factor which can affect meat consumption in Beijing, China. The signs of coefficients of household size on beef and pork are positive and negative, respectively, which indicates that a family with a child or children will consume more beef rather than pork. The reason may be because of the "one couple, one child" policy in China and the child is the center of every family. The parents may choose to purchase beef, considering the benefits for children's nutrition and health.

[2] Traditionally, Chinese consumers consider that beef is leaner and contains less fat than pork.

Table 3.4 Parameter Estimates of MVT Demand System for the Meat Items

| | Beef | Pork | Poultry | Mutton | AP |
|---|---|---|---|---|---|
| $\alpha$ | -0.6307*** | -0.1728*** | 0.1102*** | -0.9722*** | 2.6665 |
| | (0.0665) | (0.0298) | (0.0341) | (0.3511) | NA |
| $\beta$ | 0.1849*** | -0.0572*** | -0.0157*** | 0.1503*** | -0.2623 |
| | (0.0075) | (0.0022) | (0.0022) | (0.0245) | NA |
| $\gamma_1$ | -0.1035*** | 0.1636*** | -0.0138** | -0.2350*** | 0.1887 |
| | (0.0080) | (0.0059) | (0.0038) | (0.0102) | NA |
| $\gamma_2$ | 0.1636*** | 0.1822*** | -0.1572*** | -0.0302*** | -0.1584 |
| | (0.0059) | (0.0051) | (0.0023) | (0.0078) | NA |
| $\gamma_3$ | -0.0138** | -0.1572*** | 0.1761*** | -0.0008 | -0.0043 |
| | (0.0056) | (0.0029) | (0.0032) | (0.0052) | NA |
| $\gamma_4$ | -0.2350*** | -0.0302*** | -0.0008 | -0.0751 | 0.3411 |
| | (0.0102) | (0.0078) | (0.0052) | (0.0502) | NA |
| $\gamma_5$ | 0.1887 | -0.1584 | -0.0043 | 0.3411 | -0.3673 |
| | NA | NA | NA | NA | NA |
| Safety | 0.1677*** | 0.6793*** | 0.0156 | 0.4385** | -1.3012 |
| | (0.0357) | (0.0065) | (0.0082) | (0.1214) | NA |
| Education | 0.1413*** | -0.0888*** | 0.0454*** | -0.0149 | -0.0830 |
| | (0.0072) | (0.0029) | (0.0026) | (0.0328) | NA |
| Household size | 0.0437*** | -0.0148*** | 0.0049 | 0.0038 | -0.0376 |
| | (0.0061) | (0.0041) | (0.0049) | (0.0299) | NA |

Note: 1. AP is aquatic products, including fish, shrimp and other seafood
2. The expenditure share equations of aquatic products did not include in the estimation.
3. The standard errors are in parentheses.
4. * significant at the 10% level; ** at 5% level; *** at 1% level.
5. NA indicates not available

Demand Elasticities

Marshallian price elasticities and expenditure elasticities are reported in table 3.5. All of the own-price and expenditure elasticities have appropriate signs. The own-price

elasticities for beef, pork, poultry, mutton and aquatic products are in a range of – 1.18 to – 0. 37. And the expenditure elasticities for these meat categories range from 1.79 to 0.75. In terms of own-price elasticities, the demand for pork, poultry as well as mutton are price inelastic. The elasticity of pork is – 0.496, which suggests that the majority of Chinese consumers still intend to keep eating pork as the main meat item. The own-price elasticities for beef and aquatic products are above – 1, which indicates that the demand for beef and aquatic products are more sensitive to prices. But, considering the health and nutrition of children, families with children still have an increasing consumption of beef. This also reflects the changing consumption of meat demand in urban China. In terms of expenditure elasticities, the expenditure elasticity for beef is about 1.79, which is consistent with previous studies that urban Chinese people will spend more money on beef consumption as their income increases (Gale and Huang, 2007).

Table 3.5 Marshallian Price and Expenditure Elasticities

| Variables | Price elasticities | | | | | Expenditure Elasticity |
|---|---|---|---|---|---|---|
| | Beef | Pork | Poultry | Mutton | Aquatic Products | |
| Beef | -1.1851 | 0.3861 | -0.2061 | -0.4888 | -0.2719 | 1.7955 |
| Pork | | -0.4962 | -0.3626 | -0.1660 | -0.1973 | 0.8619 |
| Poultry | | | -0.3708 | -0.0398 | 0.0619 | 0.9449 |
| Mutton | | | | -0.9204 | 0.4012 | 1.4989 |
| Aquatic Products | | | | | -1.0001 | 0.7516 |

Comparison of Elasticities to Previous Studies

Comparisons of own-price and expenditure elasticities to previous studies are presented in table 3.6. The own-price elasticities of all meat items in this study are considerably below the elasticities reported by Liu *et al.* (2009). However, the own-price elasticity of pork is – 0.502, which is not significantly different from the elasticities from

the studies of Ma *et al.* (2004), and Gould and Dong (2004). The own-price elasticity for poultry is below all of the previous studies in the table, and it may be that poultry is not a price sensitive meat for the consumers in Beijing compared with other provinces in China in the other studies. In terms of expenditure elasticities, our results for beef and mutton are above those reported by the previous studies. The reason may be that our study is based on a recent household survey in Beijing, where is the capital and a well developed city in China. But these other studies are based on the earlier time periods or the regional data from other places. The expenditure elasticity for aquatic products is below the other studies, and this may be due to the aggregation of fish, shrimp, and other seafood together as the category of aquatic products.

## Conclusion

The impacts of food safety on meat consumption are analyzed in the current study using households survey data collected from Beijing in 2007. Five meat categories expenditure share equations as well as three demographic variables are estimated with a nonlinear AIDS model. Following the suggestion of Hasan and Mittelhammer (2010), the Multivariable Tobit Model (MVT) is applied in the demand system to deal with the existence of zero consumption among the households, as ignoring or deleting the zero consumption may cause bias and inconsistent estimation. In addition, for the speed, unbiased and consistent estimation, a Simulated Maximum Likelihood (SML) approach and an ORDGHK simulator are used in the estimation procedure.

The key results of the current study indicate that food safety is an important determinant for the meat consumption in urban China. Food safety has positive and statistically significant effects on the consumption of beef, pork, and mutton (Table 3.4),

which suggests that the urban Chinese consumers are willing to increase their meat consumption if the meat items are safer. The increasing demand for safer and well-packaged meat may boost the development of the standardized meat production industry and the imports from other countries such as the U.S., Australia, and Argentina.

Table 3.6 Comparison with Other Relevant Studies

| Meat Items | Current Study | Liu *et al.* (2009) | Yen *et al.* (2004) | Ma *et al.* (2004) | Gould and Dong (2004) |
|---|---|---|---|---|---|
| Own-price Elasticites | | | | | |
| Beef | -1.19 | -1.75 | -0.96 | -0.0996 | -0.968 |
| Pork | -0.50 | -1.00 | -0.21 | -0.4439 | -0.579 |
| Poultry | -0.37 | -1.55 | -0.75 | -0.824 | -0.876 |
| Mutton | -0.92 | -2.00 | | 0.0547 | |
| Aquatic products | -1.00 | -1.16 | -0.37 | | -0.608 |
| Expenditure Elasticities | | | | | |
| Beef | 1.79 | 1.34 | 1.41 | 1.41 | 1.142 |
| Pork | 0.86 | 0.77 | 0.94 | 0.66 | 1.277 |
| Poultry | 0.94 | 0.90 | 1.26 | 1.41 | 1.13 |
| Mutton | 1.50 | 1.38 | | 1.25 | |
| Aquatic Products | 0.75 | 1.21 | 1.41 | | 0.977 |

Note: Liu *et al.* (2009) is based on a cross section data of 5 provinces in 2005. Yen *et al.*(2004) is based on the 2000 Urban Household Survey Data of 29 provinces. Ma *et al.* (2004) is based on time-series and cross-section data of 28 provinces of 1990s. Gould and Dong (2004) is based on the data of 2001.

There are significantly differences in meat consumption preferences among consumers with different educational levels and household sizes. The results suggest that well educated consumers will likely consume more beef than pork, and the consumption of pork also decreases in a larger family. The own-price and expenditure elasticities for all the meat items have the expected signs in the current study. All of these represent a continuing increase and shifting preferences in consumption of meat in China.

# CHAPTER 4. ASSESSING THE VALUE OF QUALITY-RELATED ATTRIBUTES: A HEDONIC ANALYSIS OF MEAT PRICE IN BEIJING, CHINA


## Summary

The market for meat in China is quite diversified and potentially the largest in the world. Understanding how meat prices are related to quality in Beijing, China will provide a guidance for industry and policymakers interested in the Chinese meat market. In this chapter, the implicit prices of meat with the quality-related attributes from both supply and demand sides are investigated using a hedonic price model. Five meat categories are regressed on several attributes or characteristics derived from supply and demand using household survey data collected in Beijing in 2007.

The key results in the current analysis indicate that quality-related attributes or characteristics such as meat appearance, supermarket, meat brand, and semi-processed meat as well as demographic variables such as household head's income, have a significantly positive influence on the price of meat, which suggest that the consumers in Beijing are willing to pay a price premium to guarantee the quality and safety of meat. In addition, the household wives' educational levels and number of children also affect the implicit value of meat.


## Introduction and Background

China's increasingly affluent consumers have contributed to a structural change in its food consumption and an escalating demand for high quality of food over the last decade (Gale and Huang, 2007; Yu and Abler, 2009). For example, per capita annual consumption by urban households of traditional staple foods (grains) fell from 130.72

kilograms in 1990 to 77.60 kilograms in 2007 as disposable income rose. Per capita meat and seafood consumption increased from 32.85 kilograms in 1990 to 46 kilograms in 2007 (China Statistical Yearbook, 2008). High income Chinese consumers place more emphasis on the quality of food rather than price in their purchasing decision (Gale and Huang, 2007). However, recent the food quality crisis in China which includes incidents such as the blue-ear disease and the melamine-contaminated infant formula scandal, have raised the tremendous concerns about the quality of food in the Chinese market. Faced with food quality issues, more and more Chinese consumers are willing to pay at least a modest premium for food that meets the high quality standard or is free of dangerous contaminants (Gould, 2004; Calvin *et al.*, 2006; Wang *et al.*, 2008).

Theoretically, product quality can be described as a bundle of attributes (characteristics) that determine the product's performance (Caswell and Mojduszka, 1996). According to Caswell and Mojduszka, major categories of food product quality attributes, which can be regarded as having a demand and a supply that interact to determine a market clearing price, and include the effect of food safety, nutrition, value, packaging, and brand attributes. Consumers choose foods with high quality in order to maximize expected utility. Sometimes, information on food quality for consumers is featured in the media or delivered by a certain groups such as health care professionals, the government, consumer groups, or food processors (Caswell and Joseph, 2007). High income urban Chinese consumers have an inelastic demand for quantity for most foods, but food quality rises with the growth of income (Gale and Huang, 2007). Thus, the impact of consumers' demand for high quality food must be considered in terms of the food industry development and market segment.

Frequently, in asymmetric information markets, the information for food quality is not perfect. The most imperfect situations are that sellers are better informed about quality than consumers (Caswell and Mojduszka, 1996). Under this condition, consumers have to rely on certain quality-indicators and cues to access the quality of food products such as intrinsic and the extrinsic attributes or characteristics (Gao and Schroeder, 2009; Zhang *et al.*, 2010). These attributes can be presented from either the supply or demand side. In general, the supply side attributes are associated with the actual product itself during the production and distribution whereas the demand side attributes in relate to promotional and informational characteristics of the product which are perceptible for consumers (Loureiro and McCluskey, 2000; Parcell and Schroeder, 2007). Examples of demand attributes in the meat category include meat appearance, brand and certification. Traditionally, such attributes are the main criteria for Chinese consumers to evaluate the quality of food during their purchasing behaviors. But in an asymmetric information market, these kinds of attributes may fail in consumer's assessment of meat quality and safety (Zhang *et al.*, 2010). Therefore, consumers have to depend on other attributes or cues from the supply side such as purchase venue and processed form to determine the quality of the meat they purchase.

Consumers have become more discriminating in their food purchasing decisions over the past decades (Barkema, 1993). For instance, a sizable portion of consumers in Beijing are likely to consume foods which carry safety certification logos, such as the label of "Green Food" or "Organic Food" (Wang et al., 2008). Currently, China has been in place a domestic certification system of food quality and safety standards.

Sometimes, retail price reflects the qualities embodied in a commodity, which suggests that products with satisfactory quality-related attributes or cues may have a relatively high price to indicate their high quality. Consumers may purchase foods with different attributes or characteristics at different prices, based on their needs and income level (Harris, 1997). However, research examining how consumers in Beijing value these quality-related attributes embodied in meat category as the quality indicators is still unknown. In this paper, a theoretical model is developed to investigate how the quality-related attributes from both demand and supply sides affect the retail price of meat in Beijing. The parameters of this model are then econometrically estimated. These estimates will be of great interest to policy makers and the meat industry not only in China, but also for other meat export countries such as the U.S., Australia, and Argentina.

Previous empirical studies that estimate the added value of quality-related attributes of individual products provided guidance for this paper. For example, Wahl *et al.* (1995) following Rosen's approach apply hedonic price analysis to estimate Wagyu beef characteristics using Japanese Wagyu auction data. They find that beef characteristics, especially marbling, have significant effects on the prices paid at auction for Wagyu beef carcasses. Carcass price is also influenced by several measured characteristics, such as rib-eye size and meat firmness and texture. Wahl *et al.*'s analysis concludes that knowledge of the implicit values of Wagyu carcass characteristics enable U.S. beef producers and exporters to complete with Japanese producers more efficiently. Another hedonic price analysis conducted by Melton *et al.* (1996), also uses auction data to evaluate consumer perceptions, willingness-to-pay, and attribute values for fresh pork chops, which include the color, marbling and size. Their results confirm that consumers

can distinguish the subtle differences in embodied attributes of fresh pork and are able to value these differences across presentation formats. Loureiro and McCluskey (2000) analyze the effect of "protected geographical indications" (PGI) labels on the purchase of fresh meat in Spain. Their results suggest that consumers are likely to pay premiums for labeled products, but intrinsic variables, such as fat content and color, are not important factors in determining retail price. Roheim *et al.* (2007) estimate a hedonic pricing model on retail data from frozen seafood in the UK market. Their results show that species, branding, process form, package size, and product form can add the value to seafood, and seafood producers could segment the product in reaching the different target markets. In addition, Gao and Schroeder (2009) estimate the marginal effects of additional label information on consumer willingness-to-pay (WTP) for food quality attributes. Their results show that consumer WTP for a cue attributes such as Certified U.S. Product tends to be affected more than independent attributes. As additional information on food attributes provided, consumer WTP changes significantly.

We begin this paper with the hedonic technique which includes quality-related attributes or cues as well as demographic variables as the independent variables, following Rosen's (1974) theoretical framework. In order to statistically estimate the implicit value of meat's attributes in the sides of demand and supply which are associated with quality, we use the data from an urban Beijing survey, which was collected in 2007 by the Center for Chinese Agricultural Policy (CCAP) at the Chinese Academy of Sciences. The results of estimating the hedonic price model include the coefficients and marginal effects, which are then presented and discussed. In a final section of the paper, we provide conclusions and implications for this study.

## Empirical Method

Empirical work on quality of products is mostly based on a procedures referred to as the hedonic technique and this is usually justified in terms of household production theory (Deaton and Muellbauer, 1980). Economic hedonic price analysis has been widely used to analyze consumers' implicit valuation of the attributes or characteristics of food products (Morgan et al., 1979; Brester *et al.*, 1993; Wahl *et al.*, 1995; Melton *et al.*, 1996; Harris 1997; Loureiro and McCluskey, 2000; Maguire *et al.*, 2004; Parcell and Schroeder, 2007; Roheim *et al.* 2007; Wang *et al.*, 2008; Minten and Reardon, 2008). The reason is that hedonic framework allows the estimation for the price of food characteristics, which are different from the other food characteristics. And the products of food's attributes or characteristics can be either intrinsic or extrinsic (Parcell and Schroeder, 2007). The formal deviation of the hedonic price model are driven by Rosen (1974) from a market-determined approach. Briefly, Rosen's model can be described to demonstrate how people objectively evaluate the price of the products in which some attributes embodied by consumers' perceptions (Rosen, 1974; Wahl *et al.*, 1995). In practice, both the producer and consumer's optimal behavior can be represented by this approach (Maguire *et al.*, 2004).

Following Rosen's approach, a market equilibrium hedonic price model is driven from the tangency point between the consumer's optimal bid curve and the producer's selling curve (Rosen, 1974). In the demand side of the market, the Beijing consumers in our case purchase one unit of *j*th meat, which includes beef, pork, lamb, poultry and other meat in our case. The meat consists of *n* kind of attributes: $z_i = \{z_1, z_2, z_3, \ldots, z_n\}$. These attributes contains the attributes in the demand side (i.e., meat's appearance, brand and

certificate) and the attributes in the supply side (i.e., processed form, purchasing venues). The consumer's utility function is

$$f(x) = U\ (x, z_1, z_2, \dots z_n), i = 1, 2, \dots, n \tag{4.1}$$

where $x$ is all other meat consumed. The budget constraint, which is

$$m = x + p(z) \tag{4.2}$$

where $m$ is the income, and $p(z)$ is the price of meat which consists of the attributes. We take the first-order conditions to maximize consumer's utility subject to the budget constraint, and then yield the following equation:

$$\frac{\partial u/\partial z_i}{\partial u/\partial x} = \frac{\partial p}{\partial z_i}, i = 1, 2, \dots, n \tag{4.3}$$

The individual consumer achieves the optimal utility when the marginal rate of substitution between an attribute of meat, $z_i$, and other meat consumed is equal to the marginal price of that attribute. In another words, consumers will choose a unit of meat with some embodied attributes at an optimal price which could maximize their utility.

In the supply side of the market, the goal of meat suppliers or producers is to maximize their profits by producing the meat which contains component attributes $z_i = \{z_1, z_2, z_3, \dots, z_n\}$. Suppose the meat producer produce F units of meat and the costs of production are $c$(F, $z_i$). Therefore, the profit function is

$$\pi = Fp(z) - c(F, z_i). \tag{4.4}$$

And the meat producer can have the maximized profits when holding the following condition:

$$\frac{\partial p}{\partial z_i} = \frac{\partial C/\partial z_i}{F}, i = 1, 2, \dots, n \tag{4.5}$$

In an equilibrium market, $\frac{\partial p}{\partial z_i} = \frac{\partial C/\partial z_i}{F} = \frac{\partial u/\partial z_i}{\partial u/\partial x}$, which indicates that both meat producers and consumers could achieve the optimal behavior under the price of attributes $z_i$. Under this condition, the market equilibrium hedonic price model can be estimated by regressing the equilibrium prices of meat on some quality-related attributes in both supply and demand of meat itself. A general hedonic model for meat in our study can be described in equation 4.6.

$$p_j = h(S_{ij}, D_{ij}, E_i), j = 1, \dots, J, \text{and } i = 1, \dots, n \tag{4.6}$$

where $p_j$ is the price of $j$th kind of meat, such as beef, $S_{ij}$ is a vector of quality-related attributes in the supply side for $j$th meat (i.e. processed form and purchasing venue), and $D_{ij}$ is a vector of attributes embodied in the demand side for the meat (i.e. meat appearance, certificate and etc.), and $E_i$ is the economic and social demographic information of Beijing consumers, such as household income, number of children.

The marginal effects directly measure how the market price responds to a finite change in the product attributes (Wahl *et al.*, 1995). The marginal effects, which respect to particular characteristics $z_i$, can be expressed as

$$\text{ME} = p^* - p = exp\left(\sum_{j=1} \beta_j z_j + \beta_i(1 + \alpha_i z_i)\right) - p \tag{4.7}$$

if $z_i$ is a continuous variable, and

$$\text{ME} = exp(\beta_0)\,(exp(\beta_i) - 1) \tag{4.8}$$

if $z_i$ is a dummy variables. Where $\beta_i$ are the parameters and $\alpha_i$ is the percentage change in $z_i$, which is $\alpha_i = \Delta z_i / z_i$. We set $\alpha_i = 10$ percent in our case. And $p^*$ is the new price level due to the change of product characteristics

## Data and Sampling Description

The data we use in this study are collected from a survey administered in Beijing using a statistical random sample of the panel used for the Urban Household Income and Expenditure (UHIE) survey. The survey data specifically for this study are collected by interviewing the person most familiar with the food shopping and food consumption in each randomly selected household (Zhang *et al.* 2010). In this study, 100, 100, 60 and 60 households are randomly selected from four districts (Chaoyang, Haidian, Fengtai, and Dongcheng), respectively. The survey results in 315 useful household observations with 1429 recorded observations of meat consumption over the 7 days and up to 3 meals per day per household member. The meat consumption records include 738, 167, 54, 210, and 260 observations of pork, beef, lamb, poultry, and other meats, respectively

This survey includes two parts. The first includes socioeconomic and demographic information, which is collected in face-to-face interviews by enumerators. The second part includes food consumption information collected using a diary record method in which the selected households are asked to record the quantity, price, and the purchase venue of meat they consumed for every meal in a week. The individual household is also asked to rank the importance of five factors from 1 to 5 (1 least, 5 most) to determine food safety, which is an important indicator for meat quality. These five factors are certification, brand, purchase venue, price, and appearance.

In previous empirical analysis, researchers used unit values for price, which can be obtained by dividing expenditures by the quantity consumed, instead of actual price data (Gould and Dong, 2004; Ma *et al.*, 2004; Gale and Huang, 2007; Yu and Abler, 2009). But relying on unit values can bias empirical analysis because they are not exogenous

market prices (Yu and Abler, 2009), and the effects of non-quality related factors cannot be separated from price effects in most cases. According to Yu and Abler (2009), the income elasticity is likely to be biased upward, while the absolute value of the own price elasticity will be biased upward for a normal good and downward for an inferior good, if unit values are used. In this case, our survey provides an ideal dataset, which contains information on the actual prices of meat which eliminates the problem by using unit values as prices.

Selecting and describing the quality-related attributes of demand and supply about meat is an important issue to economize the parameters in the hedonic meat price function. Table 4.1 presents the description of variables for several attributes in both supply and demand side and household demographics. In reality, meat and meat products are sold in almost every outlet in Beijing. These outlets vary from supermarkets and convenience stores to wet markets, and even the small vendors. Different purchase venues can reflect consumer's purchase behavior as well as added-value aspects provided by each venue. Thus, different types of venues were included as a quality related attribute in supply side which may influence meat prices.

The Chinese government and other related authorities have invested large amounts of social, economic, and political resources to develop and implement quality or safety-related certification programs for food including certifications as "Quality Safety (QS)" and "Green Food" (Zhang *et al.*, 2010). The certification logos and brands on meat and meat products are other indicators to consumers in their evaluation of meat quality. Household income is a significant determinant for the demand or willingness to pay for high quality food in the previous studies. For example, Gale and Huang (2007) point out

that the Chinese consumers, who have high household income levels, are willing to pay more for meat and meat products to guarantee safety and reliability. Household income excluding wives' earnings and the square of the household income are added to the model in order to test the effects of household income on the price premium of meat and its tendency of willingness to pay in the future.

Family size and structure are also important determinates of the price that Beijing consumers are willing to pay. Maguire *et al.* (2004) suggest that the number of Children in the family has a positive effect on the evaluation and consumption of food. At the same time, household wives play an important role on making the purchases for the whole family in China. The education of household wives is included in our model to capture the variation in the wife's awareness of quality, safety, health and nutritional information related to meat consumption, which may help consumers to value the implicit price of quality meat.

## Estimation Procedure

To obtain the consistent and unbiased estimation, we estimate the hedonic price model with five meat categories, including pork, beef, lamb, poultry, and other meat by using STATA. Based on equation (4.6), the hedonic price function is regressed by Ordinary Least Squares (OLS) in the semi-log form as follows:

$$\begin{aligned} Log(Price) = {} & \alpha + \beta_1(Appearance_j) + \beta_2(Semi - processed_j) \\ & + \beta_3(Super\ Market_j) + \beta_4(Wet\ market_j) + \beta_5(Processed_j) \\ & + \beta_6(Certificate_j) + \beta_7(Brand_j) + \beta_8(Child_j) \\ & + \beta_9(Wife's\ education_j) + \beta_{10}(Income_j) + \beta_{11}(income^2{}_j) + \epsilon \end{aligned}$$

where price is the price per kilogram of the meat in Beijing, appearance, meat certificate, and meat brand are includes as quality-related attributes in the demand side of meat $j$, and super market, wet market, semi-processed and processed are the attrubutes embodied in the supply side in the meat $j$. Child, wife's education level, and income are demographic. The error term, $\epsilon$, captures the information of other quality-related attributes which can not be represented in the data.

A semi-log form for the hedonic function is chosen because this form is straightforward to explain as the percentage changes in the price with respect to a 1 unit increase or improvement in the attributes of meat. On the other hand, the actural price of an attribute may be a function not only of the level of attributes itself, but also the levels of other attributes, where the semi-log form can be applied as an nonlinear function of all set of the attributes to deal with the problem (Wahl *et al.*, 1995). Descriptive summary statistics for price, supply and demand attributes of these five meats, and demographic variables are presented in table 4.2.

## Hedonic Model Results and Discussion

The hedonic model is estimated including both supply and demand attributes. There are a total of 1429 observations for us to make a regression in the model. The adjusted $R^2$ for the hedonic model is 0.985, which indicates that all of the independent variables have a perfect performance for explaining the actual price of meat. A Wald test statistic was applied to test the significance of each independent variable. Overall, all of the independent variables are jointly and highly significant with an F- stat equals to 1571.06 and the $p$-value of the whole model is less than 0.000, which report that there are no differences in the value of meat due to the various attributes in any of these main

attribute categories. Table 4.3 presents the results of the hedonic meat price model of Beijing consumers and table 4.4 shows the marginal effect for each of the meat categories. In order to analyze the implicit value of the regression results, the variables about supply and demand attributes for the five meat categories are discussed in the following parts.

Meat Appearance

Meat appearance is the most direct and the first criterion for a consumer to judge the qualities of meat. A good meat appearance is always related with good smelling, nice color, appropriate portion of fat and leans, and cut. Sometimes a meat with good appearance could attract consumers' attention and influence their purchasing behavior easily. In our analysis, the estimated parameters of meat appearance are significant for beef, lamb and poultry. The appearance has a positive effect on the price of beef and lamb, and their marginal effect is 1.544 and 13.023 respectively, which indicates that one unit of improvement on beef and lamb's appearance can make the consumer pay extra 1.544 and 13.023 Yuan as the price premium for their quality. However, the appearance has a significant influence with a negative sign on the price of poultry, which means that consumers in Beijing do not rely on poultry's appearance as the evaluation criterion for poultry's price. The reason may be that during the survey days in 2007, the H5N1 avian influenza was overspread in the middle and eastern part of mainland China. The consumers in Beijing were not confident about the safety of eating poultry, so they could not give a positive valuation for poultry.

Semi-processed

In this study, semi-processed is considered as a quality-related attribute in the side of supply for meat. The estimation result shows that the attribute of semi-processed has a

significantly positive influence on the price of beef, poultry and other meat. The marginal effects for the three meats are 3.285, 6.618 and 1.431, respectively. The reason may be that semi-processed meat saves the time for increasingly prosperous and busy consumers in China because consumers are able to eat the product with minimal additional preparation or cooking before eating. Consuming semi-processed meat has a lower opportunity cost than cooking the raw meat and thus Beijing consumers are willing to pay a higher price.

Processed or Ready to Eat

Ready-to-eat is a potential and important attribute for the positioning of meat retail products among consumers, and targeting certain market segments (Roheim *et al.*, 2007). Ready-to-eat meat includes extra labor cost and ingredients, such as spices and flavoring, that have been added in the cooking process and is generally ready to consume without further preparation which provides a quick and easy meal for increasingly busy people in urban China. Based on this, we consider ready-to-eat as an attribute embodied in the supply side. Thus, we assume that the ready- to-eat form could have a significant effect on the implicit price of meat. However, from our results, this attribute for all meat categories is not significant except for pork. The sign of processed or ready-to-eat pork is significantly negative. The reason for the negative sign may be that the attribute of processed or ready-to-eat is insufficient for Beijing consumers to evaluate the quality of pork. They do not solely rely on such attribute when they make a purchase decision.

Purchase Venue

Supermarkets are spreading faster in China than another anywhere else in the world and are growing by 30 percent to 40 percent per year (Hu *et al.*, 2004). And there

are a great number of commodity producers and suppliers participating in the supply chains for the supermarkets. According to Hu *et al.* (2004), most of the supermarkets in China have their own quality and safety standards imposed on the participating commodity producers and suppliers in order to guarantee the safety and quality of food they sold. In contrast, in wet markets, which are the traditional places for Chinese consumers to purchase meat, vegetables and fruits, consumers can purchase food directly from the farmers and growers. Purchasing directly from the producer can ensure the freshness, affordability and convenience and is the reason why a considerable number of wet markets still exist in urban China. However, due to lack of safety standards and inspection systems for the wet markets in China, the foods sold in wet markets cannot guarantee the safety and quality. Consumers can judge the quality only by directly observing food's appearance or perhaps relying on the individual seller's reputation.

In our case, the variable of supermarkets has a positive and significant influence on the price of pork and beef, but it has a significantly negative effect on the value of poultry, in which the marginal effects are 2.941, 2.829, and – 3.449, respectively. The parameter estimates for wet market are significant and have a negative sign for lamb, poultry and other meat. The marginal effects for the three meat categories are – 11.15, – 7.678, and – 6.364, respectively. Thus, we can conclude that the consumers in Beijing are likely to pay the price premium if pork and beef are sold in supermarkets, which is an attribute in the side of supply. The reason could be explained as the consumers rely more on supermarkets for their daily purchase of pork and beef rather than in wet markets, considering the safety and quality issues of meat. Price is no longer the only incentive for a rational consumer to shop in wet markets. The significantly negative signs for poultry in

both of supermarkets and wet markets may also be explained by the prevailing H5N1 in China as discussed above.

Table 4.1 Description of Variables

| Variables | Description |
|---|---|
| **Actual Price** | |
| Price | price per 1 kilogram of meat (Yuan) |
| **Product Attributes** | |
| *Supply Side Attributes* | |
| Supermarket | = 1 if meat is purchased at supermarket, = 0 otherwise |
| Wet Market | = 1 if meat is purchased at wet market, = 0 otherwise |
| Processed (ready to eat) | = 1 if meat product is ready-to-eat, = 0 otherwise |
| Semi-process | = 1 if meat product is semi-process, =0 otherwise |
| *Demand Side Attributes* | |
| Meat appearance | =1 if consumer ranks appearance as the determining factor for food safety |
| Meat Certificate | = 1 if consumer ranks certificate as the determining variable for food safety, = 0 otherwise |
| Meat Brand | = 1 if consumer ranks brand as the determining factor for food safety, = 0 otherwise |
| **Demographic Variables** | |
| Child | Number of Children in the household |
| Wife's Education | Household wife's educational level (rank from 2 to 6) |
| Household Income excluding wives' earnings | Household's monthly income excluding wives' earning (1000 Yuan/Month) |

Note: 1. The processed meat is fully cooked and ready-to-eat meat.
2. Wife's educational level ranked from 2 to 7, where 2 means primary school and 7 indicates above bachelor's degree.
3. Household number are considered as child if her/his age is 16 or below

Table 4.2 Descriptive Summary Statistics

| Variable | Mean | Std. Dev | Min | Max |
|---|---|---|---|---|
| Pork Price | 23.493 | 8.021 | 2.000 | 102.4 |
| Beef Price | 31.372 | 14.42 | 2.400 | 78.50 |
| Lamb Price | 26.148 | 6.234 | 1.000 | 57.00 |
| Poultry Price | 22.704 | 9.091 | 2.000 | 59.60 |
| Other Meat Price | 27.42 | 11.85 | 2.000 | 72.00 |
| Appearance | 0.407 | 0.491 | 0.000 | 1.000 |
| Semi-process | 0.121 | 0.326 | 0.000 | 1.000 |
| Process | 0.296 | 0.457 | 0.000 | 1.000 |
| Supermarket | 0.805 | 0.397 | 0.000 | 1.000 |
| Wet Market | 0.105 | 0.308 | 0.000 | 1.000 |
| Certificate | 0.316 | 0.465 | 0.000 | 1.000 |
| Child | 0.301 | 0.468 | 0.000 | 2.000 |
| Wife's education | 4.384 | 0.928 | 2.000 | 6.000 |
| Income | 5470.95 | 2303.32 | 900.0 | 15000 |

Note: 1. The other meat includes edible offal and fat in this analysis
2. Income is the household income excluding wives' earning (Yuan/month)
3. Price: Yuan/Kg

Meat Brand and Certification

Meat brand is a relatively new concept in China, which has recently attracted more consumers' attention and has begun to develop brand loyalty among Chinese consumers. Therefore meat brand is considered as an attribute in the demand side. Sometimes, brand is a value-added factor which can affect the price significantly. In our analysis, meat brand has a positive and significant sign for the price of beef, lamb, and other meat, which Beijing's consumers are willing to pay 1.884, 13.311, and 1.446 Yuan more per one kilogram, respectively. The reason is that people think the most well-known and famous brands could guarantee the safety of meat since they have introduced quality control systems such as ISO 90001, to ensure quality and standards.

The Chinese meat certification is an oblige system imposed on all meat producers in China in order to ensure the basic quality and safety of meat. In our analysis, meat

certification has a significantly negative effect on the price of pork and poultry. The reason is that the consumers may not have a confidence in the pork and poultry certificates in China. Our results about certification are consistent with the suggestions of Zhang *et al.* (2010), which indicates that certification seems to be having trouble in winning Chinese consumers' trust in determine the quality and safety. We also confirm their finding that there is a potential inefficiency of the existing certification programs in China and possible waste of political resources in regulating food quality and safety (Zhang *et al.*, 2010).

Household Income

Obviously, consumers' evaluations of implicit price for quality meat are significantly related to household income. Both household income and the square of household income are included to test the implicit value of meat and the tendency of price premium's variation. Theoretically, consumers with high income levels will increase their demand for luxury foods. From our results, these families are willing to pay 4.074, 3.067, and 1.755 Yuan more as their incomes increase 1000 Yuan on one kilogram of the consumption of beef, lamb, and other meat, respectively. But the implicit price level for quality meat increases at a decreasing rate as the signs of quadratic terms of household head's income for beef and other meat are significantly negative. The possible reasons for these results are the affluent consumers are not relying on pork as their main meat source. And these results indicate a diversified trend of meat consumption in urban China in recent years, which are matched the conclusion of some previous studies, for example, Gale and Huang (2007). The decreasing rate of the price premium on these types of meat reflects that consumers with high income levels may gradually reduce the amount of meat

consumption in the long run and consume more healthy foods, such as vegetable, fruit and other foods. Another possible reason can explained this phenomenon is high income often associated with busy work, and such group of people is likely to pay more on dinning out or food away from home.

Household Wives' Educational Level and Children

Traditionally, household wives always play an important role on making a purchasing decision in Chinese family. Their awareness of nutrition and food safety can be related with the health of the whole family. The wife's educational level reflects their awareness of quality and safety, which will likely impact their valuation of meat. The household wives' education variable is added in the regression analysis. Meanwhile, China's national policy "one couple, one child" makes children the core of every family. So the child's health and nutrition are an important concern during the purchasing decision. In some countries such as the U. S., and U.K., parents are likely to pay a premium for the safety of baby food (Maguire *et al.*, 2004). The results of our analysis show that well-educated household wives in Beijing play a negative and significant role on evaluating lamb's purchasing price, and number of children has a positive and significant influence on the price of all kind of meat except for beef. These results indicate that Chinese consumers care more about children's health and they would like to pay a price premium for the meat price if they have children.

## Conclusion

The meat market in China is quite a diversified and potentially huge market in the world, which always contains of great interest for policy maker and meat producers.

Understanding the implicit price of meat which is related with quality in Beijing, China will provide a good guidance for people who are interested in Chinese meat market. So in this paper, we analyze the implicit price of meat with the quality-related attributes in both supply and demand sides by applying a hedonic price model. Five meat categories plus several quality-related attributes are regressed in the model using Ordinary Least Square (OLS) estimation by households survey data collected from Beijing in 2007.

The key results in the current analysis indicate that some quality-related attributes or characteristics such as meat appearance, supermarket, meat brand, and processed meat as well as demographic variables like household head's income, have a significantly positive influence on the price of meat, which suggest that the consumers in Beijing are willing to pay a price premium to guarantee the quality and safety of meat. Besides those, the household wives' educational levels and number of children also contain the factors that will affect the implicit value of meat.

The current results find that the Chinese consumers' awareness of nutrition and safety has had a tremendous improvement. And the increasing demand for safer and labeled meat may boost the development of the standardized meat production industry in China and the imports from other countries such as the U.S., Australia, and Argentina. And based on the potential inefficiency of the existing certification programs in China and possible waste of political resources in regulating food quality, the Chinese government still needs to work on in order to build a reliable and efficient meat certificate system in China.

Table 4.3 Estimation Results Using Ordinary Least Squares

| Categories | Pork | Beef | Lamb | Poultry | Other |
|---|---|---|---|---|---|
| Intercept | 2.780*** | 2.263*** | 3.322*** | 3.087*** | 2.605*** |
| | (0.115) | (0.278) | (0.508) | (0.231) | (0.208) |
| Meat Appearance | -0.059 | 0.149* | 0.382** | -0.251** | 0.033 |
| | (0.037) | (0.087) | (0.161) | (0.074) | (0.061) |
| Semi-process | -0.061 | 0.294*** | 0.316 | 0.271*** | 0.102 |
| | (0.049) | (0.069) | (0.195) | (0.064) | (0.063) |
| Ready-to-eat | -0.076* | 0.115 | -0.126 | -0.017 | 0.129 |
| | (0.041) | (0.108) | (0.167) | (0.086) | (0.124) |
| Supermarket | 0.171*** | 0.258** | 0.034 | -0.177* | -0.057 |
| | (0.054) | (0.104) | (0.177) | (0.099) | (0.105) |
| Wet Market | 0.104 | -0.055 | -0.508** | -0.448*** | -0.649*** |
| | (0.070) | (0.150) | (0.213) | (0.137) | (0.161) |
| Meat certificate | -0.078** | 0.266** | 0.314** | -0.250** | -0.037 |
| | (0.037) | (0.082) | (0.150) | (0.074) | (0.058) |
| Meat brand | 0.022 | 0.179** | 0.389** | -0.085 | 0.103* |
| | (0.037) | (0.089) | (0.154) | (0.078) | (0.062) |
| Household Income | 0.018 | 0.294*** | 0.321** | -0.027 | 0.147*** |
| | (0.018) | (0.080) | (0.156) | (0.044) | (0.033) |
| (Household Income)$^2$ | -0.0001 | -0.032*** | -0.036* | 0.004 | -0.011*** |
| | (0.002) | (0.008) | (0.022) | (0.004) | (0.003) |
| Wife's education | 0.029 | -0.012 | -0.246** | 0.051 | 0.040 |
| | (0.018) | (0.042) | (0.084) | (0.036) | (0.033) |
| Child | 0.0914** | 0.066 | 0.379** | 0.146** | 0.158** |
| | (0.032) | (0.074) | (0.143) | (0.061) | (0.059) |
| Adjusted $R^2$ | 0.985 | | | | |
| *F- Stat* | 1571.06 | | | | |
| *P-value* | < 0.000 | | | | |
| Number of observations | 1429 | | | | |

Note: 1. The standard errors are in parentheses.
2.* significant at the 10% level; ** at 5% level; *** at 1% level.

Table 4.4 Marginal Effect of the Intrinsic and Extrinsic Attributes on Meat Price

| Marginal Effect | Pork | Beef | Lamb | Poultry | Other |
|---|---|---|---|---|---|
| Meat Appearance | -0.898 | 1.544 | 13.023 | -4.720 | 0.447 |
| Semi-process | -0.927 | 3.328 | 10.403 | 6.619 | 1.835 |
| Ready-to-eat | -1.147 | 1.171 | -3.314 | 0.358 | 1.835 |
| Supermarket | 2.923 | 2.829 | 0.968 | -3.449 | -0.739 |
| Wet Market | 1.718 | -0.514 | -11.150 | -7.678 | -6.364 |
| Meat Certificate | -1.176 | 2.929 | 10.327 | -4.704 | -0.484 |
| Meat Brand | 0.349 | 1.884 | 13.311 | -1.733 | 1.446 |
| Household Income | 0.205 | 4.074 | 3.067 | -0.189 | 1.755 |
| Wife's education | 0.305 | -0.167 | -2.539 | 0.535 | 0.487 |
| Children | 1.500 | 0.656 | 12.900 | 2.343 | 2.282 |

# CHAPTER 5. SUMMARY AND CONCLUSION

The objective of this study is to identify the influence of food safety and quality on meat consumptions and meat prices, respectively, in Beijing, China, in recent years. This study utilizes a nonlinear AIDS model with SML estimation and Hedonic Price Analysis approaches to estimate the consumption demand for safe meat and the price premium which Beijing consumers are willing to pay on high quality meat.

The estimation of nonlinear AIDS model provides insights into the determinants of meat demands, especially for the food safety. The consumptions of beef, pork, poultry, mutton, and aquatic products are significantly affected by the food safety. Meanwhile, there are significantly differences in meat consumption preferences among consumers with different educational levels and household sizes. The results suggest that well educated consumers will likely consume more beef than pork, and that the consumption of pork also decreases in a larger family.

The regression of Hedonic Price Analysis investigates how the intrinsic and extrinsic quality-related attributes influence consumer's evaluation on meat prices. The key results of this model indicate that several quality-related attributes or characteristics such as meat appearance, supermarket, meat brand, and processed meat, have a significantly positive influence on the price of meat, which suggest that the consumers in Beijing are willing to pay a price premium to guarantee the quality and safety of meat. Meanwhile, the household with high income level and well-educated household wife have more awareness of food quality, this assumption are also demonstrated by the estimation results.

As a country with the largest population, China is potentially the largest market in the world. This study provides a new horizon for policy makers and agricultural commodity marketers to rethink changes in food demand, especially meat demand in China. In addition, the great demand and price premiums for high quality and safe meat may boost China's import of feed grains and meat. Therefore, this study can provide a meaningful guidance for the people who are interested in Chinese feed grain and meat markets.

In summary, this study discusses the relationship between food safety and meat consumption in China and also focuses on the price premium of meat. Few studies about China's food consumption have evaluated this relationship and issue. Some additional areas of research may be expended for the future studies. For example, they could focus on the consumption of other food categories, such as vegetables, fruits, and beverages. Also, because this study is limited to at-home meat consumption, the information about away-from-home meat consumption would allow the further investigation on the similar topics. Finally, the geographic area of this study is Beijing, which is the capital and one most developed cities in China. However, due to the economic segregation and difference in regions, how the China's rural and western residents response to the food safety and quality on food consumption may be worth to investigate in the future research.

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