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Modeling China's household food demand in the transition toward a market economy

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Modeling China's household food demand in the transition toward a market economy

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To my father and the memory of my mother

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Modeling China's household food demand in the transition toward a market economy

Qingbin Wang

Major Professor: Dr. Stanley R. Johnson
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Since 1978 China has moved gradually from a centrally planned to a mixed economic system of planning and markets. Under the new economic system consumers play more important role in determining China's food production and trade. Therefore, it is important for China's policymakers to understand household food demand because the effects of alternative food policies are conditioned by consumer demand. Information on China's food demand is also important for modeling the world food markets where China has been a major trader. Furthermore, China's long history of consumption rationing and gradual movement to a market economy provide a unique opportunity for studying consumer behavior in an economic transition.

This study models China's household food demand in the transition toward a market economy. The major contributions of this study are: (1) a quantitative assessment of the changes in China's average food consumption and nutrient availability and sources through the compilation of annual food balance sheets during 1950 to 1991; (2) theoretical demand models for Chinese urban and rural households; (3) estimation of the associated demand models using the most recently available data; and (4) policy analysis based on the estimated demand models.

The results from this study suggest four major conclusions: First, China's average dietary status changed modestly from 1950 to 1978 but has improved significantly since the

1978 economic reform. Second, China's household food consumption is in the transition from grains to animal products. The demand for animal products, and therefore feedgrains, in China is expected to increase at a significant rate. Third, with one-fifth of the world's population but only 7 percent of the earth's arable land, China is likely to be a major importer of wheat, barley, beans, and feedgrains. Fourth, government policy has been a key factor of the changes in China's household food consumption and dietary improvement since 1980 and will continue to play an important role in influencing China's household food consumption and international food trade.

CHAPTER 1. INTRODUCTION

Economic reforms in socialist countries, such as China and the former Soviet Union, have brought about significant changes in their economic systems and the structure of the global economy. Although the path and pace of the transitions vary from country to country, the general trend in reforming socialist countries is to move from centrally planned to market economic systems. The role of market forces in determining resource allocation and shaping household consumption patterns has increased significantly in these countries. For producers, decentralized decision making and management have improved their ability to make production and marketing decisions to maximize profits subject to market conditions and government policy. For consumers, the expansion of the private sector and reduction of government control over consumer goods have provided them with increased choices in budget allocations and more sovereignty in determining what will be produced for domestic consumption.

The market-oriented economic reforms in the socialist countries also have more closely linked their domestic economies with the global commodity and financial markets. The enhanced linkage with the world commodity markets is indicated by increased imports and exports, and the more direct connection with the global financial markets is reflected in the growth of foreign loans and investments in these countries. For example, China's international trade rose from 20.64 billion U.S. dollars in 1978 to 195.72 billion U.S. dollars in 1993, and foreign investments in China increased from less than 1.00 to 25.76 billion U.S. dollars in the same period (State Statistical Bureau of China 1983-1994). As China and other reforming socialist countries move toward market economic systems, their economic growth will be increasingly dependent upon the global financial and commodity markets. On the other

hand, changes in their domestic and trade policy will have greater impacts on the global economy.

Ongoing economic reforms in socialist countries are of significance for the economics profession. Many economists have attempted to identify the economic problems facing the reforming socialist countries, to test how economic theory and methods for market economies are applicable to transition problems, and to estimate the impacts of these market-oriented reforms on economic growth and on the global economy (e.g., Chow 1987; Sicular 1988; Murrell 1991; Svejnar 1991; Fischer and Gelb 1991; Lin et al. 1994). Moreover, the path and pace of economic reforms can provide insights for potential and limitations of the modern economics, especially for economics as a policy science (Murrell 1991). This study contributes to the testing and extension of the modern economic theory and methods by modeling consumer behavior in the transition from a centrally planned to a market economic system. The focus is on household food demand in the People's Republic of China. The next sections in this chapter briefly discuss the background, problem setting, objectives, and organization of the study.

Background

China is a very large developing country with about one-fifth of the world's population but only 7 percent of the earth's arable land. Because producing food for its large population with extremely limited per capita arable land (0.0814 hectare in 1992) is so important and difficult for China, agricultural development has always been a top priority of the Chinese economy. China's industrial and service sectors have developed significantly since the late 1950s, but more than 70 percent of the population are still living in rural areas and most of them are engaged in agriculture-related pursuits (State Statistical Bureau of China 1993).

Since the founding of the People's Republic of China in 1949, the Chinese government has used agricultural policy as an important economic tool to promote national objectives (Perkins and Yusuf 1984; Sicular 1988). In fact, most of the institutional and policy reforms in China since 1949 have been initiated in the rural sector and then extended to the urban sector. For example, the collectivization in the 1950s and the 1978 economic reform were both initiated in the agricultural sector (Perkins and Yusuf 1984; Lin 1987; Carter and Zhong 1988).

By redistributing farming land from landlords to peasants, China's nationwide land reform around 1950 completely changed the income distribution and socioeconomic structure in rural areas (Perkins and Yusuf 1984). As indicated by the rapid production growth in the early 1950s, China's agricultural productivity improved significantly under the new land system. Soon after the economic recovery of 1949 to 1952, the central Chinese government initiated collectivization in rural areas by organizing individual farm households into "mutual aid teams." The major objectives of the collectivization were to reduce the restrictions of small-scale household production and to improve production planning and management. For example, the mutual aid teams were able to conduct irrigation and land improvement projects that were difficult and even impossible for individual households (Perkins and Yusuf 1984). The significant agricultural growth under the mutual aid teams encouraged the Chinese government to further collectivize the agricultural sector by merging mutual aid teams into "production cooperatives" in the mid-1950s. China's collectivization in the early and mid-1950s contributed significantly to production growth and welfare improvement in rural areas (Wang et al. 1993). But the central Chinese government highly overrated the positive impacts of collectivization and inappropriately replaced the production cooperatives with the large "rural people's communes" in 1958. The communes served as the fundamental government administration and economic planning units in rural China from 1958 to 1978.

Like many East European countries, China adopted the Soviet-style command economic system in the late 1950s and subsequently began to reform the system to incorporate market concepts in the late 1970s. From 1958 to 1978, the production and distribution of almost all consumer goods in China were governed by rigid central planning through the commune system in rural areas and government administration system in urban areas (Perkins and Yusuf 1984; Chow 1987; Carter and Zhong 1988). The government procured grains and many other farm products from peasants at state-set artificially low prices and provided food to urban residents at state-subsidized prices through consumption rationing. The farm population was compensated by subsidizing some farm inputs such as chemical fertilizers and farm machinery. Because food self-sufficiency was highly emphasized by the central government, peasants were allowed to grow only grains and a few industrial crops such as cotton at the expense of economic efficiency (Sicular 1989). In urban areas, more than 80 percent of laborers were employed in the state-owned units and their wages were determined administratively by the government rather than by their efforts and productivity. To compensate for the low wages, workers and their family members received a wide range of state subsidies for food, housing, clothing, health care, and even haircuts.

Frustrated with low work incentives and productivity in agricultural and other sectors, China began to reform the agricultural sector in 1978 and has moved swiftly to a set of comprehensive economic reforms in both rural and urban areas since the early 1980s (Wang et al. 1993). In rural areas, the fundamental change has been the replacement of the commune system with the "household production responsibility system" in which land and production responsibilities are under contract with individual farm households (Lin 1987). By the end of 1984, more than 95 percent of rural households were involved in the household production responsibility system (State Statistical Bureau of China 1985). To encourage private investment and sustainable use of natural resources, the land contract has been expand from

one to three years in the early 1980s to the current length of 15 to 25 years. Although land is still owned by the state or collectives and peasants have to sell a certain amount of their output to the state at prices generally lower than market prices, the peasants have much more flexibility in making production and marketing decisions. Their products can be sold in free markets after the state contracts are fulfilled. Farm inputs like chemical fertilizers can be purchased from the state at state-set prices or from free markets at market prices. As both producers and consumers of many food products, peasants make production decisions according to their consumption preferences, market conditions, and the contract with the state. Another notable change in rural areas is the rapid development of rural industry. From 1978 to 1992, the number of rural enterprises in China increased from 1.52 to 20.79 million, while the rural laborers employed in rural industry increased from 9.23 to 24.16 percent (State Statistical Bureau of China 1983-1993). The rapid expansion of rural industry has contributed significantly to income growth in rural areas.

In urban areas, the production responsibility and contracting systems have been adopted in the industrial and service sectors to enhance work incentives and economic efficiency. Workers' wages are increasingly determined by their efforts and productivity. The number of commodities under rationing has declined significantly since the mid-1980s. Several provinces, such as Guangdong and Jiangsu, have completely replaced food consumption rationing with income subsidies. Although housing is still under strict rationing and free markets in urban areas are under many government interventions, Chinese urban households have many more choices in allocating their budgets and through the markets have more sovereignty in determining what will be produced for domestic consumption.

China's economic reform, initiated in 1978, has been on balance successful and has brought about rapid economic growth and welfare improvement compared with other periods in China's history. Major indicators of China's economy growth during 1978 to 1992 are

summarized in Table 1.1. Over the period of 14 years, China's real GNP grew by an average of 8.98 percent a year, real average per capita income increased 6.14 percent a year for urban residents and 7.65 percent a year for rural residents, and the average per capita consumption of many preferred food commodities like red meats and eggs more than doubled (State Statistical Bureau of China 1983-1993). China's market-oriented economic reform also has more closely linked its domestic economy with the global commodity and financial markets. The growth in China's imports and exports, foreign investments, and foreign loans is presented in Figure 1.1 and Figure 1.2. The World Bank officials predict China will be the world's third largest economy by 2000, and the largest economy by 2020 (Brauchli 1993). According to an index of future economic competitiveness constructed by the Union Bank of Switzerland, China ranks number one followed by Israel, Japan, Korea, and Singapore (*Business Week*, October 11, 1993).

China's economic reform has been significantly different from the reforms undertaken in Eastern Europe and the former Soviet Union (Lin et al. 1994). Unlike the "big bang" or "shock therapy" approach advocating to complete the transition from a centrally planned to a market economy in a short sequence, a "gradual" and "evolutional" approach has been adopted in China to reform its centrally planned economy. Economic reform in China has been incremental and experimental rather than large-scale privatization and marketilization, which are generally considered to be necessary components of a market-oriented economic reform (Lipton and Sachs 1990). As a result of the gradual reform, China has moved from a Soviet-style command economic system to a mixed economic system of planning and markets (Pan and Johnson 1992). China's private sector has expanded rapidly since the mid-1980s, but the state and collective sectors still dominate the private sector in major industrials.

Compared to the reforming socialist countries in Eastern Europe and the former Soviet Union, China's economic reform has been quite successful. As shown in Table 1.2,

Table 1.1. Major indicators of China's economic growth during 1978 to 1992

	1978	1992	Average annual growth rate (%)
Population (million)			
Rural	790.14	847.99	0.506
Urban	172.45	323.72	4.601
Total	962.59	1171.71	1.414
Labor supply (million)			
Rural	306.38	438.02	2.586
Urban	95.14	156.30	3.610
Total	401.52	594.32	2.841
GNP (billion yuan)			
Nominal GNP	358.81	2403.62	14.551
Real GNP	n.a.	n.a.	8.982
Real average per capita income (yuan)[1]			
Rural	109.75	307.93	7.647
Urban	240.22	553.25	6.140
Food production (mmt)			
Grains	304.77	442.66	2.702
Red meats	8.56	29.41	9.216
Poultry	0.45	4.54	17.951
Aquatic products	4.66	15.57	8.999
Eggs	1.99	10.20	12.382
Milk	0.97	5.64	13.399
Vegetable oils	2.07	6.62	8.658
Fruits	6.57	24.40	9.825
Sugar	2.27	8.29	9.693
International trade (billion U.S. dollars)			
Imports	10.89	80.61	15.371
Exports	9.75	85.00	16.727
Total	20.64	165.61	16.038

Source: State Statistical Bureau of China, *China's Statistical Yearbook*, 1983-1993 volumes.

n.a. Not available.

[1] The base year of the price indexes used to derive the real income is 1950.

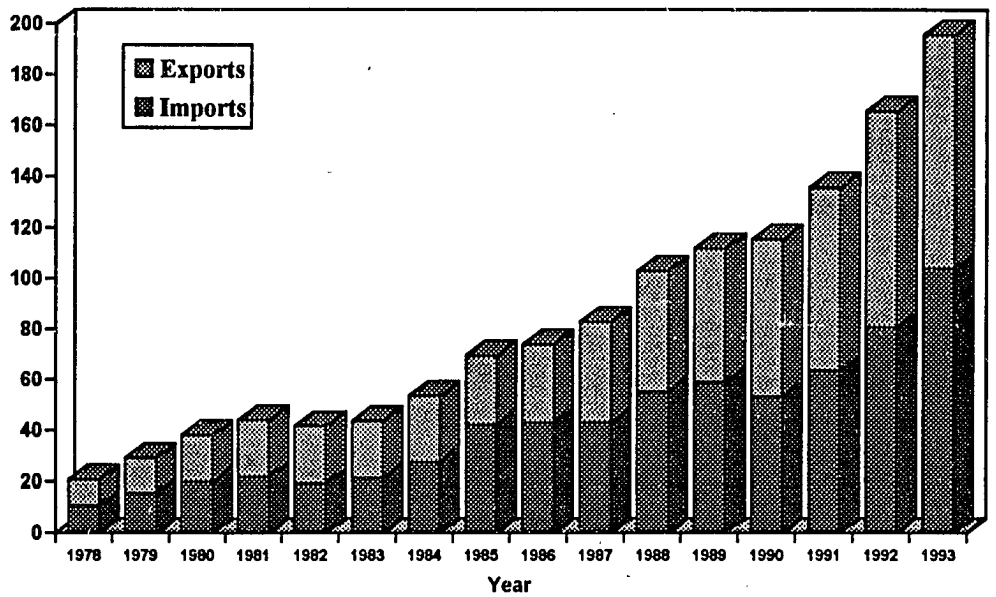

Figure 1.1. China's international trade (billion U.S. dollars)

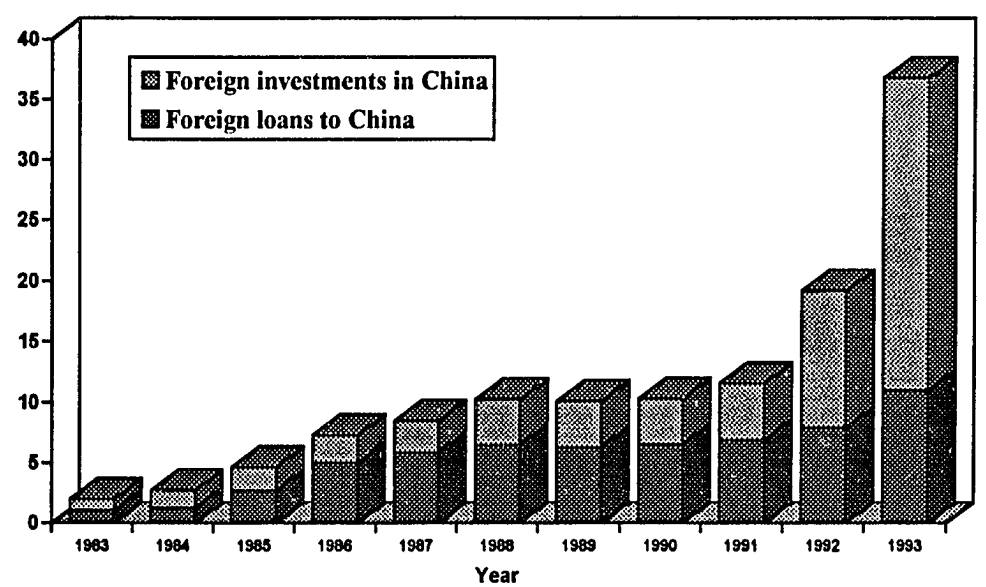

Figure 1.2. Foreign loans and investments in China (billion U.S. dollars)

Table 1.2. Economic growth and inflation rate in China, Eastern Europe, and the former Soviet Union

	Real GDP					Retail prices				
Country	1989	1990	1991	1992	1993	1989	1990	1991	1992	1993
	Percentage change									
Albania			-30	-8	3			36	200	130
Armenia			-12	-50	-10			100	1350	n.a.
Azerbaijan			-2	-30	-10			138	1350	n.a.
Belarus			-3	-11	-3			80	1076	1300
Bulgaria	-2	-9	-12	-8	-5	6	26	334	83	90
Croatia			-29	-11	-5			123	664	790
Czech	1	-1	-14	-7	n.a.	2	11	57	11	20
Estonia			-13	-26	-10			212	1050	200
Georgia			-25	-30	-10			81	1800	n.a.
Hungary	0	-4	-12	-5	-2	17	29	35	23	23
Kazakhstan			-8	-13	-15			91	1381	1000
Kyrgyzstan			-5	-25	-16			85	855	600
Latvia			-8	-44	-10			172	951	250
Lithuania			-13	-35	-10			225	1021	690
Macedonia			-11	-15	-7			115	1691	580
Moldova			-12	-21	-15			98	1460	1000
Poland	0	-11	-7	1	2	251	586	70	43	39
Romania	-7	-7	-14	-15	-9	1	7	161	210	210
Russia			-11	-19	-15	2	6	93	1354	1000
Slovak	1	0	-16	-6	-8	2	11	61	10	25
Slovenia			-9	-7	-1			115	207	47
Tajikistan			-9	-31	-18			103	1450	n.a.
Turkmenistan	4	-4	-7	-12	-9			90	980	n.a.
Ukraine			-14	-14	-10	2	4	91	1450	1450
Uzbekistan			-1	-14	-10			82	700	n.a.
China	4.3	3.9	8.0	13.2	n.a.	17.8	2.1	2.9	5.4	13

Sources: The figures of China are from State Statistical Bureau of China, *China's Statistical Yearbook*, 1989-1993 volumes, and the figures of other countries are from Lin (1994).

n.a. Not available.

China's GDP has grown continuously at a accelerated rate and the price level has been relatively stable, whereas the reforming countries in Eastern Europe and the former Soviet Union have experienced unexpected sharp and prolonged decline in real GDP with extraordinarily high inflation rates.

With more than 1.1 billion people, China is the world's largest consumer and producer of many food products such as grains and red meats (State Statistical Bureau of China 1993). China also has played an important role in the world grain markets since the early 1960s (Carter and Zhong 1991; Wang et al. 1993). From 1961 to 1991 China's average annual wheat import was 6.97 mmt, averaging about 10 percent of the world's total traded volume. In addition to wheat, China has expanded its import of barley and beans since the mid-1980s (State Statistical Bureau of China 1983-1993). Thus changes in China's food production, consumption, and trade have significant impacts not only on the welfare of about one-fifth of the world's population, but also on the food situation in many other countries through international markets.

The differences between a market economy and a centrally planned economy are significantly reflected in the role of consumers (Chow 1987). In a market economy, consumers play an important role in determining the market equilibrium levels of price and quality by making free choices of goods and services. Together with government policy, consumer demand is a key factor in determining what will be produced or traded for domestic consumption. In a centrally planned economy, consumers can only choose from state-determined sets of goods and services because the production and distribution of consumer goods are essentially controlled by the government. With a centrally planned economic system for about 20 years, China has moved gradually toward a market economy since the 1978 economic reform. As a result of the substantial reduction in government control over consumer goods and the rapid expansion of free markets, Chinese consumers under the new

economic system have been able to expand their market power in determining what will be produced for domestic consumption and what will be imported or exported (Wang and Chern 1992). When China moves closer to a market economy, its food situation and trade behavior will depend more upon consumer demand as reflected in markets with consumer sovereignty. Accordingly, understanding household demand is important for China's policymakers because the effects of alternative policies on welfare, market demand, trade, and foreign investment are all conditioned by consumer behavior.

Because China has been and will continue to be an important player in world food markets, information on household food demand in China is also important for policymakers and food industries in many other countries with significant food trade, especially for the nations heavily dependent upon world food markets. If China's pending application for membership in the General Agreement on Tariffs and Trade (GATT) is approved, China's trade barriers will be lowered and therefore increase access to the Chinese market with more than one billion consumers. China's role in world food markets will also be enhanced by the return of Hong Kong to China in 1997. Hong Kong has been a major food importer and the transition point for trade between China and many other countries.

From both domestic and international points of view, there is a great need for developing quantitative estimates of China's household food consumption and for predicting China's food demand and trade. Furthermore, China's long history of consumption rationing and significant movement toward a market economy can provide a unique opportunity for economists to study consumer behavior in the economic transition. Studies on China's household food demand can provide insights for modeling consumer behavior and predicting food demand and trade in other reforming socialist countries such as Poland and the former Soviet Union.

Problems

The study of China's household demand and expenditure has been limited in the past by the poor statistical data and various forms of consumption rationing. The State Statistical Bureau of China started its nationwide rural and urban household surveys in the mid-1950s, but the surveys were interrupted many times by the political movements of the 1960s and 1970s. Furthermore, the Chinese government has released extremely limited survey data for years prior to 1978 and only summary results for years since 1978. In fact, China was not included in most international studies of household demand and expenditure prior to 1978. As one exception, Houthakker (1957) estimated both income and price elasticities of demand for food, clothing, housing, and miscellaneous items in urban China using the data from two household surveys conducted in Beijing and Shanghai.

The significant changes in China's political and economic environment and data availability since the 1978 economic reform have resulted in a number of studies of China's household demand. Although most of these studies are descriptive in nature, several have employed partial and complete demand systems to estimate income and price elasticities for various expenditure groups.

The State Statistical Bureau of China has conducted its annual rural household survey since 1978 and urban household survey since 1980. Most empirical studies of China's household demand in the mid and late 1980s are based on the sample means by regions or income groups from China's rural and urban household surveys, whereas some recent studies have used regional data sets of individual households from China's Rural Household Survey.

The Word Bank published two studies of China's household demand in the mid-1980s (van der Gaag 1984; Li et al. 1985). Engel functions and the extended linear expenditure system (ELES) were used in both studies to estimate demand elasticities for several broad

expenditure groups and specific food commodities in both urban and rural China. The data of sample means by income groups from Beijing in 1982 were used to estimate urban demand, whereas the pooled data of sample means by income groups from Hubei province and the pooled provincial data from 1981 to 1982 were used to estimate rural demand. Chow (1987) estimated Engel functions for food, clothing, housing, and miscellaneous items using the 1981 expenditure data of rural households by 28 provinces.

Using the pooled time-series and cross-section data from China's urban and rural household surveys for the years 1982 to 1985, Lewis and Andrews (1989) have estimated demand elasticities for broad expenditure groups and food subgroups in both urban and rural China. For urban households, an ELES of five broad expenditure groups and an ELES of four food subgroups are estimated using the pooled data of sample means by income groups. For rural households, a linear expenditure system (LES) of five broad expenditure groups and a LES of four specific food items are estimated using the pooled provincial data.

Wang and Chern (1992) have examined the effects of rationing for housing and selected food commodities on the consumption behavior of Chinese urban households. An almost ideal demand system (AIDS) with rationing developed by Deaton (1981) is applied to the pooled data of sample means by six income groups from 1981 to 1987. Their results suggest that housing and food rationing has had significant impacts on the demand for nonrationed commodities in urban China.

Chern and Wang (1992) have estimated demand elasticities for major food groups and individual food commodities in urban China by applying Engel functions, a LES, and a quadratic expenditure system (QES) to a pooled time-series and cross-section data set (annual sample means by 28 provinces from 1985 to 1990). The impacts of consumption rationing for grains and vegetable oils on the consumption of other food commodities are examined in the study.

Wang and Kinsey (1993) have applied an AIDS with rationing to a data set of sample means by income groups from China's Urban Household Survey for 1981 to 1987. The estimated model is then used to examine the impacts of consumption rationing for housing and grains on household consumption and saving behavior in urban China.

Wang and Jensen (1994) have estimated the demand elasticities for alcoholic beverages (liquor, beer, and wine) and tea in urban China by applying a two-stage budgeting procedure to a data set of sample means by seven income groups and two city groups from 1986 to 1991. Household size is incorporated into the demand system by translating the intercepts.

Regional data sets from China's 1990 Rural Household Survey have been used in three recent studies (Halbrendt et al. 1993; Gao et al. 1993; Tan et al. 1994). Halbrendt et al. (1993) have estimated an AIDS of nine expenditure groups (durables, clothing and seven food commodities) using a data set of rural households from Guangdong province. Gao et al. (1993) have applied a two-stage budgeting procedure to a data set of rural households from Jiangsu province. The study includes five broad expenditure groups in the first budgeting stage and nine food commodities in the second stage. Tan et al. (1994) have estimated an AIDS of seven food commodities using a data set of rural households from Jiangsu province.

There are also some studies of China's household food demand using time-series data. Tang (1980) has estimated China's average per capita grain demand based on the national data from 1950 to 1977. Carter and Zhong (1988, 1991) have used China's time-series data to estimate rural and urban per capita grain consumption. Ito et al. (1989) have estimated and compared income elasticity of rice demand in China and several other Asian countries. Their results suggest that rice has become an inferior good in China and some other Asian countries. Halbrendt and Gempesaw (1990) have estimated China's rural and urban per capita wheat consumption using the time-series data from 1960 to 1987. Peterson et al. (1991) have

estimated income elasticity of rice demand in China by applying the single-equation demand model developed by Ito et al. (1989) to China's time-series data from 1960 to 1986. The demand model, expenditure groups, household types, and data sources for major empirical studies of China's household demand are summarized in Table 1.3.

Among the theoretical studies of China's household demand, Chow (1987) has analyzed the effects of consumption rationing on consumer demand in urban China using the framework developed by Tobin and Houthakker (1951). Byrd (1987) developed a general equilibrium approach to analyze the impacts of rationing and multiple pricing in China. The basic assumption of the model is that each individual maximizes his or her utility under a mixed economic system of planning and markets. The consumer voluntarily decides whether to participate in the free market based on the rationing level and price and market prices. Sicular (1988) has further extended this proposition by focusing on the interactions between markets and state planning in the context of China's agricultural sector. In a recent study, Pan and Johnson (1992) have developed a theoretical framework to model consumer behavior in urban China under the mixed economic system of planning and markets.

One major objective of demand analysis is to provide information for projecting future demand. Several studies have attempted to make food demand projections for China. Tang (1980) has projected China's grain demand in 2000 based on a single-equation regression model and the time-series data from 1952 to 1977. Carter and Zhong (1988, 1991) have conducted projections of China's rural and urban grain consumption in 1995 and 2000. By estimating a system of wheat production, consumption, and import equations, Halbrendt and Gempesaw (1990) have forecasted China's rural and urban per capita wheat consumption from 1988 to 1991. Peterson et al. (1991) have predicted China's per capita and total rice consumption from 1990 to 2000 based on the time-series data from 1960 to 1986.

In reviewing the empirical work on China's household food consumption and demand

Table 1.3. Summary of studies of China's household demand

Study	Demand model	Commodity or expenditure groups	Types of households	Data sources
Houthakker (1957)	Engel functions	Food, clothing, housing, and miscellaneous items.	Urban	A survey of 283 households in Beijing city in 1927, and another survey of 305 households in Shanghai city in 1930.
Tang (1980)	Single equation	Grain		Time-series data from 1952 to 1977 (26 observations).
van der Gaag (1984)	Engel functions	Food (grain, non-staple food, and other food), clothing, fuel, housing, daily articles, and culture & services.	Rural	Pooled provincial data from 1981 to 1982 (56 observations).
	Extended LES	Food, clothing, fuel, housing, and daily articles.	Rural	Pooled data of sample means by 7 income groups in Hubei province from 1981 to 1982 (14 observations).
	Extended LES	Food (grain, non-staple food, tobacco & liquor & tea, and other food), clothing, fuel, daily articles, and non-commodities.	Urban	Sample means by 9 income groups in Beijing city in 1982 (9 observations).
Li, Yang and He (1985)	Extended LES	Food, clothing, fuel, daily articles, and non-commodities.	Urban	Sample means by 9 income groups in Beijing city in 1982 (9 observations).

Table 1.3. (continued)

Study	Demand model	Commodity or expenditure groups	Types of households	Data sources
Li, Yang and He (1985)	Extended LES	Food, clothing, fuel, housing, daily articles, and culture & services.	Rural	Pooled data of sample means by 7 income groups in Hubei province from 1981 to 1982 (14 observations).
Chow (1987)	Engel functions	Food, clothing, housing & fuel, and miscellaneous.	Rural	Provincial data in 1981 (28 observations).
Carter and Zhong (1988)	Single equation	Grain	Rural Urban	Time-series data.
Ito, Peterson and Grant (1989)	Single equation	Rice		Time-series data from 1961 to 1985 (25 observations).
Lewis and Andrews (1989)	Extended LES	Food, clothing, daily articles, other commodities, and non-commodities.	Urban	Pooled data of sample means by income groups from 1982 to to 1985.
	Extended LES	Staple food, non-staple food, tobacco & liquor & tea, and other food.	Urban	Pooled data of sample means by income groups from 1982 to 1985.
	LES	Food, clothing, housing materials, daily articles, and cultural services.	Rural	Pooled provincial data from 1982 to 1985.

Table 1.3. (continued)

Study	Demand model	Commodity or Expenditure groups	Types of households	Data sources
Lewis and Andrews (1989)	LES	Grain, pork, poultry, and fish.	Rural	Pooled provincial data from 1982 to 1985.
Halbrendt and Gempesaw (1990)	System of equations	Wheat	Rural Urban	Time-series data from 1960 to 1987 (28 observations).
Peterson, Jin and Ito (1991)	Single equation	Rice		Time-series data from 1960 to 1986 (27 observations).
Carter and Zhong (1991)	Single equation	Grain	Rural Urban	Time-series data from 1952 to 1986 (35 observations).
Wang and Chern (1992)	AIDS with rationing	Grain, non-staple food, clothing, tobacco & liquor & tea, daily articles, services, fuel, and housing.	Urban	Pooled data of sample means by 6 income groups from 1981 to 1987 (42 observations).
Chern and Wang (1992)	Engel functions, LES, and QES	23 food commodities.	Urban	Pooled provincial data from 1985 to 1990 (168 (observations).

Table 1.3. (continued)

Study	Demand model	Commodity or expenditure groups	Types of households	Data sources
Halbrendt, Tuan Gempesaw, and Dolk-Etz (1993)	AIDS	Grain, meats, poultry, fruits, vegetables, sweets, other food, durables, and clothing.	Rural	1990 Rural Household Survey data from Guangdong province.
Wang and Kinsey (1993)	AIDS with rationing	Grain, non-staple food, cigarette & alcohol & tea, clothing, daily articles, services, and saving.	Urban	Pooled data of sample means by 6 income groups from 1981 to 1987 (42 observations).
Gao, Wailes and Cramer (1993)	AIDS and GLES	9 food commodities (grain, pork, beef & mutton, poultry, eggs, fish, sugar, fruits, and vegetables) and 4 nonfood groups (clothing, fuel, housing, and durables).	Rural	1990 Rural Household Survey data from Jiangsu province.
Tan, Halbrendt, Latham, and Tuan (1994)	AIDS	Grain, meats, poultry, fruits, vegetables, sweets, and other food.	Rural	1990 Rural Household Survey data from Jiangsu province.
Wang and Jensen (1994)	AIDS	Liquor, beer, wine, and tea.	Urban	Pooled sample means by 7 income groups and two city groups from 1986 to 1991 (77 observations).

projections, several limitations have emerged. First, most of the studies using aggregate data by regions or income groups do not include demographic variables. To the extent that household demand is in reality determined by factors other than income and prices, the demand systems excluding demographic variables may not give accurate estimates of price and income elasticities (Capps and Havlicek 1987). Second, although several demand systems have been applied to household expenditure data from China, few have compared the results of alternative demand systems using the same data base. Such comparisons can contribute to a more complete understanding of consumer behavior and to the evaluation of demand systems in applied contexts. Third, the small number of observations available for most previous studies has limited the robustness of the results and has restricted implications for all China or for rural and urban China separately. Fourth, most of the previous attempts to make food demand and trade projections for China mainly have been based on simple regression models of individual commodities rather than complete demand models incorporating interactions among commodities. As a result of these limitations, previous studies have yielded significantly different estimation results and interpretations. For example, studies using the fairly recent data have concluded that rice is still a normal good in China (e.g., Halbrendt et al. 1993), whereas some studies using time-series data have reported that rice is already an inferior good in China (e.g., Ito et al. 1989; Peterson et al. 1991).

As a common weakness of previous empirical studies on China's household food demand, most of them have focused on the explanation of consumer behavior and few have attempted to make policy simulation analysis using the estimated demand models. Considering the limitations of previous studies, this study will develop theoretically and analytically well-based models that can be used to assess the effects of policy reforms on household demand in China. The associated models will be estimated using the most recently available data from China. The demand models and estimation results are then used to

conduct policy analysis.

Objectives

The general objectives of this study are to develop demand models for Chinese rural and urban households in the transition toward a market economy, to estimate the associated demand systems using the most recently available data, and to evaluate the implications of the empirical findings for policy analysis. The specific objectives are:

1. to provide a quantitative assessment of the changes in China's household income, expenditure patterns, food consumption, dietary status, and food policy since 1950;
2. to generalize the demand models with quantitative restrictions to model consumer demand under rationing and dual pricing (the AIDS is modified to examine the effects of strict and partial rationing);
3. to adopt a non-nested hypothesis test developed by Vuong (1989) for demand system selection;
4. to estimate income and price elasticities of household demand for major food commodities using a multiple-stage budgeting procedure and associated demand systems; and
5. to evaluate the implications from empirical findings and conduct policy analysis using the estimated demand systems.

Organization

This study is organized into 7 chapters. Chapter 1 has discussed the background, problem setting, and objectives of the study. Chapter 2 presents a quantitative review of the changes in China's household income, expenditure patterns, food consumption, dietary status, and food policy since 1950. China's yearly food balance sheets from 1950 to 1991 are compiled to estimate the average per capita daily nutrient availability and sources. Chapter 3 discusses selected methodological issues for demand analysis. The standard consumer demand theory is extended to model consumer demand under rationing and dual pricing. A non-nested hypothesis test proposed by Vuong (1989) is adopted to examine the relative explanatory power of two non-nested demand systems such as the AIDS and translog demand system. Selected applications of demand systems in policy analysis are also discussed. Chapter 4 describes the data sources and estimation procedures used for estimating the associated demand systems. Chapter 5 presents the estimation results for both urban and rural households. Chapter 6 reports the results of policy simulation analysis using the estimated demand systems. Chapter 7 summarizes major conclusions of the study and presents suggestions for further research.

CHAPTER 2. CHINA'S HOUSEHOLD EXPENDITURE PATTERNS AND DIETARY STATUS

This chapter consists of four sections. Section 1 presents a brief profile of Chinese consumers. Section 2 reviews the changes in China's average per capita income and household expenditure patterns since the early 1950s. Although China's historical data are incomplete, an effort is made to trace the changes from 1950 to 1992. Section 3 presents a quantitative assessment of the changes in China's average food consumption and dietary status since 1950. The average per capita daily nutrient availability and sources are estimated through the compilation of annual food balance sheets (FBS) from 1950 to 1991. The last section analyzes the impacts of China's institutional and policy changes on food consumption and dietary improvement since 1950 and on household expenditure patterns since the 1978 economic reform.

Consumer profile

As the world's most populous country, China's population increased from 541.67 million in 1949 to 1185.17 million in 1993. The annual population growth rate during 1950 to 1993, plotted in Figure 2.1, indicates that China's population growth since the early 1970s has been significantly slower than that in the 1950s and 1960s except for the food crisis period around 1960. The decline in population growth rate is mainly a result of China's population control efforts initiated in the early 1970s. Frustrated with food shortage and many other problems caused by rapid population growth, the Chinese government initiated its population control efforts in the early 1970s by introducing a set of education and policy measurements

to encourage unmarried adults to marry at a mature age and each couple to have only one child. These measurements reduced China's population growth rate from 2.877 percent in 1970 to 1.403 percent in 1976 (see Figure 2.1).

To further reduce its population growth rate, the Chinese government published the family planning law in 1979 to legally enforce each couple to have only one child. But the law has not been enforced strictly in rural areas because so many rural couples strongly prefer more than one child, especially when the first one is a girl. China's population control programs in rural areas were also significantly interrupted by the dismantlement of the commune system around 1980. In response to the fluctuation and slight increase in population growth rate in the early 1980s, the Chinese government has made population control a top priority in its rural policy since the mid-1980s. As a result of the government's great efforts to enforce the family planning law under the new economic system, China's population growth rate has declined continuously since 1987 (see Figure 2.1). Although China's population policy has frequently been criticized by some western countries based on human right concerns, the decline in population growth rate has contributed significantly to the improvement of dietary status and living standard in China since the early 1970s.

China's population has been divided into rural and urban residents by an elaborate household registration system since the mid-1950s. Because urban residency is regarded as a privilege with enormous legal and administrative implications, population movements from rural to urban areas have been strictly restricted by the government. As shown in Figure 2.2, the percentage of urban population in China increased significantly in the 1950s, then slightly declined in the 1960s and 1970s, and has increased again since the 1978 economic reform. The significant growth of urban population in the 1950s was a result of the rapid industrial development, whereas the growth since 1978 partially reflects a broadening definition of urban residency and partially reflects the policy changes favoring the growth of small cities and

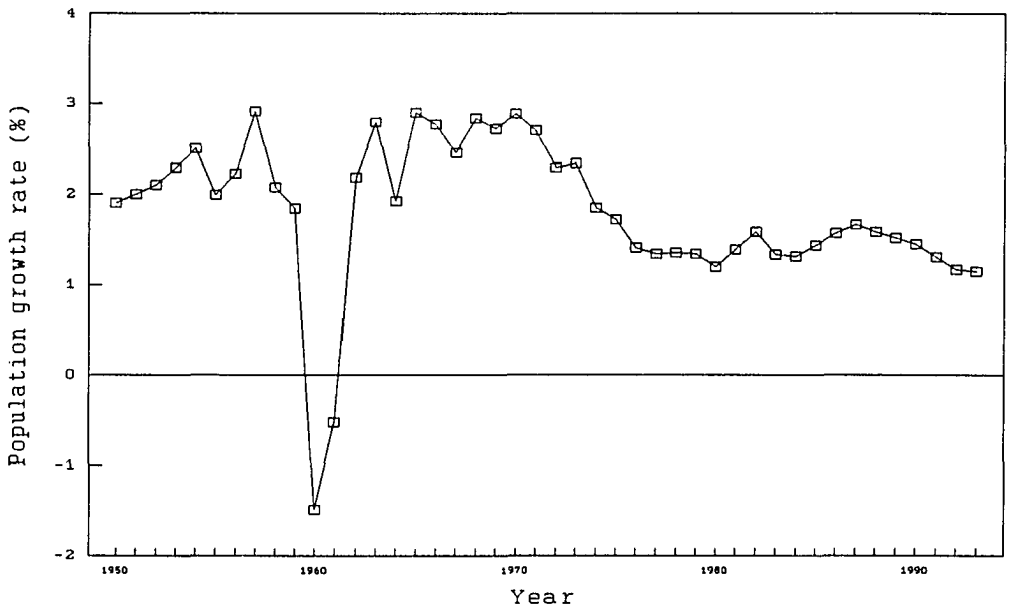

Figure 2.1. China's population growth rate

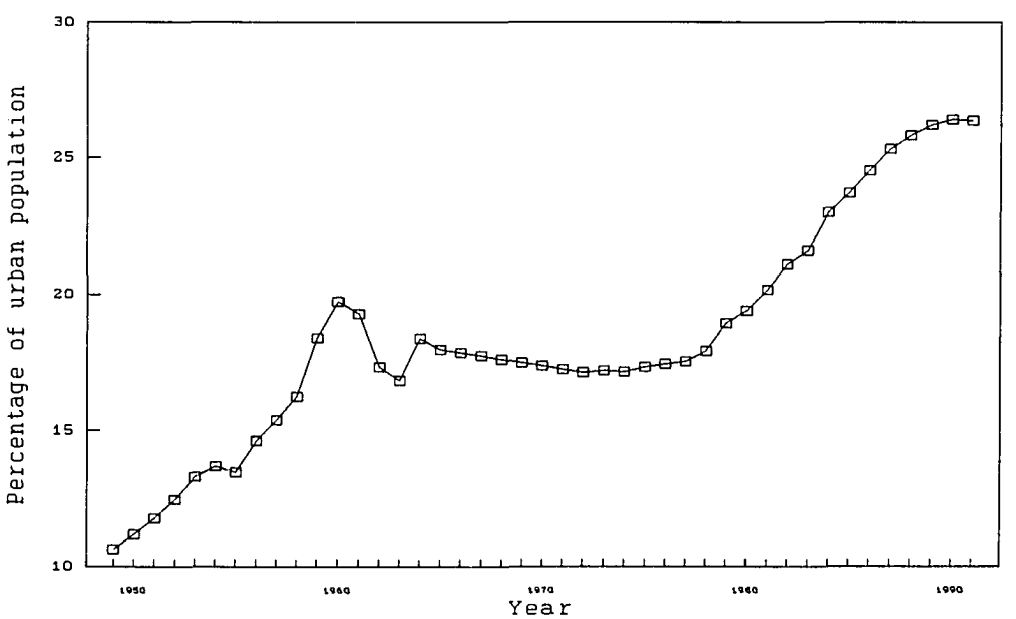

Figure 2.2. Percentage of urban population in China

towns (Taylor and Hardee 1986).

Households are the basic consumption units in both rural and urban China. Data from China's household surveys indicate that the average family size in urban areas has always been smaller than that in rural areas. The data also suggest that the average family size in both rural and urban areas has declined since the early 1970s (State Statistical Bureau of China 1983-1993). As shown in Figure 2.3, the average family size in rural areas declined continuously from 5.54 in 1980 to 4.67 in 1992, whereas that in urban areas decreased from 4.39 to 3.37 in the same period. The downward trend in family size is partially because each couple has fewer children and partially because more married couples tend to live separately with their parents.

To provide a general picture of Chinese consumers, some background information about both urban and rural population in 1991 is summarized in Table 2.1.

Per capita income and household expenditure patterns

Data on China's average per capita income from 1949 to 1977 are extremely limited. The available data plotted in Figure 2.4 suggest that the real average per capita income of both rural and urban residents in China increased insignificantly prior to 1978 but has increased rapidly since the 1978 economic reform. The real income of urban residents is derived from nominal income using the *urban living cost index*, whereas that of rural residents is derived from nominal income using the *rural retail price index*. The base year for both indexes is 1950. Figure 2.4 also indicates that the average income of urban residents has been significantly higher than that of rural residents and the difference has increased since the mid-1980s.

Given the fact that wages have been the major income source of urban households

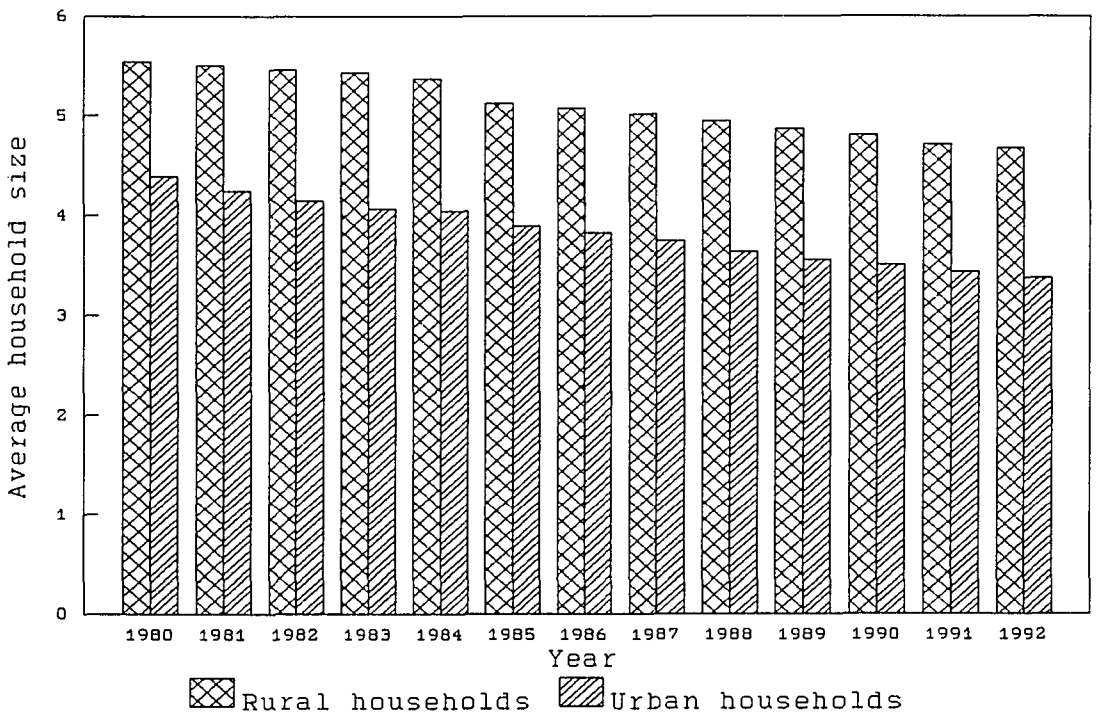

Figure 2.3. Average household size in China

Table 2.1. A profile of Chinese consumers in 1991[1]

	Rural	Urban	China
Population (million)			
Male	n.a.	n.a.	594.660
Female	n.a.	n.a.	563.570
Total	852.800	305.430	1158.230
Population growth (%)			
Birth rate	2.117	1.549	1.968
Death rate	0.713	0.550	0.670
Growth rate	1.404	0.999	1.298
Labor supply (million)	430.930	152.680	583.610
Family size (person)	4.710	3.430	4.350
Education level of people aged 6 and above in 1990 (%)			
Illiteracy	n.a.	n.a.	20.604
Preliminary school	n.a.	n.a.	42.271
Middle school	n.a.	n.a.	26.496
High school	n.a.	n.a.	7.303
College	n.a.	n.a.	2.706
University	n.a.	n.a.	6.617

Source: State Statistical Bureau of China, *China's Statistical Yearbook*, 1991-1992 volumes.

[1] Data on education level are for 1990.

n.a. Not available.

and more than 75 percent of the urban laborers have been employed in state-owned units, the real average wages in all state-owned units can provide useful information on the changes in China's average urban income. Figure 2.5 shows that the real average wages fluctuated around a low level from 1952 to 1977 and has increased significantly since the late 1970s.

The expenditure structure of Chinese rural and urban households for selected years since 1950 is summarized in Table 2.2 and Table 2.3. Household expenditure is divided into 7 major groups (food, clothing, daily articles, housing, fuel, health care, and others). The food group is further divided into three subgroups (grains, non-staple food, and other food). According to the Chinese statistical system, grains include fine grains (wheat and rice) and coarse grains (corn, barley, oats, etc.); non-staple food includes animal products, vegetables, fruits, melons, sugar, cookies, edible oils, etc.; and other food includes cigarettes, liquor, beer, wine, and tea.

Table 2.2 indicates that the share of food expenditure of rural households declined from 68.59 percent in 1954 to the lowest level of 53.41 percent in 1988 and has then fluctuated around a level higher than the 1988 level. Within the food group, the expenditure shares of non-staple food and other food have increased significantly since 1978. The changes in food expenditure shares indicate China's ongoing transition in food consumption pattern from grains to animal products such as meats. Another notable change is the significant increase in expenditure share of housing. As a result of the rapid income growth and reduction of government control over house construction, more than 20 percent of Chinese rural households have built new houses since 1978 (An 1990; State Statistical Bureau of China 1993). The slight decline in the expenditure share of housing since 1988 may be a result of the Chinese government's efforts to restrict house construction in rural areas for the purpose of saving arable land.

Table 2.3 shows that the share of food expenditure of urban households declined

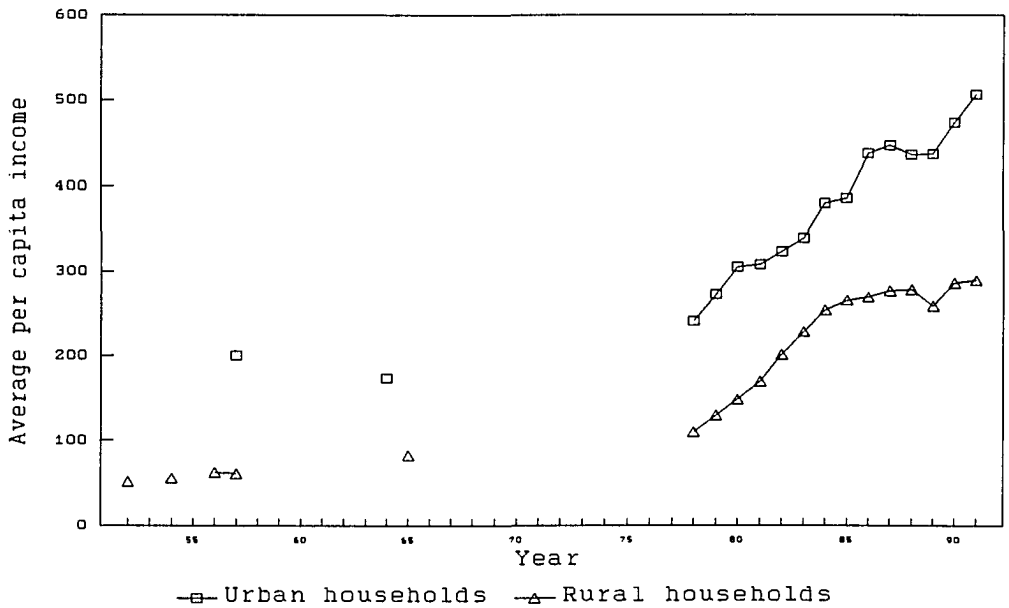

Figure 2.4. Real average per capita income in China

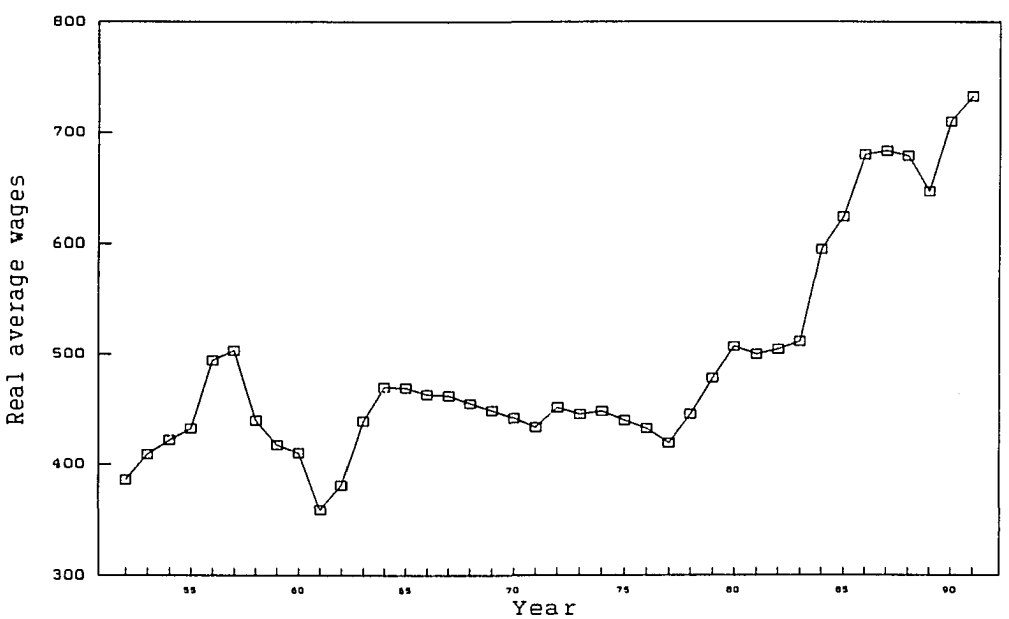

Figure 2.5. Real average wages in all state-owned units in China

Table 2.2. Expenditure shares of Chinese rural households

Year	Food				Clothing	Daily articles	Housing	Fuel	Health care	Others
	Grains	Non-staple food	Other food	All food						
	--- Percent ---									
1954	n.a.	n.a.	n.a.	68.59	13.08	6.97	2.06	6.58	n.a.	n.a.
1956	n.a.	n.a.	n.a.	68.14	13.27	6.42	2.03	7.52	n.a.	n.a.
1957	n.a.	n.a.	n.a.	65.75	13.43	6.94	2.10	10.03	n.a.	n.a.
1965	n.a.	n.a.	n.a.	68.46	10.51	7.18	2.83	8.31	n.a.	n.a.
1978	44.23	21.26	2.23	67.72	12.70	6.57	3.16	7.13	n.a.	n.a.
1979	41.16	20.71	2.09	63.96	13.11	8.28	5.69	6.20	n.a.	n.a.
1980	37.33	21.74	2.69	61.76	12.32	9.44	7.89	5.96	n.a.	n.a.
1981	32.01	21.75	5.90	59.66	12.35	10.22	9.78	5.55	n.a.	n.a.
1982	32.12	21.73	6.63	60.48	11.25	10.17	10.25	5.61	n.a.	n.a.
1983	30.22	21.62	7.45	59.29	11.14	9.36	11.10	5.43	1.47	2.21
1984	n.a.	n.a.	n.a.	59.00	10.40	n.a.	11.70	5.50	n.a.	n.a.
1985	26.22	23.00	8.53	57.75	9.87	9.63	12.43	5.72	1.73	2.87
1986	n.a.	n.a.	n.a.	56.30	9.90	n.a.	14.40	5.20	n.a.	n.a.
1987	21.98	23.65	9.52	55.15	8.59	9.96	14.50	4.84	1.89	5.07
1988	19.52	24.27	9.62	53.41	8.64	10.83	14.92	4.55	1.99	5.66
1989	18.58	25.24	10.27	54.09	8.29	10.10	14.39	4.39	2.14	6.60
1990	23.17	24.99	9.88	58.04	7.76	8.66	11.85	4.53	2.26	6.90
1991	21.44	25.13	10.28	56.85	8.23	9.24	11.12	4.33	2.41	7.82
1992	21.18	25.35	10.28	56.81	7.96	9.36	10.34	4.38	2.48	8.67

Source: State Statistical Bureau of China, *China's Statistical Yearbook*, 1983-1993 volumes.

n.a. Not available.

Table 2.3. Expenditure shares of Chinese urban households

Year	Food				Clothing	Daily articles	Housing	Fuel	Health care	Others
	Grains	Non-staple food	Other food	All food						
	--- Percent ---									
1957	22.76	26.81	8.87	58.44	12.00	7.62	2.32	3.89	1.83	13.90
1964	22.40	28.17	8.65	59.22	10.98	5.98	2.61	4.24	1.85	15.12
1978	n.a	n.a.	n.a.	57.50	13.58	8.41	1.93	2.70	1.00	14.88
1981	12.95	30.71	13.00	56.66	14.79	9.56	1.39	1.94	0.60	15.06
1982	12.89	30.71	13.06	56.66	14.79	9.56	1.39	1.86	0.60	15.14
1983	12.17	32.83	14.20	59.20	14.54	9.04	1.52	1.73	0.62	13.35
1984	11.28	32.35	14.34	57.97	15.53	9.06	1.39	1.66	0.60	13.79
1985	8.95	30.14	13.16	52.25	14.56	10.68	0.96	1.80	0.93	18.82
1986	8.11	30.35	13.97	52.43	14.15	11.13	0.90	1.62	0.95	18.82
1987	7.57	31.30	14.61	53.48	13.69	11.37	0.87	1.54	1.00	18.05
1988	6.85	31.36	13.42	51.36	13.88	13.46	0.71	1.51	1.14	17.94
1989	6.76	33.55	14.19	54.50	12.32	11.06	0.73	1.68	1.32	18.39
1990	6.61	32.94	14.70	54.25	13.36	10.14	0.74	1.79	1.54	18.18
1991	7.05	32.29	14.49	53.83	13.73	9.62	0.73	2.02	1.72	18.35
1992	6.25	n.a.	n.a.	52.93	14.39	9.68	0.86	n.a.	2.48	n.a.

Source: State Statistical Bureau of China, *China's Statistical Yearbook*, 1983-1993 volumes.

n.a. Not available.

from 58.44 percent in 1957 to 51.36 percent in 1988 and has then been higher than the 1988 level. Because housing and health care have been under state subsidies for urban residents since the early 1950s, Chinese urban households have spent a small percentage of their income on housing and health care. Housing reform to reduce state expenditure has been discussed in China since the mid-1980s, but little progress has been reported.

Comparisons of household expenditure structure between Chinese urban and rural households are difficult because urban residents receive a wide range of income and consumption subsidies that are not available to rural residents. Taylor and Hardee (1986) have suggested that even if household survey data indicate similar consumption levels for a given commodity, the personal cost for rural residents may still be higher than that for urban residents. For this reason and the differences in data sources, this study will develop and estimate different demand models for Chinese urban and rural households.

Food consumption and dietary status

China's average per capita annual consumption of major food commodities for selected years from 1950 to 1970 and all years thereafter is reported in Table 2.4. It is obvious that the average food consumption changed modestly from 1950 to 1977 but has increased significantly since the 1978 economic reform. As staple food in China, per capita grain consumption increased steadily from 195.46 kg in 1978 to 252.67 kg in 1986 and has declined continuously ever since. The average per capita consumption of vegetable oils and animal products more than doubled during 1978 to 1992. The significant changes in China's average per capita food consumption since 1978 indicate not only the increase in food intakes but also the transition in food consumption patterns from grains to animal products.

To provide a quantitative assessment of the changes in China's average dietary status,

Table 2.4. China's average per capita annual food consumption

Year	Grains	Pork	Beef & mutton	Poultry	Eggs	Aquatic products	Edible oils
			--- Kilogram ---				
1952	197.07	5.92	0.92	0.43	1.02	2.67	2.10
1955	198.27	4.94	1.18	0.42	1.05	3.90	2.20
1960	163.62	1.53	1.03	0.36	0.49	3.91	1.87
1965	182.84	6.29	1.02	0.36	1.42	3.33	1.72
1970	187.22	6.02	0.82	0.32	1.32	2.94	1.61
1971	188.27	7.03	0.76	0.34	1.62	3.24	1.64
1972	172.51	7.56	0.78	0.36	1.53	3.13	1.67
1973	187.64	7.63	0.67	0.35	1.68	3.20	1.66
1974	190.52	7.67	0.71	0.33	1.58	3.86	1.71
1975	190.52	7.63	0.72	0.35	1.63	3.26	1.73
1976	190.28	7.38	0.66	0.35	1.76	3.52	1.60
1977	192.07	7.25	0.71	0.36	1.85	3.23	1.56
1978	195.46	7.67	0.75	0.44	1.97	3.50	1.60
1979	207.03	9.66	0.82	0.57	2.08	3.22	1.96
1980	213.81	11.16	0.83	0.80	2.27	3.41	2.30
1981	219.18	11.08	0.85	0.84	2.44	3.57	2.94
1982	225.36	11.75	1.03	1.02	2.52	3.85	3.53
1983	231.52	12.31	1.10	1.18	2.95	4.00	4.01
1984	249.65	12.93	1.23	1.35	3.88	4.32	4.66
1985	251.69	13.84	1.31	1.56	4.93	4.84	5.08
1986	252.67	14.22	1.32	1.72	5.20	5.33	5.17
1987	248.88	14.39	1.43	1.71	5.50	5.49	5.60
1988	246.10	14.73	1.58	1.75	5.74	5.66	5.87
1989	239.12	15.36	1.58	1.79	5.88	6.17	5.35
1990	238.80	16.64	1.73	1.73	6.27	6.53	5.67
1991	234.50	17.44	1.79	1.98	7.10	6.79	5.89
1992	235.91	18.22	2.05	2.31	7.75	7.29	6.29

Sources: State Statistical Bureau of China, *China's Statistical Yearbook*, 1983-1993 volumes.

the average per capita daily nutrient availability and sources are estimated through the compilation of annual food balance sheets (FBS) from 1950 to 1991. Three major nutrients considered in this study are energy, protein and fat.

FBS estimate the quantities of food commodities available for direct human consumption as the differences between their domestic supply and the sum of all non-human food end uses. The former is the domestic production net of international trade and stock changes, and the later includes seed, feed, non-food industrial uses, waste during transportation and storage, and losses in processing. The estimates of food available for direct human consumption are then converted into average per capita daily nutrient availability according to the nutrient content of each food commodity and the mid-year population (Piazza 1986). In addition to average per capita daily nutrient availability, FBS also provide information about nutrient sources and food consumption patterns of the referenced population because the average per capita food and nutrient availability is calculated by food commodities and the shares of each commodity can be easily derived.

Use of FBS is one of the most useful ways to make a preliminary assessment of a referenced population's dietary status in many cases, especially in developing countries where dietary survey data are extremely limited. The Food and Agriculture Organization (FAO) first published FBS for 41 countries in 1949 and has continued a periodical series of three-year-average FBS for most countries.

There are a number of studies on China's dietary issues. But most of them are descriptive and yield substantially different results. For example, Imfeld (1976) claimed that China had eliminated hunger by the mid-1970s, whereas Smil (1981) and Lardy (1982) concluded that by the late 1970s the Chinese population's average diet was still no better than that in either the mid-1930s or the mid-1950s. Piazza's (1983, 1986) estimates of China's average per capita daily nutrient availability and sources for the period from 1950 to 1982,

derived through annual FBS, are superior to the previous attempts because of significant improvement of the data in the early 1980s. But even his results may overestimate the variation over time as a result of excluding food-stock changes in the FBS. The FAO's periodical series of three-year-average FBS for China and many other countries leave much to be desired due to their lack of documentation of sources, their methods of estimation and suspect assumptions.

By following the procedures presented by Piazza (1983, 1986), the time-series data for China's food production, changes in state-held grain stock, international trade, and non-human food end uses from 1950 to 1991 are compiled into annual FBS. As a major improvement over Piazza's estimates, this study includes the changes in state-held grain stocks in China's annual FBS and extends the period of estimation from 1982 to 1991. Detailed information on our estimation procedures and results has been reported by Wang et al. (1993).

To examine the effects of grain stocks, China's annual FBS are estimated with and without grain stock changes. The estimation results presented in Figure 2.6 and Figure 2.7 suggest that excluding grain stock changes in the FBS tends to underestimate the average energy and protein availability in lean years and overestimate it in bumper harvest years. Because grains have supplied a relatively small proportion of fat, the effect of stock changes on the estimate of fat availability is relatively small. The quantitative results clearly indicate that China's average per capita daily availability of the three macro nutrients has improved significantly since 1950. But the improvement has not been steady over time. Beginning with a low level in 1950, the average nutrient availability increased rapidly from 1950 to 1956, then fluctuated in the next four years and dropped to the lowest level in 1960. The average per capita nutrient availability increased significantly after the food crisis period around 1960, but did not recover the 1956 level until 1978. China has experienced rapid income growth and significant dietary improvement since the 1978 economic reform. After the rapid increase of

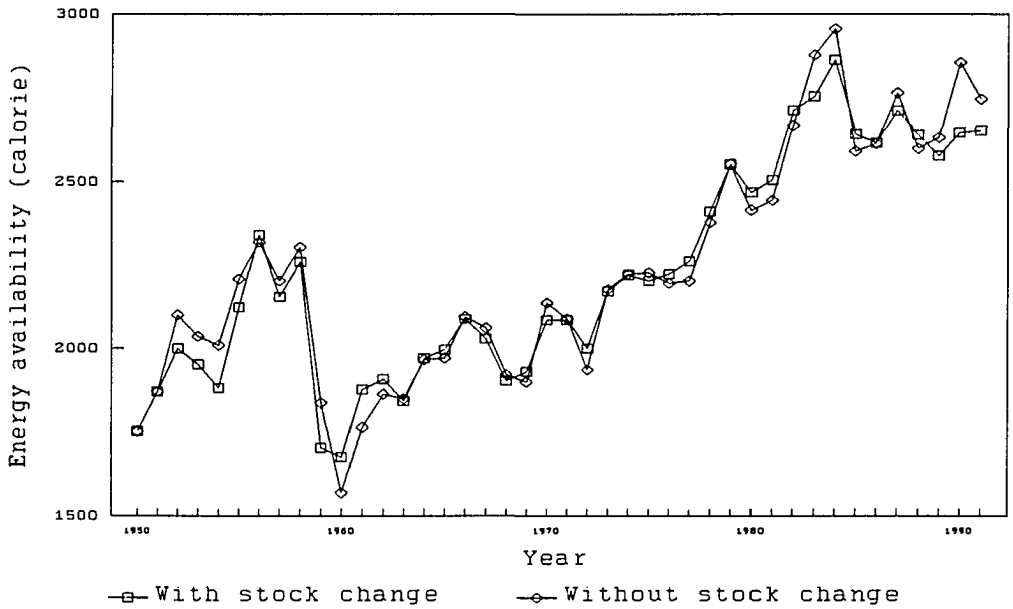

Figure 2.6. China's average per capita daily energy availability

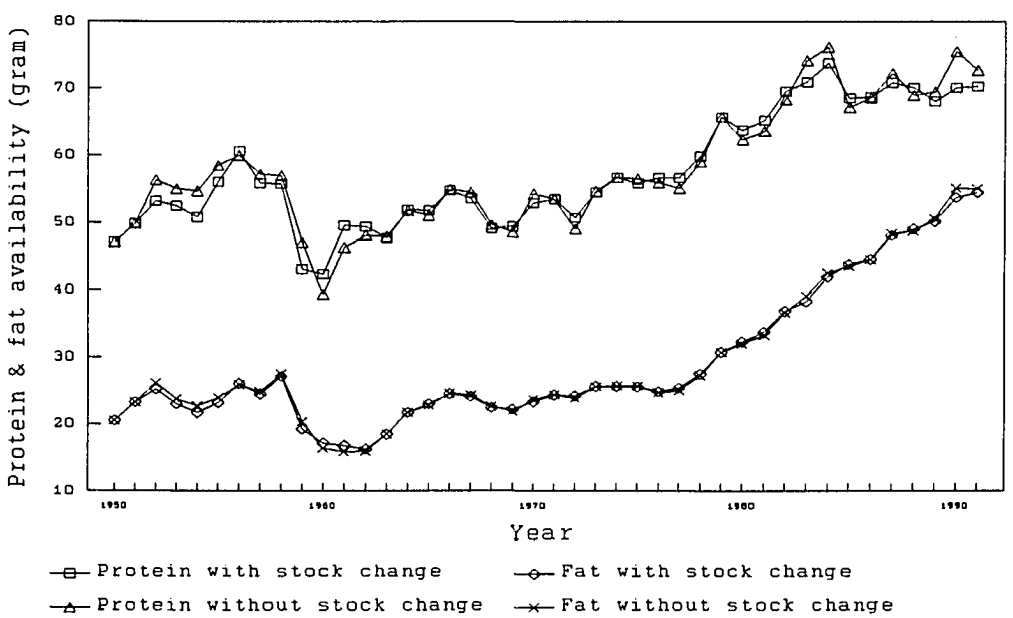

Figure 2.7. China's average per capita daily protein and fat availability

average per capita daily nutrient availability from 1978 to 1984, fat availability has increased continuously, while energy and protein availability has fluctuated close to 1982 and 1983 levels but less than the 1984 availability.

In addition to the absolute nutrient levels, nutrient sources are important indicators of a population's dietary status (Piazza 1986). An average low-income country has a diet typified by a high percentage of nutrients from crop sources, whereas a typical developed country has a mixed diet with a relatively high percentage of nutrients from animal sources. The percentages of nutrients from animal sources are presented in Figure 2.8 and Figure 2.9. The shares of energy and protein from animal sources were remarkably low and stable during 1950 to 1978, but more than doubled from 1979 to 1991. The share of animal fat fluctuated in the 1950s and has increased continuously since the early 1960s. The significant changes in nutrient sources since 1978 indicate China's ongoing transition in food consumption patterns to a more mixed diet.

Impacts of institutional and policy changes

Changes in China's average per capita food consumption and nutrient availability since 1950 correlate with major policy changes. The land reform around 1950 and the 1978 economic reform resulted in rapid growth in food production and significant improvement in nutrient availability and sources, but the commune system was most responsible for the food crisis around 1960 and the poor agricultural performance in most of the 1960s and 1970s.

By redistributing farmland from landlords to peasants, the nationwide land reform from 1949 to 1952 completely changed China's unequal land and income distribution system and therefore greatly stimulated peasants' production incentives. The annual FBS indicate rapid increases in average per capita nutrient availability in the early 1950s. China's rural

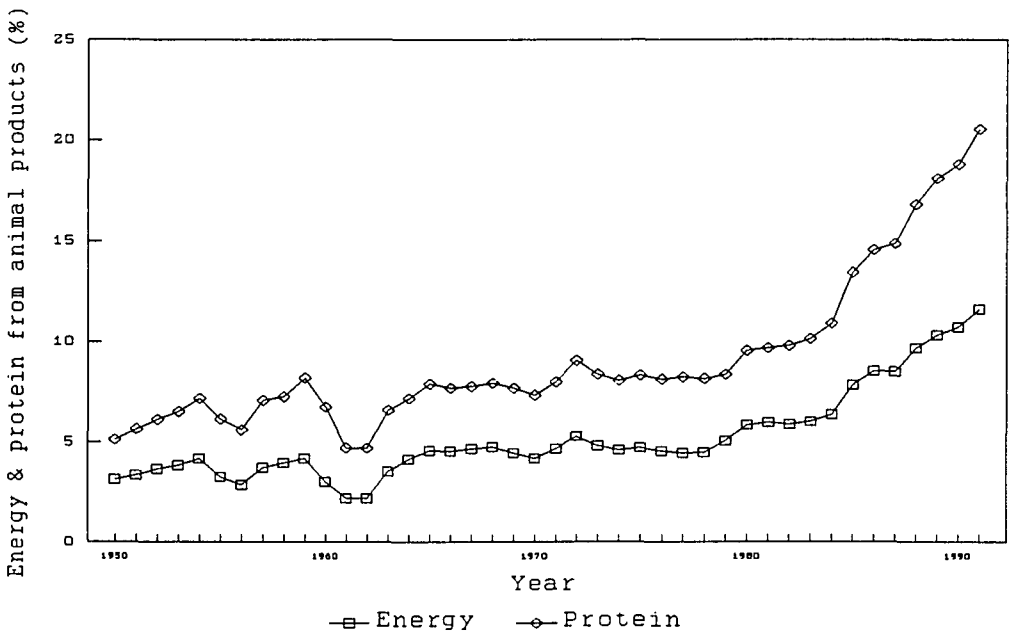

Figure 2.8. Percentage of energy and protein obtained from animal products

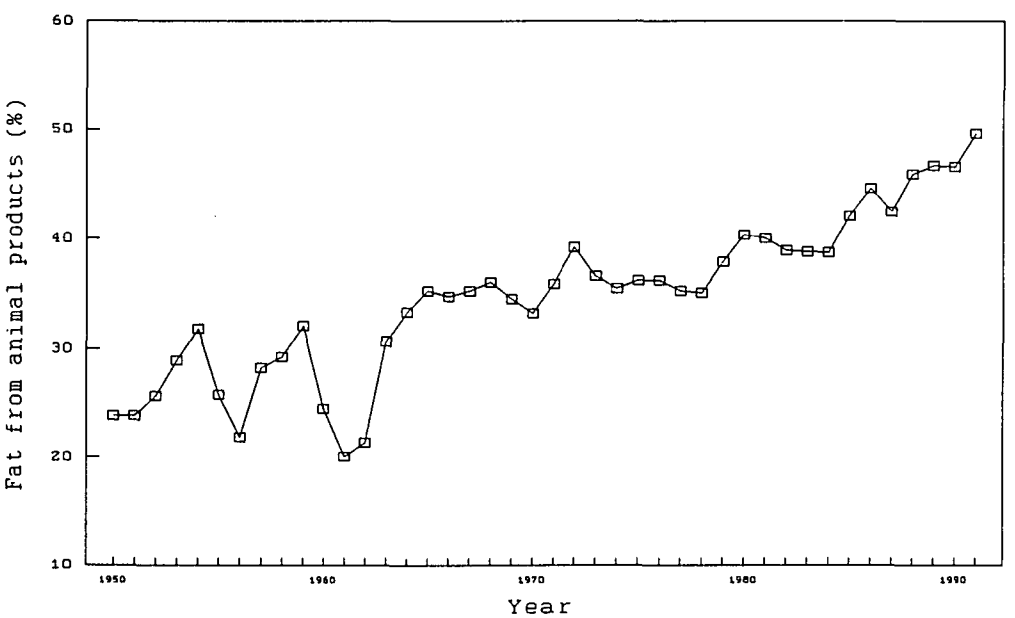

Figure 2.9. Percentage of fat obtained from animal products

collectivization, from household production units to small aid teams and then to agricultural cooperatives in the mid-1950s, significantly enabled land improvement and irrigation projects. But the central government overrated the positive impacts of collectivization and inappropriately merged the agricultural cooperatives into large communes nationwide in 1958.

Bad weather and the inappropriate institutional change precipitated the nationwide food crisis from 1958 to 1961. The crisis caused widespread malnutrition and 16-30 million deaths. Under the commune system, both production and distribution of almost all agricultural products were governed by rigid plans through the bureaucratic and communist party channels. Because food self-sufficiency was a high priority of the central government, peasants were allowed to produce only grains and a few other products to be used as industrial inputs according to state plans. Each production team had to deliver a certain amount of its products to the state at state-set artificially low prices (Walker 1984). The distribution of food and income within each production team was mainly based on household size and working hours rather than productivity. Weakened incentives and inefficient management slowed China's production growth and dietary improvement for about 20 years until the commune system was dismantled by the economic reform around 1980 (Hsu 1982).

China began its rural reform in 1978 by replacing the communes with the "household production responsibility system" in which farmland and production responsibilities are contracted to individual households. When the land contract was extended from 1-3 years around 1980 to 15-25 years in the late 1980s, the positive impacts of the new system were more fully evident (Lin 1988). In addition to the new system, the procurement price of farm products increased by an average of about 38% during the period from 1978 to 1984, while the price of major manufactured inputs, like chemical fertilizers, was almost unchanged. The favorable prices for grains contributed significantly to the rapid growth of grain output, from 304.7 mmt in 1978 to 407.3 mmt in 1984. But grain production stagnated in the next four

years at levels lower than that achieved in 1984, despite the fact that both direct and indirect demand for grains increased steadily due to income growth. Decreases in arable land (about 0.33 million hectares a year in the 1980s) and the price changes are identified as important sources of the stagnation of grain production (An 1989). During 1984 to 1988, the state purchase price for grains was basically unchanged, but the price of manufactured inputs soared year by year. Furthermore, the market price of some cash crops and animal products, which were not controlled by the state, increased significantly due to increased demand. Peasants shifted their production efforts from grains to more profitable activities.

Because of the stagnation of grain output and rapidly increasing demand, the Chinese government made grain production a top priority again in 1988 by implementing a set of measures to promote grain production, including increased purchase prices and state investment in agriculture. Together with good weather, these measures have brought about significant growth of grain production since 1988, from 400.5 mmt in 1988 to the record high of 456.44 mmt in 1993. The growth of grain output and consumer income also stimulated the rapid growth in production of many other preferred food products (e.g., animal products). China's red meat output increased from 8.56 mmt in 1978 to 29.41 mmt in 1992, while egg production increased from 2.0 to 10.2 mmt in the same period (State Statistical Bureau of China 1983-1993). The rapid growth in animal products has significantly improved China's average nutrient sources since 1978 (see Figure 2.8 and Figure 2.9).

Food trade has been another factor influencing China's food situation and dietary improvement since the early 1960s. As a net grain exporter with an average of 2.9 mmt per year in the 1950s, China first emerged as a net grain importer in 1961 and has since maintained a significant level of net grain import, except in 1985, 1986 and 1992. China's wheat and total grain imports during 1950 to 1992 are represented in Figure 2.10 and Figure 2.11. During 1961 to 1991 China's average annual wheat import was 6.97 mmt, averaging

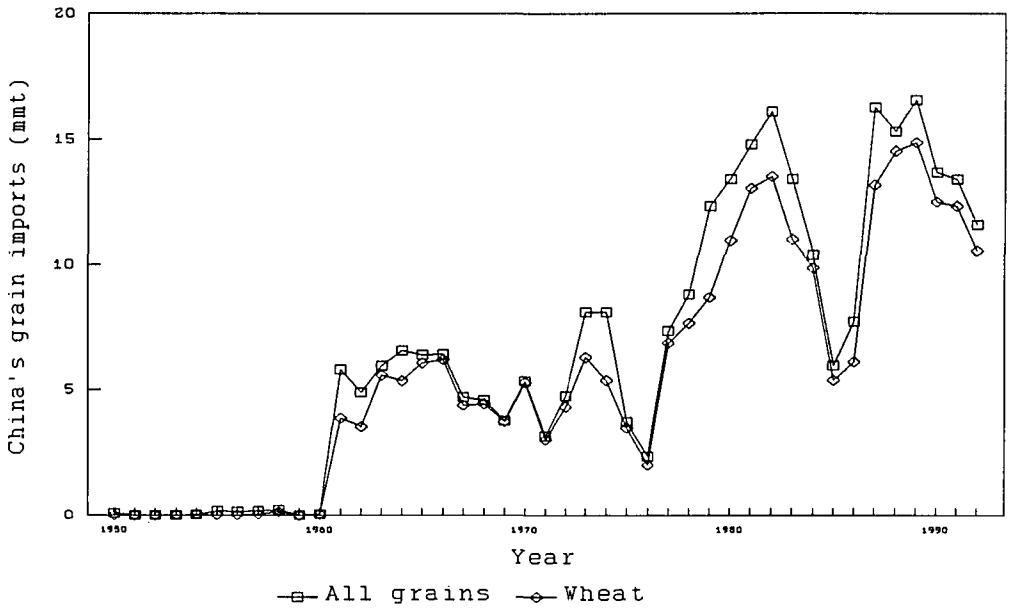

Figure 2.10. China's wheat and total grain imports

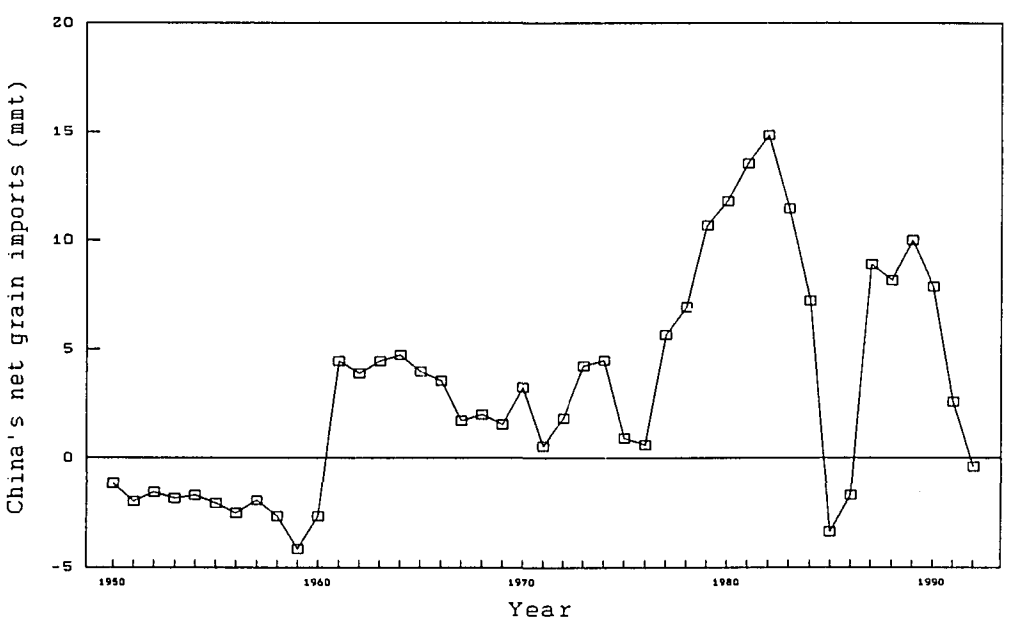

Figure 11. China's net grain imports

about 10 percent of the world's total traded volume. Although the Chinese government's delayed response to the food crisis that began in 1959 has been widely criticized, the sharp increase of net grain imports in the early 1960s did significantly increase the average per capita food and nutrient availability. During 1966 to 1976, the net grain imports fluctuated around low levels, ranging from 0.02 to 3.68 mmt. China's net grain imports increased gradually from 0.6 mmt in 1976 to the record high of 14.87 mmt in 1982, then decreased in the next four years. China was a net grain exporter in 1985 and 1986. The net grain imports were quite high during 1987 to 1990, but have dropped sharply since 1990 due to increased exports and decreased imports. The results of FBS suggest that the changes in net grain imports have significantly affected China's food and nutrient availability since the early 1960s. As China moves toward a market economy, its trade policy is likely to have much greater impacts not only on its food situation and dietary improvement, but also on the international food market.

China's institutional and policy changes since the 1978 economic reform also have brought about significant impacts on household expenditure patterns in both rural and urban areas. The reduction of government control over consumer goods and the expansion of the private sector have provided the Chinese consumers with increased choices in allocating their budgets and more sovereignty in determining what will be produced or imported for domestic consumption. For urban consumers, they can purchase food from state-owned stores and free markets. The state-owned stores may offer relatively lower and stable prices but fewer choices, whereas the free markets provide a wide range of fresh food with market-determined prices. For rural households, they make production and consumption decisions according to their own consumption preference, market conditions and their contracts with the state. Peasants can sell their products directly to urban consumers through free markets. Table 2.5 shows that the number of free markets and trade values in both rural and urban areas have

Table 2.5. Number of free markets and trade values in China

Year	Number of free markets			Total trade values		
	Rural	Urban	Total	Rural	Urban	Total
				--- Million yuan ---		
1980	37890	2919	40809	21.17	2.37	23.54
1981	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1982	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1983	43515	4488	48003	32.79	5.14	37.93
1984	50356	6144	56500	38.17	7.52	45.69
1985	53324	8013	61337	51.16	12.07	63.23
1986	57909	9701	67610	66.21	24.44	90.65
1987	58775	10908	69683	81.08	34.71	115.70
1988	59178	12181	71359	107.60	54.53	162.13
1989	59019	13111	72103	125.00	72.36	197.36
1990	59473	13016	72579	133.04	83.78	216.82
1991	60784	13891	74675	154.29	107.92	262.22
1992	64678	14510	79188	194.70	158.30	353.00

Source: State Statistical Bureau of China, *China's Statistical Yearbook*, 1983-1993 volumes.

n.a. Not available.

increased rapidly since 1980. The development of free markets also have enforced state-owned stores to improve their efficiency and services. Strong competition between the state and private sectors has been reported from China.

As a result of the rapid development of free markets and policy changes from commodity subsidy through food rationing to income subsidy for urban residents, the shares of many food commodities provided to urban residents directly by peasants through free markets have increased rapidly since 1978. The changes in free market shares of retail quantities or values for major food commodities are summarized in Table 2.6. The free market shares for all food commodities have increased significantly since 1978, but the retail of grains and vegetable oils is still dominated by the state sector. The Chinese government has highly emphasized the stability of grain supply for urban residents by purchasing grains from peasants through contracts.

Chinese urban households have received a wide range of subsidies from the government since the late 1950s. Table 2.6 shows that the Chinese government allocated more than 10 percent of its total expenditure to price subsidy for urban residents from 1981 to 1990. Price subsidy for urban residents has contributed significantly to the increased state deficit. Reducing state expenditure on price subsidy has been identified as a major task of China's economic reform in the 1990s.

Table 2.6. Free market shares of retail quantities or values of major food commodities in China[1]

Year	Grains	Edible oils	Pork	Beef	Mutton	Poultry	Eggs	Aquatic products	Fruits	Vegetables
					--- Percent ---					
1978	2.53	2.29	1.43	10.11	10.31	28.56	9.80	6.85	11.56	14.67
1979	4.08	2.39	3.46	12.76	13.48	38.20	14.62	9.92	14.97	19.41
1980	5.64	3.97	5.04	26.19	27.88	52.90	21.62	13.31	20.88	22.22
1981	5.89	4.06	7.52	36.87	28.08	54.82	27.27	22.33	30.73	31.50
1982	6.31	4.51	8.97	34.54	26.24	52.49	9.38	20.06	31.48	32.98
1983	6.34	4.42	10.16	37.11	30.06	57.96	29.38	26.35	31.94	32.98
1984	5.50	4.75	12.52	36.29	35.36	61.66	28.67	32.94	37.88	39.47
1985	6.10	6.45	23.69	46.52	48.03	67.27	46.70	44.34	37.04	42.50
1986	6.67	9.32	27.18	48.30	52.13	67.93	54.39	47.56	46.44	50.93
1987	7.08	9.40	27.96	47.88	49.81	70.35	53.30	46.89	43.26	45.79
1988	6.93	12.24	27.05	47.28	54.31	67.11	54.87	50.14	51.44	54.86
1989	6.61	11.47	26.13	49.42	54.83	68.57	53.72	49.05	55.16	57.85
1990	6.51	12.57	25.65	50.01	53.78	68.30	47.88	48.80	61.41	61.79
1991	7.68	13.36	27.88	52.98	56.65	70.82	47.94	51.48	68.63	73.42
1992	8.20	13.10	25.77	52.97	58.69	63.89	46.64	51.61	n.a.	n.a.

Source: Calculated from original data obtained from State Statistical Bureau of China, *China's Statistical Yearbook*, 1983-1993 volumes.

[1] All figures are quantity shares except for fruits and vegetables which are value shares.

n.a. Not available.

Table 2.7. China's state expenditure on price subsidies for urban residents

Year	Price subsidy				Percentage of total state expenditure
	Grains, edible oil and cotton	Meats	Others	Total	
	--- Billion yuan ---				
1978	1.114			1.114	1.003
1979	5.485		2.435	7.920	6.217
1980	10.280		1.491	11.771	9.706
1981	14.222		1.719	15.941	14.297
1982	15.619		1.603	17.222	14.933
1983	18.213		1.524	19.737	15.270
1984	20.167		1.667	21.834	14.119
1985	19.866	3.352	2.961	26.179	14.191
1986	16.937	4.224	4.587	25.748	11.047
1987	19.543	4.274	5.643	29.460	12.032
1988	20.403	4.040	7.239	31.682	11.705
1989	25.947	4.053	7.034	37.034	12.181
1990	26.761	4.178	7.141	38.080	11.031
1991	26.703	4.246	6.428	37.377	9.801
1992	22.432	3.761	5.956	32.149	7.324

Sources: State Statistical Bureau of China, *China's Statistical Yearbook*, 1983-1993 volumes.

CHAPTER 3. CONCEPTUAL DEMAND MODELS

This chapter first discusses selected issues of consumer demand theory and then presents conceptual demand models for estimating China's household food demand and conducting policy analysis. Section 1 briefly reviews the consumer demand theory and demand functions derived from utility maximization or cost minimization. Section 2 presents the basic specification of the linear expenditure system (LES), the extended linear expenditure system (ELES), the almost ideal demand system (AIDS), and a generalized demand system that nests the AIDS and translog demand system. Section 3 modifies the AIDS to model consumer demand under strict and partial rationing. Section 4 discusses how to select demand systems for a particular application based on statistical hypothesis tests. A test procedure proposed by Vuong (1989) is adopted to examine the relative explanatory power of two non-nested demand systems such as AIDS and translog demand system. Section 5 presents a framework for projecting food demand and measuring the changes in consumer welfare caused by a price change using full demand systems.

Consumer demand theory and demand functions

Utility maximization and demand functions

Analysis of consumer behavior has historically occupied a central role in economic theory and applications. The objective of consumer demand theory is to explain how individuals allocate their income among many available goods. The theory indicates that a consumer chooses among the available alternative bundles of goods for the objective of maximizing his or her satisfaction derived from consuming the goods (Deaton and Muellbauer

1980). The consumer is assumed to be able to order the alternative bundles according to the level of satisfaction derived from them.

Under a set of regularity conditions about preference ordering such as the axiom of transitivity and continuity, the consumer's preference ordering for alternative bundles of goods can be translated into a utility function which measures the level of satisfaction the consumer experiences as a result of consuming a particular bundle of goods. Because a consumer's total expenditure can not exceed his or her total income, the feasible choices of goods are limited by a budget constraint. With these assumptions, the decision problem of a typical consumer is simply to maximize a utility function subject to a budget constraint:

$$\begin{aligned} &\text{Maximize} && u(q_1, q_2, \ldots, q_n) \\ &\text{subject to} && \sum_{i=1}^{n} q_i p_i = y \end{aligned} \tag{3.1}$$

where $(q_1, q_2, \ldots, q_n)$ is a quantity vector of n goods, $(p_1, p_2, \ldots, p_n)$ is a vector of the associate prices, y is total income, and $u(\cdot)$ is the utility function measuring the consumer's satisfaction. The consumer demand theory assumes that $u(\cdot)$ is strictly increasing, strictly quasi-concave, and twice continuously differentiable (Deaton and Muellbauer 1980). When the prices and income are given for a particular specification of the utility function, this maximization problem can be solved by the straightforward application of differential calculus such as the Lagrange technical. The solution of the maximization problem is a set of demand functions that can be denoted by $q_i = g_i(p_1, p_2, \ldots, p_n, y)$. These functions derived from utility maximization are called the ordinary or Marshalian demand functions.

One important concept associated with the utility maximization problem is the indirect utility function which is obtained by substituting back the Marshalian demand equations into

the utility function in (3.1). The indirect utility function represents the maximum utility level (u^*) the consumer can achieve for a given set of prices and a particular income. As an important implication of the indirect utility function, the Roy's identity can be applied to a specific specification of the indirect utility function to derive Marshalian demand functions. The mathematical procedures of deriving the demand functions and the theoretical restrictions and properties of the demand and utility functions are not reviewed in this dissertation because they are directly available in several books (e.g., Deaton and Muellbauer 1980; Johnson et al. 1984; Goungetas and Johnson 1992).

Duality

The duality theory of mathematical optimization suggests that the utility maximization problem in (3.1) can be equivalently formulated as a cost minimization problem:

$$\begin{aligned} &\text{Minimize} && c = \sum_{i=1}^{n} q_i p_i \\ &\text{subject to} && u(q_1, q_2, \ldots, q_n) = u^* \end{aligned} \qquad (3.2)$$

where c is the total cost or expenditure and u^* is the maximum attainable utility level for a given set of prices and a particular income. Solving the cost minimization problem yields a set of demand functions that can be denoted by $q_i = h_i(p_1, p_2, \ldots, p_n, u^*)$. The demand functions derived from this procedure are called income compensated or Hicksian demand functions.

Similar to the indirect utility function, the cost function which measures the minimum cost of attaining u^* for a given set of prices can be obtained by substituting the Hicksian demand equations into the objective function in (3.2). As one important implication of the cost function, Hicksian demand functions can be derived directly from a specific specification of the cost function by using the Shephard's lemma. The concept of cost function is important

for understanding the recent advances in applied analysis of consumer behavior. For example, the almost ideal demand system (AIDS) to be discussed in the next section is derived from a particular specification of the cost function. The properties of cost and Hicksian demand functions are directly available in several books (e.g., Deaton and Muellbauer 1980; Johnson et al. 1984; Goungetas and Johnson 1992).

The duality theory indicates that the optimal solutions from utility maximization and cost minimization should be the same because the two specifications are merely two alternative ways to solve the same optimization problem.

Engel functions and demand systems

Engel function and food demand analysis

The Engel's law indicates that the proportion of income spent on food declines as income rises. Since the publication of Engel's study mainly based on an examination of about 200 budgets of Belgian labors in 1857, the law has been found to hold in many other budget surveys. The percentage of income spent on food is called Engel coefficient and the functions used to estimate the relation between income and expenditure on food are called Engel functions. By assuming all the prices are constant, an Engel function is essentially a demand function that expresses the expenditure on a particular good as a function of only income. In addition to food commodities, Engel functions have been widely used to evaluate the relation between income and expenditure on many other commodities. For example, Engel coefficient can be used to classify goods into luxuries, necessities, and inferior goods (Deaton and Muellbauer 1980).

Previous studies of China's household food demand indicate that the shares of food expenditure for Chinese urban and rural households have fluctuated and remained fairly high

since the 1978 economic reform although income has increased continuously (e.g., Lewis and Andrews 1989; Chern and Wang 1992). It is important to investigate the structural relationship between income and food expenditure in China because understanding the relationship will enable us to quantify the impacts of income changes on food demand. Furthermore, information derived from Engel functions will help us to specify appropriate demand models for Chinese households. For this purpose, this study will estimate Engel functions for several food groups and major food commodities for Chinese urban and rural households.

Among the various forms of Engel functions available in the literature, the doublelog, semilog, and the Working-Leser forms have been widely used in demand studies (e.g., Leser 1963; Praise and Houthakker 1971; Chern and Wang 1992). The doublelog specification will be used in this study to examine the relation between income and food expenditure in China. The doublelog Engel function can be specified as:

$$\ln(EXP_i) = \alpha_i + \beta_i \ln(y) \tag{3.3}$$

where EXP_i is the expenditure on good i, y is total income, and α_i and β_i are parameters to be estimated. Under this specification, β_i directly gives the income elasticity of good i and the marginal budget share of good i can be calculated by $(w_i\beta_i)$ where w_i is the budget share of good i. Although this function form does not satisfy the adding-up restriction and has a constant income elasticity, Prais and Houthakker (1971) found it to be one of the best forms to use in empirical studies. The Engel functions can be estimated using the ordinary least squares approach.

Demand systems

As discussed in the previous section, there are essentially two types of demand functions: the ordinary (Marshalian) demand functions derived from utility maximization and income compensated (Hicksian) demand functions obtained from cost (expenditure) minimization. The derivation of a system of ordinary demand functions starts with a utility function having certain properties. Maximization of the utility function subject to a budget constraint yields a system of demand functions (Deaton and Muellbauer 1980). For example, the linear expenditure system (LES) is derived from the Klein-Rubin utility function (Powell 1974). The derivation of a system of income compensated demand functions starts with a cost (expenditure) function having certain properties such as homogeneity and concavity. Minimization of the cost function subject to a fixed level of utility results in a system of compensated demand functions.

Many demand systems have been developed from utility maximization and cost minimization with specific or approximated functional forms. The commonly used demand systems include the linear expenditure system (LES), extended linear expenditure system (ELES), quadratic expenditure system (QES), translog demand system, Rotterdam model, and the almost ideal demand system (AIDS). These demand systems in original and modified forms have been widely used in demand studies. Compared to Engel functions, demand systems allow us to estimate own and cross price elasticities which are important for making demand projections and policy analysis.

The ELES and AIDS are the basic demand systems to be used in this study. Because prices are not available for aggregated expenditure groups in the data sets from China's Rural Household Survey, the ELES is applied to estimate both income and price elasticities in the absence of direct observation on prices. The AIDS in linear forms is used for the commodities when their prices are available. Because consumption rationing has been widely used in

socialist countries such as China and Poland, a demand system with strict and partial rationing will be developed for Chinese urban households in the next section. For the purpose of comparing the estimation results from alternative demand systems, this study will estimate several demand systems and test their relative explanatory power using the same data base. The basic specifications of the LES, ELES, AIDS and a generalized demand system developed by Lewbel (1989) are presented in the following paragraphs. As an interesting property of the Lewbel model, it nests both AIDS and translog demand system and therefore allows us to test their relative explanatory power using nested hypothesis tests.

LES and ELES

LES is derived by maximizing a particular utility function proposed by Klein and Rubin (1948) subject to a budget constraint (Johnson et al. 1984). The derived demand system can be written as:

$$p_i q_i = p_i \gamma_i + \beta_i (y - \sum_{j=1}^{n} p_j \gamma_j) \tag{3.4}$$

where q_i and p_i are the quantity and price of good i, γ_i can be interpreted as the minimum consumption level of good i, and β_i is the parameter to be estimated. LES has been widely used in demand studies because it is easy to estimate and has simple interpretations. The consumer first purchases a minimum required quantity of each good (γ_i) at price p_i and then allocates the remainder of his or her income among the n goods in fixed proportions represented by β_i. Thus $\sum_{i=1}^{n} p_i \gamma_i$ and $(y - \sum_{i=1}^{n} p_i \gamma_i)$ can be considered as subsistence and supernumerary incomes. The formulas to compute income and price elasticities from LES are available in several books (e.g., Johnson et al. 1984).

ELES was generalized from LES by Lluch (1973). ELES is distinguished from LES by the inclusion of a saving-consumption decision. LES assumes that the consumer spends his or her total income denoted by y on the n goods, whereas ELES assumes that the consumer spends only a proportion of y on the n goods and leaves the rest for saving. A typical demand equation in an ELES can be written as:

$$p_i q_i = p_i \gamma_i + \beta_i^* (y - \sum_{j=1}^{n} p_j \gamma_j), \tag{3.5}$$

where β_i^* represents the marginal propensity to spend on good i and $\sum_{i=1}^{n} \beta_i^* = \mu$ is the aggregate marginal propensity to spend on the n goods. Adding all the expenditure equations gives the following total consumption function:

$$E = \sum_{i=1}^{n} p_i q_i = (1-\mu) \sum_{i=1}^{n} p_i \gamma_i + \mu y. \tag{3.6}$$

This equation enables us to estimate the demand system in the absence of price data in cross-section demand analysis. When all the households are assumed to face identical commodity prices, $(p_i \gamma_i)$ and $\beta_i^* \sum_{i=1}^{n} p_i \gamma_i$ are constants to the households. Then the following system of regression equations can be estimated:

$$E_i = \alpha_i + \beta_i^* y \tag{3.7}$$

where $\alpha_i = p_i \gamma_i + \beta_i \sum_{j=1}^{n} p_j \gamma_j$. When the above system is estimated, $(p_i \gamma_i)$ and μ can be estimated from the estimated coefficients of the system:

$$\mu = \sum_{i=1}^{n} \beta_i^* \tag{3.8}$$

$$\left(\sum_{i=1}^{n} p_i \gamma_i\right) = \frac{\sum_{i=1}^{n} \alpha_i}{(1-\mu)} \tag{3.9}$$

$$(p_i \gamma_i) = \alpha_i + \beta_i^* \left(\sum_{i=1}^{n} p_i \gamma_i\right). \tag{3.10}$$

Under these specifications, the expenditure and price elasticities can be computed as follows:

$$e_i = \frac{\beta_i^*}{w_i} \tag{3.11}$$

$$\eta_{ii} = \frac{(1-\beta_i^*)(p_i \gamma_i)}{E_i} - 1 \tag{3.12}$$

$$\eta_{ij} = -\frac{\beta_i^* (p_j \gamma_j)}{E_i}. \tag{3.13}$$

The ELES discussed above will be used in Chapter 5 to estimate food demand of Chinese rural households.

The almost ideal demand system (AIDS)

As indicated by its namce, the AIDS developed by Deaton and Muellbauer (1980) has a set of desired properties: it satisfies the axioms of choice exactly, aggregates over consumers perfectly, can be used to test the homogeneity and symmetry restrictions, etc. (Deaton and Muellbauer 1980). AIDS in original and modified forms has been widely used in empirical demand analysis (e.g., Dermot and Wahl 1992; Wang and Chern 1992; Wang and Jensen 1994).

The AIDS is derived from the following cost (expenditure) function representing the PIGLOG class of preferences:

$$\ln c(u,p) = (1-u)\ln a(p) + u \ln b(p) \tag{3.14}$$

where $a(p)$ and $b(p)$ are positive and linearly homogeneous and can be interpreted as the costs of subsistence and bliss. The function forms for $a(p)$ and $b(p)$ are chosen such that the first and second derivatives of the cost function can be set equal to those of an arbitrary cost function:

$$\ln[a(p)] = a_o + \sum_{k=1}^{n} \alpha_k \ln(p_k) + \frac{1}{2}\sum_{k=1}^{n}\sum_{j=1}^{n} \gamma_{kj} \ln(p_k)\ln(p_j) \tag{3.15}$$

$$\ln[b(p)] = \ln[a(p)] + \beta_o \prod p_k^{\beta_k} \tag{3.16}$$

With these function forms for $a(p)$ and $b(p)$, an expression relating budget shares to prices and utility level can be derived by applying the Shephard's lemma. The cost function is then solved for u and finally the AIDS in budget shares can be derived as:

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln(p_j) + \beta_i \ln\left(\frac{x}{p}\right) \tag{3.17}$$

where p is a price index defined by:

$$\ln(p) = \alpha_0 + \sum_{j=1}^{n} \alpha_j \ln(p_j) + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} \ln(p_i) \ln(p_j) \tag{3.18}$$

In empirical studies, the price index is commonly replaced by the Stone's price index to reduce the demand system into a linear system which is called the linear approximation of the AIDS (LA/AIDS). The Stone's price index is defined as:

$$\ln(p) = \sum_{j=1}^{n} w_j \ln(p_j) \tag{3.19}$$

The theoretic restrictions of demand systems (adding-up, homogeneity, and symmetry) can be directly imposed on the parameters to be estimated (Deaton and Muellbauer 1980). Alternative formulas of computing demand elasticities from AIDS and LA/AIDS have been summarized by Green and Alston (1990).

A generalized demand system

Lewbel (1989) proposed a flexible demand system that nests AIDS and translog demand system. The specification of the model begins with the following indirect utility function:

$$\ln[V(p,x)] = \sum_{i=1}^{n} \beta_i \ln(p_i) + \ln\left[d + \sum_{i=1}^{n} \alpha_i \ln(p_i) + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} \ln(p_i) \ln(p_j) \right.$$

$$\left. - \left(\sum_{i=1}^{n} \alpha_i + \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} \ln(p_j) \right) \ln(x) \right], \tag{3.20}$$

where p_i is the price of good i, and x is the total expenditure. By Roy's identity, the demand system in expenditure shares can be written as:

$$w_i = \frac{\alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln(p_j) + \beta_i \left(d + \sum_{j=1}^{n} \alpha_j \ln(p_j) + \frac{1}{2} \sum_{j}^{n} \sum_{k=1}^{n} \gamma_{jk} \ln(p_j) \ln(p_k) \right)}{1 + \sum_{j=1}^{n} \sum_{k=1}^{n} \gamma_{jk} \ln(p_k)}$$

$$- \frac{\sum_{j=1}^{n} \gamma_{ij} + \beta_i \left(1 + \sum_{j=1}^{n} \sum_{k=1}^{n} \gamma_{jk} \ln(p_k) \right) \ln(x)}{1 + \sum_{j=1}^{n} \sum_{k=1}^{n} \gamma_{jk} \ln(p_k)}. \tag{3.21}$$

The interesting property of equation (3.21) is that restrictions $\beta_i = 0$ for all i reduce the system to the translog demand system, whereas restrictions $\sum_{j=1}^{n} \gamma_{ij} = 0$ for all i lead to the AIDS. Thus the adequacy and relative explanatory power of the AIDS and translog demand system can be examined by testing these restrictions. Lewbel (1989) has shown that, similar to the LA/AIDS used in empirical studies, a mechanical price index such as the Stone's price index can be used to replace the following terms in equation (3.21):

$$d+\sum_{j=1}^{n}\alpha_i \ln(p_j)+\frac{1}{2}\sum_{j=1}^{n}\sum_{k=1}^{n}\gamma_{jk}\ln(p_j)\ln(p_k). \tag{3.22}$$

The adding-up, homogeneity and symmetry properties can be imposed by the following restrictions:

$$\sum_{i=1}^{n}\alpha_i = 1,\ \sum_{i=1}^{n}\sum_{j=1}^{n}\gamma_{ij} = 0,\ \sum_{i=1}^{n}\beta_i = 0 \text{ and}$$

$$\gamma_{ij} = \gamma_{ji} \text{ for all } i \text{ and } j. \tag{3.23}$$

The expenditure and price elasticities for this demand system can be derived from (3.21) (see Lewbel 1989; Yen and Chern 1992).

Separability and multiple-stage budgeting

The consumer demand theory discussed above indicates that consumer demand for each good and service can by estimated from a utility maximization or cost minimization approach. In the real world each individual consumes a large number of goods and services. Estimating the demand parameters for all the goods and services by including them into a utility or cost function can be difficult and even impossible due to data limitation and econometric problems. For example, there are 21 food commodities, 15 cloth items, and 25 other commodities in the data set from China's Urban Household Survey, it is obviously difficult to estimate any demand system with 61 equations. Some theoretical assumptions on consumer demand behavior may simplify the problem and allow us to estimate demand parameters for a large number of goods and services. For example, the symmetry restrictions

can significantly reduce the number of parameters to be estimated for a demand system and the separability assumption makes it possible to aggregate the large number of goods and services into groups and therefore reduce the number of demand equations to be estimated.

Separability implies that goods possessing similar characteristics may be grouped and the fundamental consumption problem then can be modeled as a multiple-stage decision problem. The basic types of separability include strong separability, weak separability and Pearce separability. For the purpose of this study, only weak separability is discussed here.

Suppose the goods and services available to the consumer can be grouped into s groups $\{N_1, N_2, \ldots, N_s\}$. The necessary and sufficient condition for a set of goods and services to be weakly separable with respect to the set of commodity group N if the marginal rate of substitution between two goods, i and j, from the group N_a is independent of the quantities of goods from any other group N_b. The condition can be written as:

$$\frac{\partial\left(\frac{v_i}{v_j}\right)}{\partial x_k} = 0 \quad \text{for all } i, j \subset N_a, k \subset N_b \text{ and } N_a \neq N_b. \tag{3.24}$$

where v_i and v_j are the partial derivatives of the utility function $v(\cdot)$ with respect to the quantity of good i and j. The definition for other types of separability is directly available in several books (e.g., Johnson et al. 1984; Goungetas and Johnson 1992).

When weak separability is assumed, the multiple-stage budgeting procedure can be applied. A three-stage budgeting procedure will be discussed in Chapter 5.

Household demand under rationing

Consumer demand under rationing

The standard consumer demand theory assumes that the consumer can freely choose the quantities of goods and services at their prevailing market prices to maximize his or her utility subject to a budget constraint. However, often the consumption levels of many goods and services are not directly controlled by consumers. For example, a consumer may face an upper limit on consumption of a good under rationing, and even involuntary unemployment in the labor market can be thought of an enforced consumption of leisure. Deaton (1981) and Neary and Roberts (1981) have used the term "rationing" to deal with all the situations which involve quantity constraints on consumer behavior.

Much of the early work on rationing was done during and immediately after the World War II when rationing was introduced in some western countries such as Great Britain and the United States (Tobin 1952; Chow 1987). Studies published in that period is surveyed by Tobin (1952). Although rationing has been practiced in many socialist countries like China and Poland since the early 1950s (Chow 1987; Wang and Chern 1992; Podkaminer 1989), there appeared to be little interest in the subject during the most of the 1950s and 1960s after the rationing was abolished in western countries. However, consumer behavior under rationing has received increased attention in recent years (e.g., Neary and Roberts 1980; Deaton 1981; Chow 1987; Podkaminer 1989; Wang and Chern 1992). The impetus for the interest has come from the increasing demand for improvement of policy making in reforming socialist countries where rationing is a regular feature of the economy (Wang and Chern 1992), and also from general equilibrium contexts in which markets depend on the properties of supply and demand functions under quantity constraints (Deaton 1981).

Chow (1987) has classified the forms of rationing into three groups: ***straight***

rationing allows each consumer to buy no more than a given quantity of a commodity; ***point rationing*** assigns points to each rationed commodity which can only by purchased by money together with points (i.e., the commodity has a money price and a point price); and ***value rationing*** allows each consumer to buy no more than a certain money value of the rationed commodities. It is obvious that point rationing is the same as value rationing if the point prices equal money prices. The rationing for textiles in Great Britain during the World War II is an example of point rationing, whereas the rationing for meat in England during and immediately after the war is an example of value rationing (Chow 1987).

The forms of rationing also can be classified into two groups based on whether the consumer can purchase additional amounts of the rationed commodities from open markets at higher prices (Ray 1989). ***Partial rationing*** is defined as the rationing under which the consumer can purchase a limited amount of the commodity at rationed price and any additional amount from open markets at a higher price, whereas ***strict rationing*** is defined as the rationing under which no open market is available for the rationed commodity. The ***partial rationing*** can be further distinguished by whether the consumer is able to resell the rationed commodities at higher prices in open markets (Ray 1989).

Several forms of rationing have been practiced in China since the early 1950s. During the period from 1955 to 1978, housing and many food commodities such as grains and meats were under strict rationing for urban households, while textiles and cotton were under strict rationing for both urban and rural households (Chow 1987). Although housing is still under strict rationing, China's rationing system has changed significantly in the past decade. The rationing for textiles and cotton was abolished nationwide, food for urban residents has changed from strict to partial rationing as a result of the rapid development of free markets. Many provinces have even replaced food rationing with income subsidies.

AIDS with strict and partial rationing

Although the impacts of rationing have been examined in many studies, most of them are focused only on strict rationing (e.g., Deaton 1981; Wang and Chern 1992). This study develops a flexible demand system which includes nonrationed, strictly rationed, and partially rationed goods by generalizing the AIDS with rationing proposed by Deaton (1981).

The utility maximization problem with some goods under strict rationing and some under partial rationing can be formulated as:

$$\begin{aligned} \text{Maximize} \quad & u(q^u, q^{sr}, q^t) \\ \text{subject to} \quad & p^u q^u + p^{sr} q^{sr} + p^{pr} q^{pr} + p^m (q^t - q^{pr}) \le x, \\ & q^t \ge q^{pr}, \\ & q^{sr} = z^{sr} \text{ and} \\ & q^{pr} = z^{pr}, \end{aligned} \tag{3.25}$$

where q^u, p^u = quantity and price vectors of the nonrationed goods,

q^{sr}, p^{sr} = quantity and price vectors of the strictly rationed goods,

q^{pr}, p^{pr} = quantity and price vectors of the partially rationed goods purchased from ration shop,

q^t = quantity vector of the total consumption of the goods under partially rationing,

p^m = vector of market prices for the partially rationed goods,

z^{sr}, z^{pr} = vectors of ration levels for strictly and partially rationed goods, and

x = total expenditure.

The utility function is assumed to possess the usual neoclassical properties. Under the assumption of $q^t > q^{pr}$, it can be proved that (3.25) is equivalent to the following maximization problem:

$$\begin{aligned} &\text{Maximize} \quad u(q^u, q^{sr}, q^t) \\ &\text{subject to} \quad p^u q^u + p^{sr} q^{sr} + p^m q^t \le x + (p^m - p^{pr}) z^{pr}, \end{aligned} \tag{3.26}$$

where $(p^m - p^{pr})q^{pr}$ can be considered as an income transfer through partial rationing (Ray 1989).

The proof is illustrated in Figure 3.1. Suppose there are two goods: q_1 is not under rationing and q_2 is under partial rationing. If an individual consumes (q_1^*, q_2^*) at equilibrium, he or she can purchase z_2 amount of q_2 from the ration shop and the rest $(q_2^* - z_2)$ from free markets. If $q_2^* > z_2$, the constraint ABC is equivalent to DBC for the consumer. Thus the two utility maximization problems are the same under the assumption.

Based on the duality theory, this utility maximization problem can be solved by minimizing the expenditure function (see Deaton 1981):

$$E(u, p^u, p^{sr}, p^m, z^{sr}) = \left\{ Min \;\; p^u q^u + p^{sr} q^{sr} + p^m q^t : V(q^u, z^{sr}, q^t) \right\} \tag{3.27}$$

where $V(q^u, z^{sr}, q^t)$ is equal to the maximum value of $u(q^u, z^{sr}, q^t)$, $E(\cdot)$ is the constrained expenditure function that gives the minimum expenditure for reaching the utility level at given prices and rationed levels. If the consumer is assumed to purchase the rationed goods from ration shop at the maximum levels, the expenditure in the ration shop is a constant and can be subtracted from the budget constraint. Based on this assumption and the Le Chaterlier principle, the expenditure function is reduced to (see Deaton 1981):

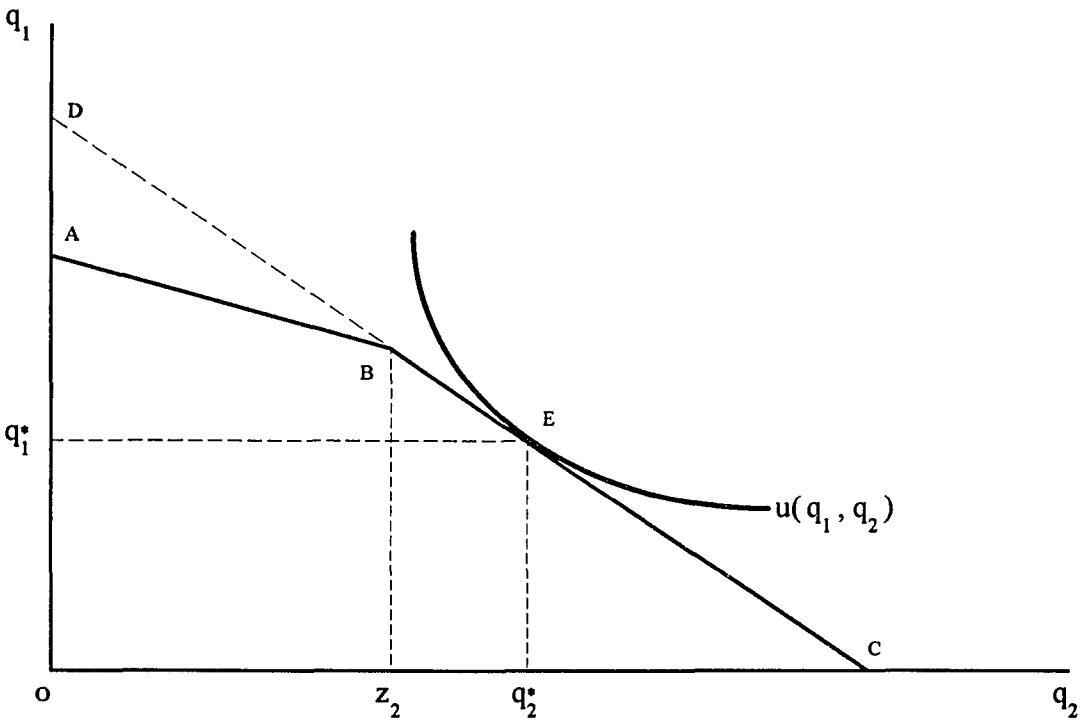

Figure 3.1. Consumer demand under partial rationing

$$E(u,p^u,p^{sr},p^m,z^{sr}) = p^{sr}z^{sr} + \{Min\ p^uq^u + p^mq^t:\ V(q^u,q^{sr},q^t) \geq u\}$$
$$= p^{sr}z^{sr} + c(u,z^{sr},p^u,p^m), \tag{3.28}$$

where function $c(\cdot)$ has all the conventional properties of an expenditure function such as the derivative property for nonrationed demands (Deaton 1981). As suggested by Deaton (1981), $c(\cdot)$ can be represented by a flexible function form used to derive the AIDS (Deaton and Muellbauer 1980). Suppose there are n nonrationed goods, m goods under strict rationing and r goods under partial rationing. The resulting demand system of $(n+r)$ equations in expenditure share forms can be expressed as:

$$w_i = \alpha_i + \sum_{k=1}^{m}\delta_{ik}z_k^{sr} + \sum_{j=1}^{n+r}\gamma_{ij}\ln(p_j)$$
$$+ \beta_i\left[\ln\left(x + \sum_{l=1}^{r}(p_l^m - p_l^{ps})z_l^{pr} - \sum_{k=1}^{m}p_k^{sr}z_k^{sr}\right) - \ln(P)\right], \tag{3.29}$$

$$\ln(P) = \alpha_0 + \sum_{k=1}^{m}\sum_{j=1}^{n+r}(\alpha_i + \delta_{jk})\ln(p_j) + \frac{1}{2}\sum_{i=1}^{n+r}\sum_{j=1}^{n+r}\gamma_{ij}\ln(p_i)\ln(p_j), \tag{3.30}$$

$$w_i = \frac{p_i q_i}{x + \sum_{l=1}^{r}(p_l^m - p_l^{pr})z_l^{pr} - \sum_{k=1}^{m}p_k^{sr}z_k^{sr}}. \tag{3.31}$$

Similar to the AIDS, the theoretical restrictions (adding-up, homogeneity and symmetry) can be imposed by restrictions on the parameters:

$$\sum_{i=1}^{n+r}\alpha_i = 1, \quad \sum_{i=1}^{n+r}\delta_{ik} = 0 \text{ for all } k, \quad \sum_{i=1}^{n+r}\gamma_{ij} = 0, \quad \sum_{i=1}^{n+r}\beta_i = 0, \tag{3.32}$$

$$\sum_{j=1}^{n+r}\gamma_{ij} = 0 \tag{3.33}$$

$$\gamma_{ij} = \gamma_{ji} \text{ for all } i \text{ and } j. \tag{3.34}$$

The price index represented in equation (3.30) can be replaced by the Stone's price index in empirical studies:

$$\ln(P^s) = \sum_{j=1}^{n+r} w_j \ln(p_j). \tag{3.35}$$

Substituting equation (3.35) into (3.29) yields the final specification of the system to be estimated.

The demand elasticities and the effects of a change in the rationed prices or levels (p^{sr}, p^{pr}, z^{sr} *or* z^{pr}) can be derived from the demand equation.

Expenditure and price elasticities

The expenditure and uncompensated price elasticities can be derived from the demand equations by calculating the partial derivatives:

$$e_i = \frac{\partial \ln(q)}{\partial \ln(I^*)} = 1 + \frac{\partial \ln(w_i)}{\partial \ln(I^*)} \tag{3.36}$$

$$\eta_{ij} = \frac{\partial \ln(q_i)}{\partial \ln(p_j)} = -c_{ij} + \frac{\partial \ln(w_i)}{\partial \ln(p_j)} \tag{3.37}$$

where e_i denotes expenditure elasticities, η_{ij} is the price elasticities, and c_{ij} equals 1 for $i=j$ and 0 otherwise.

Effects of a change in the rationed prices or levels

In addition to the expenditure and price elasticities, the impacts of a change in the prices or levels of the goods under strictly or partially rationing on nonrationed goods can be derived:

$$(wp)_{ik} = \frac{\partial \ln(q_i)}{\partial \ln(p_k)} \tag{3.38}$$

$$(wz)_{ik} = \frac{\partial \ln(w_i)}{\partial \ln(z_k)} \tag{3.39}$$

The Chinese urban consumers have been subsidized by the government for food and housing through the rationing systems since the mid-1950s. This study will examine the impacts of food rationing on household demand in urban China by using the demand system with rationing.

Hypothesis tests for demand system selection

Demand functions are derived from the maximization of a utility function or minimization of a cost function (Deaton and Muellbauer 1980). Thus a specific or approximated form of the utility or cost function leads to a specific demand system. Although there are many criteria for demand system selection, for any particular application, the basic criterion after consistency with economic theory is simply the relative explanatory power and

simplicity of estimation. The relative explanatory power of two competing models, nested or non-nested, can be examined by hypothesis tests.

Nested models

Model $G(y|z,\beta)$ is nested in $F(y|z,\alpha)$ if some restrictions on α can reduce $F(y|z,\alpha)$ to $G(y|z,\beta)$. Several statistical tests such as F and likelihood ratio tests can be used to test the null hypothesis that $F(y|z,\alpha)$ and $G(y|z,\beta)$ are equally close to the true data generating process against the alternative hypothesis that $F(y|z,\alpha)$ is closer (Judge et al. 1988; Green 1990). Although nested hypothesis tests have been used to examine the relative explanatory power of some demand models such as the Tobit and double-hurdle models (e.g., Blaylock and Blizard 1992; Lin and Millon 1993; Wang and Jensen 1994), their application in demand system selection is limited because most of the commonly used demand systems are non-nested models.

Non-nested models

The traditional strategy for testing a non-nested hypothesis is through the construction of an artificial model which nests the two non-nested models. The test procedures for nested hypotheses are then applied to examine the relative explanatory power of the artificial model versus the two competing models. Suppose there are two non-nested linear models:

$$y = x\alpha + e, \tag{3.40}$$

$$y = z\beta + u. \tag{3.41}$$

An artificial model can be constructed to nest model (3.40) and (3.41):

$$y = x^*\alpha^* + z^*\beta^* + w\delta + v \tag{3.42}$$

where x^* includes the variables in x that are not in z, z^* includes the variables in z that are not in x, and w contains the variables that are in both x and z. Compared to model (3.42), model (3.41) is rejected if the null hypothesis of $\beta^* = 0$ is not rejected by a F or likelihood ratio test, whereas model (3.40) is rejected if the null hypothesis of $\alpha^* = 0$ is not rejected. Because these tests do not really distinguish between model (3.40) and (3.41), four possible test results could occur: reject both (3.40) and (3.41), reject only (3.40), reject only (3.41), and reject neither of them. If both of them or neither of them are rejected, there is no conclusion about the relative explanatory power of (3.40) and (3.41). Furthermore, model (3.42) may have a large number of independent variables and multicollinearity may be a severe problem in estimation (Green 1990).

To overcome the estimation problems associated with model (3.42), Davidson and MacKinnon (1981) have proposed the J test for non-nested hypotheses. To discuss the test in a general framework rather than just for linear models, let $y = G(x,\beta)$ and $y = F(x,\alpha)$ denote two non-nested models. Then the following artificial nesting model can be constructed:

$$y = (1-\theta)F(x,\alpha) + \theta G(x,\beta) + v. \tag{3.43}$$

It is obvious that model $F(x,\alpha)$ is accepted if the null hypothesis of $\theta = 0$ is not rejected. On the other hand, model $G(x,\beta)$ is chosen if the null hypothesis of $\theta = 1$ is not rejected. Davidson and MacKinnon (1981) have shown that the tests can be carried out based on the standard normal distribution. The J test may overcome the practical problems associated with model (3.42), but it does not eliminate the possibility that both $F(x,\alpha)$ and $G(x,\beta)$ or neither of them could be rejected. When this possibility occurs, no conclusion can be made regarding

to the relative explanatory power of the two models. For example, Spreen and Gao (1993) have constructed an artificial demand model which nests the generalized addlog demand system and the level version of Rotterdam model for the objective of testing their relative explanatory power. But their test results show that both models are rejected compared to the artificial model.

Cox (1961, 1962), Pesaran (1974), Pesaran and Deaton (1978) and Vuong (1989) have developed test procedures for non-nested hypotheses based on the likelihood ratio principle. This study shows how the test developed by Vuong (1989) can be used for demand system selection.

Let $f(y|x,\alpha)$ and $g(y|x,\beta)$ denote the likelihood functions of two competing non-nested models [$F(y|x,\alpha)$ and $G(y|x,\beta)$]. Vuong (1989) defines the variance of the difference between $f(y|x,\alpha)$ and $g(y|x,\beta)$ as:

$$\omega_n^2 = \sum_{i=1}^{n} \frac{1}{n}\left(\ln \frac{f(y_i|x_i,\alpha)}{g(y_i|x_i,\beta)}\right)^2 - \left(\frac{1}{n}\sum_{i=1}^{n} \ln \frac{f(y_i|x_i,\alpha)}{g(y_i|x_i,\beta)}\right)^2$$

$$= \sum_{i=1}^{n} \frac{1}{n}\left(\ln \frac{f(y_i|x_i,\alpha)}{g(y_i|x_i,\beta)}\right)^2 - \left(\frac{1}{n}LL_n(\alpha) - \frac{1}{n}LL_n(\beta)\right)^2$$

$$= \sum_{i=1}^{n} \frac{1}{n}\left(\ln \frac{f(y_i|x_i,\alpha)}{g(y_i|x_i,\beta)}\right)^2 - \left(\frac{1}{n}LR_n(\alpha,\beta)\right)^2. \qquad (3.44)$$

Then the following hypotheses can be defined:

$$H_0: \; ELR \equiv E\left(\ln \frac{f(y_i|x_i,\alpha)}{g(y_i|x_i,\beta)}\right) = 0, \qquad (3.45)$$

meaning that $F(y|x,\alpha)$ and $G(y|x,\beta)$ are equivalent, against

$$H_f: ELR > 0, \tag{3.46}$$

meaning that $F(y|x,\alpha)$ is better than $G(y|x,\beta)$, or

$$H_g: ELR < 0, \tag{3.47}$$

meaning that $F(y|x,\alpha)$ is worse than $G(y|x,\beta)$.

Because a nature estimator for ELR is $\frac{1}{n}LR_n(\hat{\alpha},\hat{\beta})$, testing H_0 against H_f or H_g requires a characterization of the distribution of $LR_n(\hat{\alpha},\hat{\beta})$. Vuong (1989) has shown that this distribution depends crucially on whether or not $LL_n(\alpha) = LL_n(\beta)$ under the null, and which in turn depends on the models being tested. When the two models are ***strictly non-nested***, then $LL_n(\alpha) \neq LL_n(\beta)$ and $LR_n(\hat{\alpha},\hat{\beta})$ is asymptotically normally distributed. Thus the test statistic (normalized likelihood ratio)

$$Z_0 = \frac{LR_n(\hat{\alpha},\hat{\beta})}{\sqrt{n}\,\hat{\omega}} \tag{3.48}$$

follows a standard normal distribution and the test is therefore straight forward (where $\hat{\omega}$ is a consistent estimator of ω). After a critical value c is chosen from the standard normal distribution for a specific significance level, if $Z_0 > c$ then the null hypothesis is rejected in favor of $F(y|x,\alpha)$ being better than $G(y|x,\beta)$. On the other hand, if $Z_0 < c$ then the null hypothesis is rejected in favor of $G(y|x,\beta)$ being better than $F(y|x,\alpha)$. Finally, if $|Z_0| \leq c$ then $F(y|x,\alpha)$ and $G(y|x,\beta)$ can not be discriminated based on the data.

When the two models are ***partially non-nested (overlapping)***, it may or may not be the case that $LL_n(\alpha) = LL_n(\beta)$. Thus Vuong (1989) proposes a two-step test procedure. The first step tests whether $LL_n(\alpha) = LL_n(\beta)$ by testing the null hypothesis of $\omega^2 = 0$. This is accomplished using the variance test statistic $VT = n\hat{\omega}^2$, which is asymptotically distributed as a weighted sum of chi-squares with weights calculated as described in Vuong (1989). If the null hypothesis is not rejected, we may conclude that the two models are equivalent. If the null hypothesis is rejected, then $LL_n(\alpha) \neq LL_n(\beta)$ and the test statistic described for the strictly non-nested models can be applied.

Compared to the test procedures through an artificial model, this test not only avoids the process of estimating an artificial model, but also guarantees a unique conclusion about the relative explanatory power of the two competing models.

Vuong test for demand system selection

This section shows how the Vuong test discussed above can be applied for demand system selection. Suppose there are *m* equations in a demand system:

$$\begin{aligned} y_1 &= f_1(x,\alpha) + e_1 \\ y_2 &= f_2(x,\alpha) + e_2 \\ &\vdots \\ y_m &= f_m(x,\alpha) + e_m. \end{aligned} \tag{3.49}$$

Let $e' = (e_1', e_2', \ldots, e_m')$, it is assumed that $E[ee'] = \Sigma \otimes I_n$, where Σ is a $(m \times m)$ covariance matrix and I_n is a $(n \times n)$ identity matrix. With the additional assumption that the errors are normally distributed, the log-likelihood function for one particular observation can be written

as (see Judge et al. 1988):

$$\ln L_i(\alpha) = -\frac{m}{2}\ln(2\pi) - \frac{1}{2}\ln|\Sigma| - \frac{1}{2}e_i'\Sigma^{-1}e_i$$

$$= -\frac{m}{2}\ln(2\pi) - \frac{1}{2}\ln|\Sigma| - \frac{1}{2}(y_i - x_i\alpha)'\Sigma^{-1}(y_i - x_i\alpha) \qquad (3.50)$$

The log-likelihood function for a sample of n observations is simply the sum of (3.50) over all observations:

$$\ln L_n(\alpha) = \sum_{i=1}^{n} \ln L_i(\alpha)$$

$$= -\frac{mn}{2}\ln(2\pi) - \frac{n}{2}\ln|\Sigma| - \frac{1}{2}\sum_{i=1}^{n} e_i'\Sigma^{-1}e_i$$

$$= -\frac{mn}{2}\ln(2\pi) - \frac{n}{2}\ln|\Sigma| - \frac{1}{2}\sum_{i=1}^{n}(y_i - x_i\alpha)'\Sigma^{-1}(y_i - x_i\alpha) \qquad (3.51)$$

With this log-likelihood function, α and Σ can be estimated using the maximum likelihood method.

If another demand system with coefficient β is specified and estimated in the same way, the estimation results of the two demand systems can be used to examine their relative explanatory power using the Vuong test. It is obvious that the estimated coefficients and covariance matrix can be used to compute $f(y_i|x_i,\hat{\alpha})$ and $g(y_i|x_i,\hat{\beta})$ in equation (3.44) for each of the n observations according to equation (3.50). Equation (3.48) can then be used to calculate the test statistic.

Two of the most commonly used flexible demand systems are the translog demand

system (Christensen et al. 1975) and the AIDS (Deaton and Muellbauer 1980). Deaton and Muellbauer (1980) have strongly promoted the AIDS and disparaged the translog demand system. Similarly, Jorgenson et al. (1982) have strongly defended the translog demand system over all other PIGLOG forms that include AIDS. Although both demand systems have been widely used in demand studies, few studies have compared their adequacy and relative explanatory power using the same data base. Such comparisons can contribute to the evaluation of the two demand systems in applied contexts. Three test procedures are used in this study to examine the relative explanatory power of the AIDS and translog demand system: a non-nested hypothesis test through an artificial nesting model, the Vuong test, and a nested hypothesis test by using the Lewbel demand system discussed in the previous section.

Policy analysis using demand systems

Demand systems can be used to estimate income and price elasticities and to conduct policy analysis. This section presents a framework for making food demand projections and measuring the changes in consumer welfare using estimated demand systems. AIDS is used to illustrate the procedures.

Food demand projections using demand systems

There are essentially two objectives for estimating a demand system. The first one is to provide quantitative information on consumer behavior based on the data base. For example, the estimated price and income elasticities measure consumers' responses to income and price changes over the observed period. The second objective is to provide information on future consumer demand under alternative policy and economic conditions. One good example is using the estimated demand system as the structure model to conduct demand

projections and policy simulations (Goungetas et al. 1993). Almost all the empirical studies on China's household demand and expenditure have reported income and price elasticities (e.g., van der Gaag 1984; Lewis and Andrews 1989; Wang and Chern 1992), but few of them have used the estimated demand systems to conduct demand projections or policy simulations.

Because information on future food demand needs of a country is essential for development planning and policy making, many studies have attempted to conduct food demand projections under alternative assumptions about population growth and government policy (e.g., Sarma 1986; Yetley and Tun 1986; An 1989). Most of the projections are obtained by multiplying estimates of population size with estimates of per capita consumption (Sarma 1986; An 1989). The estimates of per capita consumption are often either as future values of base year level using current real income growth rates and income elasticities or as functions of own-price and total per capita expenditure. In either case the effects of changes in prices of substitutes and complement commodities are assumed to be zero or cancel each other out. For example, Peterson et al. (1991) have conducted rice demand projections for China using a single-equation demand model. Their projections of China's rice demand during 1989 to 2000 did not consider the impacts of price changes for other food commodities such as wheat and pork.

To the extent that food demand is in reality determined by other factors besides population size and income growth, the models excluding cross-commodity effects may not give accurate results (Goungetas et al. 1993). This study will conduct policy analysis using the estimated demand systems. The LA/AIDS discussed in the previous section is used to describe the procedure of projection.

The food demand projections are made in terms of changes in the budget shares of each commodity from a base year. Based on the LA/AIDS model represented in (3.17), the

budget share of commodity i in the base year (0) and a future year (t) can be written as:

$$w_i^0 = a_i + \sum_{k=1}^{m} b_{ik} D_k^0 + \sum_{j=1}^{n} \gamma_{ij} \ln(p_j^0) + \beta_i \left[\ln(X^0) - \ln(P^0) \right] \tag{3.52}$$

$$w_i^t = a_i + \sum_{k=1}^{m} b_{ik} D_k^t + \sum_{j=1}^{n} \gamma_{ij} \ln(p_j^t) + \beta_i \left[\ln(X^t) - \ln(P^t) \right] \tag{3.53}$$

Subtracting the budget share in the base year (3.52) from that in the future year (3.53) yields the projected changes in budget share of good i between the base and future year:

$$(w_i^t - w_i^0) = \sum_{k=1}^{m} b_{ik} (D_k^t - D_k^0) + \sum_{j=1}^{n} \gamma_{ij} \ln\left(\frac{p^t}{p^0}\right) + \beta_i \left[\ln\left(\frac{X^t}{X^0}\right) - \ln\left(\frac{P^t}{P^0}\right) \right] \tag{3.54}$$

The future year values of the explanatory variables can be expressed in terms of the corresponding base year values:

$$D_k^t = (1 + d_k) D_k^0 \tag{3.55}$$

$$p_j^t = (1 + \rho_j) p_j^0 \tag{3.56}$$

$$X^t = (1 + \mu) X^0 \tag{3.57}$$

Using the Stone price index with the base year budget shares yields

$$\ln(P^0) = \sum_{j=1}^{n} w_j^0 \ln(p_j^0) \tag{3.58}$$

$$\ln(P^t) = \sum_{j=1}^{n} w_j^0 \ln(p_j^t) = \sum_{j=1}^{n} w_j^0 \ln(1+\rho_j) p_j^0 \tag{3.59}$$

Then the following term can be obtained:

$$\left[\ln(P^t) - \ln(P^0)\right] = \sum_{j=1}^{n} w_j^0 \ln(1+\rho_j) \tag{3.60}$$

Substituting (3.55), (3.56), (3.67) and (3.60) into (3.54) and solving for w_j^t yields the equation that will be used to compute the projected budget shares in the future year:

$$w_i^t = w_i^0 + \sum_{k=1}^{m} b_{ik} d_k D_k^0 + \sum_{j=1}^{n} \gamma_{ij} \ln(1+\rho_j)$$

$$+ \beta_i \left\{ \left[\ln(1+\mu)\right] - \left[\sum_{j=1}^{n} w_j^0 \ln(1+\rho_j) \right] \right\} \tag{3.61}$$

It is possible to estimate the expenditure and consumption quantity in the future year using the projected budget shares. Expenditure (x_i^t) can be obtained as the product of the budget share and total expenditure, whereas the quantity (q_i^t) can be derived by dividing expenditure by the price. Thus the growth rate in expenditure and quantity can be given by:

$$\frac{x_i^t}{x_i^0} - 1, \tag{3.62}$$

$$\left(\frac{q_i^t}{q_i^0}\right)-1=\left(\frac{\frac{x_i^t}{p_i^t}}{\frac{x_i^0}{p_i^0}}\right)-1=\left(\frac{\frac{x_i^t}{(1+\rho_i)p_i^0}}{\frac{x_i^0}{p_i^0}}\right)-1=\left(\frac{x_i^t}{x_i^0(1+\rho_i)}\right)-1 \tag{3.63}$$

Based on the projections of per capita expenditure and quantity, the total expenditure and quantity can be estimated by multiplying the per capita level with the projected population.

One special case of the above specification is the constant-real-prices scenario which assumes that the real prices will remain constant. This implies that

$$\frac{p_i^t}{P^t}=\frac{p_i^0}{P^0} \quad \text{or} \quad \rho_1=\rho_2=\cdots=\rho_n=\rho \tag{3.64}$$

Because budget shares add up to 1, it is straightforward to show that

$$\sum_{j=1}^{n} w_j^0 \ln(1+\rho_j)=[\ln(1+\rho)]\sum_{j=1}^{n} w_j^0=\ln(1+\rho) \tag{3.65}$$

The homogeneity restrictions imply that the following term equals zero

$$\sum_{j=1}^{n} \gamma_{ij} \ln(1+\rho_j)=[\ln(1+\rho)]\sum_{j=0}^{n} \gamma_{ij}=0 \tag{3.66}$$

Under the constant-real-prices assumption, equation (3.61) reduces to

$$w_i^t = w_i^0 + \sum_{k=1}^{m}(b_{ik}d_k D_k^0) + \beta_i[\ln(1+\mu) - \ln(1+\rho)]$$

$$= w_i^0 + \sum_{k=1}^{m}(b_{ik}d_k D_k^0) + \beta_i\left[\ln\frac{(1+\mu)}{(1+\rho)}\right] \qquad (3.67)$$

This equation shows that price effects are absent under a constant-real-prices scenario and the projected budget shares depend on the growth rate in demographic variables, real total expenditure, and inflation rate.

Measuring the changes in consumer welfare

One application of estimating demand functions is to measure the changes in consumer welfare caused by price changes. The commonly used measurements of welfare changes include the true cost-of-living index, Marshalian consumer surplus, compensating variation and equivalent variation. This study will use the compensating variation (*CV*) to measure welfare changes under alternative price changes. *CV* can be defined as:

$$CV = c(u^*, p^1) - c(u^*, p^0) \qquad (3.68)$$

where u^* is the utility level, p^0 is the price vector before the price change, p^1 is the new price vector, $c(\cdot)$ is the cost function. *CV* measures the amount of money which needs to be provided or taken away to leave the consumer as well off under the new prices as he or she was under the old prices.

The procedures of computing *CV* using an estimated LA/AIDS will be discussed in Chapter 6.

CHAPTER 4. DATA SOURCES AND ESTIMATION PROCEDURES

This chapter describes the data sources and estimation procedures used to estimate the Engel functions and demand systems discussed in Chapter 3.

Data sources

Data availability and reliability have always been the major restrictions of studying China's economic performance and consumer behavior. The Chinese government published a great deal of statistical data during 1950 to 1957 but then stopped releasing official statistical data for almost 20 years as a result of the economic disasters around 1960 and the political and social turmoil of the Cultural Revolution from 1966 to 1976 (Colby et al. 1992). China began rebuilding its statistical system in the late 1970s when economic growth became a top priority of the Chinese government. The State Statistical Bureau of China (SSB) published the first volume of *China's Statistical Yearbook* in August 1980 and has continued a series of statistical yearbooks ever since 1980 (Colby et al. 1992). Many statistical data for the period of 1950 to 1977 were also recovered and reported in the statistical yearbooks published in the early 1980s.

Compared to the period prior to 1978, the availability and reliability of China's statistical data, especially the production and trade data, have improved significantly since the early 1980s (Taylor and Hardee 1986; Colby et al. 1992). But the data on household consumption and expenditure are still quite limited. Complete time-series data do not exist over a sufficiently long period for econometric analysis, whereas the cross-section household survey data released by SSB are mainly the summary results by regions or income groups

rather than by individual households. This study assesses the changes in China's food consumption patterns and dietary status since 1950 and models China's household food demand in the economic transition by using the most recently available data.

As reported in Chapter 2, the time-series data of China's food production, trade, and disappearances during 1950 to 1991 have been compiled into annual food balance sheets that provide estimates of the average per capita daily availability and sources of three macro nutrients (energy, protein, and fat). The next sections describe the available data used to estimate the Engel functions and demand systems for Chinese rural and urban households.

All the data on household expenditure and food consumption are from China's household surveys conducted by SSB. As a result of the significant differences between rural and urban households in employment, income sources, and expenditure patterns, China's household survey has been conducted separately for rural and urban households since its start in the early 1950s. The surveys were suspended in the early 1960s and resumed in the late 1970s (Taylor and Hardee 1986). In previous studies using data sets from China's rural and urban household surveys, the name of the surveys has been translated differently into English (e.g., van der Gaag 1984; Lewis and Andrews 1989; Wang and Chern 1992). Because China's Rural Household Survey and China's Urban Household Survey are the only nationwide household surveys have been conducted in China, the survey data used in previous studies are in fact from the same sources.

Available data for Chinese rural households

China's Rural Household Survey is designed to obtain information on household characteristics, employment, income, production, consumption, expenditures, etc. Sample households are selected using a three-stage stratified sampling scheme: counties are first selected from each province, production teams (villages) are then selected from each selected

county, and finally households are selected from the villages. The sample households are requested to maintain detailed daily records of their income and expenditure using the account books provided by SSB. The account books are collected, examined, aggregated, and reported every month by the local statistical agency. The participating households with satisfied records are compensated for their time and efforts by a certain amount of cash.

The number of sample households from each province is determined by SSB according the population size. Although the selection of counties, villages, and households in each province may not strictly accord with the principles of random sampling, Chinese statisticians have asserted that the impact has not been significant (Tuan and Crook 1983). There are evidences to suggest that the survey has improved significantly since the early 1980s. For example, the number of sample households of China's Rural Household Survey has increased substantially from 15914 in 1980 to 67410 in 1991. The changes in sample size of both rural and urban household surveys since 1980 are illustrated in Figure 4.1.

China's Rural Household Survey has collected rich information for analyzing household demand and expenditure in rural China. The year-round survey through daily records has avoided many problems frequently associated with short-period household surveys. For example, zero expenditures caused by infrequency of purchase may not be a problem in the year-round survey.

China's Rural Household Survey has been conducted continuously since 1978, but SSB has officially released only the summary results (sample means) by provinces and income groups rather than by individual households. Most studies of China's rural household demand published in the 1980s were based on the sample means by provinces or income groups (see Table 1.2). Fortunately, some local statistical agencies in China have provided the detailed regional data sets to some researchers under certain agreements. This study will use the sample means by provinces to estimate Engel functions and detailed survey data of 500

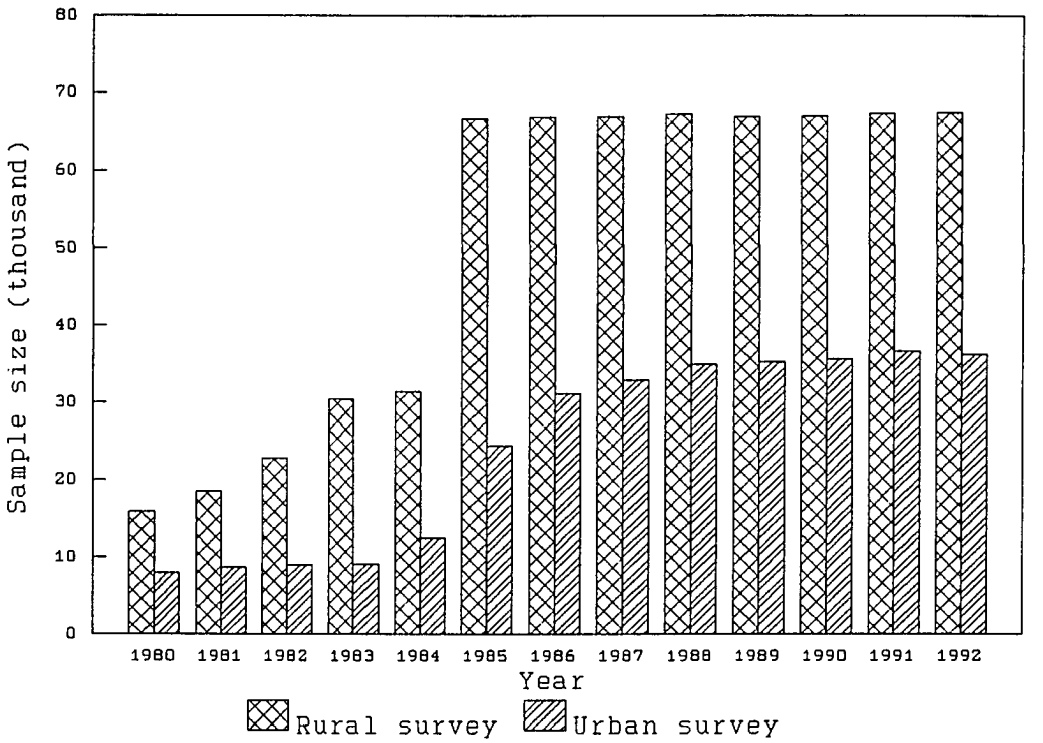

Figure 4.1. Sample size of China's rural and urban household surveys

households from Beijng and 440 households from Jiangsu province during 1988 to 1990 to estimate demand systems. The expenditure groups and national average budget shares of Chinese rural households in 1991 are summarized in Table 4.1, whereas the national average rural per capita consumption of major food commodities in 1991 is reported in Table 4.2.

In the data sets of individual households obtained from local statistical agencies in China, there are 640 variables for each household, including household characteristics, income from different sources, production investment, output distribution, expenditure, consumption, etc. Similar regional data sets from China's Rural Household Survey have been used in several recent studies (e.g., Halbrendt et al. 1993; Gao et al. 1993; Tan et al. 1994)

Available data for Chinese urban households

The design of China's Urban Household Survey is very similar to China's Rural Household Survey. Sample households are selected using a three-stage stratified sampling scheme: cities are first selected from each province, enterprises and institutions are then selected from each selected city, and finally households are selected from the selected enterprises and institutions. The information collected through daily records includes household characteristics, income, consumption, expenditure, etc. Compared to the rural survey, the urban survey has collected information for more detailed expenditure groups and commodities. The number of sample households in China's Urban Household Survey has increased from 7962 in 1980 to 36730 in 1991 (see Figure 4.1).

SSB has released only the sample means of China's Urban Household Survey data by provinces, major cities and income groups. The sample means by income groups have been used by van der Gaag (1984), Li et al. (1985), Lewis and Andrews (1989), Wang and Chern (1992), and Wang and Jensen (1994), whereas the sample means by provinces have been used by Chern and Wang (1992). In this study the data of sample means by provinces are used to

Table 4.1. Expenditure groups and budget shares of Chinese rural households in 1991

Expenditure group	Expenditure (yuan)	Budget share (%)
Food	352.30	56.84
Staple food (grains)	132.89	21.43
Non-staple food	155.72	25.12
Other food	54.52	8.80
Clothing	50.98	8.23
Housing	68.90	11.12
Fuel	26.81	4.33
Other expenditures	72.18	11.65
Durables and articles for daily use	36.93	5.96
Durables and articles for cultural life	13.52	2.18
Books, newspapers and magazines	3.33	0.54
Medical expenses	14.93	2.41
Others	3.47	0.60
Services	48.62	7.84
Cultural services	19.59	3.16
Living services	29.03	4.86
Total living expenditure	619.79	100.00

Sources: State Statistical Bureau of China, *China's Statistical Yearbook*, 1992 volume.

Table 4.2. Average per capita food consumption of Chinese rural households in 1991

Food commodity	Average per capita consumption (kg)
Grain	255.58
Vegetables	126.97
Vegetable oil	5.65
Red meats (pork, beef and mutton)	12.15
Poultry	1.34
Eggs	2.73
Fish	2.21
Alcoholic beverages	6.38
Sugar	1.40

Source: State Statistical Bureau of China, *China's Statistical Yearbook*, 1992 volume.

estimate the Engel functions for several major food commodities and the pooled data of sample means by seven income groups and two city groups from 1986 to 1991 (14 observations each year for 6 years) are used to estimate the demand systems. The data by income groups are chosen to estimate the demand systems for the consideration that the observed differences in household expenditures across income groups are more likely to be determined by economic variables such as income and prices. The national average budget shares by major expenditure groups and food commodities in 1991 are summaries in Table 4.3 and Table 4.4.

Similar to the survey data from many other developing countries, there are several problems in China's household survey data that have been obtained. First, the national averages from the household surveys are available only for years since 1981. The insufficient number of observations makes it difficult to estimate any demand system using the time-series data. Second, because prices are not directly available in the data sets for both rural and urban households, the unit values derived from expenditures and quantities are used as estimates of prices in estimating the demand systems. The cross-section variation in unit values may partially reflect the differences caused by quality effects (Deaton 1988). Third, the estimation results for rural and urban households are difficult to compare because of the differences in data sources and expenditure groups. Fourth, because the sample selection may not strictly accord with the principles of random sampling, the sample may over-represent certain elements of the population.

Although some of these data problems may affect the estimation results and interpretations, the data used in this study can be considered to be better than that for previous studies. As China moves closer to a market economy, the strict state restrictions on statistical data are likely to be reduced and even removed. The impacts of the data problems discussed above can be examined when more detailed survey data are available.

Table 4.3. Expenditure groups and budget shares of Chinese urban households in 1991

Expenditure group	Expenditure (yuan)	Budget share (%)
Commodity expenditures	1294.85	89.07
Food	782.50	53.82
Clothing	199.64	13.73
Durables and articles for daily use	139.83	9.62
Durables and articles for recreation	68.68	4.72
Books, newspapers and magazines	13.11	0.90
Medicine and medical goods	24.96	1.72
Housing materials	23.00	1.58
Fuel	25.05	1.72
Other commodities	18.06	1.24
Non-commodity expenditures	158.96	10.93
Housing rent	10.66	0.73
Water	4.66	0.32
Electricity	19.50	1.34
Gas	4.27	0.29
City transportation	4.53	0.31
Other transportation	12.36	0.85
Postage	2.82	0.19
Health care and fitness	7.14	0.49
School fees	33.82	2.33
Child care	7.01	0.48
Recreation	6.14	0.42
Repairs and services	30.82	2.12
Other non-commodity expenditure	15.23	1.05

Sources: State Statistical Bureau of China, *China's Statistical Yearbook*, 1992 volume.

Table 4.4. Food expenditure groups and budget shares of Chinese urban households in 1991

Food item	Expenditure (yuan)	Shares of total food expenditure (%)	Shares of total budget (%)
Grains	102.53	13.10	7.05
Vegetable oils	25.15	3.21	1.73
Animal products			
Pork	106.39	13.60	7.32
Beef & mutton	21.51	2.75	1.48
Poultry	31.85	4.07	2.19
Eggs	35.93	4.59	2.47
Aquatic products	40.88	5.22	2.81
Milk	6.05	0.77	0.42
Fruits, vegetables & melons			
Fresh vegetables	85.73	10.96	5.90
Dried vegetables	10.08	1.29	0.63
Fresh fruits	40.62	5.19	2.79
Dried fruits	11.07	1.41	0.76
Fresh melons	10.23	1.31	0.70
Cigarettes, alcoholic beverages & tea			
Cigarettes	48.00	6.13	3.30
Tobacco	0.25	0.03	0.02
Liquor	18.33	2.34	1.26
Beer	9.91	1.27	0.68
Wine	3.22	0.41	0.22
Tea	4.94	0.63	0.34
Sugar & other food			
Sugar	5.16	0.66	0.35
Sweets & candies	5.03	0.64	0.35
Cakes & cookies	18.36	2.35	1.26
Canned food	3.70	0.47	0.25

Sources: State Statistical Bureau of China, *China's Statistical Yearbook*, 1992 volume.

Estimation procedures

The Engel functions presented in Chapter 3 are estimated using the standard ordinary least squares (OLS) procedure, whereas the demand systems will be estimated using the Iterated Seemingly Unrelated Regressions (ITSUR) to obtain efficient estimates. The NL procedure in SHAZAM is used to estimate these demand systems. The homogeneity and symmetry properties can be tested for each demand system using the maximum likelihood ratio test. Since the share equations sum to one in the AIDS, translog, and Lewbel demand systems, one equation is dropped from the systems in the estimation to avoid singularity. The parameters of the dropped equation are derived by using the adding-up restrictions. The starting values of the coefficients in the estimation are obtained from OLS regressions of individual demand equations. Because the convergence to a local rather than a global maximum is possible, each demand system is re-estimated with different starting values to verify that the global maximum has probably been achieved.

To conduct policy analysis using the estimated demand systems, the MODEL procedure in SAS is used to derive the estimates of budget shares under alternative policy assumptions.

CHAPTER 5. ESTIMATION RESULTS

This chapter presents the estimation results of the associated conceptual demand models presented in Chapter 3. The data sources and estimation procedures used to derive the empirical results have been described in Chapter 4. This chapter is organized into five sections. Section 1 reports the income elasticities and marginal budget shares of major food commodities estimated from Engel functions for Chinese urban households. Section 2 presents the estimated demand elasticities for 21 major food commodities for Chinese urban households using a three-stage budgeting procedure. Section 3 reports the estimated income elasticities and marginal budget shares from Engel functions for Chinese rural households. Section 4 presents the estimation results of an ELES using data sets of individual households from China's Rural Household Survey. The last section reports some empirical results of hypothesis tests for demand system selections.

Engel functions for Chinese urban households

Engel functions discussed in Chapter 3 are used to estimate the relation between average per capita income and expenditure on major food commodities for Chinese urban households. The data used to estimate the functions are the sample means by 28 provinces from China's Urban Household Survey for the years 1989 to 1991. Two variables in the data set can be used to represent the average per capita income level: the average per capita gross income and the average per capita income for living expenses. This study uses the later as the income variable in estimating the Engel functions.

The Engel functions in doublelog form, represented in equation (3.3), are estimated for

major food groups and commodities using the ordinary least squares (OLS). As discussed in Chapter 3, the estimated parameters of Engel functions directly give the income elasticities and also can be used to derive the marginal budget shares. Because Engel functions do not incorporate the effects of price changes, the functions are estimated for the pooled data of three years and the annual data sets in order to examine the stability of the estimation results. The estimated income elasticities and marginal budget shares for all food, four food groups, and seven major food commodities are reported in Table 5.1. Note that the results for 1990 are not reported in the table.

The regression coefficients (R^2) suggest that the income variable can explain a large proportion of the cross-province variation in average per capita expenditure for all food, non-staple food, and other food, but only a small proportion of the variation for staple food (grains) and the group of cigarettes, alcoholic beverages and tea. The income elasticities estimated from the pooled data and the annual data sets are quite stable for all food, non-staple food, and other food, but significantly unstable for staple food and the group of cigarettes, alcoholic beverages and tea. The estimated income elasticities are slightly greater than 1.0 for all food and other food, significantly greater than 1.0 for non-staple food, and less than 1.0 for staple food and the group of cigarettes, alcoholic beverages and tea.

To examine the relation between average income and expenditure on individual food commodities, the Engel functions are estimated for seven major food commodities using the same data sets. The estimated income elasticities are greater than 2.0 for poultry and fish, slightly greater than 1.0 for pork, and less than 1.0 for grains, vegetable oils, and beef & mutton. Note that the estimation results are quite different across data sets for most of these food commodities. The instability may be caused by price changes which are not incorporated in the Engel functions.

The estimated marginal budget shares from Engel functions are reported in Table 5.2.

Table 5.1. Estimated income elasticities from Engel functions for Chinese urban households

	1989		1991		1989-1991	
	Income elasticity	R^2	Income elasticity	R^2	Income elasticity	R^2
Food groups						
All food	1.1301	0.88	1.0517	0.88	1.0559	0.88
Staple food	0.0985	0.01	0.2181	0.07	0.3446	0.13
Non-staple food	1.4730	0.75	1.3637	0.78	1.2981	0.72
Other food	1.0518	0.47	1.0426	0.56	1.0531	0.54
Cigarettes, alcoholic beverages & tea	0.2763	0.05	0.1748	0.02	0.3820	0.08
Food commodities						
Grains	0.0985	0.01	0.2181	0.07	0.3446	0.13
Vegetable oils	0.7582	0.17	0.5899	0.22	0.7878	0.24
Pork	1.2892	0.31	1.2331	0.32	1.0853	0.27
Beef & mutton	0.0407	0.01	0.1029	0.01	0.2211	0.01
Poultry	2.9966	0.59	2.7922	0.56	2.6431	0.52
Eggs	1.1675	0.22	0.6866	0.11	0.9083	0.18
Fish	2.8876	0.61	2.5896	0.56	2.3372	0.50

Table 5.2. Estimated marginal budget shares from Engel functions for Chinese urban households

	1989	1991	1989-1990
Food groups			
All food	0.5916	0.5324	0.5396
Staple food	0.0067	0.0150	0.0230
Non-staple food	0.4664	0.4043	0.3962
Other food	0.0865	0.0862	0.0863
Cigarettes, alcoholic beverages & tea	0.0157	0.0102	0.0219
Food commodities			
Grains	0.0067	0.0150	0.0230
Vegetable oils	0.0122	0.0102	0.0129
Pork	0.1032	0.0833	0.0802
Beef & mutton	0.0007	0.0018	0.0039
Poultry	0.0538	0.0512	0.0467
Eggs	0.0279	0.0154	0.0209
Fish	0.0748	0.0585	0.0564

The estimation results provide useful information on household budget allocations among different food groups and individual food commodities in urban China. For major food groups, Chinese urban households are likely to spend about 2.3 percent of their additional income for staple food, 39.6 percent for non-staple food, 8.6 percent for other food, and 2.2 percent for cigarettes, alcoholic beverages and tea. Note that these percentages are derived from the pooled data. The results are quite different across years for staple food and the group of cigarettes, alcoholic beverages and tea. For individual food commodities, Chinese urban households tend to allocate relatively more of their additional income for pork, fish and poultry, and less of that for eggs, vegetable oils, and beef & mutton.

The estimation results from Engel functions provide useful information on the relation between income and food expenditure for Chinese urban households, but the estimated income elasticities and marginal budget shares should be interpreted and applied with caution because excluding price changes in the Engel functions may affect the accuracy and reliability of the estimation results. Furthermore, given the fact that Chinese urban households across provinces are significantly different in many demographic characteristics and also facing different food availability and market conditions, the observed cross-province variation in food consumption and expenditure patterns may be determined by factors other than income.

Demand systems for Chinese urban households

As discussed in Chapter 4, the pooled data of sample means by seven income groups and two city groups from China's Urban Household Survey for the years 1986 to 1991 are used to estimate the associated demand systems discussed in Chapter 3. The nominal income and expenditures are converted into real ones using the *urban living cost index*. The estimation results are presented in this section.

A three-stage budgeting procedure

Chapter 3 has discussed the difficulties and possible strategies for estimating consumer demand for a large number of goods and services. With the assumption that consumers make their budget allocation decisions in separate steps, the multiple-stage budgeting procedure has been widely used in empirical studies (e.g., Haden 1990; Goungetas et al. 1993; Kesavan et al. 1993; Wang and Jensen 1994). The necessary and sufficient conditions for a multiple-stage budgeting procedure have been discussed in Chapter 3.

Our data set contains the average per capita expenditure for major commodity and service groups and both consumption and expenditure data for selected commodities (see Table 4.3 and Table 4.4). The data on food include the average per capita consumption and expenditure for 23 major food commodities (see Table 4.4). In order to estimate the expenditure and price elasticities for these commodities, a three-stage budgeting procedure based on the assumption of weak separability is used in this study. The Chinese urban households are assumed to allocate their total expenditure between food and nonfood categories in the first budgeting stage, then allocate the total expenditure on food among six broad food groups, and finally allocate the expenditure on each broad food group among food commodities within the group. The structure of the three-stage budgeting procedure is illustrated in Figure 5.1.

Consumer demand theory suggests that separability tests may provide guidance for aggregating the large number of goods and services into aggregated groups, but the grouping decisions in empirical studies are generally made on an *ad hoc* basis (Goungetas et al. 1993). The construction of food groups for Chinese urban households, illustrated in Figure 5.1, is determined partially by the classification used in China's statistical system and partially by previous studies of China's urban food demand.

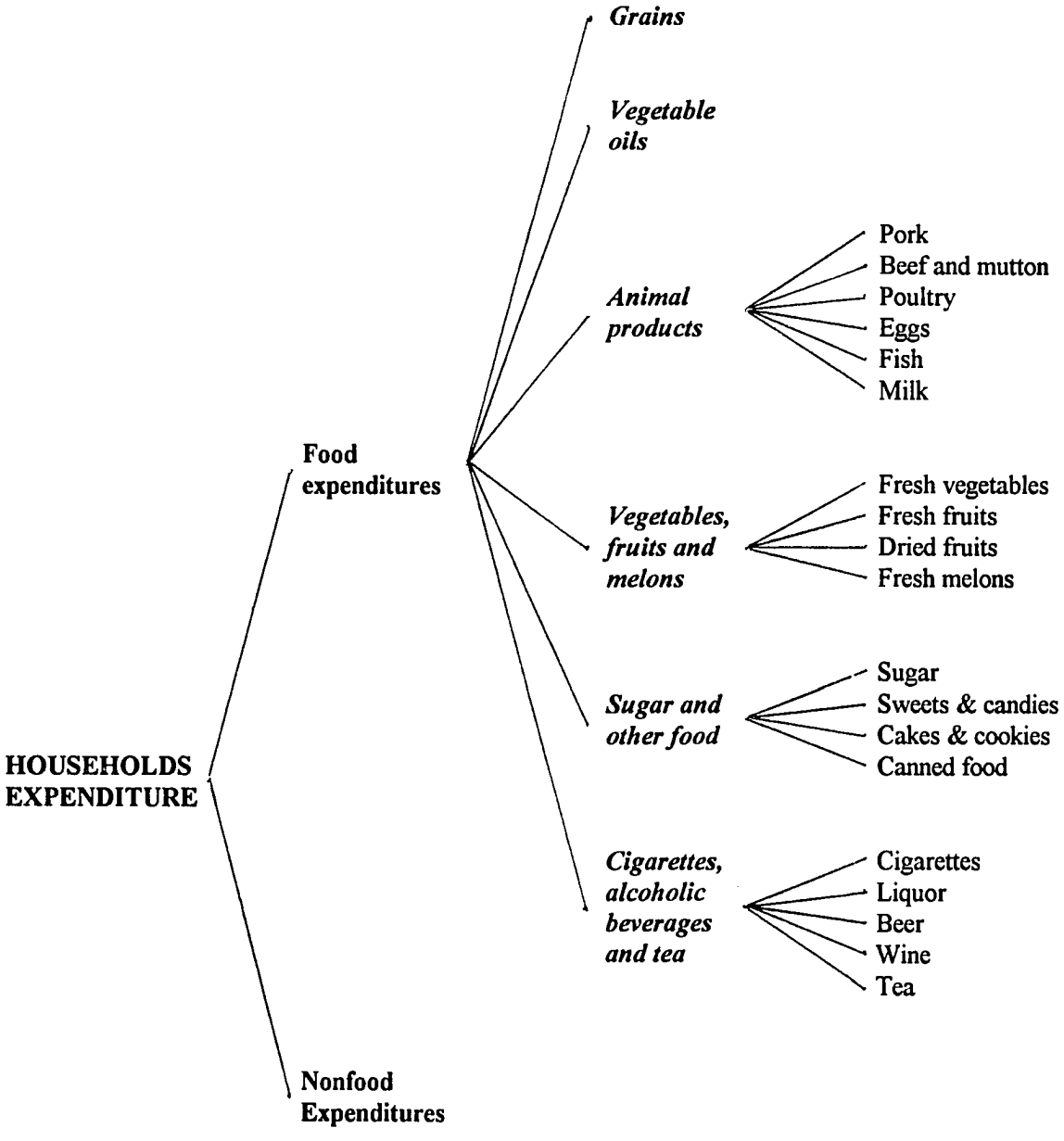

Figure 5.1. A three-stage budgeting procedure for Chinese urban households

Estimation results of the third budgeting stage

The LA/AIDS, translog demand system and Lewbel model, presented in Chapter 3, are used to model the budget allocation decisions of Chinese urban households in their third budgeting stage. The three demand systems are estimated for each of the four food groups, but only the results from LA/AIDS are reported in this section. In addition to the total expenditure and prices, two demographic variables representing household size and city size are incorporated into the demand systems by translating the intercept terms. *HS* (household size) is defined as the number of persons in a household, and *CS* (city size) equals 1.0 for medium and large cities and 0 for the county level (small) cities. The theoretical restrictions (adding-up, homogeneity, and symmetry) are imposed on the parameters to be estimated. The demand systems are estimated using the estimation procedures described in Chapter 4. The estimated parameters and expenditure and Marshalian price elasticities are reported for each of the four systems in the third budgeting stage. Note that the expenditure elasticities estimated from the third budgeting stage are conditional elasticities because the expenditures allocated to each of the four food groups are determined in the second budgeting stage. The unconditional expenditure elasticities will be computed for each of the 21 food commodities using the estimation results from all the budgeting stages. The income compensated (Hicksian) price elasticities are not reported in this dissertation.

Animal products

Our data set includes six major animal products: pork, beef & mutton, poultry, eggs, fish, and milk. Beef and mutton are generally aggregated into one meat group in China's statistical system. The estimated parameters and their t-ratios of the LA/AIDS are reported in Table 5.3. As discussed in Chapter 4, one budget share equation (milk) is dropped in estimating the demand system and the parameters of milk demand are derived from the

Table 5.3. Estimated parameters of the LA/AIDS for the third budgeting stage of Chinese urban households: **animal products**

	Pork	Beef & mutton	Poultry	Eggs	Fish	Milk
Intercept	0.8173	0.2124	-0.1591	0.2125	-0.0607	-0.0296
	(7.98)	(4.25)	(-2.66)	(2.24)	(-1.07)	
$\ln(p_1)$	0.0360	-0.0676	0.0328	0.0293	-0.0184	-0.0121
	(1.23)	(-3.70)	(2.13)	(1.36)	(-1.01)	
$\ln(p_2)$	-0.0676	0.0265	0.0059	0.0174	0.0121	0.0057
	(-3.70)	(1.10)	(0.48)	(1.48)	(0.74)	
$\ln(p_3)$	0.0328	0.0059	-0.0321	-0.0501	0.0432	0.0003
	(2.13)	(0.48)	(-2.24)	(-3.65)	(3.55)	
$\ln(p_4)$	0.0293	0.0174	-0.0501	0.0304	-0.0286	0.0016
	(1.36)	(1.48)	(-3.65)	(1.27)	(-1.99)	
$\ln(p_5)$	-0.0184	0.0121	0.0432	-0.0286	0.0016	-0.0099
	(-1.01)	(0.74)	(3.55)	(-1.99)	(0.07)	
$\ln(p_6)$	-0.0121	0.0057	0.0003	0.0016	-0.0099	0.0144
$\ln(\frac{X}{P})$	-0.0731	-0.0164	0.0564	-0.0096	0.0347	0.0080
	(-4.58)	(-2.12)	(6.07)	(-0.65)	(3.93)	
CS	-0.0585	-0.0003	-0.0012	0.0424	-0.0051	0.0227
	(-12.10)	(-0.11)	(-0.40)	(8.72)	(-1.80)	
$\ln(HS)$	0.0069	-0.0140	0.0034	-0.0136	0.0193	-0.0020
	(0.80)	(-3.13)	(0.65)	(-1.67)	(3.86)	

Estimated t-ratio in parentheses.

estimated parameters of other equations using the adding-up restrictions. The estimated parameters of the demographic variables suggest that households size and city size may have significant impacts on household demand for these animal products.

The estimated expenditure and Marshalian price elasticities based on sample means are reported in Table 5.4. According to the estimated expenditure elasticities, household demand in the third budgeting stage is income elastic for poultry, fish, milk and eggs, but income inelastic for pork and beef & mutton. These results are quite consistent with the observations from China. Pork has been the most commonly available meat for Chinese consumers, whereas fish, poultry and milk are generally considered as luxury food items in both urban and rural areas. Pork production has traditionally dominated other meat products in China for thousands of years. For example, the shares of China's total meat output in 1992 are 76.8 percent for pork, 5.3 percent for beef, 3.6 percent for mutton, 13.2 percent for poultry, and 1.1 percent for other meats.

Table 5.4 shows that all the estimated own price elasticities are negative. The demand is likely price elastic for poultry and fish, but price inelastic for other animal products. According to the estimated cross price elasticities, pork and beef & mutton, pork and fish, pork and milk, poultry and eggs, poultry and milk, eggs and fish, and fish and milk are likely to be complements, whereas pork and poultry, pork and eggs, poultry and beef & mutton, eggs and beef & mutton, fish and beef & mutton, milk and beef & mutton, and eggs and milk tend to be substitutes for Chinese urban households.

Vegetables, fruits and melons

Four commodities are included in this food group: fresh vegetables, fresh fruits, dried fruits, and fresh melons. Although the data for 1990 and 1991 include another commodity called "dried vegetables", it is not included in the demand system because the consumption

Table 5.4. Estimated expenditure and Marshalian price elasticities of the LA/AIDS for the third budgeting stage of Chinese urban households: **animal products**

		Marshalian price elasticity of good *i* with respect to good *j*					
	Expenditure elasticities	Pork	Beef & mutton	Poultry	Eggs	Fish	Milk
Pork	0.8327	-0.8503	-0.1305	0.0876	0.0844	-0.0130	-0.0227
Beef & mutton	0.8492	-0.7002	-0.6745	0.0907	0.2301	0.1736	0.0717
Poultry	1.4895	0.0549	0.0092	-1.3362	-0.5057	0.2939	-0.0068
Eggs	0.9858	0.2380	0.1281	-0.3448	-0.7766	-0.1902	0.0132
Fish	1.1909	-0.2067	0.0544	0.2337	-0.2000	-1.0253	-0.0629
Milk	1.2689	-0.8070	0.2608	-0.0303	0.0281	-0.5703	-0.2884

and expenditure data are not available for the years 1986 to 1989. The estimated parameters and demand elasticities from a LA/AIDS are reported in Table 5.5 and Table 5.6.

The estimated expenditure elasticities indicate that demand in the third budgeting stage is income elastic for fresh fruits and dried fruits, but income inelastic for fresh vegetables and fresh melons. These results seem realistic because fruits are much more expensive than vegetables and melons and therefore can be considered as luxury food items for Chinese consumers. The estimated own price elasticities suggest that the demand is price elastic for fresh fruits but price inelastic for fresh vegetables, dried fruits, and fresh melons. According to the estimated cross price elasticities, fresh vegetables and fresh fruits, and dried fruits and fresh melons are likely to be substitutes, whereas fresh vegetables and melons, fresh fruits and melons, and fresh and dried fruits tend to be complements for Chinese urban households.

Sugar and other food

This food group includes four commodities: sugar, sweets & candies, cakes & cookies and canned food. The estimation results from a LA/AIDS are reported in Table 5.7 and Table 5.8.

The estimated expenditure elasticities reported in Table 5.8 suggest that the demand is likely to be income elastic for sweets & candies and canned food, but income inelastic for sugar and cakes & cookies. The relatively high expenditure elasticity for canned food may be explained by the observation that canned food products are relatively expensive in the Chinese markets. The estimated own price elasticities are all negative except for sugar. The unexpected sign for sugar may be contributed by the dramatic fluctuation in sugar retail price in China during 1987 to 1991 (State Statistical Bureau of China 1992). According to the estimated cross price elasticities, sugar and sweets & candies, and sugar and canned food tend to be substitutes, whereas sugar and cakes & cookies, and sweets & candies and cakes &

Table 5.5. Estimated parameters of the LA/AIDS for the third budgeting stage of Chinese urban households: **vegetables, fruits and melons**

	Fresh vegetables	Fresh fruits	Dried fruits	Fresh melons
Intercept	1.8301	-0.9439	-0.0099	-0.8763
	(6.30)	(-4.41)	(-0.97)	
$\ln(p_1)$	-0.1025	0.1462	-0.1097	0.0660
	(-1.71)	(3.35)	(-3.27)	
$\ln(p_2)$	0.1462	-0.1097	0.0106	-0.0471
	(3.35)	(-3.27)	(-1.16)	
$\ln(p_3)$	-0.0099	-0.0106	0.0185	0.1018
	(-0.97)	(-1.16)	(2.57)	
$\ln(p_4)$	0.0660	-0.0471	0.1018	-0.1207
$\ln(\frac{X}{P})$	-0.2651	0.2406	0.0286	-0.0341
	(-5.68)	(6.97)	(3.58)	
CS	-0.0166	0.0048	-0.0010	0.0128
	(-2.47)	(0.97)	(-0.88)	
$\ln(HS)$	-0.0972	0.1565	-0.0065	-0.0528
	(-1.22)	(2.66)	(-0.49)	

Estimates t-ratio in parentheses.

Table 5.6. Estimated expenditure and Marshalian price elasticities of the LA/AIDS for the third budgeting stage of Chinese urban households: **vegetables, fruits and melons**

		Marshalian price elasticity of good *i* with respect to good *j*			
	Expenditure elasticities	Fresh vegetables	Fresh fruits	Dried fruits	Fresh melons
Fresh vegetables	0.5553	-0.9067	0.3596	0.0174	-0.0257
Fresh fruits	1.9342	0.0106	-1.6664	-0.1127	-0.1657
Dried fruits	1.3746	-0.3524	-0.2357	-0.7867	0.0002
Fresh melons	0.9409	-0.4488	-0.3546	0.0334	-0.1708

Table 5.7. Estimated parameters of the LA/AIDS for the third budgeting stage of Chinese urban households: **sugar and other food**

	Sugar	Sweets & candies	Cakes & cookies	Canned food
Intercept	0.6513 (6.76)	0.1639 (1.97)	0.5213 (3.97)	-0.3365
$\ln(p_1)$	0.2613 (4.20)	0.0288 (0.69)	-0.3333 (-6.68)	0.0432
$\ln(p_2)$	0.0288 (0.69)	-0.0197 (-0.36)	-0.0374 (-0.78)	0.0283
$\ln(p_3)$	-0.3333 (-6.68)	-0.0374 (-0.78)	0.4676 (7.06)	-0.0969
$\ln(p_4)$	0.0432	0.0283	-0.0969	0.0254
$\ln(\frac{X}{P})$	-0.1255 (-6.86)	0.0361 (-2.32)	-0.0251 (-1.07)	0.1145
CS	-0.0108 (-1.35)	-0.0032 (-0.48)	0.0112 (1.32)	0.0028
$\ln(HS)$	-0.0900 (-2.22)	-0.0780 (-2.19)	0.0242 (0.42)	0.1438

Estimates t-ratio in parentheses.

Table 5.8. Estimated expenditure and Marshalian price elasticities of the LA/AIDS for the third budgeting stage of Chinese urban households: **sugar and other food**

		Marshalian price elasticity of good *i* with respect to good *j*			
	Expenditure elasticity	Sugar	Sweets & candies	Cakes & cookies	Canned food
Sugar	0.3509	0.4768	0.2534	-1.4074	0.3264
Sweets & candies	1.2248	0.1363	-1.1586	-0.3427	0.1404
Cakes & Cookies	0.9486	-0.6734	-0.0685	-0.1641	-0.1905
Canned food	1.7230	0.1332	1.2248	0.9486	-0.7230

cookies are likely to be complements for Chinese urban households.

Cigarettes, alcoholic beverages and tea

Cigarettes, alcoholic beverages and tea have traditionally been classified as a food group in China's statistical system (State Statistical Bureau of China 1992). As special food commodities with significant health impacts, the demand parameters for cigarettes and alcoholic beverages are of great importance for assessing the effects of alternative policies and studying public health issues related to cigarette and alcohol consumption (Cook 1981; Nath 1986). This group includes five commodities: cigarettes, liquor, beer, wine, and tea. One note on the data is that wine includes all alcoholic beverages other than liquor and beer. The parameters of a LA/AIDS are reported in Table 5.9, and the estimated expenditure and Marshalian price elasticities from the LA/AIDS are reported in Table 5.10.

The t-ratios reported in parentheses in Table 5.9 indicate that most of the estimated parameters are significantly different from zero at 10 percent significance level. The estimated expenditure elasticities presented in Table 5.10 suggest that the demand in the third budgeting stage is likely to be income elastic for beer and wine, but income inelastic for cigarettes, liquor, and tea. The estimated own price elasticities are all negative but their absolute values are all less than 1.0. According to the estimated cross price elasticities, liquor and wine, beer and tea, and wine and tea are likely to be substitutes for each other, whereas liquor and beer, liquor and tea, and cigarettes and all beverages tend to be complements.

Estimation results of the second budgeting stage

In estimating the second budgeting stage, each of the four food groups estimated in the third budgeting stage is considered as one aggregated food commodity. Thus Chinese urban households are assumed to allocate their total food expenditure among six groups in the

Table 5.9. Estimated parameters of the LA/AIDS for the third budgeting stage of Chinese urban households: **cigarettes, alcoholic beverages and tea**

	Cigarettes	Liquor	Beer	Wine	Tea
Intercept	0.7920 (7.67)	0.2142 (2.71)	0.1387 (1.96)	-0.2272 (-5.62)	0.0823
$\ln(p_1)$	0.1289 (7.81)	-0.0312 (-2.79)	-0.0387 (-3.28)	-0.0392 (-5.83)	-0.0198
$\ln(p_2)$	-0.0312 (-2.79)	0.0633 (5.09)	-0.0284 (-2.91)	0.0152 (2.62)	-0.0189
$\ln(p_3)$	-0.0387 (-3.28)	-0.0284 (-2.91)	0.0411 (2.68)	0.0030 (0.40)	0.0230
$\ln(p_4)$	-0.0392 (-5.83)	0.0152 (2.62)	0.0030 (0.40)	0.0174 (2.90)	0.0036
$\ln(p_5)$	-0.0198	-0.0189	0.0230	0.0036	0.0193
$\ln(\frac{X}{P})$	-0.0432 (-2.62)	-0.0129 (-0.99)	0.1467 (1.29)	0.0479 (7.31)	-0.1385
CS	0.0204 (6.05)	-0.0543 (-17.73)	0.0360 (10.76)	0.0029 (1.60)	-0.0050
$\ln(HS)$	-0.0824 (-2.32)	0.0707 (2.70)	-0.0739 (-2.95)	0.0819 (5.84)	0.0037

Estimated t-ratio in parentheses.

Table 5.10. Estimated expenditure and Marshalian price elasticities of the LA/AIDS for the third budgeting stage of Chinese urban households: **cigarettes, alcoholic beverages and tea**

		Marshalian price elasticity of good *i* with respect to good *j*				
	Expenditure elasticity	Cigarettes	Liquor	Beer	Wine	Tea
Cigarettes	0.9206	-0.7196	-0.0392	-0.0619	-0.0681	-0.0316
Liquor	0.9438	-0.1057	-0.7107	-0.1175	0.0694	-0.0792
Beer	1.1255	-0.3991	-0.2717	-0.6631	0.01933	0.1890
Wine	1.9623	-1.3093	0.0859	-0.0534	-0.6988	0.0123
Tea	0.8929	-0.2659	-0.2847	0.3881	0.0632	-0.7938

second budgeting stage: (1) grains, (2) vegetable oils, (3) animal products, (4) vegetables, fruits and melons, (5) sugar and other food, and (6) cigarettes, alcoholic beverages and tea.

As discussed in Chapter 1 and Chapter 2, Chinese urban residents have received a wide range of state subsidies through consumption rationing. Although the scope and impacts of food rationing have reduced significantly since the late 1980s, the supply of grains and vegetable oils to Chinese urban households during the study period was mainly through the rationing system. Because consumer demand under rationing is significantly different from that under free market conditions (Deaton 1980; Wang and Chern 1992), the demand system incorporating consumption rationing developed in Chapter 3 is used to model the budget allocation decisions of Chinese urban households in their second budgeting stage.

Chapter 3 has developed a general demand system which includes nonrationed, strictly rationed, and partially rationed commodities. Although Chinese urban households have been able to purchase many food commodities from free markets since the 1978 economic reform, grains and vegetable oils were basically under consumption rationing during the study period (Wang and Chern 1992; Chern and Wang 1993). Because urban households can purchase a limited amount of grains and vegetable oils from the state-owned ration shops and additional amount from free markets, grains and vegetable oils should be included into the demand system as commodities under partial rationing. Unfortunately, the data are available only for the total consumption and expenditure and no reliable information is available to identify the proportions purchased from free markets. Considering the data limitation and the fact that only a small proportion of grains and vegetable oils were purchased from free markets, both grains and vegetable oils are considered as commodities under strict rationing in the estimation. Under this assumption, the AIDS with strict and partial rationing developed in Chapter 3 can be simplified by excluding the set of commodities under partial rationing. Equation (3.29) reduces to:

$$w_i = \alpha_i + \sum_{k=1}^{m} \delta_{ik} z_k^{sr} + \sum_{j=1}^{n+r} \gamma_{ij} \ln(p_j) + \beta_i \left[\ln\left(x - \sum_{k=1}^{m} p_k^{sr} z_k^{sr} \right) - \ln(P) \right], \qquad (5.1)$$

where all the variables and parameters are as defined in (3.29). Under this specification, the formulas for computing Marshalian and Hicksian price elasticities are the same as the formulas for AIDS, but the expenditure elasticity of commodity *i* is given by:

$$E_i = 1 + \left(\frac{\beta_i}{w_i} \right) \left(\frac{I}{I - \sum_{k=1}^{m} p_k z_k} \right) \qquad (5.2)$$

The estimated parameters of the demand system are reported in Table 5.11 and the estimated expenditure and price elasticities are presented in Table 5.12. The expenditure elasticities suggest that the demand is income elastic for the group of vegetables, fruits and melons and the group of sugar and other food, but income inelastic for the two other food groups. The estimated own price elasticities indicate that the demand is price elastic only for the group of vegetables, fruits and melons. According to the estimated cross price elasticities, the group of animal products and the group of vegetables, fruits and melons are likely to be substitutes, whereas the other pairs of the food groups tend to be complements.

In addition to the estimated income and price elasticities, the impacts of a change in the level or price of any commodity under rationing on the demand for nonrationed commodities can be estimated. The empirical results and policy implications will be discussed in Chapter 6.

Table 5.11. Estimated parameters of the LA/AIDS with rationing for the second budgeting stage of Chinese urban households

	Animal products	Cigarettes, alcoholic beverages and tea	Vegetables, fruits and melons	Sugar and other food
Intercept	0.8668 (12.43)	-0.0460 (-0.82)	0.6253 (12.02)	-0.4461
$\ln(p_1)$	0.0503 (3.28)	-0.0766 (-7.20)	0.0087 (0.72)	0.0176
$\ln(p_2)$	-0.0766 (-7.20)	0.1158 (8.65)	-0.0301 (-2.45)	-0.0091
$\ln(p_3)$	0.0087 (0.72)	-0.0301 (-2.45)	0.0518 (2.68)	-0.0304
$\ln(p_4)$	0.0176	-0.0091	-0.0304	0.0219
$\ln(\frac{X}{P})$	-0.0404 (-3.67)	0.0164 (1.89)	-0.0492 (-6.59)	0.0732
CS	0.0165 (3.76)	-0.0240 (-7.03)	0.0096 (3.29)	-0.0021
$\ln(HS)$	-0.1079 (-5.23)	0.0566 (3.31)	-0.0423 (-2.59)	0.0936
Z_1	-0.0237 (-0.87)	0.0505 (2.49)	-0.0327 (-1.89)	0.0059
Z_2	-0.0164 (-1.05)	0.0094 (0.78)	0.0109 (0.91)	-0.0039

Table 5.12. Estimated expenditure and Marshalian price elasticities of the LA/AIDS with rationing for the second budgeting stage of Chinese urban households

		Marshalian price elasticity of good *i* with respect to good *j*			
	Expenditure elasticities	Animal products	Cigarettes, alcoholic beverages and tea	Vegetables, fruits and melons	Sugar and other food
Animal products	0.8402	-0.9571	-0.1942	0.2794	-0.0006
Cigarettes, alcoholic beverages and tea	0.9891	-0.6403	-0.2206	-0.0651	-0.0654
Vegetables, fruits and melons	1.0296	0.3912	-0.0411	-1.3601	-0.0134
Sugar and other food	2.0191	-0.4563	-0.2842	-0.2851	-0.7867

Estimation results of the first budgeting stage

As discussed in the beginning of this section, the expenditure elasticities estimated from the first and second budgeting stage are all conditional elasticities. In order to estimate the unconditional expenditure elasticities for the 21 food commodities, the first budgeting stage, which determines total food expenditure, should be estimated.

Chinese urban households allocate their total budget among food, clothing, housing, fuel, health care, etc. Estimation of a demand system including food and other major expenditure groups can provide useful information on budget allocation decision in the first budgeting stage. The estimated parameters and sample means can be used to estimate the expenditure and price elasticities for food and other expenditure groups. Unfortunately, the data available for the expenditure groups other than food include only average per capita expenditure. The absence of prices (unit values) makes it difficult to estimate a complete demand system for the first budgeting stage. For the purpose of estimating unconditional expenditure elasticities for 21 food commodities, this study estimates a single-equation demand model for the first budgeting stage. This is considered sufficient for our empirical estimation of conditional and unconditional expenditure elasticities (e.g., Haden 1990; Kesavan et al. 1993; Wang and Jensen 1994). The estimation results of a doublelog demand equation are:

$$\ln(FD) = \underset{}{-3.7940} + \underset{(24.85)}{1.1951}\ln(Y) + \underset{(8.82)}{1.2694}\ln(HS) + \underset{(2.47)}{0.02539}CS$$
$$\qquad\qquad\quad (-7.38)$$

$$R^2 = 0.982$$

where FD is the average per capita expenditure on food, Y is the average per capita real income available for living expenses, CS is a dummy variable to present city size, and HS is

household size. The regression coefficient suggests that the variation in food expenditure can be significantly explained by the set of explanatory variables. It is obvious that the coefficient of ln (Y) directly gives the estimated income elasticity for food.

The estimated expenditure elasticities from the three budgeting stages can then be used to estimate the unconditional income elasticity for each food commodity. Under the assumption of weak separability, the unconditional income elasticity for a particular food commodity such as pork can be derived simply by multiplying the conditional elasticities estimated from the third budgeting stage with that estimated from the first and second stages. The estimated unconditional income elasticities are reported in Table 5.13. The results suggest that all the food commodities can be considered as normal goods with income elasticities significantly greater than zero. The estimated income elasticity is greater than 2.0 for fresh fruits, sweets & candies, cakes & cookies, canned food and wine, but less than 1.0 for pork, beef & mutton, eggs, fresh vegetables and sugar.

Engel functions for Chinese rural households

This section presents the estimated income elasticities and marginal budget shares from Engel functions for Chinese rural households. The data are the sample means by 28 provinces from China's Rural Household Survey for years 1989 to 1991. Compared to the data for urban households, the data available for rural households are relatively limited. Our data set includes total food expenditure and the expenditure on six major food commodities. Considering that the net income of Chinese rural households can be used for production investment and living expenses, the average per capita living expenditure is used to represent the average income level in estimating the Engel functions.

Like the estimation of Engel functions for Chinese urban households, the Engel

Table 5.13. Estimated unconditional expenditure elasticities of food demand for Chinese urban households

Food commodity	Unconditional income elasticity
Animal products	
Pork	0.8361
Beef & mutton	0.8527
Poultry	1.4956
Eggs	0.9899
Fish	1.1958
Milk	1.2741
Vegetables, fruits and melons	
Fresh vegetables	0.6833
Fresh fruits	2.3800
Dried fruits	1.6914
Fresh melons	1.1577
Sugar and other food	
Sugar	0.8467
Sweets & candies	2.9555
Cakes & cookies	2.2890
Canned food	4.1576
Cigarettes, alcoholic beverages and tea	
Cigarettes	1.0882
Liquor	1.1156
Beer	1.3304
Wine	2.3196
Tea	1.0555

functions in doublelog forms are estimated for all food and six major food commodities. The estimation results reported in Table 5.14 suggest that the income variable can explain a significant proportion of the cross-province variation in average per capita expenditure for food, poultry, eggs and fish, but only a small proportion of the variation for other commodities such as red meats.

The estimated expenditure elasticities indicate that demand is income elastic for poultry, eggs and fish, but income inelastic for all food and other food commodities. The estimated marginal budget shares for all food and major food commodities are reported in Table 5.15. The results suggests that Chinese rural households may allocate about 47 percent of their additional living expenditure for food. For major food commodities, they are likely to allocate relatively more of their additional living expenditure on grains, red meats and fish, but relatively less of that on vegetable oils and eggs.

The estimation results of Engel functions provide useful information on the relation between income and food expenditure, but the estimated expenditure elasticities and marginal budget shares from Engel functions should be interpreted and applied with cautions for the reasons discussed in the first section of this chapter.

An ELES for Chinese rural households

As discussed in Chapter 4, regional data sets from China's Rural Household Survey for the years 1988 to 1990 have been obtained from local statistical agencies in China. In the data sets there are 640 variables for each household, including household characteristics, production investment, product distribution, household consumption, expenditure, etc. It was planned originally to estimate and test the associated demand models presented in Chapter 3 using the detailed survey data of Chinese rural households. But many problems

Table 5.14 Estimated income elasticities from Engel functions for Chinese rural households

Food group	1989		1991		1989-1991	
	Income elasticity	R^2	Income elasticity	R^2	Income elasticity	R^2
All food	0.8064	0.91	0.8344	0.92	0.8542	0.89
Grains	0.2494	0.19	0.3660	0.40	0.6922	0.19
Vegetable oils	0.4651	0.17	0.5357	0.35	0.5605	0.25
Red meats	0.5745	0.12	0.7123	0.23	0.6376	0.18
Poultry	1.9691	0.35	2.2501	0.38	1.9931	0.34
Eggs	1.3803	0.52	1.4408	0.49	1.3783	0.48
Fish	4.3961	0.65	4.1439	0.57	4.0656	0.58

Table 5.15 Estimated marginal budget share from Engel functions of Chinese rural households

Food group	1989	1991	1989-1990
All food	0.4344	0.4716	0.4716
Grains	0.0595	0.0642	0.1551
Vegetable oil	0.0127	0.0171	0.0167
Red meats	0.0576	0.0705	0.0664
Poultry	0.0265	0.0280	0.0266
Eggs	0.0262	0.0258	0.0259
Fish	0.0616	0.0575	0.0564

found in the preliminary statistical analysis of the data sets have limited our demand system analysis for Chinese rural households. For example, the unit values derived from expenditures and quantities varied dramatically across households for many food commodities. Another example of the data problem is that the expenditure data for individual commodities have so many missing values. According to the preliminary analysis of the data sets, the expenditure data may be more accurate than quantity data, and the data for aggregated expenditure groups are likely to be better than that for individual commodities. One possible explanation is that the participating households and the local statistical agencies have paid more attention to expenditure data for major groups because these data are aggregated and reported every month. Considering the data availability and problems, this study presents only the estimation results of an extended linear expenditure system (ELES) of four major food groups. .

The four broad food groups are staple food (grains), non-staple food, other food, and food away from home. Non-staple food includes vegetables, meats, eggs, vegetable oils, sugar, etc., whereas other food includes fruits, sweets, candies, milk, canned food, cigarettes, alcoholic beverages, tea, etc. Note that the classification of food groups for rural households is slightly different from that for urban households. As shown in Chapter 3, the ELES can be used to estimate the income and price elasticities when the price data are not available.

The marginal budget shares, income elasticities, and own price elasticities estimated for these four food groups from an ELES are reported in Table 5.16. The estimated marginal budget shares suggest that Chinese rural households are likely to allocate relatively more of their additional food expenditure on non-staple food and other food, and relatively less of that on other food groups. The estimated income elasticities for non-staple food, other food, and food away from home are significantly greater than that for staple food. According to the estimated own price elasticities, the demand is not price elastic for all the food groups.

Table 5.16. Sample means and estimated marginal budget shares and demand elasticities from an ELES for Chinese rural households

	Staple food	Non staple food	Other food	Food away from home
Average expenditure	193.5095	212.7960	137.7050	22.0555
Estimated parameters				
Intercept	167.4253	111.8377	63.5011	0.3512
Slope	0.0241	0.0934	0.0687	0.0201
Marginal budget share	0.1170	0.4528	0.3328	0.0974
Income elasticity	0.1348	0.4744	0.5389	0.9842
Own price elasticity	-0.1031	-0.3515	-0.3697	-0.5985

Hypothesis tests and demand system selections

One decision problem in applied demand analysis is how to select an appropriate demand model for a particular application. Although there are many criteria for demand system selections, for any particular application, the basic criterion after consistency with economic theory is simply the relative explanatory power and simplicity of estimation (Lewbel 1989). Chapter 3 has shown that the relative explanatory power of two competing demand models, nested or non-nested, can be examined by hypothesis tests.

Two of the most commonly used flexible demand systems are the translog demand system (Christensen et al. 1975) and the AIDS (Deaton and Muellbauer 1980). Deaton and Muellbauer (1980) have strongly promoted the AIDS and disparaged the translog demand system. Similarly, Jorgenson et al. (1982) have defended the translog demand system over all other PIGLOG forms that include AIDS. Although both demand systems have been widely used in demand studies, few studies have compared their adequacy and relative explanatory power using the same data base. Such comparisons can contribute to the evaluation of the two demand systems in applied contexts. As discussed in Chapter 3, three test procedures are used to examine the relative explanatory power of the AIDS and translog demand system in this study: (1) a nested hypothesis test through the Lewbel demand system which nests both AIDS and translog demand system, (2) a non-nested hypothesis test through an artificial nesting model, and (3) the non-nested test procedure proposed by Vuong (1989).

The LA/AIDS, translog demand systems and Lewbel model have been estimated for each of the four food groups in the third budgeting stage of Chinese urban households. The relative explanatory power of the LA/AIDS and translog demand system has been tested for each of the four food groups using the test procedures discussed above. The test results are the same for the four food groups: the explanatory power of LA/AIDS and translog demand

system are not significantly different for the data set. Table 5.17 reports the test results for the group of animal products. The test results for other groups are not presented in this dissertation because their test procedures and test conclusions are the same as that for animal products.

According to the results from the nested test and J test in Table 5.17, both AIDS and translog demand system are rejected at 0.01 significant level when their explanatory powers are compared with the Lewbel model and the artificial nesting demand system. Thus these two tests do not give any conclusion about the relative explanatory power of AIDS and translog model.

The Vuong test is then applied to test the relative explanatory power of the AIDS and translog demand system. Because these two models are not strictly non-nested, the two-step test procedure proposed by Vuong (1989) may be needed. If the first test (variance test) fails to reject the null hypothesis that the variance of the differences between the log-likelihood functions is zero, the two models are equivalent and the second test is therefore not needed. If the first test rejects the null hypothesis, the second test should be applied to draw a conclusion about the two models. In practice, the second test can be conducted first to determine whether the variance test is needed. If the second test suggests that the two models are equivalent, then the variance test is not necessary. Otherwise, the variance test should be conducted.

According to the test results in Table 17, the hypothesis that AIDS and translog demand system are equivalent is not rejected at the 0.01 significant level and therefore the variance test is not needed.

Table 5.17. Hypothesis tests and demand system selection

Log-likelihood function:

AIDS:	1528.624
Translog:	1529.667
Lewbel:	1562.933
The artificial nesting model:	1586.881

Nested tests:

(1) Lewbel model vs. AIDS
Test statistic: $2\,LR = -2\,(1528.624 - 1562.933) = 68.618 > x^2_{0.01,\,df=5}$

(2) Lewbel model vs. translog model
Test statistic: $2\,LR = -2\,(1529.667 - 1562.933) = 66.532 > x^2_{0.01,\,df=5}$

The J tests:

(1) The artificial nesting model vs. AIDS
Test statistic: $2\,LR = -2\,(1528.624 - 1586.881) = 116.514 > x^2_{0.01,\,df=1}$

(2) The artificial nesting model vs. translog model
Test statistic: $2\,LR = -2\,(1529.667 - 1586.881) = 114.428 > x^2_{0.01,\,df=1}$

Vuong test (AIDS vs. translog model):

(1) The variance test $(H_0: \omega^2 = 0)$
Estimate of ω^2: $\hat{\omega}^2 = 0.0120523$
Conclusion: ?

(2) The second test
Test statistic: $Z_0 = 1.083 < Z_{0.01} = 2.33$
Conclusion: AIDS and translog model are equivalent for the data set

CHAPTER 6. POLICY ANALYSIS

There are essentially two objectives for estimating a demand model. The first is to derive expenditure and price elasticites that provide useful information on consumers' response to income and price changes. The second objective is to conduct policy analysis using the estimated demand functions as the structure model. As shown in Chapter 3, an estimated AIDS can be used for conducting food demand projections and for measuring the changes in consumer welfare caused by a price change. Furthermore, an estimated AIDS with rationing can be used to examine the impacts of a change in the rationing levels or prices on consumer demand for nonrationed commodities. This chapter presents the results of policy simulation analysis using the associated demand systems estimated in Chapter 5. Section 1 briefly discusses the current situation of China's policy making and problems facing the policymakers in the economic transition. Section 2 examines the impact of consumption rationing for grains and vegetable oils on household demand for nonrationed food commodities in urban China. Section 3 presents the estimated changes in budget shares and consumer welfare under alternative assumptions about price changes for selected food commodities.

China's policy making in the economic transition

With a centrally-planned economic system from the mid-1950s to the late 1970s, the Chinese economy has moved gradually toward a market economic system since the 1978 economic reform. The role of market forces in determining resource allocation and shaping household expenditure patterns has increased significantly in China. But the state-owned

enterprises remain as a major sector of the Chinese economy and the central government continues to play an important role through direct and indirect interventions. Unlike the "big bang" or "shock therapy" approach undertaken in the Eastern Europe and the former Soviet Union, China has adopted a "gradual" or "evolutional" approach for reforming its centrally-planned economy. The economic reform in China has been experimental rather than large-scale privatization and marketization which are generally considered to be necessary components of a market-oriented economic reform (Lipton and Sachs 1990). China has moved from a Soviet-style command economic system to a mixed economic system of planning and markets (Pan and Johnson 1992). The private sector has expanded significantly since the mid-1980s, but the state and collective sectors still dominate the private sector in major industrials.

The purchase and distribution of major food commodities, such as grains and vegetable oils, are still under direct or indirect control of the state-owned enterprises for the objective of stabilizing food supply for urban residents. To ensure state purchases, each farm household is required to sell a certain amount of specified grains to the state at state-set prices according to the contract. Because all the farming land is owned by the state or collectives, farm households have to sign the contract in order to use the land. On the other hand, farmers can sell their products at free markets after the contract with the state is fulfilled. Table 2.6 has shown that the free market shares of retail quantities or values of major food commodities except for grains have increased significantly since the early 1980s. Policy making under the mixed economic system of planning and markets has been a challenge for China's policymakers. Because any policy change can have a set of direct and indirect effects on the state and private sectors as well as on rural and urban consumers, there is a great need for developing quantitative approaches for assessing the effects of alternative policies.

Economic analysis of China's food and trade policy is also important for studying the

world food markets because China has been and will continue to be an important player in the international food markets. When China's moves closer to a market economic system, its economic growth and food situation are increasing dependent on the global financial and commodity markets. On the other hand, China's domestic and trade policy is expected to have greater impacts on the global economy.

China's policymakers have attempted to improve its policy making under the new economic system. But there are numerous evidences indicating that China's policy making is still heavily based on qualitative rather than quantitative analysis. Similar problems also have been reported from many other reforming socialist countries such as Poland and Russia. One major objective of this study is to develop theoretically and analytically well-based models which can be used for policy analysis in the economic transition.

Impacts of food rationing

As discussed in previous chapters, consumption rationing has been a common feature of the socialist economies. China has adopted many forms of consumption rationing for both rural and urban residents since the mid-1950s (Chow 1987; Wang and Chorine 1992). Although the number of commodities under rationing has declined significantly since the mid-1980s, the supply of grains and vegetable oils in urban areas was mainly through state rationing during the study period. Furthermore, urban housing is still under strict rationing nationwide in China. Wang and Chern (1992) have indicated that China's consumption rationing has significantly increased the demand for commodities not under rationing. This section presents the results of static analysis of the impacts of a change in the rationing price or level for grains and vegetable oils on the demand for nonrationed food commodities using the LA/AIDS with rationing estimated in Chapter 5.

Based on the LA/AIDS with rationing represented in equation (5.1), the effects of a change in the level or price of the rationed commodities on the demand for commodities not under rationing can be derived as:

$$e_{ik} = -\left(\frac{\beta_i}{w_i}\right)\left(\frac{p_k z_k}{I - \sum_{k=1}^{m} p_k z_k}\right) \tag{6.1}$$

$$wz_{ik} = \frac{\partial \ln w_i}{\partial \ln z_k} = \frac{\sigma_{ik} z_k}{w_i} - \left(\frac{\beta_i}{w_i}\right)\left(\frac{p_k z_k}{I - \sum_{k=1}^{m} p_k z_k}\right) \tag{6.2}$$

where e_{ik} can be considered as the cross-price elasticity of a nonrationed commodity (i) with respect to a rationed commodity (k). Note that an increase in p_k would enforce consumers to pay more for the fixed level of rationed commodity and reduce the expenditure on nonrationed commodities.

wz_{ik} measures the effect of a change in the level of a rationed commodity (k) on the budget share of a nonrationed commodity (i). The equation shows that a change in z_k has a substitution effect and an income effect. An increase in z_k would reduce the demand for substitutes and increase the demand for complements of the rationed commodity. The sign of this elasticity is generally ambiguous because the income and substitution effects work in opposite directions when the nonrationed commodity is normal and substitute for the rationed commodity (Wang and Chern 1992).

The estimated LA/AIDS with rationing for the second budgeting stage of Chinese urban households reported in Chapter 5 is used to derive e_{ik} and wz_{ik}. Note that there are

two rationed commodities (grains and vegetable oils) and four nonrationed food groups (animal products; vegetables, fruits and melons; sugar and other food; and cigarettes, alcoholic beverages and tea). The estimation results are presented in Table 6.1.

The estimated e_{ik} suggest that an increase in the rationing price of grains or vegetable oils is likely to have a positive effect on the demand for the group of animal products and the group of cigarettes, alcoholic beverages and tea, but a negative impact on the demand for other food groups. The estimated wz_{ik} measures the effects of a change in the rationing level of commodity k on the demand for a nonrationed commodity i. The results indicate that an increase in the rationing level of grains may have a negative effect on the group of vegetables, fruits, and positive impacts on other food groups. On the other hand, an increase in the rationing level of vegetable oils may have a positive effect on the group of vegetables, fruits and melon, but negative impacts on other food groups.

Impacts of price changes on budget shares and consumer welfare

As discussed in Chapter 3, an estimated demand system can be used as the structure model to estimate the changes in budget shares associated with an income or price change. For example, the estimated LA/AIDS of cigarettes, alcoholic beverages and tea reported in Chapter 5 allows us to examine the effects of an increase in cigarette tax on household budget allocations. The consumer demand theory indicates that a price change not only changes the consumer's budget allocation but also results in a welfare effect. Estimation of the changes in consumer welfare associated with a particular price change is of great importance for assessing the effects of alternative price policies. Chapter 3 has shown that the cost function of AIDS can be used to estimate the compensating variation (CV) associated with a price change. This section first presents the procedures for estimating CV using an estimated AIDS

Table 6.1. Estimated effects of changes in rationing levels and prices on the demand for nonrationed commodities for Chinese urban households

	Animal products	Cigarettes, alcoholic beverages and tea	Vegetables, fruits and melons	Sugar and other food
Effects of a price change (e_{ik})				
Grains	0.02535	0.001723	-0.00469	-0.16165
Vegetable oils	0.00580	0.000394	-0.00107	-0.03696
Effects of a level change (wz_{ik})				
Grains	0.23040	0.98508	-1.19538	1.12973
Vegetable oils	-0.19945	-0.18817	0.50035	-0.27471

and then reports some policy simulation results.

Chapter 3 has shown that *CV* measures the minimum amount of money by which a consumer would have to be compensated in order to be as well off as before the price change. Equation (3.15) is rewritten as equation (6.1):

$$CV = c(u^0, p^1) - c(u^0, p^0) \tag{6.1}$$

For a given cost function and two sets of prices (p^0, p^1), *CV* associated with the price change can be estimated directly using equation (6.1).

The cost function used to derive AIDS can be written as (see Deaton and Muebauller 1980):

$$\begin{aligned} \ln c(u,p) &= (1-u)\ln a(p) + u \ln b(p) \\ &= a_o + \sum_{k=1}^{n} \alpha_k \ln(p_k) + \frac{1}{2}\sum_{k=1}^{n}\sum_{j=1}^{n} \gamma_{kj} \ln(p_k)\ln(p_j) + u \prod p_k^{\beta_k} \end{aligned} \tag{6.2}$$

Then the maximum attainable utility level (u^0) for a particular total cost and a given set of prices can be derived as:

$$u^0 = \left[\ln c - \left(a_o + \sum_{k=1}^{n} \alpha_k \ln(p_k) + \frac{1}{2}\sum_{k=1}^{n}\sum_{j=1}^{n} \gamma_{kj} \ln(p_k)\ln(p_j) \right) \right] \left(\prod p_k^{\beta_k} \right)^{-1} \tag{6.3}$$

For an estimated AIDS, equation (6.3) can be used to calculate the attainable utility level for a particular observation because all the parameters are given and the cost equals the total expenditure (i.e., X in AIDS). With the estimated utility (u^0) and a new set of prices (p^1), the total cost for attaining the same utility level under the new prices can be estimated using

equation (6.2).

The procedures discussed above is used to estimate the *CV* associated with hypothesized price changes for two groups of food commodities in urban China: the group of animal products and the group of cigarettes, alcoholic beverages and tea. These two groups are chosen because the estimated *CV* can have significant policy implications. To examine consumer response to a price change, the changes in budget shares caused by the price change is also estimated.

Animal products

As discussed in Chapter 5, changes in the production and consumption of animal products have significant implication for China's dietary improvement and grain situation. China's meat production has traditionally concentrated on pork. Although the production of other animal products such as poultry and beef has increased significantly since the mid-1980s, pork production still dominates other meat products in China. Considering that pork production requires much more feedgrain than poultry, several studies have suggested China to change the production structure of animal products by increasing the production of poultry and dairy products (e.g., Webb and Dixit 1992; Wang et al. 1993). Such structure change is expected to improve the average input-output ratio from feedgrain to animal nutrients like protein. The protein content and input-output ratio for selected animal products in China are summarized in Table 6.2. Note that the amount of animal protein produced from one kilogram of feedgrain through mutton, poultry and aquatic products is significantly greater than that through pork production.

One policy option for steering the consumption from pork to other animal products is to increase the retail price of pork or reduce the retail price of other animal products. It is important to estimate the changes in household budget shares and consumer welfare

Table 6.2. Average protein content and input-output ratio of major animal products in China

Food commodity	Protein content per kg product (gm)	Meat produced from 1 kg grain (kg)	Animal protein from 1 kg grain (gm)	Share of total meat output in 1991 (%)
Meats				
Pork	117.0	0.2416	28.2672	77.99
Beef	117.0	0.1600	18.7200	4.88
Mutton	117.0	0.8621	100.8657	3.75
Poultry	156.0	0.3125	48.7500	12.56
Other meats	177.0	n.a.	n.a.	0.82
Other animal products				
Aquatic products	103.0	1.1494	118.3882	--
Milk	32.0	n.a.	n.a.	--
Eggs	115.0	n.a.	n.a.	--

Sources: Piazza (1986), Tuan (1987), and State Statistical Bureau of China, *China's Statistical Yearbook*, 1992.

n.a. Not available.

associated with the price change. For the purpose of illustrating the application of demand models for policy analysis, the sample means for 1991 are used to estimate the cost and budget shares of the baseline. Then a 10-percent increase in pork price is assumed. The effects on budget shares of the animal products are estimated using the LA/AIDS estimated in Chapter 5. The estimation results are reported in Table 6.3.

The estimated changes in budget shares suggest that a 10-percent increase in pork price would increase the budget shares of pork, poultry and eggs, and reduce the budget shares of beef & mutton, fish and milk. The slight increase in the share of pork may be explained by that the total expenditure on pork increased although the consumption level may declined as a result of the price increase. The increase in budget shares of poultry and eggs suggests that an increase in pork price would induce consumers to spend more on these two animal products.

The estimated compensating variation (*CV*) associated with the price, reported in Table 6.3, suggests that a 10-percent increase in pork price would result in a welfare loss to the consumers. Note that the estimated *CV* is in 1985 Chinese yuan because the expenditures and prices are in real terms.

Cigarettes, alcoholic beverages and tea

This is a group of food commodities with special characteristics. It is generally believed that the consumption of cigarettes and alcoholic beverages not only provide satisfaction to consumers but also cause health and safety problems. As discussed in Chapter 5, information on household demand for this group of commodities has significant policy implications. First, the rapid growth in China's tobacco production, from 0.717 mmt in 1980 to 3.119 mmt in 1992, has been identified as a factor contributing to the decline in planting areas for grains. The continuing increase in the number of smokers and the average per capita

Table 6.3. Effects of an increase in pork price on budget shares and welfare of Chinese urban consumers

	Baseline (1991)	With new prices	Changes from the baseline	
			Changes	Percentage
Budget shares				
Pork	0.46381	0.466770	0.00296	0.6382
Beef and mutton	0.08760	0.081749	-0.00585	-6.6792
Poultry	0.12127	0.124140	0.00287	2.3666
Eggs	0.13821	0.141880	0.00367	2.6554
Fish	0.16883	0.166480	-0.00235	-1.3919
Milk	0.02028	0.018981	-0.00130	-6.4053
Cost (yuan)	112.447	114.5120	2.06500	

consumption of cigarettes in China has increased government concerns about health problems related to smoking. Imposing restrictions on tobacco and cigarette production has been proposed to the Chinese government. Second, China's alcohol production and consumption have increased dramatically since the 1978 economic reform. During 1978 to 1992, China's beer output increased from 0.4 to 10.21 mmt and total alcoholic beverage production expanded from 2.56 to 17.53 mmt. As a result, alcohol production has emerged as a major use of grains in China. For example, China's liquor industry used 12.5 mmt of grains and beer production utilized 1.5 mmt barley and corn in 1991 (Sidenius 1993). The increase in average per capita alcohol consumption, from 2.57 to 12.94 kg during 1980 to 1992, has significantly increased alcohol-related accidents, criminal activities and health problems. The Xinhua News Agency reported that 81 percent of people who died of cardiovascular diseases in China in 1988 were heavy alcohol consumers (Sideniun 1993). China's rapid growth in beer production and resource limitations for malting barley production has made China a major barley importer since the mid-1980s. Third, China's rapid economic growth cigarette market with 0.3 billion smokers has been a target of many western cigarette companies. Information on the responses of Chinese consumers to changes in cigarette price can be used for studying the trade and health issues of cigarettes.

Because the alcohol content of liquor is much greater than that of beer and wine, measures to steer production and consumption from liquor to beer and wine, such as an increase in liquor tax, could be beneficial for reducing the alcohol-related problems. A shift from liquor to beer will also reduce the use of gains by the alcohol industries because liquor production uses relatively more grains. To examine the effects of increasing cigarette and liquor prices, the changes in budget shares and consumer welfare associated with a 10-percent increase in cigarette and liquor prices are estimated using the same procedures applied to the group of animal products. The results are reported in Table 6.4.

Table 6.4. Effects of an increase in cigarettes and liquor prices on budget shares and welfare of Chinese urban consumers

			Changes from the baseline	
	Baseline (1991)	With new prices	Changes	Percentage
Budget shares				
Cigarettes	0.57013	0.57944	0.00931	1.63296
Liquor	0.22172	0.22478	0.00306	1.38012
Beer	0.11254	0.10614	-0.00640	-5.68687
Wine	0.03709	0.03481	-0.00228	-6.14721
Tea	0.05852	0.05483	-0.00369	-6.30554
Cost (yuan)	40.4197	40.9578	0.53810	

The estimated budget shares indicate that an increase in cigarette and liquor prices will increase their budget shares and decrease the budget shares of other commodities within the group. The results suggest that Chinese urban households may reduce their consumption of cigarettes and liquor in response to price increases, but the reduction may by limited and therefore increase the budget shares for these two commodities because the demand for cigarettes and liquor are not price elastic.

The estimated change in the cost for maintaining the same utility level indicates that the increase in cigarette and liquor prices resulted in a consumer welfare loss. For the consumer to achieve the same utility level he or she achieved before the price change, each consumer has to be compensated by 0.5381 yuan.

Because the reduction in cigarette and liquor consumption associated with an increase in their retail prices is quite limited, measurements besides increasing tax may be recommended for the Chinese government. For example, public education programs can be expected to increase public health concerns about smoking and drinking. Furthermore, a minimum legal drinking age to ban alcohol consumption by children may be warranted for China because a large proportion of China's 0.3 billion alcohol consumers are children under 15 years old (*The World Journal*, October 20, 1992).

CHAPTER 7. SUMMARY AND CONCLUSIONS

The ongoing economic reforms in China and several other socialist countries have brought about significant changes in their economic systems and the structure of the global economy. Although the path and pace of the reforms vary from country to country, the general trend of the reforms is to move from centrally planned to market economic systems. The role of market forces in determining resource allocation and shaping household consumption patterns has increased significantly in these countries. The market-oriented economic reforms in the socialist countries also have more closely linked their domestic economies with the global commodity and financial markets. This has been reflected in their increased trade and the growth in foreign loans and investments in these countries. As China and other reforming socialist countries move closer to market economic systems, their economic growth will be increasingly dependent upon the global financial and commodity markets. On the other hand, changes in their domestic and trade policy will have greater impacts on the global economy.

The ongoing economic transitions are of significance for the economics profession. It is important to test how the economic theory and methods for market economies are applicable to transition problems and to estimate the impacts of the reforms on economic growth and on the global economy. The path and pace of economic reforms can also provide insights for potential and limitations of modern economics, especially for economics as a policy science.

As a developing country with more than 1.1 billion people but only seven percent of the earth's arable land, changes in China's food production and consumption not only affect the welfare of about one-fifth of the world's population, but also result in significant impacts

on the food situation in many other countries through international markets. When China moves toward a market economic system, its food consumption and trade are increasingly dependent upon consumer demand as reflected in markets with consumer sovereignty. This study models China's household food demand in the transition toward a market economy.

This study has three major objectives: (1) to provide a quantitative assessment of the changes in China's household income, expenditure structure, food consumption pattern, dietary status and impacts of institutional and policy changes; (2) to construct food demand models for Chinese households in the economic transition; and (3) to estimate the associated demand models by using the most recently available data and to derive policy implications based on the estimation results.

The dissertation is organized into seven chapters. Chapter 1 discusses the background, problem setting and the objectives of the study. Chapter 2 presents a quantitative assessment of the changes in China's household income, expenditure patterns, food consumption, dietary status and the impacts of institutional and policy changes. The average per capita daily nutrient availability and sources are estimated through the construction of annual food balance sheets for the period from 1950 to 1991.

Chapter 3 briefly reviews the traditional consumer demand theory and then develops conceptual models for Chinese households. Because consumption rationing has been practiced in China since the early 1950s, a demand system including commodities under strict and partial rationing is developed for Chinese urban households. Chapter 3 also illustrates how to use hypothesis tests for selecting demand systems for a particular application. In addition to nested hypothesis tests, a relatively new test procedure proposed by Vuong (1989) is adopted for testing the relative explanatory power of two non-nested demand systems such as AIDS and the translog demand system. Compared to the traditional test procedures for non-nested models through an artificial nesting model, this test procedure not only avoids the

construction and estimation of the artificial nesting model, but also guarantees a unique conclusion about the relative explanatory power of two competing models. For the purpose of policy analysis, Chapter 3 presents a theoretical framework for conducting food demand projections and measuring consumer welfare changes associated with a price change using an estimated AIDS.

Chapter 4 describes the data sources and estimation procedures used to estimate the demand models developed in Chapter 3. Compared to the data available for western countries, data on China's household food consumption and expenditure are significantly limited. This study attempts to use the most recently available data from China.

Chapter 5 presents the results of estimating the associated demand models for Chinese urban and rural households. Income elasticities and marginal budget shares of major food groups and commodities are estimated from Engel functions for both rural and urban households. A three-stage budgeting procedure is used to estimate the conditional and unconditional demand elasticities for 19 major food commodities in urban China. Because grains and vegetable oils were mainly under state rationing during the study period from 1986 to 1991, the AIDS with rationing developed in Chapter 3 is used to model the second budgeting stage of Chinese urban households. Furthermore, an extended linear expenditure system is estimated for Chinese rural household in order to derive demand elasticities when the price data are not available.

Chapter 6 first presents the estimated effects of a change in the rationing prices or levels of grains and vegetable oils on the demand for other food groups not under rationing and then reports the estimated changes in budget shares and consumer welfare associated with hypothesized changes in the retail price of pork, cigarettes and liquor. These results provide useful information for China's policymakers in assessing the effects of alternative options for a policy objective such as reducing cigarette and liquor consumption.

The general conclusion of this study is that Chinese households, just like those in other countries, are rational economic agents who change their budget allocations in response to income and price changes. Although the Chinese economy is significantly different from a market economic system, the demand theory and models developed for market economies can be modified to model China's household demand in the economic transition. Specific conclusions drawn from the estimation results of this study can be summarized as follows.

First, the average nutrient availability and sources of the Chinese population have improved significantly since the early 1950s. But the improvement has not been steady over time. Besides natural factors such as weather, institutional and policy changes are identified as a major factor contributing to the fluctuation in China's average per capita nutrient availability and sources. The estimated nutrient sources also show that the percentage of nutrients obtained from animal products more than doubled during 1978 to 1991. The rapidly increasing consumption of animal products indicates China's ongoing transition in food consumption patterns from an energy to a more mixed diet.

Second, the estimated income elasticities and marginal budget shares from Engel functions suggest that Chinese urban and rural households are likely to allocate a large proportion of their additional income on food commodities. China's Engel coefficient is significantly greater than many other countries with similar income levels. One explanation for the inconsistency with the Engel's law is that household budget allocation to many other goods and services such as housing is restricted in China.

Third, the estimation results of individual food commodities suggest that all the food commodities considered in this study can be considered as normal goods. When income increases, Chinese households are likely to allocate more of their additional food expenditure on non-staple food such as poultry and fish and relatively less on grains.

Fourth, the estimated own price elasticities are inelastic for most food commodities.

This is consistent with consumer behavior observed from many other nations, especially when large proportions of household budget are allocated to food items. The estimated changes in budget shares associated with an increase in cigarette and liquor prices suggest that households may reduce their consumption in response to a price increase but the reduction may be limited because the demand is price inelastic. For the objective of influencing food consumption pattern such as reducing cigarette consumption, policy measurements besides tax increase should be considered.

Fifth, the results from both food balance sheets and demand analysis indicate that the Chinese consumers are shifting their food consumption from grains to animal products like poultry and other food such as beer as a result of their income growth. Because the production of animal products, especially pork, requires a lot of grains as inputs, the anticipated increase in demand for animal products will result in tremendous pressure on domestic feedgrain supply. Furthermore, the growing demand for beer and other alcoholic beverages will also increase the demand for barley and other grains as inputs. Considering China's extremely limited per capita arable land and rapid growth in exports of manufactured goods, China is likely to increase its import of wheat, barley and feedgrains.

Like many other studies of household demand in developing countries, the empirical estimation of the demand models presented in this study is limited by the data availability and reliability. Some conceptual models such as food demand projections using a complete demand system presented in Chapter 3 are not estimated and tested due to data limitations. China's economic reform has brought about significant changes in its political and economic environment and data availability. It is highly hoped that China's economic reform will continue and more reliable data from China will be available for studying its food demand and trade behavior.

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