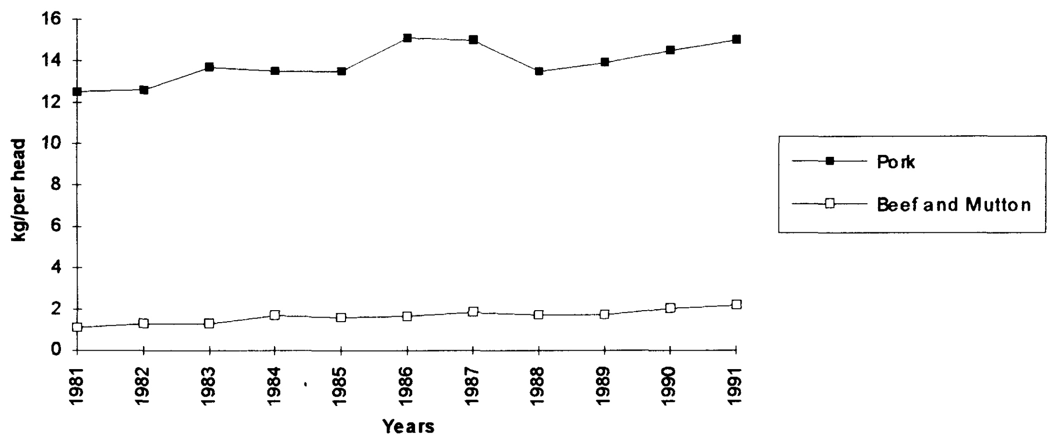
1. An Overview

1.1 Research background

China is one of the world's largest producers and consumers of agricultural commodities. It accounts for around a third of world pork production and Chinese consumption accounted for around 14 per cent of world's meat in the mid-1980s (Anderson 1990). Between 1979-92 China experienced rapid economic growth at an average rate of just over nine per cent a year with real incomes per person increasing by almost seven per cent a year. This result was due to economic and rural policy reforms which were introduced in 1979. Rapid income growth over the past decades and the prospect of this continuing, at least until the end of this century, is likely to bring with it considerable changes in China's consumption patterns, particularly in food products (Crompton and Phillips 1993). Consequently, the dietary patterns of the population have gradually moved away from staple starchy foods, like rice to high protein livestock products like pork, beef and mutton. These are defined as red meat in this study.

The consumption of red meat grew strongly from 10.48 kg per person in 1979 up to 20.35 kg in 1992, even though it fluctuated slightly during late of 1980s (State Statistical Bureau 1993). Pork is the most important source of animal protein in China, with consumption increasing from about 11 kg per person in 1980 to about 17 kg per person in 1990 (Crompton *et al.* 1993). Beef and mutton are consumed in very small quantities because of preferences, availability and prices. In Figure 1.1 the main trends in per capita consumption of pork and beef and mutton between 1981-1991 are shown.

Figure 1.1: Per capita consumption of pork and beef and mutton between 1981-1991



Source: Yang and Ren 1994, 'A review and projection on demand and consumption for Chinese agricultural commodities', *China's Rural Economy* 94(4),40-44 (in Chinese).

Red meat consumption in China tends to follow the seasonal trend. The quantity consumed in December, January and February is higher than that for other months. The reason is that both the New Year and the Spring Festival are held in those months. As well, the three months of winter are a time when people need to eat more meat to keep warm. In recent years, however, the seasonal fluctuations in red meat consumption have declined greatly since both income and meat supply have increased dramatically.

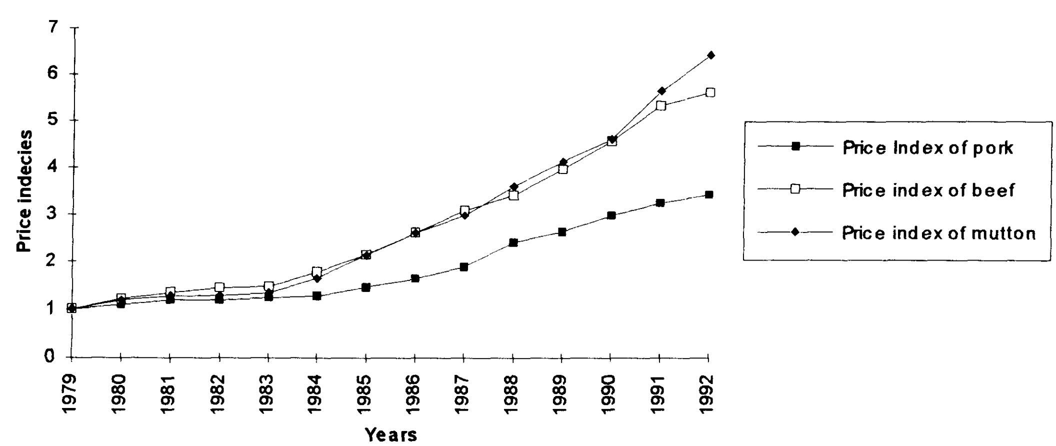
Before the agricultural policy reforms of 1979, red meat production was not consistently promoted in China because the government placed most emphasis on crop production and gave limited consideration to the livestock industry. Following a series of agricultural reforms, total output of red meat increased strongly, especially after 1985. The government eliminated restrictions on private ownership of livestock, introduced livestock trading centres and, implemented a 'dual track' price system that included both state controlled and free prices. The price indices for pork, beef and mutton increased from 100 in 1979 to 342, 561 and 641 respectively by 1992 (State

Statistical Bureau 1993 and USDA 1994). In Figure 1.2 it can be seen that all the price indices increased greatly, especially after the middle of 1980s. Relatively, the indices of beef and mutton grew faster than that of pork and almost moved concurrently.

As a result of the economic reforms and increases in prices, farmers were encouraged to produce more meat. Aggregate production of red meat in 1985 was 17.6 million tons and increased to approximately 30 million tons in 1992. Production grew at an average rate of around ten per cent a year between 1985-1992. The majority of red meat, which was mainly pork, came from backyard production in rural areas or close to big cities. As economic growth and development proceeds, the importance of backyard livestock production is likely to decline.

Pork output accounted for a dominant but declining share of total production, falling from 94 per cent in 1985 to 88 per cent in 1992 (State Statistical Bureau 1993). Production of pork reached 14.3 million tons in the first six months of 1994, with a growth rate of 10.3 per cent annually. In addition, 1.7 million tons of beef and mutton were produced at an annual growth rate of 31.7 per cent (Zhang 1994).

Figure 1.2: Comparison of price indecies of pork, beef and mutton between 1979-1992



Source: State Statistical Bureau 1993 and USDA 1994.

China exported a relatively small quantity of red meat in 1992, accounted for approximately 1.14 per cent of the production (State Statistical Bureau 1993). There were no official records on imports of meat in China although some international agencies collected some data from either joint venture enterprises or local traders. Thus, the rapid development of the livestock sector seems to have met the increased domestic demand for red meat.

If the demand for red meat is to be studied empirically, it is important to have an understanding of the retail pricing mechanism in China. Controls over consumption have been important since the early 1950s. Before 1980, most livestock products were allocated to consumers through coupons, direct allocations and sales at negotiated prices (Lewis and Andrews 1989). During the economic reforms, controls over the marketing of meat were eased considerably. However, the implementation of price reform that began in 1979 caused changes that occurred in two stages. At first, from 1979 to 1984, the government simulated the market. That is, the state pricing department raised the prices of commodities for which demand exceeded supply and *vice versa.* In the second stage, markets forces were allowed to influence price formation, in addition to the simulation processes (Nolan and Dong 1990). Hence, it was not until the mid-1980s that growth in free markets became important. However, the rationing of meat (especially pork) to urban consumers still involved a mixture of policy and market forces, even in 1989. Registered urban residents were issued with coupons for limited amounts of pork. The rationed amounts could be purchased at state shops at relatively low but heavily subsidised prices. Consumers supplemented their ration with non-rationed products at higher market prices. As a consequence, consumer demand was met in part from rations and demand in excess to that was satisfied by the free market.

1.2 Research problem

The production of red meat rose substantially after 1985 following the increase in meat prices, the freeing of both rural and urban markets and the introduction of the household responsibility system under which mainly farmers are given freedom to make production and marketing decisions. As production of red meat expands rapidly in China, consumption of these products is also likely to increase. China's food consumption pattern seems to have closely followed those of other East-Asian economies, particularly Taiwan. For example, over 50 per cent of the total protein intake in Taiwan has come from meat, since the mid-1980s (Crompton *et al.* 1993). In comparison, meat consumption in China currently accounts for only 15 per cent of total protein intake (Webb and Coyle 1992). There is the potential for the Chinese economy to continue to experience rapid income growth in the future, thus increasing the demand for meat. This could be the case even though meat already accounts for the largest proportion of consumer food expenditures in China (about 23.4 per cent of total food expenditure in 1992).

However, China is a very large and diverse country. Given the variation in climate, topography and soils, Chinese meat production is likely to be vary between regions and provinces. Thus, growth in supply is not likely to be equal in all regions. Moreover, variations in the level of income per person across regions and provinces are considerable. This is particularly evident in the coasted provinces along the southern and eastern seaboards of China. For example, per capita income in Guangdong Province was 3184 yuan in 1992 compared to 1345 yuan in Inner Mongolia (State Statistical Bureau 1993). Consequently, demand is also likely to differ among regions.

Red meat demand in the past decades has been dominated by the 'income effect' which has outweighed any substitution effects. Consumption of meat increased even when all retail prices rose simultaneously. If this rising trend continues, demand may not continue to be met domestically, as China has 20 per cent of the world population but only seven per cent of the earth's arable land. Despite what is obviously going to be a problem, no studies on red meat demand in China have considered this dilemma. Therefore, a critical economic assessment of red meat demand and consumption is important in assisting the Chinese government to formulate policies to deal with an increase in both consumption and production.

1.3 Research objectives and hypotheses

The main objective in this study is to obtain an adequate explanation for the observed changes in consumption of red meat in China. In this study the changes in consumer demand with respect to prices and incomes are evaluated. Socioeconomic and demographic factors such as tastes and preferences, social status and convenience are excluded. In addition, the role of supply response is left to other researchers. Given this relatively narrow focus, it may be inferred that such an approach is limited. However, as was stated by Joan Robinson (1941, p.8), '...in order to know anything, it is necessary to know everything, but to talk about anything, it is necessary to neglect a great deal.'

Demand elasticities for red meat in China have been reported by a few analysts, notably by Lewis *et al.* 1989 and Carter *et al.* 1991. But these studies have concentrated either on aggregate food or on only one single city/region.

To be more specific, the objectives of this study are to:

- examine the demand and consumption pattern or trends for red meat in China between 1979 and 1992;
- undertake a quantitative assessment of the price and income elasticities underlying demand;
- project future demand and consumption trends and patterns by 2000; and

- discuss some of the policy implications of empirical estimates of demand.

Regarding the research problem and research objectives in general, two null hypotheses can be formulated:

- Changes in income have no significant effect on the demand and consumption of red meat in China between 1979 and 1992;
- Changes in prices have no significant effect on the demand and consumption of red meat in China between 1979-1992.

In other words, both price and income elasticities are tested to see if they are significant in determining demand for red meat in China.

1.4 Outline of the study

In Chapter two a review of previous studies which are relevant to the study is presented. The economic and modelling framework upon which the estimation of demand elasticities is based is examined in Chapter 3. The concepts of neoclassical demand theory and the derivation and explanation of necessary general restrictions are outlined, also in Chapter three.

In Chapter 4, the data and methodology used in this study are presented, including theoretical considerations and tests of model specifications, both with and without restrictions. The empirical results are presented and interpreted in Chapter 5. As well, demand and consumption of red meat by the year 2000 are forecast on the basis of the empirical model. Then, policy implications are fully discussed in Chapter 6. Finally, in Chapter 7, conclusions are drawn from preceding discussions, and limitations of the study and suggestions for future study are also discussed which bring this study to an end.

2. Relevance of Past Studies

2.1 Introduction

To understand the present and predict the future it is necessary to study the past by identifying relevant factors and establishing the relationships between them. In this Chapter, the objective is to review the research literature relevant to the economic structure of red meat demand in China.

It is difficult to undertake applied demand analysis based on complex statistical procedures when data is limited. Research in this area is largely constrained, particularly in China, by the quality and quantity of available data. Thus, little attempt has been made to examine the demand and consumption patterns for red meat on a quantitative basis. From a review of the literature, it would appear that no previous studies have been undertaken on China's meat consumption and per capita income effects when estimating demand on the regional differences. The present study focuses on this problem by emphasising income and price responses estimated from a combination of both time-series and cross-section data. In this review, selective studies on meat demand analysis, of income and price responses and on some related research on Chinese consumption behaviour are examined.

2.2 Income and price

To explain consumer demand for meat with respect to changes in prices and incomes researchers have usually used national-level per capita data. The majority of analyses have used annual data (David, Richard and James 1989). In a study of the long-run demand for meat, Tomek and Cochrane (1962) concluded that the full adjustment of the quantity demanded to changes in prices and income took place within a year, for meat products. This result supported the use of annual data and simpler model specifications in assessing the structure of demand. As a result of using annual time-series data, the number of observations is limited so that additional theoretical restrictions have to be placed on the structure of demand.

The predominant approach taken in the literature is to assume that prices of other goods have a constant relationship to demand. That is, the prices of all but a few closed related goods can be aggregated into a single composite variable. All other prices are combined in the form of an index. Thus, the Consumer Price Index (CPI) may be introduced in the estimation process. This specification is referred as separability of the utility function and results in consumer demand functions. Nyarkori and Miller (1982), Jolly (1983) and Moschini and Meilke (1984) took this general approach to the estimation of demand functions for meat.

An alternative approach can be termed as the demand system approach. George and King (1971) were pioneers in proposing and estimating the complete demand system. They analysed the interdependent nature of demand for food in the United States, by pooling observations together on different commodities. Symmetry and other restrictions from demand theory were introduced, which incorporate the economic interdependency between response parameters. These restrictions can also be used to reduce the number of independent parameters to be estimated by approximately one-half (David *et al.* 1989). Furthermore, their incorporation permits a closer correspondence between the structure of the empirical and theoretical models of demand behaviour. In addition, empirical results indicate that it may be better to use a combination of cross-section and time-series data for estimating demand interrelationships. Different models can be applied to estimate demand functions by using those data. The question that what kind of model should be used is to be discussed briefly in next section.

2.3 Alternative demand models

In demand analyses a number of different models exist. These include the Linear Expenditure System (LES), the Almost Ideal Demand System (AIDS) and the Double Logarithm Model, all which have been used to specify and construct the interrelationship among the economic variables.

Among a wide variety of complete demand system, the LES has been very popular and used in many empirical studies. Stone's (1954) linear expenditure system, Leser's (1960) approximation and Powell's (1966) approximation are the three commonly employed versions of LES. However, Raunikar and Huang (1987) point out that LES approach appears questionable as a method of undertaking demand projections.

The AIDS model has become popular recently in demand studies. It is derived from the consumer cost function and corresponds to Price-Independent Generalised Logarithmic consumer preferences functions formulated by Deaton and Muellbauer (1980). The AIDS model satisfies the axioms of choice exactly and allows for the consistent aggregation, at a microlevel, for the estimation of a market demand function. Deaton and Muellbauer (1980a) and Blanciforti *et al.* (1986) have applied the approach to economy-level of food demand. Chalfant, Eales and Unnevehr (1988) applied it to meats. Although the AIDS model has these advantages, it is a tortuous method of determining and interpreting demand elasticities, which are the objectives of this study. In the AIDS model there is no immediacy and ease of estimation.

Consequently, it could be argued that the most popular method of assessing demand relationship is the Double Logarithm model. Houthakker (1965), Reynolds (1978) and Bai *et al.*(1986) employed this functional form to estimate demand parameters for different groups of commodities. The Double Logarithm model has the characteristics of ease of estimation, immediacy of parameter and thus model interpretation. If aggregate market data is used the Double Logarithm model will approximate an aggregated individual utility maximising behaviour (Reynolds 1978).

Therefore, the estimation of systems of linear or transformed linear equations can be considered as the most applicable method to examine the relationship between consumption, prices and income in this study. Restrictions can be imposed by this approach giving direct estimates of elasticities. When demand models are specified for a number of related commodities by pooling both time-series and cross-section data, basic consideration of error specification would determine that SUR (seemingly unrelated regression) techniques are likely to be most efficient method of estimation .

2.4 Chinese perspectives

Few formal econometric studies of demand have been conducted using Chinese data. Houthakker (1957) pioneered modelling demand functions with this approach using four categories of goods--- food, clothing, housing and miscellaneous household goods using 1927 household data for Beijing and 1929 data for Shanghai (Lewis and Andrews 1989). However, these results have little relevance today because of their age.

Among recent demand studies on China have been undertaken by Chow (1984), Gaag (1984), He (1985), Li *et al.* (1985) and Bai *et al.* (1986), all who used data on expenditure and employed linear expenditure systems (LES) approaches. Chow (1984) estimated the demand for the same categories as Houthakker, but used 1981 data on expenditure per capita in rural provinces. Using LES, Gaag (1984), He (1985) and Li *et al.* (1985) worked on the demand and consumption structure for rural households in Hubei Province and urban households for Beijing for 1981 and 1982. Because of the small number of observations and because only two provinces were analysed, the applicability of these results is of limited use. Bai *et al.* (1986) used household survey data for Tianjin, the third largest city in China. Expenditure elasticities for a wide range of commodity groups were estimated as well (Lewis and Andrews 1989).

One of the most recent studies was undertaken by Lewis and Andrews (1989). In their study a linear expenditure system was applied to Chinese data on urban and rural households and relevant elasticities were estimated. The demand for a wide range of groups commodities including food, clothing and articles for daily use were estimated using mainly income, expenditure and consumption data from sample surveys of urban and rural households. No compatible price data were available for the commodity groups, given the cross sectional nature of the survey data. Thus, although this study can be regarded as a major advance on previous studies of consumption behaviour in China, the results of the analysis should be viewed as tentative. However, Lewis and Andrew's conclusion that there will be considerable increase in the demand for meat as the Chinese economy becomes more highly developed, has great relevance to this present study.

Other studies focus on commodities other than food or meat. However, these studies are relevant to the demand and consumption pattern for red meat in China. Crompton and Phillips (1993) undertook a qualitative assessment of demand for feedgrain in China resulting from an increase in meat consumption. They concluded that continuing income growth in China is likely to lead to considerable increases in demand and consumption for livestock products by the year 2000.

2.5 Summary

From the literature it can be concluded that changes in demand and consumption for meat are usually explained by changes in prices and income within a complete demand system. Income elasticity parameters estimated in cross-sectional demand studies are generally regarded as the long-run income elasticity of demand, assuming that there is no structural change. Also, price effects of other products, rather than the item in question can be included in index form to provide a numeraire good in the analysis of consumer demand. Although the 'dual track' price system was dominant in China between 1978 to 1992, demand would still appear to be sensitive to changes in prices of red meat. To detect and measure parameter changes on a relatively timely and accurate basis, one should turn to alternative data sources that provide many more observations on consumer behaviour. A panel set of data may be useful in accomplishing this goal.

Because of the unavailability of data, no specialised empirical analysis of red meat demand and consumption in China has been possible before. Appropriate consumption (approximated from production) data, price and income data in both time-series and cross-section forms, have recently become available and will be used in this study. SUR is applied to pool time series and regional cross-sectional data in estimation. As well, a complete demand system is to be used which incorporates the constraints implied by demand theory.

3. The Economic and Modelling Framework

3.1 Introduction

The problem with which economists are critically concerned in demand is the identification and magnitude of demand responses to changes in certain specified variables. The purpose of this chapter is to discuss theoretical framework and importance of empirical research in the present context. Thus, the theory and concepts of neoclassical demand theory are outlined from an axiomatic point of view (in Sections 3.2 and 3.3). The derivation of demand functions and the 'general' restrictions that can be imposed upon them in the form of the assumptions made in orthodox economic theory are detailed in Sections 3.4 and 3.5. Meanwhile, in Section 3.5 a brief discussion on some 'particular' restrictions is detailed. Then the most appropriate model as a basis for data manipulation is described and selected in Section 3.6. The material detailed in this Chapter together with the results of previous studies reviewed in Chapter 2, will enable the choice of variables to be made and the empirical analysis to be conducted, dependent upon the availability of data.

3.2 Basic axioms on the preference relation

The static theory of demand and consumption is couched in terms of a choice problem facing an individual consumer with given income, tastes and preferences. The consumer must choose a set of goods and services which maximises his/her satisfaction and reacting to prices. It is assumed, however, that the extent of satisfaction is determined by the consumer's preference relationship. Economists refer to this preference relationship as a utility indicator. The preference relationship of the individual should satisfy the following set of axioms, which are detailed in George and King (1971).

3.2.1 Axiom of comparability

For any pair of commodity bundles q^0 and q' in the commodity set q, the consumer is able to choose one bundle over the other or:

$$q^0 \leq q' \quad \text{or} \quad q' \leq q^0 . \qquad (3.1)$$

The aim of comparability is to exclude the case where the consumer would be unable to make a choice about some bundles. Thus, it makes the preference relation complete.

3.2.2 Axiom of transitivity

With transitivity, $q^0 \leq q'$ and $q' \leq q''$ imply $q^0 \leq q''$. (3.2)

Suppose that there are three bundles q^0, q' and q". If the bundle q^0 is not preferred to the bundle q', and the latter is not preferred to q", then q^0 is not preferred to q". In other words, the consumer's preferences are consistent (Phlips 1974).

3.2.3 Axiom of antisymmetry

If q^0 is preferred to q', it is not possible that q' is preferred to q^0 simultaneously. Hence, the axiom of antisymmetry avoids any ambiguity in the preference ordering.

These three axioms (of comparability, transitivity and antisymmetry) are necessary and sufficient conditions for a complete ordering of the commodities in the commodity space (George and King 1971). Furthermore, the axioms, along with utility maximisation are a good description of the observed behaviour of the consumer in the market. However, to make this process operational, three additional axioms need to be introduced.

3.2.4 Axiom of monotonicity

The consumer prefers the bundle that contains more of one of the two goods and not less of the other good. One always prefers more to less. Consequently, it makes utility a strictly increasing function of the quantities consumed.

3.2.5 Axiom of convexity

If a consumer is indifferent between two bundles q' and q^0, then a linear combination of these bundles is preferred to q' and q^0. A fundamental property of the utility indicator is that the indifference curves represent convex sets. The minimal property of all utility indicators is quasi-concavity (George and King 1971).

3.2.6 Axiom of differentiability

Finally, it is assumed that the strictly quasi-concave (A.5) utility function that displays monotonicity (A.4) is also twice differentiable. In other words, the area under the utility curve can be calculated (Phlips 1974).

These axioms on consumers preference relationships are important as they allow for the formulation of a differentiable utility function that results in the specification of demand equations.

3.3 Basic demand theory

Marshall (1890) popularised classic demand theory focusing on the quantity price relationship for a single commodity given that income and all other prices are held constant (Hicks 1962). Marshall's specialisation of the demand function was uncompensated for income effects. The basic demand theory was, however, clarified and developed by Slutsky (1915) and Hicks and Allen (1934). They linked utility theory with demand analysis explicitly. Their major contribution was to provide the basis of what has been known as 'neoclassical' demand theory. The utility maximisation hypothesis became the empirical framework for demand theory, incorporating the 'general' constraints and reasoning assumptions to explain demand.

Primary demand theory is based upon the behaviour of an individual consumer, who selects the utility maximising combination of goods and services, when faced with given prices and a limited income. Thus, the extent of economic behaviour considered is limited to decisions on quantities demanded. The demand relationship obtained as a result of maximising a consumer's satisfaction subject to a budget constraint is expressed as a function of its own price, prices of other commodities and income. Demand elasticities measure quantity responses to changes in prices and income. A number of theoretical restrictions closely related own- and cross-price elasticities and income elasticities of demand have been formulated, which can be classified into two types: 'general' and 'particular' restrictions. The former apply to any utility function and the latter result from particular specifications of the utility function.

3.4 Derivation of demand functions from the utility maximisation hypothesis

Based on the preference axioms, a continuous utility function for an individual consumer can be formulated as:

$$U = U(q_1, q_2, \ldots, q_n), \tag{3.3}$$

where U is utility derived from a certain bundle of quantities of n commodities and q_i (i =1, ..., n) is the quantity of goods i purchased in a certain time interval. In other words, q stands for the column vector with elements q_1, q_2, ..., q_n The function (3.3) can be interpreted as measuring the consumer's satisfaction when buying and consuming q_1 units of the first commodity, q_2 units of the second and so on.

If it is assumed that the utility function has only positive first derivatives in the relevant range and also possesses second derivatives. It still cannot be maximised unconditionally until to the consumer's financial limitations are considered. They are expressed by the budget constraint:

$$\sum_{i=1}^{n} p_i q_i = y, \tag{3.4}$$

where $p_1, \ldots, p_n$ are the prices of the n commodities during that period considered and y is the amount of total expenditure available for that period and is usually referred to as income. These p's and y are taken as fixed and given positive numbers from the consumer's point of view (Thell 1975). The budget constraint (3.4) can be expressed in vector notation as:

$$p' q = y, \tag{3.5}$$

where p is the column vector with elements $p_1, \ldots, p_n$ and p' its transpose, and y is the scalar of the consumer's income. The maximisation of the utility function (3.3) subject to the budget constraint (3.4) is a Lagrangian multiplier analysis and is equivalent to

$$U(q_1, \ldots, q_n) - \lambda\left(\sum_{i=1}^{n} p_i q_i - y\right), \tag{3.6}$$

where λ is a Lagrangian multiplier.

Differentiating (3.6) with respect to q_i and λ, after equating it to zero, leads to the following equations:

$$\begin{array}{l} U_i(q_1, q_2, \ldots, q_n) - \lambda p_i = 0 \\ y - p_1 q_1 - p_2 q_2 - \ldots - p_n q_n = 0 \end{array}, \text{ where } i=1,\ldots, n \tag{3.7}$$

or Gossen's second law

$$\partial U / \partial q_i = \lambda p_i \tag{3.8}$$

The left hand side of (3.8) is the marginal utility of commodity i, while λ can be interpreted as the marginal utility of income.

Equations (3.4) and (3.8) are n+1 equations in 2(n+1) variables: the n quantities of the commodities, the n prices, λ and income itself. If the second order conditions for a constrained maximum are fulfilled, a unique solution for the quantities of n commodities can be found under given prices and income (Barten 1967). This solution provides the individual with the highest possible level of utility. The solution will be in the form

$$q_i = q_i(p_1, p_2, \ldots, p_n, y), \text{ where } i=1,2, \ldots, n \tag{3.9}$$

The quantity consumed of each commodity is expressed as a function of its price, price of other commodities and income. Hence, the relationships in (3.9) are a set of demand functions that describe postulated consumer behaviour.

Here the quasi-concavity assumption of utility indicators plays its role since the demand functions (3.9) must satisfy the second-order conditions of utility maximisation. The Hessian matrix can be used as a tool to prove the significant properties of concave and quasi-concave functions. The proof procedure is omitted here to avoid tediousness. Straightforwardly, quasi-concave functions guarantee that if the first order conditions are satisfied at a certain point, it corresponds to a point of maximum satisfaction. Even though there is an increasing marginal rate of substitution, there is a maximum for a quasi-concave function. This implies that a relaxation of the preference relationship from a restrictive assumption of diminishing marginal utility would occur (George and King 1971).

3.5 Restrictions on the demand functions

The demand functions derived from the utility maximisation detailed above are characterised by a number of general properties. These properties can be termed as being either 'general' or 'particular'. General properties are independent of the form of the utility function. Particular properties result from extra assumptions about particular specifications of the utility function. In general, these restrictions are mainly properties of the partial derivatives of equation (3.9) with respect to income and prices.

3.5.1 'General' restrictions

'General' restrictions of the consumer demand functions must hold irrespective of the form of utility function. If empirical tests show these restrictions to be inconsistent with the data, the underlying utility maximisation hypothesis itself can be questioned. These restrictions follow from differentiation of the first order conditions.

3.5.1.1 Homogeneity condition

In the case of two commodities, the first order condition from (3.7) by differentiating with respect to q_1, q_2 and λ yields

$$U_1 - \lambda p_1 = 0 ,$$
$$U_2 - \lambda p_2 = 0 \text{ and} \qquad (3.10)$$
$$y - p_1 q_1 - p_2 q_2 = 0$$

By rearranging (3.10), a condition is yielded as

$$U_1 / U_2 = p_1 / p_2$$

when income and prices are changed by the same proportion k, the equations (3.10) become

$$U_1 - k\lambda p_1 = 0,$$
$$U_2 - k\lambda p_2 = 0 \text{ and} \qquad (3.11)$$
$$ky - kp_1 q_1 - kp_2 q_2 = 0.$$

This leads to the same condition as

$$U_1 / U_2 = p_1 / p_2$$
$$y - p_1 q_1 - p_2 q_2 = 0$$

The first order conditions remain unaffected so that the optimal commodity bundle is unchanged. This is known as the homogeneity condition. It implies that demand functions are homogeneous of degree zero in prices and income.

To make the condition operational, Euler's theorem is used, which states that if a function z =f(x, y) is homogeneous of degree γ then

$$x\frac{\partial z}{\partial x}+y\frac{\partial z}{\partial y}=\gamma z \ .$$

Straightforward application of the theorem into equation (3.9) yields

$$p_1\frac{\partial q_i}{\partial p_1}+p_2\frac{\partial q_i}{\partial p_2}+\ldots+p_n\frac{\partial q_i}{\partial p_n}+y\frac{\partial q_i}{\partial y}=0 \ . \qquad (3.12)$$

Converting (3.12) into elasticities by dividing throughout by q_i leads to the condition

$$e_{i1}+e_{i2}+\ldots+e_{in}+e_{iy}=0 \ . \qquad (3.13)$$

This implies that the own- and cross-price elasticities and income elasticities add to zero. That is, when income and prices are changed by the same proportion, demand does not change.

3.5.1.2 Engel aggregation

The budget constraint (3.4) can be also denoted as:

$$p_1q_1+p_2q_2+\ldots+p_nq_n=y \ . \qquad (3.14)$$

Differentiating (3.14) with respect to y, yields:

$$p_1\frac{\partial q_1}{\partial y}+p_2\frac{\partial q_2}{\partial y}+\ldots+p_n\frac{\partial q_n}{\partial y}=1 \ , \qquad (3.15)$$

Multiplying each item of the left side of equation (3.15) by $(q_1/y).(y/q_1)$ yields

$$\frac{p_1q_1}{y}.\frac{y}{q_1}\frac{\partial q_1}{\partial y}+\ldots+\frac{p_nq_n}{y}.\frac{y}{q_n}\frac{\partial q_n}{\partial y}=1 \ , \qquad (3.16)$$

which enables equation (3.16) to be expressed in terms of budget proportions and income elasticities as

$$w_1e_{1y}+w_2e_{2y}+\ldots+w_ne_{ny}=1 \ , \qquad (3.17)$$

where w_j = share of expenditure in the jth commodity.

This property is sometimes known as the 'adding-up' condition. From this condition, it can be implied that the income elasticities, weighted by their respective expenditure proportions, sum to unity. This condition requires that any relocation of the budget due to income changes will exhaust total income.

3.5.1.3 Cournot aggregation

The budget constraint (3.14) can be differentiated with respect to p_j to show the effect of a change in the price of jth commodity, with all other prices held constant, as:

$$p_1 \frac{\partial q_1}{\partial p_j} + p_2 \frac{\partial q_2}{\partial p_j} + \ldots + p_j \frac{\partial q_j}{\partial p_j} + \ldots + p_n \frac{\partial q_n}{\partial p_j} = -q_j \quad , \tag{3.18}$$

Expressing (3.18) in terms of price elasticities and budget proportions yields

$$\frac{p_1 q_1}{y} \cdot \frac{p_j}{q_1} \frac{\partial q_1}{\partial p_j} + \ldots + \frac{p_n q_n}{y} \cdot \frac{p_j}{q_n} \frac{\partial q_1}{\partial p_j} = -\frac{p_j q_j}{y} \qquad \text{or}$$

$$w_1 e_{1j} + w_2 e_{2j} + \ldots + w_n e_{nj} = -w_j \quad . \tag{3.19}$$

This condition states that relocation of the budget due to income and price changes must continue to exhaust total income. It requires that the weighted sum of the elasticities for the commodity j is equal to the negative of the expenditure proportion on the jth commodity (George and King 1971).

3.5.1.4 Slutsky symmetry condition

Taking total derivatives of the first order condition in (3.7) can present the effects of simultaneous changes in prices and income. A cross-price elasticity, namely a change in the consumption of the ith commodity as a result of a change in jth commodity price, can be denoted as

$$\frac{\partial q_i}{\partial p_j} = (\frac{\partial q_i}{\partial p_j})_{u=cons} - q_{ij}(\frac{\partial q_i}{\partial y})$$
$$= k_{ij} - q_j \frac{\partial q_i}{\partial y} \qquad (3.20)$$

The first term on the right-hand side represents that compensation occurs to hold utility constant in case of changes in prices. The price derivative of a demand equation is thus decomposed into the substitution effect (k_{ij}) and income effect ($q_{ij}.\partial q_i/\partial y$). Furthermore, the compensated cross-price derivative have a symmetry property as well, which is

$$\frac{\partial q_i}{\partial p_j} + q_j(\frac{\partial q_i}{\partial y}) = \frac{\partial q_j}{\partial p_i} + q_i(\frac{\partial q_j}{\partial y}) \quad \text{or} \qquad (3.21)$$

$$k_{ij} = k_{ji}.$$

Equation (3.21) can be expressed as elasticities and budget proportions as:

$$e_{ij} = \frac{w_j}{w_i} e_{ji} + w_j(e_{jy} - e_{iy}). \qquad (3.22)$$

This symmetry property reduces the number of independent k_{ij} terms ($i \neq j$) by one-half (Barten 1967). Thus, this restriction allows for an increase in the degrees of freedom in estimation.

Finally, the negativity property of the substitution effect of the own price derivative should be emphasised viz

$$k_{ii} = \frac{\partial q_i}{\partial p_i} + q_i(\frac{\partial q_i}{\partial y}) \;<\; 0. \qquad (3.23)$$

The consequence of this property is that an increase in the price of the commodity will lead to a decrease in the quantity purchased. That is in the case where the income derivative in (3.20) is negative when the commodity in question is an inferior commodity.

In general, this condition incorporates a fundamental relationship between changes in quantities and prices, and the marginal utility of income. It well deserves as the 'fundamental equation of the theory of value' as such this condition provides the analytical justification of the law of demand.

As stated previously, the four general demand conditions are not dependent upon the choice of a particular utility function. They follow from all utility functions, which describe a preference ordering. If demand functions satisfy all the general restrictions, utility theory can be regarded as an appropriate basis for demand analysis. Furthermore, the number of independent parameters to be estimated by using this approach can be reduced. Whatever method is used to impose general restrictions, it will lead to economies in parameterisation (Phlips 1974). In Table 3.1 the general restrictions in terms of elasticities is summarised.

3.5.2 Particular restrictions

Particular restrictions are derived from specific properties assumed about the utility function and are additional to the general demand restrictions specified above. Two important assumptions, additivity and separability, are discussed briefly in this section.

3.5.2.1 Additivity

Based on prior information, it is possible to break up the utility function into a number of sub-utility functions each of which represents some sub-group of commodities. Thus, the general utility function (3.3) could be re-expressed as

$$U = f_1(q_1) + f_2(q_2) + \ldots + f_n(q_n) \; . \qquad (3.24)$$

This function is directly additive and the utility provided by the consumption of one good is independent of the consumption of any other good.

Table 3.1: General restrictions on demand functions (in considering the matrix of demand elasticities)

Quantity consumed	Price			Income
q_i	p_1	p_2	p_n	y
q_1	e_{11}	e_{12}	e_{1n}	e_{y1}
q_2	e_{21}	e_{22}	e_{2n}	e_{y2}
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
q_n	e_{n1}	e_{n2}	e_{nn}	e_{yn}

expenditure proportions as defined;

w_i w_1 $w_2 \ldots\ldots\ldots w_n$

We have:

General Restriction Involved		Restrictions Provided
(i) Engel Aggregation	$\sum_j w_i e_{yi} = 1$	1
(ii) Cournot Aggregation	$\sum_i w_i e_{ij} = -w_j$	(n)
(iii) Homogeneity	$\sum_i e_{ij} + e_{yi} = 0$	n
(iv) Symmetry	$e_{ji} = e_{ij}(w_j / w_i) - w_j(e_{yi} - e_{yj})$	$\frac{1}{2}n(n-1)$

Total=$(n^2 + n + 2)/2$

Thus, the number of parameters to be estimated independently is:

$$n(n+1) - (n^2 + n + 2)/2 = (n-1)(\tfrac{1}{2}n - 1)$$
$$= (n^2 + n - 2)/2$$

Source: George and King (1971) .

An alternative additivity specification is that of indirect additivity. If the utility function is not specified directly, but derived from demand functions chosen as appropriate in estimation, then total utility is derived from the addition of the individual demand equation. The demand equations are assumed additive in the function of maximising the individual quantities of each commodity group purchasable within the given budget.

It can easily be seen that direct additivity in (3.24) implies independent of marginal utilities and the compensated cross-substitution effects are proportional to the derivative of income (Phlips 1974). Deaton (1974) pointed out, however, that this assumption was unreasonable in case of disaggregated commodity groups and at best is doubtful with highly aggregated commodity groups. Some empirical studies show that the additivity postulates seriously distort the measurement of own-price and income elasticities (Reynolds 1978). Hence, this additivity assumptions seem to be unrealistic and inappropriate for empirical work.

3.5.2.2 Separability

Separability is a necessary and sufficient condition for a demand function and means that the marginal rate of substitution between any two variables belonging to the same group is independent of the value of any variable in any other group (Phlips 1974). Thus, it is possible to undertake sub-grouping of the commodity set. The sub-groups represent those commodities which are closer substitutes or complements with each other than with commodities in other sub-set. The utility function (3.3) can then be written as

$$U(q) = f[U_1(q_1), U_2(q_2), \ldots, U_n(q_n)] \qquad (3.25)$$

The utility is separable into groups without necessarily being additive. Depending upon the assumptions, the separability property can be classified into three types---weak, strong and Pearce separability. Among these, weak separability is of greatest interest to the economists. It assumes that the ratio of marginal utilities of any two commodities in one group is independent of the quantity consumed of any commodity outside the group. Weak separability implies that the sum of compensated price elasticities is proportional to the product of income derivatives (Brown and Deaton 1972). Strotz (1957) discussed the two-stage maximisation procedure based on this weak separability assumption. Income is first allocated among broad commodity groups and then the optimal expenditure allocations within groups occur. When a budget allocation is made to a branch, the effect of prices of commodities outside the group can be ignored. Therefore, demand for a particular commodity can be written as a function of prices in the group and of the budget share of the group to which it belongs (Reynolds 1978).

Strong separability is applicable only to those utility functions which are additive among groups. Pearce separability includes both weak and strong separability. Both strong and Pearce separability will be neglected here as it does not apply to the case in question.

It is worthwhile to emphasise, however, that the assumption of separability and two-stage maximisation can make it possible to estimate a much more disaggregated commodities (ie. 'pork' rather than 'meat') in the framework of a complete demand system (Phlips 1974).

3.6 Prior specification of the demand function

In the analysis of the demand for a particular commodity taken in isolation, an *ad hoc* specification of the demand function has to be found. Again, this specification has to be such that the general conditions are satisfied. As discussed in Chapter 2, the Double Logarithmic specification that is very popular can be used in obtaining estimates of the price and income elasticities for the different red meat. It is usually expressed as

$$q_1 = Ap_1^{\beta_{11}} p_2^{\beta_{12}} p_3^{\beta_{13}} y^{\gamma} , \qquad (3.26)$$

in which good 1 is the particular commodity to be analysed, goods 2 and 3 are close substitutes or complements, and A is a scaling factor.

In logarithmic form, the function (3.25) can be written as

$$\log q_1 = A + \beta_{11} \log p_1 + \beta_{12} \log p_2 + \beta_{13} \log p_3 + \gamma \log y \qquad (3.27)$$

Thus, elasticities are specified directly. β_{11}, β_{12} and β_{13} are own- and cross-price elasticities respectively, and γ is the income elasticity to be analysed. Because of its ease of estimation and immediacy of parameter, many empirical studies have used the double-logarithmic demand function. Furthermore, it is argued that this specification approximates aggregated individual utility maximising behaviour. This could ease the aggregation error somewhat over individuals.

3.7 Summary

In conclusion, economic framework for this study is the theory of utility-maximising consumers. The preference axioms of the individual consumer are such that they make their choices of the commodity bundle in order to obtain the maximum satisfaction subject to this budget limitation. The demand equation derived from the constrained utility function satisfy a number of important relationships. However, the extra 'particular' demand restrictions seem to provide an insufficient conceptual framework for empirical demand analysis. The prior specification of modelling are usually the Double Logarithmic function. However, whether all the results of this theory are rejected by the empirical data or not needs to be researched using econometric analyses. If not, one cannot argue that the procedure sketched above does not describe actual behaviour of Chinese consumers.

4. Empirical Considerations and Estimation of a Reference Model

4.1 Introduction

In this Chapter, the model used to obtain a demand interrelationship for pork, beef and mutton in China is outlined. The appropriate restrictions among the demand elasticities of three commodities are imposed. For each commodity dummy variables are used to pool the cross-section data of different regions and time series data. In Section 4.2 the economic model that forms the basis for understanding the behaviour of economic variables is presented. The restrictions to be imposed in this study are briefly discussed in Section 4.3. The statistical model is specified in Section 4.4. A discussion of the sources of data is then presented in Section 4.5, while the relevant techniques of estimation are detailed in Section 4.6.

4.2 The economic model

Economic theory has been usd to suggest the general types of function that may be appropriate for a particular research problem and also the economic variables that should appear in each equation. In a demand relationship, quantity is hypothesised to be a function of the commodity's own price, the prices of other commodities, income and other variables. A demand sub-system for meat is formed by grouping the individual demand functions for each of the major meat commodity groups. Thus, the economic model can be expressed as:

$$\begin{aligned} Q_1 &= f(P_1, P_2, P_3, Y), \\ Q_2 &= f(P_1, P_2, P_3, Y), \qquad (4.1) \\ Q_3 &= f(P_1, P_2, P_3, Y), \end{aligned}$$

where Q denotes consumption (domestic disappearance);

P denotes price (retail);

Y is per capita income on red meat; and

the subscripts 1, 2, 3 denote pork, beef and mutton, respectively.

For any commodity, like food, economic principles can be used to suggest how these variables are related. The commodity's quantity and price are expected to be inversely related, while income and quantity would be most positively related. however, to examine the consumption relationship, it is also necessary to examine the identification problem. Identifying a relationship requires the consideration of what other relationships may unknowingly be measured. For example, supply is simultaneously influenced the same data as the demand schedule yet is usually more stable than supply (Reynolds 1978). However, in this study the focus is on demand side, although the important role and relevance of supply in the real world can not be ignored.

The economic model specified above is a special case of a simultaneous equation system in which each equation contains only one endogenous variable. All right hand side variables of the model are assumed to be either independent or pre-determined. This assumption seems straight-forward for income, but some explanation is necessary in the case of meat prices. The choice of either price or consumption as a pre-determined variable requires an explicit and restrictive assumption that the short-run elasticity of supply is perfectly price elastic. Furthermore, it seems reasonable to assume that prices are pre-determined. Retailers are assumed to establish selling prices and supply at levels which are needed to meet consumers demand at that price. Consumers are thus faced with given prices and vary their purchases accordingly. Prices can logically be taken as the independent variable and the proposed economic model approximates the Cournot-Marshall demand curve, subject to the *ceteris paribus* conditions (Reynolds 1978).

To understand the quantity, prices and income relationship, elasticities are the basic conceptual tools in demand theory and in estimation. Demand elasticities measure the quantity reactions to changing prices and income. Such elasticities are important in framing growth strategies in developing countries such as China. They are used for classifying commodities as luxuries or necessities. If the income elasticity of demand greater than one is a luxury, whereas a necessity has an income elasticity less than one (Griffiths *et al.* 1993). Yet, agricultural economists often use flexibility measures for making agricultural pricing decisions. Price flexibility is the percentage of change in the price of a commodity, associated with an isolated one per cent increase in the quantity sold or in a related variable (Houck 1966). When the objective is to evaluate the effects of price changes on quantity, however, only elasticities from a directly estimated ordinary demand system should be used (Huang 1994).

The economic model forms the starting point for the treatment of consumer behaviour. Furthermore, a system of demand functions may also satisfy a number of restrictions which are discussed in the next section.

4.3 Restrictions in a complete demand system

As the complete demand systems approach is applied in this study observations on different commodities can be pooled together and Slutsky symmetry condition and other restrictions from demand theory are introduced to incorporate the economic effects of interdependency between response parameters. Even if the general restrictions are theoretically appropriate within the framework of the demand functions, they have to be empirically tested for applicability and desirability.

4.3.1 Homogeneity restriction

From the theory of utility maximisation it could be said that consumers are indifferent to a monotonic transformation of the utility formation and that all demand functions are homogeneous of degree zero in prices and income, see equation (3.13). The theoretical homogeneity condition without money illusion is most applied implicitly in the estimation of demand parameters by deflating money prices and income by an index of general price movements. In this study, the Consumer Price Index (CPI) is used to deflate money prices and incomes to constant dollar values. Consequently, the CPI is included in the regression model as a deflator rather than as a separate variable to avoid multicollinearity problems. The homogeneity restriction can then be enforced by requiring that the sum of all elasticity coefficients equals to zero, which can be expressed as :

$$e_{i1} + e_{i2} + e_{i3} + e_{iy} = 0 \qquad (4.2)$$

where e_{i1}, e_{i2} and e_{i3} denote price elasticities; and

e_{iy} denotes income elasticities.

4.3.2 Slutsky symmetry restrictions

In the equation (3.22) it was shown that if the demand functions are specified in linear logarithmic form, the symmetry restrictions can be expressed as a set of linear restrictions between pairs of budget proportion reciprocals. Thus, (3.22) can be specified as:

$$\frac{e_{ij}}{w_j} + e_{iy} = \frac{e_{ji}}{w_i} + e_{jy} \quad \text{or} \qquad (4.3)$$

$$K_{ij} = K_{ji}$$

where e_{ij} is the cross price elasticity of ith commodity to jth price;

e_{ji} is the cross price elasticity of jth commodity to ith price;

e_{iy} and e_{jy} are the income elasticities of ith and jth commodity respectively;

w_i and w_j are the ith and jth commodity budget expenditure proportion; and

k_{ij} and k_{ji} are the elasticities of substitution.

By evaluating the elasticities of substitution at specified values, the sample means are usually used to denote the budget shares. They can be computed based on the following formula (Judge *et al.* 1988):

$$\overline{W}_i = T^{-1}\sum_{t=1}^{T}(P_{it}Q_{it} / Y_t) \qquad i=1, 2, 3 \quad T=1,2,...,14 \tag{4.4}$$

Thus, equation (4.4) indicate the relationship among cross-price elasticities, average budget proportions and income elasticities for any pairs of red meat. The validity of both the linear restrictions inherent in the three symmetry constraints separately, and the set of restrictions appropriate to the demand sub-model as a whole are tested respectively. The Wald Chi-square (R^2) statistic is used to justify whether or not to reject the null hypotheses that true coefficients obey the theoretical symmetry restriction.

Because the negativity restrictions are non-linear and involve inequalities, they are not imposed in this study to avoid inconsistency and overelaborateness.

4.3.3 Aggregation restrictions

In appling the Engel aggregation the income elasticities weighted by their respective expenditure proportions must sum to unity. The condition can be expressed as:

$$w_1e_{1y} + w_2e_{2y} + w_3e_{3y} = 1 \tag{4.5}$$

where subcripts 1, 2, 3 denote pork, beef and mutton respectively;

w denotes budget expenditure proportion; and

e_y denotes income elasticity.

Applying the Cournot aggregation means that the weighted sum of the elasticities for the commodity j is equal to the negative of the expenditure proportion on the jth commodity. The restriction can be expressed as:

$$w_1 e_{1j} + w_2 e_{2j} + w_3 e_{3j} = -w_j \qquad j=1, 2, 3 \qquad (4.6)$$

where w denotes budget expenditure proportion; and

e denotes price elasticity.

Both of the aggregation restrictions require that any reallocation of the budget, which is due to income or price changes, must exhaust total income. Thus, they are not relevant in this study because total consumption expenditure is not exhausted in demand sub-systems for red meat only.

4.4 The statistical model

To convert the theoretical model of the demand for meat, embodied in equations (4.1) such that they can be used for estimation and inference, three changes need to be made. The notation also has to be changed to make it conform more to the statistical conventions. Subscripts *i, j* and *k* are added to denote the commodities, the observations and the regions, respectively. An intercept coefficient α is added to represent the effect of a trend-like shift in preferences. Finally, a random unpredictable component, 'e' acts like a catchall for the effects of factors other than trends, prices, income and, furthermore, takes care of all observational and approximation errors (Barten 1967).

Given China's vast territory and the wide range of natural and economic geography, dummy variables are used to capture most regional variations that allow behavioural differences between regions. China can be divided into seven broad regions according to the geographical distribution. They are:

Northeast (Region 1)---Heilonjiang, Liaoning and Jilin;

North (Region 2)---Shandong, Hebei, Beijing, Tianjin, Henan and Shanxi;

Northwest (Region 3)---Shaanxi, Gansu, Inner Mongolia, Ningxia, Xinjiang and Qinghai;

East (Region 4)---Zhejiang, Jiangsu, Shanghai and Anhui;

Central (Region 5)---Hubei, Hunan and Jiangxi;

South (Region 6)---Guangdong, Guangxi, Fujian and Hainan; and

Southwest (Region 7)---Sichuan, Guizhou, Yunnan and Xizang.

Differences over cross cross-sectional units are assumed to be reflected in the intercept term and the cross-sectional units provide natural partitions for which dummy variables can be defined in this study. Since a constant term is included in the model, one of the dummy variables is omitted. Consequently, six dummies are used to incorporate non quantitative or qualitative factors into the economic model. To allow for a change only in the intercept parameter across the sample partition, a dummy variable is defined as one for one particular region and zero for the others. Therefore, statistical model of this study can then be expressed:

$$Q_i = \alpha_{i1} + \alpha_{i2}D_{i2} + \alpha_{i3}D_{i3} + \alpha_{i4}D_{i4} + \alpha_{i5}D_{i5} + \alpha_{i6}D_{i6} + \alpha_{i7}D_{i7} + \beta_{i1}p_1 + \beta_{i2}p_2 + \beta_{i3}p_3 + \beta_{i4}y + e_i \qquad i=1,2,3 \quad (4.7)$$

where Q_i, D_{i2}, ..., D_{i7}, p_1, p_2, p_3 and Y_i are 98×1 vectors;

Q_i denotes quantity of commodity;

β_{i1}, β_{i2} and β_{i3} denote price elasticities;

β_{i4} denotes income elasticity;

e_i denotes error term; and

D denotes a dummy variable, which is defined as:

$$D_k^i(j) = \begin{cases} 1 & j=14(k-1)+1,\dots,14k \\ 0 & otherwise \end{cases} \qquad (i=1,\ 2,\ 3;\ k=2,\dots,\ 7;\ j=1,2,\dots,\ 98)$$

Alternatively, equation (4.8) may be presented in summation form as:

$$Q_i = \alpha_i + \sum_{k=2}^{7} \alpha_k D_{ik} + \sum_{j=1}^{3} \beta_{ij} p_j + \beta_{i4} y_i + e_i \qquad (i=1,\ 2,\ 3) \qquad (4.8)$$

Based on the preceding discussion in Chapter 3, the Double Logarithm (the derivatives usually assume natural base e) is used, and the model can then be represented more specifically as:

Pork

$$\ln Q_1 = \alpha_{10} + \sum_{k=2}^{7} \alpha_k D_k + \beta_{11} \ln P_1 + \beta_{12} \ln P_2 + \beta_{13} \ln P_3 + \beta_{14} \ln Y + e_1 \quad (4.9)$$

Beef

$$\ln Q_2 = \alpha_{20} + \sum_{k=2}^{7} \alpha_k D_k + \beta_{21} \ln P_1 + \beta_{22} \ln P_2 + \beta_{23} \ln P_3 + \beta_{24} \ln Y + e_2 \quad (4.10)$$

Mutton

$$\ln Q_3 = \alpha_{30} + \sum_{k=2}^{7} \alpha_k D_k + \beta_{31} \ln P_1 + \beta_{32} \ln P_2 + \beta_{33} \ln P_3 + \beta_{34} \ln Y + e_3 \quad (4.11)$$

The assumptions embodied in this statistical model are detailed below and their applicability is subject to testing. Five assumptions are made. They are:

- The adjustment period for the meat demand sub-system is assumed to be of annual duration. That is, in a period of twelve months, changes in any of the pre-determined variables can be fully represented by changes in the endogenous variables. No underlying structural change is assumed to occur within a year.

- The effect of population growth on the level of total consumption and total income is removed through the use of per capita data. The effects of taste and preference and cultural factors are assumed to be constant over the period of the analysis. If a change occurs, and such a change is steady, a time trend variable may be used. As the classical demand theory relates to an individual consumer, it is a crude simplification of the aggregate demand process. Problems of aggregation are ignored and any resulting aggregation errors are assumed to be insignificant. The analysis is based on an assumed demand function for the representative consumer.

•It is assumed that consumer response to price and income variation is based on proportional changes in these variables rather than absolute levels of them. As the log-linear formulation of relationships is adopted, constant elasticity estimates over the range of the data is imposed. A meat demand sub-system in double logarithmic form may satisfy all prior restrictions, which is, however, subject to the result of later testing. Double Logarithmic functions are assumed appropriated and are favoured in this analysis because they provide reasonable goodness of fit, ease of estimation and immediacy of interpretation.

•Changes in prices of commodities, other than the meat groups specified, are incorporated implicit by deflating price and income variables with the consumer price Index (CPI). By deflating, the theoretical homogeneity restriction is imposed implicitly. That is, consumers are assumed not to be subject to money illusion.

•In absence of any substantive prior information concerning the degree of substitution among meats, it is reasonable to begin with the system in which all red meat prices and income appear as explanatory variables in each equation. Slutsky symmetry restrictions are relevant and will be applied empirically and then tested. The other restrictions may also be tested for justification by using the available data. The statistical application of general theoretical restrictions has advantages of greater statistical efficiency and of ensuring integration between theory and empirical analysis (Reynolds 1978).

4.5 Data

The data used in this study are composed of 14 annual observations from 1979-1992 with seven regional cross sections of data. China State Statistical Bureau publications are used as sources where possible. Otherwise, the data published by USDA (various issues) are supplemented. Two different sets of data are used and compared to see which is more reliable. One is based on per capita income data; while the other is based on expenditure data on red meat which can be regarded as proximity for income. The two data series are presented in Appendix 1 and Appendix 2, respectively.

As disaggregated consumption data on pork, beef and mutton are not available in China a domestically disappearance series had to be constructed. Consumption is calculated as production, less net exports, with an adjustment for changes in the quantity of frozen stocks. Since China's exports have accounted for only around 2.4 per cent of the total production averagely in the past decades, and no official records in imports exist, regional production data on pork, beef and mutton are used as the closest approximation of domestic disappearance (State Statistical Bureau 1993). As discussed in last section, thirty provinces and municipalities are grouped into seven broad regions based on geographical distribution while an intra-trade influence is taken into account. The fact that inter-province trade usually takes place within each of the seven broad regions makes the approximation even closer to the actual consumption. Furthermore, red meat stocks are so small in China, mainly due to its shortage in freezing, processing and transport facilities as well as those data's unavailability that it may be ignored in this study.

Annual mixed average retail prices of pork, beef and mutton are used to compute retail CPI based on Laspeyres or base-weighted formula. Mixed average price in their case is defined as an average of fixed, negotiated and free-market prices with average of various standards, grades and qualities. The base year is set as 1979, and retail price indices for pork, beef and mutton are calculated sequentially up to 1992. Since regional or provincial price data are not available and somehow close to each other, the same set of retail price indices at national level are applied in each broad region.

Annual provincial per capita income data in some key years including 1978, 1980, 1985, 1989, 1991 and 1992 were directly obtained from the China Statistics

Yearbooks and other local statistical publications. Unfortunately, there are some missing data in some provinces and discontinuity in other years. But those data can be either calculated based on other sources or approximated closely to make up for the gap. Per capita income for 1979 and 1990 was obtained by averaging data available between 1978 and 1980, and between 1989 and 1991, respectively. An average annual income growth rate of 6.9 per cent between 1981-86 was calculated based on the data from State Statistics Bureau by Zhao Renwei, Director of Economics Research Institute of Chinese Academy of Social Sciences. Thus, 1981-84 data can be generated according to the growth rate. Income data in 1986 and 1987 are obtained directly from the Chinese Academy of Social Sciences and State Statistics Bureau, respectively (Howes and Lanjouw 1994). The 1988 data can then be calculated by averaging data between 1987 and 1989. Finally, all these income data are deflated by general CPI so that real per capita income, rather than nominal one, is used in estimation to generate more reliable results.

Alternatively, annual regional expenditure data on red meat are used as an explanatory factor to compare the estimates from quantity and income relationship. The expenditure on red meat can easily be generated from price and quantity data available and then divided by general CPI. In a static analysis, it is assumed that the consumer makes a change in consumption, if there is any, as soon as there is a change in expenditure. The expenditure data can reflect the demand pattern in the sense of long run income changes more directly. Moreover, the expenditure on red meat is a price value-weighted sum of physical quantities used. Thus, the money value or expenditure measure implies both a quantity and quality component of demand (David *et al.* 1989).

4.6 Estimation

Since the demand models are specified for three related commodities, using both time-series and cross-section data, they could be estimated simultaneously as a meat demand sub-system. However, several methods are used to estimate the relationship between the dependent and the independent variables of time-series and cross-sectional data to compare and examine the efficiency and the reliability.

Ordinary least square (OLS) is first applied to estimate the unknown parameters in each equation separately. The coefficient of determination (R^2) can be computed and is a descriptive device about the "fit" of the model in terms of the proportion of variation in the dependent variable, explained by the explanatory variables and in terms of the predictive ability of the model over the sample period (Griffiths *et al.* 1993). As well, the Durbin-Waston statistic is computed to test for the presence of autocorrelated errors. However, it is generally accepted that it is more efficient to estimate all equations jointly, where there is more than one equation to estimate, rather than to estimate each one separately using least squares.

This joint estimation technique is often known as seemingly unrelated regressions (SUR) estimation that is applied in this study. The use of such a technique can also be regarded as one method for pooling time-series and cross-sectional data. The distinguishing features of seemingly unrelated regression techniques relate to contemporaneous correlation in the disturbances and the assumption that each cross-sectional unit has a different coefficient vector. After imposing the restrictions among the elasticities of the three types of red meat, the three equations are estimated jointly by using SUR model. In the case of three equations to be estimated and considering pork, beef and mutton at the same time in each equation, seemingly unrelated regression techniques would yield estimates which are asymptotically more efficient than those obtained by ordinary least square.

Meanwhile, a dummy variable method is employed to pool time-series and regional cross-sectional data in each equation. The different regional cross-sectional units provide natural sample partitions for which different coefficients or different structures may exist. It is assumed that differences in cross-sectional units can be adequately captured by specifying a different intercept coefficient for each regional cross-sectional unit. Thus, dummy variables are used to model differences in intercepts of each equation. This model can also be viewed as a special case of the seemingly unrelated regression model.

Conclusively, in the absence of auto-correlation as assumed, the seemingly unrelated regression coefficient estimates are asymptotically more efficient than single equation least squares estimates (Zellner and Huang 1962). Additionally, estimates of the standard deviations of the regression coefficients are expected to be lower. As well, the inclusion of qualitative factors into the empirical analyses can produce more reasonable estimates. Hence, the gain in precision can increase the applicability and reliability of the policy based on those estimates.

4.7 Summary

On the basis of the demand functions, a more applicable statistical mode is derived in this Chapter. The secondary data are used directly, and some of them are used for generating the data unavailable. The seemingly unrelated regression procedure is adopted as an appropriate least square estimator of the statistical model of retail demand for meat under certain restrictions. Furthermore, the general restrictions embedded in the utility maximisation hypothesis are discussed. Only the Slutsky symmetry restrictions remain to be imposed within the framework of the chosen simultaneous statistical analysis.

5. Empirical Results and Demand Projections

5.1 Introduction

In this Chapter the complete demand system analysis results are computed, using SHAZAM Version 7.0, and are reported. The estimates of own-price elasticities, cross-price elasticities and income elasticities are generated by applying ordinary least squares techniques, seemingly unrelated regressions without restrictions and seemingly unrelated regressions with restrictions. After comparing the results from each of these methods, the demand for red meat in China by year 2000 can be predicted, using the most efficient and reliable estimates.

5.2 Empirical results

The purpose in this Section is to report the results of the analysis. The major results for the models estimated using income and expenditure data, are reported in Tables 5.1 and 5.2, respectively. In each Table, the results derived by both OLS and by SUR techniques are reported.

5.2.1 Results from using income data

In Table 5.1 the SUR estimates (in Part B of the Table) without restrictions are reported and were found to be more efficient than the OLS estimates (which are reported in Part A of the Table). The restricted SUR estimates (reported in Part C) were more efficient than the unrestricted estimates. The difference in efficiency are reflected in terms of standard errors coefficients. All the standard errors estimated using SUR techniques are smaller than those estimated using OLS techniques. The Durbin-Watson statistics derived from the OLS techniques are small enough and that it can be implied that autocorrelation may exist in the residuals. The R-squares are low

Table 5.1: Estimated elasticities with different methodologies using income data

Quantity: (A) OLS estimates

	Pork	Beef	Mutton	Income	Constant	D2	D3	D4	D5	D6	D7	R^2/DW	σ^2
Pork	-.1630	-.6789	-.1649	1.6474	5.1884							.3210	.2585
	(.8033)	(1.3321)	(1.3353)	(.4730)	(.5908)							.2866	
	.2029	.5097	.1235	3.4830	8.7826								
Beef	.1305	-.2339	1.8147	-.6078	3.9016							.4902	.5736
	(1.1966)	(1.9841)	(1.9889)	(.7045)	(.8799)							.1214	
	.1091	.1179	.9124	.8627	4.4340								
Mutton	.9538	.3201	-.5332	.1533	3.2308							.0637	1.7332
	(2.0800)	(3.4490)	(3.4573)	(1.2246)	(1.5296)							.0858	
	.4586	.0928	.1542	.1252	2.1122								

Quantity: (B) SUR estimates with dummies and without restrictions

	Pork	Beef	Mutton	Income	Constant	D2	D3	D4	D5	D6	D7	R^2/DW	σ^2
Pork	-.1644	.3412	.0680	.2468	7.4545	-1.0970	-.2482	-1.5244	-.2870	-.2149	-.5807	.9778	.0080
	(.1417)	(.2431)	(.2359)	(.1196)	(.1484)	(.0344)	(.0342)	(.0349)	.03803	(.03556)	.03482		
	1.1602	1.4039	.2881	2.0629	50.244	31.849	7.2577	43.614	7.5469	6.0441	16.679		
Beef	.1309	-.5029	1.7533	-.2385	4.0294	-.8319	.0142	.3889	-.9355	-1.5693	-1.1007	.8991	.1077
	(.5185)	(.8896)	(.8634)	(.4378)	(.5430)	(.1261)	(.1252)	(.1279)	.1392	(.1302)	(.1274)		
	.2524	.5653	2.0308	.5448	7.4208	6.5994	.1131	3.0405	6.7219	12.058	8.6376		
Mutton	.9535	.5802	-.4739	-.2037	4.2461	-1.5218	.7381	1.1995	-.1877	-1.9220	-2.3775	.9829	.0301
	(.2741)	(.4703)	(.4565)	.2315	(.2871)	(.0667)	(.0662)	(.0676)	(.0736	(.0688)	(.06737)		
	3.4785	1.2335	1.0382	.8802	14.790	22.833	11.154	17.736	2.5505	27.930	35.288		

Table 5.1 continued.

Quantity: (C) SUR estimates with Slutsky symmetry restrictions

Pork	-.1993*	.2574*	.2680*	.1282*	7.6089	-.1.1031	-.2437	-1.5329	-.2699	-.2256	-.5728	.9774	.0082
	(.1480)	(.2077)	(.2003)	(.0988)	(.1242)	(.0365)	(.0363)	(.0368)	(.0388)	(.0372)	(.0367)		
	1.3468	1.2392	1.3384	1.2971	61.294	30.238	6.7080	41.644	6.9489	6.0643	15.599		
Beef	.3542*	.1266*	.7095*	.1348*	3.5168	-.8127	-.0002	.4156	-.9893	-1.5357	-.1256	.8970	.1099
	(.4878)	(.4213)	(.3595)	(.0097)	(.1616)	(.1243)	(.1243)	(.1244)	(.1250)	(.1245)	(.1244)		
	.7262	.3005	1.9736	1.3921	21.769	6.5377	6.5377	3.3409	7.9150	12.333	9.0497		
Mutton	1.0276	.7365	-.9501	.1338*	3.8093	-1.5044	.7252	1.2237	-.2364	-1.8971	-2.4000	.9823	.0310
	(.2691)	(.3137)	(.3120)	(.0984)	(.1382)	(.0661)	(.0660)	(.0662)	(.0674)	(.0665)	(.0662)		
	3.8191	2.3474	3.0449	1.3592	28.679.	22.773	10.991	18.472	3.5076	28.460	36.256		

Note: 1. In the First row the estimated coefficients are reported.
2. The second row in bracket is standard errors.
3. The third row is t-ratio, omitted'-' if it is negative.
4.* denotes insignificance.

Table 5.2: Estimated elasticities with different methodologies using expenditure data

	Pork	Beef	Mutton	Income	Constant	D2	D3	D4	D5	D6	D7	R^2/DW	σ^2
Quantity: (A) OLS estimates													
Pork	-1.2758	-.4528	.3168	1.2058	4.0310							.9117	.0336
	(.2927)	(.4655)	(.4808)	(.0451)	(.1281)							.2057	
	4.3592	.9728	.6589	26.746	31.475								
Beef	.2480	-.5741	1.6918	-.1269	3.4957							.4887	.5753
	(1.2106)	(1.9254)	(1.9887)	(.1865)	(.5298)							.1240	
	.2049	.2982	.8507	.6805	6.5988								
Mutton	.6560	.1710	-.4521	.3230	2.5710							.0736	1.7149
	(2.0901)	(3.3243)	(3.4336)	(.3220)	(.9146)							.0845	
	.3139	.0514	.1317	1.0032	2.8110								
Quantity: (B) SUR estimates with dummies and without restrictions													
Pork	-.8093	-.0440	.2295	.6996	5.5794	-.3470	-.1359	-.8287	-.0691	-.0338	-.1420	.9919	.0029
	(.0981)	(.1435)	(.1424)	(.0519)	(.1625)	(.0602)	(.0219)	(.0568)	(.0246)	(.0255)	(.0374)		
	8.2487	.3067	1.6117	13.478	34.338	5.7661	6.2150	14.600	2.8147	1.3263	3.7917		
Beef	.5453	-.3136	1.6362	-.4495	5.1373	-1.3096	-.0610	-.0523	-1.0870	-1.6785	-1.3879	.9010	.1058
	(.5885)	(.8606)	(.8542)	(.3113)	(.9746)	(.3610)	(.1312)	(.3404)	(.1473)	(.1527)	(.2246)		
	.9266	.3644	1.9154	1.4437	5.2713	3.6280	.4657	.1537	7.3808	10.995	6.1804		
Mutton	.7890	.2874	-.4770	.1788	3.4443	-1.3164	.7566	1.3964	-.1705	-1.8516	-2.2832	.9829	.0230
	(.3133)	(.4582)	(.4549)	(.1658)	(.5189)	(.1922)	(.0698)	(.1813)	(.0785)	(.0813)	(.1196)		
	2.5178	.6273	1.0486	1.0784	6.6372	6.8490	10.833	7.7034	2.1738	22.780	19.095		

Table 5.2 continued.

Quantity:(C) SUR estimates with Slutsky symmetry restrictions

Pork	-.6850	-.0942*	.3849	.5377	6.0957	-.5235	-.1597	-.9938	-.1113	-.0808	-.2397	.9909	.0033
	(.1411)	(.1687)	(.1688)	(.0598)	(.1890)	(.0728)	(.0334)	(.0691)	(.0358)	(.0366)	(.0484)		
	4.8549	.5583	2.2802	8.9775	32.253	7.1891	4.7777	14.390	3.1068	2.2056	4.9477		
Beef	-.1375*	-.2350*	.8625	.5238	2.0547	-.2487	.0820	.9400	-.8334	-1.3955	-.8004	.8898	.1176
	(.4927)	(.4068)	(.3599)	(.0605)	(.2242)	(.1411)	(.1251)	(.1392)	(.1258)	(.1260)	(.1300)		
	.2790	.5777	2.3966	8.6588	9.1642	1.7619	.6552	6.7538	6.6267	11.075	6.1567		
Mutton	.4873*	.3703*	-.8382	.5883	2.1426	-.8700	.8168	1.8139	-.0638	-1.7326	-2.0360	.9817	.0321
	(.2750)	(.2806)	(.2794)	(.0648)	(.2078)	(.0963)	(.0662)	(.0930)	(.0677)	(.0682)	(.0763)		
	1.7724	1.3198	2.9996	9.0839	10.310	9.0307	12.329	19.494	.9420	25.404	26.674		

Note: 1. In the first row the estimated coefficients are reported.
2. The second row in bracket is standard error.
3. The third row is t-ratio, omitted '-' if it is negative.
4. * denotes insignificance.

at 0.32, 0.49 and 0.06 for estimated equations for pork, beef and mutton, respectively. Thus, it can be implied that only 32 per cent, 49 per cent and 6 per cent of variations in quantity of pork, beef and mutton, respectively are explained by the explanatory variables, including the prices of pork, beef, and mutton and the real per capita income. Thus, the "fit" of the model is not satisfactory. As well, some signs, such as the cross price elasticities in the pork equation and income elasticities in the beef equation are not as expected, which would seem to be inconsistent with the economic theory. Very few coefficients are statistically significant, except the constant.

The results from SUR that incorporate dummy variables for the regional differences are improvement in terms of their efficiency, over those reported above (see Part B of Table 5.1). All the standard errors are smaller than those derived using OLS techniques. The R-square values are higher at 0.98, 0.90 and 0.98 for pork, beef and mutton, respectively. All the intercept dummies are statistically significant in each equation except for one dummy variable in beef equation. Thus, it can be implied that large regional variations do exist in China, and that it is reasonable to include regional dummy variables in this study. However, the signs of the income coefficients in both beef and mutton equations are negative, which is suggestive of the fact that beef and lamb are both inferior commodities. It was hypothesised that both beef and mutton would at least be normal goods in China. The expenditure data may provide a better result.

Finally, the efficiency of the SUR estimates is improved by imposing Slutsky symmetry restrictions, compared with the estimates derived from the unrestricted equations. The most important improvement that was obtained estimating the restricted functions was that all the signs of the income coefficients were found to be positive. This is consistent with the idea that as income increases, a consumer buys more of most products and yet when income decreases, the opposite occurs. The magnitudes of all the income elasticities are less than one. Hence, it can be implied that pork, beef and mutton are necessities. Additionally, most standard errors are smaller than those without any restrictions. The Wald Chi-square statistics is computed to be 4.31, which is smaller than the critical value, 7.81, at the 5 per cent level of significance. Thus, it can be concluded that the Slutsky symmetry conditions are valid in the SUR models. However, the sign of the own-price elasticity in beef equation was found to be positive which is contrary with theory of demand. Furthermore, most price elasticities, and all the income elasticities, are statistically insignificant. Therefore, it is likely that the income data are unreliable and provide inappropriate estimates of the complete demand system of this study.

5.2.2 Results from using expenditure data

In empirical analyses, income elasticities of demand are sometimes estimated from observations on expenditures rather than observations of incomes (Tomek and Robinson 1991). Estimates of the Chinese meat demand sub-system model using computed expenditure data are reported in Table 5.2. What is revealed is that the unrestricted SUR estimates are more efficient than the OLS estimates, while the restricted SUR estimates are more efficient than the unrestricted ones. This is reflected in terms of smaller standard errors and correspondingly smaller variances of the estimated-sigma and other statistics regarding the "fit" of the model.

All the standard errors estimated from OLS (reported in Part A of Table 5.2) are relatively larger than those estimated from SUR, and the variances of the estimated-sigma are correspondingly larger. The DW tests from the equations estimated using OLS techniques are very small. Thus, it can be implied that autocorrelation may exist in the residuals. The R-squares are 0.91 for the pork equation, 0.49 for the beef equation and 0.07 for the mutton equation. Few of the parameter estimates are statistically significant at 5 per cent level, except the constant. The sign of income elasticity in beef equation was not as expected either.

The results from SUR with dummies and without restrictions are more efficient estimates than the OLS estimates. The R-squares increased, and now range from 0.99, 0.90 and 0.98 for pork, beef and mutton, respectively. Most standard errors became smaller and all the variances are much smaller than those estimated using OLS techniques. Most intercept dummies are very significant, indicating that a one-time shift in demand has occurred. Although a few improvements do occur, using system equations and including the six regional dummies, some signs (as described above) were not as expected and only small proportion of the estimated coefficients were significant.

Finally, the efficiency of the SUR estimates was improved by imposing restrictions among the demand elasticities of the three equations, compared with the unrestricted estimates. The results were also found to be consistent with the demand theory underlying the complete demand system. As discussed in the previous chapter, the three linear restrictions can be expressed more specifically as:

$$\begin{aligned} 0.1636\, e_{12} + e_{14} &= 0.0107 e_{21} + e_{24} \\ 0.1450\, e_{23} + e_{24} &= 0.1636\, e_{32} + e_{34} \\ 0.0107\, e_{31} + e_{34} &= 0.1450\, e_{13} + e_{14}\ , \end{aligned} \tag{5.1}$$

where the means of the budget proportion reciprocals for pork, beef and mutton are 0.0107, 0.1636 and 0.1450, respectively. The method adopted in estimating the demand functions subject to the linear restrictions is specified in Byron (1970).

The signs of income coefficients were found to be positive at 0.54 for pork, 0.52 for beef and 0.58 for mutton (see Part C in Table 5.2). They all exceed 0.5 which indicates that a relatively high degree of income sensitivity exists, which is consistent with the fact that red meat accounts for a relatively large proportion of budget share in consumer goods. To interpret these results, a 0.54 per cent increase in pork consumption will result from a one per cent increase in income, a 0.52 per cent increase in beef consumption will result from a one per cent increase in income and 0.58 per cent increase in mutton consumption will result from a one per cent increase in income. The magnitudes seem reasonable and close to each other. Consequently, those commodities can be seen to be necessities or normal goods in China, instead of luxuries. Furthermore, all of the income coefficients are statistically significant.

A rather wide range of price elasticities is reported in Part C in Table 5.2. The own-price elasticities were found to be 0.69 for pork, 0.24 for beef and 0.84 for mutton, in absolute value terms. Mutton has the highest degree of own-price sensitivity, pork also presents its stronger sensitivity to its own-price elasticities and beef shows a rather low degree of own-price sensitivity. Additionally, the cross-price elasticities were found to vary greatly. The highest cross-price relationship, of 0.86 for beef with respect to mutton, and the lowest at 0.09, was estimated for pork with respect to beef. Moreover, half of the price elasticities became significant. Hence, it could be concluded that changes in prices do affect the quantity demanded and consumption of other meat products to some degree.

It is more interesting to note that both cross-price elasticities with respect to beef in the pork equation and with respect to pork in beef equation, are negative. As usual, the substitution effect is positive for substitute commodities such as pork and beef, and negative for complementary commodities. However, these generalisations need not be true in all circumstances, particularly in the typical Chinese economy. If the income effect "outweighs" the substitution effect, there will be a net reduction in the demand for commodity i when the price of commodity j increases (Tomek and Robinson 1991). Thus, the net effect is negative even though pork and beef are substitutes when the income effect exceeds the substitution effect in China.

Table 5.3: Summary of estimated price and income elasticities

	Pork	Beef	Mutton	Income
Pork	-0.685	-0.0942	0.3849	0.5377
Beef	-0.1375	-0.2350	0.8625	0.5238
Mutton	0.4837	0.3703	-0.8382	0.5883

To summarise these results, the own-, cross-price and income elasticities of demand from the preference restricted SUR model are reported in Table 5.3. It is shown that the own-price elasticity of mutton is the strongest and beef has the lowest own-price elasticity among these three commodities. However, the income elasticities are close to each other.

In regard to the results reported in Table 5.2, it was found that all the constant and intercept dummies are significant, except some dummy variables in the beef equation. The constant intercepts in three equations are relatively large and positive which indicate rapid growth in the share of pork, beef and mutton, independent of relative price movements and income changes. The dummy variable is significant and negative in the pork equation, indicating that exogenous demand growth is slower in all the regions. Dummy results in the beef equation indicate opposite movements of exogenous demand in different regions, of which two dummies are insignificant. All the dummies are significant in the mutton equation.

The R-squares statistics remain almost the same as the unrestricted estimates and were found to be reasonably high. Whether the demand system has contemporaneous correlation needs to be tested. An appropriate test statistic is the Lagrange Multiplier Statistic suggested by Breusch and Pagan (1980). The critical value at 5 per cent for the Chi-square with three degrees of freedom is 7.81 while the calculated value was 65 (much larger than the critical value). Hence, it can be concluded that contemporaneous correlation does exist. This means that the disturbances in each equation are correlated across the three equations at the same time period. Consequently, the estimation efficiency can be improved by using SUR rather than OLS techniques.

The tests of the symmetry restrictions were conducted, both jointly and separately. The Wald Chi-square statistic from a joint restriction was estimated to be 13.73, which is close to the critical value of 11.34 at 1 per cent significance. In addition, the imposition of symmetry restrictions separately is most accepted by the Wald tests. These results are indicative that the symmetry restrictions imposed jointly should be accepted.

Overall, the results seem to reject the null hypotheses that changes in prices and income do have a significant effect on demand and consumption of red meat in China. Furthermore, the estimates of restricted SUR models by using expenditure data are more efficient and consistent using the prior information as these results are relatively reliable, especially the SUR model with restrictions (Table 5.3), can be used to make projections.

5.3 Demand projections by 2000

The final to be undertaken in this study is to draw policy implications from the empirical results, an effort should be made to predict future demand, so that policy-making becomes more precise and rational. Thus, in this section, a standard method is used to predict demand for red meat in China by 2000. The projection is based on the assumption of constant demand matrix results from the restricted SUR model. The year 2000 is chosen, not only because it can be regarded as short or medium term projection which is consistent with the static model used, but also because of its significance as a milestone for the new century.

5.3.1 Projections

The demand interrelationship matrix is developed under conditions of static equilibrium. If the demand matrix is denoted by B, then:

$$Q = X \bullet B \qquad (5.2)$$

where Q is the vector of quantities, expressed in logs;

B is the matrix of price and income elasticities, and of the dummy variables;

X is the vector of prices and expenditure expressed in logs;

This matrix where Q is a T×2 vector, X is a T×k matrix and B a K×1 vector, when T is equal to the 14 years by seven regions by the three commodities and K is equivalent to the 10 independent variables.

Predictions of the future values of the exogenous variables, in vector X are needed before demand can be forecast for next eight years. So, the forecasts in this study are conditional on these values. Thus, the exogenous variables can be projected based on the following equations:

$$P_p = P_{p0}\,(1+S_p)$$
$$P_b = P_{b0}\,(1+S_b)$$
$$P_m = P_{m0}\,(1+S_y)$$
$$Y = Y_0\,(1+S_y) \qquad (5.3)$$

where P_p, P_b, and P_m denotes projected values of CPI for pork, beef and mutton;

Y is the projected expenditure;

P_{p0}, P_{b0}, and P_{m0} denote values of CPI for pork, beef, and mutton in the base year (1992);

Y_0 is the expenditure on red meat in base year (1992); and

Sp, Sb, Sm and Sy denote average growth rates in CPI of pork, beef and mutton,and the expenditure on red meat respectively, during 1979-92.

The average growth rates were calculated to be 10.08 per cent for price of pork, 14.23 per cent for price of beef, 15.69 per cent for price of mutton and 19.57 per cent for expenditure on red meat (calculations based on State Statistical Bureau 1993 and USDA 1994). Thus, the values of projected exogenous variables can be computed, and reported in Appendix 3, in which a strong increased trend in all casual factors is detailed. Given the values of exogenous variables, the estimated vector B can be used to obtain the forecast of Q. The projected demand for pork, beef and mutton in seven regions is summarised in Appendix 4. All of these projections were computed directly by using SHAZAM Version 7.0.

In Figures 5.1 and 5.2 the demand for all of the red meat in China by 2000 is illustrated. The total demand for red meat in the year 2000 is projected to reach 55.4 million tons, which is almost double what the consumption (at 29.5 million tons) was in 1992. It is noted, moreover, that the share of pork will decline accounting for 82 per cent of red meat consumption in 2000, compared with almost 90 per cent in 1992. Demand for beef is forecast to have the highest growth rate at 19 per cent per year, while demand for pork would appear to grow at a relatively slower pace of 7.6 per cent per annum. Finally, demand for mutton is projected to increase gradually as well, at an average growth rate of 8.2 per cent per annum. Hence, demand for pork, beef and mutton in China are predicted to grow strongly by the end of this century, but each commodity will grow at a different rate.

Although the demand for red meat by the year 2000 is projected to increase greatly in China which is mainly due to a sustained high growth rate in real per capita income, much variation does exist in different regions (see Figures 5.3, 5.4 and 5.5).

Figure 5.1: Projected trends in demand for pork in China by 2000

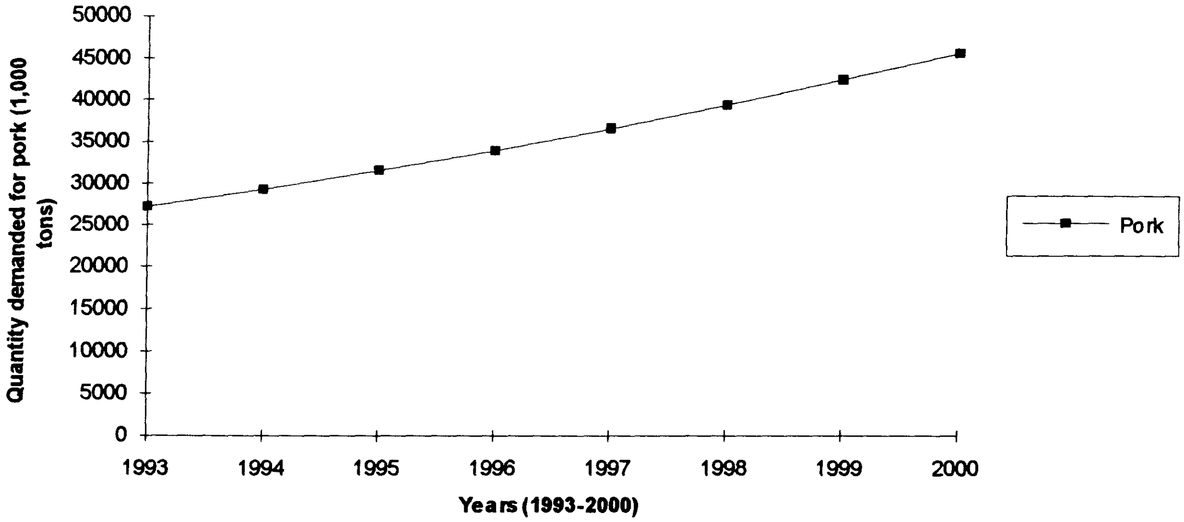


Figure 5.2: Projected trends in demand for beef and mutton in China by 2000

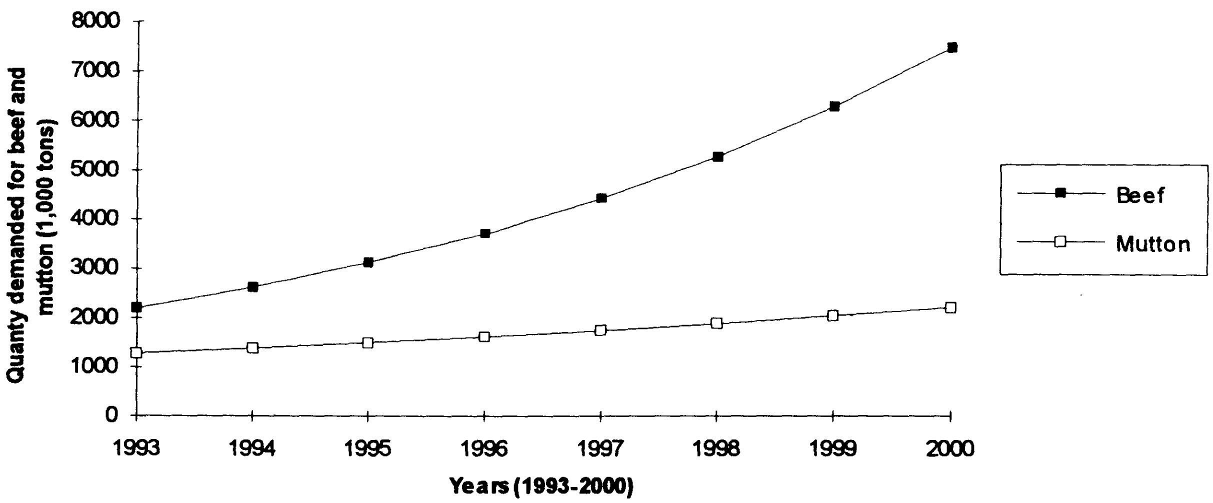


Figure 5.3: Projected regional differences in demand for pork

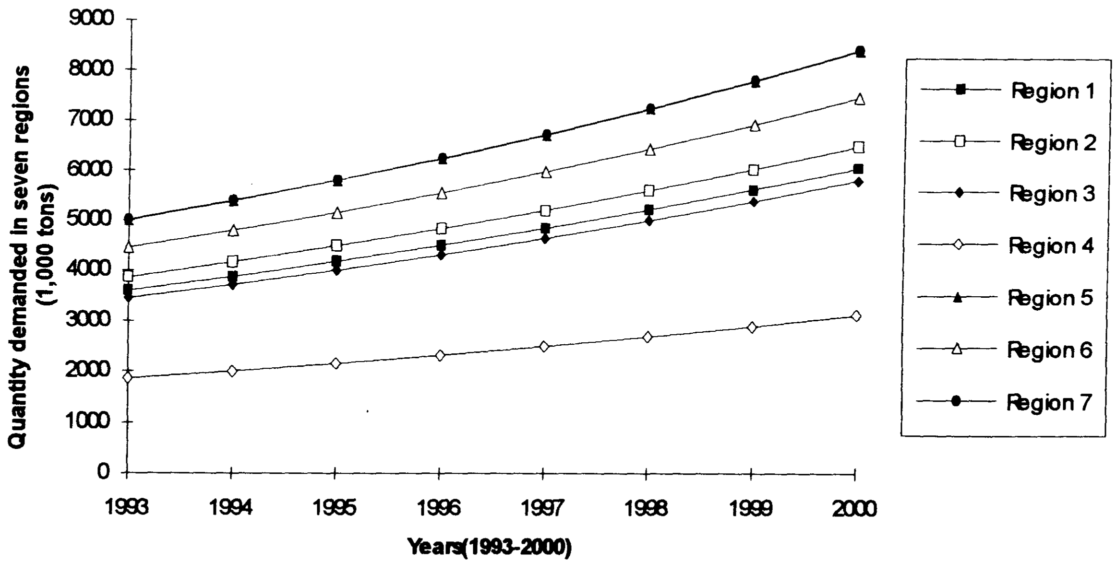


Figure 5.4: Projected regional differences in demand for beef

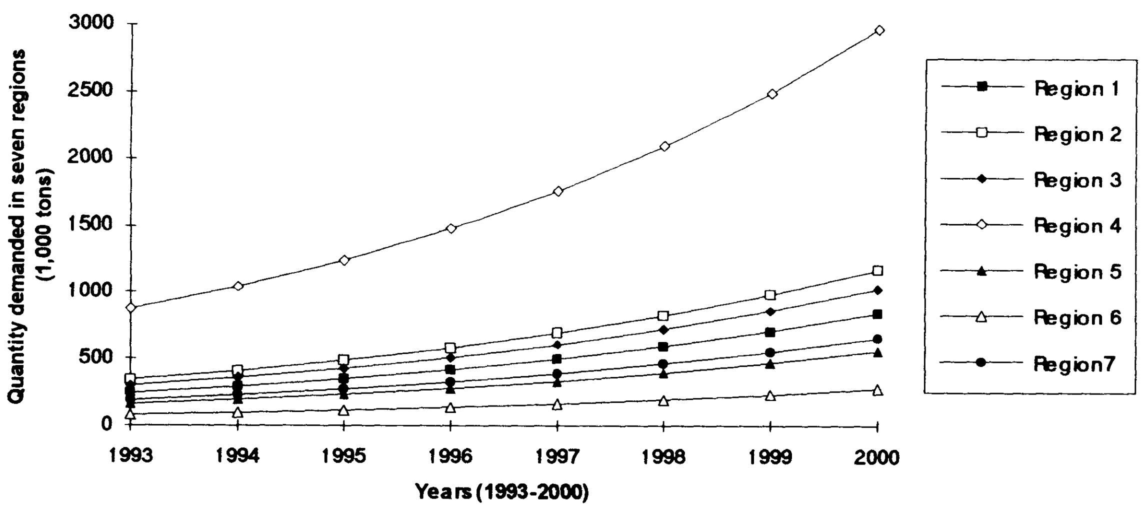
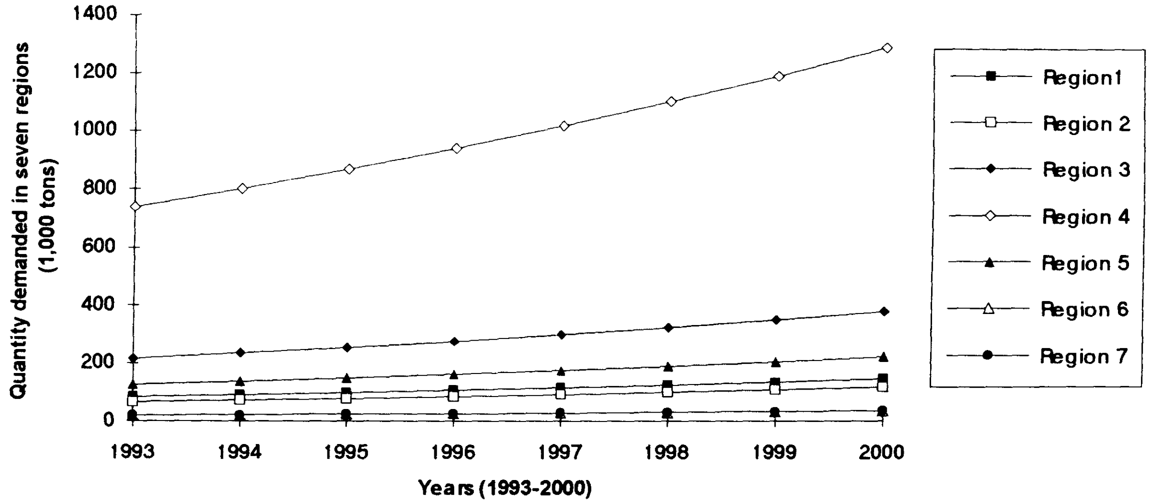


Figure 5.5: Projected regional differences in demand for mutton



The magnitude of regional disparities in demand for red meat is likely to become more significant by the year 2000, which is mainly due to increasing interprovincial income and consumption inequalities, tastes and preferences, and cultural influence, as well. For example, observing the demand for beef and mutton across the regions, the Southwest is projected to have the highest level of consumption at 2.97 million tons for beef and 12.87 million tons of mutton in year 2000, while the South has only 0.28 million tons of beef and 0.035 million tons of mutton. Despite this, the predicted demand growth rates for red meat in all regions are significant and considerable at an average of 8.83 per cent per annum in China by 2000.

5.3.2 Evaluating projections and sensitivity analysis

There are several methods of assessing forecasts. Forecast accuracy can be assessed by simple descriptive measures such as mean square errors. Although there are important differences between the various approaches to forecasting, no consensus exists to suggest which method is appropriate.

Many empirical analyses regard tests of a model's predictive accuracy as the best measure of its usefulness. Tests of a model's ability to predict have been detailed by Theil (1967), Freebairn (1975) and Holden *et al* (1990) to mention just a few. However, due to the unavailbility of required data for a test, this process is not undertaken.

It is useful to experiment with a range of assumptions in order to see how sensitive the forecasts are to the particular values chosen. In this study, two scenarios are taken into account. They involve changing real per capita income or expenditure on red meat because of its significance, and yet keeping other exogenous variables unchanged. One scenario is based on the assumption of a 50 per cent reduction in the prefered growth rate. In other words, it is assumed that the per capita expenditure on red meat would grow at 9.79 per cent instead of 19.57 per cent per annum which was used is the reference scenario. As a result, the projected demand for red meat by the year 2000 would be reduced to 36.6 million tons at a 3.81 per cent growth rate per annum.

Another scenario was undertaken, utilising the assumption that the growth rate is 50 per cent higher than the preference expenditure growth rate. That is, a growth rate at 29.35 per cent is applied to compute the values of expenditure. Consequently, demand for red meat by the year 2000 is projected to increase by up to 75.8 million tons, a growth rate of 13.2 per cent per annum.

The results of these two scenarios and the reference one which is recommended in this study are summarised in Table 5.4. Thus, the sensitivity analysis indicates that changes in real per capita income or expenditure do produce a great impact on changes in quantity demanded for red meat in China by the year 2000.

Table 5.4: Summary of three scenarios on demand projections for red meat in China (1,000 tons)

	Low scenario	Reference scenario	High scenario
1993	29335.998	30716.274	32046.732
1994	30402.791	33330.412	36279.772
1995	31532.253	36193.672	41101.476
1996	32730.668	39334.41	46165.177
1997	34005.271	42784.879	52258.973
1998	35300.871	46581.937	59157.157
1999	36645.834	50767.748	66965.901
2000	38042.04	55390.665	75805.399
Assumed growth rate in expenditure	9.79 %	19.57 %	29.35 %
Projected growth rate of demand	3.81 %	8.83 %	13.2 %

However, as six dummy variables are incorporated in the models (4.7) to adjust regional differences, and regional production data were used to approximate the consumption in the past decade, forecasting errors may exist as well.

5.4 Summary

This Chapter has focused on reporting and interpreting the empirical results. It can be concluded that the null hypotheses presented in Chapter 1 should be rejected. The results also indicate that red meat in China are necessities instead of luxuries. As well, projections on demand for red meat between 1993 and 2000 have been made. Meanwhile, projections evaluation and sensitivity analysis in terms of changes in income or expenditure were briefly discussed. Based on these projections, the demand for red meat by 2000 will grow significantly, which is unlikely met by domestic production by then.

6. Policy Implications

6.1 Introduction

As was discussed in Chapter 5, the demand for red meat by the year 2000 is projected to increase considerably in China. This projection was based on the assumption of a constant demand matrix and resulted from the results of the restricted SUR model. This indicates that maintaining reasonable growth rates in red meat production in coming years to meet the perspective excess demand will be a critical issue because of the continuous population growth and income increases. In this Chapter, the implication that arise from the results are discussed. Thus, the research problem is briefly restated in Section 6.2. In Section 6.3 policy implications are suggested and assessed. Then, two alternative measures are discussed in detail in Sections 6.4 and 6.5 respectively. Finally, summary of this Chapter is made briefly in Section 6.6.

6.2 Restatement of the problem

It is well known that China is a densely populated country. It has 22 per cent of the world's population crowded onto 7.13 per cent of the world's land area. Only a little over 11 per cent of China's total area is cultivated. Moreover, due to the urbanisation and commercialisation that has occurred in the past decade, the average cultivated area fallen to 0.086 hectares per head in 1994 (Lu 1995). Nevertheless, China is currently the world's leading pork producer and the second largest total meat producer, after the United States. Yet, on the other hand, annual per capita consumption of meat is still low in China compared with world averages.

It is important to recognise that China is a large and diverse country. Natural endowments, production patterns, income and marketing infrastructures vary from region to region and from province to province. Consequently, patterns of red meat consumption per person will not be necessarily be uniform across regions. Thus, the impact this regionalisation may have on overall food consumption pattern is of considerable importance when assessing future demand for red meat. In all regions of China, the demand for enough to eat has given way to a demand for better quality food with high protein like pork, beef and mutton.

Although the growth of red meat production is expected to continue, the rate at which this occurs will be much slower as natural endowments are being exhausted rapidly in China. For example, grain output is depend on the cultivated area available. Grain output is also the foundation of livestock development. Yet grain output has been stagnant in recent years and is expected to increase much more slowly during the rest of this century (Tuan 1993). Meanwhile, a sustained increase in per capita income combined with fewer controls on the meat market is projected to raise total red meat consumption to 55.4 million tons by the year 2000 (see Chapter 5). The total population of China is projected to reach 1.3 billion in the year 2000. Thus, the consumption of red meat in China by then will be 42 kg per head, which is double than that of 1992, and similar to the level consumed in Taiwan in the 1970s.

6.3 Policy implications

As a result of the rapid increase in demand, the consumption of red meat is unlikely met by domestic production by the year 2000. With this projected increase in meat demand, China may face the choice of either importing meat or feedgrain or improving production and marketing efficiency or inclusivenesses to meet the continuous increased demand for red meat.

To deal with the dilemma described above, two general aspects are usually analysed within a complete demand systems context. One pertains to policies that use prices as the instruments for change, and the other uses quantities as the instruments. In this study, it was found that changes in prices and income have a significant effect on demand and consumption of red meat in China. But, the degree of price sensitivity is not uniform between pork, beef and mutton. Mutton demand was found to be most responsive to mutton prices, and beef demand was also found to be most responsive to mutton prices. Pork demand was found to be less responsive to pork prices. These inconsistencies make policy designs a complex process. However, two alternatives would appear to exist which may alleviate the situation confronting the Chinese government of a constrained domestic supply and yet a continuous growth in the demand for red meat by the year 2000. They are the importation of meat or grains, to satisfy demand or undertake a range of domestic measures.

6.4 Importing Meat or Feedgrain?

Given the extreme constraints in natural endowments in China the potential to develop livestock industry, particular beef and mutton which depend on more arable land for pasture, is becoming less and less possible mainly due to recently rapid urbanisation and commercialisation. On the other hand pork output, which holds a dominant and extremely important position in red meat production in China, and grain output are highly correlated. The grain-pork conversion ratio is usually 1:4 in China, indicating that 1 kilogram of pork requires 4 kilograms of grain (Tuan 1993). Consequently, given a projected demand for pork in year 2000 of 45.7 million tons in year 2000 will require an equivalent of 182.8 million tons of grain for pig feed. This implies that China will experience great difficulty in generating sufficient domestic supplies of feed-grain to meet its requirements. In addition, the subsequent slow down and even negative growth in 1994 (of -2.5 per cent) in grain production will worsen the feed supply situation (State Statistical Bureau 1995). Therefore, to overcome these difficulties, China can either directly import red meat, mainly beef and mutton, or feedgrain from those countries who have comparative advantages in those industries. However, foreign currencies will need to be available. The evidence from other rapidly growing developing countries is that importing feedgrains is more likely than importing meat, particularly at the initial stages of expansion in red meat demand associated with rapid income growth.

6.5 Internal potential avenues

The Chinese policy makers would be horrified by the prospect of depending on meat and feedgrain imports. For this to be avoided, an alternative may be to increase the productivity growth of red meat production, mainly by improving pricing structures, encouraging interregional trade, developing marketing infrastructure and establishing a good information system.

6.5.1. Pricing structure

Although livestock products like pork, beef and mutton were the first agricultural commodities in which government procurement and retail sales price were liberalised, the structure of these aspects needs to be made more rational. This can be achieved by accounting for the different demand elasticities and regional conditions.

In this context, the fact that both beef and mutton demand are very responsive to mutton prices indicates that pricing structure for mutton should be regulated and adjusted very carefully to reduce consumers' excess demand. On the other hand, if the procurement of and the retail sales prices are sufficiently high, individual farmers and livestock enterprises will invest more in the establishment or the expansion of modern livestock production and feed manufacturing operations. Furthermore, pork, beef and mutton prices should be differentiated among regions and seasons. Poultry meat prices should be cheaper than red meat, in order to reflect red meat production costs and help promote non-red meat consumption. In this way, disequilibrium between demand and supply for red meat could be eased to some extent.

6.5.2 Specialisation on red meat production

The rapid development of the livestock sector over recent years has been aided by both central and local governments investing in the establishment or expansion of modern specialised production enterprises. Despite this, the majority of China's livestock production still remains relatively undeveloped. The red meat industry, mainly pork, is dominated by small scale and semi-commercial sideline production systems. Thus, to alleviate supply shortages and achieve continuous increased production, farmers and enterprises should be encouraged to develop large-scale, commercial and specialised operations. If specialised red meat production can reach a proper production scale, production efficiency would increase greatly. As its main objectives are to produce red meat for the market and to make a profit, the specialised enterprises can be made responsible for adjusting to market signals and can promote the development of the meat market as well. This is particularly true recently since the market-oriented economic system has been gradually established in China.

In addition, specialised meat producers are usually more willing to adopt new technology. By obtaining good genetic lines, red meat productivity can be enhance. Meanwhile, producers should be able to set aside part of their profits in order to improve production, enlarge scale, improve raising facilities and gradually move towards modern "factory" production.

6.5.3 Promoting interregional trade in red meat

Since the natural conditions and the size of the regions differ greatly, red meat production varies considerably. As well, since 1979 a campaign to enhance the decision-making powers of production units was initiated and that shift was accompanied by a rediscovery of the principle of comparative advantage and the encouragement of specialised production. The movement towards regional specialisation has increased the agricultural productivity generally, but the output of red meat has become more differentiated across regions and even declined in some regions. For example, pork production in the Central and the Southwest reached 4.95 million tonnes and 5.95 million tonnes respectively in 1992, while in the Northeast and the Northwest only 1.82 and 1.32 million tonnes were produced in the same year (State Statistical Bureau 1993). On the contrary, beef and mutton production which is highly depend on pasture are mostly centralised in the pastoral regions like North and Northwest where are relatively sparsely populated. Although a few beef production units have been established near the large cities, the serious shortage in supply still exist in non-pastoral regions. Thus, interregional trade in red meat should be promoted and facilitated so that a shortage in supply of red meat in some regions can be eased and then allocation of resource can become more efficient.

During the 1980s, interregional trading was blocked by local governments, especially when a red meat shortage occurred. In the pork crisis of 1987, Dongxiang county in Jiangxi province set up a check station on the borders with Guangdong and Fujian provinces and the private traders involved in interprovincial pig trading were fined. In Fenghua county of Zhejiang province, private traders from other regions were forbidden to purchase pigs in the area (Xiao 1988). When the authorities realised that supplies were not secure from other regions, they began to encourage production by insisting on meat self sufficiency even if there is no comparative advantage in meat production at all. As a result, the productivity declined and meat prices become even higher, particularly after the Chinese government eliminated urban consumption subsidies in 1993.

According to the projections made in this study, the consumption of red meat across regions will become more varied by the year 2000 (see Figures 5.3, 5.4 and 5.5). This requires an even more easy and smooth flow of interregional trade for red meat in China. Thus, full liberalisation should be given to interprovincial or interregional trade to bring efficiency gains and to offset one's weaknesses so that the disparity can be lessened from region to region and from province to province.

6.5.4 Improving marketing infrastructure

For greater interregional trade for red meat to occur, in turn, largely depends on the availability of marketing infrastructure such as transportation, storage and processing plants. Deficiencies in China's transportation facilities, the lack of cold storage and the shortage of holding pens for live animals have constituted a major bottleneck and often caused procurement stations or private traders to limit their purchases of red meat.

Because of past policies, which emphasised local self-sufficiency and the relative neglect of local transportation networks, the problems of transport in China have become acute. Although improvements have been made in road conditions and capacities of both truck and train facilities have increased in recent years, more meat transport vehicles would put additional stress on China's rural road system including remote and mountainous regions, which is already over-burdened. As a result, a substantial amount of red meat have not be moved to deficit regions. Thus, an improvement of transportation and road networks is essential if interregional trade is to be fully liberalised.

A lack of adequate investment in storage facilities in the past, despite the surge in production in recent years, has created an increasingly serious red meat storage problem. Cold storage capacity, especially in rural China where more meat is produced, is much less than required. When red meat production increases, the procurement stations at times have to refuse to purchase it simply because their storage is full.

The red meat processing industry is also under developed. Thus, as relative red meat surplus occurred in some regions, while meat shortage was dominate in other regions the marketing infrastructure was not sufficiently developed to send processed meat between them. Therefore, at the national level, an inadequate physical infrastructure for trade has been a major problem in red meat marketing, particularly since China has gradually moved towards market-oriented economy recently.

6.5.5 Establishing a better and symmetric information system

A modern information system which provides producers and consumers with timely and accurate information on prices and supplies is critical to the development of the livestock sector. Without a good system, false information seriously undermines both regional and national livestock products markets. Regular national and regional surveys of livestock raising plans, as well as exchanges of technical information and farm management experience are disseminated through a good information system. These are badly needed in China, particularly in rural and remote regions.

Furthermore, the current decentralisation and marketisation in the Chinese economy requires symmetric information instead of traditional information asymmetry in the multilevel control livestock system. Thus, a healthy symmetric information system can strengthen the tendency for competition, which is the characteristic of a market-oriented economy, rather than one which promotes collusion.

Finally, it must be realised that the introduction of market mechanism is not a panacea which can cure all diseases in a socialist economy. The market mechanism, if not carefully prepared and regulated, could turn into a wild horse. Just as much effort has to be poured into the introduction of market mechanisms, the information transmission mechanisms of the planning system, so that the red meat market can be moved more towards a stable equilibrium.

6.6 Summary

The policy implications discussed above can be summarised into two aspects-external policies and internal measures. External policies are more direct, but less applicable in China as they could induce a series of problems such as increased foreign deficits and higher unemployment which are of concern to the Chinese government. On the other hand, internal policies are more difficult to be implemented, but can help to ease the disequilibrium between demand and supply for red meat. Except for what has been discussed in the previous sections, more measures can be considered, such as making better use of available pasture and intensified economic research. However, these could also give rise to some side effects, like environmental problem by over-grazing.

7. Summary, Limitations and Suggestions for Future Research

7.1 Introduction

If the sensitivity analysis conducted in Chapter 5 is anything to go by, continuing income growth in China by the year 2000 would produce a considerable change in Chinese food consumption patterns. This would mostly be reflected in the continuous rapid growth of red meat demand in China. The policy issues that were addressed in Chapter 6 deal with the dilemma of an excess demand and a probable deficit supply for red meat. In this Chapter, a summary of the study is provided. In addition, the limitations of this study are discussed and directions for future research are suggested.

7.2. Summary of findings

In this study the demand and consumption trends for red meat in China between 1979 and 1992 were examined. The following hypotheses were tested.

- Changes in income have no significant effect on the demand and consumption of red meat between 1979 and 1992;
- Changes in prices have no significant effect on the demand and consumption of red meat in China between 1979-1992.

The seemingly unrelated regression procedure was adopted as an appropriate least square estimator of the Double Logarithm model of retail demand for red meat under the Slutsky symmetry restrictions. It was found that both the effects of changes in prices and income were significant in the demand for red meat in China. It is also interesting to note that income elasticities are positive and less than one, which is indicative of the fact that pork, beef and mutton are necessities in China. From these findings, the argument made by most western economists that red meat in China is a luxuries can be rejected. Thus these two hypotheses were rejected.

Based on these results, if economic growth and development proceeds, red meat demand in China was projected to reach 55.4 million tons by the year 2000, an annual growth rate of 8.6 per cent. Red meat consumption per person is forecast to rise to 42 kg by the year 2000 if population reaches 1.3 billion. It is also projected that demand for red meat will increase at a different rate for each commodity. The rates of growth of pork, beef and mutton per annum were projected to be 7.6 per cent, 19 per cent and 8.2 per cent respectively. The magnitude of regional disparities in demand for red meat is likely to become more significant towards 2000 (see Figures 5.3, 5.4 and 5.5).

Given this projected increase in red meat demand, China may have to confront the dilemma resulting from a constrained domestic supply and a continuously increased demand for red meat. In order to alleviate this difficulty, both external and internal avenues have been proposed. They are the importation of meat or feed grains, to satisfy demand or undertake a range of domestic measures such as improving pricing structure, specialisation on red meat production, promoting interregional trade, improving marketing infrastructure and establishing a better and symmetric information system. Whether the policy designers are biased towards external or internal channels would have a considerable effect on world food market.

7.3. Limitations of the study

In this study, data limitations restricted the scope to certain aspects of the demand. Regional production data on pork, beef and mutton were used as a proxy variable for domestic consumption for red meat. Even though both demand and consumption are very close to each other, the empirical results will not be as precise as one would like. There was no alternative but to use national prices in place of regional prices because it was unavailable. This could lead to the estimation of inappropriate price elasticities which may not fully explain demand responsiveness.

Changes in the demand for red meat can be influenced in addition to prices of pork, beef and mutton and income, but by the prices of chicken and eggs as well. These poultry products are likely to be the closest substitutes for red meat in China. Meanwhile, sociodemographics and cultural factors may also affect red meat consumption patterns as well. Inclusion of these as independent variables in a system equations model would most possibly provide better estimates of red meat consumption behaviour in China. Unfortunately, those data were either unavailable or a full continuous survey was not available. In addition, the sociodemographic and cultural variables can not be measured directly.

China had been dominated by government who centrally plans economies. Since 1979, the Chinese government has gradually relaxed its control over production planning and consumption rationing. The market-oriented economy is beginning to dominate in China. However, there is still some degree of state intervention, notably in agriculture. Consequently, the markets in China are not completely competitive, which leads to a suboptimal competitive equilibrium (Innes and Rausser 1989). However, it should be noted that government policies are themselves the outcome of the demand pressure which forces the government to find the means to solve the emerging red meat shortage problem.

This study would have been much conclusive if these limitations were overcome. However, they do not reduce the usefulness of the results which, as in the case of all these types of study, are derived from only an approximation of the relationships.

7.4. Suggestions for future research

Future research in this area should be directed towards the limitations identified from the present study, which is mentioned in the previous section. The quality of this study could be improved by using domestic disappearance and cross-sectional regional prices data, and could be based on alternative models such as the AIDS model, if the Chinese economy's typicality is taken into account.

The effects of changes in income and regional differences on the quantities consumed were analysed in detail. It was also pointed out that some other variables such as age distribution, education and religion may also influence consumption. Although it may be difficult to obtain data on all these factors, some of them can be obtained. For example, the 1992 census obtained data on age distribution and education and the complete set of data may be available in the next few years. These data will provide an excellent source of material for analysing the effect of sociodemographics on the demand and the interactions of these factors and regions have on consumption behaviour. Isolation of other similar factors will contribute towards a better understanding of consumption behaviour.

The next main area of research could be undertaken on comparing the empirical results estimated from different models to determine which model best explains the Chinese consumers' behaviour. Among a wide variety of demand system, the AIDS model might be prefered because of its advantages and applicability.

Appendix 1

Data: Regional production of, national consumer price indecies of pork, beef and mutton and real per capita income per annum

Regions/Years	Qp (1,000 tons)	Qb	Qm	Pp (Yuan/kg)	Pb	Pm (100 yuan)	Y
Northeast							
1979	880.0000	21.00000	8.000000	1.000000	1.000000	1.000000	3.530000
1980	1007.000	28.00000	12.00000	1.090000	1.210000	1.180000	3.830000
1981	1031.000	25.00000	13.00000	1.190000	1.340000	1.270000	4.220000
1982	1097.000	26.00000	19.00000	1.190000	1.440000	1.280000	4.650000
1983	1078.000	20.00000	17.00000	1.240000	1.470000	1.340000	5.130000
1984	1084.000	17.00000	18.00000	1.270000	1.770000	1.640000	5.660000
1985	1139.000	28.00000	17.00000	1.450000	2.140000	2.130000	5.910000
1986	1198.000	50.00000	16.00000	1.630000	2.610000	2.600000	8.190000
1987	1149.000	70.00000	18.00000	1.870000	3.080000	2.970000	8.090000
1988	1258.000	81.00000	19.00000	2.400000	3.400000	3.590000	8.770000
1989	1328.000	86.00000	22.00000	2.630000	3.960000	4.120000	9.460000
1990	1525.000	122.0000	34.00000	2.970000	4.550000	4.590000	11.82000
1991	1702.000	167.0000	39.00000	3.240000	5.320000	5.640000	13.09000
1992	1824.000	216.0000	45.00000	3.420000	5.610000	6.410000	14.67000
North							
1979	1828.000	18.00000	63.00000	1.000000	1.000000	1.000000	3.610000
1980	2111.000	22.00000	84.00000	1.090000	1.210000	1.180000	4.000000
1981	2186.000	25.00000	107.0000	1.190000	1.340000	1.270000	4.410000
1982	2190.000	21.00000	119.0000	1.190000	1.440000	1.280000	4.860000
1983	2131.000	42.00000	144.0000	1.240000	1.470000	1.340000	5.360000
1984	2418.000	64.00000	157.0000	1.270000	1.770000	1.640000	5.910000
1985	2838.000	109.0000	148.0000	1.450000	2.140000	2.130000	6.470000
1986	3068.000	150.0000	158.0000	1.630000	2.610000	2.600000	9.130000
1987	2993.000	232.0000	195.0000	1.870000	3.080000	2.970000	9.510000
1988	3399.000	305.0000	263.0000	2.400000	3.400000	3.590000	10.17000
1989	3759.000	368.0000	325.0000	2.630000	3.960000	4.120000	10.82000
1990	4089.000	455.0000	374.0000	2.970000	4.550000	4.590000	12.88000
1991	4505.000	545.0000	399.0000	3.240000	5.320000	5.640000	14.93000
1992	4913.000	683.0000	426.0000	3.420000	5.610000	6.410000	17.16000
Northwest							
1979	483.0000	78.00000	173.0000	1.000000	1.000000	1.000000	3.490000
1980	529.0000	99.00000	204.0000	1.090000	1.210000	1.180000	4.000000
1981	583.0000	88.00000	201.0000	1.190000	1.340000	1.270000	4.410000
1982	587.0000	95.00000	233.0000	1.190000	1.440000	1.280000	4.410000
1983	593.0000	120.0000	243.0000	1.240000	1.470000	1.340000	4.860000
1984	633.0000	139.0000	268.0000	1.270000	1.770000	1.640000	5.360000
1985	782.0000	145.0000	275.0000	1.450000	2.140000	2.130000	5.910000

Appendix 1. continued.

1986	875.0000	169.0000	290.0000	1.630000	2.610000	2.600000	6.160000
1987	891.0000	215.0000	321.0000	1.870000	3.080000	2.970000	8.190000
1988	939.0000	233.0000	314.0000	2.400000	3.400000	3.590000	9.090000
1989	1023.000	268.0000	387.0000	2.630000	3.960000	4.120000	9.490000
1990	1115.000	281.0000	418.0000	2.970000	4.550000	4.590000	11.54000
1991	1206.000	319.0000	479.0000	3.240000	5.320000	5.640000	13.59000
1992	1321.000	348.0000	492.0000	3.420000	5.610000	6.410000	15.04000

<u>East</u>

1979	2154.000	13.00000	50.00000	1.000000	1.000000	1.000000	3.540000
1980	2383.000	15.00000	52.00000	1.090000	1.210000	1.180000	4.290000
1981	2279.000	11.00000	53.00000	1.190000	1.340000	1.270000	4.730000
1982	2603.000	15.00000	53.00000	1.190000	1.440000	1.280000	5.220000
1983	2516.000	18.00000	49.00000	1.240000	1.470000	1.340000	5.760000
1984	2613.000	29.00000	47.00000	1.270000	1.770000	1.640000	6.350000
1985	2957.000	37.00000	53.00000	1.450000	2.140000	2.130000	7.360000
1986	3047.000	52.00000	58.00000	1.630000	2.610000	2.600000	9.660000
1987	2922.000	73.00000	73.00000	1.870000	3.080000	2.970000	10.74000
1988	3170.000	90.00000	87.00000	2.400000	3.400000	3.590000	11.75000
1989	3240.000	98.00000	107.0000	2.630000	3.960000	4.120000	12.77000
1990	3414.000	122.0000	116.0000	2.970000	4.550000	4.590000	15.19000
1991	3497.000	136.0000	121.0000	3.240000	5.320000	5.640000	17.61000
1992	3717.000	138.0000	133.0000	3.420000	5.610000	6.410000	20.91000

<u>Central</u>

1979	1582.000	18.00000	9.000000	1.000000	1.000000	1.000000	2.940000
1980	1817.000	18.00000	13.00000	1.090000	1.210000	1.180000	3.410000
1981	1909.000	13.00000	12.00000	1.190000	1.340000	1.270000	3.760000
1982	2002.000	13.00000	11.00000	1.190000	1.440000	1.280000	4.150000
1983	2079.000	13.00000	10.00000	1.240000	1.470000	1.340000	4.580000
1984	2477.000	15.00000	11.00000	1.270000	1.770000	1.640000	5.050000
1985	2939.000	16.00000	11.00000	1.450000	2.140000	2.130000	5.750000
1986	3360.000	18.00000	10.00000	1.630000	2.610000	2.600000	8.420000
1987	3530.000	23.00000	12.00000	1.870000	3.080000	2.970000	8.870000
1988	3875.000	38.00000	15.00000	2.400000	3.400000	3.590000	9.310000
1989	4030.000	33.00000	17.00000	2.630000	3.960000	4.120000	9.750000
1990	4240.000	39.00000	16.00000	2.970000	4.550000	4.590000	11.51000
1991	4535.000	57.00000	19.00000	3.240000	5.320000	5.640000	13.27000
1992	4951.000	74.00000	21.00000	3.420000	5.610000	6.410000	15.35000

<u>South</u>

1979	1185.000	16.00000	6.000000	1.000000	1.000000	1.000000	3.490000
1980	1301.000	14.00000	5.000000	1.090000	1.210000	1.180000	3.750000
1981	1380.000	14.00000	6.000000	1.190000	1.340000	1.270000	4.140000
1982	1563.000	17.00000	6.000000	1.190000	1.440000	1.280000	4.570000
1983	1729.000	18.00000	5.000000	1.240000	1.470000	1.340000	5.040000
1984	1878.000	23.00000	7.000000	1.270000	1.770000	1.640000	5.560000
1985	2019.000	35.00000	7.000000	1.450000	2.140000	2.130000	6.560000
1986	2160.000	42.00000	7.000000	1.630000	2.610000	2.600000	9.090000
1987	2343.000	51.00000	7.000000	1.870000	3.080000	2.970000	9.320000
1988	2615.000	62.00000	10.00000	2.400000	3.400000	3.590000	10.64000
1989	2791.000	64.00000	10.00000	2.630000	3.960000	4.120000	11.97000

Appendix 1. continued.

1990	3065.000	75.00000	12.00000	2.970000	4.550000	4.590000	15.15000
1991	3351.000	94.00000	15.00000	3.240000	5.320000	5.640000	18.33000
1992	3638.000	132.0000	17.00000	3.420000	5.610000	6.410000	21.79000

Southwest

1979	1902.000	66.00000	72.00000	1.000000	1.000000	1.000000	3.330000
1980	2192.000	71.00000	75.00000	1.090000	1.210000	1.180000	3.700000
1981	2461.000	72.00000	83.00000	1.190000	1.340000	1.270000	4.080000
1982	2616.000	77.00000	81.00000	1.190000	1.440000	1.280000	4.500000
1983	2917.000	84.00000	75.00000	1.240000	1.470000	1.340000	4.960000
1984	3275.000	88.00000	76.00000	1.270000	1.770000	1.640000	5.470000
1985	3786.000	97.00000	81.00000	1.450000	2.140000	2.130000	6.770000
1986	4157.000	108.0000	82.00000	1.630000	2.610000	2.600000	6.850000
1987	4422.000	128.0000	91.00000	1.870000	3.080000	2.970000	9.250000
1988	4920.000	149.0000	94.00000	2.400000	3.400000	3.590000	9.990000
1989	5057.000	155.0000	94.00000	2.630000	3.960000	4.120000	10.72000
1990	5363.000	162.0000	98.00000	2.970000	4.550000	4.590000	13.23000
1991	5727.000	184.0000	109.0000	3.240000	5.320000	5.640000	15.74000
1992	5949.000	212.0000	116.0000	3.420000	5.610000	6.410000	19.88000

Note: Qp, Qb and Qm denote annual quantity of production for pork, beef and mutton; Pp, Pb and Pm denote retail price indices for pork, beef and mutton annually; Y denotes annual per capita income in real term.

Source: China State Statistical Bureau 1992 and 1993, China Statistical Information Service Centre 1990, Jiangsu Statistical Bureau 1992 and ERS, USDA 1994.

Appendix 2

Data: Regional production of, national consumer price indecies of pork, beef and mutton and real per capita expenditure on red meat per annum

Regions/Years	(1,000 tons) Qp	Qb	Qm	(yuan/kg) Pp	Pb	Pm	(yuan) Ym
Northeast							
1979	880.0000	21.00000	8.000000	1.000000	1.000000	1.000000	8.911765
1980	1007.000	28.00000	12.00000	1.090000	1.210000	1.180000	10.80821
1981	1031.000	25.00000	13.00000	1.190000	1.340000	1.270000	12.51863
1982	1097.000	26.00000	19.00000	1.190000	1.440000	1.280000	13.41698
1983	1078.000	20.00000	17.00000	1.240000	1.470000	1.340000	13.68374
1984	1084.000	17.00000	18.00000	1.270000	1.770000	1.640000	13.97169
1985	1139.000	28.00000	17.00000	1.450000	2.140000	2.130000	16.06324
1986	1198.000	50.00000	16.00000	1.630000	2.610000	2.600000	20.04566
1987	1149.000	70.00000	18.00000	1.870000	3.080000	2.970000	22.53206
1988	1258.000	81.00000	19.00000	2.400000	3.400000	3.590000	28.37814
1989	1328.000	86.00000	22.00000	2.630000	3.960000	4.120000	33.30934
1990	1525.000	122.0000	34.00000	2.970000	4.550000	4.590000	51.32625
1991	1702.000	167.0000	39.00000	3.240000	5.320000	5.640000	64.36229
1992	1824.000	216.0000	45.00000	3.420000	5.610000	6.410000	73.41831
North							
1979	1828.000	18.00000	63.00000	1.000000	1.000000	1.000000	18.71569
1980	2111.000	22.00000	84.00000	1.090000	1.210000	1.180000	22.89368
1981	2186.000	25.00000	107.0000	1.190000	1.340000	1.270000	27.05791
1982	2190.000	21.00000	119.0000	1.190000	1.440000	1.280000	27.36663
1983	2131.000	42.00000	144.0000	1.240000	1.470000	1.340000	28.54325
1984	2418.000	64.00000	157.0000	1.270000	1.770000	1.640000	33.47879
1985	2838.000	109.0000	148.0000	1.450000	2.140000	2.130000	42.86397
1986	3068.000	150.0000	158.0000	1.630000	2.610000	2.600000	54.74660
1987	2993.000	232.0000	195.0000	1.870000	3.080000	2.970000	64.21827
1988	3399.000	305.0000	263.0000	2.400000	3.400000	3.590000	85.55924
1989	3759.000	368.0000	325.0000	2.630000	3.960000	4.120000	107.6609
1990	4089.000	455.0000	374.0000	2.970000	4.550000	4.590000	156.0357
1991	4505.000	545.0000	399.0000	3.240000	5.320000	5.640000	191.8947
1992	4913.000	683.0000	426.0000	3.420000	5.610000	6.410000	221.6769
Northwest							
1979	483.0000	78.00000	173.0000	1.000000	1.000000	1.000000	7.196078
1980	529.0000	99.00000	204.0000	1.090000	1.210000	1.180000	8.840755
1981	583.0000	88.00000	201.0000	1.190000	1.340000	1.270000	10.41953
1982	587.0000	95.00000	233.0000	1.190000	1.440000	1.280000	11.12434
1983	593.0000	120.0000	243.0000	1.240000	1.470000	1.340000	12.19054
1984	633.0000	139.0000	268.0000	1.270000	1.770000	1.640000	14.48891
1985	782.0000	145.0000	275.0000	1.450000	2.140000	2.130000	18.65763
1986	875.0000	169.0000	290.0000	1.630000	2.610000	2.600000	24.72962
1987	891.0000	215.0000	321.0000	1.870000	3.080000	2.970000	30.58472
1988	939.0000	233.0000	314.0000	2.400000	3.400000	3.590000	35.21570

Appendix 2 continued.

1989	1023.000	268.0000	387.0000	2.630000	3.960000	4.120000	45.38379
1990	1115.000	281.0000	418.0000	2.970000	4.550000	4.590000	63.74848
1991	1206.000	319.0000	479.0000	3.240000	5.320000	5.640000	80.71992
1992	1321.000	348.0000	492.0000	3.420000	5.610000	6.410000	91.30759

East

1979	2154.000	13.00000	50.00000	1.000000	1.000000	1.000000	21.73529
1980	2383.000	15.00000	52.00000	1.090000	1.210000	1.180000	25.25453
1981	2279.000	11.00000	53.00000	1.190000	1.340000	1.270000	27.28574
1982	2603.000	15.00000	53.00000	1.190000	1.440000	1.280000	31.27586
1983	2516.000	18.00000	49.00000	1.240000	1.470000	1.340000	31.64493
1984	2613.000	29.00000	47.00000	1.270000	1.770000	1.640000	33.53035

to be continued

1985	2957.000	37.00000	53.00000	1.450000	2.140000	2.130000	41.17390
1986	3047.000	52.00000	58.00000	1.630000	2.610000	2.600000	49.55783
1987	2922.000	73.00000	73.00000	1.870000	3.080000	2.970000	55.03998
1988	3170.000	90.00000	87.00000	2.400000	3.400000	3.590000	69.42051
1989	3240.000	98.00000	107.0000	2.630000	3.960000	4.120000	79.37284
1990	3414.000	122.0000	116.0000	2.970000	4.550000	4.590000	109.9620
1991	3497.000	136.0000	121.0000	3.240000	5.320000	5.640000	123.7730
1992	3717.000	138.0000	133.0000	3.420000	5.610000	6.410000	136.0422

Central

1979	1582.000	18.00000	9.000000	1.000000	1.000000	1.000000	15.77451
1980	1817.000	18.00000	13.00000	1.090000	1.210000	1.180000	19.03443
1981	1909.000	13.00000	12.00000	1.190000	1.340000	1.270000	22.50361
1982	2002.000	13.00000	11.00000	1.190000	1.440000	1.280000	23.70147
1983	2079.000	13.00000	10.00000	1.240000	1.470000	1.340000	25.71892
1984	2477.000	15.00000	11.00000	1.270000	1.770000	1.640000	31.03482
1985	2939.000	16.00000	11.00000	1.450000	2.140000	2.130000	39.69871
1986	3360.000	18.00000	10.00000	1.630000	2.610000	2.600000	52.35642
1987	3530.000	23.00000	12.00000	1.870000	3.080000	2.970000	62.51240
1988	3875.000	38.00000	15.00000	2.400000	3.400000	3.590000	80.02574
1989	4030.000	33.00000	17.00000	2.630000	3.960000	4.120000	91.67759
1990	4240.000	39.00000	16.00000	2.970000	4.550000	4.590000	125.7952
1991	4535.000	57.00000	19.00000	3.240000	5.320000	5.640000	146.7813
1992	4951.000	74.00000	21.00000	3.420000	5.610000	6.410000	165.8650

South

1979	1185.000	16.00000	6.000000	1.000000	1.000000	1.000000	11.83333
1980	1301.000	14.00000	5.000000	1.090000	1.210000	1.180000	13.59368
1981	1380.000	14.00000	6.000000	1.190000	1.340000	1.270000	16.29473
1982	1563.000	17.00000	6.000000	1.190000	1.440000	1.280000	18.56850
1983	1729.000	18.00000	5.000000	1.240000	1.470000	1.340000	21.44946
1984	1878.000	23.00000	7.000000	1.270000	1.770000	1.640000	23.70866
1985	2019.000	35.00000	7.000000	1.450000	2.140000	2.130000	27.73309
1986	2160.000	42.00000	7.000000	1.630000	2.610000	2.600000	34.42094
1987	2343.000	51.00000	7.000000	1.870000	3.080000	2.970000	42.49096
1988	2615.000	62.00000	10.00000	2.400000	3.400000	3.590000	55.04388
1989	2791.000	64.00000	10.00000	2.630000	3.960000	4.120000	64.81299
1990	3065.000	75.00000	12.00000	2.970000	4.550000	4.590000	93.03996
1991	3351.000	94.00000	15.00000	3.240000	5.320000	5.640000	111.1946

Appendix 2 continued.

1992	3638.000	132.0000	17.00000	3.420000	5.610000	6.410000	126.1048

Southwest

1979	1902.000	66.00000	72.00000	1.000000	.1.000000	1.000000	20.00000
1980	2192.000	71.00000	75.00000	1.090000	1.210000	1.180000	24.18575
1981	2461.000	72.00000	83.00000	1.190000	1.340000	1.270000	30.57109
1982	2616.000	77.00000	81.00000	1.190000	1.440000	1.280000	32.65554
1983	2917.000	84.00000	75.00000	1.240000	1.470000	1.340000	37.84296
1984	3275.000	88.00000	76.00000	1.270000	1.770000	1.640000	43.18726
1985	3786.000	97.00000	81.00000	1.450000	2.140000	2.130000	53.95046
1986	4157.000	108.0000	82.00000	1.630000	2.610000	2.600000	68.59425
1987	4422.000	128.0000	91.00000	1.870000	3.080000	2.970000	83.25862
1988	4920.000	149.0000	94.00000	2.400000	3.400000	3.590000	106.7684
1989	5057.000	155.0000	94.00000	2.630000	3.960000	4.120000	121.4006
1990	5363.000	162.0000	98.00000	2.970000	4.550000	4.590000	167.6301
1991	5727.000	184.0000	109.0000	3.240000	5.320000	5.640000	195.8126
1992	5949.000	212.0000	116.0000	3.420000	5.610000	6.410000	211.3706

Note: Qp, Qb and Qm denote annual quantity of production for pork, beef and mutton; Pp, Pb Pm denote retail price indices for pork, beef and mutton annually; Ym denotes deflated expenditure on red meat, i.e. pork, beef and mutton.

Source: China State Statistical Bureau 1992 and 1993 and ERS, USDA 1994.

Appendix 3

The projected values of exogenous variables

Table 3.1: Projected prices of pork, beef and mutton (kg/yuan)

Years	Price of pork	Price of Beef	Price of Mutton
1993	3.76	6.41	7.42
1994	4.14	7.32	8.58
1995	4.56	8.36	9.93
1996	5.02	9.55	11.48
1997	5.53	10.91	13.28
1998	6.09	12.46	15.37
1999	6.7	14.24	17.78
2000	7.37	16.26	20.57

Table 3.2: Projected expenditure on red meat in seven region (yuan/per head)

Years	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7
1993	87.79	265.06	109.18	162.66	198.33	150.78	252.74
1994	104.97	316.94	130.55	194.5	237.14	180.29	302.2
1995	125.51	378.96	156.09	232.56	283.55	215.57	361.34
1996	150.07	453.12	186.64	278.07	339.04	257.75	432.05
1997	179.44	541.79	223.17	332.49	405.4	308.2	516.6
1998	214.56	647.83	266.84	397.56	484.73	368.51	617.7
1999	256.55	774.61	319.06	475.36	579.59	440.63	738.58
2000	306.76	926.2	381.5	568.39	693.02	526.86	883.12

Appendix 4

Projected national and regional demand and consumption for Pork, beef amd mutton (1,000 tons)

Table 4.1: Projected national demand and consumption for pork, beef and mutton

	1993	1994	1995	1996	1997	1998	1999	2000
Pork	27241.19	29330.1	31579.12	34000.61	36607.79	39414.9	42437.26	45691.37
Beef	2200.21	2620.61	3121.33	3717.73	4428.08	5274.16	6281.91	7482.2
Mutton	1274.87	1379.74	1493.24	1616.06	1749	1892.87	2048.58	2217.09
Total	30716.27	33330.41	36193.67	39334.41	42784.88	46581.94	50767.75	55390.67

Table 4.2: Projected regional demand and consumption for pork

	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7
1993	3604.65	3868.65	3454.85	1859.03	4998.59	4447.12	5008.3
1994	3881.06	4165.3	3719.77	2001.58	5381.88	4788.13	5392.34
1995	4178.66	4484.7	4005	2155.06	5794.57	5155.28	5805.83
1996	4499.09	4828.59	4312.11	2320.31	6238.9	5550.59	6251.03
1997	4844.08	5198.84	4642.76	2498.24	6717.3	5976.22	6730.36
1998	5215.52	5597.49	4998.77	2689.80	7232.39	6434.47	7246.45
1999	5615.45	6026.71	5382.08	2896.06	7786.97	6927.87	7802.11
2000	6046.05	6488.84	5794.78	3118.13	8384.08	7459.12	8400.38

Appendix 4 continued.

Table 4.3: Projected regional demand and consumption for beef

	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7
1993	246.65	343.12	300.12	872.2	164.26	81.11	192.76
1994	293.77	408.68	357.46	1038.85	195.65	96.6	229.59
1995	349.91	486.77	425.77	1237.34	233.03	115.06	273.76
1996	416.76	579.77	507.12	1473.77	277.56	137.05	325.71
1997	496.4	690.55	604.01	1755.36	330.59	163.23	387.94
1998	591.24	822.5	719.42	2090.76	393.75	194.42	462.06
1999	704.21	979.65	856.88	2490.24	468.99	231.57	550.35
2000	838.77	1166.84	1020.61	2966.06	558.60	275.82	655.51

Table 4.4: Projected regional demand and consumption for mutton

	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7
1993	83.9	67.34	215.88	739.8	127.14	20.39	20.4
1994	90.8	72.88	233.64	800.66	137.60	22.07	22.08
1995	98.27	78.87	252.86	866.52	148.92	23.89	23.9
1996	106.36	85.36	273.66	937.8	161.17	25.85	25.86
1997	115.11	92.38	296.17	1014.94	174.43	27.98	27.99
1998	124.57	99.98	320.53	1098.43	188.78	30.28	30.29
1999	134.82	108.21	346.9	1188.79	204.31	32.77	32.79
2000	145.91	117.11	375.44	1286.57	221.11	35.47	35.48

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