

1977

Demand estimation of meat in Iran

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BOLOORFOROOSH, Mohsen, 1951-
DEMAND ESTIMATION OF MEAT IN IRAN.

Iowa State University. Ph.D., 1977
Economics, general

Xerox University Microfilms, Ann Arbor, Michigan 48106

Demand estimation of meat in Iran

by

Mohsen Bolorforoosh

A Dissertation Submitted to the
Graduate Faculty in Partial Fulfillment of
The Requirements for the Degree of
DOCTOR OF PHILOSOPHY

Major: Economics

Approved:

Signature was redacted for privacy.

In Charge of Major Work

Signature was redacted for privacy.

~~For~~ the Major Department

Signature was redacted for privacy.

For the Graduate College

Iowa State University
Ames, Iowa

1977

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PREFACE

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

دینار که ما در آن زندگی کردیم، بسیار محک و نظیرات است. جای که دیگر بر این سکونت داشتند و کوه
 کوه مجازات است. اگر نخواستیم که در این سرحد بیچاره و در بند چندان خوش بود
 سینه و تن و اندوه هم در فراق هم نیت که چند شنید کرده و گفتم. در این برادر شریعت کدوان
 تنگ که در سوره موفقیات است بر نظیر که در این شکر است هیهات از هر چه پاپیستین. نیز بر یوفقیات رساله
 پیوسته است که در این باب است که در میان ما علم بعد از آن بر بنیان علم است و خوب بود و در نو استوار است علم و
 شدگان عمل در این است و روان در این است و در این است. شایسته است که در این است که در این است و در این است
 آماز کرده ام که در این است و در این است که در این است که در این است که در این است که در این است که در این است
 این قدر است که در این است که در این است که در این است که در این است که در این است که در این است که در این است
 لا ابرم چاره از جز این نیست برای ما و محامد کشف در این است که در این است که در این است که در این است که در این است
 رقیه همیشه در هر امری است که در این است که در این است که در این است که در این است که در این است که در این است
 و محامد را چه صورت برنامه ای در حال و کوه نامه است و چه بلای است از آن بیامیند. همه برنامه در این است
 شده در حال مضمون است بسیار بزرگ در آنچه است که همه روز در دنیا می باشد که در این است که در این است
 آن استیم. لازم است که در این است که در این است که در این است که در این است که در این است که در این است
 محبت شکر فراوانم تقدیم بر تمام کتب که مرا در این است که در این است که در این است که در این است که در این است
 و بعد و در این است که در این است که در این است که در این است که در این است که در این است که در این است

موسسین و مؤلفین
 ۱۳۵۵
 اصفهان - ایران

CHAPTER I. BASIC PROBLEMS, OBJECTIVES
AND IMPORTANCE OF THE STUDY

Introduction

The Middle Eastern country of Iran has an area of 1,648,000 square Km. Since the Iranian solar year starts at the beginning of spring (March 21), the Iranian calendar year 1351 covers the period between March 21, 1972 and March 20, 1973 of the Gregorian calendar. The Iranian unit of currency is the rial. Because of the floating rate of exchange between the U.S. dollar and the Iranian rial in recent years, the exact rate of exchange between these two cannot be determined; however, throughout this study the value \$1.00 = Rls 70 has been assumed.

The population of Iran according to the 1335 and 1345 censuses was over 18 and 25 million, respectively. The population in 1353 is approximated at more than 32 million. The distribution of rural and urban population is about 56 and 44 percent, respectively, in 1353.

The Iranian economy has been experiencing one of the world's highest growth rates during the past decade. The Gross Domestic Product (G.D.P.) at factor costs is distributed as 12.4, 40.8, 17.6 and 29.2 percent for "agriculture," "oil," "industries and mining" and "services," respectively in 1353. Of the 12.4 percent share of the agricultural sector, 3.7 percent is attributed to livestock breeding. This share of the G.D.P. shows production at 16 Kg per capita. Adding live animal and frozen meat imports to this production, the meat consumption per capita would still be below 19 Kg (1353), a figure relatively low when compared to the con-

sumption figures of most developed countries. The following table (1.1) compares the animal protein consumption of several selected countries.¹

Table 1.1. World levels of animal protein consumption (1325-45) (grams of animal protein per capita/per day)^a

	Average	Range
Australia	69	69-76
North America	64	62-66
Europe	44	20-73
Latin America	24	5-68
Middle East	17	8-40
Asia	15	5-51
Africa	12	4-38
World	35	
Iran	12	

^aSource: (3).

Basic Iranian Meat Problems

As recently as 20 years ago, there existed an exportable surplus of meat in Iran. The price of meat was relatively low and the supply was sufficient to meet the demand at the existing price. By U.S. standards, however, the demand for meat is still quite low--at 19 Kg per capita at the existing price. But now there is a shortage of meat that has developed for two basic reasons: 1) demand has increased, and 2) supply has

¹The other sources of protein besides animal protein in Iran are vegetable (e.g., wheat, rice, barley) and dairy products (e.g., milk, yogurt, cheese). The total amount of protein from nonanimal sources was about 43 grams per capita/per day in 1344.

not increased much. Price controls have limited retail price increases. Low imports plus excess animals relative to feed have kept the supply of meat at an insufficient level relative to demand. Consequently, an actual shortage or unavailability of meat in the shops has occurred over the past few years.

There are four main species of meat consumed in Iran: lamb, chicken, beef and fish. It might be best not to consider fish, because fish is widely consumed in only a few areas and is a very high luxury for the majority of people in other areas, although we analyzed fish, too. Of the other three species, lamb is the most popular, chicken is the most rapidly expanding and beef is least preferred.

Traditionally, sheep and cattle in Iran have been raised by using mostly pastures with little or no harvested forage or supplementary grain feeding. Iran has a "tragedy of the commons." There is very little, or at most times, no direct cost to the sheep owner for use of pastures on public lands; thus to the individual the marginal cost of placing more animals on the pasture is almost zero and below the return the individual expects from more animals. Therefore, the pastures are overused to the point of absolute deterioration and animal malnutrition. Up to 20 years ago the pastures were stable and able to meet the grazing requirement. The cattle and sheep were enough to meet the low demand for meat. However, with the rapid (3%/yr.) increase of the total Iranian population and particularly with the rise of real income and population in urban areas, the demand for meat in urban areas has boomed. To respond to the meat shortage, the number of animals rose and total meat production fell; pastures deteriorated; animals used feed inefficiently; and deterioration

of the environment followed. In the last five years, the cost of meat has increased, larger and larger amounts have been imported, pastures have been growing worse and the total amount of feed available is no longer enough to feed the sheep. They are malnourished, sick and unproductive.

With existing government price control, nevertheless, the importation of meat has increased in the last few years. Yet there is still a large gap between the demand and supply of meat in Iran.

Objectives of the Study

The objectives of this study are twofold. The first is to explain the demand function, the relation between variables and effectiveness of different variables on demand for different kinds of meats in both rural and urban areas. The strength and degree of reliability of each coefficient (i.e., price and income elasticities) will be tested and the coefficients and elasticities for different models and other studies in the same area will be compared to eventually come up with the best economical and statistical selections.

Secondly, with some certain behavioral, economic, and statistical assumptions about population and income and the use of the above selected elasticities, make projections of different kinds of meats for some selected years. The projected demand with the forecasted supply in each of these years is compared.

Importance of the Study

The importance of explanations and projections of the growth of any economic factor need not be overemphasized, especially when dealing with situations of both limited quality and quantity of data.

In order to achieve rapid economic development, plans for this development are required. Looking broadly at agriculture, there are three major contributions to economic development that become evident: 1) by direct contribution to increase rural income and welfare; 2) by releasing labor from farms to help build up the other sectors of the economy; and 3) by providing more production in order to meet the needs of a larger population with higher incomes.

The sensitivity of the demand, with respect to other economic factors, in conjunction with all other demand related information, is useful in formulating both economic plans and governmental policies. With the goal of minimizing or avoiding an economic crisis, both our expectations about how much we will need and how much we will have is important information. This information not only helps match supply with demand, but also contributes to the efficient allocation of natural resources and economic development in the various economic sectors.

CHAPTER II. ECONOMICS, MATHEMATICS AND STATISTICAL
DEVELOPMENT OF DEMAND ESTIMATION

The concepts of demand, as stated in the middle of the nineteenth century by Cournot and Duiuit, were popularized by Marshall. The Marshall theory, focusing on the quantity-price relation for a single commodity, holding income and all other prices constant, provided a demand function uncompensated for income effects. The work of Pareto and Walras focused on the more general case in which all prices and income are variable. However, the basic theory was clarified by Hicks (1939), in his famous mathematical appendix, in which explicitly links utility theory with demand analysis. His work drew on the article written in 1915 by Slutsky (1952) who distinguished between income and substitution effects due to a price change and between a compensated and uncompensated demand function. (34)

Mathematical Demand Derivation

An ordinary demand function for an individual consumer obtained as a result of maximizing the consumer's satisfaction subject to a budget restraint is expressed as a function of the price of the commodity itself, the prices of other commodities and the consumer's income.

Assuming K commodities, i.e., q_1, q_2, \dots, q_K , and expressing income as (y), then consumers want to maximize their utility $U(q_1, q_2, \dots, q_K)$ subject to their budget constraint, $Y - \sum_{i=1}^K P_i q_i = 0$, where P_i is the price of q_i .

Mathematically, the demand function could be derived as follows:

$$V = U(q_1, q_2, \dots, q_K) + \lambda(y - \sum_{i=1}^K P_i q_i)$$

where λ is an undetermined Lagrange multiplier.

V is a function of q_1, q_2, \dots, q_K and is equal to U for the values of q_i which satisfies the budget constraint, since $y - \sum_{i=1}^K P_i q_i = 0$. To

maximize V , we calculate the partial derivatives of V with respect to $(K + 1)$ variables (i.e., q_i 's and λ) and set them equal to zero.

$$\frac{\partial V}{\partial q_i} = U_i - \lambda P_i = 0 \quad i = 1, 2, \dots, K$$

and

$$\frac{\partial V}{\partial \lambda} = y - \sum_{i=1}^K P_i q_i = 0$$

assuming the second order condition is satisfied.

By solving the above $(K + 1)$ equations for $(K + 1)$ unknowns, we can derive

$$q_{ji} = f(y_j, P_1, P_2, \dots, P_K) \quad i = 1, 2, \dots, K \quad j = 1, \dots, n$$

which are the demand functions of an individual (j) consumer for a single commodity (i).

Factors Affecting Demand

One of the crucial problems in demand analysis is to determine which variables should be included in a demand function. In an ordinary demand equation for an individual consumer, we take quantity as a dependent variable and the independent variables would be consumer income and all commodity prices. However, if we include the prices of all commodities, the model would become much more complicated and difficult to present.

Moreover, the inclusion of many independent variables would contribute to the conceptual accuracy of the model; however, it would make the model much more complicated. Especially with a small number of observations and the existence of measurement errors in the variables, we cannot include many independent variables in the demand equation. All these

factors make it impossible to obtain statistically significant coefficients for more than three or four independent variables in most cases.

Cross-section and time-series analysis

There are two major approaches to the estimation of demand. One is from a family budget (cross-section) survey and the other from time-series data.

Given a sample of the population at a period of time, cross-section data has been applied to the consumption behavior of consumers. Early cross-section studies were concerned with estimating income elasticities from food consumption data. Most publications on consumption data survey the quantities of food items consumed or expenditures on them by specific income classes.

Using this kind of data, a weighted regression can be obtained to estimate the aggregate income elasticity.

Time-series data relate to aggregate or per capita series on consumption, income and also the price of those commodities consumed. Both models of single equations and simultaneous equations can be utilized for time-series data. These data were used for estimating different income and price elasticities. Based on available data on prices and per capita consumption and income, it is possible to estimate aggregate income, price and cross price elasticities.

Isolation of the effects of noneconomic elements such as sociological, psychological, cultural and regional factors is essential for analyzing the effects of prices and income on the quantity consumed.

The family budget (cross-section) survey enables us to estimate the effect of income on consumption free from effective price changes, since prices do not fluctuate in a cross-section (short period) of time.

In order to make an unbiased and efficient estimate of a quantity-income relationship, effects of these noneconomic elements should be determined prior to deciding on the reliability of the income coefficient estimated from the cross-section data. Unfortunately it is often difficult, if not impossible, to quantify the effects of most noneconomic factors. Change in the income coefficient over time can be evaluated using cross-section analysis in two different years; the effects of redistribution of income on food consumption can also be analyzed.

In time-series analysis, not only do those difficulties discussed in cross-section analysis exist, but the possibility that consumer preferences will change within the period of study should also be considered. Generally, many factors which are constant within a short period of time (cross-section) would become variable in time-series analysis and by not considering those the coefficients are made statistically insignificant. Because both time-series and cross-section analysis have certain essential disadvantages, attempts have been made to combine one method with the other. The conditional regression analysis is used, based on the insertion of income elasticities obtained from budget studies into time-series data analysis.

Income vs. total expenditure

The economist has always been faced with a problem in using income data in demand analysis, since many people do not like to give actual earnings figures during household interviews. In most cases, the income

figures reported are less than the actual income earned. Fear of having to pay higher taxes is the reason for this discrepancy. In contrast expenditure figures seem to be reported quite accurately.

In supporting the use of expenditure data rather than income data, it has been argued that consumption decisions are based on permanent income. If the permanent income hypothesis is accepted, it is preferable to use total expenditure rather than total income since the relationship between total expenditure and permanent income is more stable than that between total income and current income. Many researchers have found it useful to employ total expenditure rather than total income as an exogenous variable in the demand equation.

The fundamental disadvantage of using total expenditure as an exogenous variable in the demand equation is the fact that bias is involved in regression parameters. This is so because expenditure on a certain commodity is only a fraction of total expenditure. This bias can be removed by using income as an instrumental variable. However, the extent of this bias is negligible for most food commodities. The second problem with the use of total expenditure is the purchase of expensive and durable commodities during the period of the cross-section survey. This causes the people making such purchases to move into a higher income class because their total expenditure in that period is the sum of their permanent or regular expenses plus the expense for those "special" durable goods obtained in that period. This problem can be eliminated by highlighting the expensive durable goods in conducting household surveys. Since these durable goods usually require substantial financial outlays, it should not be hard for those surveyed to remember these purchases.

Prices

The price of the commodity under investigation and the prices of immediate substitutes and complements are commonly used variables in time-series analysis. Since cross-section analysis usually deals with a one-year period, the price of the commodity itself and other substitutes and complementary commodities are therefore assumed to be constant. The effect of price on quantity demanded is extremely difficult to identify in a cross-section analysis since it involves reflection of quality as well as quantity price-relations within different expenditure classes. By using longitudinal surveys, it is possible to isolate the effect of price on quantity demanded if there have been changes during the period of study.

Household size (cross-section analysis)

After income, household size is the most common variable used in demand equations. If household data is used, excluding the household size as a second variable in the demand equation, biased regression coefficients will result. Even when utilizing per capita data to explain consumption behavior of an individual, household size is the second most common explanatory variable.

The most important reason for including household size in the latter case is the economies of scale (65) which large families may experience. Some reasons that economies of scale may exist in food consumption are: 1) larger families may find value in large-quantity buying, which results in paying lower unit-prices for the commodity; 2) food may be wasted less in larger families because of the economies of scale; and 3) the greater

number of children in large families results in less per capita consumption since children usually consume less of most foods than do adults.

In order to check for the existence of economies of scale within a family, the household data should be divided by the household size to arrive at the per capita data. Then the quantity should be regressed on income and household size, using that per capita data. In order for household size to be included in the demand equation, the coefficient of household size should be negative and significant.

Location and seasonality

It is essential to test for any fundamental differences which may exist in differing regional or seasonal demand-patterns if consumer surveys are conducted in different areas or different seasons. It is also desirable to test for any structural differences which may exist in regional and especially seasonal demand-patterns in time-series analyses. In this case, separate time-series data are required for each region or season.

The Gap Between Demand Theory and Empirical Analysis

Econometricians have always been faced with the gap between theory and empirical analysis. P. S. George and G. A. King in "Consumer Demand for Food Commodities in the United States with Projections for 1359" indicate this problem as follows:

In theoretical development, we specify certain postulates and deduce the behavior of the variables through logic. In contrast, empirical studies deal with quantifiable phenomena. Often theoretical developments and empirical analysis complement each other--empirical analysis can be used to verify the validity of certain theories. Sometimes certain theories are reached by starting from an empirical analysis. In the field of demand analysis,

econometricians have often built empirical models based on the significance of economic variables like prices and quantities and justified their findings through economic theory. On the other hand, some models in consumption theory are not subject to empirical verification because of deficiencies in data or in statistical procedures. As a result of this, we are faced with a situation of insufficient predictive power, inappropriate basis for empirical analysis, and difficulties in establishing empirical confrontation which is often referred to as the 'the gap between theory and empirical analysis.'

In demand theory, since consumption of a single commodity is a function of income, its own price and prices of other commodities, the demands for all commodities are interrelated and the system of consumption functions should be solved simultaneously. If there are n goods (34), this involves $(n \times n)$ price elasticities and n income elasticities. To solve the model, the number of observations ought to be equal to the number of parameters to be estimated; in this case $n^2 + n$. When a larger number of commodities is included in the system, this condition cannot be satisfied and we run into the problem of "degrees of freedom."

Multiple Regression as a Method of Statistical Demand Estimation

In order to estimate the coefficients of a demand function, the method of multiple regression is one of the most appropriate ones.

An economic theory can be evaluated by its power to explain and to predict. Statistical multiple regression technique is one of the most important tools used by economists for explaining and forecasting.

The multiple regression technique is a very useful and appreciated tool for data analysis if it is applied with caution and care. However, it may also become a dangerous tool if it is used incorrectly. It is very important, therefore, to understand what multiple regression means, what the assumptions are and how it is applicable.

Previously we derived the quantity demanded of an individual for a single good as a function of consumer income and all commodity prices.

$$q_{ji} = F(y_j, P_1, P_2, \dots, P_K)$$

Let us assume that a linear relationship exists between a dependent variable q_{ji} , $(K + 1)$ explanatory variables $y_j, p_1, p_2, \dots, p_K$ and a disturbance term U_{ji} . If we have a sample of n observations on q_{ji} and explanatory variables we can write (40)

$$q_{ji} = \alpha_j + \beta_j y_j + \gamma_{j1} P_{j1} + \gamma_{j2} P_{j2} + \dots + \gamma_{jK} P_{jK} + U_{ji} \quad \begin{matrix} j = 1, \dots, n \\ i = 1, \dots, K \end{matrix}$$

The α , β and γ coefficients and the parameters of the U distribution are unknown, and our problem is to obtain estimates of these unknowns.

equations can be written compactly in matrix notation as

$$Q = XB + U$$

where

$Q = n \times 1$ - vector of dependent variables

$X = n \times (K + 2)$ - matrix of explanatory variables

$B = (K + 2) \times 1$ - vector of unknown parameters

$U = n \times 1$ - vector of disturbance terms

The least square solution would be obtained by $\hat{B} = (X'X)^{-1}X'Q_j$, where $\hat{B}_j = (\hat{\alpha}_j, \hat{\beta}_j, \hat{\gamma}_{j1}, \hat{\gamma}_{j2}, \dots, \hat{\gamma}_{jK})$.

In order to obtain the best linear unbiased estimates of the coefficients, we have to make the following assumptions:

1. The error term has an expected value of zero.
2. The error term has a constant variance.
3. There is no correlation between error term and explanatory variables.
4. X is a set of fixed numbers and observed without error.

5. The equation contains only one endogenous variable, with all other variables being exogenous.
6. The error terms are serially independent; i.e., no autocorrelation.
7. There are no high correlations among independent variables, i.e., no multicollinearity.
8. x has rank $K + 2 < n$.

The assumptions are implicit in the ordinary least square (OLS) estimation, but in many economic cases these assumptions do not completely hold. Therefore, all the assumptions should be examined and proper adjustment ought to be applied.

A plot of the residuals for each equation facilitates a rough check to see if their average value is zero. Also, any trace of regularity in the residuals may indicate a systematic tendency which had somehow been left unexplained.

It sometimes occurs that some of the observations used in a regression analysis are less reliable than others (14). What this usually means is that the variances of the observations are not all equal; in other words, the matrix of the variance is not a diagonal matrix with all elements equal.

When this event occurs, the OLS estimation formula $\hat{B} = (x'x)^{-1}x'Q$ does not apply and it is necessary to amend the procedures for obtaining estimates. The basic idea is to transform the observations Q to other variables Z which do appear to satisfy the usual tentative assumptions.

Estimation by OLS requires that the error is not correlated with explanatory variables. Measurement error in the X variables thus poses a

serious estimation problem, and alternative estimators are required (40). There are two main types of estimators described in the literature; one type is based on instrumental variables of various kinds and the other on maximum likelihood methods buttressed with fairly strong assumptions about the covariance matrix of the measurement error.

The OLS estimation cannot be applied if we have more than one endogenous variable in each equation. Consider a linear case in which Commodity one is a function of consumer income, the price of the commodity itself and the price of Commodity two.

$$q_1 = \beta_0 + \beta_1 Y + \beta_2 P_1 + \beta_3 P_2$$

The OLS technique can be applied to this equation if--and only if--we assume that the income and price of commodity two are exogenous variables; i.e., those are determined out of the system.

Serially dependent error term in cross-section analysis means that there is interdependence of household preferences; that is, that people consume certain commodities simply because their friends and neighbors do. Usually the assumption of serially independent error terms is violated for luxury goods, but it is not believed to be unreasonable with regard to meat consumption.

The assumption of serially dependent error terms is mostly a crucial problem in time-series analysis. Technically it means nonzero covariance for the disturbance terms. This could occur in many ways, for example, by making an incorrect specification of the form of the relationship between the variables.

The best way to handle this problem is to transform the observations to other variables so that new variables satisfy the assumption.

The data matrix x which is of order $n \times (K + 2)$ should be full rank-- that is, no linear independence exists between the explanatory variables. The reason for this assumption is that the OLS estimator requires the inversion of $(x'x)$, which is impossible if the rank of x , and hence the rank of $x'x$ is less than $K + 2$. This is the case of extreme multicollinearity which exists when some or all of the explanatory variables are perfectly colinear. A less extreme but still very serious situation arises when the assumption is only just satisfied, that is, when some or all of the explanatory variables are highly but not perfectly colinear.

As Johnston (40) indicated:

The main consequences of multicollinearity are as follows: a) The precision of estimation falls so that it becomes very difficult, if not impossible, to disentangle the relative influences of the various x variables. b) Investigators are sometimes led to drop variables incorrectly from an analysis because their coefficients are not significantly different from zero, but the true situation may be not that a variable has no effect but simply that the set of sample data has not enabled us to pick it up. c) Estimates of coefficients become very sensitive to particular sets of sample data, and the addition of a few more observations can sometimes produce dramatic shifts in some of the coefficients.

The easiest way to handle this problem is to drop one or more explanatory variables; however, this method causes some other difficulties, such as specification error, to arise. We can also use the linear combination of explanatory variables or regress one independent variable on the other explanatory variable and use the residual as an explanatory variable.

The last assumption of the linear model simply states that the number of observations should be larger than the number of explanatory variables and, hence, the number of regression coefficients.

CHAPTER III. REVIEW OF LITERATURE

The developing countries of today are compelled to match the standards of the developed countries with comparable economic growth. The exploration and prediction of the demand and supply of agricultural products plays an essential role in planning and formulating governmental policies. It is important to recognize the gap that exists between demand and supply and the means possible to match these two.

Almost all developing countries are faced with a lack of accurate time-series data for a period long enough to give sufficient degrees of freedom. Therefore, most of the methodologies that have been used in these countries are based on one or more family-budget (cross-section) analyses.

Studies About Other Countries

The methodology used in some of these studies is briefly reviewed in the following sections (66).

India (39)

The study covers the fifteen year period of 1339-50 to 1354-55 and is concerned with projection of supply and demand for selected agricultural commodities.

The projection of demand is based upon population growth, increase in per capita income and corresponding income elasticities of demand.

The ready-made estimates of national income by the planning commission in the Third Five-Year Plan were used to arrive at the per capita income for the projected years.

For income elasticities of demand for different commodities, two independent approaches are accepted; one is an analysis of a time-series of the market demand (1317-18 to 1336-37), and the other is an analysis of cross-section data on consumer expenditure which is available for rural and urban areas separately.

Mexico (44)

The study covers the base year of 1339 in order to project the supply and demand of agricultural products for 1344, 1349 and 1354.

Projections of G.D.P. are based on the possibilities of investment in each sector in the future and the prospect of their capital output ratios. A survey of five thousand households was carried out in 1342 to study family income and expenditure. This survey was the source of information for the estimates of income elasticity of demand. The study separates the demand for rural and urban population, using family expenditures as an independent variable. A consumption function, expressed primarily in physical units, was constructed. Linear, logarithmic, semi-logarithmic and inverse-logarithmic functions are applied to the series of data to select the function with the highest correlation and a lower standard error of estimation.

Nigeria (45)

The projection of demand, supply and imports of major farm products was the objective of this study. The period of research covers the year 1344 to 1354. The estimate of income growth is based on the assumption of a certain level of foreign investment as well as domestic investment.

Philippines (46)

This study covers the survey of 1339. Its goal was to investigate the long-term supply and demand for selected agricultural products for the years 1344 and 1354. Together with similar studies in other countries the USDA also evaluates the long-term prospects regarding the supply of and demand for agricultural products throughout the world in this study.

The total demand and supply of each product was projected to estimate needed imports or exports.

The population has been projected by applying the United Nations' component method.

The Gross Domestic Product (G.D.P.) was predicted, based on the assumption of a certain percent capital-output ratio and a certain percent of the G.D.P. to be invested on the average for each period. Personal income was considered a linear function of gross income.

The household demand for each individual commodity was assumed to be a logarithmic function of the income and the size of the household.

An inter-industry analysis of 39 sectors was used to measure the direct and indirect domestic production requirement. The next task was to determine whether or not these requirements could be met for each commodity.

Saudi Arabia (68)

Based on a survey of the years 1340-41, supply and demand projections were made.

Total demand of imports as well as domestic production for each food item was estimated in quantity terms. The increased volume of foodstuffs

in the projected years is the result of an increase in population and of the effect of an increase in private per capita expenditures. The chief objective of this study was to estimate the need for imports. The report uses high and low projections for both supply and demand and, consequently, for imports. Oil, by far the largest single sector of the Saudi Arabian economy, is assumed to be the main determinant of the country's total income growth. This is because neither the size of the labor force nor capital expenditures are assumed to be determinants of growth; they are not the limiting factors. The direct local expenditures of the oil companies and the royalties and taxes paid are two channels by which the growth of oil is related to the growth of the economy.

Venezuela (72)

This study was designed to evaluate supply and demand of agricultural and livestock production for the years 1344, 1349 and 1354, based on the survey of 1341.

For calculating per capita demand, income and price elasticity of demand, the propensity to consume for each commodity is considered. The model utilized, in general, relates consumption as a linear function of one or more of the production variables: imports, exports, population and government policies.

To measure the growth of GNP as a measurement of the level of economic activities, the rate of capital accumulations was studied. Four different hypotheses are used in regard to the growth of investment in different sectors of the economy. In that the estimated percentage for growth of investment and that of production is the same, it seems that the

capital output ratio is assumed to remain constant throughout the study. However, different hypotheses have different ratios.

All of these studies mentioned above are concerned with both demand for and supply of major agricultural products. Furthermore, the main objective of each study is the projection of both demand and supply for selected future years. In demand projections, the focus is on change in national income and in population and demand elasticities. The following table (3.1) shows the variables, functional form and allocation of data which have been used in each study to estimate the demand elasticities.

Table 3.1. Comparison of methods of demand elasticities estimation in selected countries

Country	Variables	Functional form	Data allocation
India	Income	Linear	Cross-section & Time-series
Mexico	Income	Linear, semi-logarithmic, double logarithmic, inverse logarithmic	Cross-section
Nigeria	Income	Linear	Cross-section
Philippines	Income & family size	Semi-logarithmic	Cross-section
Saudi Arabia	Income	Linear	Cross-section
Venezuela	Income	Linear	Cross-section

Studies About Iran

There are three specific characteristics common in all meat demand studies of Iran: 1) the studies are based on cross-section data; 2) the studies are based on single equation; and 3) the studies are mainly concerned with demand projection.

The methodologies used in a few of these studies are reviewed briefly in the following section.

"Iran Long Term Projection of Demand for and Supply of Major Agricultural Commodities" by H. Ronaghy, 1348

This study (66) is a long term projection for demand and supply of major agricultural commodities in Iran covering the years 1349, 1354, 1359 and 1364, over the base year of the 1344 family budget survey.

The effect of the stage or timing of transformation from mortality to fertility rates of population is determined and emphasized in this study. This occurrence is assumed to be different in urban and rural areas, thereby affecting the values of vital statistics in each area. The projections contained in the study are therefore based on evaluations of the trend of fertility and mortality rates of different age groups in the population, with emphasis on the percentage of population in the age group. Both the first national population census of 1335 and the second of 1345 are utilized. Ronaghy argues that the Iranian population generally "fits" the definition of a class B-1 population given by U.N. demographers; thus, with slight adjustments for rural and urban populations, he employs their model. This has some drawbacks, since in the process of working out results he is forced to rely on the best estimates of Iranian demographers showing the rate of population growth as 2.5 percent. His

division of rural and urban population is based on his consideration of having populations of 15,000 or more rather than on the official system which considers cities as having populations of 5,000 or more. Ronaghy assumes the 1335 and 1345 urban enumerations to be correct, and then subtracts from their differences. He estimates the urban crude rate of natural increase at 2.493% and obtains an immigration rate of 3.5 percent during the inter-census decade. It is assumed that this rate will hold constant in the future for his "low assumption" projections. For the "high assumption" work, a correction is made by adding 1 percent per 5-year interval.

Change in income is determined by estimating the increase in the income side of the G.N.P. The economy is divided into eight sectors and the increase in each sector is estimated from past trends, investments, the sector's relation to the total G.N.P. or sectors, and government policy. From the total values of these eight sectors, the G.N.P. at market price, N.N.P. (Net National Product), disposable income and per capita income are estimated.

Projections on the basis of the past trends of different sectors are made by either the least square method or by measuring the annual percentage increase, depending on their respective correlation coefficient.

Distribution of income between rural and urban population is estimated on the basis of the portion of these populations engaged in the eight producing sectors.

The per capita food expenditure and the elasticities of demand for urban population were calculated on the basis of a budget survey made by

the Bank Melli in 1338. The per capita food expenditure and the elasticities of demand for rural areas were based on the international comparison of rural populations of India and Italy.

The method used for calculating income elasticities was simply the linear relation between income and consumption for each income bracket.

The aggregate demand is approximated, based on

$$x_{irt} = (1 + e_{ir} \frac{\Delta yr}{yro}) (x_{iro}) (N_{rt})$$

where x_{irt} stands for the aggregate rural (r) demand for i, commodity for the projected year t, e - income elasticity of demand, Δyr - change in per capita income between the base and projection year for ruralities, yro - the per capita income of the rural population in the base year of 1344, x_{iro} - the per capita consumption of product i in the rural area in the base year, N_{rt} - the population size of the rural area in the projection year of t.

The same model was also used for the urban areas and for different projected commodities and years.

"Long Term Projections of Supply and Demand for Selected Agricultural Products in Iran," by A. LeBaron, 1349

The demand projection (42) is based on the estimates of the 1344 rural, Tehran and other urban areas family-budget survey of per capita consumption. Per capita consumption is combined with per capita income projections and income elasticity coefficients for individual products.

In the past, Iran's rate of population growth was mainly a function of the mortality rate. However, the future rate is tied to changes in fertility rates. In this study, LeBaron chiefly utilizes the population

studies by Chasteland and Ronaghy. Linear extrapolation of percentage trends in division of personal consumption expenditures between urban areas, of Tehran, nine large cities, and other cities and rural areas is used.

The logarithmic equation of the average per capita expenditure was regressed upon per capita income and household size for different agricultural commodities, for both urban and rural areas. Moreover, in order to use pooled data of different years or different seasons, dummy variables were introduced into the model.

"An Econometric Analysis of the Demand for Animal Protein in Iran" by H. Saleh, 1352

The study (67) is based on a family budget survey conducted by Central Bank and Iran Statistical Center (ISC) from 1344 through 1348.

The two national censuses as well as demographic studies by Chasteland, Ronaghy, and LeBaron were used to analyze the population and its rate of growth in different areas.

The rate of growth of income and also distribution of income have been approximated, based on the Lorenz curve and log-normal distribution. Private consumption expenditure was used as income since accurate data on national income was nonexistent.

After four different functional forms of demand were tried, the semi-logarithmic form was used to estimate the income elasticities of different kinds of meats. For each year of 1344 through 1348 the quantity of demand, as well as demand expenses of different meat, was regressed on private consumption expenditure and family size. The coefficients for both economic theory and statistical significance were tested.

The regression results for each kind of meat are combined over the period of the study in order to come up with a single answer. Based on the single solution and previous analysis of population and income, the demand for different kinds of meat was projected for rural areas, urban areas and Tehran, separately. At the end of the study, the estimated amount of meat demand for the whole country is compared to the supply of meat production for some selected years, and the gap between demand and supply is analyzed.

National Cropping Plan (NCP) "Ministry of Agriculture and Natural Resources, Planning Bureau" 1354

The NCP (11) is a study of agriculture and livestock in Iran conducted by the Bookers Agricultural and Technical Services Limited and Hunting Technical Services Limited, 1354. The analysis of demand for agriculture and livestock products is based on a 1350 family budget survey by the ISC, separately for rural and urban areas. The population and income analysis is based for the most part on the ISC and Central Bank data.

The semi-logarithm is the functional form of demand equations used for regression analysis. The income elasticities of demands were estimated and utilized for prediction of demand of different food products. "Meat Supply in Iran" by Agricultural and Rural Development Advisory Mission (ARDAM), 1354

This paper (1,2,3) analyzes the present and future demand and supply situation for Iran and makes recommendations on related policies and programs. This study, in the sense of livestock demand projection, is

very similar to that of the NCP. Again the 1350 family budget survey of the ISC was used separately for rural and urban areas, with population and income estimated in the same manner as by NCP.

The major difference of this study and the NCP is the method of estimating income elasticities, for which ARDAM simply utilizes the linear relationship between consumption and income.

The following table presents the different functional forms and subject of these studies (Table 3.2).

Table 3.2. Comparison of the functional form and subject of different studies of Iran

Study	Functional Form	Subject
Ronaghy	Linear	Agricultural products
LeBaron	Double logarithmic	Agricultural products
Saleh	Semi-logarithmic	Animal protein
NCP	Semi-logarithmic	Agricultural products
ARDAM	Semi-logarithmic	Meat

CHAPTER IV. DATA

Sources of the Data

Data on consumption of agricultural products in Iran have been derived from the following sources:

1. The Ministry of Agriculture
2. Plan Organization and the Iran Statistical Center (ISC)
3. The World Bank
4. The Central Bank (Bank Markazi)
5. FAO
6. Various independent reports

The data used in this study were collected by the author in Iran.

The data include two parts

Cross-section data

The major sources for this kind of data were surveys conducted by the Bank Markazi and the ISC. The Central Bank investigations have been solely concerned with consumption statistics in the nation's urban areas, while the ISC has been primarily engaged in collecting similar data from rural areas which have a population of fewer than 5,000 people. The following chart indicates the time periods and areas covered by the different surveys.

In 1338, only expenditure data were recorded, while the remaining surveys collected both expenditure and quantity figures. From 1346 onward, the ISC discontinued the publication of their quantity data. From 1350 the size of the sample used was increased to nearly three times the previous size in both rural and urban areas.

Central Bank

1338 - Annual, Urban
 1344 - Annual, Urban
 1345 - Annual, Urban
 1346 - Annual, Urban
 1347 - Annual, Urban
 1348 - Annual, Urban

ISC

1342 - Fall & Winter, Rural
 1343 - Annual, Rural
 1344 - Fall & Winter, Rural
 1345 - Winter, Rural
 1346 - Annual, Rural
 1347 - Annual, Rural
 1347 - Annual, Urban
 1348 - Annual, Rural
 1348 - Annual, Urban
 1349 - Annual, Rural
 1349 - Annual, Urban
 1350 - Annual, Rural
 1350 - Annual, Urban
 1351 - Annual, Rural
 1351 - Annual, Urban

Time-series data

It is very difficult to find time-series data prior to 1338; indeed, even the available data for the period after 1338 are not wholly reliable. In this section we are concerned with prices and per capita consumption of different meats and per capita income. The price indexes and per capita income are published by Bank Markazi, but there are actually no time-series data on meat consumption. Thus, the meat consumption data in this study have been calculated as shown below:

$$\text{consumption} = \text{production} + \text{imports} - \text{exports}$$

where production and import-export data are reported by ISC and Foreign Trade Statistics of Iran, respectively.

Cross-Section Data Processing

The 1347-1351 family budget surveys (54 to 63) conducted by the Iran Statistical Center (ISC) are used in this section, with consumption data in terms of family expenditure. Income data are not reported, rather family total expenditure data are used. For the years of 1347, 1348 and 1349, the sample size is about 5,000 and the number of total expenditure brackets is six for both urban and rural areas. The sample size and number of total expenditure brackets are increased to 15,000 and eleven, respectively, for the years of 1350 and 1351 for both urban and rural areas. For each total expenditure brackets not only is the number of families falling into that category reported but the total number of individuals for each bracket is also available.

The average size of family for each total expenditure bracket can be obtained as

$$N_j = \frac{N_{Ij}}{N_{Fj}}$$

where

N_j = average family size in total expenditure bracket j

N_{Ij} = total number of individuals in total expenditure bracket j

N_{Fj} = total number of families in total expenditure bracket j

Since the distribution within each bracket was not available, therefore, the median of each total expenditure category was used¹, rather than the mean.

The first total expenditure category was adjusted by assuming the minimum survival income of 1,000 Rls/month total expenditure for each family of about size two.

The "Pareto Distribution" (74) was used to find a point estimate for the last total expenditure bracket, since there is no upper limit for total expenditure in this category.

The method for applying "Pareto Distribution" is as follows:

$$F(X) = aX^{-b}$$

where

$F(X)$ = cumulative probability distribution function

X = random variable

a = shift parameter

b = distribution parameter

Then, the probability distribution function would be

$$f(X) = ab X^{-b-1}$$

Also,

$$\begin{aligned} \text{PCE} = \text{TE}/F(X) &= \int_{r_j}^{r_{j+1}} f(X)X dX / F(X) \\ &= \frac{b}{1-b} [(r_{j+1})^{1-b} - (r_j)^{1-b}] / (r_j)^{-b} \end{aligned}$$

¹If the distribution within each total expenditure bracket is normal, then, mean = median.

where

r_j = lower total expenditure limit of the bracket

r_{j+1} = upper total expenditure limit of the bracket

TE = Total Expenditure in the bracket

PCE = Per Capita Expenditure in the bracket/per family

Now, since we are concerned with the last total expenditure bracket, therefore,

$$r_{j+1} = \infty$$

$$(r_{j+1})^{1-b} = 0 \quad \text{if } b > 1$$

Then,

$$PCE = \frac{b}{b-1} (r_j)$$

The "Distribution Parameter" (b) could be obtained from the following formula:

$$b = [\ln(N_{Fj} + N_{Fj-1}) - \ln(N_{Fj})] / [\ln(r_j) - \ln(r_{j-1})]^1$$

¹For example, the application of the method to 1351 urban data (63) is shown below:

$$N_{Fj} = 411$$

$$N_{Fj-1} = 691$$

$$r_j = 30,000$$

$$r_{j-1} = 20,000$$

Then,

$$b = [\ln(411 + 691) - \ln(411)] / [\ln(30,000) - \ln(20,000)]$$

$$b = 2.43$$

$$PCE = \frac{2.43}{2.43-1} (30,000)$$

$$PCE \doteq 50940 \quad \text{per family/per month}$$

The total family expenditure and family consumption expenditure for each commodity are transferred to the total individual expenditure and individual consumption expenditure of the same commodity by dividing family data in each bracket by the average size of the family of the same bracket. Then, the resulting data for each bracket are weighted by percentage frequency of individuals in the same bracket.¹

The consumption of a few commodities in the lowest income bracket is zero (e.g., poultry, 1351 urban). In order to be able to take a log of these consumption data, the zero data have been changed to (.01).

Time-Series Data Processing

It is extremely difficult, and in most cases impossible, to find accurate time-series data for the period prior to 1338 in Iran. Furthermore, there is no official report on consumption data, even for recent years.

$${}^1 y_j = Y_j \frac{1}{N_j} (f_j) \text{ and } q_{ij} = Q_{ij} \frac{1}{N_j} (f_j)$$

where

N_j = average family size in bracket j

f_j = percentage frequency of individuals in bracket j

Y_j = total expenditure in bracket j/per family

y_j = total expenditure in bracket j/per individual weighted for the individual number in each bracket

Q_{ij} = consumption expenditure of commodity i in bracket j/per family

q_{ij} = consumption expenditure of commodity i in bracket j/per individual weighted for the individual number in each bracket

The kind of data we are concerned with in this section are per capita total expenditure, the per capita consumption of different meats and the prices of those meats. The analysis has two parts, of which the first deals with demand for lamb and beef in the urban areas and the second with demand for red meat (lamb and beef) and white meat (poultry) in the whole country.

The data have been collected from different government reports, and adjusted by the author as shown in the following:

Urban

The per capita consumption of lamb and beef in the urban areas is estimated as follows:

$$q_{LUt} = \frac{S_{Lt} + I_{Lt} + M_{Lt}}{Z_{Ut}} \quad t = 1338, \dots, 1353$$

$$q_{BUt} = \frac{S_{Bt} + I_{Bt} + M_{Bt}}{Z_{Ut}} \quad t = 1338, \dots, 1353$$

where

S_L^1 = total amount of lamb slaughtered in official slaughter houses²
(Kg)

S_B = total amount of beef slaughtered in official slaughter houses
(Kg)

I_L^3 = total amount of lamb illegally slaughtered for urban areas (Kg)

¹See (48 to 52).

²There are no slaughter houses in rural areas in Iran, therefore, all cattle slaughtered by slaughter houses are included in urban consumption.

³A nonofficial estimate of illegally slaughtered is 20% and 3% of legally slaughtered for "Tehran, Esfahan Ostans," and "other Ostans," respectively.

I_B = total amount of beef illegally slaughtered for urban areas (Kg)

M_L^1 = total amount of lamb imported² (either frozen or fresh) (Kg)

M_B = total amount of beef imported (either frozen or fresh) (Kg)

Z_U^3 = total population of urban areas

q_{LU} = per capita consumption of lamb in urban areas (Kg)

q_{BU} = per capita consumption of beef in urban areas (Kg)

Because of consistency with the cross-section study, rather than using the "Gross National Product" (G.N.P.), the "Total Consumption Expenditure" is used. Neither is the G.N.P. reported separately for urban and rural areas in regular publications.

The deflated per capita consumption expenditure in urban areas is estimated below:

$$y_{Ut} = \frac{Y_{Ut}^*}{Z_{Ut}} \frac{1}{\pi_{Ut}}$$

where

Y_{Uj}^4 = total consumption expenditure in urban areas

π_U^5 = consumer urban retail sale price index (1348 = 100)

y_U = deflated per capita total expenditure in urban areas

¹See (16 to 31).

²The numbers of live animal imports are not included, since those are already included in slaughter house reports.

³See (10).

⁴See (5 to 8 and 10).

⁵Bank Markazi, the economics statistics directory. The data were collected by direct interview.

Lamb and beef price indexes are used, since there are not actual prices available.

The deflated lamb and beef retail sale prices indexes are as follows:¹

$$P_{LUt} = \frac{P_{LUt}^*}{\pi_{Ut}}$$

$$P_{BUt} = \frac{P_{BUt}^*}{\pi_{Ut}}$$

where

P_{LU}^* = lamb urban retail sale price index (1348 = 100)

P_{BU}^* = beef urban retail sale price index (1348 = 100)

P_{LU} = lamb urban deflated retail sale price index (1348 = 100)

P_{BU} = beef urban deflated retail sale price index (1348 = 100)

Country

The per capita (red meat² and white meat³) consumption in the country is estimated as follows:

$$q_{Rt} = \frac{Q_{Rt} + M_{Rt} + M_{RAt} - X_{RAt}}{Z_t} \quad t = 1338, \dots, 1353$$

$$q_{Wt} = \frac{Q_{Wt} + M_{Wt} + M_{WA t} - X_{WA t}}{Z_t} \quad t = 1338, \dots, 1353$$

¹Bank Markazi, the economic statistics directory. The data were collected by direct interview.

²Red meat = lamb + beef.

³White meat = poultry.

where

Q_R^1 = total amounts of red meat produced in the country (Kg)

Q_W = total amounts of white meat produced in the country (Kg)

M_R^2 = total amounts of red meat imported (either frozen or fresh) (Kg)

M_W = total amounts of white meat imported (either frozen or fresh) (Kg)

M_{RA}^2 = total amounts of live animal red meat imported (Kg)

M_{WA} = total amounts of live animal white meat imported (Kg)

X_{RA}^2 = total amounts of live animal red meat exported (Kg)

X_{WA} = total amounts of live animal white meat exported (Kg)

Z^3 = total population of the country

q_R = per capita consumption of red meat in the country (Kg)

q_W = per capita consumption of white meat in the country (Kg)

To be consistent with the cross-section study, the "Total Consumption Expenditure" is used rather than G.N.P.

The deflated per capita consumption expenditure in the country is estimated below:

$$y_t = \frac{Y_t^*}{Z_t} \frac{1}{\pi_t}$$

where

Y_t^1 = total consumption expenditure in the country

π^4 = consumer country wholesale price index (1348 = 100)

¹See (5 to 8 and 10).

²See (16 to 31).

³See (10).

⁴See (9).

y = deflated per capita consumption expenditure in the country

The red meat and white meat price indexes are used, since there are no actual prices available.

The deflated red meat and white meat wholesale price indexes are as follows:

$$P_{Rt} = \frac{P_{Rt}^*}{\pi_t}$$

$$P_{Wt} = \frac{P_{Wt}^*}{\pi_t}$$

where

P_R^1 = red meat country wholesale price index (1348 = 100)

P_W^* = white meat country wholesale price index (1348 = 100)

P_R = red meat country deflated wholesale price index (1348 = 100)

P_W = white meat country deflated wholesale price index (1348 = 100)

¹See (9).

CHAPTER V. FUNCTIONAL FORM OF DEMAND

In this chapter, the functional form of demand economically and statistically the most appropriate in this study is investigated. Three different demand functions, namely linear, semi-log and double-log, are studied and compared in this chapter.

In order to utilize either cross-sectional or time-series analysis to estimate desired demand equations, functional form needs to be identified, as its regression coefficients are estimated and checked for significance and reliability.

Regarding the statistical requirements, one initially desires:

1. A high coefficient of multiple correlation
2. Reliable regression coefficients
3. A random error term (i.e., not serially correlated)

Furthermore, with regard to the economic theory, it is essential that the relation be economically defined; namely, the sign and size of coefficients must be consistent with those expected from the theory of consumer behavior. Since the sizes of different elasticities are very dependent on the functional form of demand, special treatment must be given to the choice of the appropriate function.

In cross-section and time-series analysis the following demand equations are investigated:

Cross-section:

$$q_i = \alpha_i + \beta_i y + U_i \quad (5.1)$$

$$q_i = \alpha_i + \beta_i \text{Lny} + U_i \quad (5.2)$$

$$\text{Ln}q_i = \alpha_i + \beta_i \text{Ln}y + U_i \quad (5.3)$$

where

$q_i = n \times 1$ - vector of expenditure on commodity i by n groups each in separate expenditure brackets

$y = n \times 1$ - vector of total expenditure by n groups each in separate expenditure average brackets

α_i = unknown constant coefficient for commodity i

β_i = unknown total expenditure coefficient for commodity i

Time-series:

$$q_i = \alpha_i + \beta_i y + \gamma_i P_i + U_i \quad (5.4)$$

$$q_i = \alpha_i + \beta_i \text{Ln}y + \gamma_i \text{Ln}P_i + U_i \quad (5.5)$$

$$\text{Ln}q_i = \alpha_i + \beta_i \text{Ln}y + \gamma_i \text{Ln}P_i + U_i \quad (5.6)$$

where

$q_i = t \times 1$ - vector of per capita consumption of commodity i over t years

$y = t \times 1$ - vector of per capita expenditure over t years

$P_i = t \times 1$ - vector of price index for commodity i over t years

α_i = unknown constant coefficient for commodity i

β_i = unknown total expenditure coefficient for commodity i

γ_i = unknown price coefficient for commodity i

The symbol "Ln" stands for natural logarithm.

The linear form (5.1 & 5.4) assumes that the elasticities tend toward unity as explanatory variables increase indefinitely. The semi-logarithm form (5.2 & 5.5) allows no consumption below an initial level of income; it has an income elasticity varying inversely with the level of consumption. The double logarithm form (5.3 & 5.6) is a unique function in that the regression coefficients are also elasticities. It assumes a constant elasticity over the whole range of income and prices.

The simple least square regressions were applied: 1) to equations 5.1, 5.2 and 5.3 for lamb, beef, poultry and fish of the 1351 urban cross-section data; 2) to equations 5.4, 5.5 and 5.6 for lamb and beef of the 1338-1353 urban time-series data. The equations yielded the following coefficients:

Cross-section:

$$q_L = 11.43 + 0.07 Y \quad R^2 = 0.85 \quad (5.7)$$

(33.25) (0.01)

$$q_L = -457.84 + 192.97 \text{ Ln}Y \quad R^2 = 0.84 \quad (5.8)$$

(135.431) (42.31)

$$\text{Ln}q_L = -1.19 + 1.02 \text{ Ln}Y \quad R^2 = 0.96 \quad (5.9)$$

(0.33) (0.1)

$$q_B = 2.97 + 0.01 Y \quad R^2 = 0.70 \quad (5.10)$$

(4.83) (0.002)

$$q_B = -36.66 + 16.39 \text{ Ln}Y \quad R^2 = 0.67 \quad (5.11)$$

(19.33) (6.04)

$$\text{Ln}q_B = -1.54 + 0.82 \text{ Ln}Y \quad R^2 = 0.87 \quad (5.12)$$

(0.50) (0.15)

$$q_P = -3.24 + 0.01 Y \quad R^2 = 0.74 \quad (5.13)$$

(5.63) (0.002)

$$q_P = -55.11 + 21.58 \text{ Ln}Y \quad R^2 = 0.70 \quad (5.14)$$

(23.17) (7.24)

$$\text{Ln}q_P = -8.15 + 2.73 \text{ Ln}Y \quad R^2 = 0.97 \quad (5.15)$$

(0.67) (0.21)

$$q_F = -0.36 + 0.004 Y \quad R^2 = 0.94 \quad (5.16)$$

(0.93) (0.41)

$$q_F = -22.73 + 9.26 \text{ Ln}Y \quad R^2 = 0.90 \quad (5.17)$$

(4.67) (1.46)

$$\text{Ln}q_F = -4.60 + 1.63 \text{ Ln}Y \quad R^2 = 0.96 \quad (5.18)$$

(0.48) (0.15)

Time-series:

$$q_L = 17.06 + 0.0002 Y - 0.11 P_L \quad R^2 = 0.75 \quad (5.19)$$

(1.26) (0.00006) (0.03)

$$q_L = -3.04 + 6.17 \text{Ln}Y - 10.41 \text{Ln}P_L \quad R^2 = 0.80 \quad (5.20)$$

(6.70) (1.43) (2.16)

$$\text{Ln}q_L = 1.21 + 0.51 \text{Ln}Y - 0.86 \text{Ln}P_L \quad R^2 = 0.81 \quad (5.21)$$

(0.49) (0.11) (0.17)

$$q_B = 5.80 + 0.0002 Y - 0.05 P_B \quad R^2 = 0.75 \quad (5.22)$$

(0.35) (0.00005) (0.02)

$$q_B = -16.01 + 3.54 \text{Ln}Y - 3.11 \text{Ln}P_B \quad R^2 = 0.68 \quad (5.23)$$

(6.73) (1.20) (1.29)

$$\text{Ln}q_B = -1.93 + 0.60 \text{Ln}Y - 0.54 \text{Ln}P_B \quad R^2 = 0.67 \quad (5.24)$$

(1.15) (0.21) (0.22)

where

q_L = per capita expenditure of lamb (cross-section)

= per capita consumption of lamb (time-series)

q_B = per capita expenditure of beef (cross-section)

= per capita consumption of beef (time-series)

q_p = per capita expenditure of poultry (cross-section)

q_f = per capita expenditure of fish (cross-section)

P_L = price of lamb (time-series)

P_B = price of beef (time-series)

Y = per capita total expenditure (cross-section and time-series)

R^2 = multiple correlation

The parentheses indicate standard error.

Regressions similar to the above were also calculated for rural data. Each demand equation was first tested for logic and then for statistical significance.

The estimated parameters for each equation were subjected to t-test¹ to determine if they were significantly different from zero. Also, the scatter diagrams in Figures 5.1-5.6 show the relations of 1) lambs, beef, poultry and fish to expenditure²; and 2) lamb and beef with their prices for the above tested equations.

After due consideration of the theoretical implications of each model, the above statistical results³ and figures, the double logarithmic form was chosen as the one most suitable for this study. The next chapter will therefore present the demand equations for lamb, beef, poultry and fish as estimated by fitting the double log function to all the available cross-section and time-series data.

¹In all cases in demand theory, we have a priori information about the sign of coefficients; therefore, the one-tailed t-test was used throughout the next chapter.

²Figures 5.2 and 5.4 show the per capita expenditure of beef and fish in the last total expenditure group is by far higher than the other groups. This is so because:

1. The quality of beef (fish) consumption in the last group of total expenditures is much higher than in the others. As a rule the beef consumption in last group is of "fat" whereas grass-fed cattle are consumed in the other groups.
2. The service attained from certain amounts of beef (fish) consumption is much higher in the last group of total expenditure than in the other groups.

It is important to include the observations in the last group of total expenditure, since the total consumption of meat by this group is considerable, compared to the other groups.

³Especially the multiple correlation which, with the exception of the last equation, is always larger in double log form.

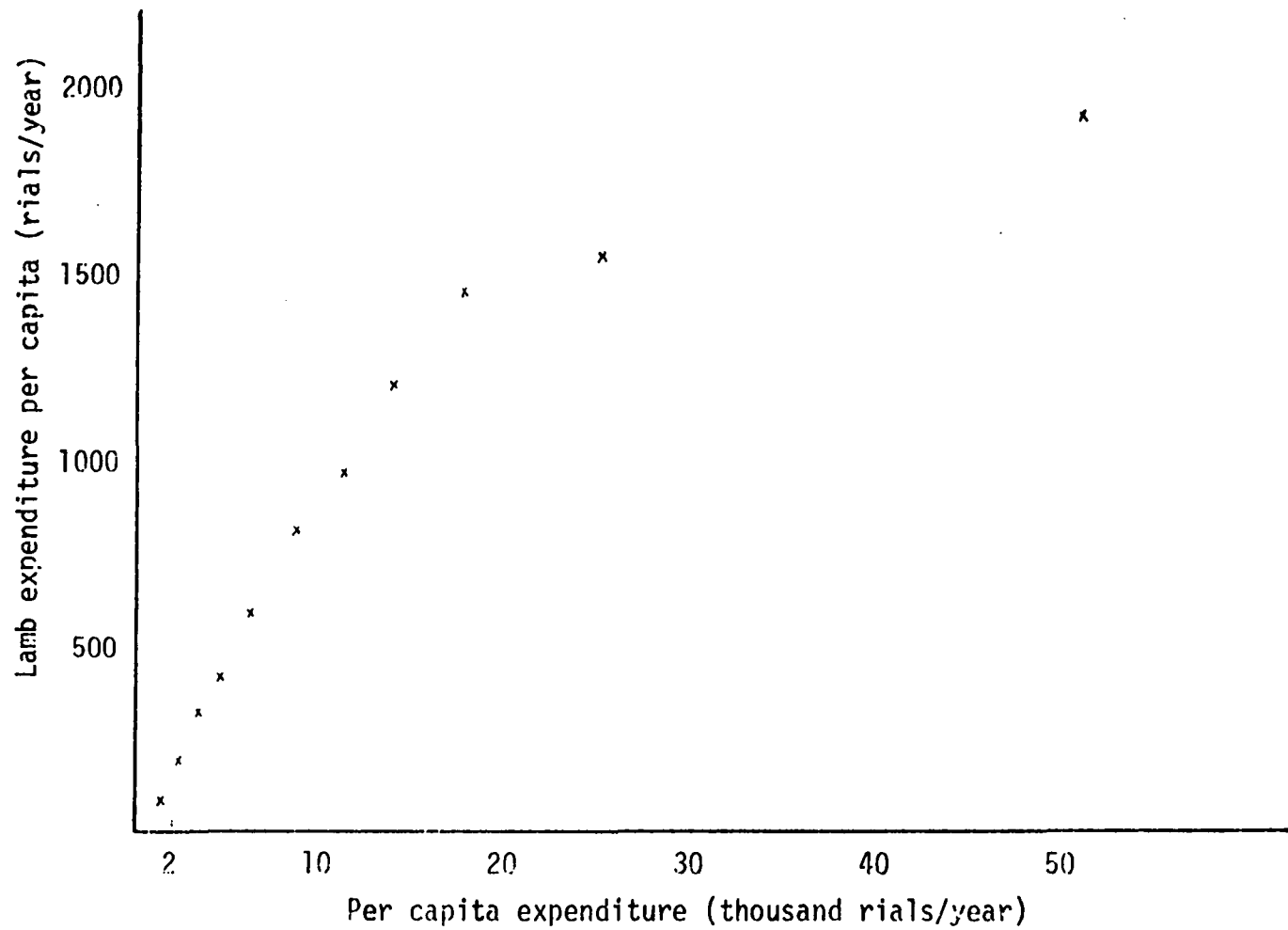


Figure 5.1. Scatter diagram for lamb (1351, urban)

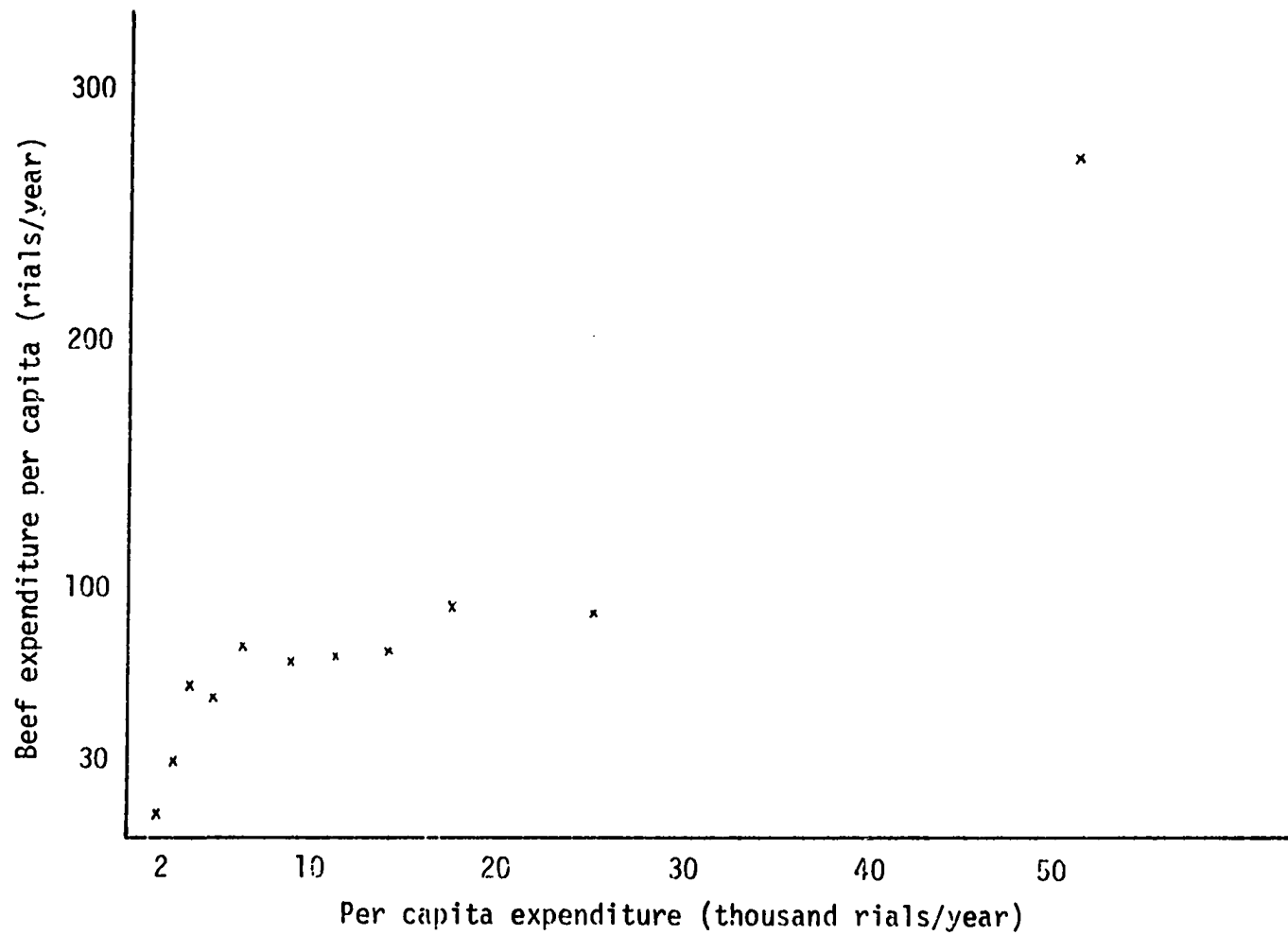


Figure 5.2. Scatter diagram for beef (1351, urban)

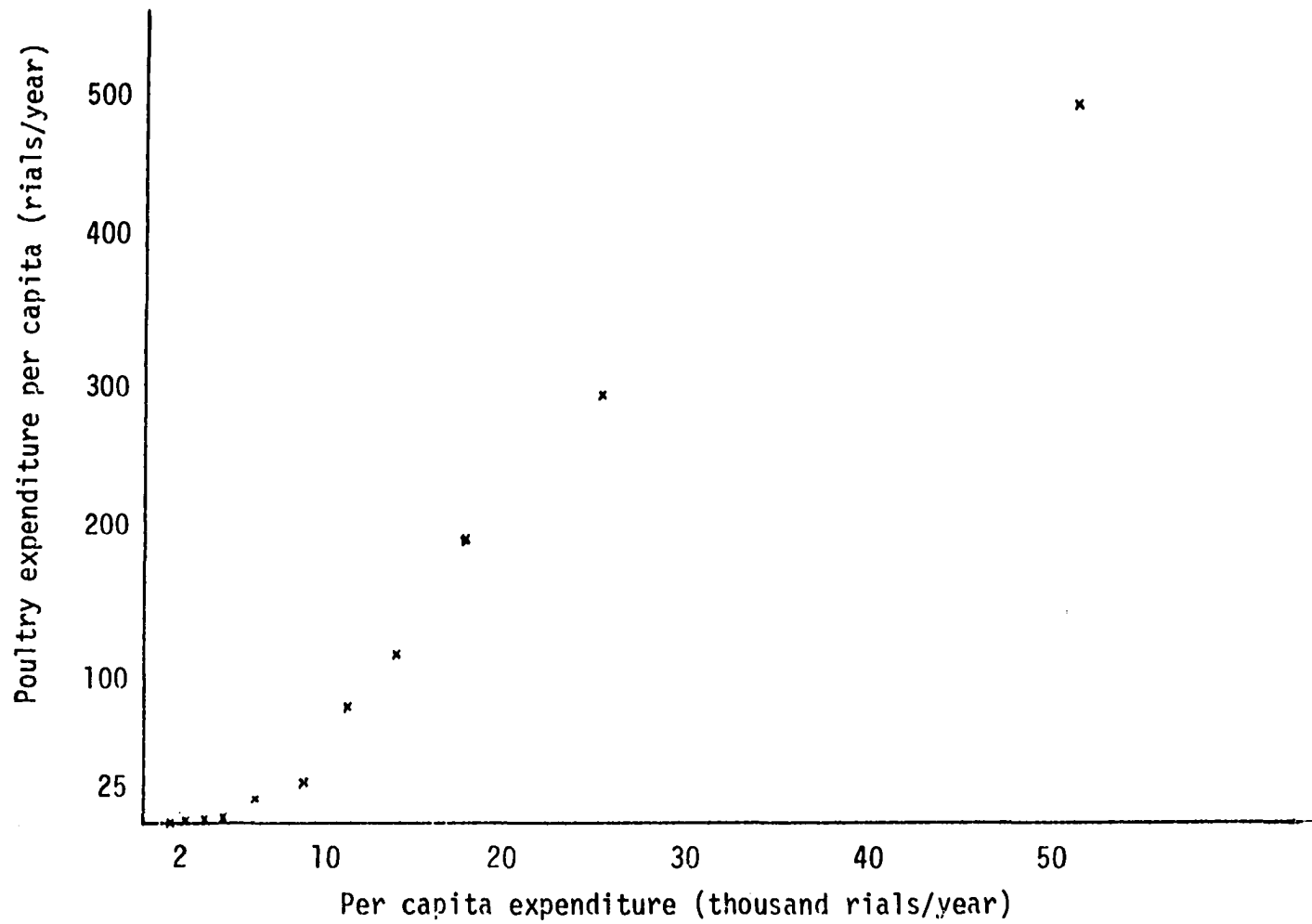


Figure 5.3. Scatter diagram for poultry (1351, urban)

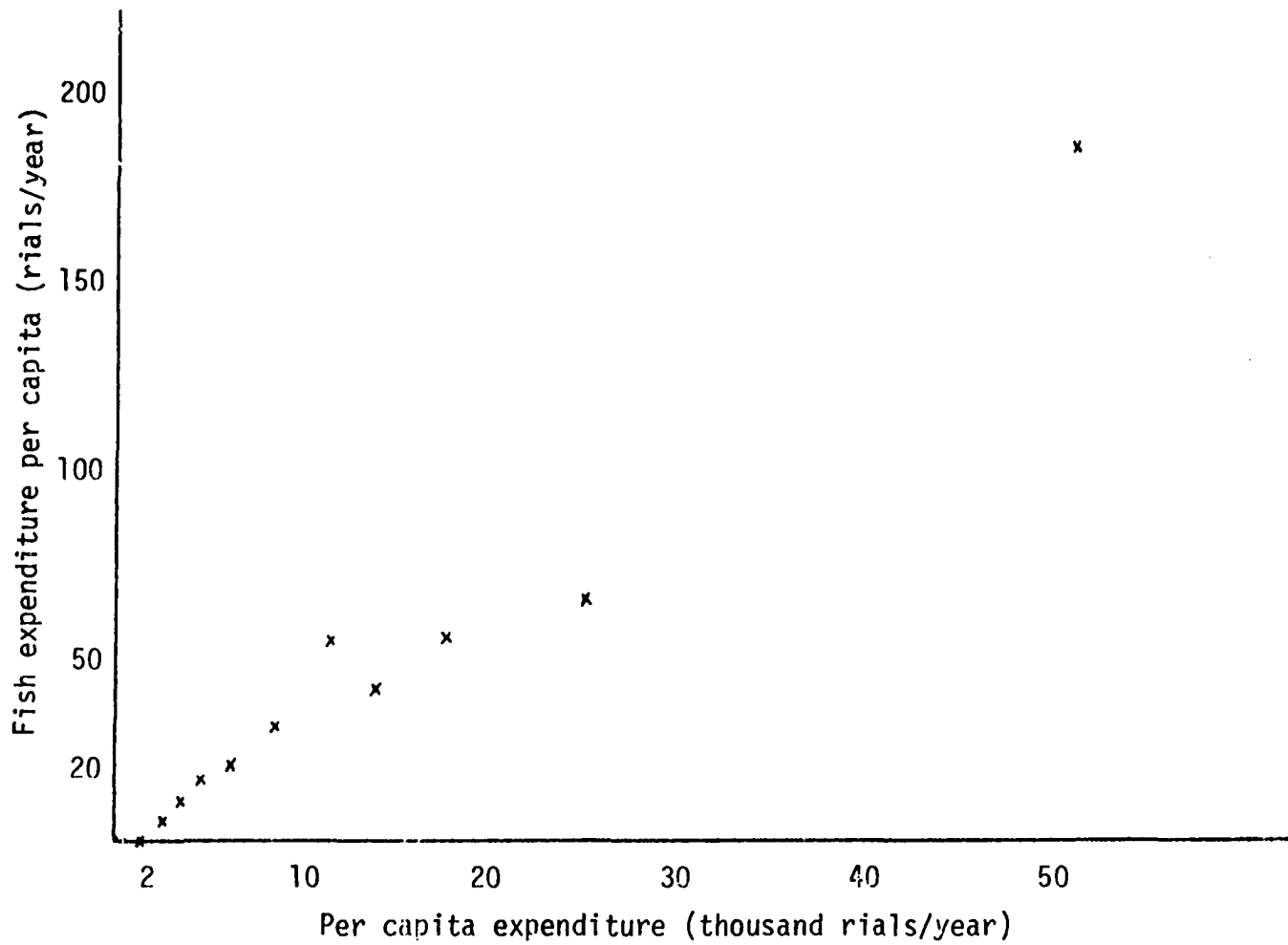


Figure 5.4. Scatter diagram for fish (1351, urban)

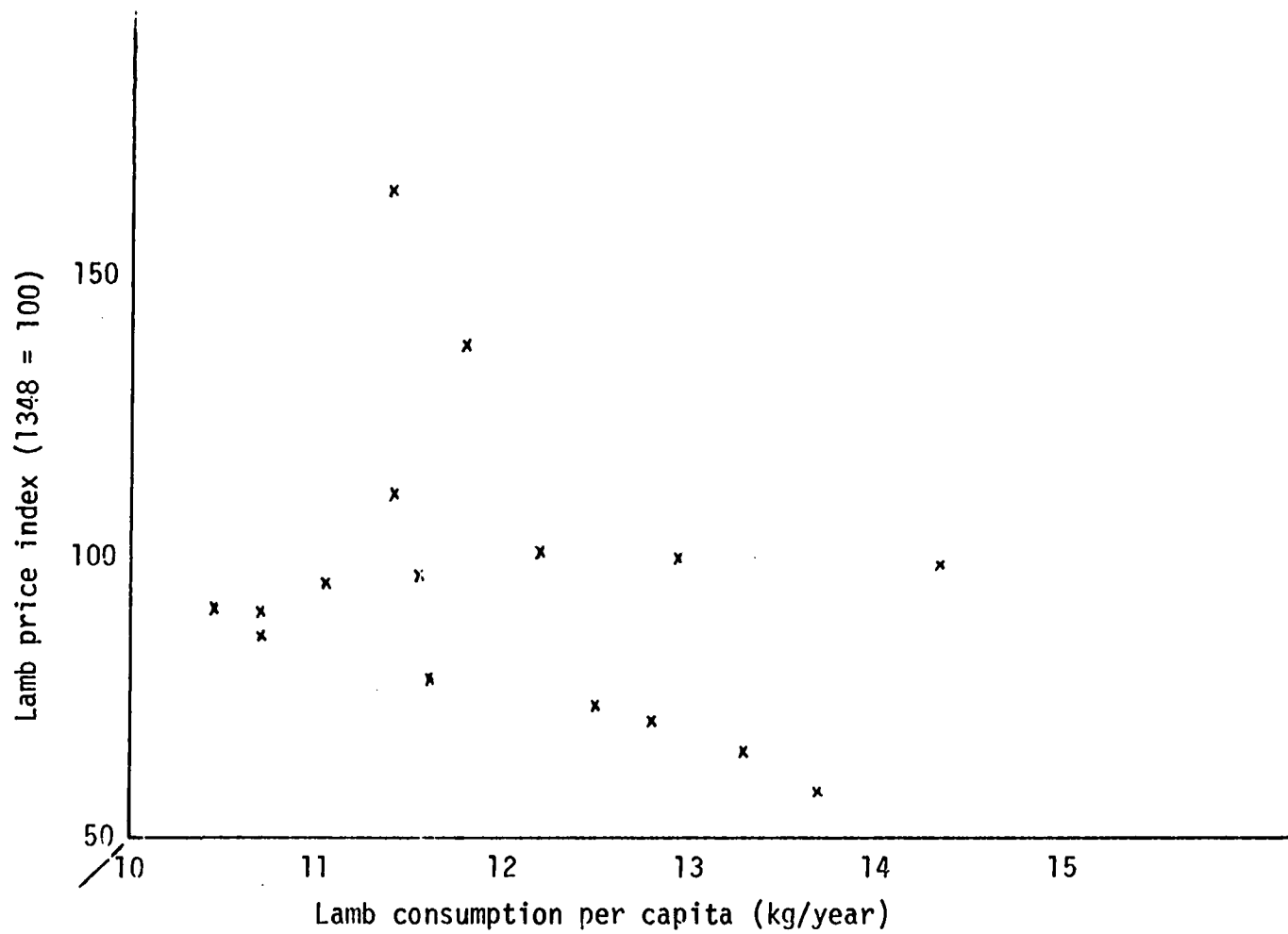


Figure 5.5. Scatter diagram for lamb (1338-1353, urban)

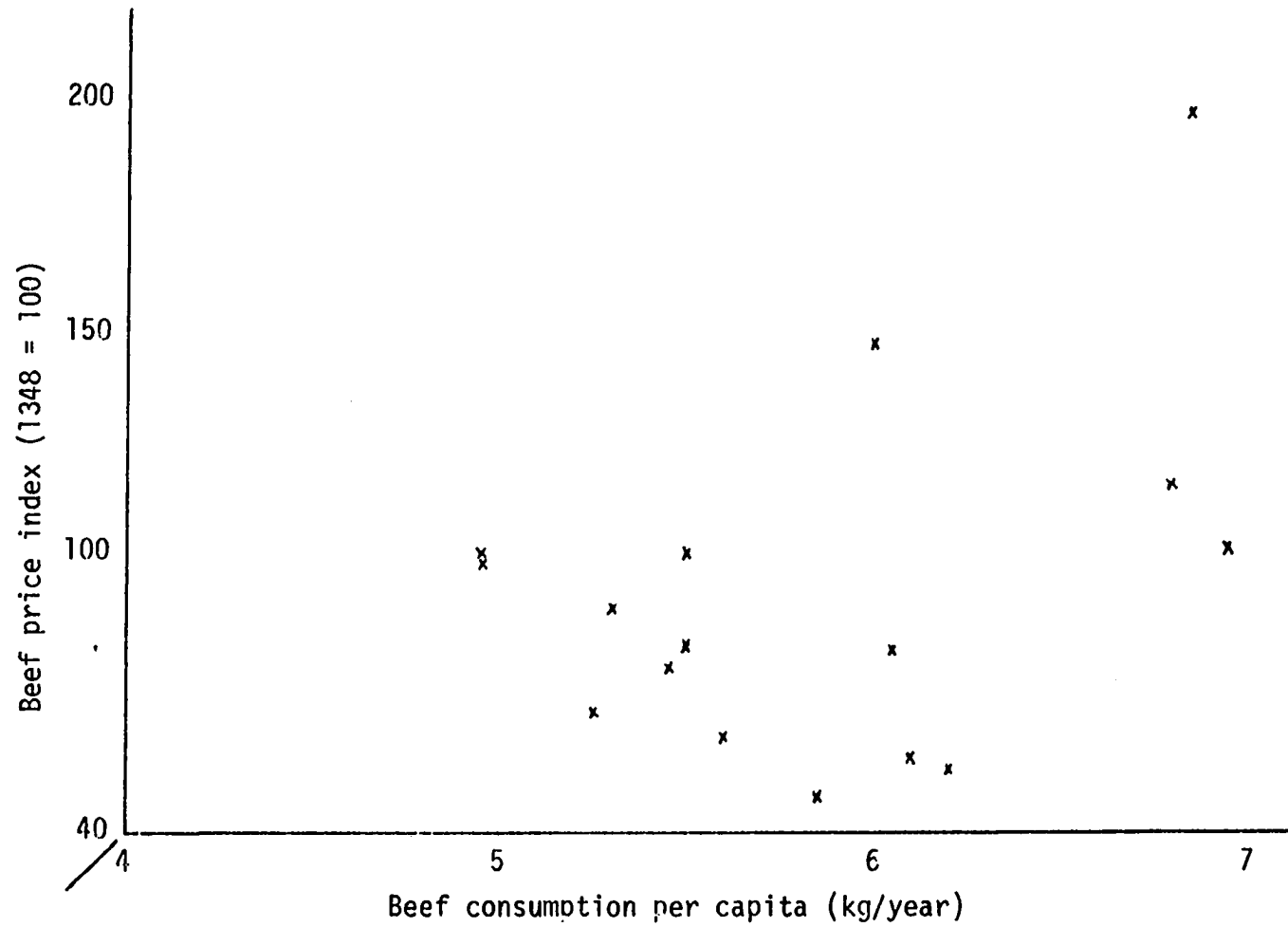


Figure 5.6. Scatter diagram for beef (1338-1353, urban)

CHAPTER VI. PRESENT STRUCTURE OF DEMAND

The chief purpose of this chapter is to develop and utilize different models for cross-section and time-series data as well as combine them (i.e., pooled cross-section, time-series). The chapter is divided into three sections with each section containing the development of the model and presenting the numerical results.

Cross-Section Analysis

Model

The consumption expenditure is regressed on total expenditure and family size for both urban and rural data of the year 1351.

$$\text{Ln}q_i = \alpha_i + \beta_i \text{Ln}Y + \gamma_i \text{Ln}N + U_i \quad (6.1)$$

where

q_i = per capita consumption expenditure of commodity i

Y = total per capita expenditure

N = family size

U_i = error term

The coefficients yielded are tested for economic logic and statistical significance. Both urban and rural coefficients of "LnN" for different kinds of meat are either in the wrong sign¹ or not significant. Therefore variable N (family size) is excluded from the model.

Analysis of covariance In order to combine the information of five years (1347-1351) of cross-section data, dummy variables are introduced into

¹The signs of the family coefficients were expected to be negative, since it shows economies of scale.

the model (43). There are many advantages in using dummy variables in economic analysis, especially when it is believed that the periods are not homogeneous in the single analysis. In such cases we cannot set up a continuous scale for the variable. We must assign some levels to these variables in order to take account of the fact that the various variables may have separate deterministic effects on the response.

It has been useful to use dummy variables in the yearly observations, requiring some adjustment for a possible period effect. It has been common to use the zero-one variables-simple covariance model to represent dichotomous variables indirectly observable. Dummy variables can be used also to allow the change in slopes. However, the technique of using dummy variables will help to increase the degrees of freedom we have and give an estimation of the coefficient estimates for each year exactly equal to the coefficient estimates obtained from separate functions for each year.

The framework developed to test the presence of yearly changes in the demand¹ for individual meats consists of three basic models:

1. Specifies no yearly shifts in either the slope or level of the demand curve.
2. Specifies no change in the slope but allows change in the level of the demand curve.
3. Allows both the slope and the level of the demand curve to change by years.

The structural form of three models follow.

¹Through this section and that of the cross-section economic analysis of Chapter VII, the relation between per capita meat expenditure and per capita total expenditure " $q = f(Y)$ " is called the demand function (equation). This is comparable to the Engle curve which is the relation between quantity of consumption and income.

$$\text{Ln}q_i = \alpha_i + \beta_i \text{Ln}Y + U_i \quad \text{Model I} \quad (6.2)$$

$$\text{Ln}q_i = \alpha_i + \beta_i \text{Ln}Y + \alpha_{i1} D_1 + \gamma_{i2} D_2 + \gamma_{i3} D_3 + \gamma_{i4} D_4 + U_i \quad (6.3)$$

Model II

$$\begin{aligned} \text{Ln}q_i = \alpha_i + \beta_i \text{Ln}Y + \gamma_{i1} D_1 + \gamma_{i2} D_2 + \gamma_{i3} D_3 + \gamma_{i4} D_4 + \delta_{i1} D_1 \text{Ln}Y + \\ \delta_{i2} D_2 \text{Ln}Y + \delta_{i3} D_3 \text{Ln}Y + \delta_{i4} D_4 \text{Ln}Y + U_i \quad \text{Model III} \quad (6.4) \end{aligned}$$

where D's are dummy variables and $D_i = 1$ for year i and $D_i = 0$ for other years.

The intercepts and slopes of each year are found below:

<u>Year</u>	<u>Intercept</u>	<u>Slope</u>
1347	$\alpha + \gamma_4$	$\beta + \delta_4$
1348	$\alpha + \gamma_3$	$\beta + \delta_3$
1349	$\alpha + \gamma_2$	$\beta + \delta_2$
1350	$\alpha + \gamma_1$	$\beta + \delta_1$
1351	$\alpha +$	$\beta +$

The F tests are used to investigate whether any difference among these models exists. The null hypothesis and F ratio would be as follows:

- Ho: 1. Model II is not an improvement of Model I.
2. Model III is not an improvement of Model II.

$$F_{\frac{n_1-n_2}{n_2}} = \frac{(SS_{\text{reduced model}} - SS_{\text{full model}})/(n_1-n_2)}{MS_{\text{full model}}}$$

where

n_1 = degrees of freedom of reduced model

n_2 = degrees of freedom of full model

SS = sum of square residual

MS = mean square residual

Numerical structure of demand

Lamb (urban) The results of three models investigated follow:

$$\text{Ln}q_{LU} = -2.62 + 1.00 \text{ Ln } Y_U \quad R^2 = 0.95 \quad (6.5)$$

(0.40) (0.05)

$$\text{Ln}q_{LU} = -2.48 + 0.99 \text{ Ln}Y_U - 0.11 D_1 + 0.02 D_2 + 0.08 D_3 + 0.03 D_4$$

(0.43) (0.06) (0.14) (0.17) (0.17) (0.17)

$$R^2 = 0.95 \quad (6.6)$$

$$\text{Ln}q_{LU} = -2.74 + 1.02 \text{ Ln}Y_U - 0.70 D_1 + 1.06 D_2 + 0.90 D_3 + 1.68 D_4$$

(0.80)(0.11) (1.12) (1.32) (1.73) (1.61)

$$+ 0.08 D_1 \text{ Ln}Y_U - 0.13 D_2 \text{ Ln}Y_U - 0.11 D_3 \text{ Ln}Y_U - 0.21 D_4 \text{ Ln}Y_U$$

(0.15) (0.17) (0.22) (0.21)

$$R^2 = 0.96 \quad (6.7)$$

where

q_{LU} = per capita lamb expenditure in urban areas

Y_U = per capita total expenditure in urban areas

Table 6.1. Intercepts and slopes of demand for lamb in urban areas (1347-1351)

Year	Intercept	Slope
1347	-1.06	0.81
1348	-1.84	0.91
1349	-1.68	0.89
1350	-3.44	1.1
1351	-2.74	1.02

Test of hypothesis:

H_0 : Model II is not an improvement of Model I.

$$F_{3,4}^4 = \frac{(3.777 - 3.6203)/4}{.10648} = 0.37$$

We fail to reject the null hypothesis, since table value of $F_{3,4}^4 = 2.65$.¹

Ho: Model III is not an improvement of Model II.

$$F_{3,0}^4 = \frac{(3.6203 - 3.2915)/4}{.10972} = 0.75$$

We fail to reject the null hypothesis since table value of $F_{3,0}^4 = 2.69$.

Therefore, it can be concluded that there is no significant difference between intercepts and slopes of different years, and Model I is thus proposed.

The income regression coefficient of Model I (1.00) is highly significant.

Lamb (rural) The three models were investigated, and the results are as follow:

$$\text{Ln}q_{LR} = -4.17 + 1.19 \text{Ln}Y_R \quad R^2 = 0.95 \quad (6.8)$$

(0.44) (0.06)

$$\text{Ln}q_{LR} = -4.36 + 1.22 \text{Ln}Y_R + 0.08 D_1 + 0.01 D_2 + 0.05 D_3 - 0.18 D_4$$

(0.46) (0.07) (1.00) (0.12) (0.12) (0.12)

$$R^2 = 0.96 \quad (6.9)$$

$$\text{Ln}q_{LR} = -4.38 + 1.22 \text{Ln}Y_R + 0.06 D_1 - 0.97 D_2 + 0.90 D_3 - 0.27 D_4$$

(0.71) (0.10) (1.16) (0.55) (1.37) (1.61)

$$+ .003 D_1 \text{Ln}Y_R + 0.14 D_2 \text{Ln}Y_R - 0.12 D_3 \text{Ln}Y_R + 0.01 D_4 \text{Ln}Y_R$$

(0.17) (0.08) (0.19) (0.22)

$$R^2 = 0.96 \quad (6.10)$$

where

q_{LR} = per capita lamb expenditure in rural areas

Y_R = per capita total expenditure in rural areas

¹Through this section 5% is used as the level of significance.

Table 6.2. Intercepts and slopes of demand for lamb in rural areas (1347-1351)

Year	Intercepts	Slopes
1347	-4.65	1.23
1348	-3.48	1.10
1349	-5.35	1.36
1350	-4.32	1.25
1351	-4.38	1.22

Test of hypothesis:

Ho: Model II is not an improvement of Model I.

$$F_{34}^4 = 1.22$$

We fail to reject the null hypothesis.

Ho: Model III is not an improvement of Model II.

$$F_{30}^4 = 0.97$$

We fail to reject the null hypothesis.

Therefore, it can be concluded that there is no significant difference between intercepts and slopes of different years. Model I is proposed.

The income regression coefficient of Model I (1.19) is highly significant.

Beef (urban) Following are the results of the three models investigated.

$$\text{Ln}q_{\text{BU}} = -2.84 + 0.72 \text{Ln}Y_{\text{U}} \quad R^2 = 0.77 \quad (6.11)$$

(0.75) (0.10)

$$\text{Ln}q_{\text{BU}} = -2.67 + 0.70 \text{Ln}Y_{\text{U}} - 0.14 D_1 - 0.09 D_2 + 0.06 D_3 + 0.22 D_4$$

(0.81) (0.11) (0.26) (0.32) (0.31) (0.32)

$$R^2 = 0.78 \quad (6.12)$$

$$\text{Ln}q_{\text{BU}} = -3.54 + 0.82 \text{Ln}Y_{\text{U}} + 2.29 D_1 - 2.21 D_2 + 1.51 D_3 + 3.86 D_4$$

(1.44) (0.19) (2.01) (2.38) (3.12) (2.90)

$$-0.33 D_1 \text{Ln}Y_{\text{U}} + 0.26 D_2 \text{Ln}Y_{\text{U}} - 0.19 D_3 \text{Ln}Y_{\text{U}} - 0.47 D_4 \text{Ln}Y_{\text{U}}$$

(0.27) (0.31) (0.40) (0.37)

$$R^2 = 0.82 \quad (6.13)$$

where

q_{BU} = per capita beef expenditure in urban areas

Y_{U} = per capita total expenditure in urban areas

Table 6.3. Intercepts and slopes of demand for beef in urban areas (1347-1351)

Year	Intercept	Slope
1347	+0.32	0.35
1348	-2.03	0.63
1349	-5.75	1.08
1350	-1.25	0.49
1351	-3.54	0.82

Test of hypothesis:

H_0 : Model II is not an improvement of Model I.

$$F_{34}^4 = 0.38$$

We fail to reject the null hypothesis.

H_0 : Model III is not an improvement of Model II.

$$F_{30}^4 = 1.35$$

We fail to reject the null hypothesis.

Thus, the conclusion is that there is no significant difference between intercepts and slopes of different years and the proposal is for Model I.

The income regression coefficient of Model I (0.72) is highly significant.

Beef (rural) The three models were investigated and the results are as follows:

$$\text{Ln}q_{BR} = -6.75 + 1.28 \text{Ln}Y_R \quad R^2 = 0.79 \quad (6.14)$$

(1.13) (0.16)

$$\text{Ln}q_{BR} = -7.36 + 1.40 \text{Ln}Y_R - 0.20 D_1 - 0.77 D_2 - 0.47 D_3 - 0.05 D_4$$

(1.15) (0.17) (0.25) (0.31) (0.31) (0.31)

$$R^2 = 0.83 \quad (6.15)$$

$$\text{Ln}q_{BR} = -7.08 + 1.36 \text{Ln}Y_R + 0.32 D_1 - 2.67 D_2 - 2.59 D_3 + 1.42 D_4$$

(1.79) (0.26) (2.93) (1.40) (3.45) (4.07)

$$-0.08 D_1 \text{Ln}Y_R + 0.28 D_2 \text{Ln}Y_R + 0.29 D_3 \text{Ln}Y_R - 0.20 D_4 \text{Ln}Y_R$$

(0.43) (0.20) (0.48) (0.56)

$$R^2 = 0.85 \quad (6.16)$$

where

q_{BR} = per capita beef expenditure in rural areas

Y_R = per capita total expenditure in rural areas

Table 6.4. Intercepts and slopes of demand for beef in rural areas (1347-1351)

Year	Intercept	Slope
1347	-5.66	1.16
1348	-9.67	1.07
1349	-9.75	1.64
1350	-6.76	1.28
1351	-7.08	1.36

Test of hypothesis:

Ho: Model II is not an improvement of Model I.

$$F_{34}^4 = 1.96$$

We fail to reject the null hypothesis.

Ho: Model III is not an improvement of Model II.

$$F_{30}^4 = 0.67$$

We fail to reject the null hypothesis.

Therefore, it can be concluded that there is no significant difference between intercepts and slopes of different years and Model I is proposed.

The income regression coefficient of Model I (1.28) is highly significant.

Poultry (urban) The three models were investigated, with the following results:

$$\text{Ln}q_{pU} = -23.91 + 3.28 \text{Ln}Y_U \quad R^2 = 0.81 \quad (6.17)$$

(2.91) (0.38)

$$\text{Ln}q_{pU} = -26.03 + 3.72 \text{Ln}Y_U - 0.12 D_1 - 2.75 D_2 - 2.59 D_3 - 2.72 D_4$$

(2.65) (0.35) (0.85) (1.04) (1.03) (1.04)

$$R^2 = 0.88 \quad (6.18)$$

$$\text{Ln}q_{pU} = -18.78 + 2.73 \text{Ln}Y_U + 2.84 D_1 - 18.01 D_2 - 34.22 D_3 - 26.55 D_4$$

(3.32) (0.45) (4.65) (5.50) (7.21) (6.69)

$$-0.41 D_1 \text{Ln}Y_U + 2.00 D_2 \text{Ln}Y_U + 4.09 D_3 \text{Ln}Y_U + 3.08 D_4 \text{Ln}Y_U$$

(0.63) (0.71) (0.93) (0.86)

$$R^2 = 0.95 \quad (6.19)$$

where

q_{pU} = per capita poultry expenditure in urban areas

Y_U = per capita total expenditure in urban areas

Table 6.5. Intercepts and slopes of demand for poultry in urban areas (1347-1351)

Year	Intercept	Slope
1347	-45.33	5.81
1348	-53.00	6.82
1349	-36.79	4.73
1350	-15.94	2.32
1351	-18.78	2.73

Test of hypothesis:

Ho: Model II is not an improvement of Model I.

$$F_{3,4}^4 = 3.85$$

We reject the null hypothesis.

Ho: Model III is not an improvement of Model II.

$$F_{3,0}^4 = 10.258$$

We reject the null hypothesis.

In this case, it is concluded that there is significant difference between intercepts and slopes of different years.

Since the cross-section data of the two last years, 1350 and 1351, seems to be more accurate and both the sample size and number of different income brackets are much larger, there was further investigation into significant difference between the intercepts and slopes of these two years.

The results of three new models¹ which only combine 1350 and 1351 family budget data follows:

$$\text{Lnq}_{\text{PU}} = -17.33 + 2.52 \text{LnY}_{\text{U}} \quad R^2 = 0.95 \quad (6.20)$$

(1.43) (0.19)

$$\text{Lnq}_{\text{PU}} = -17.27 + 2.52 \text{LnY}_{\text{U}} - 0.13 D_1 \quad R^2 = 0.95 \quad (6.21)$$

(0.20) (0.37)

$$\text{Lnq}_{\text{PU}} = -18.78 + 2.73 \text{LnY}_{\text{U}} + 2.84 D_1 - 0.41 D_1 \text{LnY}_{\text{U}} \quad (6.22)$$

(2.08) (0.28) (2.91) (0.40)

$$R^2 = 0.95$$

Test of hypothesis:

Ho: Model II is not an improvement of Model I.

$$F_{1,9}^1 = 0.132$$

We fail to reject the null hypothesis.

Ho: Model III is not an improvement of Model II.

$$F_{1,8}^1 = 1.32$$

We fail to reject the null hypothesis.

There is, therefore, no significant difference between intercepts and slopes of these two years (i.e., 1350 and 1351).

The income regression coefficient of Model I (2.52) is highly significant.

¹The structural forms of three new models are:

$$\text{Lnq}_i = \alpha_i + \beta_i \text{LnY} + U_i \quad \text{Model I}$$

$$\text{Lnq}_i = \alpha_i + \beta_i \text{LnY} + \gamma_i D + U_i \quad \text{Model II}$$

$$\text{Lnq}_i = \alpha_i + \beta_i \text{LnY} + \gamma_i D + \delta_i D \text{LnY} + U_i \quad \text{Model III}$$

where D's are dummy variables.

Poultry (rural) The three models were investigated, with the results shown below:

$$\text{Ln}q_{\text{PR}} = -4.83 + 0.98 \text{Ln}Y_{\text{R}} \quad R^2 = 0.25 \quad (6.23)$$

(4.32) (0.61)

$$\text{Ln}q_{\text{PR}} = -3.23 + 0.77 \text{Ln}Y_{\text{R}} - 0.94 D_1 + 0.10 D_2 + 0.21 D_3 + 0.26 D_4$$

(4.77) (0.70) (1.02) (1.28) (1.26) (1.27)

$R^2 = 0.32 \quad (6.24)$

$$\text{Ln}q_{\text{PR}} = 0.35 + 0.24 \text{Ln}Y_{\text{R}} - 13.64 D_1 - 4.45 D_2 - 0.16 D_3 + 3.63 D_4$$

(7.48) (1.10) (12.24) (5.84) (14.44) (17.03)

$$+ 1.86 D_1 \text{Ln}Y_{\text{R}} + 0.71 D_2 \text{Ln}Y_{\text{R}} + 0.09 D_3 \text{Ln}Y_{\text{R}} - 0.42 D_4 \text{Ln}Y_{\text{R}}$$

(1.79) (0.85) (2.02) (2.36)

$R^2 = 0.40 \quad (6.25)$

where

q_{PR} = per capita poultry expenditure in rural areas

Y_{R} = per capita total expenditure in rural areas

Table 6.6. Intercepts and slopes of demand for poultry in rural areas (1347-1351)

Year	Intercept	Slope
1347	+3.98	-0.18
1348	+0.19	+0.33
1349	-4.10	+0.95
1350	-13.29	+2.10
1351	+0.35	+0.24

Test of hypothesis:

H_0 : Model II is not an improvement of Model I.

$$F_{34}^4 = 0.38$$

We fail to reject the null hypothesis.

Ho: Model III is not an improvement of Model II.

$$F_{30}^4 = 0.49$$

We fail to reject the null hypothesis.

Therefore, we conclude that there is no significant difference between intercepts and slopes of different years.

The income regression coefficient of Model I (0.98) is significant.

Fish (urban) The three models were investigated and the results are as follow:

$$\text{Ln}q_{FU} = -8.09 + 1.30 \text{Ln}Y_U \quad R^2 = 0.94 \quad (6.26)$$

(0.58) (0.08)

$$\text{Ln}q_{FU} = -8.47 + 1.34 \text{Ln}Y_U + 0.37 D_1 - 0.67 D_2 - 0.28 D_3 - 0.49 D_4$$

(0.58) (0.08) (0.19) (0.23) (0.23) (0.23)

$$R^2 = 0.95 \quad (6.27)$$

$$\text{Ln}q_{FU} = -10.65 + 1.64 \text{Ln}Y_U + 4.51 D_1 + 2.11 D_2 + 0.53 D_3 + 3.89 D_4$$

(0.96) (0.13) (1.34) (1.59) (2.08) (1.93)

$$- 0.57 D_1 \text{Ln}Y_U - 0.30 D_2 \text{Ln}Y_U - 0.09 D_3 \text{Ln}Y_U - 0.52 D_4 \text{Ln}Y_U$$

(0.18) (0.20) (0.27) (0.25)

$$R^2 = 0.96 \quad (6.28)$$

where

q_{FU} = per capita fish expenditure in urban areas

Y_U = per capita total expenditure in urban areas

Table 6.7. Intercepts and slopes of demand for fish in urban areas (1347-1351)

Year	Intercept	Slope
1347	-6.76	1.12
1348	-10.12	1.56
1349	-8.54	1.34
1350	-6.14	1.07
1351	-10.65	1.64

Test of hypothesis:

Ho: Model II is not an improvement of Model I.

$$F_{34}^4 = 1.63$$

We fail to reject the null hypothesis.

Ho: Model III is not an improvement of Model II.

$$F_{30}^4 = 2.88$$

We reject the null hypothesis.

Therefore, it is concluded that there is no significant difference between intercepts of different years. However, there is significant difference between slopes of these years.

Further investigation of any significant difference between slopes of 1350 and 1351 demand equations was also carried out. Therefore, Models II and III were studied to combine the data observations of these two years.

The results of two new models are as follows:

$$\text{Ln}q_{FU} = -8.55 + 1.35 \text{Ln}Y_U + 0.37 D_1 \quad R^2 = 0.94 \quad (6.29)$$

(0.83) (0.11) (0.21)

$$\text{Ln}q_{FU} = -10.65 + 1.64 \text{Ln}Y_U + 4.51 D_1 - 0.57 D_1 \text{Ln}Y_U \quad (6.30)$$

(0.98) (0.13) (1.38) (0.19)

$R^2 = 0.96$

Test of hypothesis:

Ho: Model III is not an improvement of Model II.

$$F_{18}^1 = 9.14$$

We reject the null hypothesis.

Therefore, we conclude there exists significant difference between slopes of these two years.

Fish (rural) The results of the three models investigated follow:

$$\text{Ln}q_{FR} = -7.26 + 1.23 \text{Ln}Y_R \quad R^2 = 0.77 \quad (6.31)$$

(1.18) (0.17)

$$\text{Ln}q_{FR} = -8.38 + 1.43 \text{Ln}Y_R + 0.01 D_1 - 0.65 D_2 - 0.78 D_3 - 0.30 D_4$$

(1.17) (0.17) (0.25) (0.31) (0.31) (0.31)

$R^2 = 0.83 \quad (6.32)$

$$\text{Ln}q_{FR} = -7.88 + 1.36 \text{Ln}Y_R + 0.93 D_1 - 1.45 D_2 - 6.16 D_3 + 2.17 D_4$$

(1.77) (0.26) (2.89) (1.38) (3.41) (4.03)

$$- 0.13 D \text{Ln}Y_R + 0.12 D \text{Ln}Y_R + 0.75 D \text{Ln}Y_R - 0.33 D \text{Ln}Y_R$$

(0.42) (0.20) (0.48) (0.56)

$R^2 = 0.85 \quad (6.33)$

where

q_{FR} = per capita fish expenditure in rural areas

Y_R = per capita total expenditure in rural areas

Table 6.8. Intercepts and slopes of demand for fish in rural areas (1347-1351)

Year	Intercept	Slope
1347	-5.71	1.03
1348	-14.04	2.11
1349	-9.33	1.48
1350	-6.85	1.23
1351	-7.88	1.36

Test of hypothesis:

Ho: Model II is not an improvement of Model I.

$$F_{34}^4 = 2.56$$

We fail to reject the null hypothesis.

Ho: Model III is not an improvement of Model II.

$$F_{30}^4 = 1.07$$

We fail to reject the null hypothesis.

The conclusion is, therefore, that no significant difference exists between intercepts and slopes of different years and Model I should be proposed.

The income regression coefficient of Model I (1.23) is highly significant.

Time-Series Analysis

Model

Endogenous and exogenous variables In Chapter II demand equations were derived, in which quantity is a dependent (endogenous) variable and income and prices are independent (exogenous) variables.

$$q_{ti} = f(Y_t, P_1, \dots, P_K, U_{ti}) \quad t=1, \dots, n \quad i=1, \dots, K \quad (6.34)$$

In fact, most economic demand theory could be explained by the above structural equation. However, considering the case of a nondurable agricultural commodity at harvesting time in a closed economy (32), the demand structural equation for such a commodity could very well be defined as:

$$P_{ti} = f(Y_t, q_1, \dots, q_K, U_{ti}) \quad t=1, \dots, n \quad i=1, \dots, K \quad (6.35)$$

which shows quantities as exogenous or explanatory variables and prices as endogenous or dependent variables.

As far as income and own price elasticities are concerned, mathematically, there is no difference between these two structural equations, and one is the reverse of the other. But in statistical application, there is a difference between these two, since the error term exists.

The criteria on which structural equations should be chosen depend on the assumptions and nature of the model.

Based on the following six reasons, the first form, showing quantity as a dependent variable, is selected for this study.

1. Iranian meat market is influenced by the international meat market. This is especially true since meat imports have been increasing over the past five years.

2. The government has indirect control of the amount of meat imports, and there is no predetermined plan. That is, the decisions regarding meat imports are made within each year.
3. There had been no direct price control for the period under study, but since meat is a main item in the consumer basket, the government has been very sensitive to the fluctuations of the price of meat in Iran. Frequently, the price of meat has been controlled by indirect government policies. Consumer subsidizing of the price of meat has been practiced occasionally. Namely, the government buys meat at a higher price from the producer and sells at a lower price to the consumer.
4. Contrary to some agricultural crops, the meat supply is storable, in the form of live animals.
5. Since in this study we are very concerned with elasticities, because of the presence of stochastic terms, it is preferable to estimate the elasticities of demand from the equation with quantity as the dependent variable.
6. Both models were tried. Based on statistical aspects (multiple correlation and level of significance) and economic logic (sign and size of elasticities) the model with quantity as the dependent variable has a much better fit compared to the model with structural form of price as a dependent variable.

Single equation approach

The structural equation of single approach follows:

$$\text{Ln}q_{ti} = \alpha_i + \beta_i \text{Ln}Y_t + \gamma_i \text{Ln}P_{ti} + \delta_j \text{Ln}P_{tj} + U_{ti} \quad t=1, \dots, n \quad (6.36)$$

The method of Least Square was applied. All the assumptions of multiple regression were tested and justified (e.g., whenever necessary, the equation was adjusted for autocorrelation problem).

The regression coefficients were tested both for economic logic (e.g., one expects the sign of own price elasticity to be negative) and statistical significance.¹

Simultaneous equations approach² The structural equations of simultaneous approach follow:

$$\text{Ln}q_{ti} = \alpha_i + \beta_i \text{Ln}Y_t + \gamma_i \text{Ln}P_{ti} + \delta_i \text{Ln}q_{tj} + U_i \quad t=1, \dots, n \quad (6.37)$$

$$\text{Ln}q_{tj} = \alpha_j + \beta_j \text{Ln}Y_t + \gamma_j \text{Ln}P_{tj} + \delta_j \text{Ln}q_{ti} + U_j \quad t=1, \dots, n \quad (6.38)$$

The system is just identified if the number of endogenous variables in each equation minus one equals the number of exogenous variables in the system but not included in that equation.

In this study, the systems are both simply identified because each equation has two endogenous variables (q_i and q_j) and there are three exogenous variables (Y , P_i and P_j) in each system of which only two appear in each equation.

Two State Least Squares (2SLS) If the system is just identified, it could be solved using 2SLS. In stage one, each endogenous variable is

¹Through this section and the next 10% is used as the level of significance.

²The rationale for applying the simultaneous method rather than the single approach is the latter one violates the assumption of one endogenous variable in each equation. However, prices are taken as predetermined variables, so there is no problem of simultaneous interaction between quantities and prices.

regressed on all exogenous variables, and the estimated results are placed as explanatory variables. In stage two, the Least Square method is applied to the result of stage one. The yielded coefficients are the results of 2SLS.

Specification The specification relies heavily on received economic theory and on any special knowledge or insight that the investigator may have of the system. This a priori knowledge will determine the nature of the B and A matrixes.¹ For example, playing any direct role in a specific equation will imply that certain elements in the rows of B and A corresponding to that equation are zero. One may also have a priori knowledge which places restrictions on one element or combinations of elements in the B and A matrixes, for example, certain elasticities are known (e.g., in this study, the income elasticities are known from cross-section analysis).

Identification The identification of simultaneous equations is perhaps the most difficult step in solving a simultaneous system. A simultaneous model is solvable if the system is over-identified or just identified.

This structural form could be as the following reduced form.

$$\text{Ln}q_{ti} = \alpha_i + \beta_i \text{Ln}Y_t + \gamma_i \text{Ln}P_{ti} + \delta_i^j \text{Ln}P_{tj} + U_{ti} \quad t=1, \dots, n \quad (6.39)$$

$$\text{Ln}q_{tj} = \alpha_j + \beta_j \text{Ln}Y_t + \gamma_j \text{Ln}P_{tj} + \delta_j^i \text{Ln}P_{ti} + U_{tj} \quad t=1, \dots, n \quad (6.40)$$

where

¹For B and A matrixes see the following sections.

q_i and q_j are endogenous variables and all other variables are exogenous.

More compactly the model could be written as

$$BY = AX + V \quad (6.41)$$

where

B = the coefficient matrix of endogenous variables

Y = the vector of endogenous variables

A = the coefficient matrix of exogenous variables

X = the vector of exogenous variables

V = the vector of error terms

Structure of demand (single equation approach) The following

seven equations have been tried for urban lamb, urban beef, country red meat and country white meat analysis.

$$\text{Ln}q_{ti} = \alpha_i + \beta_i \text{Ln}Y_t + U_{ti} \quad t=1, \dots, n \quad (6.42)$$

$$\text{Ln}q_{ti} = \alpha_i + \gamma_i \text{Ln}P_{ti} + U_{ti} \quad t=1, \dots, n \quad (6.43)$$

$$\text{Ln}q_{ti} = \alpha_i + \delta_i \text{Ln}P_{tj} + U_{ti} \quad t=1, \dots, n \quad (6.44)$$

$$\text{Ln}q_{ti} = \alpha_i + \beta_i \text{Ln}Y_t + \gamma_i \text{Ln}P_{ti} + U_{ti} \quad t=1, \dots, n \quad (6.45)$$

$$\text{Ln}q_{ti} = \alpha_i + \beta_i \text{Ln}Y_t + \delta_i \text{Ln}P_{tj} + U_{ti} \quad t=1, \dots, n \quad (6.46)$$

$$\text{Ln}q_{ti} = \alpha_i + \gamma_i \text{Ln}P_{ti} + \delta_i \text{Ln}P_{tj} + U_{ti} \quad t=1, \dots, n \quad (6.47)$$

$$\text{Ln}q_{ti} = \alpha_i + \beta_i \text{Ln}Y_t + \gamma_i \text{Ln}P_{ti} + \delta_i \text{Ln}P_{tj} + U_{ti} \quad t=1, \dots, n \quad (6.48)$$

where

i and j stand for lamb and beef, respectively; further, Y stands for urban per capita expenditure in urban lamb analysis.

i and j stand for beef and lamb, respectively, with Y standing for

urban per capita expenditure in urban beef analysis.

i and j stand for red meat and white meat, respectively, with Y standing for country per capita expenditure in country red meat analysis.

i and j stand for white meat and red meat, respectively. Y stands for country per capita expenditure in country white meat analysis.

Structure of demand (simultaneous equation approach) The method of 2 SLS is applied to both urban and country data.

Numerical structure of demand

Tables 6.9-6.16 show the numerical results of the single equation approach. Tables 6.17 and 6.18 show the numerical results of the simultaneous equation approach.

where: column

DV = dependent variable

α = coefficients of intercepts

β = coefficients of per capita total expenditure

γ = coefficients of the price of commodity itself

δ = coefficients of the price of competing commodity

δ' = coefficients of the quantity of competing commodity

d* = coefficients of Durbin-Watson "d" statistics (simple model)

d = coefficients of Durbin-Watson "d" statistics (adjusted model for autocorrelation)

R*² = coefficients of multiple correlation (simple model)

SS = is starred when all coefficients of the model are statistically significant.

Figures in parentheses indicate standard errors of coefficients.

Table 6.9. Estimated coefficients of different demand models for lamb in urban areas

DV	α	β	γ	δ	d^*	R^{2*}	SS
$\text{Ln}q_L$	2.51 (0.94)	-0.002 (0.09)			0.58	0.01	
$\text{Ln}q_L$	3.76 (0.75)		-0.28 (0.16)		0.72	0.41	*
$\text{Ln}q_L$	2.99 (0.44)			-0.11 (0.10)	0.63	0.29	*
$\text{Ln}q_L$	2.73 (0.67)	0.37 (0.12)	-0.87 (0.23)		1.30	0.73	*
$\text{Ln}q_L$	-0.14 (1.00)	0.56 (0.17)		-0.69 (0.19)	1.05	0.71	
$\text{Ln}q_L$	6.40 (1.33)		-1.66 (0.81)	0.81 (0.36)	1.33	0.63	*
$\text{Ln}q_L$	1.94 (2.82)	0.43 (0.24)	-0.65 (0.82)	-0.19 (0.66)	1.24	0.73	

Table 6.10. Estimated coefficients of different demand models for lamb in urban areas (adjusted for autocorrelation)

DV	α	β	γ	δ	d	SS
$\text{Ln}q_L$	2.52 (1.30)	-0.002 (0.13)			1.35	
$\text{Ln}q_L$	3.40 (0.88)		-0.20 (0.19)		1.42	*
$\text{Ln}q_L$	2.99 (0.58)			-0.11 (0.13)	1.39	*
$\text{Ln}q_L$	2.55 (0.91)	0.30 (0.16)	-0.68 (0.29)		1.65	*
$\text{Ln}q_L$	0.30 (1.41)	0.47 (0.23)		-0.57 (0.25)	1.64	
$\text{Ln}q_L$	4.78 (1.48)		-0.93 (0.74)	0.43 (0.45)	1.46	*
$\text{Ln}q_L$	-0.14 (2.88)	0.50 (0.28)	0.14 (0.86)	-0.69 (0.71)	1.57	

Table 6.11. Estimated coefficients of different demand models for beef in urban areas

DV	α	β	γ	δ	d^*	R^{*2}	SS
$\text{Ln}q_B$	0.03 (0.97)	0.17 (0.96)			0.98	0.43	
$\text{Ln}q_B$	1.34 (0.93)			0.92 (0.21)	0.82	0.12	*
$\text{Ln}q_B$	1.37 (0.52)		0.87 (0.12)		0.84	0.20	*
$\text{Ln}q_B$	0.18 (0.89)	0.42 (0.16)		-0.58 (0.30)	1.24	0.60	
$\text{Ln}q_B$	-2.08 (1.22)	0.62 (0.21)	-0.55 (0.23)		1.38	0.66	*
$\text{Ln}q_B$	3.47 (1.84)		0.66 (0.49)	-1.02 (0.86)	0.97	0.36	*
$\text{Ln}q_B$	-5.00 (3.42)	0.81 (0.30)	-1.25 (0.80)	0.90 (0.99)	1.52	0.68	*

Table 6.12. Estimated coefficients of different demand models for beef in urban areas (adjusted for autocorrelation)

DV	α	β	γ	δ	d	SS
$\text{Ln}q_B$	0.11 (1.33)	0.16 (0.13)			1.57	
$\text{Ln}q_B$	1.28 (1.14)			0.11 (0.25)	1.51	
$\text{Ln}q_B$	1.38 (0.69)		0.87 (0.15)		1.51	*
$\text{Ln}q_B$	-0.01 (1.24)	0.36 (0.22)		-0.41 (0.39)		
$\text{Ln}q_B$	-1.70 (1.67)	0.54 (0.27)	-0.43 (0.30)		1.84	*
$\text{Ln}q_B$	2.21 (2.02)		0.37 (0.65)	-0.46 (1.04)	1.53	
$\text{Ln}q_B$	-3.45 (3.77)	0.65 (0.36)	-0.88 (0.92)	0.57 (1.11)	1.91	

Table 6.13. Estimated coefficients of different demand models for red meat in entire country

DV	α	β	γ	δ	d^*	R^{*2}	SS
LNq_R	-1.59 (0.60)	0.40 (0.06)			0.65	0.87	*
Lnq_R	0.64 (1.60)		0.40 (0.36)		0.18	0.29	*
Lnq_R	-3.59 (4.43)			1.33 (0.98)	0.26	0.34	*
Lnq_R	-0.47 (0.74)	0.48 (0.06)	-0.43 (0.20)		1.20	0.91	
Lnq_R	-2.65 (2.38)	0.39 (0.07)		0.26 (0.55)	0.62	0.87	
Lnq_R	-3.07 (4.73)		0.19 (0.44)	1.03 (1.23)	0.24	0.36	
Lnq_R	-4.20 (1.88)	0.48 (0.06)	-0.64 (0.20)	1.03 (0.49)	1.70	0.93	*

Table 6.14. Estimated coefficients of different demand models for red meat in entire country (adjusted for autocorrelation)

DV	α	β	γ	δ	d	SS
Lnq_R	-0.51 (0.87)	0.29 (0.09)			1.33	
Lnq_R	0.86 (0.94)		0.15 (0.21)		1.10	*
Lnq_R	1.08 (1.76)			0.31 (0.39)	1.10	
Lnq_R	-0.62 (0.90)	0.37 (0.08)	-0.15 (0.20)		1.29	
Lnq_R	-1.64 (1.83)	0.28 (0.09)		0.28 (0.36)	1.40	*
Lnq_R	1.02 (1.79)		0.99 (0.24)	0.23 (0.43)	1.06	
Lnq_R	-3.31 (1.92)	0.43 (0.07)	-0.44 (0.22)	0.75 (0.49)	1.66	*

Table 6.15. Estimated coefficients of different demand models for white meat in entire country

DV	α	β	γ	δ	d*	R* ²	SS
Lnq _W	-11.47 (0.93)	1.17 (0.09)				1.05	0.96 *
Lnq _W	-8.92 (3.68)			2.05 (0.83)	0.34	0.55	*
Lnq _W	-17.46 (11.58)		3.90 (2.55)		0.32	0.38	*
Lnq _W	-11.60 (1.34)	1.16 (0.12)		0.05 (0.36)	1.06	0.96	
Lnq _W	-14.72 (3.60)	1.14 (0.10)	0.78 (0.83)		1.18	0.96	*
Lnq _W	-12.35 (11.14)		0.95 (2.89)	1.86 (1.04)	0.36	0.56	
Lnq _W	-15.08 (3.86)	1.16 (0.12)	0.96 (1.00)	-0.15 (0.41)	1.18	0.96	

Table 6.16. Estimated coefficients of different demand models for white meat in entire country (adjusted for autocorrelation)

DV	α	β	γ	δ	d	SS
Lnq _W	-10.31 (1.32)	1.05 (0.13)				1.64 *
Lnq _W	-1.64 (12.4)			0.44 (0.54)	0.96	
Lnq _W	-0.82 (4.61)		0.25 (1.02)		0.96	
Lnq _W	-10.15 (1.73)	1.03 (0.16)		0.01 (0.38)	1.70	
Lnq _W	-12.14 (3.44)	1.05 (0.13)	0.40 (0.75)		1.68	
Lnq _W	-1.18 (4.71)		-0.14 (1.16)	0.48 (0.63)	0.96	
Lnq _W	-11.96 (3.66)	1.05 (0.16)	0.47 (0.89)	-0.11 (0.45)	1.75	

Table 6.17. Estimated coefficients of reduced and structural form of demand for lamb and beef in urban areas

DV	α	β	γ	δ	δ'	SS
Reduced form						
$\text{Ln}q_L$	2.70 (0.80)	0.30 (0.29)	-0.78 (0.44)		0.15 (0.60)	
$\text{Ln}q_B$	-2.28 (1.07)	1.42 (0.76)	-1.52 (0.93)		-1.40 (1.31)	*
Structural form						
$\text{Ln}q_L$	4.87	-1.4	-0.64	1.76		
$\text{Ln}q_B$	-1.55	1.21	-1.26	-0.97		

Table 6.18. Estimated coefficients of reduced and structural form of demand for red and white meats in entire country of Iran

DV	α	β	γ	δ	δ'	SS
Reduced form						
$\text{Ln}q_R$	11.95 (9.81)	-0.76 (0.98)	-0.49 (0.29)		1.07 (0.84)	*
$\text{Ln}q_W$	-14.11 (3.79)	1.05 (0.25)	0.73 (0.82)		0.23 (0.59)	
Structural form						
$\text{Ln}q_R$	-4.19	0.48	-0.37	1.03		
$\text{Ln}q_W$	-15.07	1.16	0.96	-0.15		

Pooled Cross-Section/Time-Series Analysis

In this section, the information gained from cross-section and time-series analyses is combined; namely, the expenditure elasticities yielded from cross-section study (1351) are imposed onto time-series demand equations.

Model

In the single equation approach, the known cross-section total expenditure elasticity of demand¹ (b_i) is substituted into equation (6.36), so that

$$\text{Ln}q_{ti} = \alpha_i + b_i \text{Ln}Y_t + \gamma_i \text{Ln}P_{ti} + \delta_i \text{Ln}P_{tj} + U_{ti} \quad t=1, \dots, n \quad (6.49)$$

If the " $b_i \text{Ln}Y$ " is taken to the left hand side, since it is a constant term, then a new structural equation is derived as follows:

$$\text{Ln}q_{ti} - b_i \text{Ln}Y_t = \alpha_i + \gamma_i \text{Ln}P_{ti} + \delta_i \text{Ln}P_{tj} + U_{ti} \quad t=1, \dots, n \quad (6.50)$$

¹To obtain the elasticities of red meat and white meat for the whole country, the same method of analysis of covariance is applied to cross-section data. However, some adjustments were necessary to change the data to red meat and white meat for the whole country. The data adjustment is found below:

$$q_{Rj} = q_{Lj} + q_{Bj}$$

$$q_{Wj} = q_{pj}$$

where

q_{Rj} = per capita consumption of red meat in total expenditure bracket j

q_{Lj} = per capita consumption of lamb in total expenditure bracket j

q_{Bj} = per capita consumption of beef in total expenditure bracket j

q_{Wj} = per capita consumption of white meat in total expenditure bracket j

q_{pj} = per capita consumption of poultry in total expenditure bracket j

Furthermore, both observations of urban and rural areas are utilized and weighted by the ratio of the population of each area to the sample size of that area.

In the simultaneous approach imposing (b_i and b_j) known cross-section total expenditure elasticities for commodities i and j into the structural equation, then the reduced form would be as follows:

$$\text{Ln}q_{ti} - b_i \text{Ln}Y_t = \alpha_i + \gamma_i \text{Ln}P_{ti} + \delta_i (\text{Ln}q_{tj} - b_j \text{Ln}Y_t) \quad t=1, \dots, n \quad (6.51)$$

$$\text{Ln}q_{tj} - b_j \text{Ln}Y_t = \alpha_j + \gamma_j \text{Ln}P_{tj} + \delta_j (\text{Ln}q_{ti} - b_i \text{Ln}Y_t) \quad t=1, \dots, n \quad (6.52)$$

Structure of demand (single equation approach) The following three equations were tried for urban lamb, urban beef, country red meat and country white meat analysis.

$$\text{Ln}q_{ti} - b_i \text{Ln}Y_t = \alpha_i + \gamma_i \text{Ln}P_{ti} + U_{ti} \quad t=1, \dots, n$$

$$\text{Ln}q_{ti} - b_i \text{Ln}Y_t = \alpha_i + \delta_i \text{Ln}P_{tj} + U_{ti} \quad t=1, \dots, n$$

$$\text{Ln}q_{ti} - b_i \text{Ln}Y_t = \alpha_i + \gamma_i \text{Ln}P_{ti} + \delta_i \text{Ln}P_{tj} + U_{ti} \quad t=1, \dots, n$$

where

i and j stand for lamb and beef, respectively. Y_t and b_i stand for urban per capita expenditure and known expenditure elasticity of demand for lamb, respectively, in urban lamb analysis.

i and j stand for beef and lamb, respectively. Y_t and b_i stand for urban per capita expenditure and known expenditure elasticity of demand for beef, respectively, in urban beef analysis.

i and j stand for red meat and white meat, respectively. Y_t and b_i stand for country per capita expenditure and known expenditure elasticity of demand for red meat, respectively, in country red meat analysis.

i and j stand for white meat and red meat, respectively. Y_t and b_i stand for country per capita expenditure and known expenditure elasticity of demand for white meat, respectively, in country white meat analysis.

Structure of demand (simultaneous equation approach) The method of 2SLS is applied to both urban and country data for restricted models.

Numerical structure of demand

Tables 6.19-6.26 show the numerical results of the restricted single equation approach. Tables 6.27 and 6.28 show the numerical results of the restricted simultaneous equation approach.

where: column

DV = dependent variables

α = coefficients of intercepts

γ = coefficients of the price of commodity itself

δ = coefficients of the price of competing commodity

δ' = coefficients of the quantity of competing commodity

d^* = coefficients of Durbin-Watson "d" statistics (simple model)

d = coefficients of Durbin-Watson "d" statistics (adjusted model for autocorrelation)

R^{*2} = coefficients of multiple correlation (simple model)

SS = is starred when all coefficients of the model are statistically significant

Figures in parentheses indicate standard errors of coefficients.

Table 6.19. Estimated coefficients of different demand models for lamb in urban areas; known expenditure elasticity is imposed

DV	α	γ	δ	d^*	R^{*2}	SS
$\text{Ln}q_L - b_L \text{Ln}Y$	0.91 (1.03)	-1.92 (0.23)		0.76	0.91	*
$\text{Ln}q_L - b_L \text{Ln}Y$	-2.66 (0.41)		-1.15 (0.09)	0.90	0.96	*
$\text{Ln}q_L - b_L \text{Ln}Y$	-4.20 (1.45)	0.75 (0.68)	-1.57 (0.39)	0.86	0.96	*

Table 6.20. Estimated coefficients of different demand models for lamb in urban areas; known expenditure elasticity is imposed (adjusted for autocorrelation)

DV	α	γ	δ	d	SS
$\text{Ln}q_L - b_L \text{Ln}Y$	-0.52 (1.20)	-1.61 (0.26)		1.65	
$\text{Ln}q_L - b_L \text{Ln}Y$	-2.88 (0.54)		-1.11 (0.12)	1.70	*
$\text{Ln}q_L - b_L \text{Ln}Y$	-4.86 (1.55)	1.06 (0.80)	-1.74 (0.51)	1.59	*

Table 6.21. Estimated coefficients of different demand models for beef in urban areas; known expenditure elasticity is imposed

DV	α	γ	δ	d^*	R^{*2}	SS
$\text{Ln}q_B - b_B \text{Ln}Y$	-0.95 (0.92)		-1.23 (0.20)	1.03	0.85	*
$\text{Ln}q_B - b_B \text{Ln}Y$	-3.17 (0.41)	-0.75 (0.09)		1.37	0.91	*
$\text{Ln}q_B - b_B \text{Ln}Y$	-5.05 (1.44)	-1.26 (0.39)	0.92 (0.67)	1.51	0.92	*

Table 6.22. Estimated coefficients of different demand models for beef in urban areas; known expenditure elasticity is imposed (adjusted for autocorrelation)

DV	α	γ	δ	d	SS
$\text{Ln}q_B - b_B \text{Ln}Y$	-1.66 (1.13)		-1.07 (0.25)	1.80	*
$\text{Ln}q_B - b_B \text{Ln}Y$	-3.30 (0.52)	-0.72 (0.12)		1.88	*
$\text{Ln}q_B - b_B \text{Ln}Y$	-5.06 (1.67)	1.25 (0.49)	0.91 (0.82)	1.94	*

Table 6.23. Estimated coefficients of different demand models for red meat in entire country; known expenditure elasticity is imposed

DV	α	γ	δ	d*	R* ²	SS
$\text{Ln}q_R - b_R \text{Ln}Y$	-1.92 (2.00)	-1.52 (0.45)		0.63	0.67	*
$\text{Ln}q_R - b_R \text{Ln}Y$	-0.92 (7.34)		-1.71 (1.62)	0.37	0.27	
$\text{Ln}q_R - b_R \text{Ln}Y$	-5.67 (5.97)	-1.73 (0.55)	1.04 (1.55)	0.63	0.68	

Table 6.24. Estimated coefficients of different demand models for red meat in entire country; known expenditure elasticity is imposed (adjusted for autocorrelation)

DV	α	γ	δ	d	SS
$\text{Ln}q_R - b_R \text{Ln}Y$	-5.53 (2.01)	-0.73 (0.45)		0.60	*
$\text{Ln}q_R - b_R \text{Ln}Y$	-9.42 (3.90)		0.14 (0.86)	0.53	
$\text{Ln}q_R - b_R \text{Ln}Y$	-8.54 (4.08)	-0.90 (0.52)	0.84 (1.02)	0.75	*

Table 6.25. Estimated coefficients of different demand models for white meat in entire country; known expenditure elasticity is imposed

DV	α	γ	δ	d^*	R^{*2}	SS
$\text{Ln}q_W - b_W \text{Ln}Y$	-12.84 (2.05)		-0.89 (0.46)	0.64	0.46	*
$\text{Ln}q_W - b_W \text{Ln}Y$	-13.34 (6.46)	-0.76 (1.43)		0.57	0.14	
$\text{Ln}q_W - b_W \text{Ln}Y$	-16.32 (6.14)	0.96 (1.60)	-1.09 (0.57)	0.65	0.48	

Table 6.26. Estimated coefficients of different demand models for white meat in entire country; known expenditure elasticity is imposed (adjusted for autocorrelation)

DV	α	γ	δ	d	SS
$\text{Ln}q_W - b_W \text{Ln}Y$	-13.9 (2.26)		0.67 (0.51)	1.0	*
$\text{Ln}q_W - b_W \text{Ln}Y$	16.73 (4.82)	-0.31 (1.06)		1.01	
$\text{Ln}q_W - b_W \text{Ln}Y$	-16.50 (4.68)	0.74 (1.17)	-0.84 (0.59)	1.21	

Homogeneous demand functions

Considering the demand equation of the general form derived previously,

$$\text{Ln}q_{ti} = \alpha_i + \beta_i \text{Ln}Y_t + \gamma_{i1} \text{Ln}P_t + \dots + \gamma_{iK} \text{Ln}P_{tK} + U_{ti} \quad \begin{matrix} i=1, \dots, K \\ t=1, \dots, n \end{matrix}$$

Using Euler's theorem (38) for homogeneous functions of degree zero, we have

$$\beta_i + \gamma_{i1} + \dots + \gamma_{iK} = 0 \quad i=1, \dots, K$$

Table 6.27. Estimated coefficients of reduced and structural form of demand for lamb and beef in urban areas; known expenditure elasticities are imposed

DV	α	γ	δ	δ'	SS
Including intercepts					
Reduced form					
$\text{Ln}q_L - b_L \text{Ln}Y$	2.10 (1.53)	-0.39 (0.81)		1.25 (0.61)	
$\text{Ln}q_B - b_B \text{Ln}Y$	0.08 (4.77)	0.66 (2.05)		1.22 (1.77)	
Structural form					
$\text{Ln}q_L - b_L \text{Ln}Y$	-4.19	0.74	-1.53		
$\text{Ln}q_B - b_B \text{Ln}Y$	-5.15	-1.26	0.93		
Excluding intercepts					
Reduced form					
$\text{Ln}q_L - b_L \text{Ln}Y$		8.36 (30.19)		7.02 (21.04)	
$\text{Ln}q_B - b_B \text{Ln}Y$		0.62 (0.54)		1.19 (0.31)	*
Structural form					
$\text{Ln}q_L - b_L \text{Ln}Y$		-1.14	-0.1		
$\text{Ln}q_B - b_B \text{Ln}Y$		0.08	-7.98		

Table 6.28. Estimated coefficients of reduced and structural form of demand for red and white meats in entire country; known expenditure elasticities are imposed

DV	α	γ	δ	δ'	SS
Including intercepts					
Reduced form					
$\text{Ln}q_R - \text{Ln}_R \text{Ln}Y$	11.92 (10.56)	-0.56 (0.76)		1.08 (0.82)	*
$\text{Ln}q_W - \text{Ln}_W \text{Ln}Y$	-12.76 (3.19)	0.31 (0.77)		0.63 (0.18)	
Structural form					
$\text{Ln}q_R - \text{Ln}_R \text{Ln}Y$	-5.82	-1.75	1.05		
$\text{Ln}q_W - \text{Ln}_W \text{Ln}Y$	-16.43	0.97	-1.10		
Excluding intercepts					
Reduced form					
$\text{Ln}q_R - \text{Ln}_R \text{Ln}Y$		-1.52 (0.58)		0.11 (0.15)	*
$\text{Ln}q_W - \text{Ln}_W \text{Ln}Y$		-2.87 (0.58)	0.44 (0.30)		*
Structural form					
$\text{Ln}q_R - \text{Ln}_R \text{Ln}Y$		-1.60	-0.33		
$\text{Ln}q_W - \text{Ln}_W \text{Ln}Y$		-3.37	-0.70		

where

β_i = income elasticity of commodity i

γ_{ii} = own price elasticity of commodity i

γ_{ij} = cross price elasticity of commodity i with respect to commodity j
 $j=1, \dots, K-1$ and $i \neq j$

Reducing the model into two-good economy, then we have

$$\text{Ln}q_{ti} = \alpha_i + \beta_j \text{Ln}Y_t + \gamma_i \text{Ln}P_{ti} + \gamma_j \text{Ln}P_{tj} + U_{ti} \quad i \neq j, i, j=1, 2$$

$$\beta_i + \gamma_i + \gamma_j = 0 \quad i \neq j, i, j=1, 2$$

Also, by imposing the known expenditure elasticity of demand from cross-section study

$$\beta_i = b_i$$

Combining these restrictions and putting them in the demand single equation¹, we have

$$\text{Ln}q_{ti} - b_i (\text{Ln}Y_t - \text{Ln}P_{tj}) = \alpha_i + \gamma_i (\text{Ln}P_{ti} - \text{Ln}P_{tj})$$

Applying this model to urban lamb, urban beef, country red meat and country white meat analysis, the yielded coefficients would be as follow:

$$\text{Ln}q_L - b_L (\text{Ln}Y_u - \text{Ln}P_B) = -3.27 + 0.31 (\text{Ln}P_L - \text{Ln}P_B) \quad R^2 = 0.39$$

(0.02) (0.20) d = 0.93

$$\text{Ln}q_B - b_B (\text{Ln}Y_u - \text{Ln}P_L) = -2.84 - 0.75 (\text{Ln}P_B - \text{Ln}P_L) \quad R^2 = 0.69$$

(0.03) (0.21) d = 1.33

$$\text{Ln}q_R - b_R (\text{Ln}Y - \text{Ln}P_W) = -3.78 - 1.74 (\text{Ln}P_R - \text{Ln}P_W) \quad R^2 = 0.68$$

(0.06) (0.50) d = 0.66

¹Imposing Euler's theorem into simultaneous demand equations requires an estimation procedure of nonlinear parameters which need more advanced statistical methods than are within the scope of this study.

$$\text{Ln}q_W - b_W(\text{Ln}Y - \text{Ln}P_R) = -9.27 - 0.70 (\text{Ln}P_W - \text{Ln}P_R)^1$$

$(0.15) \quad (0.62)$

$$R^2 = 0.99$$
$$d = 1.13$$

¹The estimation is adjusted for autocorrelation.

CHAPTER VII. ECONOMIC INTERPRETATION

In Chapter II the linear demand curve which shows quantity as a linear function of income and all commodity prices was derived. Assuming there is linear relation between demand variables, then

$$q_i = \alpha_i + \beta_i Y + \gamma_1 P_1 + \dots + \gamma_K P_K \quad (7.1)$$

The constant term (α_i) shows the demand for commodity i regardless of income and prices; that is, ($\alpha > 0$) states that there is a certain level of demand even with income and prices all zero. α could be negative, zero or positive, depending on different commodities and individuals.

The coefficient of income (β_i) shows the slope of demand for commodity i with respect to income, β indicates how much demand will be affected by certain change in income. For normal goods (15) the sign of income coefficient is expected to be positive; i.e., an increase in income will cause an increase in the quantity demanded, and a decrease in income will cause a decrease in the quantity demanded.

The coefficients of prices (γ_i) show the slope of demand with respect to different prices; namely, γ_i , indicates how much demand will be affected by certain changes in the price of commodity i ($i=1, \dots, K$). For normal goods the sign of price coefficients is expected to be as follows:

- Negative - for price of commodity itself
- Positive - for price of substitute commodities
- Negative - for price of complementary commodities

Elasticities

An income elasticity of demand for an ordinary demand function (38) is defined as the proportionate change in the purchases of a commodity relative to the proportionate change in income with prices constant.

$$\eta_i = \frac{\partial q_i}{\partial Y} \cdot \frac{Y}{q_i} = \beta_i \cdot \frac{Y}{q_i} \quad (7.2)$$

The income elasticity of demand is positive if β_i is positive, which is the case with normal goods.

The own price elasticity of demand for commodity i is defined as the proportionate rate of change of q_i divided by the proportionate rate of change of its own price with income and other prices constant.

$$\epsilon_{ii} = \frac{\partial q_i}{\partial P_i} \cdot \frac{P_i}{q_i} = \gamma_i \cdot \frac{P_i}{q_i} \quad (7.3)$$

The own price elasticity of demand is negative if γ_i is negative, which is the case with normal goods.

The cross price elasticity of demand for commodity i is defined as the proportionate rate of change of q_i divided by the proportionate rate of change of price of commodity j ($i \neq j$), with income and other prices constant.

$$\epsilon_{ij} = \frac{\partial q_i}{\partial P_j} \cdot \frac{P_j}{q_i} = \gamma_j \cdot \frac{P_j}{q_i} \quad j=1, \dots, n-1, i \neq j \quad (7.4)$$

The cross-price elasticity of demand is negative, zero or positive if γ_j is negative, zero or positive as in cases of substitute, independent and complementary goods, respectively.

Considering the general form of demand,

$$q_i = f(Y, P_1, P_2, \dots, P_K) \quad (7.5)$$

Taking total differentials of (7.5),

$$dq_i = \frac{\partial q_i}{\partial Y} \cdot dy + \frac{\partial q_i}{\partial P_1} dp_1 + \frac{\partial q_i}{\partial P_2} dp_2 + \dots + \frac{\partial q_i}{\partial P_K} dP_K \quad (7.6)$$

Dividing (7.6) by q_i

$$\frac{1}{q_i} dq_i = \frac{1}{q_i} \cdot \frac{\partial q_i}{\partial Y} dy + \frac{1}{q_i} \frac{\partial q_i}{\partial P_1} dp_1 + \frac{1}{q_i} \frac{\partial q_i}{\partial P_2} dp_2 + \dots + \frac{1}{q_i} \frac{\partial q_i}{\partial P_K} dP_K \quad (7.7)$$

But

$$\frac{d(\text{Ln}q_i)}{dq_i} = \frac{1}{q_i}$$

Therefore,

$$\begin{aligned} \frac{dq_i}{q_i} &= d(\text{Ln}q_i) \\ \frac{1}{q_i} \cdot \frac{\partial q_i}{\partial P_j} dP_j &= \frac{P_j}{q_i} \frac{\partial q_i}{\partial P_j} \frac{dP_j}{P_j} = \epsilon_{ij} d(\text{Ln}P_j) \end{aligned}$$

Similarly

$$\frac{1}{q_i} \frac{\partial q_i}{\partial Y} dy = \eta_i d(\text{Ln}Y)$$

Substituting these results in (7.7), we have

$$d(\text{Ln}q_i) = \eta_i d(\text{Ln}Y) + \epsilon_{i1} d(\text{Ln}P_1) + \epsilon_{i2} d(\text{Ln}P_2) + \dots + \epsilon_{in} d(\text{Ln}P_n) \quad (7.8)$$

Therefore we can easily find different elasticities:

$$\eta_i = \frac{d(\text{Ln}q_i)}{d(\text{Ln}Y)} \quad (7.9)$$

$$\epsilon_{ij} = \frac{d(\text{Ln}q_i)}{d(\text{Ln}P_j)} \quad (7.10)$$

The present study made extensive use of equations of type (7.8) in order to estimate income and price elasticities. The cross-section study utilized a one variable model of the Cobb-Douglas (38) demand function which follows.

$$q_i^1 = AY^\beta \quad (7.11)$$

Taking natural logs of (7.11), we have

$$\text{Ln}q_i = \alpha + \beta \text{Ln}Y \quad (7.12)$$

where

$A = e^\alpha =$ shift parameter

$\beta =$ total expenditure elasticity of demand

For example, consider the demand function of lamb in urban areas (1351):

$$\text{Ln}q_L = -2.74 + 1.02 \text{Ln}Y$$

or

$$q_L = .06 Y^{1.02}$$

$${}^1 \text{Ln}q_i = \alpha + \beta \text{Ln}Y$$

$$\text{Ln}q_i = \text{Ln}A + \text{Ln}Y^\beta$$

$$\text{Ln}q_i = \text{Ln}AY^\beta$$

$$q_i = AY^\beta$$

where

$$A = 0.06$$

$$\alpha = -2.74$$

$$\beta = 1.02$$

The time-series study utilized a three-variable model of the Cobb-Douglas demand function, given below.

$$q_i^1 = AY^\beta P_i^\gamma P_j^\delta \quad (7.13)$$

Taking natural logs of (7.13), we have

$$\text{Ln}q_i = \alpha + \beta \text{Ln}Y + \gamma \text{Ln}P_i + \delta \text{Ln}P_j \quad (7.14)$$

where

$$A = e^\alpha = \text{shift parameter}$$

$$\beta = \text{total expenditure elasticity of demand for commodity } i$$

$$\gamma = \text{owner price elasticity of demand for commodity } i$$

$$\delta = \text{cross price elasticity of demand for commodity } i \text{ with respect to commodity } j$$

For example, consider the demand function of red meat in the whole country.

$$\text{Ln}q_R = -5.82 + 1.11 \text{Ln}Y - 1.75 \text{Ln}P_R + 1.05 \text{Ln}P_W$$

or

$$q_R = 0.003Y^{1.11}P_R^{-1.75}P_W^{1.05}$$

$$^1 \text{Ln}q_i = \alpha + \beta \text{Ln}Y + \gamma \text{Ln}P_i + \delta \text{Ln}P_j$$

$$\text{Ln}q_i = \text{Ln}A + \text{Ln}Y^\beta + \text{Ln}P_i^\gamma + \text{Ln}P_j^\delta$$

$$\text{Ln}q_i = \text{Ln}AY^\beta P_i^\gamma P_j^\delta$$

$$q_i = AY^\beta P_i^\gamma P_j^\delta$$

where

$$A = e = .003$$

$$\beta = 1.11$$

$$\gamma = -1.75$$

$$\delta = 1.05$$

Cross-Section Economic Analysis

The analyses of covariance were used in order to test the existence of any statistical significance between different demand coefficients of 1347 through 1351 for both urban and rural areas. The result could be summarized as follows.

Urban

There are no significant differences between demand intercepts or demand expenditure elasticities of 1347-1351 for lamb and beef. Neither are there significant differences between demand intercepts nor demand expenditure elasticities of 1350-1351 for poultry.

There are significant differences between demand intercepts and demand expenditure elasticities of 1347-1351 for fish.

Rural

There are neither significant differences between demand intercepts nor demand expenditure elasticities of 1347-1351 for lamb, beef, poultry and fish.

The coefficients of different demands for both urban and rural areas during 1347-1351 are shown in Table 7.1.

Table 7.1. Estimated coefficients of demands for lamb, beef, poultry and fish (1347-1351), both urban and rural areas

DV	Urban			Rural		
	α	A	β	α	A	β
Lamb expenditure						
1347	-1.06	0.35	0.81	-4.65	0.01	1.23
1348	-1.84	0.16	0.91	-3.48	0.03	1.10
1349	-1.68	0.19	0.89	-5.35	5×10^{-3}	1.36
1350	-3.44	0.03	1.1	-4.32	0.01	1.25
1351	-2.74	0.06	1.02	-4.38	0.01	1.22
Beef expenditure						
1347	0.32	1.38	0.35	-5.66	3×10^{-3}	1.16
1348	-2.03	0.13	0.65	-9.67	6×10^{-5}	1.07
1349	-5.75	3×10^{-3}	1.08	-9.75	6×10^{-5}	1.64
1350	-1.25	0.29	0.49	-6.76	1×10^{-3}	1.28
1351	-3.54	0.03	0.82	-7.08	8×10^{-4}	1.36
Poultry expenditure						
1347	-45.33	2×10^{-20}	5.81	3.98	53.52	-0.18
1348	-53.00	1×10^{-23}	6.82	0.19	1.21	0.33
1349	-36.79	1×10^{-16}	4.73	-4.10	0.17	0.95
1350	-15.94	1×10^{-7}	2.32	-13.29	2×10^{-6}	2.10
1351	-18.78	7×10^{-9}	2.73	0.35	1.42	0.24
Fish expenditure						
1347	-6.76	1×10^{-3}	1.12	-5.71	3×10^{-3}	1.03
1348	-10.12	4×10^{-5}	1.56	-14.04	8×10^{-7}	2.11
1349	-8.54	2×10^{-4}	1.34	-9.33	9×10^{-5}	1.48
1350	-6.14	2×10^{-3}	1.07	-6.85	1×10^{-3}	1.23
1351	-10.65	2×10^{-5}	1.64	-7.88	4×10^{-4}	1.36

Selection of the best demand functions

Since there are no significant differences between demand coefficients of lamb and beef in urban areas and all meats in rural areas for 1347-1351 the pooled estimates of this period were selected as the best demand equations of these meats.

In the case of demand for poultry in urban areas pooled estimates of 1350-1351¹ were selected as the best demand equation and the estimates of 1351 were chosen as the best demand equation for fish in urban areas.²

Therefore, the selected demand equations over all the five years of the 1347-1351 cross-section analysis are as follow:

$$q_{LU} = 0.07 Y \quad (7.15)$$

$$q_{LR} = 0.02 Y^{1.19} \quad (7.16)$$

$$q_{BU} = 0.06 Y^{0.72} \quad (7.17)$$

$$q_{BR} = 0.001 Y^{1.28} \quad (7.18)$$

$$q_{PU} = 3 \times 10^{-8} Y^{2.52} \quad (7.19)$$

¹The family budget survey of 1350 and 1351 have two special characteristics: 1) the reliability of data is much higher than for other years, 2) the sample size is about three times as great as that of other years.

²The consumption of fish in Iran has several special characteristics:

1. Fish is not a regular meal in an individual's diet in urban areas.
2. Demand for some certain kinds of fish is very high in urban areas. The prices of these kinds of fish are high too, and yet these kinds of fish are not always available.
3. Fish is a traditional dish for the Iranian new year and therefore the demand and supply of fish are very high in this season.
4. Fishing is controlled by government.
5. Fish is a regular meal in some parts of rural areas like the shores of the Caspian Sea and the Persian Gulf, but it is almost impossible to find fish in other rural areas.

Considering all these factors, it is not surprising to find significant differences between the demand coefficients of different surveys.

$$q_{PR} = 0.008 Y^{0.98} \quad (7.20)$$

$$q_{FU} = 2 \times 10^{-5} Y^{1.64} \quad (7.21)$$

$$q_{FR} = 7 \times 10^{-4} Y^{1.23} \quad (7.22)$$

These demand functions are graphed in Figures 7.1 through 7.4.

Size of elasticities

Theoretically speaking, those demands which have elasticities greater than one are called elastic demands; others with elasticities less than one are called inelastic demands, whereas demands with elasticities equal to one are grouped as unitary elastic demands.

The concept of an expenditure elasticity of demand is fairly straight forward: It measures the relative change in demand brought about by changes in expenditure. Thus, an elasticity of 1.5 implies that a 10 percent rise in income will lead to a 15 percent rise in demand, while an elasticity of 0.5 implies that a 10 percent rise in income will lead to a 5 percent rise in demand, and finally an elasticity of 1.0 implies that a 10 percent rise in income will lead to a 10 percent rise in demand.

By grouping the elasticities of this study, it can be determined that the demands for poultry and fish in urban areas, and also for lamb, beef and fish in rural areas are elastic. The demand for beef in urban areas is inelastic, while the demands for lamb in urban areas and poultry in rural areas are almost unitary elastic.

It seems that lamb and beef demands are more elastic in rural areas than in urban areas; that is, the consumption of lamb and beef in rural areas is more responsive to changes in income than it is in urban areas.

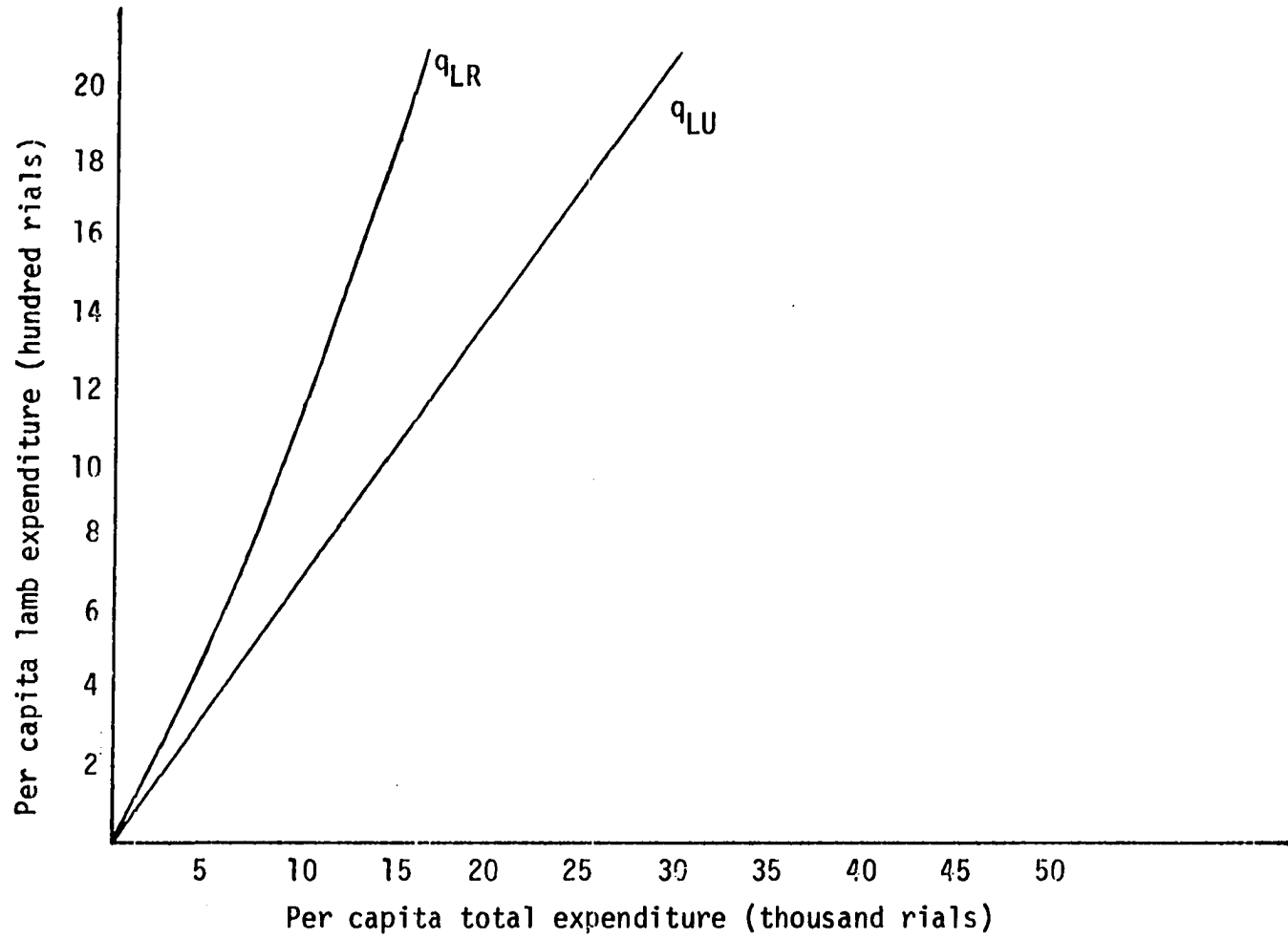


Figure 7.1. Demand function for lamb (urban and rural areas)

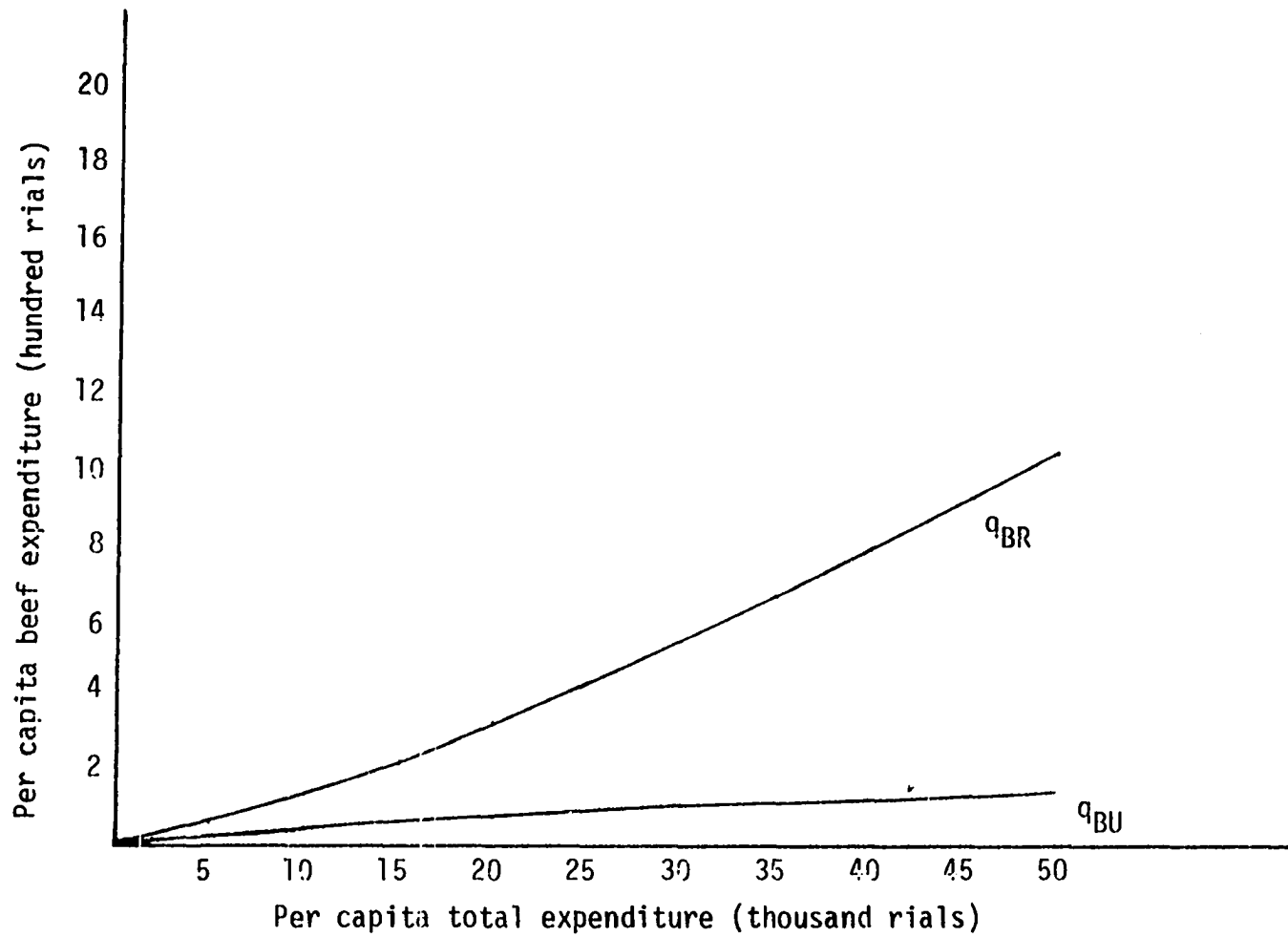


Figure 7.2. Demand function for beef (urban and rural)

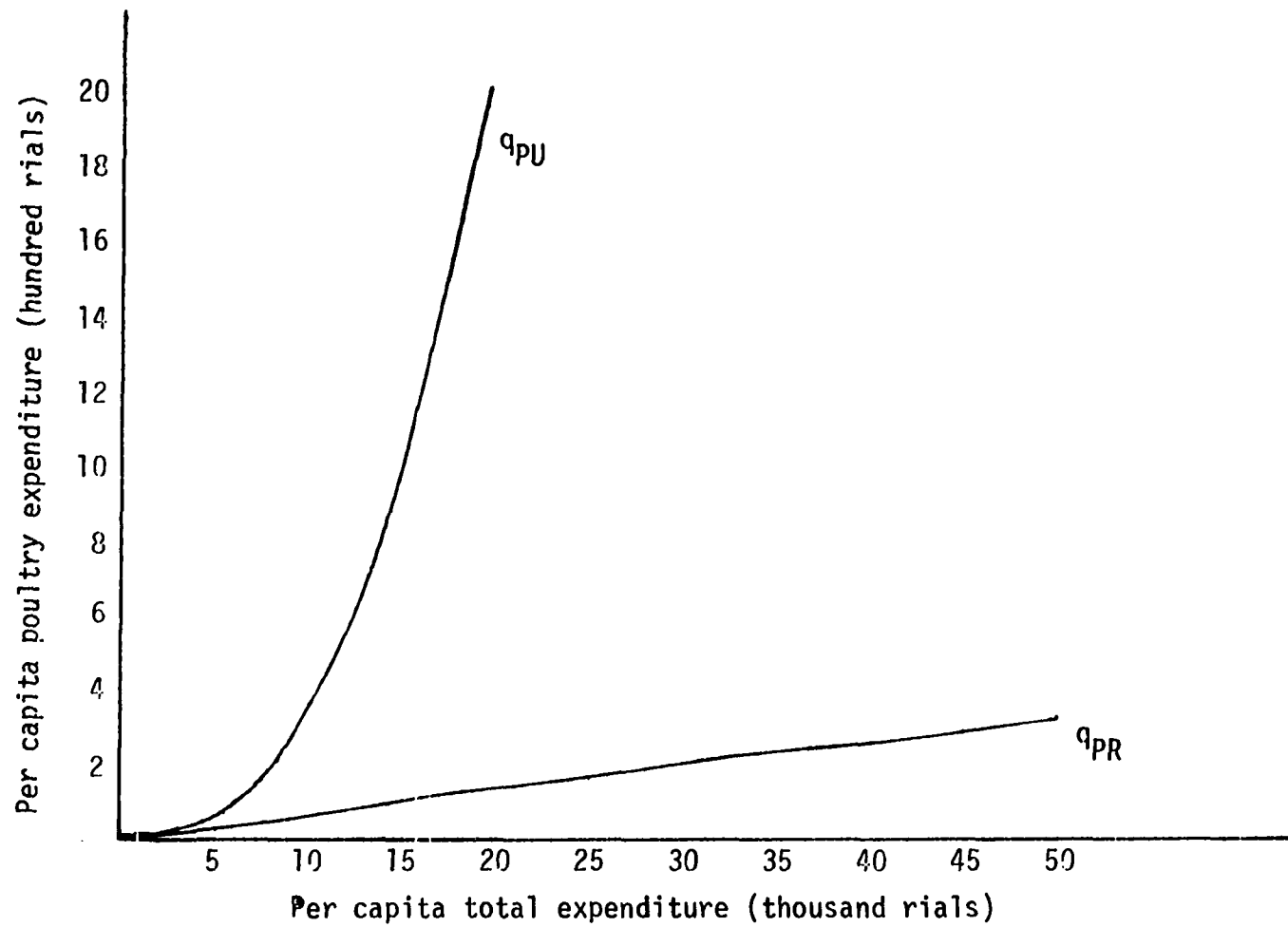


Figure 7.3. Demand function for poultry (urban and rural)

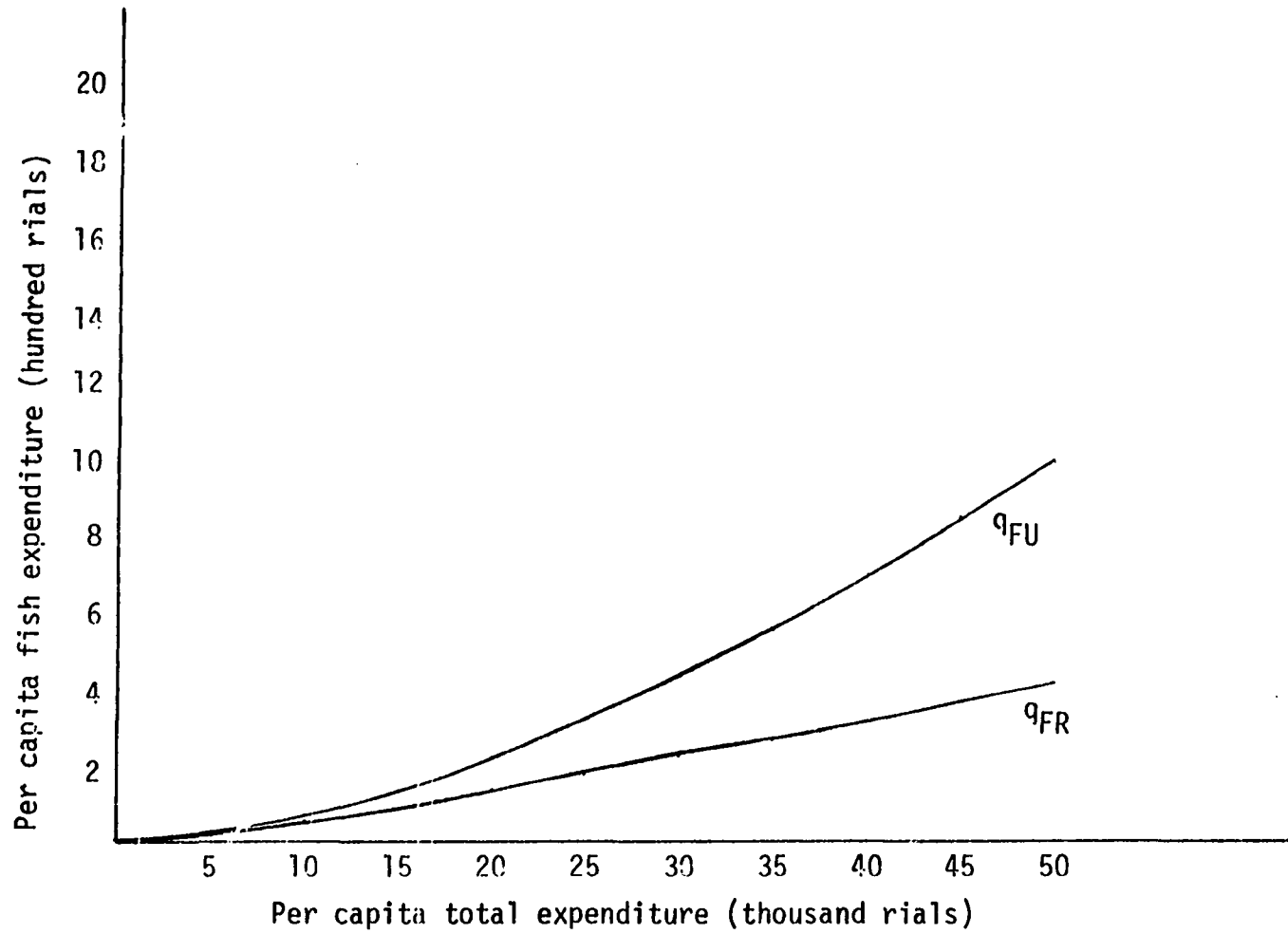


Figure 7.4. Demand function for fish (urban and rural)

The exact opposite is true in the cases of poultry and fish: The consumption of poultry and fish in urban areas is more responsive to changes in income than it is in rural areas.

This is so for several reasons. First, the average level of total expenditure (income) in rural areas is by far less than it is in urban areas. Since lamb and beef are superior goods in both urban and rural areas, their consumption by low level income people in rural areas is therefore more responsive to changes in income than their consumption by high level income people, those of urban areas. Secondly, poultry used to be a luxury item in urban areas and a self-produced food in rural areas. Therefore the data from the 1347-1351 surveys show that the total expenditure elasticity in urban areas is higher than in rural areas for poultry. Furthermore, there is no organized market for fish in Iran.¹

The size of income (expenditure) elasticity is very important in policy-making and demand-projection, especially for a country such as Iran, which expects the total per capita expenditure to double in the next five years.

Marginal propensity to consumption (M.P.C.)

Another important coefficient in demand analysis is the M.P.C., which shows the slope of consumption function.² It simply shows the percentage share of change in consumption of each meat due to change in income (expenditure).

¹See Chapter VII, p. 96.

²Expenditure elasticity is merely a number, while M.P.C. has dimension.

M.P.C. is a constant, regardless of the level of income in linear equations. However, in double log equations: 1) M.P.C. increases as income (expenditure) increases if the demand is elastic, 2) M.P.C. decreases as income (expenditure) increases if the demand is inelastic, and 3) M.P.C. is constant if the demand is unitary elastic.

The M.P.C. of different meats for a range of total expenditure from 2,000 to 30,000 Rials is shown in Tables 7.2 and 7.3 for urban and rural areas, respectively.

Table 7.2. Estimated marginal propensity to consumption of different meats in urban areas

Total expenditure	M.P.C.			
	Lamb	Beef	Poultry	Fish
2,000	.07	0.005	0.008	0.004
3,000	.07	0.005	0.015	0.006
4,000	.07	0.004	0.026	0.007
5,000	.07	0.004	0.032	0.008
10,000	.07	0.003	0.091	0.012
15,000	.07	0.003	0.168	0.015
20,000	.07	0.003	0.261	0.019
30,000	.07	0.002	0.483	0.024

Table 7.3. Estimated marginal propensity to consumption of different meats in rural areas

Total expenditure	M.P.C.			
	Lamb	Beef	Poultry	Fish
2,000	0.101	0.011	0.007	0.005
3,000	0.109	0.012	0.007	0.005
4,000	0.115	0.013	0.007	0.006
5,000	0.120	0.014	0.007	0.006
10,000	0.137	0.017	0.007	0.007
15,000	0.148	0.019	0.006	0.008
20,000	0.156	0.020	0.006	0.008
30,000	0.169	0.023	0.006	0.009

Time-Series Economic Analysis

The main objective of the time-series analysis of this study was to find the price-quantity relationship of different meats in urban areas, as well as in the whole country

The scope of the study was restricted by the availability of existing data. The analysis has two parts: The first part deals with urban demands for lamb and beef, while the second deals with nationwide demands for red meat and white meat.

Two statistical methods were used--single equation and simultaneous equations. Even though the results of the simultaneous methods were not

satisfactory, cross price coefficients of demands in the single equation method were significant in some cases, thus showing the interrelationship between two markets.

Urban lamb analysis

The urban per capita consumption of lamb decreased from 13.7 Kg in 1338 to 11.4 Kg in 1353, while during the same period, real urban per capita expenditure increased by 155 percent. Assuming all other factors to be constant, the urban time series data show negative expenditure elasticity which is statistically insignificant. However, if the price of lamb is allowed to vary, the following demand equation exists.

$$q_L = 12.81 Y^{0.30} P_L^{-0.68} \quad (\text{Auto}^1, 7.23)$$

The signs of both elasticities are correct, but compared to the cross-section analysis, the size of expenditure elasticity seems to be low. Therefore the known expenditure elasticity is imposed on the model², with the following result.

¹Auto = adjusted for autocorrelation.

²A priori information is a very useful and valuable tool in econometric analysis of demand. Namely, if by any logic (e.g., from past analysis) we know the size of income (total expenditure) elasticity of demand, then imposing this information into the model not only increases degrees of freedom, it also reduces the number of variables. These two statistics (degrees of freedom and number of variables) are very important in significance level and efficiency of coefficients.

In this analysis, the total expenditure elasticity of demand from cross-section data has the role of a priori information, since it is believed that the reliability of cross-section data is much higher than that of time-series data, and the results of cross-section data seem to be economically and intuitively right.

$$q_L = 0.59 Y^{1.02} P_L^{-1.61} \quad (\text{Auto, 7.24})$$

The absolute value of own price elasticity in the restricted (Auto, 7.24) model is much larger than in the unrestricted model (7.23). This increase is due to the restriction of imposing larger expenditure elasticity. Since higher expenditure elasticity requires a larger quantity of demand (given a certain level of total expenditure) and higher own price elasticity requires a smaller quantity of demand (given a certain level of own price), in order for the amount of demand to remain constant or have small change, these two elasticities should vary in the same way in absolute terms. This economic phenomenon is very important in the study of lamb demand in Iran. It can be seen that the increase in price of lamb not only has compensated for the tremendous increase in per capita expenditure (income), but it has also made the per capita consumption of lamb decrease over time. In other words, whenever expenditure (income) has increased, the price of lamb has increased, too. This relationship between expenditure and own price elasticities could also be shown by comparing the two last demand equations and the following demand function in which expenditure is dropped.

$$q_L = 29.96 P_L^{-0.20} \quad (\text{Auto, 7.25})$$

By decreasing expenditure elasticity to zero, the absolute value of own price elasticity is also decreased.

Figure 7.5 illustrates different demand functions for lamb of the type equation (7.24) given the level of real per capita expenditure and demand function of the type equation (7.25). Consider point A in Figure 7.5: At this point the level of real price index and consumption of lamb

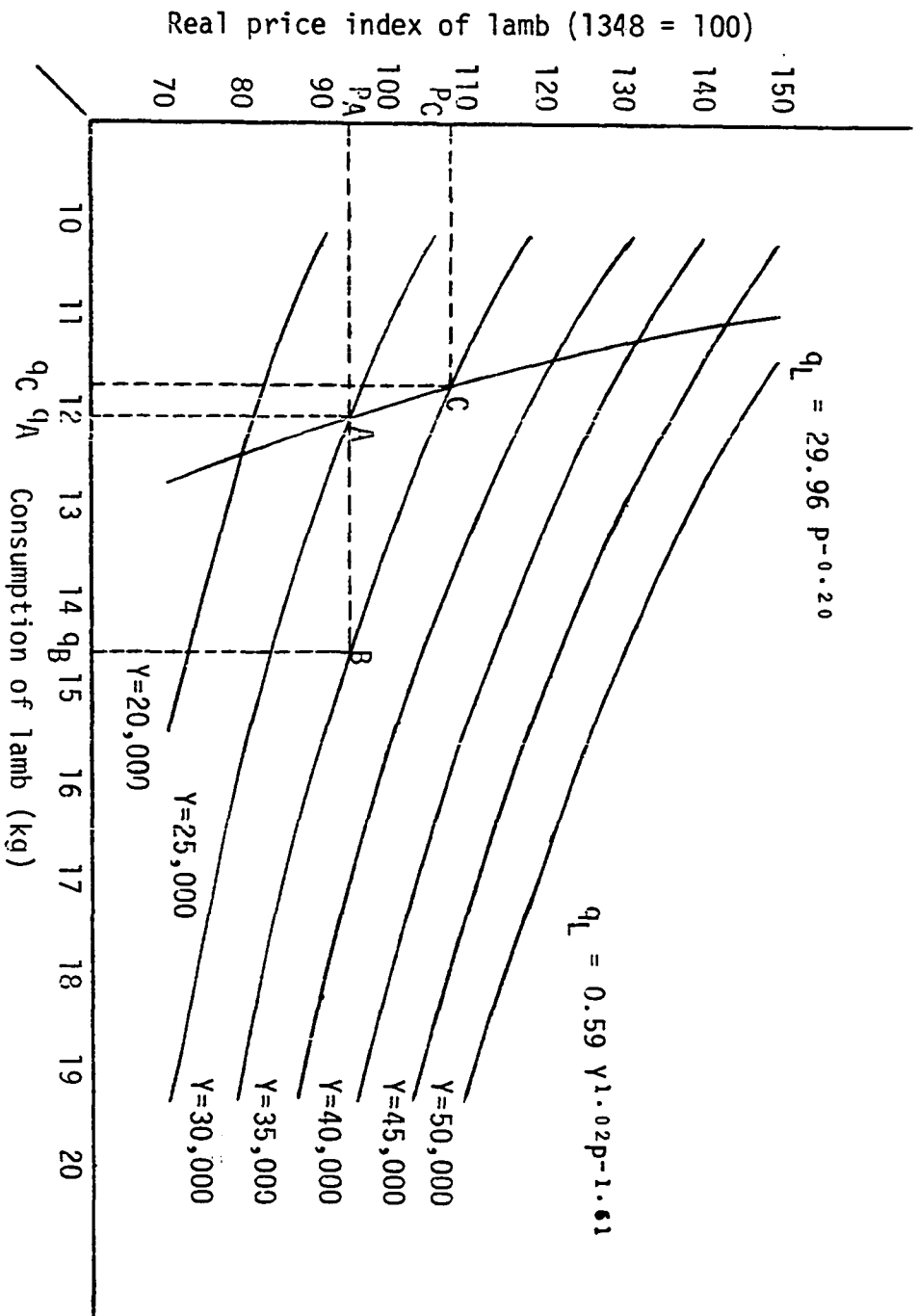


Figure 7.5. Demand curves for Lamb in urban areas

are $OP_A\%$ and Oq_A Kg, respectively. If the price of lamb had remained constant, with an increase in real per capita expenditure from 25,000 to 30,000 Rials, the consumption of lamb would increase by q_Aq_B . However, at the same time, the price of lamb had increased by P_AP_C , and this increase in price of lamb not only removed the income effect on the consumption of lamb, but it has caused the consumption to decrease by q_Cq_A .

By introducing beef as a substitute commodity into the model the choice is given as to whether to solve the model by the single equation or by simultaneous equation approaches. However, the application of 2SLS (simultaneous approach) as the method of lamb demand estimation did not yield satisfactory results. Three different models of single equation (unrestricted, imposing known expenditure elasticity, imposing Euler's theorem and known expenditure elasticity) were also applied. The results were either statistically insignificant or economically meaningless.

Consider the following demand equation where known expenditure elasticity is imposed.

$$q_L = 0.008 Y^{1.02} P_L^{1.06} P_B^{-1.74} \quad (\text{Auto, 7.26})$$

Both signs of own and cross price elasticities are unsatisfactory, since both lamb and beef are normal goods and substitute for each other. Economically, it is expected that the sign of own and cross price elasticity will be negative and positive, respectively. The existence of this undesired result could be explained because of the high correlation between prices of lamb and beef (i.e., $r_{P_LP_B} = 0.97$). Two prices have increased almost the same over the period of this study.

However, if expenditure is constant, the lamb demand equation is as follows:

$$q_L = 601.84 P_L^{-1.66} P_B^{0.81} \quad (7.27)$$

Both the sign and size of elasticities are reasonable. Moreover, the shift parameter has increased because expenditure was taken as a constant. If the price of lamb is taken to be constant, and if the constant term is dropped since it is not statistically significant, the following demand equation is provided.

$$q_L = \gamma^{0.52} P_B^{-0.64} \quad (\text{Auto, 7.28})$$

The price of beef in equation (7.28) has the role of P_L , since the price of lamb has been taken as constant; therefore it is not surprising that sign of cross price elasticity is negative.

Considering all these different demand models for lamb, it can be concluded that the demand for lamb is elastic, with respect to consumer expenditure (income) and its own price. Also the lamb market is affected by the beef market, but since lamb is the predominant meat in Iran, the effect of beef on lamb is not very strong, especially when it is noted that the price of beef has followed almost the same pattern of increase as has the price of lamb. The beef market is a follower market with respect to the lamb market.

Urban beef analysis

The urban per capita consumption of beef increased from 5.76 Kg in 1338 to 6.86 Kg in 1353, while during the same period, real urban per capita expenditure has increased by 155 percent. Assuming all other factors to be constant, the urban time-series data shows a very low

expenditure elasticity which is statistically insignificant. However, if the price of beef is allowed to vary, the following demand equation would exist:

$$q_B = 0.18 Y^{0.54} p_B^{-0.43} \quad (\text{Auto, 7.29})$$

The signs of both elasticities are correct, but compared to cross-section analysis, the size of expenditure elasticity seems low. Therefore the known expenditure elasticity is imposed to the model, with the following result.

$$q_B = 0.04 Y^{0.82} p_B^{-0.72} \quad (\text{Auto, 7.30})$$

Introducing the lamb as a substitute commodity into the model provides a choice of solving the model either by the single equation or the simultaneous equation approaches. However, applying 2SLS (simultaneous approach) as the method of beef demand estimation did not yield satisfactory results. Three different models of single equations (unrestricted, imposing known expenditure elasticity, imposing Euler's theorem and known expenditure elasticity) were applied. The result of the unrestricted single equation approach is as follows:

$$q_B = 0.007 Y^{0.81} p_B^{-1.25} p_L^{0.90} \quad (7.31)$$

Both sign and size of all coefficients are reasonable. Interestingly, the imposed known expenditure elasticity estimation method gives almost exactly the same result, shown below.

$$q_B = 0.006 Y^{0.82} p_B^{-1.25} p_L^{0.91} \quad (\text{Auto, 7.32})$$

Applying both restrictions of known expenditure elasticity and Euler's theorem causes the coefficients of both own and cross-price

elasticities to decrease. The following equation shows the result.

$$q_B = 0.06 Y^{0.82} P_B^{-0.75} P_L^{0.07} \quad (\text{Auto, 7.33})$$

However, both price elasticities in equation (7.33) seem low since it is intuitively expected that the demand for beef with respect to its own price will be elastic and also that the cross-price elasticity of beef with respect to lamb will be more elastic than was found in equation (7.33).

Taking total expenditure to be constant presents the following demand equation.

$$q_B = 32.14 P_B^{0.66} P_L^{-1.02} \quad (7.34)$$

A focus on the above equation as demand function first seems to indicate beef is an inferior food item since its own price elasticity is positive. This economic phenomenon can be explained by the following.

Consider Figure 7.6 which illustrates: 1) different demand functions for beef of the type equation (7.32), given the level of real per capita expenditure and the real price index for lamb, 2) demand equation of the type (7.34), given the level of the real price index for lamb. At point A on Figure 7.6, the level of the real price index and consumption of beef are $OP_A\%$ and Oq_A Kg, respectively. If the price of beef had remained constant, by increase in real per capita expenditure from 25,000 to 30,000 Rials, the consumption of beef would have increased by $q_A q_B$. But, at the same time, the price of beef increased by $P_A P_C$, and this increase in the price of beef removed some of the income effect on the consumption of beef, namely the consumption of beef had only increased by $q_A q_C$ rather than $q_A q_B$. Therefore, we can conclude that, even though both the price

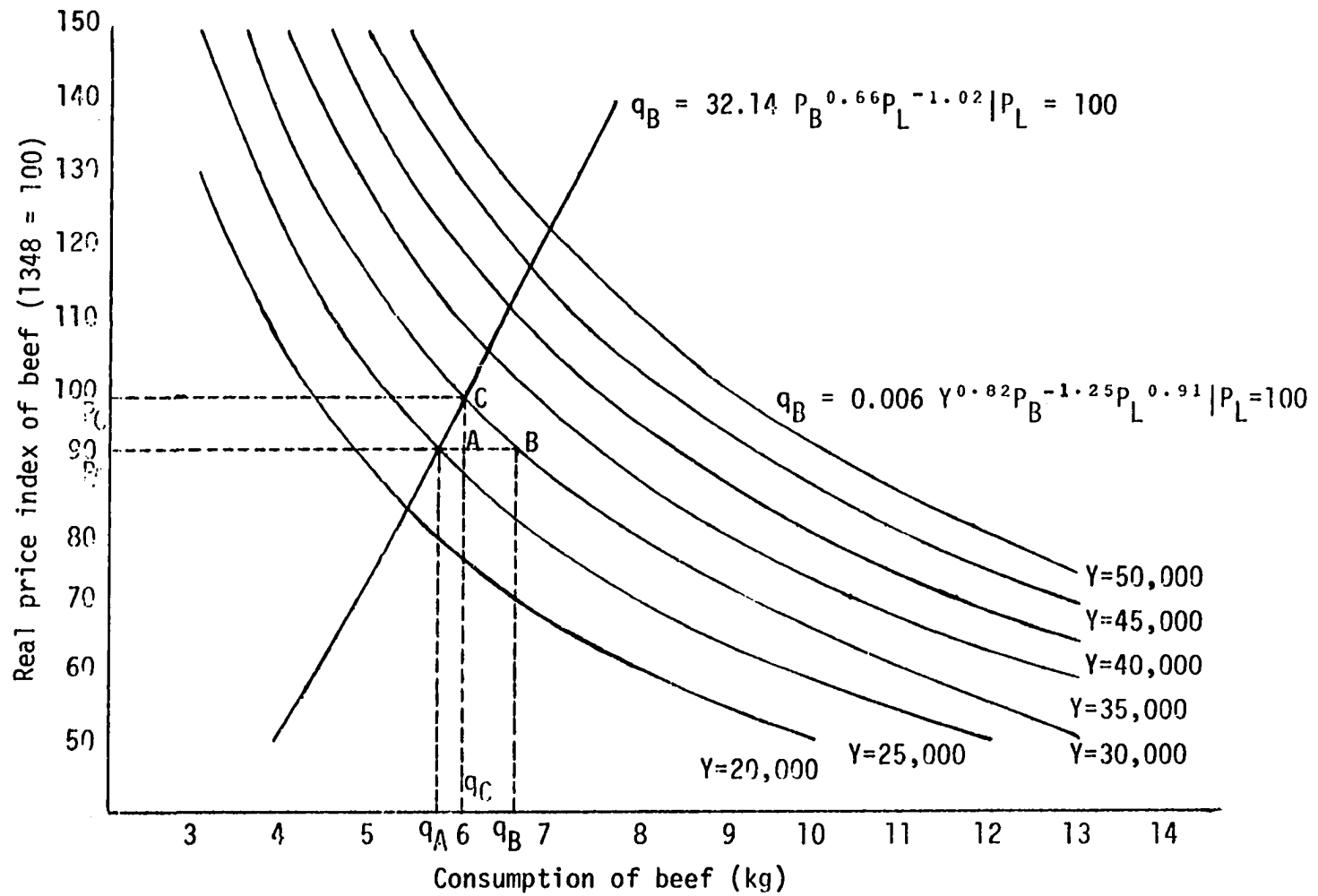


Figure 7.6. Demand functions for beef in urban areas

and consumption of beef had increased over time and the price-quantity relationship in equation (7.34) is positive, the cause of increase in the consumption of beef was the increase in total expenditure not the increase in price of beef. Equation (7.32) shows the price, quantity and total expenditure relationship in the beef market and its relation to the lamb market.

Country red meat analysis

The per capita consumption of red meat increased from 10.58 Kg in 1338 to 15.23 Kg in 1353, while during the same period, real per capita expenditure increased by 92 percent. Assuming everything else to be constant, the national time-series data shows a low expenditure elasticity. Allowing the price of red meat to vary gives the following demand equation.¹

$$q_R = Y^{0.47} p_R^{-0.52} \quad (7.35)$$

The signs of both elasticities are correct, but compared to the cross-section analysis, the size of expenditure elasticity seems to be low. Therefore the known expenditure elasticity is imposed on the model. The result is as follows:

$$q_R = 0.15 Y^{1.11} p_R^{-1.52} \quad (7.36)$$

Introducing the white meat as a substitute commodity into the model, we have the choice of solving the model either by single equation or simultaneous equation approaches.

¹The intercept has been dropped, since it was not statistically significant.

The results of single equation and 2SLS are shown in equation (7.37) and (7.38), respectively.

$$q_R = 0.01 Y^{0.48} p_R^{-0.64} p_W^{1.03} \quad (7.37)$$

$$q_R = 0.02 Y^{0.48} p_R^{-0.37} p_W^{1.03} \quad (7.38)$$

Both methods give almost the same result, except the absolute value of own price elasticity is larger in the single equation approach.

The expenditure elasticity seems too low, when compared to the cross-section analysis. Therefore the known expenditure elasticity is imposed. The following equations, (7.39) and (7.40), show the result of the single equation and 2SLS approaches.

$$q_R = 0.0002 Y^{1.11} p_R^{-0.90} p_W^{0.84} \quad (\text{Auto, 7.39})$$

$$q_R = 0.003 Y^{1.11} p_R^{-1.75} p_W^{1.05} \quad (7.40)$$

The application of both restriction of known expenditure elasticity and Euler's theorem gives the following demand equation of red meat.

$$q_R = 0.02 Y^{1.11} p_R^{-1.74} p_W^{0.63} \quad (7.41)$$

In comparing the last three equations, it is difficult to choose one as the best estimate of demand for red meat. However, intuitively one expects the demand for red meat in Iran to be elastic, with respect to its own price. Since white meat (mainly chicken) is a very good substitute for red meat in Iran, one might also expect the cross-price elasticity of red meat, with respect to white meat, to be elastic to some extent. Therefore, the equation (7.40) was selected as the best fit, but with regard to planning and policy making, the combination of the three equations gives much more information than does a single one.

Figure 7.7 illustrates both different demand functions for red meat of the type equation (7.40), given the level of real per capita expenditure and real price index of white meat, and the demand function of the type $(q_R = 1.90 P_R^{0.40})$.¹

The same argument for demand for beef in urban areas with respect to the sign of own price elasticity holds for demand for red meat in the country as well.

Country white meat analysis

The per capita consumption of white meat increased from 0.77 Kg in 1338 to 2.10 Kg in 1353. During the same period, real per capita expenditure increased by 92 percent. If it is assumed that other factors are constant, the national time-series data shows a low expenditure elasticity when compared to cross-section analysis data. The following equation shows this relation.

$$q_W = 0.00001 Y^{1.17} \quad (7.42)$$

Allowing the price of white meat to vary, we will have

$$q_W = 0.0000004 Y^{1.14} P_W^{0.78} \quad (7.43)$$

The sign of own price elasticity is positive, which is not desirable.

The size of expenditure elasticity also still seems low. Therefore, known expenditure elasticity is imposed into the model and the constant term is dropped since it is statistically insignificant.

$$q_W = Y^{1.7} P_W^{-3.72} \quad (\text{Auto, 7.44})$$

¹The price of white meat was not significant. Therefore it was dropped.

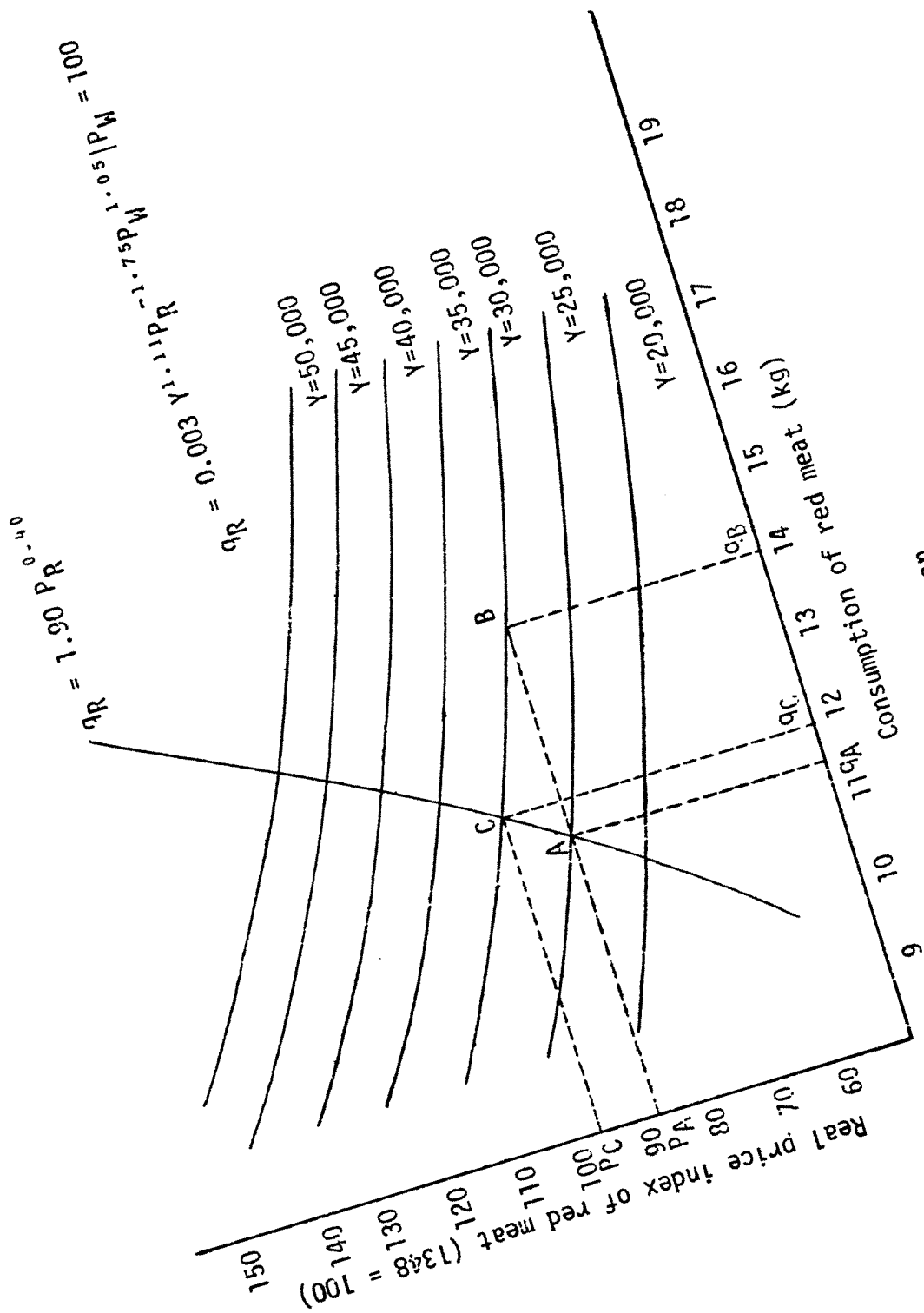


Figure 7.7. Demand functions of red meat in Iran

The size of own price elasticity seems high. This is true chiefly because of the increase in the shift parameter.

Introducing red meat as a substitute commodity into the model makes possible the choice of solving the model by the single equation or simultaneous equation approaches. However, applying 2SLS as the method of white meat demand estimation did not yield satisfactory results. Also, three different models of single equation (unrestricted, imposing known expenditure elasticity, imposing Euler's theorem and known expenditure elasticity) were applied. The results of all three models were either statistically insignificant or economically meaningless.

Figure 7.8 illustrates different demand functions for white meat of the type equation (7.44), given the level of real per capita expenditure as well as the demand functions of the type ($q_W = 3 \times 10^{-8} P_W^{3.9}$).

The same argument of demand for beef in urban areas with respect to the sign of own price elasticity also holds for demand for white meat in the country.

Summary of Elasticities

Before summarizing estimates of different elasticities, reference must be made to estimates made by other organizations and researchers. The most important results are summarized in Table 7.4.

The estimated elasticities of the present study are summarized in Table 7.5 for cross-section and time-series analysis.

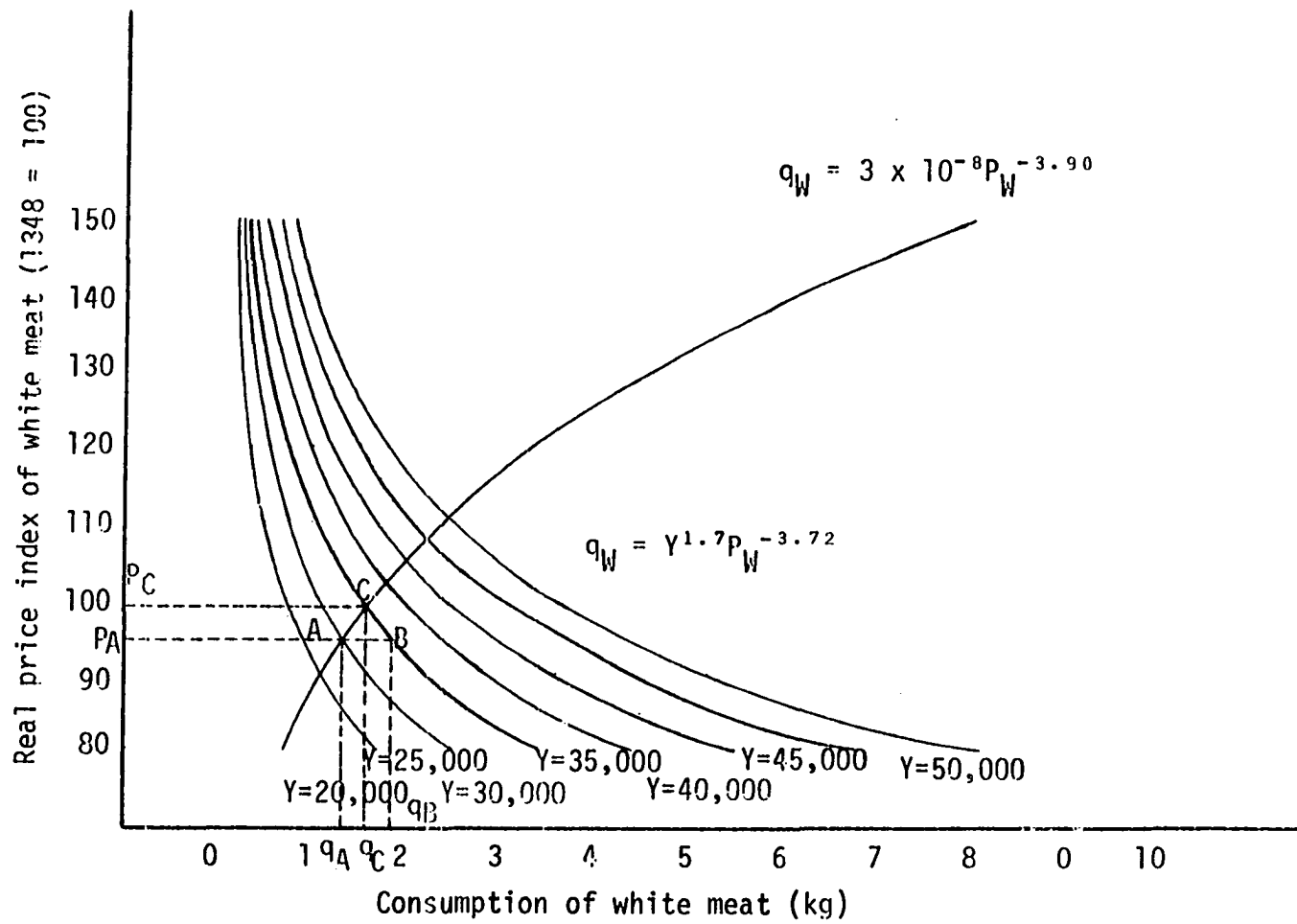


Figure 7.8. Demand functions of white meat in Iran

Table 7.4. Estimated income elasticities of demand for different meats in Iran (11)

	1348		1349		1352	1354		1354	1354	
	Ronaghy		LeBaron		ISC	World Bank		FAO	Bookers	
	Urban	Rural	Urban	Rural	Country	Urban	Rural	Country	Urban	Rural
Lamb	0.7438 ^a	1.4 ^a	0.87 ^c	2.43 ^c	-	0.51	0.96 ^b	0.97 ^b	0.77 ^b	1.55 ^b
Beef	-0.405 ^a	0.8 ^a	0.37 ^c	1.8 ^c	0.57 ^c	0.94	0.90 ^b	1.00 ^a	-	1.21 ^b
Poultry	2.2647 ^a	3.0 ^a	1.72 ^c	2.31 ^c	1.04 ^c	1.51	1.36 ^b	1.50 ^a	1.70 ^b	2.13 ^b
Fish	1.4122 ^a	0.85 ^a	1.20 ^c	1.84 ^c	-	0.35	0.85 ^b	0.73 ^b	-	-

^aEstimation function: linear.

^bEstimation function: semi-log.

^cEstimation function: double log.

Table 7.5. Estimated expenditure, own price and cross-price elasticity for different meats in Iran

	Cross-section		Time-series					
	Expenditure		Expenditure		Own price		Cross-price	
	Urban	Rural	Urban	Country	Urban	Country	Urban	Country
Lamb	1.0	1.19	1.02		-1.61		* ^a	
Beef	0.72	1.28	0.82		-1.25		0.91	
Poultry	2.52	0.98						
Fish	1.64	1.23						
Red meat				1.11		-1.75		1.05
White meat				1.70		-3.90		*

^aUndetermined.