DEMAND SYSTEMS
FOR AGRICULTURAL PRODUCTS IN THE OECD COUNTRIES

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF SOCIAL SCIENCES
OF
THE MIDDLE EAST TECHNICAL UNIVERSITY

BY

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY
IN
THE DEPARTMENT OF ECONOMICS

JANUARY 2003

Approval of the Graduate School of Social Sciences

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ABSTRACT

DEMAND SYSTEMS FOR AGRICULTURAL PRODUCTS IN THE OECD COUNTRIES

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January 2003, 268 pages

The estimation of demand equations provides the earliest example of the use of statistical and econometric techniques on economic data. It is possible to identify two distinct approaches to the estimation of demand equations. The first and original approach concentrated on the demand for particular goods by paying attention to any special characteristics of the single market involved. The second approach involved simultaneous estimation of complete systems containing the demand equations for every commodity group purchased by consumers. The estimation of a complete system of demand equations in principle enables us to obtain better estimates of each equation in the system than the first approach because of interaction in the demand behavior of different commodities. This study is directed towards the estimation of demand systems for agricultural products in the OECD countries. Three representatives demand systems with their extensions, namely the Rotterdam Model, An Almost Ideal Demand System (AIDS), and CBS model are used. These models are estimated by Seemingly Unrelated Regression (SUR) method. The procedures to estimate demand systems suggest significant empirical regularities for agricultural products in the OECD countries. The main contribution of this study is its procedure for model selection. This procedure implies the superiority of AIDS and CBS models over the Rotterdam model.

Keywords: Agriculture, Demand Systems, Rotterdam Model, AIDS, CBS Model, SUR method, OECD Countries.

ÖZ

OECD ÜLKELERİ TARIM ÜRÜNLERİ İÇİN TALEP SİSTEMLERİ

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Doktora, İktisat Bölümü
Danışman: Prof.Dr. Erol Çakmak
Ocak 2003, 268 sayfa

Talep denklemlerinin tahmini istatistiksel ve ekonometrik tekniklerin iktisadi veri için kullanımının ilk örneklerin biridir. Talep denklemlerinin tahmininde iki farklı yaklaşımdan söz edilebilir. İlk yaklaşım belli malların tek bir piyasadaki özellikleri üzerine yoğunlaşmaktadır. İkinci yaklaşımsa tüketiciler tarafından satın alınan her bir mal grubu için tanımlanmış talep denklemlerini içeren sistemlerin eş anlı tahmini ile ilgilenmektedir. Farklı mallara olan talep davranışındaki karşılıklı ilişki nedeniyle talep denklemleri sisteminin tahmin edilmesi sistem içindeki her bir denklemin denklemleri tek başına tahmin etmekten daha iyi tahminler verebileceği en azından prensip olarak geçerlidir. Bu çalışma OECD ülkeleri tarım ürünleri için talep sistemlerinin tahmin edilmesine yöneliktir. Rotterdam Modeli, İdeale Yakın Talep Sistemi (AIDS) ve CBS adıyla anılan üç temsili talep sistemi ve uzantıları kullanılmıştır. Bu modeller Görünüşte İlişkisiz Regresyon (SUR) yöntemi ile tahmin edilmiştir. Talep sistemlerini tahmin etmek için kullanılan yöntemler OECD ülkeleri tarım ürünleri için anlamlı ampirik düzenlilikler ortaya koymaktadır. Bu çalışmanın temel katkısı model seçimi için bir yöntem önermesidir. Bu yöntem de AIDS ve CBS modellerinin Rotterdam modeline göre üstünlükleri olduğunu belirlemektedir.

Anahtar Kelimeler: Tarım, Talep Sistemleri, Rotterdam Modeli, AIDS, CBS Modeli, SUR Yöntemi, OECD Ülkeleri.

To My Family

ACKNOWLEDGMENTS

This thesis is a result of my research at Middle East Technical University and University of Maastricht. I would like to state only few people who have been supportive in carrying out the research since there are too many to mention all. First of all, I would like to thank my supervisor Prof.Dr.Erol Çakmak, ex-supervisor Prof.Dr. Zehra Kasnakoğlu, and Prof.Dr. Haluk Kasnakoğlu who gives the intimates of this thesis with an earlier study. I am thankful to them not only for their guidance and insight throughout the research but also for their confidence in me. Without their contribution this study would have never been finished. I would also like to thank to the examining committee.

Second, I would like to thank Turkish Academy of Sciences for providing me a scholarship for a research abroad. In this sense, I am especially thankful to Prof.Dr. Fikret Şenses for his continuous support.

Third, I would like to appreciate my colleagues at the Department of Economics, Middle East Technical University in general and ones at the first floor in particular for their never-ending support.

Finally, I would like to thank my wife Aysun, and lovely daughter İpek, and my parents for their encouragement and precious support.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

The theory of consumer demand has been a fundamental theme in economics, and modern economic theory has dealt with consumer demand for some significant period. The conventional theory of consumer demand has paved the way towards econometric applications, and such applications shaped the main idea of this study. The aim of this thesis is to evaluate the relative performance of widely used demand models in the literature. In this sense, the major contribution of this study is to apply a test procedure to compare three models of demand systems, namely Rotterdam, AIDS, and CBS models, in an attempt to analyse demand elasticities in the OECD countries.

There are two distinct approaches to the estimation of demand equations. The orthodox approach concentrates on the demand for a particular commodity by paying attention to any special characteristics of the single market involved. The second approach, developed since the 1950s, involves the simultaneous estimation of complete systems containing demand equations for every commodity group purchased by consumers. The current study will be in the tradition of the second approach.

The demand analysis in this study will concentrate on the combination of theory of the utility-maximizing agents with the data, to estimate the systems of demand equations. The ultimate aim is to find out the empirical regularities in consumption patterns. In other words, the systems approach to demand analysis constitutes a joint analysis of the expenditures or consumption volumes of all commodities which make up total private consumption. System approach to demand analysis is mainly concerned with the problem of distributing total expenditure to an exhaustive set of different commodities. Demand system studies typically presume that the problem of deciding how much to consume at any given time has been settled, and they concentrate on the problem of allocation.

The rising number of studies and advocates of system-wide approach is a natural result of its advantages both on theoretical and practical grounds. In theory, the demand for any commodity depends on the prices of all goods yet the data drawbacks make it impossible to include all such prices in any empirical demand equation. Such limitation makes those equations identified in a more or less spontaneous way with a minor reference to any fundamental theory of consumer behavior. Explanatory variables are generally limited with own-price, the prices of a very limited number of close substitutes or complements, and an income or gross expenditure variable.

The complete system approach has a more reliable theoretical foundation. In a complete system, each equation contains as explanatory variables the prices of all goods and income. Unrestricted estimation of such systems is thus as impractical as the estimation of a single demand equation under similar conditions. Notwithstanding, the theory of consumer behaviour proposes a list of restrictions that the equations of complete system must conceptually satisfy. The restraint of these restrictions significantly reduces the number of independent price and income responses that have to be estimated. The imposition of such restrictions further suggests that the efficiency of the estimating procedure improves, and more precise estimates of the parameters of each demand equation can be secured. Nevertheless, the decisive element is that most of these restrictions are cross-equation restrictions; and hence they include the parameters of more than one equation. Consequently, they cannot be imposed provided that each equation is estimated in isolation. Therefore, the estimation of a complete system of demand equations makes possible to achieve better estimates of each equation in the system than single equation estimation.

For many applications, studies are mainly directed towards the income and price sensitivity of demand for narrowly defined goods. The interest of the current study is to provide a detailed analysis of the whole market via broad aggregates, and to discover empirical regularities in consumption patterns of different OECD member countries. The serious problem in analyzing of consumption data is that these data are expressed in national currencies. However, the data used by the study overcomes this problem by using prices obtained through international trade. The second problem is the formulation of a system of cross-country demand equations for numerous goods. It is, naturally, not at all self-evident that such a system is feasible since different countries may have different tastes that can be ignored while using broadly defined aggregates. The present study includes as many agricultural products as possible to capture all the taste differentials. However, there are still issues left for a dynamic analysis of habit formation.

The principles of utility theory are routinely imposed in econometric demand models. The impositions, whether by choice of functional form or by parametric restrictions are proposed to make an econometric model compatible with one or more standard properties deduced from individual utility maximization theory. For the estimation of demand systems, considerable intuition has been accumulated through both theoretical and applied studies. There is a strong impression that this question is primarily settled since it is in the realm of Seemingly Unrelated Regression (SUR) estimation method. Moreover, if there are nonlinearities in the parameters, the Maximum Likelihood (ML) method can be employed to produce superior outcomes especially for large samples. The SUR method is preferred over the others in this study as a result of the theoretical discussions, and it is further shown that both ML and Ordinary Least Squares (OLS) produce identical estimates under some circumstances related with the degrees of freedom.

Two demand systems seem to have distinction in agricultural economics: the Almost Ideal Demand System (AIDS) and Rotterdam model. Since AIDS was introduced by Deaton and Muellbauer (1980), it has been broadly approved and utilized by agricultural economists to the point that it now seemed to be the most popular of all demand systems. Its prevalence can be attributed to two crucial properties. First, AIDS is as flexible as the other locally flexible functional forms, but has the advantage of being consistent with aggregation over consumers. Secondly, it is rather easy to estimate and interpret as compared to its antecedents especially by using approximation to the original AIDS. Nearly all empirical applications employed the Linear Approximate (LA/AIDS) version of AIDS in which the almost ideal price index was substituted with Stone's price index. The approximation generally provides a sensible resemblance to the AIDS.

Barten (1964) inventively offered the Rotterdam Model before the evolution of flexible functional forms and the appearance of duality theory. It had been thought to be extremely restrictive and this may justify why it was less popular as compared to AIDS in the contemporary agricultural economics literature. However, further studies recognized that the Rotterdam model was as flexible as any other locally flexible functional forms (Deaton and Muelbauer, 1980, Barnett 1979, 1984; Byron, 1984; Mountain, 1988; Alston and Chalfant, 1993).

A main disadvantage of AIDS is that concavity restriction cannot be easily translated into a condition on the parameter matrices because of their relation to the Slutsky coefficients. The solution to this problem is offered by Keller and van Driel (1982, 1985) with the so-called CBS model. CBS model combines the PIGLOG Engel curve with the simplicity of the Slutsky matrix, including the ease of implementing concavity and other restrictions. In other words, the CBS model connects a flexible and agreeable Engel curve model to a directly interpretable representation of the price effects through the matrix of estimated price coefficients. The estimates satisfy all the restrictions from the theory of consumer demand and they can easily be obtained. In addition, CBS model provides flexible and agreeable Engel curves by imposing simple restrictions on the matrix of estimated price coefficients.

These three models are similar in several ways. They are second-order locally flexible functional forms; they have the same data requirements; they are identically parsimonious with regard to numbers of parameters; and they are linear in parameters. These models are chosen more frequently than any others since they each have all of these attributes and most of the alternative approaches do not. Economic theory does not offer a basis for choosing ex ante among the three models and presents a limited basis for ex post differences such as when one model violates the law of demand or another strong prior belief. Simple goodness-of-fit measures will not be appropriate for the evaluation of these models, since the dependent variables are different in the three systems. In a typical study, only one functional form is employed thus the choice among the models is likely to be decided arbitrarily in advance. However, all three models are utilized in this study because of their theoretical superiorities over the other models, and a formal method of selection is applied by estimating a nested model that results with a model selection tool after carrying out relevant tests of hypothesis. The data on demand for selected agricultural products in the OECD countries are utilized in the models. The study is unique in terms of diversity of models, and the coverage of product categories, and countries.

The plan of the study is as follows. Chapter II discusses the theory of system-wide approach by presenting its pre-eminence over the single equation methods. The classification of the existing demand systems according to the underlying theory is also presented in this chapter. The following chapter addresses the empirical applications of those systems. Chapter IV summarizes the structure of production and trade in the OECD countries. The structures of the models used in the study supplemented by the discussion on the estimation problem in the context of demand systems are in Chapter V. The data and the associated problems close the Chapter V. Chapter VI portrays the estimation results and contemplates the findings. The final chapter is reserved for the general conclusions and recommendations for further research.

CHAPTER 2

THE THEORY OF DEMAND SYSTEMS

This part of the study mainly deals with the theoretical background of the demand systems. Traditionally, estimation of demand systems is predicated on the validity of several axioms of consumer behavior. While such abstractions make empirical work easier, they can also overlook important economic behavior. In recent years, there has been a resurgence of interest in demand systems especially in agricultural economics. Several economists are engaged in deciphering consumer responses to changes in prices, income, and a host of other variables. Their efforts have provided a better understanding of consumer behavior and functioning of the markets. This admirable progress has arisen in large part because economists have imposed a system on the problem. The utility-optimizing consumer is a powerful tool, which supplies a useful framework to analyze consumer behavior. However, it often carries with it restrictions on agent behavior. While these types of abstractions are always necessary, they can have a significant impact on empirical work if violated by actual behavior. This part of the study intends to illustrate the consequences of such abstraction on demand estimation.

The first section will discuss the advantages of system-wide approach to the estimation of demand equations. Then, the various approaches, namely Linear Expenditure Systems (LES), Inverse Demand System, Rotterdam Model, Almost Ideal Demand System (AIDS), and other specifications, on formulating demand systems will be classified and analyzed. This chapter will give necessary insights for the formulation of models employed in this study.

2.1 A Prelude to System-Wide Approach

The estimation of demand equations provides the earliest example of the use of statistical and econometric techniques on economic data. It is possible to identify two distinct approaches to the estimation of demand equations. The first and original approach concentrates on the demand for a particular commodity by paying attention to any special characteristics of the market involved. The second approach developed since the 1950s involves the simultaneous estimation of complete systems containing demand equations for every commodity group purchased by consumers. Estimation of complete demand systems within a framework consistent with classical demand theory originated with Stone's (1954) pioneering contribution and now constitutes a large body of theoretical and applied literature. In a system-wide context, applied demand analysis is combined with the theory of the utility-maximizing consumer with the data to estimate systems of demand equations. There are obvious advantages and disadvantages to estimate demand equations in a system-wide context. The system-wide approach theoretically puts considerable restrictions that will be discussed in a detailed manner in the sections on specific models.

In general, Theil (1980:4-5) who has invaluable contributions to the theory with his pioneering works, analyzed the problems associated with the system-wide approach under two subheadings. First problem is the Slutsky symmetricity assumption which is closely related with the concept of substitutability. The so-called Slutsky coefficients give the total substitution effect. The equality of these coefficients that can be considered as a constraint in estimation is an important concern while estimating the demand for several goods. The number of Slutsky symmetry relations increases almost proportionately to the square of the number of goods under consideration. Moreover, pair-wise tests of these relations are not an issue yet they should be tested simultaneously. This problem is more or less tackled by a cumbersome rearrangement of the output using the modern computer technology.

Second, the number of unconstrained coefficients rises after the imposition of Slustky symmetry. This increase causes degrees of freedom problem because of the necessity of simultaneous estimation of the coefficients. In order to solve the problem further restrictions are necessary to impose. The solution proposes an aggregation towards utility function being the sum of *n* functions that entails independency between marginal utility of each good and quantities consumed of other goods (Theil, 1980:47).

The additional burden of the restrictions was questioned. The advocates of the system-wide approach[1] claim that the traditional approach is not suitable in the specification of demand equations in numerical form. They tend to see the system-wide approach offering new prospects in the sense that the theory is a prototype of an allocation or a decomposition theory in which it is concerned about a given total and questions how this total is fragmented into components. Moreover, once such a system is formulated, a researcher is able to determine globally helpful summary measures. Finally, the estimation of a complete system of demand equations in principle enables to obtain better estimates of each equation in the system than single equation approach, because of the interaction in the demand behavior of

[1] For the detailed surveys on the topic see Brown and Deaton (1972), Philips (1974), Powell (1974), Barten (1977), Theil (1980), Clements (1987), Selvanathan (1987), and Thomas (1987).

different commodities. In sum, it can be claimed that the application of system-wide approach to demand costs less than its valuable insights.

2.2 Demand Systems Classified[2]

In this section, the theoretical properties and derivation of various types of demand systems will be discussed. Our aim is not to identify the best system, but to give an idea about the relative theoretical superiorities and weaknesses of the frequently used systems in the literature. The section is organized through the discussion of Linear Expenditure Systems (LES), Inverse Demand System, Rotterdam Model, Almost Ideal Demand System (AIDS), and other specifications. In some cases, the differences between the systems are not exactly clear-cut but they may be derived by using the beginning assumptions of each other. Thus, the question of which is the best is not a matter indeed.

2.2.1 Linear Expenditure Systems (LES)

The most orthodox model of demand system specifications is the linear expenditure systems of various sorts. Some of the assumptions of this theory are further used by the models that will be discussed later.

2.2.1.1 Consumer Preferences

As a first step to derive demand equations, we assume to have the following utility function

(2.1) $u = u(q_1, \ldots\ldots\ldots, q_n)$

[2] For a wider discussion on the models evaluated in this chapter , see Barten (1964a, 1964b, 1977), Theil (1965, 1980), Barnett (1979), Deaton and Muellbauer (1980), Green and Alston (1990), Buse (1994), Keller and van Driel (1982,1985), and Imhoff (1985).

where q_i is the quantity consumed of good *i*. It is further assumed that this function is differentiable and that there is no nonsatiation, thus each marginal utility is positive,

(2.2) $$\frac{\partial u}{\partial q_i} \rangle 0 \qquad i=1,...,n.$$

It is also assumed that there is generalized diminishing marginal utility, so that the Hessian matrix of the utility function is negative definite. Since Hessian are symmetric,

(2.3) $$U = \left[\frac{\partial^2 u}{\partial q_i \partial q_j} \right]$$

The budget constraint is that expenditure on *n* goods must equal a fixed total income, *M*.

(2.4) $$\sum_{i=1}^{n} p_i q_i = M$$

where p_i stands for the price of good *i*.

The differential of the budget constraint given in (2.4) is

(2.5) $$\sum_{i=1}^{n} p_i d\, q_i + \sum_{i=1}^{n} q_i d\, p_i = dM$$

Dividing both sides by *M*, using the identity $dx/x=d(\log x)$ and $w_i= p_i q_i/M$ it follows that

(2.6) $$\sum_{i=1}^{n} w_i d\,(\log q_i) + \sum_{i=1}^{n} w_i d\,(\log p_i) = d(\log M)$$

This can also be written as

(2.7) $$d(\log Q) \ + d(\log P) \ = d(\log M)$$

where $d(\log Q) = \sum_{i=1}^{n} w_i d(\log q_i)$ is called as Divisia volume index and

$d(\log P) = \sum_{i=1}^{n} w_i d(\log p_i)$ is Divisia price index (Theil and Clements, 1987:16).

Hence, equation (2.7) decomposes the change in income into a volume and price index. The volume index is a weighted average of the *n* logarithmic quantity changes where the weights are the budget shares. In a like fashion, the price index is a weighted average of the price changes.

In order to derive demand equations, we should maximize (2.1) subject to (2.4). The first order conditions for a maximum of (2.1) are (2.4) and

(2.8) $\frac{\partial u}{\partial q_i} = \lambda p_i \quad i=1,...,n.$

The first-order conditions includes $n+1$ equations that can be solved for $n+1$ unknowns, $q_1,..., q_n$ and λ. It is assumed that the resulting quantities are unique and positive for relevant values of prices and income. The optimal quantities depend on income and prices, thus demand functions are obtained as

(2.9) $q_i = q_i(M, p_1, \ldots, p_n) \quad i=1,...,n.$

We proceed with how the endogenous variables $q_1,...,q_n,\lambda$ reacts the changes in exogenous variables $p_1,...,p_n,M$. As a first step, we begin by differentiating the budget constraint given in (2.4) with respect to p_j and M.

(2.10a) $\sum_{i=1}^{n} p_i \frac{\partial q_i}{\partial p_j} = -q_j \qquad j=1,...,n.$

(2.10b) $\sum_{i=1}^{n} p_i \frac{\partial q_i}{\partial M_j} = 1$

These can be expressed in matrix notation as

(2.10c) $$p'\frac{\partial q}{\partial\ p'} = -q' \qquad \text{and} \qquad p'\frac{\partial q}{\partial M} = 1 \ ,$$

where $\partial q/\partial p' = [\partial q_i/\partial p_j]$ is the nxn matrix of price derivatives of the demand functions, and $\partial q/\partial M = [\partial q_i/\partial M]$ is the vector of n income slopes of the demand functions.

Then, first order conditions given in (2.8) are differentiated with respect to p_j and M.

(2.11a) $$\sum_{k=1}^{n} \frac{\partial^2 u}{\partial q_i \partial q_k}\frac{\partial q_k}{\partial p_j} = \lambda \Delta_{ij} + p_i \frac{\partial \lambda}{\partial p_j} \qquad i,j=1,\ldots,n,$$

where Δ_{ij} is the Kronecker delta and $\Delta_{ij}=1$ *if* $i=j$, $\Delta_{ij}=0$ *if* $i\neq j$, and

(2.11b) $$\sum_{k=1}^{n} \frac{\partial^2 u}{\partial q_i \partial q_k}\frac{\partial q_k}{\partial M} = p_i \frac{\partial \lambda}{\partial M} \qquad i,j=1,\ldots,n$$

These can be written in matrix form as

(2.11c) $$U\frac{\partial q}{\partial p'} = \lambda I + p\frac{\partial \lambda}{\partial p'} \qquad \text{and,} \quad U\frac{\partial q}{\partial M} = p\frac{\partial \lambda}{\partial M}$$

where U is the Hessian matrix of (2.3), I is the nxn identity matrix, and $\partial\lambda/\partial p' = [\partial\lambda/\partial p_i]$.

Finally, we combine (2.10c) and (2.11c)

(2.12) $$\begin{bmatrix} U & p \\ p' & 0 \end{bmatrix}\begin{bmatrix} \partial q/\partial M & \partial q/\partial p' \\ -\partial\lambda/\partial M & \partial\lambda/\partial p' \end{bmatrix} = \begin{bmatrix} 0 & \lambda I \\ 1 & -q' \end{bmatrix}$$

This equation is originally introduced by Barten (1964a, b) and is known as fundamental matrix equation in consumption theory. The second matrix on the left-hand side contains the derivatives of all the endogenous variables with respect to all exogenous variables. We continue our analysis with the solution of the matrix in (2.12).

The inverse of the first matrix on the left-hand side of equation (2.12) is obtained as

(2.13) $$\begin{bmatrix} U & p \\ p' & 0 \end{bmatrix}^{-1} = \frac{1}{p'U^{-1}p}\begin{bmatrix} \left(p'U^{-1}p\right)U^{-1} - U^{-1}p\left(U^{-1}p\right)' & U^{-1}p \\ \left(U^{-1}p\right)' & -1 \end{bmatrix}.$$

Using this inverse the solution of (2.12) is obtained as

(2.14) $$\begin{bmatrix} \partial q/\partial M & \partial q/\partial p' \\ -\partial\lambda/\partial M & \partial\lambda/\partial p' \end{bmatrix} = \frac{1}{p'U^{-1}p}\begin{bmatrix} \left(p'U^{-1}p\right)U^{-1} - U^{-1}p\left(U^{-1}p\right)' & U^{-1}p \\ \left(U^{-1}p\right)' & -1 \end{bmatrix}$$

$$\begin{bmatrix} 0 & \lambda I \\ 1 & -q' \end{bmatrix}$$

Carrying out the matrix multiplication block by block gives

(2.15) $$\frac{\partial q}{\partial M} = \frac{1}{p'U^{-1}p}U^{-1}p,$$

(2.16) $$\frac{\partial q}{\partial p'} = \lambda U^{-1} - \frac{\lambda}{p'U^{-1}p}U^{-1}p\left(U^{-1}p\right)' - \frac{1}{p'U^{-1}p}U^{-1}pq',$$

(2.17) $$\frac{\partial\lambda}{\partial M} = \frac{1}{p'U^{-1}p},$$

(2.18) $$\frac{\partial\lambda}{\partial p} = \frac{\lambda}{p'U^{-1}p}U^{-1}p - \frac{1}{p'U^{-1}p}q.$$

In order to simplify these equations (2.17) is used to substitute $\partial\lambda/\partial M$ for the reciprocal of $p'U^{-1}p$ in (2.15), (2.16), and (2.18). Then, equation (2.15) becomes

(2.19) $$\frac{\partial q}{\partial M} = \frac{\partial\lambda}{\partial M}U^{-1}p.$$

Then, $U^{-1}p$ in (2.16) and (2.18) is replaced with $\partial q/\partial M$ divided by $\partial\lambda/\partial M$. This gives

(2.20) $$\frac{\partial q}{\partial p'} = \lambda U^{-1} - \frac{\lambda}{\partial\lambda/\partial M}\frac{\partial q}{\partial M}\frac{\partial q'}{\partial M} - \frac{\partial q}{\partial M}q',$$

(2.21) $$\frac{\partial\lambda}{\partial p} = -\lambda\frac{\partial q}{\partial M}\frac{\partial\lambda}{\partial M}q,$$

Equations (2.19) and (2.20) give the income and price derivatives of the demand functions. Equation (2.19) can be written in the scalar form as

(2.22) $$\frac{\partial q_i}{\partial M} = \frac{\partial\lambda}{\partial M}\sum_{j=1}^{n}u^{ij}p_j \quad ,i=1,\ldots,n.$$

Equation (2.20) can also be rewritten in scalar form as

(2.23) $$\frac{\partial q_i}{\partial p_j} = \lambda u^{ij} - \frac{\lambda}{\partial\lambda/\partial M}\frac{\partial q_i}{\partial M}\frac{\partial q_j}{\partial M} - \frac{\partial q_i}{\partial M}q_j \qquad i,j=1,\ldots,n$$

where u^{ij} is the *(i,j)th* element of U^{-1}. This shows that the effect of a change in p_j on q_i is made up of three terms, with income and other prices constant. $-q_j(\partial q_i/\partial M)$ is the income effect of the price change. The remaining two terms of the left-hand side of equation (2.23) represent the total substitution effect. This total substitution effect includes the specific substitution effect, λ^{ij} and the general substitution effect, $[-\lambda/(\partial\lambda/\partial M)](\partial q_i/\partial M)(\partial q_j/\partial M)$. The general substitution effect is concerned with the competition of all goods for an extra unit of the consumer's income, on the other hand, the specific substitution effect stresses the interaction of goods *i* and *j* in the utility function.

Now, we will continue with the derivation of a general system of differential demand equations by using the solution to the fundamental matrix equation. The total differential of (2.9) is given by

(2.24) $dq_i = \frac{\partial q_i}{\partial M} dM + \sum_{j=1}^{n} \frac{\partial q_i}{\partial p_j} dp_j$ *,i=1,...,n.*

This can be transformed to logarithmic-differential form by multiplying both sides with p_i/M and defining $w_i = p_i q_i / M$.

(2.25) $w_i d(\log q_i) = \frac{\partial (p_i q_i)}{\partial M} d(\log M) + \sum_{j=1}^{n} \frac{p_i p_j}{M} \frac{\partial q_i}{\partial p_j} d(\log p_j)$

Equation (2.23) is used to express the second term on the right hand-side of (2.25).

(2.26) $\sum_{j=1}^{n} \frac{p_i p_j}{M} \frac{\partial q_i}{\partial p_j} d(\log p_j) = \sum_{j=1}^{n} \frac{p_i p_j}{M} \left(\lambda u^{ij} - \frac{\lambda}{\partial \lambda / \partial M} \frac{\partial q_i}{\partial M} \frac{\partial q_j}{\partial M} - \frac{\partial q_i}{\partial M} q_j \right) d(\log p_j)$

Substituting equation (2.26) into equation (2.25) and rearranging gives

(2.27) $w_i d(\log q_i) = \frac{\partial (p_i q_i)}{\partial M} \left[d(\log M) - \sum_{j=1}^{n} w_j d(\log p_j) \right]$

$$+ \sum_{j=1}^{n} \left[\frac{\lambda p_i p_j u^{ij}}{M} - \frac{\lambda / M}{\partial \lambda / \partial M} \frac{\partial (p_i q_i)}{\partial M} \frac{\partial (p_j q_j)}{\partial M} \right] d(\log p_j)$$

The term in square brackets on the right-hand side of equation (2.27) is the Divisia volume index d(logQ),

(2.28) $\frac{\partial (p_i q_i)}{\partial M} \left[d(\log M) - \sum_{j=1}^{n} w_j d(\log p_j) \right] = \theta_i (d \log Q)$

In order to simplify the price substitution term of (2.27), we define

(2.29) $\phi = \frac{\lambda / M}{\partial \lambda / \partial M} = \left(\frac{\partial \log \lambda}{\partial \log M} \right)^{-1} \langle\ 0$

(2.29) is the reciprocal of income elasticity of the marginal utility of income. We further define

(2.30a) $\theta_{ij} = \frac{\lambda p_i p_j u^{ij}}{\phi M}$ *i,j=1,...,n..*

which satisfies

(2.30b) $\sum_{j=1}^{n} \theta_{ij} = \theta_i \qquad i=1,...,n.$

$[\theta_{ij}]$ is a symmetric positive definite *nxn* matrix.

The substitution term of (2.27) can be expressed as

(2.31a)

$$\sum_{j=1}^{n}\left(\frac{\lambda p_i p_j u^{ij}}{M} - \frac{\lambda / M}{\partial\lambda / \partial M}\frac{\partial(p_i q_i)}{\partial M}\frac{\partial(p_j q_j)}{\partial M}\right) d(\log p_j) = \phi\sum_{j=1}^{n}\theta_{ij}\left(d(\log p_j) - d(\log p')\right)$$

where

(2.31b) $d(\log p') = \sum_{i=1}^{n}\theta_i d(\log p_i)$

is the Frisch price index and it is different from the Divisia price index which uses budget shares as weights rather than marginal shares.

Substituting (2.28) and (2.31a) into (2.27) gives the demand equation for good *i*,

(2.32a) $w_i d(\log q_i) = \theta_i d(\log Q) + \phi\sum_{j=1}^{n}\theta_{ij} d\left(\frac{\log p_j}{P'}\right)$

where

(2.32b) $d\left(\frac{\log p_j}{P'}\right) = d(\log p_j) - d(\log P')$

and where $w_i=p_iq_i/M$ is the i^{th} budget share $\Sigma w_i=1$; $\theta_i=\partial(p_iq_i)/\partial M$ is the marginal share of good *i*, with $\Sigma\theta_i=1$; $d(logQ)= \Sigma w_i d(logq_i)$ is the Divisia volume index; $\phi<0$ is the income flexibility; $d[log(p_j/P')]=d(logp_j)-d(logP')$ is the change in the

j^{th} relative price, $d(\log P')$ is the Frisch price index defined as $\Sigma\theta_i d(\log p_i)$; and θ_{ij} is the $(i,j)^{th}$ normalized price coefficient.

The variable on the left-hand side of (2.32a) has two interpretations. First, it is the quantity component of the change in the i^{th} budget share. Second, it is the contribution of good i to the Divisia volume index.

The first term on the right of (2.32a) gives the effect of real income on the demand for good i. This term is a multiple θ_i of the Divisia volume index $d(\log Q)$. As this volume index equals $d(\log M)-d(\log P)$, where $d(\log P)$ is the Divisia price index, this means that Divisia price index transforms the change in money income into the change in real income. Moreover, since the Divisia price index is budget-share weighted, this index measures the income effect of the n price changes on the demand for the i^{th} good. The second term on the right-hand side of (2.32a) concerns with the effects of relative prices. The Frisch price index deflates the each price change.

2.2.1.2 Independent Preferences and Conditional Demand Equations

We first begin by specifying the utility function when preferences can be represented by a utility function that is additive in the n goods,

(2.33) $$u = \sum_{i=1}^{n} u_i(q_i)$$

This form of utility function can be named preference independent utility function as the marginal utility of good i is independent of the consumption of good j for $i \neq j$. Under (2.33) the Hessian matrix of the utility function and its inverse are both diagonal. It follows from (2.30a) and (2.30b) that $\theta_{ij}=0$ for $i \neq j$ and $\theta_{ii}=\theta_i$, thus the demand equation (2.32a) reduces to

(2.34) $w_i d(\log q_i) = \theta_i d(\log Q) + \phi\theta_i d\left(\frac{\log p_i}{P'}\right)$

According to equation (2.34), under preference independence only the own Frisch-deflated price appears in each demand equation, hence no pair of goods is either a specific substitute or complement. Furthermore, (2.30b) implies that each θ_i is positive under preference independence that rules out inferior goods. The implications of the preference independence assumption are rather strong.

A weaker version of preference independence is block independence (Theil, 1980) where the additive specification of (2.33) is applied to groups of goods rather than to individual goods. Let the *n* goods be divided into $G<n$ groups written $S_1,...,S_G$, such that each good belongs to only one group. Moreover, let the consumer's preferences are such that the utility function is the sum of *G* group utility functions, each involving the quantities of only one group,

(2.35) $u = \sum_{g=1}^{G} u_g\left(q_g^*\right)$

where q^*_g is the vector of the q_i's that fall under S_g. According to (2.35), the marginal utility of a good depends only on the consumption of goods belonging to the same group. Block independence implies that $[\theta_{ij}]$ of equation (2.30a) is block diagonal. Thus, if i belongs to S_g, equations (2.32a) and (2.30b) can be rewritten as

(2.36) $w_i d(\log q_i) = \theta_i d(\log Q) + \phi \sum_{j\in S_g} \theta_{ij} d\left(\frac{\log p_j}{P'}\right)$

(2.37) $\sum_{j\in S_{g1}}^{n} \theta_{ij} = \theta_i \qquad i \in S_g.$

Therefore, block independence suggests that the only deflated prices that appear in the i^{th} demand equation are those of goods belonging to the same group as the commodity under consideration. As $\theta_{ij}=0$ for i and j in different groups, under block independence no good is a specific substitute or complement of any good that belongs to a different group.

In order to derive the demand for groups of goods under block independence, let

(2.38a) $W_g = \sum_{i \in S_g} w_i$

(2.38b) $\Theta_g = \sum_{i \in S_g} \theta_i$

for the budget and marginal shares of group g. The marginal of Θ_g tells us the increase in expenditure on S_g as a result of a one unit increase in income. Summing both sides of equation

(2.39) $\sum_{i \in S_g} \sum_{j \in S_{g1}} \theta_{ij} = \Theta_g > 0$

where the inequality sign is the result of the positive definiteness of the matrix $[\theta_{ij}]$. According to the equation (2.39) block independence ensures that no group as a whole can be inferior, however, members of the group can be inferior.

Group Divisia volume and Frisch price indices can be defined respectively as

(2.40) $d(\log Q_g) = \sum_{i \in S_g} \frac{w_i}{W_g} d(\log q_i)$

(2.41) $d(\log P'_g) = \sum_{i \in S_g} \frac{\theta_i}{\Theta_g} d(\log p_i)$

These two indices aggregate consistently since a budget-share-weighted average of $d(\log Q_1, \ldots, d(\log Q_G)$ equals the Divisia volume index of all the n goods $d(\log Q)$;

and a marginal-share-weighted average *of* $d(\log P'_1),\dots, d(\log P'_G)$ equals the overall Frisch price index $d(\log P')$.

The demand equation for the group S_g as a whole under block independence can be obtained by adding over $i \in S_g$ both sides of the demand equation for good i under block independence given by equation (2.36). By using equations (2.38a), (2.38b), and (2.40), the demand equation is given by

$$\textbf{(2.42)} \quad w_i d(\log Q_g) = \Theta_g d(\log Q) + \phi \sum_{i \notin S_g} \sum_{j \in S_g} \theta_{ij} d\left(\frac{\log p_j}{P'}\right)$$

In order to simplify the price substitution term of equation (2.42), we make use of the fact that θ_{ij} is symmetric in *i* and *j*. Equation (2.37) can be expressed as

$$\textbf{(2.43)} \quad \sum_{i \in S_{g_1}}^{n} \theta_{ij} = \theta_j \qquad j \in S_g$$

and

$$\textbf{(2.44)} \quad \phi \sum_{i \in S_g} \sum_{j \in S_g} \theta_{ij} d\left(\frac{\log p_j}{P'}\right) = \phi \sum_{j \in S_g} \theta_j d\left(\frac{\log p_j}{P'}\right) = \phi \Theta_g d\left(\frac{\log P'_g}{P'}\right)$$

Then, the demand equation can be written as

$$\textbf{(2.45)} \quad w_g d(\log Q_g) = \Theta_g d(\log Q) + \phi \Theta_g \left(\frac{\log p'_g}{P'}\right)$$

and this is the composite demand equation for S_g as a group. Equation (2.45) shows that under block independence, the demand for a group of goods as a whole depends on real income and the relative price of the group $d[(\log(P'_g/P')]$. This relative price is the Frisch-deflated Frisch price index of the group. If both sides of equation (2.45) is divided by W_g, it is found that Θ_g/W_g is the income elasticity of demand for the group, and $\phi\Theta_g/W_g$ is the own-price elasticity.

There are G composite demand equations of the form (2.45) since there are G groups of goods. These equations give the allocation of income to each of the G groups. This allocation depends on income and relative prices of the groups. Given the demand for a group, in order to find how expenditure on the group is allocated to the commodities within the group, conditional demand equations should be formulated. Firstly, (2.45) is arranged to obtain conditional demand equations.

(2.46) $$d(\log Q_g) = \frac{W_g}{\Theta_g} d(\log Q_g) + \phi d\left(\frac{\log p'_g}{P'}\right)$$

Second, the right-hand side of equation (2.46) is substituted in equation (2.36) and this gives

(2.47) $$w_i d(\log Q_g) = \theta'_i W_g d(\log Q_g) + \phi \sum_{j \in S_g} \theta_{ij} d\left(\frac{\log p_j}{P'_g}\right)$$

where $\theta_i' = \theta_i / \Theta_g \; i \in S_g$ is the conditional marginal share of good i within the group S_g, with $\Sigma \theta_i' = 1 \; i \in S_g$. The conditional demand equation, (2.47) shows that the allocation of expenditure to goods within in the g^{th} group depends on the total consumption of the group, as measured by $W_g d(\log Q_g)$, and the relative prices of goods within the group. The deflator for these relative prices is the Frisch price index of the group $d(\log P'_g)$. Consumption of other groups and the prices of goods outside S_g do not appear in (2.47). Hence, the within group allocation of expenditure depends on variables pertaining to the group under consideration.

In sum, block independent preferences suggest that consumer's problem can be settled in two steps. The first step covers the allocation of income to the G groups, as described by the G group demand equations given in (2.45). Each of these demand equations contains real income and the relative price of the group under consideration but not the prices of individual goods. In the second step, for each of the groups expenditure is allocated to the goods within the group. The conditional demand equations describe this allocation and they contain total consumption of the group, as determined by the previous step, and the relative prices within the group.

2.2.2 The Rotterdam Model

The Rotterdam model is formulated by Barten (1964 a,b) and Theil (1965). In this section, the Rotterdam model (RM) will be discussed in the context of conditional demand equations. First, consider the equation (2.47) in terms of finite changes

(2.48) $\overline{w}_{it} dq_{it} = \theta_i' \overline{W}_{gt} DQ_{gt} + \sum_{j \in S_g} v_{ij} (Dp_{jt} - DP_{gt}')$

where $W_{gt}DQ_{gt} = \Sigma\, w_{it}Dq_{it}$; $DP'_{gt} = \Sigma\, \theta'_i Dp_{it}$ is the Frisch price index of the group in terms of finite changes. When the conditional marginal share and price coefficients in (2.48) are treated as constants, it is known as the *ith* equation of the first conditional version of the Rotterdam model; it is the conditional demand equation for commodity *i* belonging to the group S_g. The constraint on v_{ij}'s within S_g are given by

(2.49) $\sum_{j \in S_g} v_{ij} = \phi \Theta_g \theta_i' \quad i \in S_g$

Furthermore the price coefficients within the group are symmetric

(2.50) $v_{ij} = v_{ji} \qquad i,j \in S_g$

The absolute price version of (2.48) is

(2.51a) $\overline{w}_{it} Dq_{it} = \theta' \overline{W}_{gt} DQ_{gt} + \sum_{j \in S_g} \pi_{ij}^g Dp_{jt}$

where

(2.51b) $\pi_{ij}^{g} = v_{ij} - \phi\Theta_g \theta_i' \theta_j' \qquad i,j \in S_g$

is the *(i,j)*th conditional Slutsky coefficient. This coefficient measures the effect of a change in the price of good *j* on the consumption of *i* (i,*j* $\in S_g$) under the condition that other prices and total consumption of the group remain constant. The conditional Slutsky coefficients meet demand homogeneity,

(2.52) $\sum_{j \in S_g} \pi_{ij}^{g} = 0 \qquad i,j \in S_g$

Moreover, they are symmetric

(2.53) $\pi_{ij}^{g} = \pi_{ji}^{g} \qquad i,j \in S_g$

Second, we derive another version of the Rotterdam model. Consider the modification of the conditional demand equation (2.47) obtained by dividing both sides by W_g and multiplying and dividing the substitution term by Θ_g;

(2.54) $\frac{w_i}{W_g} d(\log q_i) = \theta_i' d(\log q_g) + \frac{\phi\Theta_g}{W_g} \sum_{j \in S_g} \frac{\theta_{ij}}{\Theta_g} d\left(\frac{\log p_j}{P_g'}\right)$

W_i/W_g is interpreted as the proportion of expenditure on S_g devoted to good *i* belonging to the group and this proportion is the conditional budget share of *i* within S_g. The left-hand side variable in equation (2.54) is the quantity component of the change in the conditional budget share of *i*. This variable is also the contribution of *i* to the Divisia volume index of S_g. The term $\phi\Theta_g/W_g$ on the right-hand side is the own-price elasticity of demand for the group S_g as a whole.

The second conditional Rotterdam model is the finite-change version of (2.54)

(2.55) $$\frac{\overline{w}_{it}}{\overline{W}_{gt}} Dq_{it} = \theta_i' DQ_{gt} + \sum_{j \in S_g} v_{ij}' (Dp_{jt} - DP_{gt}')$$

where $v'_{ij} = v_{ij}/W_g$ $(i,j \in S_g)$ is a modified price coefficient. These coefficients satisfy

(2.56) $$\sum_{j \in S_g} v_{ij}' = \frac{\phi \Theta_g \theta_i'}{W_g} \quad i,j \in S_g$$

Moreover, they are again symmetric

(2.57) $$v_{ij}' = v_{ji}' \qquad i,j \in S_g$$

The sum of all the modified price coefficients within S_g equals the constant own-price elasticity of demand for the group.

The absolute price version of (2.54) is

(2.58a) $$\frac{\overline{w}_{it}}{\overline{W}_{gt}} Dq_{it} = \theta_i' DQ_{gt} + \sum_{j \in S_g} \pi_{ij}' Dp_{jt}$$

where

(2.58b) $$\pi_{ij}' = v_{ij}' - \frac{\phi \Theta_g \theta_i' \theta_j'}{W_g} \qquad i,j \in S_g$$

is the modified conditional Slutsky coefficient of the i^{th} and j^{th} commodities with

(2.59) $$\sum_{j \in S_g} \pi_{ij}' = 0 \qquad i,j \in S_g$$

and they are symmetric

(2.60) $$\pi_{ij}' = \pi_{ji}' \qquad i,j \in S_g$$

A comparison of absolute price version of the first Rotterdam model given in equation (2.51a) with the second Rotterdam model given in equation (2.58a) implies that the second parametrization treats the original Slutsky coefficients π^g_{ij} as varying proportionately with W_{gt}.

2.2.3 An Almost Ideal Demand System

In their distinguished study, Deaton and Muellbauer (1980) adopt the following flexible functional form for the cost function of an individual household h.

(2.61) $$\log(m^h) = \alpha_0 + \sum_{j=1}^{n} \alpha_i \log(p_i) + \frac{1}{2} \sum_{j=1}^{n} \sum_{j=1}^{n} \gamma_{ij}^* \log(p_i) \log(p_j) + U^h \beta_0 \Pi_j p_j^{\beta_j}$$

Equations for the budget shares of each good can be obtained from (2.61) by using the logarithmic version of the Shephard's lemma and then substituting for U^h using the indirect utility function.

(2.62) $$w_i = \frac{\partial \log(m)}{\partial \log(p_i)}$$

The indirect utility function can be obtained by rearranging the cost function given in equation (2.61) to express U^h in terms of m and p_i. The budget share equations for household h are given by

(2.63) $$w_i^h = \alpha_i + \sum_{j=1}^{n} \log(p_j) + \beta_i \log\left(\frac{m^h}{P}\right) \qquad i, j=1,...n.$$

where P is an index of prices defined as

(2.64) $$\log(P) = \alpha_0 + \sum_{j=1}^{n} \alpha_i \log(p_i) + \frac{1}{2} \sum_{j=1}^{n} \sum_{j=1}^{n} \gamma_{ij}^* \log(p_i) \log(p_j)$$

and the γ_{ij} are defined as

(2.65) $$\gamma_{ij} = \frac{1}{2}\left(\gamma_{ij}^* + \gamma_{ji}^*\right) = \gamma_{ji}$$

Equations (2.63) represent the Almost Ideal Demand System (AIDS) and Deaton and Muellbauer (1980) express several advantages of AIDS. First, not only the cost function can be regarded as a local second-order approximation to the underlying cost function but also the budget share equations of (2.63) contain sufficient parameters to be regarded as a local first-order approximation to any demand system.

Second, as in the case of Rotterdam model, the general restrictions of consumer theory are unchanged for all the values of total expenditure and prices and can be expressed in terms of the parameters of the budget share equations of (2.63). This makes the AIDS as an appropriate tool for testing these restrictions.

Another advantage of AIDS is that the budget share equations of (2.63) can be aggregated and the aggregate equations can also be expected to be in conformity with the above restrictions. The aggregate budget share equations can be written as

(2.66) $$\overline{w}_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \log(p_j) + \beta_i \log\left(\frac{\overline{m}}{P}\right)$$

where *m* is the mean expenditure and *P* is the general price index.

The final advantage of AIDS is the ease of estimation. Equation (2.66) is linear in parameters given *P*. Since prices tend to move collinearly over time, a good approximation to P is given by a price index such as $\Sigma w_i log(p_i)$ may be calculated prior to the estimation. Therefore, since it is not required to enforce the cross-equation symmetry restriction, the AIDS may be estimated equation by equation, for instance, using ordinary least squares. If an adequate approximation of *P* is not possible or symmetry is imposed, then estimation may be cumbersome and maximum likelihood methods involving nonlinear estimation are necessary.

Following Deaton and Muellbauer, some authors introduce dynamic elements into the demand models. Blancifiorti and Green (1983) introduced habit effects into the original AIDS model, Anderson and Blundell(1983, 1984) included flexible dynamic demand system and used the AIDS model to describe long-run behavior with nonsymmetric and nonhomogenous short-run behavior. The symmetry and homogeneity restrictions are expected to hold in steady state. Dynamic equations of the following type are estimated;

(2.67)

$$\Delta w_{it} = \sum_{j=1}^{n} c_{ij} d\log(p_{jt}) + b_i d\log\left(\frac{m}{P}\right)_t - \lambda\left(w_{it-1} - \sum_{j=1}^{n}\log(p_{jt-1}) + \beta_i \log\left(\frac{m}{P}\right)_{t-1}\right)$$

Therefore, current changes in budget shares depend not only on current changes in the original AIDS explanatory variables but also on the extent of consumer disequilibrium in the previous period. In steady state, equation (2.67) reduces to a normal AIDS equation.

2.2.4 Other Models of Demand Systems

Although, there are numerous other models used in the literature on demand systems, the ones that have been used more frequently in the empirical studies, namely Inverse Demand Systems and Fractional Demand Systems are considered. There are other models that can be named as *hybrids* of the models discussed so far. However, it is not possible to discuss all these models in detail. A representative well-known example called as CBS (Central Bureau voor Statistiek) model is developed by the Netherlands Central Bureau of Statistics. We also touch upon these models in the following chapter while discussing the empirical applications.

2.2.4.1. Inverse Demand Systems[3]

Let *q* stands for an n-coordinate column vector of quantities demanded for a representative consumer, *p* an n-coordinate vector of corresponding prices, $m = p'q$ the consumer's expenditure, and *U(q)* the utility function, assumed to be non-

[3] Anderson (1980) who is the originator of Inverse Demand gives full discussion on the topic.

decreasing and quasi-concave in q. Then, the Lagrangian function to be maximized is

(2.68) $\underset{q,k}{Max}\, L = U(q) - k(p'q - m)$

The necessary conditions are

(2.69a) $U_i(q) = kp_i \qquad i = 1,2,\ldots,n$

(2.69b) $p'q = m$

in which $U_i(q)$ is the marginal utility of the ith commodity.

The inverse demand system is obtained by eliminating the Lagrangian multiplier k from (2.69a). Multiplying by q_i in equation (2.69a) and summing over n to satisfy the budget constraint of (2.69b), then the Lagrangian multiplier is

(2.70) $k = \sum_{j=1}^{n} q_j U_j(q) / m$

Substituting (2.70) into (2.69a) gives the Hotelling-Wold identity (Huang:1988,903), that identifies the inverse demand system from a differentiable direct utility function as

(2.71) $r_i = \dfrac{U_i(q)}{\sum_{j=1}^{n} q_j U_j(q)}$

in which $r_i = p_i/m$ is the normalized price of the ith commodity and the budget constraint is $r'q = 1$ for an n-coordinate vector of the normalized prices r. All income elasticities are implicitly constrained to unitary values on the basis of inverse demand system of (2.71) (Young:1990, 237). In other words, it can be claimed that an increase in income will cause the price of each commodity to increase at the same rate for given quantities demanded.

It is possible to define the quantity variable in (2.71) as $q = sq^*$ in order to analyze the comparative static properties. q^* can be defined as the geometric place of all possible equilibrium points that is shown by the intersection of a 45 degree reference line with the base period utility curve. Then, the variable s can be labelled as the factor of proportionality between q and q^*. Therefore, the inverse demand system becomes a function of the scale variable s and the reference vector in commodity space q^* as in the following way:

(2.72) $r_i = f_i(sq^*) \qquad i = 1,2,...,n$

In equation (2.72) the price effect in response to a change in the reference quantity is interpreted as the compensated price effect at the base period utility level. The scale variable s in (2.72) may be named as distance function (Deaton:1979). A distance function, $D(U_0,q_t)$ on the utility U_0 in the base period for a quantity vector q_t at time t can be defined as a scalar measure of the magnitude of the quantity vector q_t proportional to the quantity vector that lies on the utility U_0, q_0^* (ibid, 393):

(2.73) $D(U_0,q_t) = q_t / q_0^*$

In general, the distance function in (2.73) is approximated by the Laspeyres quantity index in which its precision depends on the closeness between the reference quantity vector and the equilibrium of demand in the base period. The cost of taking a decision in the base period is $p_0.q_0$ and it is the minimum cost of reaching U_0 at prices p_0. From this point it is possible to write that

(2.74) $p_0.q_o \leq p_0.q_0^*$

By virtue of (2.74) the following inequalities should also be valid

(2.75a) $D(U_0,q_t).(p_0.q_0) \leq (q_t / q_0^*).(p_0.q_0^*)$

(2.75b) $D(U_0, q_t) \leq (p_0.q_t)/(p_0.q_0)$

Consequently, the distance function or the base-weighted constant-utility quantity index is not greater than the base-weighted Laspeyres quantity index as expressed by the right-hand side of (2.75b) (ibid, 398).

There are two approaches used in the literature to specify a functional form for the inverse demand system given in (2.72). The first is based on a direct approximation of the conceptual demand relationship without imposing any rigid assumptions on the from of the utility structure like in Heien (1982), Chambers and McConnell (1983), and Brown et.al.(1995). Second approach is build upon a specified functional form for utility function as Huang (1983), Huang and Haidacher (1983), and Huang (1988). Huang (1988) approximates the inverse demand system in differential form as in the following way:

(2.76) $dr_i = \sum_{j=1}^{n} (\partial r_i / \partial q_j^*) dq_j^* + (\partial r_i / \partial s) ds \qquad i = 1,2,...,n$

Moreover, the price slopes of equation (2.76) in terms of price elasticities may be written by letting a compensated price elasticity of the i^{th} commodity with respect to a quantity change of the j^{th} commodity as

(2.77a) $f_{ij}^* = (\partial r_i / \partial q_j^*)(q_j^* / r_i)$

In addition, by letting a scale elasticity to show the effect of the i^{th} commodity price on the proportional change in all quantities demanded, we obtain

(2.77b) $g_i = (\partial r_i / \partial s)(s / r_i)$

If one replaces the derivatives in (2.76) by elasticities defined above, demand system is obtained by the following equation:

(2.78) $dr_i / r_i = \sum_{j=1}^{n} f_{ij}^* (dq_j^* / q_j^*) + g_i (ds / s) \qquad i = 1,2,...,n$

By using the demand structure consisting of n commodities given by (2.78), a complete inverse demand system can be written as a set of linear equations with *n(n+1)* demand parameters.

(2.79) $$\begin{bmatrix} \dot{r}_1 \\ \cdot \\ \cdot \\ \dot{r}_n \end{bmatrix} = \begin{bmatrix} f_{11}^* & f_{12}^* & \cdot & \cdot & f_{1n}^* \\ f_{21}^* & f_{22}^* & \cdot & \cdot & f_{2n}^* \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ f_{n1}^* & f_{n2}^* & \cdot & \cdot & f_{nn}^* \end{bmatrix} \bullet \begin{bmatrix} \dot{q}_1 \\ \cdot \\ \cdot \\ \dot{q}_n \end{bmatrix} + \begin{bmatrix} g_1 \\ \cdot \\ \cdot \\ g_n \end{bmatrix} \bullet \begin{bmatrix} \dot{s} \\ \cdot \\ \cdot \\ \dot{s} \end{bmatrix}$$

where $\dot{r}_i$ is relative change in the normalized price of the ith commodity; $\dot{q}_i$ relative change in the reference quantity of the ith commodity; $\dot{s}$ is the relative change in the scale of the quantity demanded; f_{ij}^* is compensated price elasticity of the ith commodity with respect to a quantity change in the jth commodity; and g_i is scale elasticity of the ith commodity.

Finally, Anderson (1980) also obtained the theoretical constraints among the compensated elasticities of an inverse demand system that can be named as scale aggregation, homogeneity, symmetry and negativity that are given by the equations (2.80).

(2.80a) $\sum_{i=1}^{n} w_i g_i = -1$

(2.80b) $\sum_{j=1}^{n} f_{ij}^* = 0$

(2.80c) $f_{ji}^* / w_i = f_{ij}^* / w_j$

(2.80d) $f_{ii}^* < 0$

where $w_i = p_i q_i / m$ is the expenditure weight of the ith commodity. The uncompensated price elasticities can be written by using the compensated price elasticities with the help of the following identity (Huang:1988).

(2.81) $f_{ij} = f_{ij}^* + g_i w_j \qquad i, j = 1,2,...,n$

2.2.4.2 Fractional Demand Systems[4]

These demand systems are one of the most orthodox and conventional ones existing in literature dating back into 1950s such as Stone (1953), Theil (1954), Gorman (1961), and Manser (1976). Lewbel (1987) presents a comprehensive and complete classification of fractional demand systems. Fractional demand systems are defined as being utility-derived demand equations that have quantities or budget shares proportional to *af* + *bg* where *f* and *g* depend on income and *a* and *b* vary across goods and depend on prices (Lewbel:1987, 311). This study further classifies the fractional demand systems into seven categories, four of which exist in the literature.

Let S_i be the budget share of consumption good *i* for i=*1,2,...,n, x* be the total expenditure level, *P* be the vector of prices, $P_1, P_2, ...P_n$, and *log(P)* the vector $(\log P_1, \log P_2, ...\log P_n)$. The fractional demand systems have the following general functional form:

(2.82) $S_i = \dfrac{a_i(P)v(x) + b_i(p)\mu(x)}{c(P)\tilde{v}(x) + d(P)\tilde{\mu}_i(x)} \qquad i = 1,2,...,n$

where a_i, b_i, *c*, and *d* are arbitrary differentiable functions of prices and v, $\tilde{v}$, μ, *and* $\tilde{\mu}$ are arbitrary differentiable functions of income. It is further assumed that

[4] Lewbel (1987) is an example of a good survey that discusses these systems in a more theoretical and comprehensive way than summarized here.

equation (2.82) represents demands that arise from utility maximization and hence it can be derived from the application of the logarithmic form of Roy's identity,

(2.83) $$S_i = \frac{\partial log(U)/\partial log(P_i)}{\partial log(U)/\partial log(x)}$$

to an indirect utility function *U(P,x)*. Demand systems that are represented by the equation (2.82) that can be derived from twice differentiable, indirect utility functions may be termed as fractional demand systems. There are seven possible functional forms for fractional demand systems, namely homothetic, PIGLOG, PIGL, LOG1(Translog), LOG2, EXP, and TAN demand systems (Lewbell:1987, 314-16).

Let *U(P,x)* be any twice differentiable, homogeneous of degree zero function, and S_i is the budget share of good *i* as given by equation (2.83). Then, any system of equations is fractional demand system if and only if one of the following seven cases holds:[5]

a) Homothetic Demands: For function *f(P)* satisfying $\sum_{i=1}^{n} f_i = 1$, S_i is given by

(2.84) $$S_i = f_i$$

b) PIGLOG Demands: For functions *f(P)* and *g(P)* satisfying $\sum_{i=1}^{n} g_i = 0$ and $\sum_{i=1}^{n} f_i = e^{-g}$, S_i is written as

(2.85) $$S_i = f_i e^g + g_i \, log(x)$$

[5] For the proof of these cases see Lewbell (1987, 325-36).

c) PIGL Demands: For functions *f(P)* and *g(P)* satisfying $\sum_{i=1}^{n} f_i = 1$, $\sum_{i=1}^{n} g_i = 0$, and constant $k \neq 0$, S_i is given as

(2.86) $S_i = f_i + e^{kf} g_i x^k$

d) LOG1 (Translog Type) Demands: For functions *f(P)* satisfying $\sum_{i=1}^{n}\sum_{j=1}^{n} f_{ij} = -1$, S_i is

(2.87) $S_i = \dfrac{f_i - \left(\sum_j f_{ij}\right) log(x)}{\sum_j f_j + log(x)}$

e) LOG2 Demands: For functions *f(P)*, *g(P)*, and *F(f+g)* satisfying $\sum_{i=1}^{n} f_i = -1$ and $\sum_{i=1}^{n} g_i = 1$, S_i is written as

(2.88) $S_i = \dfrac{F(f_i + g_i) + fg_i + g_i \, log(x)}{f + log(x)}$

f)EXP Demands: For functions *f(P)*, *g(P)*, *F(log(f)+kg)*, and constant $k \neq 0$ satisfying $\sum_{i=1}^{n} f_i = -kf, \quad f \neq 0$ and $\sum_{i=1}^{n} g_i = 1$, S_i is given by

(2.89) $S_i = \dfrac{g_i + (F_i + g_i) fx^k}{1 + fx^i}$

g) TAN Demands: For functions *f(P)*, *g(P)*, *G(f)*, *F(g)*, and constant $k \neq 0$ satisfying $A \neq 0$, $\sum_{i=1}^{n} g_i = 0$, $G = tan^{-1}(A)$,and $\sum_{i=1}^{n} G_i = k$, S_i is

(2.90) $S_i = \dfrac{G_i + (F - f)kg_i + (fG_i + (Ff + 1)kg_i) tan(k \log x)}{k + (kf) tan(k \log x)}$

These seven models embrace all probable fractional demands. The first three (Homothetic, PIGLOG, and PIGL) are degenerate in the sense that they are not really represented as a fraction (ibid, 315). They are equivalent to two-term demands rather than proportional. The fourth case, LOG1, relegates to a translog model when the function f is quadratic in $log(P)$. The first four models are generally seen in the literature nevertheless the last three models are proposed and named by Lewbel (1987).

2.2.4.3 An Example of a Hybrid Model: CBS Model

The hybrid model proposed by Keller and van Driel (1982), namely CBS model, is chosen as an example. The reason behind this choice is that the model starts with the assumptions of Rotterdam model and proposes new parametrizations for the budget shares. Moreover, CBS model, as an effort in contemplating the shortcomings of Rotterdam model, comprises the elements underlying the AIDS model. In an attempt to propose an alternative to Rotterdam Model, Keller and van Driel (1982) present different choices for estimating the consumer demand. In doing so, they show how different demand equations can be derived by applying different parametrizations[6] to the differentials of the budget shares given by the Rotterdam Model in equation (2.48).

A first alternative to equation (2.48) is found by using the differential of budget share (ibid, 379), that is

(2.91) $$dw_i = \mu_i D\left(\frac{m}{P}\right) + \sum_j v_{ij} Dp_j + w_i Dp_i - w_i Dm$$

that might further be parametrized as

[6] Here, the term 'parametrization' refers to the assumptions about the constancy of certain parameters.

(2.92) $dw_i = \beta_i D\left(\frac{m}{P}\right) + \sum_j \gamma_{ij} Dp_j$

where

(2.93a) $\beta_i = \mu_i - w_i$

(2.93b) $\gamma_{ij} = v_{ij} - w_i w_j + w_i \Delta_{ij}$

and Δ_{ij} is Kronecker delta.

β_i and γ_{ij} must satisfy both adding up and homogeneity restrictions.

(2.94a) $\sum_i \beta_i = 0$

(2.94b) $\sum_i \gamma_{ij} = 0$

(2.94c) $\sum_j \gamma_{ij} = 0$

Equation (2.92) is an alternative parametrization of the budget share differentials proposed by the Rotterdam model. Furthermore, a new version can be established by assuming β_i and γ_{ij} as constant. For the PI (Preference Independence) version(2.92), identical reparametrizations can be derived. The constancy of β_i, instead of μ_i, indicates Engel curves of PIGLOG types.

(2.95) $w_i = \alpha_i + \beta_i \log(m)$

Deaton and Muellbauer (1980) verify that PIGLOG type Engel curves ensure consistent aggregation over individuals. Furthermore, the absolute price version given by equation (2.92) resembles AIDS model proposed by Deaton and Muellbauer (1980). One of the major disadvantages of the AIDS version is related with the concavity restriction. The concavity restriction cannot readily be restated into a condition on the matrix γ_{ij} in view of its relation to v_{ij} as given in equation

(2.93b). This problem calls for the need of another parametrization. In order to formulate the new version, we need the differential of budget share given as

(2.96) $dw_i = w_i Dq_i + w_i Dp_i - w_i Dm$

Using equations (2.96) and (2.93b), the following equation can be derived

(2.97) $w_i D\left(\frac{q_i}{Q}\right) = \beta_i D\left(\frac{m}{p}\right) + \sum_j v_{ij} D(p_j)$

where the quantity index Q is

(2.98) $DQ = D\left(\frac{m}{P}\right)$

This model is called as the CBS model and incorporates the preferred Engel curve with the simplicity of the Slutsky matrix. The CBS model further embodies the ease of resolving the concavity and other restrictions.

2.3 Concluding Remarks

This chapter has analyzed the various demand system specifications proposed in the literature. Although linear expenditure systems that are widely used in the literature can be treated as the most primitive approach to demand system specification, they may be considered as the predecessor of other models that take their bases from this approach. Although LES models are commonly used in the literature, they have numerous deficiencies. First, the model cannot be employed to test the homogeneity and symmetry hypotheses. This is not the case with the Rotterdam model. Second, the preference independence assumption implied by the LES further imposes certain additional restrictions on the demand equations. These are called as particular restrictions (Philips, 1974) that rule out specific substitutes or complements. Third problem is related with the parametrization of LES. Theil (1983) criticizes this model in the sense that income elasticity is inversely related with the corresponding budget share such as food becomes less of a necessity or more of a luxury with increasing income. This behavior of the elasticity under LES is clearly implausible (Selvanathan, 1993:9)

During the past two decades, Almost Ideal Demand System and the Rotterdam model have been adopted by agricultural economists as the demand systems of choice in most applications. The Rotterdam has advantages especially over the LES. When the infinitesimal changes are replaced by first differences and the coefficients are taken to be constants we end up with the Rotterdam model. The Rotterdam model can be used to test the validity of the general restrictions of demand theory. Moreover, since the model is linear in the parameters, it is easy to estimate. There are mainly two disadvantages of the Rotterdam model. First, the number of π_{ij}'s to be estimated increases rapidly with the number of commodities. Therefore, the model is not appropriate for large systems. Secondly, the constant marginal shares leads to implausible behavior of the income elasticities as it is in the case in LES.

It has shown that AIDS model can be obtained from Rotterdam model by simple substitutions and assumptions. The apparent explanation is that the two models are both (second-order) locally flexible and compatible with demand theory, they have identical data requirements and are equally parsimonious with respect to parameters, and both are linear in the parameters. While both models are thus equally attractive in most respects, and indeed appear very similar in structure, they lead to different results in some applications. Both two models are likely to continue to be chosen more often than any others are since they each have all of these characteristics, and most alternatives do not. Economic theory does not provide a basis for choosing ex ante between the two models, and provides only a limited basis for ex post discrimination (i.e. one model violating the law of demand or another strong prior belief about the direction of the relation between prices and quantities.). They are difficult to compare using simple goodness-of-fit measures, because the dependent variables are different in the two systems.

Although it is difficult to evaluate the superiorities of AIDS over the Rotterdam model, it is still possible to conclude that AIDS has numerous theoretical and empirical advantages. First, not only the cost function can be regarded as a local second-order approximation to the underlying cost function but also the budget share equations contain sufficient parameters to be regarded as a local first-order approximation to any demand system unlike the Rotterdam model. Second, as in the case of Rotterdam model, the general restrictions of consumer theory are unchanged for all the values of total expenditure and prices and can be expressed in terms of the parameters of the budget share equations. AIDS turns out to be an appropriate tool for testing these restrictions. Third, budget share equations can be aggregated and the aggregate equations can also be expected to be in conformity with the necessary restrictions. The final advantage of AIDS is the ease of estimation.

The CBS model links a flexible and agreeable Engel curve model to a directly interpretable representation of the price effects through the matrix of estimated price coefficients. It is possible to reach estimates by imposing simple restrictions on this matrix. Moreover, these estimates satisfy all the restrictions from the theory of consumer demand and provide flexible and agreeable Engel curves. In particular, the possibility to impose concavity directly on the matrix of Slutsky coefficients is an advantage of the CBS model over the AIDS model.

In this section, we have discussed the possible shortcoming and advantages of the demand systems. In the following chapter, the discussion will be centered on the empirical applications of the model. From the above theoretical discussion, it seems reasonable to conclude that Rotterdam, AIDS, and CBS models seem to be best alternatives for an empirical study.

CHAPTER 3

THE EMPIRICS OF DEMAND SYSTEMS

This chapter is devoted to the discussion of empirical applications of theories presented in the previous chapter. The aim is not only provide evidence on the relative empirical performance of the models but also gather available information on the possible practical problems while dealing with the data. The econometric techniques employed in these studies are far ranging from simple ordinary least squares (OLS) to complicated techniques like error correction mechanism (ECM). This chapter solely attempts to discuss the empirics of demand systems. The econometric techniques widely used in the applied demand analysis will be reviewed in the chapter concerning the methodology.

The chapter is organized as follows: First, the applications of linear expenditure systems will be presented. The studies on the Rotterdam and different versions of AIDS models are discussed in the second part since most of the studies often compare and contrast both models. Third, the findings of other demand systems, namely in the tradition of inverse, fractional and hybrid models will be discussed. Finally, the analysis will be completed with a comprehensive discussion on the evidence provided by the reviewed studies.

3.1 Linear Expenditure Systems

Houthakker (1960, 277) describes his study as an exercise in the combined use of time series on consumers' expenditure in different countries, and in the use of first differences. The data of the study consist of annual time series for thirteen OECD countries for five goods (food, clothing, rent, durables, and other) covering the period 1948-59. The underlying model is called as Constant Elasticity Demand System (CEDS) that can be considered in the family LES. This study concentrates on the distinction between short-run and long-run elasticities. Moreover, a distinction is realized in terms of within countries and between countries regressions in a covariance analysis. However, Houthakker (1960, 287-88) ends with many theoretically incorrect signs. At the level of aggregation being used, all goods are presumably normal, but 3 of the 65 income elasticities are found to be negative and 21 of the price elasticities are positive. Thus, the fitted model presents lack of theoretical consistency.

Theil (1965) offers the use of information approach in demand analysis and legitimizes the use of constant-utility price indices in the context of differential and LES models by working on the Dutch data. He considers four cases. Two of them are related with the imports and exports of the Netherlands in 1921-36 divided into fifteen commodity groups; the remaining two groups are consumption in the interwar period (1921-39) and the postwar period (1948-58) for the fourteen commodity groups (ibid, 72-75). He finds that there is a considerable dissimilarity between the price and volume components on the one hand and the information component on the other hand. Further Theil (1965) offers a differential specification of a system of demand equations. It is nothing but a special case of double log demand system. However, it has an empirical shortcoming. All income elasticities must not be equal to one. If they are equal to one, the proportion of total expenditure spent on different goods remains the same when prices do not change. When the consumer faces with rising income and constant prices, then the expenditure pattern of the consumer would likely to change. Thus, it is reasonable to claim that income elasticities are not equal to one. The Theil's system does not satisfy this property.

For the Australian expenditure series on ten commodity groups, Powell (1966) estimates two versions of LES model for the period 1949-62 using two different econometric methods. First model is the one offered by Lesser (1960) in which it uses the assumptions of classical OLS. The second model of additive preferences uses the estimates of first for the proportionality factor and employs these estimates in the second round of iterated estimation. There are negligible differences between the parameters of two models except for the estimated price elasticities (ibid, 669). Then, he uses the results of the second model for prediction purposes. Although the study is somewhat innovative in terms of the LES models, but it seriously suffers from aggregation problem.

In order to compare the results of different demand systems, Yoshihara (1969) use the Japanese data on per capita consumption for the period 1902-60. He first theoretically discuss the relevancy of LES, double log, Theil's, and indirect addilog systems. The discussion shows that only LES and indirect addilog systems satisfy the theoretical properties of demand systems (ibid, 261-65). Then, the empirical application continues with these models for five commodity groups. The study find an internal inconsistency for the addilog model that gave rise a larger sum of squared residuals than the sum of squared residuals obtained by LES (ibid, 272). Finally, Yoshihara (1969) concludes that not only LES performs better generally, but also the sum of squared residuals for each group under LES is smaller than that under the indirect addilog system.

Pollak and Wales (1969) estimate four different dynamic versions of LES in terms of different formulations of necessary quantities of goods, namely constant change in demand, demand with linear time trend, proportional habit formation, and linear lagged consumption habit formation. They use the US data on food, clothing, shelter, and miscellaneous expenditures for 1948-65 period. In order to control the claim that tastes changed during the war, they also used the data between 1930 and 1941. They conclude that the linear time trend and proportional habit formation models are consistent with the underlying utility functions (ibid, 625). Moreover, they also detect a change in tastes during the war (ibid, 622-23).

Goldberger and Gamaletsos (1970) carry out research to compare cross-country consumer expenditure patterns. Their exercise contemplates two types of demand systems, LES and CEDS. The data belongs to 13 OECD countries for food, clothing, rent, durables, and other over the 1950-61 period. They first estimate LES. As a result of this estimation, authors claim that estimation of LES gives some indication that a demand model integrated into consumer demand theory can compete with the constant elasticity of demand model (ibid, 379). It seems feasible to consider for observed variation in expenditures in terms of change in income and prices with fixed parameters over time within each country. In the following stage, they carry out the estimation with the same data by utilizing CEDS model. The results from both indicated that income elasticities do not differ too much, yet some considerable discrepancies exist. In terms of the goodness of fit, a larger proportion of variation is observed for the LES. However, because of additional parameters in CEDS sharp definitions of the theoretical model is prevented (ibid, 398). Finally, authors conclude that LES maintains some attraction as a rival to CEDS for the analysis of consumer expenditures even though it has some weaknesses (ibid, 398-99).

In order to compare the effects of prices, income, and population composition on consumption patterns in a cross-country context, Parks and Barten (1973) hypothesize that differences in demand behavior between countries can be explained by differences in the age composition of population. They fit OECD data on fourteen countries between 1950 and 1967 to the LES. The results indicate that population composition has considerable and significant effects on the parameters of the demand model after correcting for the effect of differences in the level of real income (ibid, 838-49). They also find evidence that the impact of population is stronger in the cases of food, clothing, and housing whereas it is somewhat weaker for durable goods and services.

Sasaki and Saegusa (1974) estimated three alternative versions of the LES. They employed Japanese data for the period 1958-68 comprising 10 commodities, 9 food groups and aggregate of non-foods. The LES system requires that all commodities be normal goods, substitutes by the conventional definition, and gross complements. However, these conditions are not always satisfied for subgroups of food commodities (ibid, 269).

In a cross-country application of LES, Lluch and Powell (1975) estimate a system for eight commodities (food, clothing, housing, household equipment, personal care, transportation and communication, recreation, and miscellaneous services) by using the data of 19 countries. The most important finding for us is that a commodity's own-price and the price of food account for the most of the price effects in each demand equation in all countries (ibid, 299). However, the methodology used in this study has some shortcomings indicated by the authors. The first is the limited scope for price substitution. The second deficiency of the model is more vital for our study. The cost of estimates of the subsistence basket seem to be instable that is they are very responsive to small changes in data or model specification (ibid, 298-99).

Lluch, Powell and Williams (1977) utilize an extended LES where total consumption expenditure is assumed to be endogenous. Their data set comprises of 13 countries. For 11 countries extended LES is estimated and for 2 countries an ordinary LES is estimated because of the unavailability of the income data. There are 8 commodities (Food, clothing, housing, durables, personal care, transport, recreation, and other services) for the period ranging from 1955 to 1969. They found food and housing as necessities, clothing as borderline and the other five goods as luxuries.

Pollak and Wales (1987) estimated two models, namely LES and QES (Quadratic Expenditure System) by pooling an international consumption data. The data set includes three countries (Belgium, UK and US) for the period 1961-78. They consider the LES as a special case of QES. The permanent difference specification postulates that some sets of demand system parameters differ across countries while the remaining parameters do not (Pollack and Wales, 1987:91). Therefore, they made an explicit assumption that different countries may have different demand system parameters and proposed an estimation procedure that permit pooling while allowing both short-run and long-run demand systems to differ across countries (ibid, 90). Thus, they prevent the critiques towards pooling by applying QES. Finally, the estimates of QES exhibit a significant improvement as compared to LES in terms of both significance and functional form tests.

Hansen and Sienknecht (1989) make a comprehensive analysis of demand systems in their analysis of West German data. Their data consist of six commodity groups; agricultural products, housing expenditures, energy expenditures, expenditures for mineral oil, expenditures abroad, and services of credit institutes and private insurance companies for the period 1965-80. They investigate six different types of demand systems, namely LES, Homogenous Translog-System (HTL), Generalized Linear Expenditure System (GLES), Nonseperable Generalized Linear Expenditure System (NGLES), Translog model (LTL), and AIDS. They conclude that nonflexible demand systems such as LES and HTL are rejected by means of proposed information criteria and likelihood ratio tests whereas there are minor differences between GLES, NGLES, LTL and AIDS as a result of information criteria and nonnested hypotheses (Hansen and Sienknecht:1989, 59). However, they tend to prefer AIDS.

Buse (1992) compares and contrasts the relative performance of LES and QES in terms of their aggregative, distributional, and dynamic performance using the Canadian household expenditure data between 1965 and 1986. The famous dynamic performance of LES and QES models in the literature is found to be misleading and other functional forms are necessary to investigate the dynamic behavior.

Chalfant (1993) discusses the advantages and disadvantages of the Bayesian approach in the context of LES for the Australian meat demand with a quarterly data set covering the period 1968-88 and LA/AIDS by using meat consumption data from the US. These experiments show that prior beliefs about parameters of commonly estimated models can easily be incorporated into estimation. It is done with equality constraints on parameters by imposing homogeneity or symmetry.

Chalfant (1993) claims that while Bayesian techniques are not only philosophically appealing, but the possibility to impose inequality restrictions will provide additional incentive for their adoption (ibid, 1206).

Fan and Wailes (1995) estimate the complete demand system of Chinese rural household using a two-stage budgeting system and pooled provincial and time-series data from 1982 to 1990. They somewhat combined LES and AIDS models in their two-stage analysis. In the first stage, total expenditure is allocated over broad groups of goods and the resulting expenditure function is LES. In the second stage, group expenditures are allocated over individual commodities in the from of AIDS type model (Fan and Wailes:1995, 56). Most food items are found to have elasticities ranging from -0.005 to -0.63 whereas housing and other commodities are luxury goods (ibid, 62).

Chatterjee and Michelini (1994) carry out numerous tests to compare the relative empirical performance of LES and PIGLOG systems. They use Australian (1984-89) and New Zealandian (1984-91) household expenditure surveys. For both countries, the tests are in favor of PIGLOG demand system (Chatterjee and Michelini, 1994, 287).

In a study of Australian household expenditures on food, clothing, tobacco, and other, Cooper and McLaren (1996) employ LES and PIGLOG models for the period 1954-1992. Although LES's parsimonious demand system has been found to fit extremely well in a number of applied studies, it is criticized for the additive preference structure. The PIGLOG type model proposed by Cooper and McLaren (1996:363) allows a simple generalization away from additivity, as maintaining the parsimony of parametrization.

In a study for analyzing food commodity groups according to household poverty status, Park and Halcomb (1996) use cross-sectional data on 4,068 US households for 1988. Twelve aggregate commodity groups were chosen for this analysis: food away from home, beef, pork, chicken, fish, cheese, milk, fruits, vegetables, breakfast cereals, bread, and fats and oils. Additional information was collected on various socioeconomic and demographic characteristics of households including income and household size. They estimate LES parameters to obtain subsistence expenditures, own-price elasticities, expenditure elasticities, and income elasticities. The model results have important policy implications. If the emphasis of policy analysis is centered on poverty status households then demand parameter estimates should be employed using observations indigenous to this income group, and not average estimates for the population as a whole (ibid, 297-98). Although they have the data on household size, authors do not provide an analysis on the relation of household size, consumption, and poverty.

Arie, et al. (1997) used the theoretical model of Gaertner (1974) and Pollak (1976) for the interdependence of preferences in the Linear Expenditure System using cross-section data of UK households in 1994. The interdependence of consumption of different households has implications for the stochastic structure of the model and for the identifiability of the parameters. The empirical results indicate a significant role played by the interdependence of preferences. One of its implications is that predictions of the effects of changes in a household's exogenous variables differ according to whether the exogenous variable only changes for this household or for all households jointly.

In order to identify the habit in Japanese food consumption, Price and Gislason (2001) estimate LES by incorporating habit component in the form of the variable designed as stock. The authors claim that stocks represent the habit for the consumption of non-durables (ibid, 290). The data cover the period 1963-91 for five commodities, namely seafood, meat, cereal, vegetables, and fruit. The study implies that habit is important for meat and cereal in Japan (ibid, 294).

3.2 AIDS and Rotterdam Models

In this section, empirical studies on AIDS and Rotterdam models are analyzed simultaneously, since most of the studies compare the relative performance of these two models.

Barten (1964, a,b) introduces the formulation and workings of Rotterdam model in his ground-breaking study. In fact, Barten and Vorst (1962) made the first attempt, but the model is completed with the addition of the detailed behavior of additive preferences by Barten (1964a, b). The time series data on total consumer expenditure in the Netherlands on 14 types of commodities or services covering the periods 1921-39 and 1948-58 are used. He also incorporates the stochastic prior information in to the study and provides prior estimates (ibid, 9-13). The discussion of sample and posterior estimates completes the study. The findings show that standard errors of the posterior estimates are smaller than those of sample estimates (ibid, 27). This study not only provides basics of Rotterdam model in an extensive manner but also provides econometrically significant and efficient estimates. Therefore, it is still an invaluable study after almost 40 years.

Parks (1969) uses average information inaccuracy measure to compare the performance of the Rotterdam model, indirect addilog system, LES with or without linear trends, and also a naive model indicating no changes from year to year. The data refer to annual demand for consumer goods for eight industries in Sweden for the period 1862-1955. It is found that Rotterdam model has an unchallenged superiority. The indirect addilog is slightly better than the LES where the introduction of trends does not change the results radically and that is sometimes even inferior to the naive model.

In an attempt to outline the estimation and imposing demand system restrictions, Barten (1969) uses the Dutch time series data for sixteen groups of commodities for the periods 1923 through 1939 and 1950 through 1962. He describes the detailed procedure of maximum likelihood estimation and test procedures (ibid, 22-66). In fact, the aim of this study is to estimate a system of demand equations under numerous constraints with respect to the coefficients of the system, since use of these constraints gives more precise estimates of the coefficients by strikingly reducing the values of their estimated standard errors (ibid, 69).

Deaton (1974) employs British data for nine groups of consumer goods for the years 1900-70. He uses the values of likelihood function maximized for the various models. The symmetric version of the Rotterdam system dominates the direct addilog, the LES, and a system with zero substitution matrix in this order. The additive version of the Rotterdam model is worse than LES yet better than the zero substitution matrix system.

Theil (1975) applies the average information inaccuracy measure in order to compare the additive version of Rotterdam model, LES, and indirect addilog model. He utilizes Dutch data for 1900-38. For all groups together, the Rotterdam system is superior to indirect addilog model that is better than LES. For the individual groups, different results are obtained. For food, beverages, and tobacco, the Rotterdam model is better; for durables, the indirect addilog is slightly better than the Rotterdam model; while the LES is clearly prominent for the remaining groups.

In their pioneering study, Deaton and Muellbauer (1980) not only propose somewhat a revolutionary model to estimate demand systems but also apply this model to the postwar British data. The data includes eight nondurable groups of consumers' expenditure, namely food, clothing, housing services, fuel, drink and tobacco, transport and communication services, other goods, and other services for the period between 1954 and 1974. The model sufficiently explains a high proportion of the variance of the commodity budget shares (ibid, 322). Furthermore, their results submit an evidence on the fact that influences other than current prices and current total expenditure must be systematically modeled, even if the broad pattern of demand is to be explained in a theoretically consistent and empirically robust way (ibid, 323).

Ray (1982) applies AIDS model to the Indian budget surveys data. He estimates the household AIDS on time series (1952-1969) and pooled cross section data. Moreover, the effects of both price and household size variables are measured. The study is concerned food, clothing, fuel and light, and other non-food commodity groups. The author claims that incorporating the household size effect to AIDS improves the results (ibid, 365). Another significant result is the difference between the elasticities obtained from time series and cross-section data. The time series (short run) price elasticities understate the cross section (long run) price elasticities (ibid, 365). However, the most important shortcoming of this study is its treatment of size effect as identical across commodities.

Blanciforti and Green (1983) make the AIDS dynamic by explicitly including habit effects. Annual US time series data on 1948 to 1978 are used to estimate the demand systems. A wide variety of commodity groups are included in the study. The commodity groups are food, alcohol and tobacco, clothing, housing, utilities, transportation, medical care, durable goods, other nondurable goods, other services, other miscellaneous goods. Their results verify the presence of habits or persistencies in consumption behavior patterns of consumers when the AIDS is used as the maintained hypothesis (ibid, 515). The approximate proportionality relationship that exists for the additive LES is not found to exist for the more flexible AIDS. This result brings the most important conclusion of this study; AIDS incorporating habits appears to be more viable system for modelling the consumer behavior.

The relative performance of Rotterdam, AIDS, and CBS demand systems is compared for the Dutch data by Imhoff (1984). The Dutch data covers the period from 1951 to 1977 for five commodity groups: food, stimulants, durables, other articles, and services. The similarity of the estimated elasticities of the three models is remarkable. This study is carried out by using the data in two different ways: time series and pooled data. In each case, the models are estimated with and without intercept term. Including the intercept term is legitimized on two grounds. First, it captures the obscure effects. Second, it can be interpreted as a trend term since the models are formulated in terms of first differences (ibid, 425). Therefore, an important shortcoming of the usual applications is corrected since the change in taste and technical progress are not considered in the models. When the pooled data is employed, again all models generally agree on both the magnitude and the significance of coefficients, yet the estimation without intercept term now produces less unstable estimates for the compensated own price elasticities (ibid, 434). The models and estimation techniques used in this study is comprehensive in the sense that it not only compares the relative performance of the models but also rectifies the possible shortcomings of the models under consideration.

Alcordo and Johnson (1985) propose a new approach to the use of Rotterdam model to deal with the so-called parametrization and aggregation problems.[7] Therefore, the authors modified the Rotterdam model to solve these problems and nested the absolute price version of the Rotterdam model in their original model to directly allow comparisons of two models.[8] The data are annual observations on consumption and prices of beer, wine and spirits in Australia for the period 1955-1982. They claim that the parameter constancy assumption and tests for it are not well-established in the absolute price version of the Rotterdam model and the results of the absolute price version of the Rotterdam model are contradictory with the modified model (ibid, 388). Although they criticize the applications of absolute price version of the Rotterdam model, their modified model does not come with any tests of homogeneity and symmetry restrictions. Moreover, they suppose that the results of these tests do not radically change and reach the conclusions on *ad hoc* basis.

Keller and van Driel (1985) propose more or less the same models like Imhoff (1984). Rotterdam and AIDS models are same as in the study of Imhoff (1984), but the CBS model is modified with two new versions because of data limitations. They applied the Dutch data on 108 commodities for the period 1953-1981. The overall results suggest that all four models give reasonable estimates and no model gives practically better or worse results than the others with some rare

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[7] Byron (1984) showed that the usual substitution of fixed parameters for estimation purposes can result in severe loss of precision in the Rotterdam approximation. This problem can be referred as parametrization problem. Moreover, the theory of consumer demand is derived for the individual agents yet the data are generally available for the aggregates of agents. This problem is known as aggregation problem.

[8] Their formal model is not discussed in detail here since the proof of handling these problems is quite tedious. See Alcordo and Johnson (1985, 388-92).

exceptions. Finally, they conclude that the modified CBS model has performed better in case the number of observations is small relative to number of commodities (ibid, 389).

Heien and Wessels (1988) used AIDS to model US consumer preferences for dairy products. They applied a micro data set to measure demographic, price, and income effects. They also provide the results of a prediction interval test of the demand system (ibid, 223-24). The data belongs to Household Food Consumption Surveys of 1977-78 and further aggregated for twelve different food groups together with the demographic characteristics of consumption. They find that demographics, especially age-sex population and proportion of meals at home, have sizeable effects on demand as does own-price effects (ibid, 226). Further, they employed another time series data for the period 1948-84 to question the predictive performance of the model. The results verify the predictive performance of the model in the sense that prediction error is reasonably small. Finally, they incorporate the analysis with some policy implications of the model. Although it is not an extensive discussion, it is rare to observe such discussions in the literature.

Moschini and Meilke (1989) model the pattern of structural change in US meat demand in the context of an AIDS model. Quarterly data for the period 1967.1-1987.4 for beef, pork, chicken and fish are used to estimate AIDS and to test constancy of parameters in the model. The hypothesis of constancy of the parameters of AIDS for meat demand is rejected against a more general time-varying parameter model and this finding is further qualified by estimated distorting effects of structural change.

Green and Alston (1990) compare two demand systems in the same theoretical path, AIDS and linear approximate version of AIDS (LA/AIDS) using

US consumption data for meats, fruits and vegetables, cereal and bakery products, and miscellaneous foods. Moreover, LA/AIDS is reestimated in four alternative approaches.[9] There are no significant differences among AIDS and versions of LA/AIDS. However, when the LA/AIDS model is corrected for autocorrelation, the real income effect is reduced to zero. The authors aim to warn the researchers for the possible econometric and theoretical deficiencies of LA/AIDS although it is very popular to linearize AIDS without careful examination.

Chalfant, Gray, and White (1991) show how to impose the inequality restrictions of monotonicity and concavity of consumer's expenditure function, using AIDS for per capita consumption of meats and fish in Canada. Moreover, a new set of inequality restrictions is suggested by Chalfant et al (1991, 478-83). They employed Canadian data for 1960-88 period for beef, pork, poultry, and fish by using a Bayesian procedure. The most significant finding of this study is related with the trend effects concerning taste changes through time. Chalfant et al (1991, 488) put forward a powerful conclusion that AIDS cannot be estimated without the trend effects.

In order to estimate the demand for meats in US using traditional and new measures of ground and table cut beef, Brester and Wohlgenant (1991) formulate two models, namely the absolute price version of the Rotterdam model and LA/AIDS. They use annual data for the period 1962-89. All of the elasticity estimates from the LA/AIDS model are very similar to those of the Rotterdam models. Brester and Wohlgenant (1991, 1185-87) apply a non-nested test procedure for alternative specifications. Although the proposed test is robust for testing alternative specifications, the major failure is considerable aggregation bias. The

[9] For the detailed derivation of these alternative approaches see Green and Alston (1990).

ground beef data are constructed with the unrealistic assumption that fixed proportions of beef carcasses are processed into ground beef (ibid, 1190).

Agrawal and Powell (1992) fit a modified version of AIDS to Australian monthly time-series data between 1953.4 and 1985.6. They used six different commodity groups as food, tobacco, cigarettes, and alcoholic drinks, clothing and footwear, household durables, rent, all other expenditures. Agrawal and Powell (1992, 18) claim that they have proved the superiority of MAIDS. However, this proof is only possible under very strong assumptions. Although they introduce MAIDS in a comprehensive way, more flexible forms are needed to estimate demand parameters.

Barten (1992) derives a mixed demand system which is a midway between the regular demand systems with all prices exogenous and inverse demand systems with all quantities exogenous. Barten (1992, 37-42) further shows that a mixed demand system can be obtained from a regular demand system by treating some of the prices as endogenous and the corresponding quantities as exogenous. For this end, he uses the Rotterdam specification for Belgian vegetable market for the period 1975.1-1984.4 including 12 types of vegetables. He treats the prices of fresh vegetables as endogenous and the prices of frozen and canned vegetables as exogenous. The results indicate that the absolute value of the price effects at the equilibrium is inclined to increase with the introduction of some of the prices as endogenous (Barten:1992, 55). Barten's model is quite a suitable approach, only in the case of disaggregated types of commodities.

Moschini and Vissa (1992) also use a mixed demand system again based on a Rotterdam specification for the Canadian meat (beef, pork, and chicken) demand. The quarterly data period is 1980.1-1990.1. The endogeneity of poultry products is introduced because of the existence of import quota that insulates the domestic market and internal price formation mechanism (Moschini and Vissa:1992, 5). They found that estimated elasticities from the mixed demand system are similar to those of a direct Rotterdam model, except that the own-price elasticity of chicken demand is greater than the one in the Rotterdam model (ibid, 8).

Alston and Chalfant (1993) developed a test for comparing the econometric performance of the Rotterdam model and LA/AIDS. They estimate two versions of the Rotterdam model and four versions of AIDS for US meat demand with time series data for the period of 1967-88. The proposed specification test rejected the LA/AIDS but not the Rotterdam model (ibid, 309-12). However, this evidence should not imply that the Rotterdam model must be preferred over LA/AIDS. The authors express this concern by stating that other data sets can yield quite different conclusions and, they only advise the applicability of this test for comparing the models for a specific data set (ibid, 312). In fact, the proposed tests are only specification tests and can well produce different results for different data sets.

An inverse of the AIDS, the IAIDS, is developed in order to test the endogeneity of prices and quantities in the US meat demand system by Eales and Unnevehr (1993). The models include beef, pork, chicken, non-meat food, and all other goods. Data are annual per capita consumption from 1962 through 1989. The IAIDS has all the desirable theoretical properties of the AIDS except aggregation from the micro to the market level (ibid, 260-61). They compare the relative performance of AIDS and IAIDS, but specification tests do not clearly indicate whether the IAIDS or the AIDS model is the more appropriate. Using annual data, both prices and quantities appear to be endogenous within the entire meat market. Comparison of IAIDS and AIDS gives answer to a major question. Can prices be taken as predetermined in meat demand systems? (ibid, 266) The answer seems to be negative. Prices and quantities are both endogenous in the meat demand system as a whole; however, tests of individual variables indicate that beef quantity could be predetermined. Thus, the typical demand model in which prices are assumed predetermined is misspecified; this could influence parameter estimates, including findings of structural change in demand. In sum, the findings are extremely beneficial in terms of the price formation mechanisms in demand systems. However, simultaneous consideration of both demand and supply shocks is not considered by Eales and Unnevehr (1993) in the price formation mechanism. For completeness of the study, supply side impacts should also be contemplated.

Buse (1994) explores the properties of linearized AIDS (LAIDS) estimators and associated elasticities by applying the model to the same data used by Green and Alston (1990). He also extends their approach by developing some alternative LAIDS elasticities. The most important conclusion of this study is that income elasticities constructed for the LAIDS model are inferior to the ones obtained from the non-linear model (Buse, 1994:792-93).

Lee, Brown, and Seale (1994) applied four versions of the Rotterdam model, a differential version of the AIDS, and two mixed models the CBS and NBR (National Bureau of Research) system with features of both the Rotterdam and AIDS system to the Taiwanese data on seven types of expenditure items for the period between 1970 and 1989. They also parametrize a general model that includes features of all demand system reviewed, that is a general demand system that nests all four. This system is used as a model selection tool. Lee et al (1994, 511) conclude that AIDS model explains the price and income responsiveness of Taiwanese expenditure behavior better than the other models.

Moschini, Moro, and Green (1994) theoretically analyze the parametric restrictions required to implement the separability conditions for AIDS, Translog, and Rotterdam models. They also specify a seven-good Rotterdam system for US food expenditure data. The period covered by the data is 1947-78. Wald and Likelihood Ratio tests are employed to test these restrictions, and Likelihood ratio test seems to be a more desirable procedure (Moschini et al: 1994, 68-71).

Alston, Foster, and Green (1994) carry out a simulation study to compare the AIDS and LA/AIDS. They conclude that LA/AIDS provides accurate estimates of elasticities when the true data generating process is AIDS (Alston et al: 1994, 355).

Halbrendt and Tuan (1994) analyze Chinese consumer behavior based on data on food consumption of rural households by using AIDS. The data consist of 2,560 households for the 1990 survey year. The results can be summarized as follows (ibid, 798-99): First, own-price elasticities of most food items are inelastic. Second, except for grains, there is very little commodity substitution when relative prices change. Third, the commodities most responsive to expenditure fluctuations are meats, poultry, fruits, sweets, "other foods," and durable goods. Fourth, as income increases, the consumption of meat also rises. As animal protein consumption rises, direct human grain consumption will be replaced by less efficient, indirect grain consumption in the form of meat and poultry products. This study also proposes policy prescriptions by using the above explained results and calls the Chinese government to take an active role in balancing grain supply and demand.

Fan, Wailes, and Cramer (1995) use a two-stage model by using Chinese data for five commodity groups, food, clothing, fuel, housing, and other at the first stage. The data is a pooled cross-section and time series on 66,960 households for the period between 1982 and 1990. They use LES for the first stage by assuming that separability is not desperately restrictive for aggregate commodities. In the second stage, they employ AIDS for seven food subgroups (Fan et al:1995, 56-58). Their methodology seems to be plausible because of the simplicity of LES and its associated economic interpretation. However, it is not possible to get accurate estimates for the disaggregated commodities, that is why they use AIDS in the second stage which exactly satisfies the axioms of choice.

Moschini (1995) analyzes some properties of linear AIDS models. Moschini (1995, 63) notes that linear AIDS model estimations generally utilize Stone price index and this may cause some problems since Stone index is not invariant to the arbitrary choice of units of measurement for prices and quantities. In order to show the problems associated with Stone price index, Moschini (1995) performs a simulation experiment. He puts forward that the consequences of using usual Stone index can be serious depending on the nature of the data. Moschini (1995, 66-67) advise the use of other indices like Tornqvist index or a modified version of Stone index. Hence, the linear AIDS model may properly approximate the nonlinear AIDS if a proper index is used. This study is highly valuable for its attention to use price and quantity indices that is rather an untouched concern in most of the applied studies. Another study points out the dangers of using Stone index (Pashardes, 1993). Pashardes (1993) concludes that the Stone price index may cause a bias in estimated parameters in the AIDS. However, the bias is shown to be more serious when the budget share equations are estimated from micro rather than aggregate data (ibid, 915). In a study of testing homegeneity restrictions in the linearized AIDS, Buse (1998) does not agree with the results of Moschini (1995) that concludes only Stone index is unsatisfactory as an approximating index. Buse (1998, 219) points out the same results for the Paasche index. When Buse (1998) contrasts the relative merits of the different approximating indices, Laspayres index is chosen as the best approximation as a result of Monte Carlo design (ibid, 212-18).

Dhaene (1995) deals with the empirical comparison of complete parametric demand models. A new score test is derived and applied to four different demand models (AIDS, the translog, the generalized Leontieff, and LES) together with the popular Cox statistics. He utilizes cross-section United Nations 1975 data for 34 countries. The test outcomes support AIDS and generalized Leontieff systems (Dhaene: 1995, 317-20).

A two-stage demand model is employed to rural household micro data from Jiangsu Province of China by Gao, Wailes, and Cramer (1996). They use an extension of AIDS to estimate elasticities of aggregate commodity groups and generalized linear expenditure system for individual commodities. However, these two models are nested. The vital disadvantage of this approach is the restriction that the subutility function be affine homothetic, in which the expenditure term is linear in the conditional demand system. The most important finding of this study is that expenditure elasticities plausibly present that the stagnation of grain and other food demand is due to income stagnation rather than to food demand saturation (Gao et al:1996, 612).

In the recent years, we have observed increasing number of studies on the forecasting ability of demand systems. In this context, Kastens and Brester (1996) carry out a model selection analysis for the absolute price version of Rotterdam model, a first-differenced linear approximate almost ideal demand system (FDLA/ALIDS) model, and a first-differenced double-log demand system (FDDL).

This study aims not only to estimate the elasticities but also to forecast per capita food consumption in the USA. The data used in this study belong to US food consumption from 1923 to 1992. For these data, FDDL has superior forecasting ability compared to the Rotterdam model that is superior to the FDLA/AIDS model (ibid, 308-10).

Asche (1996) uses a linearized AIDS model to estimate demand equations for salmon in the European Union. The demand structure is analyzed for fresh, frozen, and smoked salmon using quarterly data for the period 1984-92. The significance of this study is related with the estimation technique. Seemingly Unrelated Estimation (SUR) method cannot be employed since budget shares, prices, and expenditure in the system were found to be non-stationary but cointegrated. This problem is handled by using fully modified least squares estimator of Philips and Hansen (1990) in which nonstandard distributions caused by unit roots and autocorrelation are corrected.

Chambers and Nowman (1997) employ AIDS as a representation of long run demands. The main objective is to find forecasts of budget shares for UK non-durable commodity groups. The data are on four commodity groups, namely food, alcoholic drink, and tobacco; energy products; clothing and footwear; other non-durable goods for the period 1955.1-1986.2. This study applies an Error Correction Model (ECM) for discrete and continuous time horizons both of which were based around a set of long run cointegrating relationships determined by the AIDS (ibid, 936-37). Hence, the study uses a dynamic modelling and forecasting with AIDS. Moreover, several tests regarding the specifications of the models are provided. Beyond all these nice properties of estimation procedures introduced by Chambers and Nowman (1997), a major deficiency is still observed. Although the authors are aware of the problems associated with the Stone price index, they still use it for the ease it brings to the estimation procedure.

Serena (1997) puts forward that flexible functional forms of indirect utility and expenditure functions are frequently used in approximating the behavior of utility maximizing consumers to arrive at demand systems that can be easily estimated. A common finding in time series estimations of the AIDS is strong persistence in the estimated residuals. Serena (1997) suggests two explanations for this result. First, the functions used to approximate total expenditure do not allow for the possibility of economic growth. Hence when the data on expenditure have trends, the inadequacy of the approximation results in residuals that are serially correlated. Second, when the economy grows and/or the trends in prices are different, Stone's price index provides a poor approximation to the theoretically appropriate price variable. The consequence is also reflected in the error term. The study uses simulations to illustrate these arguments (ibid, 8-10) and cointegration is proposed as a guide to model specification. Consequently, this Study argues that the original AIDS is ill-suited for analyzing the non-stationary data.

Kalwij, Alessie, and Fontein (1997) investigate the effects of demographics, household expenditure and female employment on the allocation of household expenditure to consumer goods. For this purpose, they estimate an AIDS for six categories of goods based on Dutch micro data covering 2,000 households belonging to Dutch Budget Survey of 1991. They find that interactions between household expenditure and demographics have significant importance in explaining the allocation to consumer goods (ibid, 16). As a consequence, consumer goods such as housing and clothing change with demographic characteristics from luxuries to necessities. Furthermore, this implies that budget and price-elasticities cannot be consistently estimated from aggregated data and that equivalence scales are not identified from budget survey data alone (ibid, 17). The study rejects weak separability of consumer goods from female employment. A couple with an employed spouse has a smaller budget share for housing and *personal care* and a larger budget share for education, recreation & transport and clothing compared to a couple with a non-employed spouse. This study is extremely helpful in identifying and determining the demographic effects shaping the demand for consumer goods. However, the introduction of interaction terms seems to be rather arbitrary lacking any rigorous statistical attempt.

Chen (1998) compares the linearized AIDS (LAIDS) and usual AIDS by using the Moschini's (1985) US meat demand data. This study proposes a set of linear and nonlinear symmetry restrictions to make LAIDS a better approximation to AIDS if all prices are allowed to vary (ibid, 311-12). Consequently, estimated demand elasticities are found to be affected insignificantly by the introduction of new symmetry conditions.

In order to determine how demand elasticities may differ among regions/countries, and to evaluate the non-price promotion effectiveness in selected international markets for US poultry meat products, Jan, Huang, and Epperson (1998) estimated LA/AIDS and a gradually switching dynamic AIDS model. They use US international trade data of poultry meat for 30 countries aggregated in six groups for the period 1972-1996. This study demonstrates that advertising can significantly cause the demand curve not only to shift but also to rotate which reflects the underlying changes in income and price elasticities (ibid, 7-8). The estimated elasticities and parameters seem to be plausible for price and expenditure effects, and positively encourage the effect of advertising on US poultry meat product exports in the thirty targeted international markets (ibid, 8). This study is valuable since it considers the differences in cross-country demand behavior. Jan et al (1998) apply LA/AIDS to estimate demand elasticities and a nonlinear switching AIDS to discriminate the advertisement effects among the countries. However, it is not apparent why they prefer LA/AIDS in the first step and nonlinear AIDS in the second step. It is more appropriate to nest two models into one, and then carry out the necessary tests.

A system-wide import allocation model, basically employing a Rotterdam specification to determine the degree of substitutability among different types of wheat imports of Japan, is exhibited by Schmitz and Wahl (1998). They employed annual wheat import data for eight different types of wheat imports between 1970 and 1994. The results point out that durum wheat imports from Canada and US, and white wheat imports from Australia and US are specific substitutes (ibid, 9-13). However, hard red spring wheat from Canada and US are detected as specific complements. This study lacks procedures to estimate and test various blockwise separability conditions. It is anticipated that these modifications will improve the performance of estimates, and cause to discover new paths of substitutability and complementarity relations.

Flake and Patterson (1999) aim to determine whether food safety information issues on beef have effected the demand for beef and other meats. This issue is analyzed by the help of a LA/AIDS model employing a quarterly US data on beef, pork, and chicken for the period 1987 through 1997. Interestingly enough different types of meets are generally found as complements, except for one case. However, health information proxy has a significant negative impact on beef consumption but not as strong as expected (ibid, 8). Notwithstanding it has some methodological deficiencies. This study is interesting in the sense that it produces useful information to evaluate health issues in the context of a demand system approach.

Glaser and Thompson (1999) employ a nonlinear version of AIDS to estimate demand for organic and frozen vegetables in US in a four-good system, namely broccoli, green beans, green peas, and sweet corn. The monthly data covering the period September 1990 through December 1996 are employed. At the very first step of the study, they compare AIDS and LA/AIDS and corresponding Likelihood Ratio tests favor the AIDS (ibid, 8). Thus, for further analysis, AIDS is preferred. Elasticity estimates suggest that consumers are very sensitive to the own-price changes of frozen vegetables. The substitution between organic and frozen vegetables is statistically weak (ibid, 12). The main deficiency of this study is related with its ignorance about the impact of income distribution for such goods and geographical differences.

Buse and Chan (2000) explore the properties of price indices in the context of linearized almost ideal demand system (LAI). They compare the Stone, Paasche, Laspeyres, and Tornqvist indices by applying a Monte Carlo design. Laspeyres, and Tornqvist indices are found to be superior to the Stone and Paasche indices (ibid, 527-38). Consequently, the authors claim that the invariance property of an index does not necessarily produce better estimates of price and income elasticities. The second attempt is directed to evaluate the relative performance of AIDS and LAI by using two earlier representative cases; Moschini's 1958-85 annual US data on beef, pork, chicken, and other food, Alley, Ferguson, and Stewart (1992) monthly data on five types of alcohol consumption for the period 1981-86 in the province of British

Columbia. The findings support the use of non -linear AIDS (Buse and Chan:2000, 524-26).

Jung and Koo (2000) analyzes the Korean meat and fish demand structure in the framework of a LA/AIDS model. Three sets of time series data with different levels of periodicity (monthly, quarterly, and annual) are utilized for 1980-98 period. Meat and fish are divided into 4 and 3 subgroups, respectively. They first carry out a nested test to compare Rotterdam and LA/AIDS models. The results favor the use of the latter. What is more interesting in this study is that the magnitude of parameter estimates and calculated elasticities are similar for all types of data although standard errors are larger and t-ratios are smaller when the quarterly and annual data are utilized (ibid, 13-21). This results show that it might be preferred to use disaggregated data to avoid aggregation bias and/or to satisfy the concerns on degrees of freedom if the data is available.

In order to analyze the food consumption patterns in Japan, Taniguchi and Chern (2000) use cross-sectional data with 95,223 observations in the year 1997. They estimate a single equation model for rice and then a complete demand system by using a LA/AIDS specification. From the single equation estimation, rice is found to be a normal good as opposed widely held belief that it is an inferior good (ibid, 28). On the other hand, they estimate LA/AIDS by using two different price indices, Stone and Laspeyres. The finding verify the results of the previous studies in the literature that Laspeyres price index is superior to Stone index.

Xudong and Chern (2000) investigate the demand for healthy food groups in US by employing a monthly data set for 1981-1995 period on seven healthy food groups. Since the LA/AIDS with Stone price index produces inconsistent estimates, the study introduces a modified LA/AIDS with Laspeyres index. This modified model has two essential advantages. First, use of Laspeyres index improved the quality of estimates as it represents a better approximation to the nonlinear AIDS. Second, the prices in the system are normalized to one at the point where elasticities are reported because the expressions for price and expenditure elasticities are identical between AIDS and LA/AIDS at the data point where prices are unity (Asche and Wessells, 1997). The findings show that poultry is the most price elastic while cereals are the least elastic. Moreover, fresh fruits and fresh vegetables are more price elastic than the processed ones (Xudong and Chern, 2000: 11-16).

A dynamic linear version of AIDS is used to estimate US meat demand by Poray, Foster, and Dorfman (2000). The data is quarterly belonging to the period 1966-87. Their estimation method allows parameters to evolve slowly overtime known as Generalized Flexible Least Squares (GFLS) that penalize parameter movement fairly strong. The demand for pork has become more elastic while beef and chicken less responsive to own price (ibid, 16). In order to determine the source of changes in consumption patterns, further sets of regressions were estimated by using the uncompensated price elasticities as dependent variables. The results are convincing about the significant role of relative prices and changing tastes and preferences mainly because of health considerations.

In a dynamic setting of AIDS, Karagiannis, Katranidis, and Velentzas (2000) estimate Greek Meat demand over the period 1958-1993. They construct an error correction version of AIDS that fine-tunes cross-equation contemporaneous correlation and thus take into account the optimization process behind any demand system (ibid, 31). The proposed model also gives the estimates for both short-run and long-run demand elasticities. It is found that short and long-run elasticities for Greek meat demand exhibit significant dissimilarities except for chicken (ibid, 34).

This study is invaluable in constructing a model by using recent developments on cointegration techniques and error correction models. Although the authors claim AIDS and LA/AIDS are somewhat identical at the point of approximation, they do not provide any result regarding the nonlinear version of AIDS.

By defending the fact that economists should be aware of the existence of discontinuities in consumer response, Mancuso (2000) uses a switching regime model to find the threshold behavior that implies adjustments in elasticity estimates if unavoidable. Thus, Mancuso (2000) uses a differential Rotterdam model. The data comprise quarterly observations of US consumption of beef, pork, chicken and turkey covering the period 1970.1-1990.3. The results establish that differential responses may have significant effects in the magnitude of the elasticities.

Dameus, Tilley and Brorsen (2000) offered a version of AIDS called as restricted source differentiated AIDS (RSDAIDS) that embeds two-stage budgeting and separability assumptions. The data on the Caribbean demand for starchy foods for the period 1982-96 are utilized to estimate the proposed model. The statistical tests for the homogeneity and symmetry restrictions have justified the use of RSDAIDS. However, the most important limitation of the study that curtails the reliability of the results is the short data problem. With only fifteen observations it is not plausible to estimate such a demand system. This problem might be solved by a panel data set including individual countries.

A two-stage demand system in the context of LA/AIDS is proposed by Carpentier and Guyomard (2001). The authors verify that it is feasible approximate the first stage of a two-stage budgeting scheme by a maximization problem involving a single price index and a single quantity index for each of the broad groups Carpentier and Guyomard, 2001, 222-23). The authors further investigate the relationship between conditional and unconditional expenditure and price elasticities in this context (ibid, 224-26). The proposed model is applied to French data for 1980, but the data units are not reported (assumed as households). The results seem to verify the approximation although the diagnostic tests are not explained. Furthermore, whether the used method is applicable to non-linear version of AIDS is untouched.

Alston, Chalfant, and Piggott (2001) study on the units of measurement problem in AIDS. In the literature, the generally accepted way of dealing with this issue is assembling the intercepts of the share equations linear functions of demand shift variables, a procedure that implies that the results are not invariant to disproportionate changes in the units of measurement (ibid, 77). Alston et al (2001) outline two specific alternative approaches for incorporating demand shifters in the AIDS that overcome this invariance problem. The more appealing approach, from an empirical standpoint, involves adopting the Generalized Almost Ideal (GAIDS) model proposed by Bollino (1987), and allowing the pre-committed quantities to be linear functions of demand shift variables. This approach allows the demand shifters to be included in a fashion that is flexible, parsimonious, and maintains the model's invariance to changes in units of measurement. Identical results may be encountered with other models of the PIGLOG class. For example, Lewbel's (1989) model that nests the Almost Ideal and Translog models exhibits the same dependency on units as the Almost Ideal model. One solution is to include demand shift variables as modifications of the pre-committed quantities as in the Bollino and Violi's (1990) generalization of Lewbel's model. The proposed procedure based on the existing literature is invaluable in the sense that it allows to compare the performance of alternative specifications in a more deliberate way.

LaFrance, Betty, Pope, and Agnew (2002) compare the relative performance of AIDS, quadratic price independent generalized linear (QPIGL), and quadratic expenditure system in the context of income distribution in food demand. The annual US data for the 1919-1995 period are employed.[10] The study rejects all versions of AIDS in favour of QPIGL and QES.

In an attempt to use time-series techniques in estimating demand systems, Karagiannis and Mergos (2002) estimated a linearized version of AIDS. The main motivation of employing time series techniques is associated with resolving the problems of violating the theoretical restrictions of homogeneity and symmetry, and thus improving the theoretical consistency of the demand system. Annual Greek food expenditures for the period 1950-93 are utilized to estimate an error correction mechanism. Homogeneity is found to be sensitive to the sample size, whereas symmetry to aggregation scheme is applied (Karagiannis and Mergos, 2002, 142). The most serious problem encountered in the study is the rejection of the homogeneity and symmetry restrictions. In another similar study using Greek data, Karagiannis et.al. (2000) ignore totally the non-linearities (quadratic prices) introduced by AIDS. They also note that true aggregate price index is I(2) that causes further problems in the model specification (ibid, 142-43).

Lazaridis (2003) examines meat consumption patterns of households in Greece using data from family budget surveys. For that purpose, the linear approximate Almost Ideal Demand System was employed to investigate the economics and demographic effects on the demand for four types of meat. Prices were adjusted for quality, and the demographic translation method was used to

[10] This data set excludes the period 1942-1946 to eliminate the structural impact of World War II (LaFrance, et. al., 2002, 236).

incorporate the demographic variables. Finally, the two-stage generalized Heckman procedure was employed to take into account censoring of the dependent variables

3.3 Other Models of Demand Systems

In this section, selected studies on the applications for the inverse, fractional, and hybrid demand systems will be reviewed. The number of these studies is limited and they are less popular in the recent literature, no further categorization is necessary.

K. Huang, famous on the empirical application of inverse demand systems, apply an inverse demand system for US composite goods (Huang, 1987). Huang (1987, 902) claims that quantities rather than prices are more appropriate control variables in order to analyze agricultural policies and problems because of the deterministic role of lags between producers' decisions and marketing season. Huang (1987) employed an inverse demand system using US data from 1947 through 1983. The data belong to 13 aggregate food categories and a non-food sector (ibid, 906). The estimated demand system searches for the interdependencies of food price variations to the changes in quantity. The estimated price flexibilities show the change in commodity price needed to induce the consumer to absorb a marginal increase in the quantity of that commodity or of another commodity. Moreover, the model is also properly applicable for forecasting purposes since the calculated forecasting errors for price variations in each category over the sample period are generally less than 10% (ibid, 908). However, there are some significant drawbacks in Huang's (1987) study. Five of the significant compensated price elasticities violate the law of demand, given that a fundamental property of the negative semidefinite Slutsky matrix that requires non-positive diagonal elements. These intractable results carry over to the uncompensated forms of the own-price elasticities in four cases, and may be due to two types of deficiencies. First, the bias in aggregation is so prominent that the theoretical constraints do not hold. Second, the model is somewhat misspecified even if the restrictions are valid. Despite the problems in estimates, Huang's analysis can still be functional in the design of agricultural policies. As stated by Huang (1987, 909), it is possible to define potential quantity changes for each food category under various scenarios and simulate the program effects of controlling market supplies on food prices at aggregate levels.

Brown, Lee, and Seale (1995) use the properties of inverse Rotterdam (RIDS), and inverse AIDS (AIIDS) models to propose so-called *synthetic* inverse demand system. They use the US data on three different types of fresh oranges to estimate the models with weekly data extending from first week in November through the third week in January from 1984-85 through 1993-94 seasons. The November-January period is the peak harvesting and marketing period for most of the fresh oranges (ibid, 525). RIDS and AIIDS models are assumed to have common right-hand side variables. Brown et al. (1995, 523-24) reach a synthetic model by taking a scalar weighted average of the AIIDS model under well-specified restrictions. Following the specification, the models are compared by a likelihood test. All other models are rejected against synthetic model and the synthetic model estimates are also individually significant (ibid, 526-28). The theoretical reasoning in proposing inverse demand systems, especially for AIIDS, is malicious in the sense that some arbitrary terms added to the models without deriving the reduced forms. The proposed model, which is both an example of an inverse demand and hybrid system, seems to be quite successful as compared to other models in explaining the demand for fresh oranges, yet the construction of alternative models is still open to discussion.

Gould (1995) employed a translog model of the demand for three different types of fluid milks that vary by fat content in the USA. The household panel data set includes over 4,300 households. The three milk types investigated are substitutes. All own- and cross-price elasticities were statistically significant and less than one. With a public health objective of reducing the fat intake of individuals, the results provide some hope for a continuation of shifting the consumption away from whole and towards reduced-fat varieties, given that whole milk exhibits relatively high price elasticities. All milks were found to be substitutes, and there are significant differences in the effect of demographic characteristics on milk demand (ibid, 15). A methodological limitation of the model used by Gould (1995) is the need to evaluate multi-dimensional integrals of probability density functions which makes estimation very difficult for households that are consuming less than two or three commodities. An obvious extension of this model would be to allow for greater number of commodities to be identified. Finally, a natural extension of the analysis is the inclusion of commodities other than milk.

A differential inverse demand system is studied by Huang (1996) to link food choice with nutritional status in the context of the classical demand framework. The study is based on a demand system consisting of thirty-five food categories to estimate nutrient elasticities for fifteen nutrients, using annual US data from 1953 to 1990. Demand elasticities from traditional demand analysis are used to estimate elasticities for changes in the nutritional content of consumers' diets (ibid, 29). The unique feature of the procedure is the possibility to incorporate existing interdependent demand relationships into measuring the changes in nutrients available to consumers. According to Huang (1996, 30), the nutrient elasticities provide relevant information for food policy decisions to assess the impact of food programs on the quality of consumer diets. This study is interesting with its two-step procedure. In the first step, elasticities are estimated and then the analysis is incorporated with the nutritional content of different types of food.

Cranfield, Hertel, Eales, and Preckel (1998) used two versions of directly additive demand system (AIDADS) for a cross section sample of countries from International Comparisons Project of 1985 consisting 64 countries and 113 goods of which 36 food items. Their aim is to present the changes in global food demand composition. In the first demand system, food is treated as an aggregate good together with other non-durable goods, services, and durable goods. However, in the second demand system, other goods remain the same, but food is disaggregated into four subgroups; grain, livestock, horticulture and vegetable, and other food products (Cranfield et al, 3). The estimates are used to make to 2020. The general tendency is that the share of food expenditure is projected to fall while food expenditure is projected to grow (ibid, 11). Moreover, most of the relative growth in global food demand will occur in low-income countries. The significance of this study is not related with the model it employed but with the data it utilized. The model is a hybrid one in the sense that it brings LES and fractional systems in one complete demand system. The data make possible the cross-country comparisons, and such attempts are rarely observed in the empirical literature.

Kim, Chern, and Jones (1998) apply a flexible demand system explained by Lewbel (1989) study that nests the translog demand system and AIDS. The annual data belong to Japanese fats and oils market for the period 1964-94. Seven vegetable oils and four animal fats are included in the study. They compare six alternative models with and without AR(1) (ibid, 9). The results of Wald test reject both the translog and AIDS models in favor of Lewbel's flexible demand system. The results further reveal that translog model is rejected more solidly than AIDS. Then the study continues with Lewbel's model for further analysis. The variables included in this model are found to be non-stationary and integrated at degree 1 (ibid 9-10). Therefore, the cointegration relation is found to be superior in providing both more efficient and consistent parameter estimates than AR(1). All the elasticities have the correct and significant signs with two exceptions. Butter is found to have a considerable income effect in Japan (ibid, 12). Both vegetable oils and animal fats are substitute inside the group while they are complements as groups. This study not only presents methodological achievements but also introduce more reliable econometric techniques. The only shortcoming is related with the econometrics of the AR(1) models since the same autocorrelation parameter is embodied into each share equation, instead of estimating different parameters.

Gracia, Gil, Angulo (1998) investigate the dynamic relations and long-run food demand structure in Spain. They used a Generalized Addilog Demand System (GADS) proposed by Theil (1969). The advantage of GADS is that it meets the property of nonnegativity of the estimated average budget share that is satisfied by neither AIDS nor LA/AIDS. Gracia et al (1998, 1401-2) also offer a procedure to determine the dynamic behavior of long-run coefficients. It is assumed that changes in endogenous variables are responsive to anticipated and unanticipated changes in exogenous variables needed to maintain a long-run relationship among them (ibid, 1401). The study use annual data for the sample period of 1964-91. Food products are aggregated into six categories: bread and cereals; meat; fish; milk, dairy products and eggs; fruits, vegetables, and potatoes; and oils and fats. They test different specifications and find the autoregressive specification as the best (ibid, 1401). This result suggests that Spanish food consumption show certain inertia. In other words, as income or prices fluctuate, the impact on consumption is not instantaneous since consumers have the previous level of these variables in mind and do not alter their behavior until they conceive that income or prices have effectively changed. This study is one of the rare attempts to specify the presence of inertia in consumption and persistence of habits. However, it has two principal drawbacks. First, the results of specification test clearly show an aggregation bias. Second, as it is noted by authors, a further analysis can be incorporated with a more disaggregated data in order to test the hypothesis that as income rises budget allocation remains stable, and the limited relevance of the substitution effect for the specified products, like different types of meat or dairy products.

A quadratic inverse demand system (IQUAIDS) is derived by Moro and Sckokai (1999). It generalizes the AIDS inverse demand system to estimate the meat demand (beef, pork, and poultry) equations for Italy for the period 1960-1990. They also compare the differences in estimates for inverse AIDS (IAIDS) and proposed (IQUAIDS). The proposed model satisfies both separability and concavity assumptions and the R^2 values are greater than IQUAIDS (ibid, 9-11). However, their estimated elasticities do not constitute evidence against IAIDS and do not provide a significant change in the performance of the estimates.

Beach and Holt (1999) present an inverse demand system with quadratic scale terms named as Normalized Quadratic Inverse Demand-Quadratic Scale System (NQID-QSS) that introduces an additional non-linearity into the estimating equations. Monthly data on finfish landings aggregated on 9 groups covering the period 1980.1-1996.12 are employed. By using likelihood ratio tests, quadratic scale terms are supported, that is to say, nonlinear model is preferred over the linear model (ibid, 11). This study is significant in the sense that it may be useful to introduce nonlinearity into the inverse demand systems.

Goodwin, Harper, and Schnepf (2000) analyze short-run demand relations for edible fats and oils in US by fitting an inverse AIDS (IAIDS) specification. The monthly data for the period 1981.10 and 1999.5 are used. First, they utilize a smooth transition function to a model of switching IAIDS that assesses short-run demand conditions. The results suggest that rapid structural shift occurs for fats and oils in the early 1990s, and marginal valuations for most fats and oils in response to consumption increases are rather small (ibid, 6-9). Second, the authors estimate dynamic IAIDS that considers habit effects. Although nested hypothesis tests support the dynamic specification, elasticities are almost similar with the static case (ibid, 9-11). This study is quite successful both in detecting the expected structural shift in 1990s as a result of health consciousness in the consumption of animal fats and incorporating the habit effects in a dynamic setting.

Lewbel and Serena (2000) provide theoretical and empirical evidence that both the regressors and the errors in ordinary aggregate demand systems are nonstationary. Therefore, they claim that estimates based on standard models are inconsistent. They further show that nonstationarity can arise from the aggregation of consumers with heterogeneous preferences in a slowly changing population. Lewbel and Serena (2000), then, propose a variant of an aggregate Translog demand system called as the Nonstationary Translog Demand System (NTLOG). The NTLOG has many desirable properties. It is flexible, yet linear in the variables without making approximations. It can be consistently estimated using Generalized Method of Moments (GMM), even in the presence of nonstationarity, and the estimates have classical t- distributions (ibid, 8-11). Moreover, the error term has a precise economic interpretation and can be derived as an aggregate of random utility parameters (ibid, 11). They estimate NTLOG model by using aggregate US annual data over the sample period 1954-1998 on food, energy, clothing and other expenditure categories and verify the theoretical advantages of model discussed above. However, the model produces suspicions about the use of more disaggregated data since the model becomes tedious to estimate with an increase in restrictions imposed on the parameters.

In order to determine the characteristics of wheat demand in Japanese Flour milling industry, Koo, Mao, and Sakurai (2001) estimate a demand model starting with a translog cost function. Annual time series data from 1967 to 1997 for six different classes of food wheat (domestic and imported) are used. The results suggest that Japanese demand for food wheat is notably elastic (ibid, 16). They further conclude that if Japan liberalizes its domestic wheat market, the milling industry would use more imported wheat instead of domestic wheat and there is a strong tendency to use US soft wheat (ibid, 17).

Holt's (2002) study is on the inverse demand systems and the choice of functional form. In this context, a hybrid inverse demand system (HIDS) is proposed that artificially nests inverse translog demand system (ITLDS), inverse AIDS (IAIDS), inverse Lewbel demand system (ILDS), and inverse non-separable linear expenditure system (INLES). Quarterly data on US meat demand for the period 1961-96 are used. Holt (2002, 119) considers the inverse demand system in general and the proposed hybrid model in particular as a promising and useful demand system in calculating the elasticities. The results show that HIDS is preferred over the other models in terms of statistical performance. This study seems to be valuable in the literature on the family of inverse demand systems in terms of its theoretical, statistical, and empirical concerns. However, it is difficult to claim the theoretical superiority of proposed HIDS despite its statistical performance. The functional form tests are data sensitive and may produce totally different results for a different data set.

Soregaroli, Huff, and Meilke (2002) examine the relative performance of various models in testing the Engel curve specification with the Italian data. Although they compare 16 models in their study, it is not easy to understand why they do not directly include a linearized version of AIDS. Their tests are in favor of Quadratic-Log and Quadratic Expenditure models.

A new inverse demand system, normalized quadratic inverse demand system, is suggested by Holt and Bishop (2002). In this new demand system where prices are determined endogenously as a function of exogenous quantities, a globally concave and locally flexible distance function is proposed (Holt and Bishop, 2002, 25). The empirical application of this study is for the US fish demand for the period 1971-1991. The relative performance of the proposed demand system is also compared with an inverse AIDS that is very popular in the literature. Although the results seem to be promising, the applied method has a major deficiency noted by the authors (ibid, 25-26). Marginal valuations related with consuming proportionally more or less of all goods in the bundle will change in the same way regardless of initial bundle size.

3.4 Concluding Remarks

The lessons learnt from the empirical applications of demand systems will improve our attempts for model selection and the results. Moreover, the empirics also highlight the optimism in advocating different theoretical alternatives.

Table 3.1 presents a summary of selected studies in the literature. The first striking feature in the Table 3.1 is the undeniable dominance of the Rotterdam and AIDS models in the demand system estimation during last two decades. The next observation is given by the country column; the number of studies on US markets is relatively high. Few studies concentrate on the demand behavior in Europe, developing countries, and other geographical areas. The data availability problem for some countries make demand system estimation almost impossible. Even the availability of the new econometric techniques falls short of solving data problems that lead to the results inconsistent with the theory. The identification of the non-market forces, such as quota restrictions and subsidies, widely used in agricultural products represents additional difficulties. Therefore, the spectrum of studies in terms of the geographical areas is quite limited.

Most of the cross-country studies fall into the LES group. The main reason for this preference is related to the estimation techniques of the demand systems in the remaining groups. The estimation becomes complex and tedious with large number of commodities and countries. Hence, in cross-country studies, more simple models like LES are usually preferred over the others.

The results verify that both the Rotterdam and AIDS have superiority among the other models. It is not easy to decide whether the Rotterdam or AIDS performs better. It seems to depend on the model specification. In other words, the Rotterdam performs better in the linear world while nonlinearity favors AIDS.

The lessons drawn from Table 3.1 and the discussion in this chapter provide the necessary clues to suggest a new and more considerable contribution to the existing literature: The number of observations should not cause any worries about the degrees of freedom; data should be systematically collected as much as possible to attain a minimum level of standardization; the Rotterdam, the AIDS and the CBS stem as potential models for cross-country comparisons. It is clear that the Rotterdam and a version of AIDS should be included. Moreover, the CBS model is also incorporated to the analysis in order to demonstrate the performance of a hybrid model. Nevertheless, it is preferred to stay in the linear world. The reason is rather technical. The iterative non-linear methods generally require large number of observations and these techniques are used with cross-section, quarterly, and monthly data. The data used in this study are annual and inconvenient for the application of nonlinear techniques.

In sum, we will use the Rotterdam, the AIDS, and the CBS models will be used to estimate demand parameters by employing a panel of countries with sufficient number of time series observations.

CHAPTER 4

PRODUCTION AND TRADE OF AGRICULTURAL PRODUCTS IN THE OECD AREA

The structure of production and international trade in the selected agricultural products of the OECD area will be investigated in this chapter. The analysis will provide further clues to interpret the results obtained in the following chapters. The study includes four agricultural product categories; cereals and pulses, meat, milk and milk products, and oils.[11]

4.1 Some Stylized Facts on the Agricultural Production in the OECD Area

First, the relative position of selected OECD countries in the world production will be presented, and then the production levels of four categories under sixteen product groups will be examined for the period 1961-2000.

4.1.1 World versus OECD in Agricultural Production

Table 4.1 presents the percentage share of OECD area in global agricultural production for the year 2000. In five commodities, the share of OECD is greater than 50 per cent. These are maize, cheese, dry milk, olive oil, and soy oil. Further, for 5 commodities its share is more than 40%, namely wheat, bovine, poultry, milk, and butter. Therefore, in ten out of sixteen commodities the OECD area has a significant share. Rice has the lowest share (5.40%) followed by ovine (25.69%),

[11] The detailed country tables for these agricultural products are presented in the Appendix A.

and pulses (27.61). Almost one third of the world production occurs in the OECD area for the rest of three commodities, pig meat, sunflower oil, and other oils.

Table 4.1: The Share of OECD Area for Selected Agricultural Commodities, 2000

Commodity	% of World Production
Wheat	40.61
Maize	54.30
Rice	5.40
Pulses	27.67
Bovine	44.11
Ovine	25.69
Poultry	46.62
Pig	34.91
Milk	47.30
Cheese	76.64
Dry Milk	63.86
Butter	46.61
Olive Oil	80.06
Soy Oil	55.67
Sunflower Oil	33.36
Other Oils	31.51

Source: FAOSTAT (2001)

4.1.2 Cereals and Pulses

This category includes wheat, maize, rice, and pulses. Figure 4.1 presents cereals and pulses production in the OECD area.

4.1.2.1 Wheat

For the whole period, wheat production rises 2.5 times. The production generally follows an upward trend with the exception of the periods 1968-70, 1976-77, 1984-88, 1990-94, 1996-99 periods. The production level became unstable in 1990s mainly because of the downward trend in the non-EU members of the OECD. The detailed examination of the decades present that the highest percentage rise took place in 1970s (90.1%) followed by 1960s (51.1%), and 1980s (37.6%). In 1990s, the production fell around 1.3%

Figure 4.1: Cereals and Pulses Production in the OECD Area, 1961-2000

Source: FAOSTAT (2001)

4.1.2.2 Maize

Figure 4.1 points out that maize production grows around 3 times from 1961 to 2000. The production level started to fluctuate more after the early 1980s until the mid 1990s. This was principally due to the nature of maize production in the USA. The highest growth rate is attained during 1970s (77.5%) while the lowest in 1980s (14.4%). In 1960s, the average growth rate of the decade is 33.5% and 1990s stand with 23.1%.

4.1.2.3 Rice

The share of OECD in the world rice production (5.4%) is the lowest as compared to the other agricultural products. Only 11 countries produce rice. The highest shares in terms of the total OECD rice production belong to traditional rice producers and consumers, Japan (36.7%) and Korea (21.9%). USA has also a significant share with 26.8%. For the period under consideration, the rice production increases approximately 27% in the OECD area.

As it is evident from Figure 4.1, the rice production in the OECD area follows a stable path with few exceptional years; 1971,1980, 1983, 1993. The peak is reached in 1994. In fact, the highest growth in the production of rice is noticed in 1960s with 20.1%. The rate of growth of production varied between 2 percent and 17percent in the other decades.

4.1.2.4 Pulses

Pulses production increases around 2.7 times in the considered period. The highest shares belong to Australia, Canada, France, and USA in the year 2000.

A huge jump in the pulses production is observed in 1980s (Figure 4.1). This is the case almost for all countries in our sample. In this period, the production rises more than 90%, followed by a 17% increase in 1990s, with the exceptions in 1989 and 1992. Slight falls (around 2%) occurred both in 1960s and 1970s.

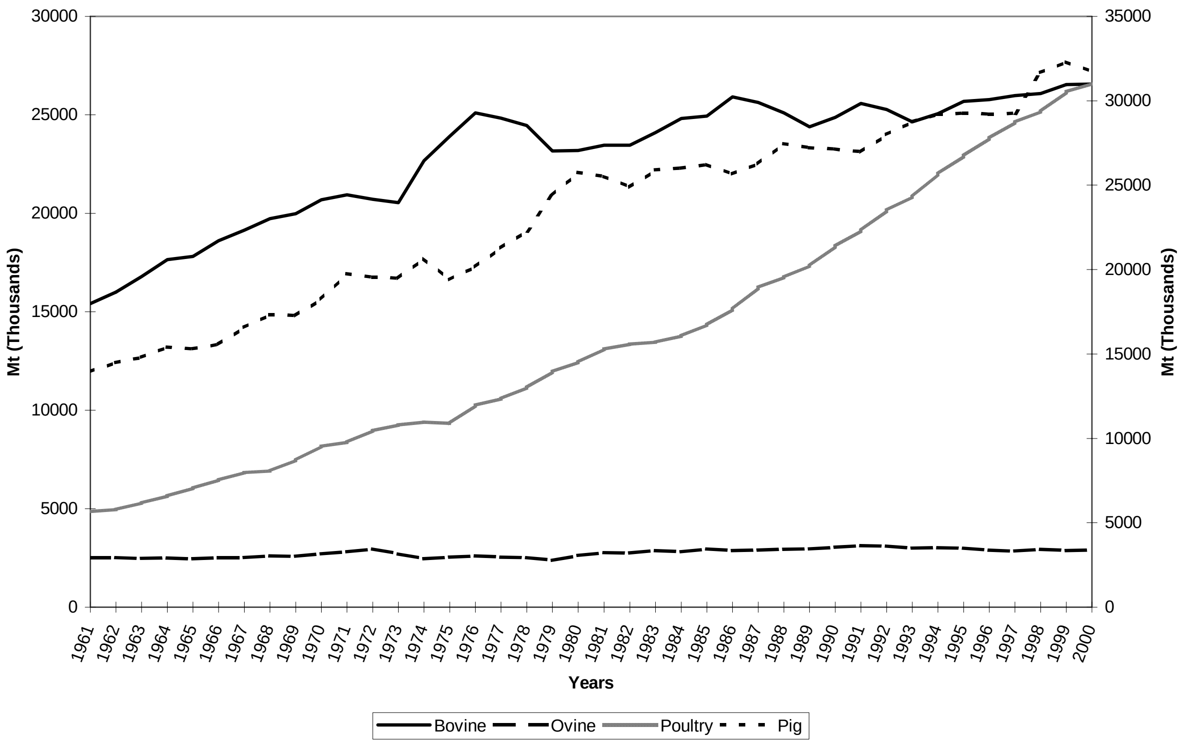
4.1.3 Meats

Bovine, ovine, poultry, and pig meat form this category. Figure 4.2 presents the meat production in the OECD area. The share of OECD area fluctuates around 25 to 46% of the world production.

4.1.3.1 Bovine Meat

What is the most significant from Figure 4.2 is the persistent and stable rise in the production with the exceptions of decreases between 1976-79 and 1986-89 periods. USA has an unchallenged superiority among OECD members in the production of bovine meat with 46.3% share in the year 2000. USA is followed by Australia (7.5%), France (5.9%), Mexico (5.3%), and Germany (5.1%). The highest percentage change in the production is noticed in the 1960s (29.7) in which the rise in US production is around 45% for the same period. In the following decades, we observe a fall in the rate of growth of production; 11.9% in 1970s, 5.3%in 1980s, and 6.3% in 1990s. The rising health concerns against red meat or the disease known as Mad Cow may be accounted for this slowdown.

Figure 4.2: Meats Production in the OECD Area, 1961-2000



Source: FAOSTAT (2001)

4.1.3.2 Ovine Meat

As evident from the Figure 4.2, there is a slight increase in ovine meat production as compared to the other agricultural products during the period. The level of production in 2000 is 1.15 times greater than that of 1961. The country with the highest share in the ovine meat production among the OECD members is Australia (22.6%) followed by New Zealand (18.1%), Turkey (12.7%), UK (12.4%), and Spain (8.3%) in 2000. In the ovine production the highest rise is observed in 1980s (12.4%). In two of four decades, a fall in the production is observed. In 1970s, the fall in the ovine meat production is around 12%, and this figure is more than 5% for the 1990s. On the other hand, in the first decade the meat production in OECD area grew by 3.2%.

4.1.3.3 Poultry Meat

As presented by Figure 4.2, the picture for the poultry meat is interesting in the sense that poultry meat production constantly grows throughout the period. The reason might again be the rising health consciousness that causes a bias toward poultry consumption and in turn production. The production level in the year 2000 is approximately 5.5 times greater than that of 1961. According to the 2000 data, USA with her share of 53.1% has an undeniable superiority in the poultry meat production among the OECD members. France (6.5%), Mexico (6.1%), Japan (4.9%), and UK (3.9%) follow USA. Among the four decades, the highest rate of growth is observed for 1960s (53.6%). In the last decade, this figure is around 42.7%. It will not be surprising that the growth in production will continue in the future.

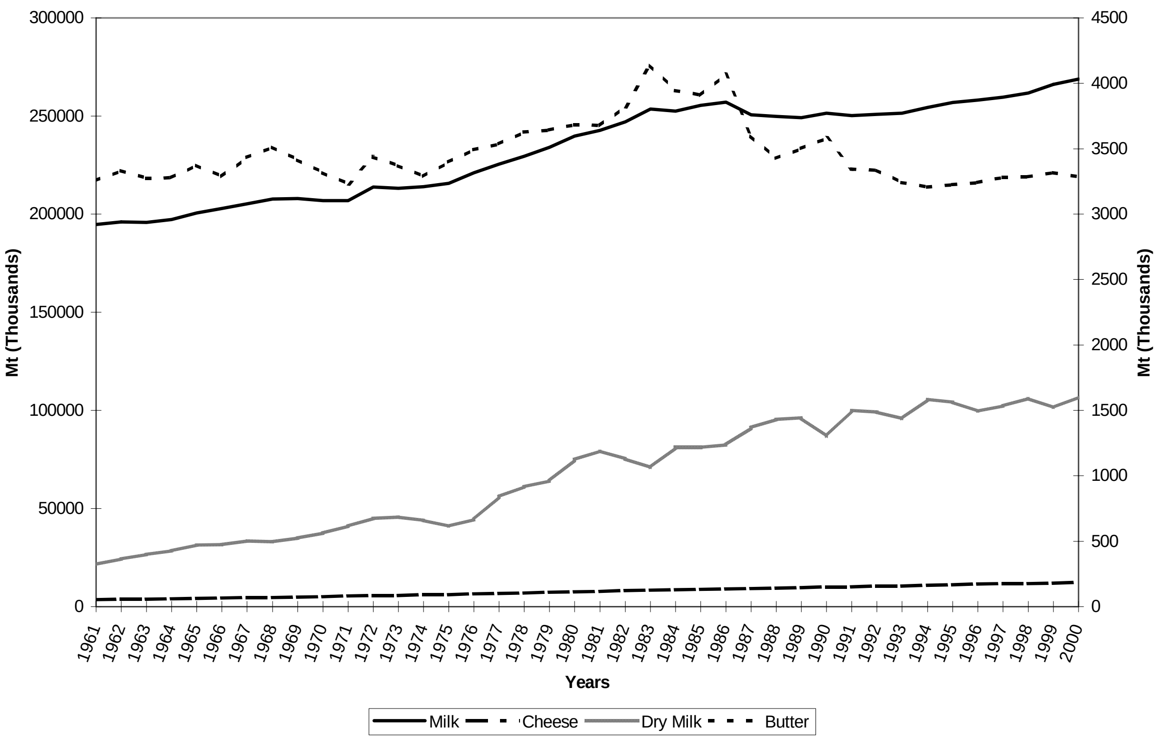
4.1.3.4 Pig Meat

OECD area realises more than one third of world production in the pig meat. As compared to bovine and ovine meat production, the rise in pig meat production is higher. Throughout the period, the rise in the production is 2.3 times. 1970s witnessed the biggest rise in the production with 33.7%. The rate of growth of production especially slows down in the 1980s (5.7%). The highest share among the members again belongs to USA (26.9%) followed by Germany (12.1%), Spain (9.3%) and France (7.3%).

4.1.4 Milk and Dairy Products

This category includes milk, cheese, dry milk, and butter, and it is the most important category in terms of production of agricultural commodities as compared to world production. In 2000, more than 75% of world cheese production, around two third of dry milk, and approximately half of the milk and butter production is realized by the OECD area. All these facts make the OECD area as the leader in the world markets in terms of the milk and dairy products. Figure 4.3 presents milk and dairy production in the OECD area.

Figure 4.3: Milk and Dairy Production in the OECD Area, 1961-2000



Source: FAOSTAT (2001)

4.1.4.1 Milk

In the last four decades, the milk production goes up around 38%, and displayed a stable path (Figure 4.3). The highest rate of growth is attained in 1970s (13.1%). A slight fall is viewed from 1986 to 1989.The changes in 1960s (6.8%) and 1990s (5.8%) are almost similar. 1980s are the lowest-growth years with 3.9%

rise in the production. Country figures show that USA is the leader in the OECD with 28.4% of the OECD production followed by Germany (10.6%), France (9.5%), and UK (5.4%).

4.1.4.2 Cheese

Cheese production in OECD countries is at the most conceited rank compared to the world production. According to the 2000 data, 12.3 million tones of cheese were produced, where as the world production is around 16 million tones. Figure 4.3 shows a persistent upward trend in cheese production.

During the whole period cheese production rose around 3.4 times, although the rate of growth slows down in the last two decades. The highest rate of growth was attained during the 1970s in which the cheese production increases around 44.3%. In 1980s, this figure was 26.4% and fell to 18.8% in 1990s. In 2000, USA realizes approximately one third of the OECD production. France (13.6%), Germany (13.5%), Italy (8.2%), and the Netherlands (5.6%) followed the USA.

4.1.4.3 Dry Milk

In the period under consideration, dry milk is the product that the highest rate of growth is perceived. In the last 40 years, the level production rose around five times.

However, the rise in production is not as steep as in milk (Figure 4.3). There were turning points during the period. Moreover, the variability increased in the 1990s. The highest share among the OECD members belongs to New Zealand (26.9%) followed by France (16.3%), Australia (10.7%), UK (6.5%), and Denmark (6.3%).

IV.1.4.4 Butter

As it is evident from Figure 4.3, there is a significant turning point in 1983 for the butter production. In fact, the butter production increased less than 1% in the OECD area in the period from 1961 to 2000.

During the first two decades, butter production expands 4.9% and 9.8% respectively. However, negative figures are observed in 1980s (-4.9%) and 1990s (-7.3%). The fall in the production accelerated in 1990s. The possible reason may again be the rising health consciousness and resulting bias towards vegetable oils. In the butter production, USA (17.6%) leads. France (13.4%), Germany (12.9%), New Zealand (9.7%), and Australia (6.1%) track the USA.

4.1.5 Oils

Oils category includes four commodities; olive oil, soy oil, sunflower oil, and other oils.[12] Among these types of oils, OECD area has an unchallenged supremacy in the production of olive oil. According to the 2000 data, 80% of olive oil production in the world is realized by OECD area. In the recent years, similar situation has been noticed in soy oil (55.7%). Finally, almost one third of sunflower oil production and other oils were produced in the OECD area.

4.1.5.1 Olive Oil

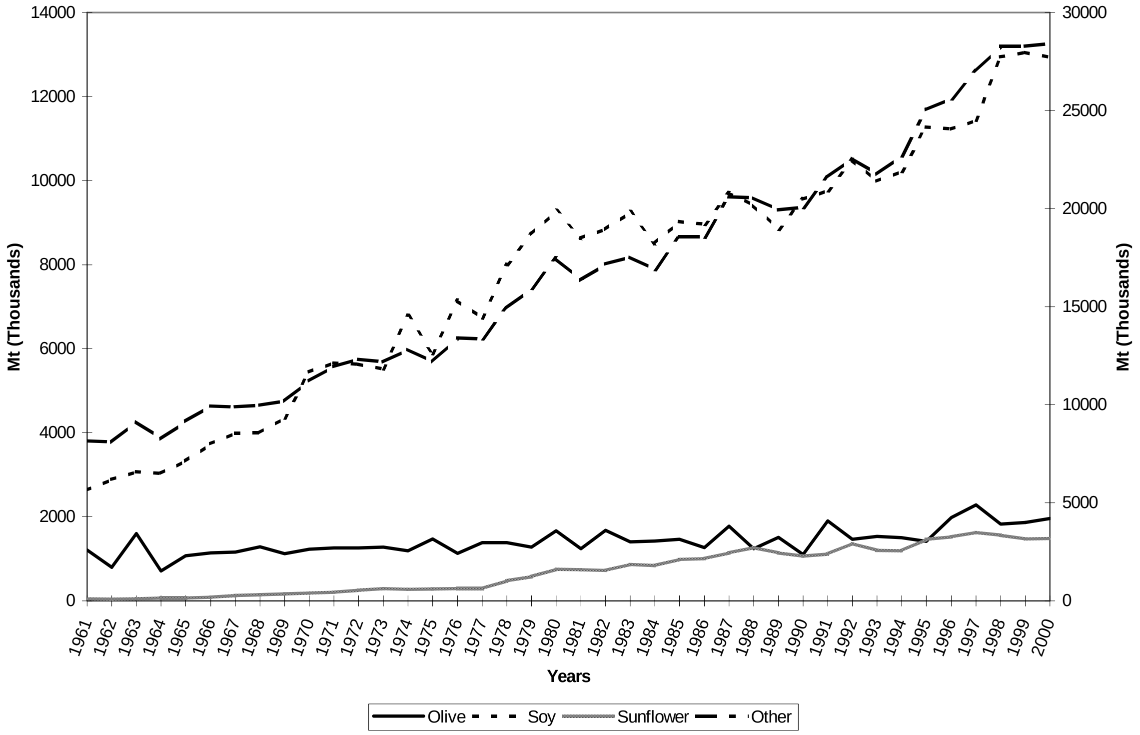
Olive oil production rises about 70% in the last four decades. However, this change is uneven indeed as can be seen from Figure 4.4. In fact, the irregularity in the olive and olive oil production is an expected outcome because of the seasonality

[12] Other oils consists of Oil of Castor Beans , Oil of Citronella , Oil of Coconuts , Oil of Cotton Seed , Oil of Groundnuts , Oil of Hempseed , Oil of Jojoba , Oil of Kapok , Oil of Linseed , Oil of Maize , Oil of Mustard Seed , Oil of Palm , Oil of Palm Kernels , Oil of Poppy Seed , Oil of Rapeseed , Oil of Rice Bran , Oil of Safflower , Oil of Sesame Seed , Oil of Stillingia , Oil of Tung , Other Oils of Vegetable Origin, Oils Boiled etc , Oils Hydrogenated .

behaviour of this crop, that is to say huge amount of harvests is followed buy low level of harvest in the following year.

In 1990s we observe a tremendous climbing that occur especially after 1995. In this period, olive oil production rose around 68%. However, the production fell in 1960s (-7.3%) and in 1980s (-9.3). According to FAOSTAT, only nine member states of OECD carry out olive oil production that require specific climate.[13] Spain (42.4%) is the leader in the olive oil production. Italy (25.1%), Greece (20.8%), and Turkey (9.2%) follow Spain. The share of the remaining countries is negligible. In fact, these four countries produce 78 percent of world olive oil production.

Figure 4.4: Oils Production in the OECD Area, 1961-2000



Source: FAOSTAT (2001)

[13] These are Australia, France, Greece, Italy, Mexico, Portugal, Spain, Turkey, and USA.

4.1.5.2 Soy Oil

Soy oil production exhibits a persistent upward trend between 1961 and 2000 (Figure 4.4). As compared to level in 1961, the soy oil production increase almost 5 times in the last forty years.

The highest rates of growth in the production have occurred in 1960s and 1970s fluctuating around 60 to 65%. A decline in production is viewed in 1980s (-4.7%). A final rise is occurred in 1990s (36.5%). USA has a conclusive dominance in the production of soy oil, approximately two third of OECD soy oil production take place in the USA in 2000. The Netherlands, Germany, Japan, and Mexico track the USA with shares around 5%.

4.1.5.3 Sunflower Oil

The rise in the production of sunflower oil is incredible in the last four decades as suggested by Figure 4.4. The sunflower oil production rose around 30 times in this period.

The rise in 1960s and 1970s is more 200% induced with the humungous rise in production in the Mediterranean countries of OECD. The rate of growth slows down in 1980s (51.7%) and 1990s (38.1%). As evident from the 2000 data, three quarters of OECD production is realized by five countries; Spain (19.7%), France (17.9%), USA (14.9%), Turkey (14.7%), and Italy (8%).

4.1.5.4 Other Oils

Other oils production rose about 3.5 times from 1961 to 2000. The highest rates of growth are observed in 1970s (42%) and 1990s (41%). Three countries, namely USA (37.7%), Germany (9.9), and Spain (7.4%), produce more than half of the OECD aggregate.

4.2 Trading Agricultural Products by the OECD Area

The volume of international trade in the OECD area is as important as the production to determine the total demand of agricultural products. Thus, the development on the volume of both exports and imports of agricultural products in the OECD area is the subset of this section.[14,15,16]

4.2.1 Cereals and Pulses

In all four sub-categories, OECD area is net exporter of cereals and pulses on aggregate. Moreover, the most significant changes are observed in 1970s. For some products, negative changes in the volume of international trade are observed. The major exporting and importing countries remained the same in almost all cases. Finally, both the exports and imports follow the same path and sometimes exactly have the same turning points except in the case of wheat.

4.2.1.1 Wheat

Figure 4.5 shows the wheat exports and imports in the OECD area. The first appealing fact from the Figure 4.5 is that imports follow a more stable path than exports.

In aggregate, the rise in exports is higher than the rise in imports. As a net exporter of wheat, the OECD area strengthens its position during the period; wheat exports rose 5.8 times whereas imports 4.7 times. The highest growth rates in the volume of international trade for wheat are observed in 1970s. The volume of

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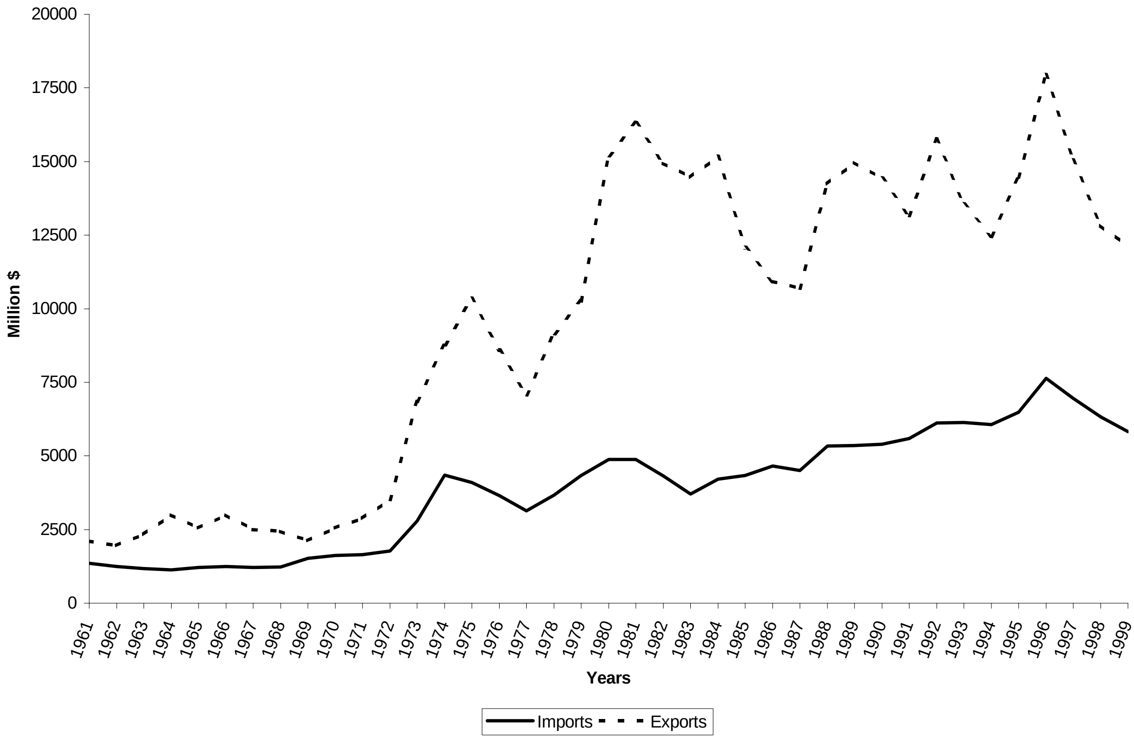
[14] The detailed country tables for these agricultural products are presented in the Appendix B.

[15] Different from the production data, the data on international trade are available for the period between 1961 and 1999.

[16] However, we are not able to measure the intra-OECD trade from the FAOSTAT. We assume that OECD countries are realized trade with the other OECD members although the figures may differ, that is why for some products exports and imports follow the more or less identical paths, and this is a real difficulty especially for EU member states.

exports was almost tripled between 1972 and 1975. As pointed out by the 2000 data, around 30% of OECD wheat exports are realized by USA. Canada (18.9%), France (18.7%), and Australia (17.7%) come after the USA. These four countries approximately account for 85% of total OECD wheat exports. Japan (18.4%), Italy (16%), and Korea (9.2%) are the leading wheat importers of the OECD area.

Figure 4.5: Wheat Exports and Imports in the OECD Area, 1961-1999



Source: FAOSTAT (2001)

4.2.1.2 Maize

As in the case of wheat, OECD area is a net exporter of maize on aggregate.[17] The maize exports and imports follow the same path, having identical turning points as seen from Figure 4.6. The rise in exports is two times more than

[17] However, we are not able to measure the intra-OECD trade from the FAOSTAT. We assume that OECD countries are realized trade with the other OECD members although the figures may differ, that is why for some products exports and imports follow the more or less identical paths.

the rise in imports thorough the period. The major upward trends are noticed for the periods 1977-80, 1986-90, and 1994-96. The highest increases occurred in 1970s, followed by falls in 1980s and 1990s. According to the 2000 data, 95% of total exports are achieved by two countries, namely USA (74.7%) and France (20.4%). On the other hand, almost two third of total maize imports are traded by four countries, Japan (32.7%), Korea (15.3%), Mexico (11.3%), and Spain (7,1%).

Figure 4.6: Maize Exports and Imports in the OECD Area,

1961-1999

Source: FAOSTAT (2001)

4.2.1.3 Rice

OECD area is a net exporter of rice on aggregate yet the percentage rise in imports is higher than that of exports during the last four decades. Imports increases by 21.7 times whereas the figure for exports is 13.3 times. The highest growth rates were observed in 1960s and 1970s. Then the growth rate of both exports and imports slowed down even became negative for exports in 1980s. In 1990s, the rise in imports is 51.6% while 23.4% for the exports.

Figure 4.7: Rice Exports and Imports in the OECD Area, 1961-1999

Source: FAOSTAT (2001)

Almost three quarters of the exports are attained by USA (43.5%), Italy (16.8%), and Australia (12.3%). The leaders in rice imports are Japan (14.8%), UK (13%), and France (11%).

4.2.1.4 Pulses

Pulses are the agricultural products that the highest growth rates are observed in the volume of international trade in the OECD area. The remarkable changes again took place in 1970s. The significant upward trends are especially observed at 1979-81 and 1984-90 periods. However, the trend is reversed in 1990s at which imports drop by 30.7% and exports by 7.7%.

Figure 4.8: Pulses Exports and Imports in the OECD Area, 1961-1999

Source: FAOSTAT (2001)

More than 60% of the exports are concluded by three countries, Canada (31.5%), USA (20%), and France (11.9%). The leading importers are Spain (15%), Italy (10.7%), Japan (8.6%), UK (8.5%), and the Netherlands (8.4%).

4.2.2 Meats

In all sub-categories of meat, OECD area is again a net exporter. A sudden rise in the volume of international trade is persistent in all of these commodities after the mid of 1980s.

4.2.2.1 Bovine Meat

Figure 4.9 shows bovine meat exports and imports in the OECD area. Throughout the period, the rise in exports is more than the rise in imports thus the trade balance shows a development in favor of OECD area.

Figure 4.9: Bovine Meat Exports and Imports in the OECD Area, 1961-1999

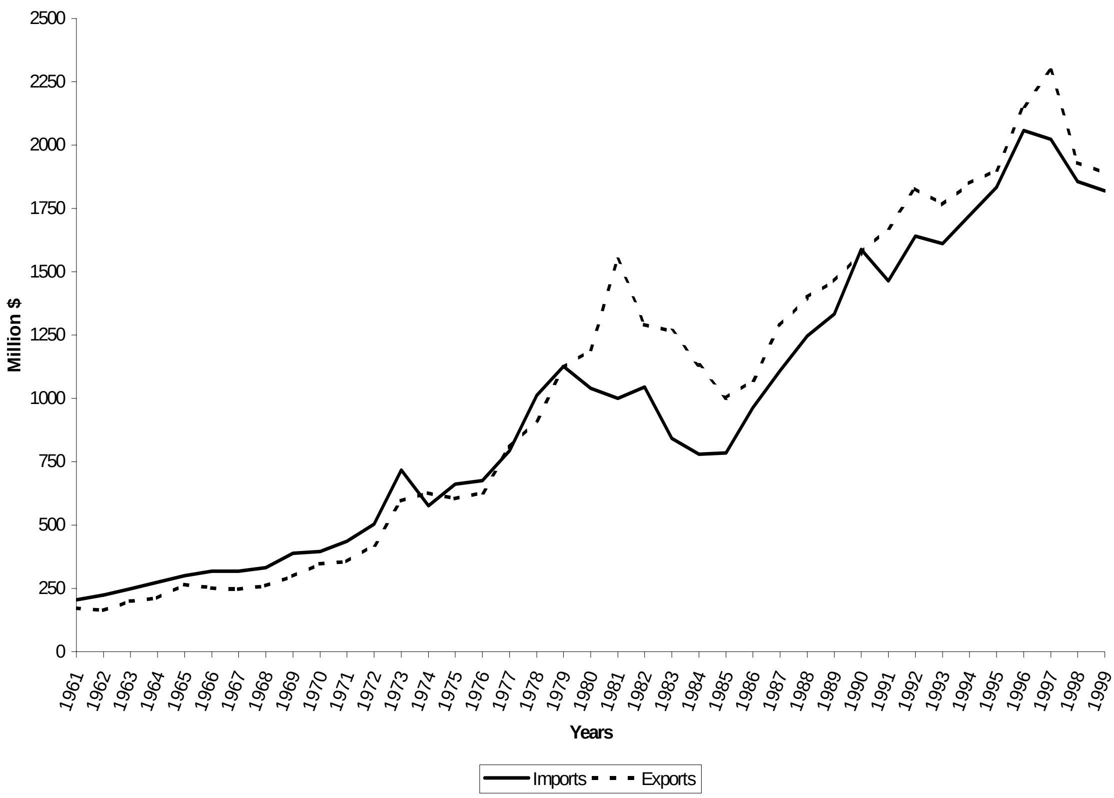
Source: FAOSTAT (2001)

In the last decade there is a fall in the volume of imports. Especially after the 1985, there is a huge increase in the volume of trade. Three countries realized almost half of the bovine meat exports of OECD area in 2000. The leading exporter is USA (21.2%) followed by Australia (15.5%) and the Netherlands (11.5%). The top three countries again with half of the OECD imports are Japan (20%), USA (17.9%), and Italy (12.7%).

4.2.2.2 Ovine Meat

During the period, ovine meat exports rose faster than the imports (Figure 4.10). The volume of international trade rose by from 1961 to 1981 followed by a fall between 1981 and 1985.

Figure 4.10: Ovine Meat Exports and Imports in the OECD Area, 1961-1999



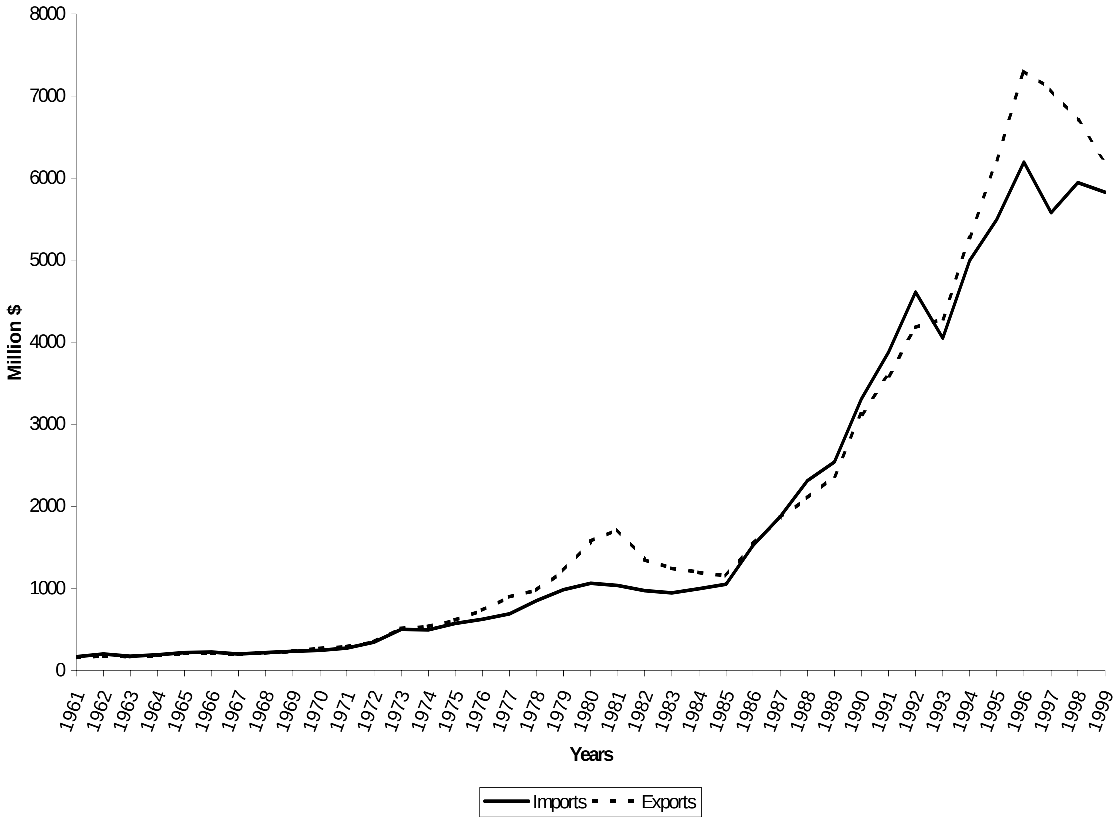
Source: FAOSTAT (2001)

Another rise is seen until 1997 and fall thereafter. Ovine exports are very much concentrated in the sense that almost 80% of the exports are made by New Zealand (38.1%) with Australia 22.8%, and UK 17.6% share in total exports. The major importing countries are France (28.3%), UK (17.3%), and USA (11.1%).

4.2.2.3 Poultry Meat

As in the case of production, the highest rise in the meat trade occurred in poultry (Figure 4.11). OECD poultry meat exports rose around 40 times and imports by 35 times.

Figure 4.11: Poultry Meat Exports and Imports in the OECD Area, 1961-1999



Source: FAOSTAT (2001)

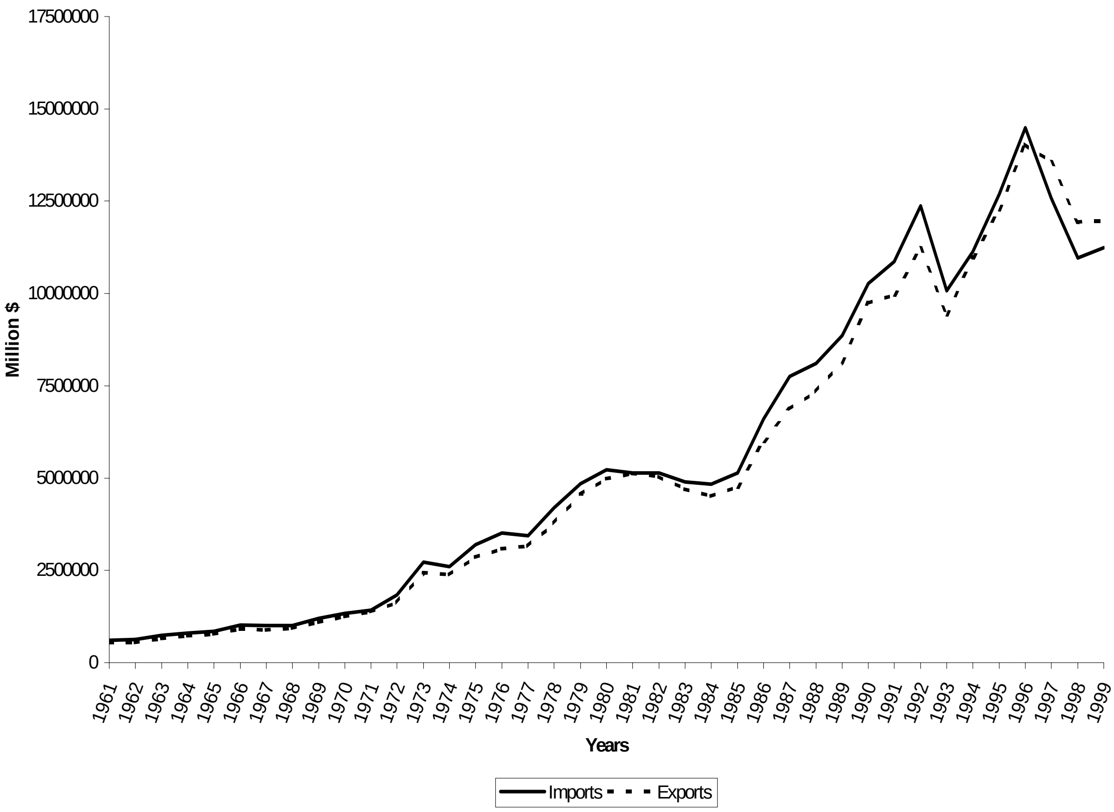
The highest change was at the 1970s at which the volume is more than tripled for both exports and imports. Tremendous upward trend was observed between 1986 and 1996. The rising health consciousness possibly the main reason causing the volume of trade for poultry meat rising more than any other type of meat in this category. More than half of the OECD poultry meat exports are carried out by two member states; USA (28.5%) and France (23.4%). The Netherlands

(18.8%) follow these two countries. In terms of the import shares, Japan (23.9%), UK (19.9%), and Germany (17.6%) are the import leaders.

4.2.2.4 Pig Meat

Pig meat trade also shows a considerable rise among the meat category. However, the trend is not as stable as in the case of the other categories as shown by Figure 4.12.

Figure 4.12: Pig Meat Exports and Imports in the OECD Area, 1961-1999



Source: FAOSTAT (2001)

There occurred three major falls; from 1981 to 1985, 1992 to 1994, and 1996 to 1998. For the whole period, both the volume of exports and imports rose by approximately 20 times and the highest percentage change is observed in 1970s. As in all meat categories with some rare exceptions, we detect that the rate of increase in the volume of international falls in the last decade. Four members are exporting the around 56% of total OECD pig meat exports; Denmark (22.7%), Netherlands (14.4%), USA (9.9%), Belgium-Luxembourg (9%). Japan (27.6), Germany (13.9%), and UK (11.4%) are the major pig meat-importing countries.

4.2.3 Milk and Dairy Products

For all commodities in this category, OECD is a net exporter. The last four decades witnessed an increase in the volume of trade for milk and dairy products. Among them, the trade in milk went up tremendously. The rate of increase in exports was higher for cheese and butter whereas imports grew faster for milk and dry milk.

4.2.3.1 Milk

Figure 4.13 demonstrates milk trade in the OECD area. During the period, both the exports and imports present a persistent upward trend with some rare exceptions starting from almost no trade situation in 1961. The rising trend commencing in 1970s, especially after 1971, prolonged without disruption until 1984. In fact, the milk exports rose by 11.3 times and imports by 18.7 times in 1970s. In the following decades the rate of change is still positive yet less than the figures in 1970s and incessantly falling. Around two third of both OECD exports and imports are realized by three countries in each case. The export leaders are Germany (32.2%), France (16.3%), and Belgium-Luxembourg (15.3%). The top three in imports are Italy (31%), Belgium-Luxembourg (17.4%), and France (16.2).

Figure 4.13: Milk Exports and Imports in the OECD Area, 1961-1999

Source: FAOSTAT (2001)

4.2.3.2 Cheese

Different from the pattern exhibited by the milk trade, cheese exports and imports are more volatile. An obvious upward trend was observed until 1980. A gradual fall followed this tendency in the first half of the decade. In 1990s, the pattern became unstable. The rate of increase of both exports and imports fluctuate around 20 to 25% in 1990s that have varied nearly 65 to 70% in 1980s. France (19.9%), the Netherlands (17.1), and Germany (14%) lead slightly more than half of the exports of OECD area. Imports are less concentrated in the sense that Germany (19.9%), Italy (12.5%), UK (11.7%), and USA (8.6%) are accounted for half of the OECD imports.

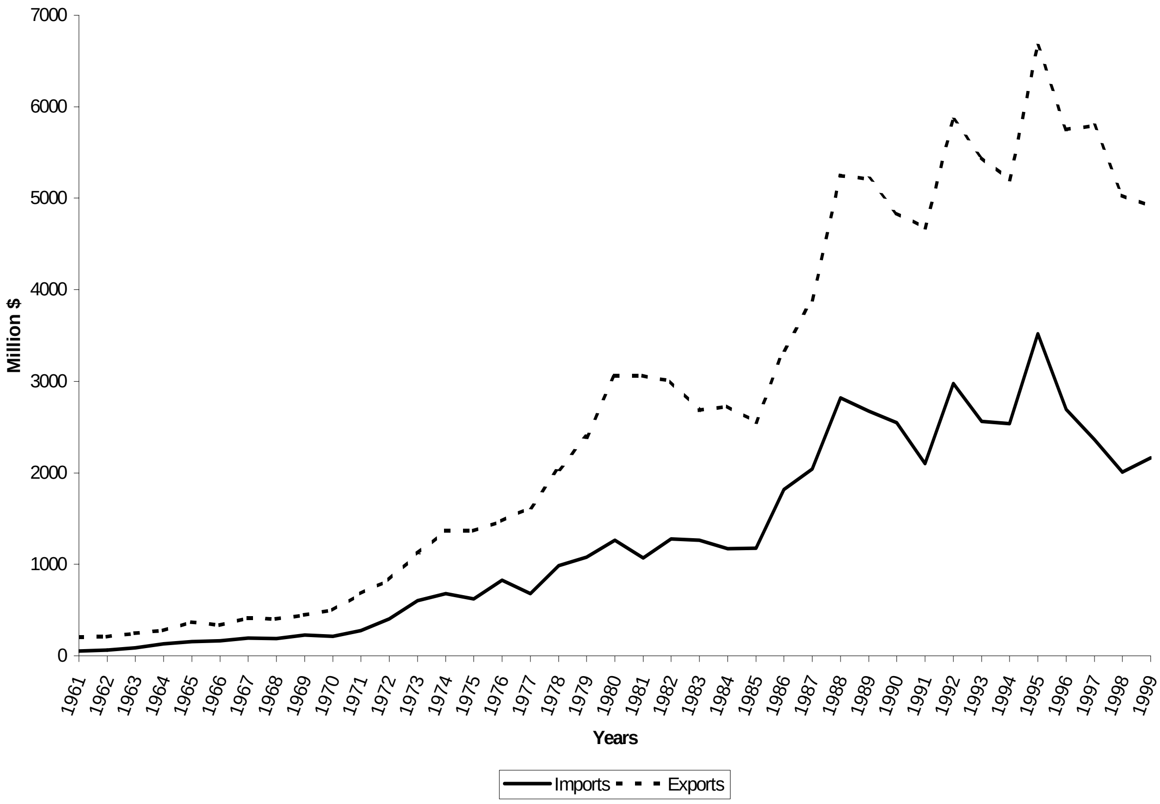
Figure 4.14: Cheese Exports and Imports in the OECD Area, 1961-1999

Source: FAOSTAT (2001)

4.2.3.3 Dry Milk

The trade of dry milk in the OECD area possibly displays the highest volatility among the examined commodities. The upward rising trend lasting until 1980 interrupted with frequent turning points. After 1988, the frequency of the cycles lessened. This pattern might represent some sort of seasonality or stock-keeping behaviour. In the last decade, the imports fell roughly 15% as exports rose only 1.6%. These figures are too much behind the changes in 1970s with almost 400% rise in this decade. During the whole period, the rise in imports was higher than the rise in exports, that is to say the net exporter identity of OECD area is rather threatened in the last four decades. Figure 4.15 shows further that a particular decline is observed especially after 1995 that has not recovered until 1998. However, a small rise in the volume of trade is viewed in 1999. 56% of the exports are realized by New Zealand (17.5%), Germany (14%), France (13%) and Australia (12.1%) For more or less the same percentage of imports are achieved by the Netherlands (32.9%), Italy (12.4%), and Mexico (11.1%).

Figure 4.15: Dry Milk Exports and Imports in the OECD Area, 1961-1999



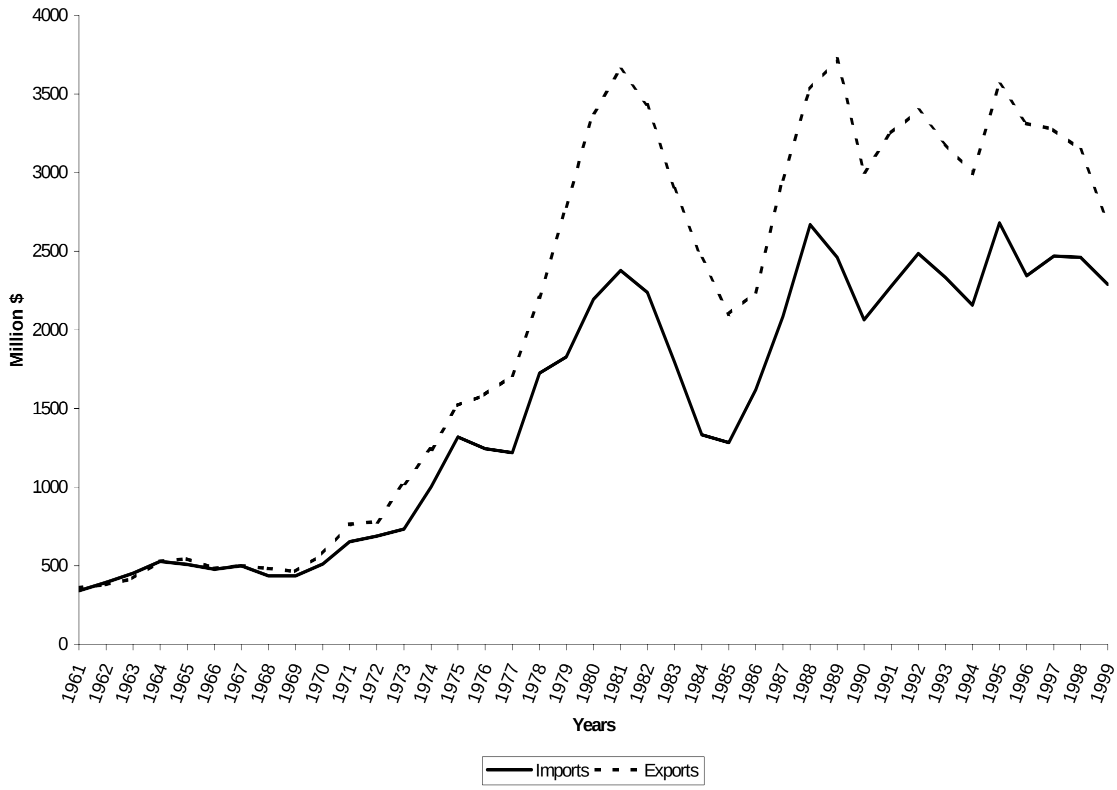
Source: FAOSTAT (2001)

4.2.3.4 Butter

The lowest rates of changes in this category are noticed for the butter. In the considered period, exports rose by 7.4 times while the imports by 6.7 times. The position of OECD area as a whole in the world markets became more import-oriented still it is a net exporter on average.

In the last decade, imports rose around 10% as the exports felt around the same amount. The rising health consciousness in developed countries may probably be a reason of such a trend. As evident from the Figure 4.16, two peaks were observed at 1981 and 1988 a generally falling trend thereafter. The Netherlands (17.6%), New Zealand (15.8%), Ireland (14.4%), and Belgium-Luxembourg (12.5%) sell abroad the 60% of total OECD butter exports. The import leaders having very similar shares are Germany (17.9%), France (17.5%), and UK (17.2%) according to the 2000 data.

Figure 4.16: Butter Exports and Imports in the OECD Area, 1961-1999



Source: FAOSTAT (2001)

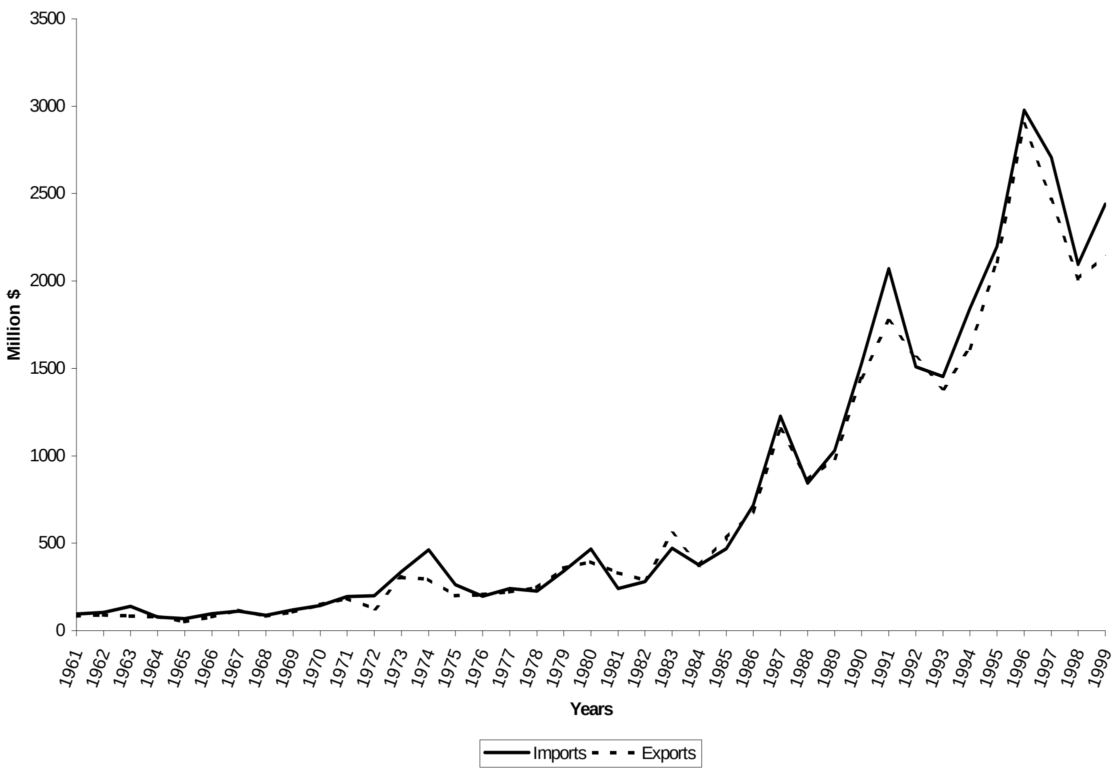
4.2.4 Oils

Oils category is a significant example where fundamental changes are observed in the trade behavior of OECD countries with important fluctuations in international trade. Figure 4.8 exhibits these changes in the oil trade.

4.2.4.1 Olive Oil

Figure 4.17 exhibits the changes in the olive oil trade. As we have seen in the previous section, OECD area comprises important olive oil producers like Italy, Spain, Greece, and Turkey. Both the imports and exports of OECD area rose about 25 times as discerned from Figure 4.17. Frequent ups and downs that represent an apparent seasonality as the characteristic of the commodity. Olive oil trade became more stimulated just after 1984.

Figure 4.17: Olive Oil Exports and Imports in the OECD Area, 1961-1999



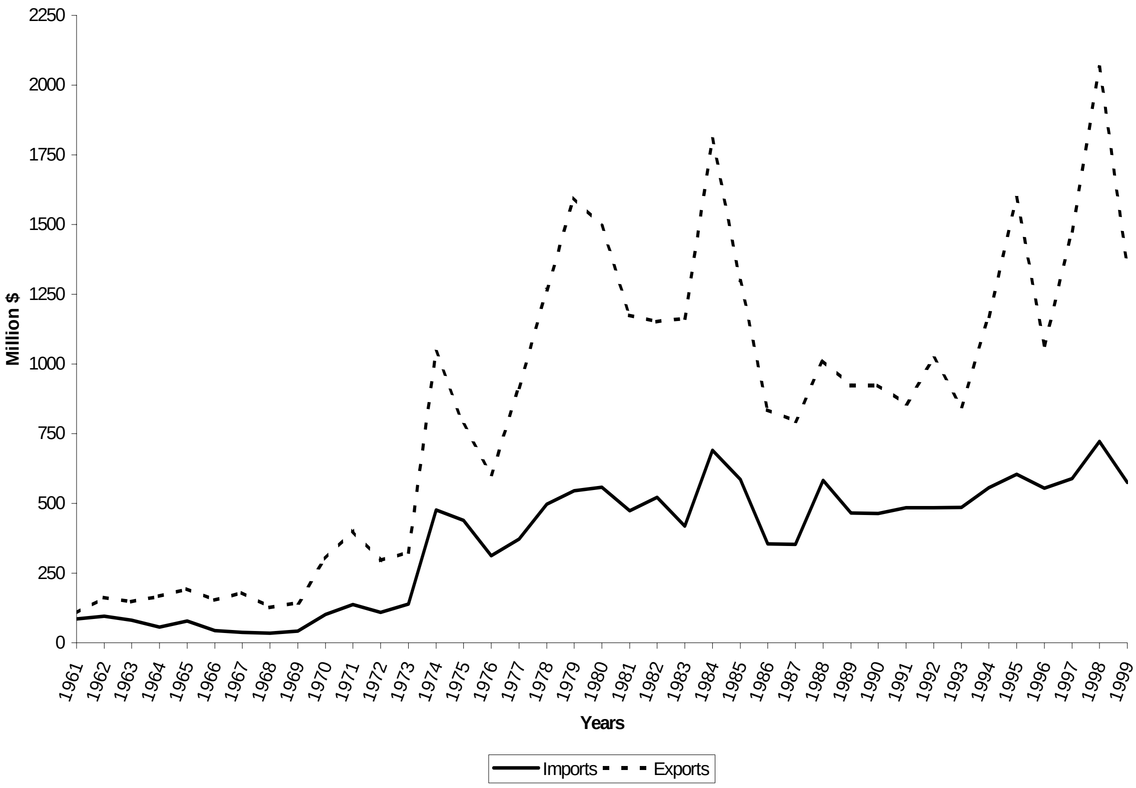
Source: FAOSTAT (2001)

In fact, the highest rises in international trade occurred in 1980s and 1970s. Although the rate of increase was lessened, the volume of trade escalates around 50 to 60% in 1990s. According to the 2000 data, 95% of OECD olive oil exports and 75% of global exports are realized by main producers; Italy (34.1%), Spain (29.8%), Greece (23.5%), and Turkey (7.9%). The leading importers, on the other hand, are Italy (39.3%), US (15.1%), and France (9.2%). In order to explain that Italy leads both export and imports by assuming that the popularity of Italian olive oil cause such level of exports. However, huge amount of exports cause a scarcity in the domestic markets and Italian consumers traditionally use olive oil that are shaped by habits motivate imports.

4.2.4.2 Soy Oil

Soy oil trade in the OECD area is really instable. It is, in fact, not possible to observe a definite trend. However, some general trends can be produced from Figure 4.18.

Figure 4.18: Soy Oil Exports and Imports in the OECD Area, 1961-1999



Source: FAOSTAT (2001)

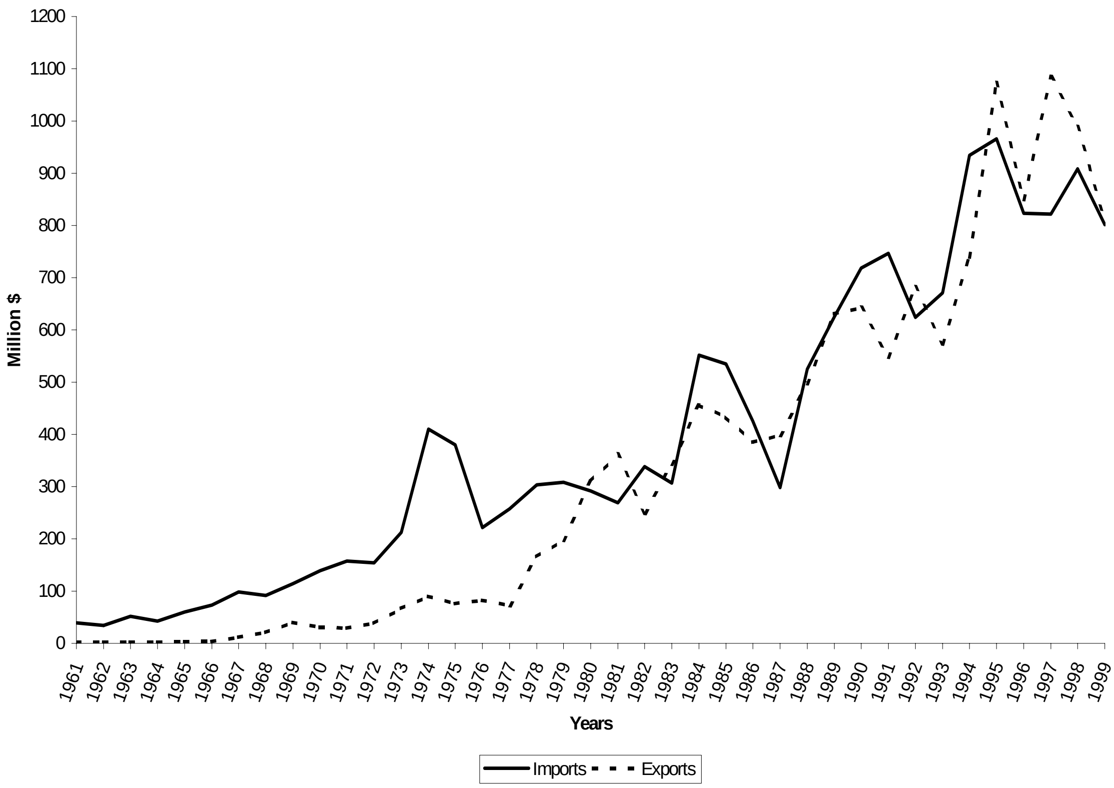
In the period, the imports rose around 6 times as the exports by 12 times. When we analyze the decades, it is noticed that a fall is followed by a rise. The highest rise is at the 1970s while the highest fall of imports at 1960s and exports at 1980s. Different from the other products the behavior of exports and imports seems to be more independent. The main exporters of soy oil are US (32.6%), the

Netherlands (20.7%), and Germany (16.8%). Belgium-Luxembourg (19.5%), Turkey (15%), and Korea (12.4%) are the leading importers.

4.2.4.3 Sunflower Oil

As shown by the Figure 4.19, the rate of increase in exports of sunflower oil is considerably higher than that of imports. The highest percentage rise in exports is seen in 1960s. The rate of increase constantly falls in the rest of the period. For the imports, the percentage rise is less obvious yet the pattern is almost same. The leading exporters are US (25.9%), France (19.1%), and the Netherlands (16%). Approximately half of the OECD exports is made by the Netherlands (13.5%), Mexico (13.2%), France (12.3%), and UK (10.8).

Figure 4.19: Sunflower Oil Exports and Imports in the OECD Area, 1961-1999



Source: FAOSTAT (2001)

4.2.4.4 Other Oils

OECD area is a net importer of other types of oils. However, it is difficult state some specific observations on this category because of the level of aggregation at both the commodity and country levels. US realizes 58.9% of OECD exports followed by Canada (15.1%) as given by the 2000 data. The leading importers are Japan (19.8%), Germany (14.5%), the Netherlands (13.1%), and Mexico (11.1).

Figure 4.20: Other Oils Exports and Imports in the OECD Area, 1961-1999

Source: FAOSTAT (2001)

4.3 Concluding Remarks

The purpose of this part of the study was to sketch a panorama of OECD agricultural production and international trade. A descriptive approach was preferred rather than evaluating the agricultural policies of member countries. However, it is necessary to enrich the descriptive approach with some analytical comments on the developments pronounced by the data. The first and the most important fact is that OECD area is a significant producer of agricultural commodities under investigation. In this part, we briefly focus our attention on aggregate commodity groups in terms of production and trade.

In the production of cereals and pulses, similar fluctuations were observed in some extent. However, the fluctuations for maize, rice and pulses are more parallel as compared to wheat. The major fluctuations were seen at five intervals; 1969-71, 1982-84, 1986-88, 1992-94, 1994-96. The most striking point is that in 1990s, the production became more volatile and the frequency of the cycles lessened especially for maize, rice, and pulses. Wheat production seems to be more stable. The international trade data show a different structure for the pulses. For both exports and imports, wheat and maize follow similar paths. We find out that there are significant rises in the trade for the periods 1972-76, 1978-80, 1988-90, and 1993-96. After 1980s, with the rising worldwide applications, the fluctuations in international trade became an observed reality.

The meat production displays two different groups: poultry and pig, bovine and ovine. In general, poultry and pig meat production have a linear upward trend with very rare fluctuations, the former being more stable. Bovine and ovine meat production follows a flatter line at which a fluctuation is observed for the period between 1973 and 1979. The volume of trade of ovine meat has a special structure as compared to others. During the period there is almost no change in the volume of trade for ovine meat primarily because of rising health consciousness. The main boom is experienced between 1985-92 period for the poultry and pig meat whereas the upward trend with a lower percentage change prolonged until 1996 for the bovine meat. Once more we observe a rise in the number of minor fluctuations in 1990s for all categories of meat.

The production levels of the milk and dairy products follow closely the same path since all are interdependent to the milk production in a greater or lesser extent. For the international trade, we observe a rising rate of specialization of OECD area for cheese. Dry milk and butter demonstrate almost parallel changes in the volume of trade. However, the milk and cheese trade uninterruptedly increase throughout the period from 1972-96 for the former and 1984-92 for the latter. The dry milk trade frequently fluctuates more than butter that might be explained by some sort of a stock-keeping behavior.

The production levels of sub-categories of oils are differentiated. Olive has a very stable structure because of some sort of monopoly of OECD countries. Soy and sunflower oils have similar structure. Although other oils category is closer to soy and sunflower oils, the production level is less unstable as compared to the other category. Other oils have higher yet a less stable volume of trade while the others follow a similar path. Finally, soy oil has a more fluctuating behavior.

This part provides us a bird’s eye-view of the production and trade of agricultural products for the OECD members. However, what is more helpful is that it gives us necessary vision to interpret the elasticities that we will estimate.

CHAPTER 5

THE DEMAND SYSTEMS AND THE STRUCTURE OF THE DATA

There exits various possibilities of specifying a demand system, as it is evident from the chapters II and III. The Rotterdam and AIDS models and their extensions are the most popular forms in the literature. Both models have some sort of superiorities over each other as discussed in chapter II. The topic of this chapter is to present the reduced form equations that will be estimated. The analysis will be enriched by adding the hybrid CBS model. In sum, the Rotterdam, linearized version of AIDS and the CBS models will be focus of the following discussion, and some details discussed previously will be skipped.

5.1 The Rotterdam Model in Absolute Prices[18]

The primary equation of the Rotterdam model in differentials is

(5.1a) $w_i Dq_i = \alpha_i D(m/p) + \sum_j \pi_{ij} Dp_j$

where w_i is the budget share, α_i is the marginal budget share, q_i and p_i are quantities and prices, m is total expenditure, and π_{ij} are Slusky coefficients. Dx symbolizes the total differential of log x, that is $Dx = d(logx)$.

By substitution,

(5.1b) $w_i d\,log\,q_i = \alpha_i d\,log(m/p) + \sum_j \pi_{ij} d\,log\,p_j$

[18] For a wider discussion on this model, see Barten (1964a, 1964b, 1977), Theil (1965, 1980), and Barnett (1979).

P which is the Divisia price index can be written as

(5.2) $DP = \sum_i w_i Dp_i$

The budget shares w_i is defined as

(5.3) $w_i = p_i q_i / m$

The total differential of budget share equation gives

(5.4) $dw_i = w_i Dq_i + w_i Dp_i - w_i Dm$

The weak restrictions on the parameters of the primary equation of the Rotterdam model can be listed as:

(5.5a) $\sum_i w_i = 1$ (adding-up)

(5.5b) $\sum_i \alpha_i = 1$ (adding-up)

(5.5c) $\sum_i \pi_{ij} = 0$ (adding-up)

(5.5d) $\sum_j \pi_{ij} = 0$ (homogeneity)

The main strong restriction on the parameters of the equation (5.1) is

(5.6) $\pi_{ij} = \pi_{ji}$ (symmetry)

and the other strong restriction is that $[\pi_{ij}]$ is negative semidefinite with rank n-1. From equation (5.1), the income (η_i), compensated (ε_{ij}*) and uncompensated price elasticities (ε_{ij}) are obtained as,

(5.7) $\eta_i = \alpha_i / w_i$

(5.8a) $\varepsilon_{ij}{*} = \pi_{ij} / w_i$

(5.8b) $\varepsilon_{ij} = \varepsilon_{ij}{*} - \eta_i w_j$

5.2 Considering an Almost Ideal Demand System[19]

The Rotterdam model is a special parametrization of a system of differential demand equations, where demand parameters α_i and π_{ij}'s are assumed to be constant. However, there is no strong a priori reason that these demand parameters should be held constant. An alternative parametrization is based on the Working model

(5.9) $w_i = \alpha_i + \beta_i \log m$

Since the sum of budget shares equals one, $\sum \alpha_i = 1$ and $\sum \beta_i = 0$. In order to obtain the marginal shares implied by (5.9), this equation should be multiplied by m and differentiated with respect to m that gives

(5.10) $$\begin{aligned} \partial(p_i q_i)/\partial m &= \alpha_i + \beta_i(1 + \log m) \\ &= w_i + \beta_i \end{aligned}$$

Consequently, this expression reveals that the i^{th} marginal share differs from the corresponding budget share by β_i. The budget share is not constant with respect to income, and neither is the associated marginal share. The income elasticity is,

(5.11) $\eta_i = 1 + \beta_i / w_i$

The AIDS has the same intercept and income term like equation (5.9) yet also contains price effects and specified as

(5.12) $w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log(m/P)$

where P is a price index defined as

(5.13) $\log P = \alpha_0 + \sum_j \alpha_j \log p_j + \frac{1}{2} \sum_j \sum_i \gamma_{ij} \log P_i \log P_j$

[19] For a wider discussion on this model, see Deaton and Muellbauer (1980), Green and Alston (1990), and Buse (1994).

The restrictions on parameters are

(5.14a) $\sum_i \alpha_i = 1$ (adding-up)

(5.14b) $\sum_i \beta_i = 1$ (adding-up)

(5.14c) $\sum_i \gamma_{ij} = 0$ (adding-up)

(5.14d) $\sum_i \gamma_{ji} = 0$ (homogeneity)

(5.14e) $\gamma_{ij} = \gamma_{ji}$ (symmetry)

Using the price index from equation (5.13) frequently causes empirical difficulties, especially when aggregate annual time-series data are used. The differential from of equation can be obtained by substituting the Divisia price index $\left(\sum w_i d\, log\, p_i\right)$ for *dlogP*.

(5.15) $dw_i = \beta_i d\, log\, Q + \sum_j \gamma_{ij} d\, log\, p_j$

where $dw_i = w_i(d\, log\, p_i + d\, log\, q_i - d\, log\, m)$ and $d\, log\, m = d\, log\, P + d\, log\, Q$ and $dQ = d(m / P)$. Substituting these into (5.15) gives

(5.16) $w_i d\, log\, q_i = (\beta_i + w_i) d\, log\, Q + \sum_j \{\gamma_{ij} - w_i(\delta_{ij} - w_j)\} d\, log\, p_j$

where Δ_{ij} is the Kronecker delta equal to unity if $i = j$ and zero otherwise.

The parameters of the Rotterdam and AIDS are interrelated as in the following way:

(5.17a) $\beta_i = \alpha_i - w_i$

(5.17b) $\gamma_{ij} = \pi_j + w_i \delta_{ij} - w_i w_j$

Again the corresponding income (η_i), compensated (ε_{ij}*) and uncompensated price elasticities (ε_{ij}) for the LA/AIDS version given by (5.15) are derived as,

(5.18) $\eta_i = 1 + \beta_i / w_i$

(5.19) $\varepsilon_{ij}* = \varepsilon_{ij} + w_j \left(1 + \dfrac{\beta_i}{w_i} \right)$

(5.20) $\varepsilon_{ij} = -\delta_{ij} + \gamma_{ij} / w_i$

5.3 A Hybrid Parametrization: The CBS Model[20]

The major disadvantage of AIDS is that the concavity restriction is too complicated to be translated in to a condition on the γ_{ij} matrix in the view of their relation to π_{ij}. Replacing the α_i of the basic Rotterdam model given by the equation (5.1) with (5.10) and rearranging produces the following model:

(5.21)

where β_i and π_{ij} are constant coefficients.

The CBS model given by (5.21) combines the preferred Engel curve with the simplicity of the Slutsky matrix, including the simplicity of implementing concavity and other restrictions. The restrictions previously noted also hold for the CBS model. The elasticities can be found by using the following equations:

(5.22) $\eta_i = 1 + \beta_i / w_i$

(5.23) $\varepsilon_{ij}* = \varepsilon_{ij} + \left(1 + \dfrac{\beta_i}{w_i} \right)$

(5.24) $\varepsilon_{ij} = -\delta_{ij} + \pi_{ij} / w_i$

The three models given by equations (5.1b), (5.15), and (5.21) have the same left-hand side variables $w_i d\, log\, q_i$. They can be regarded as three different alternatives to parametrize a general demand system. Marginal budget shares are

[20] For a wider discussion on this model, see Keller and van Driel (1982,1985), and Imhoff (1985).

assumed to be constant in the Rotterdam model but they are variable in the AIDS and CBS. The Slutsky coefficients are assumed to be constant in the Rotterdam and CBS, while variable in the AIDS. The CBS model can be considered as income-response variant of the Rotterdam model.

5.4 Estimation Methods for Demand Systems

A study aimed at analysing demand is always faced with difficulties caused by almost infinite number of goods and services available to the consumer. In order to examine a complete demand system involving many equations would have huge data requirements. In addition the selection of the method of estimation and the identification of the best-fitting model to the existing data remain as a major problem. The objective of this section is to provide possible.[21]

As a first step to explore the opportunities for determining the appropriate method, consider the system of demand equations given by

(5.25) $w_{it} = f_i(\mathbf{X_t};\boldsymbol{\pi}) + \varepsilon_{it}$

where w_{it} is any form of budget share, $\boldsymbol{X_t}$ is the vector of explanatory variables, $\boldsymbol{\pi}$ is a vector of parameters, and $\boldsymbol{\varepsilon_t}$ is the *(nx1)* vector of errors. The classical assumptions are as follows:

(5.26a) $E(\boldsymbol{\varepsilon}_\mathbf{t}) = \mathbf{0}$ Unbiasedness

(5.26b) $E(\boldsymbol{\varepsilon}_\mathbf{t}\boldsymbol{\varepsilon}'_\mathbf{s}) = \mathbf{0}$ Serial noncorrelation $(t \neq s)$

(5.26c) $E(\boldsymbol{\varepsilon}_\mathbf{t}\boldsymbol{\varepsilon}'_\mathbf{t}) = \mathbf{\Sigma}$ Homoscedasticity

(5.26d) $E(\boldsymbol{\varepsilon}_\mathbf{t}|\mathbf{I}_\mathbf{s}) = \mathbf{0}$ Instrumental variables$(t \geq s)$

[21] For a wider discussion of these issues see Judge et al. (1988), Harvey (1990), and Greene (1999).

(5.26e) $\boldsymbol{\varepsilon}_{\mathbf{t}} \sim N(\mathbf{0},\boldsymbol{\Sigma})$ Normality[22]

where $\boldsymbol{H_t}$ is the instrument set that contains all the exogenous variables in $\boldsymbol{Z_t}$ and sufficient number of variables to perform the estimation. If none of the predetermined variables are endogenous, it is possible to set $\boldsymbol{H_t} = \boldsymbol{Z_t}$. Moreover, a number of regularity conditions are necessary related with the f and its first two derivatives with respect to θ. In a demand model, the fact that the sum of the budget shares equal to unity suggests that the covariance matrix of the errors, Σ, must be singular. The usual way to overcome this is to drop one equation.

Table 5.1: Methods for Estimating Demand Equations

Method	**Procedure (minimize)**
Single Equation Methods	
Ordinary Least Squares (OLS)	$\hat{\boldsymbol{\varepsilon}}_{\mathbf{i}}''\hat{\boldsymbol{\varepsilon}}_{\mathbf{i}}$
Ordinary Two-Stage Least Squares (2SLS)	$\hat{\boldsymbol{\varepsilon}}_{\mathbf{i}}''\mathbf{P}\hat{\boldsymbol{\varepsilon}}_{\mathbf{i}}$
Limited Information System Methods	
Systemwise Least Squares (SLS)	$tr\hat{\mathbf{E}}'\hat{\mathbf{E}}$
Systemwise Two-Stage Least Squares (S2SLS)	$tr\hat{\mathbf{E}}'\mathbf{P}\hat{\mathbf{E}}$
Full Information System Methods	
Seemingly Unrelated Regressions (SUR)	$tr\mathbf{S}^{-1}\hat{\mathbf{E}}'\hat{\mathbf{E}}$
Iterated Seemingly Unrelated Regressions (ISUR)	$tr\hat{\mathbf{S}}^{-1}\hat{\mathbf{E}}'\hat{\mathbf{E}}$
Maximum Likelihood (ML)	$det\,\hat{\mathbf{E}}'\hat{\mathbf{E}}$
Three-Stage Least Squares (3SLS)	$tr\mathbf{S}^{-1}\mathbf{P}\hat{\mathbf{E}}'\hat{\mathbf{E}}$
Iterated Three-Stage Least Squares (3SLS)	$tr\hat{\mathbf{S}}^{-1}\hat{\mathbf{E}}'\mathbf{P}\hat{\mathbf{E}}$

Source: Edgerton, et. al, 1996.

There are three sets of estimation methods for demand equations given by

(5.27) $w_{it} = f_i(\mathbf{X_t};\hat{\boldsymbol{\pi}}) + \hat{\varepsilon}_{it}$

[22] The assumption of normality is only necessary when performing tests and for securing the asymptotic efficiency of the estimates.

These methods are single equation, limited information system, and full information system as presented in Table 5.1. In table 5.1, $\hat{\mathbf{E}}$ represents the *{Tx(n-1)}* matrix of residuals, with i^{th} row $\hat{\varepsilon}_i'$ and where $\mathbf{P} = \mathbf{I}(\mathbf{I}'\mathbf{I})^{-1}\mathbf{I}'$ is a *(TxT)* projection matrix. ***S*** is the estimate of Σ formed from OLS/SLS, and as $\hat{\mathbf{S}}$ the estimate of Σ found as a result of iteration. Since this study is focused on the estimation of full information demand system, the first and second sets of methods are ruled out.[23] Among the methods in the third set, ISUR and ML produce identical estimates considering Oberhofer-Kmenta conditions are satisfied. For linear models OLS/SLS/SUR/ISUR/ML are same if all equations have the same explanatory variables like 2SLS/S2SLS/3SLS/I3SLS. The definitions of 2SLS and 3SLS given here are based on the assumption that the same instruments are used in all equations. Although this assumption is not necessary, the computation of estimates becomes very complex without it, especially in the case of 3SLS. The potential degrees of freedom problem eliminates the possibility of using all exogenous variables in the whole system as instruments. The only pragmatic option for 3SLS is to use only a subset of the exogenous variables or their principal components as instruments. However, this prevents to use the exogenous variables present in that equation as instruments for at least some equations (Judge et al., 1988, 646-51). This is a certainly undesirable feature that eliminates the use of 3SLS. Therefore, SUR and ML appear as feasible choices.

All the variables on the right-hand side of all three models are identical, thus method of OLS will give ML estimates satisfying the adding-up restrictions (Barten, 1969). Nevertheless, it is only possible if the number of observations is

[23] In fact, single equation methods and the limited information system methods are identical if there

greater than the number of commodities plus one, that is to say $T > N+1$. As it will be shown later that the selected system satisfies this condition, thus SUR with OLS is chosen as the appropriate estimation technique.[24]

The three models are not nested yet a general demand system can be developed that nests them (Barten, 1993 and Lee et al., 1994). The general system can be written as

(5.28) $$w_i d\log q_i = (d_i + \delta_1 w_i) d\log Q + \sum_j \left[e_{ij} - \delta_2 w_i(\delta_{ij} - w_j)\right] d\log p_j$$

$i=1,2,\ldots,n$

where $d_i = \delta_1\beta_i + (1-\delta_1)\alpha_i$, $e_{ij} = \delta_2\gamma_{ij} + (1-\delta_2)\pi_{ij}$, and δ_1 and δ_2 are two new parameters that should be estimated. The general system of (5.28) turns into the Rotterdam model if δ_1 and δ_2 are restricted to zero; into the CBS when $\delta_1 = 1$ and $\delta_2=0$; the AIDS when $\delta_1 = 1$ and $\delta_2 =1$. The restrictions on parameters can be summarized as follows:

(5.29a) $\sum_i d_i = 1-\delta_1$ (adding-up)

(5.29b) $\sum_i e_{ij} = 0$ (adding-up)

(5.29c) $\sum_j e_{ij} = 0$ (homogeneity)

(5.29d) $e_{ij} = e_{ji}$ (symmetry)

The practical easiness that (5.28) bring about is its property of model selection tool since it nests all our three models. As proposed by Amemiya (1985), the likelihood ratio test for model selection is

(5.30) $$Q_{LR} = -2\left[\log L(\boldsymbol{\theta}^*) - \log L(\boldsymbol{\theta})\right] \approx \chi^2(q)$$

are no cross-equation restrictions.

[24] Unfortunately, applying ISUR is not possible because of degrees of freedom problem.

where θ^* is the vector of parameter estimates of either the Rotterdam, the AIDS, or the CBS while θ is the vector of parameter estimates of the general model; *logL(.)* is the log value of the likelihood function; and q is the number of restrictions imposed. For instance, under the null hypothesis that the Rotterdam model best describes the data, test statistics Q_{LR} has an asymptotic $\chi^2(q)$ distribution, in which $q=2$ is the number of imposed restrictions, that is the degrees of freedom equal to the difference between the number of parameters in the general model and in the Rotterdam model (Lee et al., 1994).

5.5 Description of the Data Structure

This study uses the data provided by Food and Agricultural Organization (FAO) of United Nations. The Statistical database called FAOSTAT 2001 supplies more than 1 million time-series records. It incorporates statistical information up to September 2001, covering 210 countries and territories and 3,000 items in the following areas of agriculture, fisheries, forestry and nutrition (FAO, 2002):

- Production
- Trade
- Food Balance Sheets
- Food Aid Shipments
- Fertilizers and Pesticides
- Land Use and Irrigation
- Fishery Production and Fish Production
- Forestry Products
- Population
- Agricultural Machinery

- Forestry Trade Flow
- Codex Alimentarius

In terms of food products statistics, FAOSTAT is used to it includes the following commodity groups:

- Cereals & derived products
- Roots & tubers & derived products
- Sugar crops & sweeteners & derived products
- Pulses & derived products
- Nuts & derived products
- Oil-bearing crops & derived products
- Vegetables & derived products
- Fruits & derived products
- Water & ice & beverages
- Beverage crops & spices
- Vegetable fibres
- Feedstuffs
- Cattle & products
- Buffaloes & products
- Sheep & products
- Goats & products
- Pigs & products
- Poultry & products
- Horses & asses & mules & products
- Camels & products

- Other animals & products
- Other animal products

Our data consist of production and trade figures in four categories for 26 OECD member countries out of 30 members. We only exclude four transition economies, namely Czech Republic, Hungary, Poland, and Slovak Republic. The countries included into the data set are presented by Table 5.2.

Table 5.2: Countries in the Data Set

Australia	Austria	Belgium
Canada	Denmark	Finland
France	Germany	Greece
Iceland	Ireland	Italy
Japan	Korea	Luxembourg
Mexico	The Netherlands	New Zealand
Norway	Portugal	Spain
Sweden	Switzerland	Turkey
United Kingdom	United States	

Source: http://www.oecd.org

However, the number of countries reduces to 25 since FAOSTAT reports Belgium and Luxembourg data jointly.

The four commodity groups and the products included in each group are given by Table 5.3:

Table 5.3: Commodity Groups in the Data Set

Cereals&Pulses	**Meat**	**Milk&MilkProducts**	**Oils**
Wheat	Bovine	Milk	Olive Oil
Maize	Ovine	Cheese	Soy Oil
Rice	Poultry	Dry Milk	Sun Flower Oil
Pulses	Pig	Butter	Other Oils

We will first start with the clarification of the variables used; namely production and trade.[25] According to FAOSTAT 2001, crop production data refer to the actual harvested production from the fields, orchards, and gardens; excluding loss in harvesting and threshing, and parts of crop not harvested for any reason. Production therefore includes the quantities of the commodity sold in the market (marketed production) and the quantities consumed or used by the producers (auto-consumption). When the production data available refers to a production period falling into two successive calendar years and it is not possible to allocate the relative production to each of them, it is usual to refer production data to that year into which the bulk of the production falls. Crop production data are in metric tons (MT). Production figures for livestock relate to animals slaughtered within national boundaries regardless of their origin, whether indigenous or foreign in metric tons. Production data for oils are reported in terms of dry products as marketed in metric tons. Exceptions to this general rule include: groundnuts, which are reported as groundnuts in the shell; coconuts, which are reported on the basis of the weight of

[25] All these definitions and information on commodities are taken from FAOSTAT 2001 CD-ROM

the nut including the woody shell, but excluding the fibrous outer husk. Milk and milk products are also reported in metric tones.

As a group, cereals are generally of the gramineous family and, in the FAO concept, refer to crops harvested for dry grain only. Crops harvested green for forage, silage or grazing are classified as fodder crops. Also excluded are industrial crops, e.g. broom sorghum (Crude organic materials nes) and sweet sorghum when grown for syrup (Sugar crops nes). For international trade classifications, fresh cereals (other than sweet corn), whether or not suitable for use as fresh vegetables, are classified as cereals. Cereals are identified according to their genus. However, when two or more genera are sown and harvested as a mixture they should be classified and reported as "mixed grains". Production data are reported in terms of clean, dry weight of grains (12-14 percent moisture) in the form usually marketed. Rice, however, is reported in terms of paddy. Apart from moisture content and inedible substances such as cellulose, cereal grains contain, along with traces of minerals and vitamins, carbohydrates - mainly starches - (comprising 65-75 percent of their total weight), as well as proteins (6-12 percent) and fat (1-5 percent). The FAO definitions cover 17 primary cereals, of which one - white maize - is a component of maize. As a sub-group of cereals, common and durum wheat are the main types. Among common wheat, the main varieties are spring and winter, hard and soft, and red and white. At the national level, different varieties should be reported separately, reflecting their different uses. It is used mainly for human food. Maize is grain with high germ content. At the national level, hybrid and ordinary maize should be reported separately owing to widely different yields and uses. Used largely for animal feed and commercial starch production. The rice data utilized is rice grain after threshing and winnowing. It is also known as rice in the husk and rough rice and used mainly for human food.

Pulses are annual leguminous crops yielding from one to 12 grains or seeds of variable size, shape and colour within a pod. They are used for both food and feed. The term "pulses" is limited to crops harvested solely for dry grain, thereby excluding crops harvested green for food (green peas, green beans, etc.) which are classified as vegetable crops. Also excluded are those crops used mainly for oil extraction (e.g. soybean and groundnuts) and leguminous crops (e.g. seeds of clover and alfalfa) that are used exclusively for sowing purposes. In addition to their food value, pulses also play an important role in cropping systems because of their ability to produce nitrogen and thereby enrich the soil. Pulses contain carbohydrates, mainly starches (55-65 percent of the total weight); proteins, including essential amino acids (18-25 percent, and much higher than cereals); and fat (1 - 4 percent). The remainder consists of water and inedible substances. FAO cover 11 primary pulses.

FAO defines meat as the flesh of animals used for food. In production data, meat is normally reported inclusive of bone and exclusive of meat that is unfit for human consumption. As reported by individual countries, meat production data may refer either to commercial production (meat entering marketing channels), inspected production (from animals slaughtered under sanitary inspection), or total production (the total of the above- mentioned categories plus slaughter for personal consumption). All FAO annual production data refer to total production. Country statistics on meat production adhere to one or more of the following concepts:

- Live weight: the weight of the animal immediately before slaughter.
- Killed weight: the live weight less the uncollected blood lost during slaughter.

- Dressed carcass weight: weight minus all parts- edible and inedible- that are removed in dressing the carcass. The concept varies widely from country to country and according to the various species of livestock. Edible parts generally include edible offals (head or head meat, tongue, brains, heart, liver, spleen, stomach or tripes and, in a few countries, other parts such as feet, throat and lungs. Slaughter fats (the unrendered fats that fall in the course of dressing the carcasses) are recorded as either edible or inedible according to country practice. Inedible parts generally include hides and skins (except in the case of pigs), as well as hoofs and stomach contents.

Meat production data for minor animals (poultry, rabbits, etc.) are reported in one of the following three ways:

- Ready-to-cook weight: giblets are sometimes included and sometimes excluded.
- Eviscerated-weight: including the feet and head.
- Dressed weight: i.e. the live weight less the blood, feather and skin.

FAO data relate to dressed carcass weight for livestock and, wherever possible, ready-to- cook weight for poultry.

Among individual countries, one of the following three concepts is used to measure production:

- Production from all animals, of both indigenous and foreign origin, that are slaughtered within national boundaries.
- Production from the slaughter of indigenous animals plus exports of live indigenous animals during the reference period. Derived from meat production as follows: production from slaughtered animals plus the meat equivalent of all animals exported alive, minus the meat equivalent of all animals imported alive.

As imports/exports of live animals are recorded by FAO in numbers, not weight, animal type and size are of significance.

- The biological production concept covers indigenous animals that are either slaughtered or exported live, plus net additions to the stock during the reference period. Derived from indigenous production as follows: indigenous production plus (or minus) the meat equivalent of the change in the stock numbers during the reference period. Production is expressed in terms of live weight. Changes in the total live weight of all animals are not taken into account.

FAO uses the first concept of meat production in the construction of its food balance sheets and for related indicators. The second concept, indigenous meat production, in measuring the output of the national livestock sector, is useful mainly in the construction of index numbers of agricultural production. The third concept, biological production, would be the most complete as it also reflects changes in the livestock herd, but it is not used because of difficulties in obtaining information from national reporting offices. The prices applied to indigenous meat production are derived from prices of live animals. This covers not only the value of meat, but also the value of offals, fats, hides and skins.

Milk and milk products, eggs, honey and beeswax are included as products of live animals. The milk production data refer to raw milk containing all its constituents. Cheese is a curd of milk that has been coagulated and separated from whey. It may include some skimmed milk. Dry Milk contains milk and cream from which water has been completely removed by various methods. It is in form of powder, granules or other solid forms. It may contain added sugar or other sweeteners. However, the extraction rate, the rate at which fresh milk is converged to dry milk differentiates in terms of countries. The extraction rates are introduced by Table 5.4. Finally, for butter, the data mean emulsion of milk fat and water that is obtained by churning cream.

Table 5.4: Extraction Rates for Dry Milk

Country	Extraction Rate (%)
Australia	12
Austria	15
Belgium-Luxembourg	14
Canada	13
Denmark	16
Finland	16
France	13
Germany	26
Greece	-
Iceland	13
Ireland	13
Italy	27
Japan	17
Korea, Republic of	12
Mexico	12
Netherlands	12
New Zealand	14
Norway	12
Portugal	12
Spain	13
Sweden	11
Switzerland	16
Turkey	-
United Kingdom	13
United States of America	13
Average	**14.57**

Source: http://www.fao.org

There is a serious data standardization problem for oils. Because of the very different nature of the various oil crops, the primary products cannot be aggregated in their natural weight to obtain total oil crops. For this reason, FAO converts the crops to either an oil equivalent or an oilcake equivalent before aggregating them. Only 5-6 percent of the world production of oil crops is used for seed (oilseeds) and animal feed, while about 8 percent is used for food. The remaining 86 percent is processed into oil. The fat content of oil crops varies widely. Fat content ranges from as low as 10-15 percent of the weight of coconuts to over 50 percent of the weight of sesame seeds and palm kernels. Carbohydrates, mainly polysaccharides, range from 15 to 30 percent in the oilseeds, but are generally lower in other oil-bearing crops. The protein content is very high in soybeans, at up to 40 percent, but is much lower in many other oilseeds, at 15-25 percent, and is lower still in some other oil-bearing crops. FAO lists 21 primary oil crops. Oil extraction by traditional methods often requires various preliminary operations, such as cracking, shelling, dehulling, etc., after which the crop is ground to a paste. The paste, or the whole fruit, is then boiled with water and stirred until the oil separates and can be collected. Such traditional methods have a low rate of efficiency, particularly when performed manually. Oil extracted by pressing without heating is the purest method and often produces an edible product without refining. Modern methods of oil recovery include crushing and pressing, as well as dissolving the crop in a solvent, most commonly hexane. Extracting oil with a solvent is a more efficient method than pressing. The residue left after the removal of oil (oilcake or meal) is used as feed stuff. Crude vegetable oils are obtained without further processing other than degumming or filtering. To make them suitable for human consumption, most edible vegetable oils are refined to remove impurities and toxic substances, a process which involves bleaching, deodorization and cooling (to make the oils stable in cold temperatures). The loss involved in these processes ranges from 4 to 8 percent. The FAO concept includes raw, refined and fractioned oils, but not chemically modified oils. With some exceptions, and in contrast to animal fats, vegetable oils contain predominantly unsaturated (light, liquid) fatty acids of two kinds: monounsaturated (oleic acid - mainly in extra virgin olive oil) and polyunsaturated (linoleic acid and linolenic acid - in oils extracted from oilseeds). Vegetable oils have a wide variety of food uses, including salad and cooking oils, as well as in the production of margarine, shortening and compound fat. They also enter into many processed products, such as mayonnaise, mustard, potato chips, French fries, salad dressing, sandwich spread and canned fish. Four types of oil are included in this study; olive oil, soy oil, sunflower oil, and other oils. Olive oil is obtained from olives by mechanical or other physical means. Olive oil is the only vegetable oil that can be consumed without refining. The data also includes oil extracted from olive residues with solvents. Oil of soybeans is acquired by solvent extraction from the beans. It is used mainly for food. Sunflower oil is obtained by pressure extraction and it is mainly for food use. For other oils, FAO data of oil-equivalent method is applied. The findings on production data are summarized by Table 5.5.

Table 5.5: Summary of Production Data

Product	Description	Unit	Measurement
Wheat	Actual harvested production	MT	Dry weight of grains
Maize	Actual harvested production	MT	Dry weight of grains
Rice	Actual harvested production	MT	Paddy Rice
Pulses	Actual harvested production	MT	Dry weight of grains
Bovine Meat	Animals slaughtered in national boundaries	MT	Dressed carcass weight
Ovine Meat	Animals slaughtered in national boundaries	MT	Dressed carcass weight
Poultry Meat	Animals slaughtered in national boundaries	MT	Dressed weight
Pig Meat	Animals slaughtered in national boundaries	MT	Dressed carcass weight
Milk	Raw Milk	MT	Raw weight
Cheese	Curd of milk	MT	Separated from whey
Dry Milk	Removed water	MT	Milk-equivalent
Butter	Emulsion of milk fat	MT	Churning cream weight
Olive Oil	Pressure and Solvent extraction	MT	Oil-equivalent
Soy Oil	Solvent extraction	MT	Oil-equivalent
Sunflower Oil	Pressure extraction	MT	Oil-equivalent
Other Oils	Various methods	MT	Oil-equivalent

Source: http://www.fao.org

The second group of data is trade data from FAOSTAT. The trade data are used to find the prices for the commodity groups. Both quantities and values are reported for imports and exports. The unit of measure for quantity is weight (metric tons) for all commodities, except for live animals which are reported in units (heads). In addition, poultry, pigeons and rabbits are reported in thousand units. As a general rule, trade data refer to net weight, excluding any sort of container. Values express foreign trade in value terms. Data are stored in thousand US Dollars. National currencies used as legal tender in international transaction by the countries are converted by using the average annual exchange rate series provided by the International Monetary Fund (IMF). Only in a few cases are exchange rates drawn from national sources. In order to find the prices, first the export and import prices are found by dividing the values by quantities. As a second step, we determine whether a country under consideration is a net exporter or net importer of a particular commodity. Depending on her status in international trade, either export or import prices are used in the models.

The production data of FAOSTAT is between 1961-2000 yet the trade data covers the period 1961-1999. Therefore, the data period of the study is 1961-1999. However, the data for some countries in few commodities are problematic that originate from the trade data. Moving averages are used to fill the missing data for one or two years. If there are discontinuities more than two years, these commodities are dropped from the models. The commodities excluded from the estimations are summarized by Table 5.6.

Table 5.6: Excluded Commodities

Commodity	**Countries**
Maize	Turkey
Ovine	Finland
Poultry	Finland, Iceland, Turkey
Pig	Iceland, Turkey
Milk	Canada, Iceland, Japan, Korea, Norway, Turkey
Dry Milk	Iceland
Butter	Iceland
Sunflower Oil	Greece, Korea, Mexico

5.6 Concluding Remarks

In this part, our focus is on the methodology and the data. In the methodology part, the lessons learnt from the previous chapters are exploited to construct the models. The econometrics of demand systems is also incorporated in the analysis. All of these pieces of information provide further lessons prior to the estimation of the models. Three models are proposed; specifically Rotterdam, AIDS, and CBS. These models will be estimated by SUR for 25 OECD member countries for the period 1961-1999 by using the data obtained from FAOSTAT.

However, there are particular data problems. Some of these problems are already solved by FAO and some minor problems are resolved by making simplifying assumptions. Unfortunately, remaining unsolved data issues caused to drop some commodities from the estimations. Against all odds of the data, the study employs comprehensive models and rich data set as compared to the previous studies.

CHAPTER 6

ESTIMATION OF ELASTICITIES FOR AGRICULTURAL PRODUCTS IN THE OECD COUNTRIES

The demand systems discussed in the previous chapters will be employed to estimate the elasticities of agricultural products for OECD countries. The three models, namely Rotterdam, AIDS, and CBS are already presented by the equations (5.1b), (5.16), (5.21), and they can be summarized as:

Rotterdam Model:

(6.1) $$w_i d\,log\,q_i = \alpha_i d\,log(m/p) + \sum_j \pi_{ij} d\,log\,p_j$$

AIDS Model:

(6.2) $$w_i d\,log\,q_i = (\beta_i + w_i) d\,log\,Q + \sum_j \{\gamma_{ij} - w_i(\delta_{ij} - w_j)\} d\,log\,p_j$$

CBS Model:

(6.3) $$w_i d\log q_i = (\beta_i + w_i) d\log Q + \sum_j \pi_{ij} d\log p_j$$

where w_i is the budget share, α_i is the marginal budget share, q_i and p_i are quantities and prices, m is total expenditure, π_{ij} are Slusky coefficients, $dQ = d(m/P)$, and Δ_{ij} is the Kronecker delta equal to unity if $i = j$ and zero otherwise.

The three models are estimated by employing the FAOSTAT data of 25 OECD countries for 16 agricultural products and for the period between 1961-1999. The estimation method is chosen as Seemingly Unrelated Regression (SUR) method because of the reasons discussed in the previous chapter.

6.1 Model Selection

Following the estimation of the models, the model selection tool given by equation (5.28) is estimated and the likelihood ratio tests are performed for each individual country. The results are displayed by Table 6.1.

Table 6.1: Model Choice for Each Country

Country	***Model Choice***
Australia	Rotterdam
Austria	AIDS
Belgium-Luxembourg	Rotterdam
Canada	AIDS
Denmark	CBS
Finland	CBS
France	CBS
Germany	Rotterdam
Greece	CBS
Iceland	CBS
Ireland	AIDS
Italy	CBS
Japan	AIDS
Korea	CBS
Mexico	AIDS
Netherlands	AIDS
New Zealand	AIDS
Norway	AIDS
Portugal	AIDS
Spain	CBS
Sweden	AIDS
Switzerland	CBS
Turkey	AIDS
UK	AIDS
USA	CBS

Source: Author's calculations.

The most significant result of the table is the relative insignificance of the Rotterdam model. Rotterdam model is found to be significant only for three countries. The CBS model, on the other hand, achieved significance for ten countries. Finally, for twelve countries, the AIDS model seems to be significant as a better representation of modeling the demand. The results are not surprising in the sense that both the AIDS and CBS have theoretical superiorities over the Rotterdam model. Therefore, one should consider the results of likelihood ratio tests in interpreting the elasticities.[26,27]

6.2 Income Elasticities

The income elasticities calculated from the parameter estimates of the models are presented in Tables 6.2 through 6.4. However, as discussed in the previous section, for each country a different model is relevant according to the model selection process. Therefore, the income elasticities are chosen accordingly, and they are included in the Table 6.5.

6.2.1 Cereals and Pulses

The income elasticities for this commodity group present a two-layer segmented structure: wheat and maize, and rice and pulses. As in conformity with our expectations, the income elasticities for rice and pulses are generally higher than that of wheat and maize. All of the income elasticities of wheat are positive as expected and less than 1 that labels wheat as a normal good. Among the significant figures, the highest value belongs to Australia (0.707) and the lowest to Canada (0.108). Income elasticities of maize are highly significant as compared to wheat; apart from Turkey where the data is unavailable, only 6 out of 24 coefficients are observed as insignificant. All significant coefficients are positive with the exception of Australia (-1.316) and France (-0.708).

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[26] The diagnostics (Breusch-Pagan LM test for heteroscedasticity and Durbin-Watson test of autocorrelation show that the models are generally robust. (See Appendix D).

[27] All the parameter estimates are presented in the Appendix D.

Table 6.2: Income Elasticities for the OECD Countries - Rotterdam Model, 1961-1999

Commodity Group/	***Cereals and Pulses***				***Meats***				***Milk&Dairy Products***				***Oils***			
Country	Wheat	Maize	Rice	Pulses	Bovine	Ovine	Poultry	Pig	Milk	Cheese	Dry Milk	Butter	Olive	Soy	Sunflower	Other
Australia	0.707**	-1.316**	-0.378	0.551	0.133*	0.009	0.032	0.012	0.009	0.116	0.555	0.431**	0.082	0.492*	-0.640	0.735
Austria	0.069	0.826*	0.098	0.095	0.023	0.006	0.038	-0.016	0.003	0.144	0.233*	-0.079*	0.122	1.190**	0.732**	0.125
Belgium-Luxembourg	0.286	0.584**	0.070	0.188	0.099	-0.104	0.152*	0.083	0.233**	0.179*	4.617	2.072	0.021	0.522*	0.991	0.201
Canada	0.654**	0.133	0.067	-0.476	0.121*	0.036	0.084	-0.111**	n.a.	0.047	0.776	0.148*	0.636**	0.072	1.502**	0.473
Denmark	-0.230	0.033	0.155	1.900**	0.033	0.449*	0.513**	0.652**	0.491**	0.888*	0.718	0.319	0.265	0.148	-0.227	-0.265
Finland	0.786*	2.518**	3.234	0.562	1.019	n.a.	n.a.	0.999	0.171	0.447	1.751	0.901	1.747	4.615**	-2.205**	0.779
France	0.185**	0.391	0.594**	0.833	0.362*	0.140	0.546**	0.121	0.218**	0.076*	2.644	0.611**	0.264	0.782*	0.117	0.905
Germany	0.092	0.755**	0.477	-0.555	0.049	-0.052	0.048	0.257**	0.165*	0.256**	0.356	0.500**	0.081	0.281	0.544**	0.551**
Greece	0.872**	0.214	0.285	0.310*	0.50**	-0.035	0.246**	0.097	0.056	0.050	0.261	0.254	0.911	-0.839	n.a.	0.362
Iceland	0.145	0.088	-0.89017	1.860	1.269	0.508	n.a.	n.a.	n.a.	0.402	n.a.	n.a.	9.679	6.523	1.672	1.844
Ireland	0.004	0.188	0.073*	-0.015	0.210	0.041*	0.025	-0.029	0.064**	0.980	0.448	2.850**	0.037	0.049	0.061	-0.417
Italy	0.727**	0.319*	1.639**	0.082	0.405**	0.259	0.018	0.207*	0.031	0.121	0.905*	0.629**	0.797	0.361	-0.543	0.229
Japan	0.096	0.266*	0.670**	-0.019	-0.017	0.220	0.059	0.116**	n.a.	0.026	0.416**	0.041	1.090**	0.033**	1.337	0.024
Korea	0.605**	0.228	0.848**	0.508**	0.116	1.314**	0.199**	0.176	n.a.	0.105	0.334	0.060	-0.019	0.085	n.a.	0.135
Mexico	0.178**	0.005	0.596	0.115	0.290	0.172**	0.364	0.117**	0.432	0.502**	2.239	0.370	5.033	0.105	n.a.	0.131**
Netherlands	0.747**	0.228	1.219*	0.081	0.368*	-0.268	0.079	0.297*	0.324**	0.199	0.291	0.830	1.494**	0.456**	0.544	0.859**
New Zealand	0.214	0.404	0.043	-0.816	0.246	0.164	0.255**	0.079	0.666**	0.032	-0.117	3.020**	0.008	0.228	-0.026	0.752
Norway	0.287	0.351	-0.225	0.371**	0.095	0.209*	1.030**	0.280**	n.a.	0.040	-2.906*	0.060	1.440**	0.246	0.608	1.258**
Portugal	0.411*	0.211	0.151	0.206	0.062	0.115	0.351**	0.238**	0.274**	0.083	2.140*	0.104	1.639*	0.622	0.388	0.148
Spain	0.833**	0.177	0.642*	0.400**	0.228**	-0.039	0.143	0.122*	0.135**	0.147*	0.595	1.293**	0.350*	1.630*	1.351**	1.017**
Sweden	0.271**	0.324	0.054	-0.071	0.042**	0.107**	0.009	0.030*	0.020	0.029	3.698**	0.115*	0.067	0.031	0.183	0.081
Switzerland	0.509**	-0.008	0.182	0.640**	0.644**	0.640**	0.416**	0.222*	0.047*	0.107	1.546*	-0.119	0.090	0.418	0.276	0.265**
Turkey	0.723**	n.a.	0.293	0.377**	0.023	0.060	n.a.	n.a.	n.a.	0.037	1.812**	0.078	1.379	0.146	-0.032	0.238
UK	0.068	0.106	0.086	0.198	0.042	0.050	0.014	0.032	0.219**	1.137**	0.838	-0.315	0.318	0.122	0.268	0.230*
USA	0.910	0.734*	0.802**	0.940	0.066**	1.191*	0.184	0.101*	0.433*	0.174	0.882	-0.395	3.431	0.185**	0.442**	1.647

** Significant at 10% level*
*** Significant at 5% level*
Source: Author's calculations.

Table 6.3: Income Elasticities for the OECD Countries- AIDS Model, 1961-1999

Commodity Group/ Country	***Cereals and Pulses***				***Meats***				***Milk&Dairy Products***				***Oils***			
	Wheat	Maize	Rice	Pulses	Bovine	Ovine	Poultry	Pig	Milk	Cheese	Dry Milk	Butter	Olive	Soy	Sunflower	Other
Australia	0.149**	0.092**	-1.963	0.407	0.294**	0.516**	0.253**	0.064**	0.035**	0.082**	1.942**	0.184**	0.601**	0.556**	0.286*	1.185
Austria	0.153**	0.195**	0.172**	0.182**	0.023**	0.268**	0.261**	0.172**	0.213**	0.240**	0.349**	-0.251**	0.600	0.320**	0.108**	0.228**
Belgium-Luxembourg	0.147**	0.486	0.163*	0.160**	0.199**	0.172**	0.205**	0.178**	0.442	0.233**	0.968*	2.584**	0.522	0.431	0.043	0.125**
Canada	0.108**	0.194**	0.200*	0.265*	0.199**	0.214**	0.244**	0.248**	n.a.	0.202**	0.704	0.217**	0.329**	0.261**	0.251*	0.293
Denmark	0.307**	0.203**	1.969**	0.704**	0.236**	0.124*	0.337**	0.111**	0.118**	0.196	0.385	0.182	1.211	0.205**	0.328*	0.228**
Finland	0.852	6.800	1.298	1.808	-0.437	n.a.	n.a.	0.013	-0.110	0.344*	2.330*	-0.195	1.663	0.607	1.823	-1.590*
France	0.198	-0.315*	1.054*	0.865	0.142**	0.259**	0.110*	0.224**	0.184	0.217	1.256	-0.137	0.135	0.421**	0.272**	-0.567
Germany	0.244**	-0.377	-0.357**	-0.426**	0.236**	-0.188**	0.220**	0.174**	0.157**	0.115**	-2.564	0.403**	2.455**	0.172**	0.141**	0.107**
Greece	0.906	0.159**	1.682**	1.802**	0.134**	0.232**	0.442**	0.238**	0.192**	0.211**	1.338**	0.126**	0.186	0.465*	n.a.	0.159**
Iceland	0.118**	0.929*	-0.190	-1.977	0.879*	-0.386	n.a.	n.a.	n.a.	1.288	n.a.	n.a.	5.535	6.286	5.967	1.137**
Ireland	0.158**	0.699**	1.200**	1.589**	0.091**	0.161**	0.144**	0.016**	0.416**	0.260*	1.162	0.272**	0.692**	0.128**	0.208**	0.195**
Italy	0.434**	0.153**	1.505	0.263**	0.146**	0.165**	0.229**	0.193**	0.260**	0.191**	1.410	0.891	0.778	0.107	0.313**	0.161**
Japan	0.212**	0.142**	0.619	0.213**	0.179**	0.298**	0.211**	0.216**	n.a.	0.182**	0.949**	0.209**	3.347**	0.268**	0.633	0.261**
Korea	0.094*	0.158**	0.477**	0.217**	0.186**	0.107	0.281**	0.115*	n.a.	0.256	-1.361	0.181**	-0.778	0.124*	n.a.	0.137**
Mexico	0.636	0.536	1.511**	0.601	0.102	1.268	0.436	0.164**	0.068	0.256	2.491**	1.139	1.304	0.198	n.a.	0.058*
Netherlands	0.641	0.329**	0.479	0.890	0.173**	-0.242**	0.200**	0.171**	0.758*	0.182**	1.397	0.452	4.319**	0.979*	0.521	0.376
New Zealand	0.164**	-0.272	1.748**	0.315*	0.290**	0.249**	0.189**	0.266**	0.690**	0.265	-1.811	0.362*	1.021	0.162**	0.197**	-0.300
Norway	0.171**	1.449	2.653**	1.852**	0.217**	1.627**	0.169	0.175**	n.a.	0.229**	-2.135	0.274**	0.602	0.160**	0.435**	1.333**
Portugal	0.115**	0.174**	0.301**	0.283**	0.223**	0.233**	0.273**	0.134**	0.113**	0.202**	0.553**	0.185**	2.063	0.393**	0.219	0.233**
Spain	0.195	0.211**	1.257	1.111*	0.158**	0.237**	0.196**	0.138**	0.175**	0.133**	-1.199	0.760	1.458	0.197	1.804	-0.104
Sweden	0.240**	0.224**	2.152**	1.768**	0.167**	0.195**	0.242**	0.178**	0.512**	0.208**	6.720**	0.377	2.155**	0.182**	0.158**	0.150**
Switzerland	0.344**	0.229**	1.588**	0.355**	0.937**	-0.399	0.911**	0.305	0.206**	0.249**	0.442**	-0.281**	0.246**	0.177*	0.147**	0.109**
Turkey	0.439*	n.a.	0.316**	0.128**	0.195**	0.469**	n.a.	n.a.	n.a.	0.214**	0.641	0.299**	0.769	1.267*	0.214**	0.154**
UK	0.218**	0.299**	1.235**	0.138*	0.227**	0.264**	0.140**	0.212**	0.239	0.912	0.158	-1.547*	0.298	0.155**	0.053	0.178**
USA	0.587**	0.205	1.020	1.489	0.155*	-1.388**	0.418*	0.760	0.791*	0.194*	0.390**	-0.904	8.663	0.652*	0.489	1.790

** Significant at 10% level*
*** Significant at 5% level*
Source: Author's calculations.

Table 6.4: Income Elasticities for the OECD Countries- CBS Model, 1961-1999

Commodity Group/ Country	*Cereals and Pulses*				*Meats*				*Milk&Dairy Products*				*Oils*			
	Wheat	Maize	Rice	Pulses	Bovine	Ovine	Poultry	Pig	Milk	Cheese	Dry Milk	Butter	Olive	Soy	Sunflower	Other
Australia	0.218**	0.186**	3.109**	1.613	0.159**	0.529**	0.485**	0.087**	0.071**	0.314**	2.959**	0.185	2.733**	2.960*	0.463**	-3.559
Austria	0.318**	0.148**	0.274**	0.121**	0.018**	0.513**	0.430**	0.083**	0.071**	0.388**	2.481**	-0.088**	2.014**	1.035**	-0.178**	0.395
Belgium-Luxembourg	0.167**	-0.162*	0.284*	0.235**	0.129**	-0.263**	0.416**	0.090**	0.684**	0.326**	1.673*	3.975**	2.014	0.766	-0.341	0.171**
Canada	0.098**	0.218**	0.326**	-0.721	0.074**	-0.317**	0.170**	0.096**		0.227**	0.223	0.499**	0.237**	0.200**	0.490	0.741*
Denmark	0.578**	0.183**	1.002**	0.568**	0.320**	0.677**	0.203**	0.493	0.163**	0.774	1.909	0.065*	3.187	0.240**	0.765**	0.430
Finland	0.455**	1.621	4.230	1.768	1.221**	n.a.	n.a.	0.086	-0.104	0.607	1.973**	-0.107	0.698	1.191	0.871	1.102
France	0.230*	-0.708*	1.853*	1.548	0.102**	0.098**	0.168*	0.114**	0.493**	0.154**	1.995*	-0.274**	0.528	0.261**	0.392**	0.319
Germany	0.219**	-0.182	0.870**	0.520**	0.123**	-0.059**	0.470**	0.055**	0.084**	0.157**	0.233	0.116	2.645*	0.165**	0.201**	0.195**
Greece	0.887	0.246**	2.003**	0.745**	0.151**	0.361**	0.587**	0.346**	0.067**	0.182**	0.368**	0.343**	0.310	0.425**	n.a.	0.332**
Iceland	0.095	0.508	0.447**	-1.639	0.312**	-0.792	n.a.	n.a.	n.a.	-0.518	n.a.	n.a.	1.038	1.854	0.511	0.297
Ireland	0.314**	0.111**	1.300**	0.549**	0.156**	0.468**	0.419**	0.021**	0.404**	0.277**	2.563	0.563*	0.504**	0.081**	0.091**	0.620**
Italy	0.263**	0.205**	0.731	0.167**	0.629**	0.154**	0.229**	0.131**	0.118**	0.161**	1.567	0.352	0.723	0.276**	-0.105**	0.422**
Japan	0.306**	0.177**	1.578	-0.192**	0.271**	0.221**	0.246**	0.098**	n.a.	0.136**	1.527**	0.322**	4.463**	0.120**	0.540**	0.201**
Korea	0.106	0.246**	0.761**	1.484**	0.233**	0.762	0.438	0.144	n.a.	0.423**	-0.639	0.365**	-0.829**	0.346*	n.a.	0.666**
Mexico	0.159	0.556	3.462	0.630	0.160	1.253	0.260	0.535	0.373	0.260**	0.936	0.233	6.116	0.071	n.a.	0.243
Netherlands	0.158	0.281**	0.449	0.796	0.078**	-0.545**	0.416**	0.085**	0.600**	0.258**	0.638	0.619	1.083**	0.580**	0.433	0.185
New Zealand	0.172**	-0.501**	2.869**	0.388**	0.640**	0.092**	0.302**	0.132**	0.772**	0.199	-0.865	0.381	0.731	0.202**	-0.855**	0.574
Norway	0.198**	0.788	0.423**	0.259**	0.078**	0.249**	0.788	0.689**	n.a.	0.136**	-5.246**	0.548**	3.345	0.384**	0.314	2.503**
Portugal	0.120*	0.181**	0.558**	0.118**	0.199**	0.733**	0.328**	0.112**	0.090**	0.455**	1.551**	0.227**	0.666	1.861	0.516	0.164**
Spain	0.818	0.236**	0.378	0.353**	0.172**	0.602**	0.198**	0.082**	0.093**	0.420**	-0.324	0.137	0.505	1.948	0.384	0.413
Sweden	0.544**	0.881**	0.423**	1.594**	0.127**	0.432**	0.428**	0.132**	0.448**	0.234**	2.701**	0.575**	4.175**	0.207**	0.171**	0.135*
Switzerland	0.811**	0.163**	0.412**	0.202**	0.549**	0.156	0.441**	0.496**	0.060**	0.306**	0.629**	-0.124**	0.110**	0.112*	0.425**	0.087**
Turkey	0.135**	n.a.	1.063**	0.210**	0.295**	0.303**	n.a.	n.a.	n.a.	0.648**	2.730	0.486**	2.841**	3.713**	0.683**	0.125**
UK	0.262**	0.106**	0.416**	0.179**	0.183**	0.633**	0.236**	0.160**	0.364**	1.634*	-0.295	-0.749**	0.226**	0.468**	0.081	-0.073**
USA	0.200	0.607*	3.390**	0.712*	0.086	0.434*	0.110	0.852	0.662	0.247*	0.923	-0.751	2.310*	0.581*	0.161*	1.767

** Significant at 10% level*

*** Significant at 5% level*

Source: Author's calculations.

Table 6.5: Income Elasticities for the OECD Countries, 1961-1999

Commodity Group/ Country	***Cereals and Pulses***				***Meats***				***Milk&Dairy Products***				***Oils***			
	Wheat	Maize	Rice	Pulses	Bovine	Ovine	Poultry	Pig	Milk	Cheese	Dry Milk	Butter	Olive	Soy	Sunflower	Other
Australia	0.707**	-1.316**	-0.378	0.551	0.133*	0.009	0.032	0.012	0.009	0.116	0.555	0.431**	0.082	0.492*	-0.640	0.735
Austria	0.153**	0.195**	0.172**	0.182**	0.023**	0.268**	0.261**	0.172**	0.213**	0.240**	0.349**	-0.251**	0.600	0.320**	0.108**	0.228**
Belgium-Luxembourg	0.286	0.584**	0.070	0.188	0.099	-0.104	0.152*	0.083	0.233**	0.179*	4.617	2.072	0.021	0.522*	0.991	0.201
Canada	0.108**	0.194**	0.200*	0.265*	0.199**	0.214**	0.244**	0.248**	n.a.	0.202**	0.704	0.217**	0.329**	0.261**	0.251*	0.293
Denmark	0.578**	0.183**	1.002**	0.568**	0.320**	0.677**	0.203**	0.493	0.163**	0.774	1.909	0.065*	3.187	0.240**	0.765**	0.430
Finland	0.455**	1.621	4.230	1.768	1.221**	n.a.	n.a.	0.086	-0.104	0.607	1.973**	-0.107	0.698	1.191	0.871	1.102
France	0.230*	-0.708*	1.853*	1.548	0.102**	0.098**	0.168*	0.114**	0.493**	0.154**	1.995*	-0.274**	0.528	0.261**	0.392**	0.319
Germany	0.092	0.755**	0.477	-0.555	0.049	-0.052	0.048	0.257**	0.165*	0.256**	0.356	0.500**	0.081	0.281	0.544**	0.551**
Greece	0.887	0.246**	2.003**	0.745**	0.151**	0.361**	0.587**	0.346**	0.067**	0.182**	0.368**	0.343**	0.310	0.425**	n.a.	0.332**
Iceland	0.095	0.508	0.447**	-1.639	0.312**	-0.792	n.a.	n.a.	n.a.	-0.518	n.a.	n.a.	1.038	1.854	0.511	0.297
Ireland	0.158**	0.699**	1.200**	1.589**	0.091**	0.161**	0.144**	0.016**	0.416**	0.260*	1.162	0.272**	0.692**	0.128**	0.208**	0.195**
Italy	0.263**	0.205**	0.731	0.167**	0.629**	0.154**	0.229**	0.131**	0.118**	0.161**	1.567	0.352	0.723	0.276**	-0.105**	0.422**
Japan	0.212**	0.142**	0.619	0.213**	0.179**	0.298**	0.211**	0.216**	n.a.	0.182**	0.949**	0.209**	3.347**	0.268**	0.633	0.261**
Korea	0.106	0.246**	0.761**	1.484**	0.233**	0.762	0.438	0.144	n.a.	0.423**	-0.639	0.365**	-0.829**	0.346*	n.a.	0.666**
Mexico	0.636	0.536	1.511**	0.601	0.102	1.268	0.436	0.164**	0.068	0.256	2.491**	1.139	1.304	0.198	n.a.	0.058*
Netherlands	0.641	0.329**	0.479	0.890	0.173**	-0.242**	0.200**	0.171**	0.758*	0.182**	1.397	0.452	4.319**	0.979*	0.521	0.376
New Zealand	0.164**	-0.272	1.748**	0.315*	0.290**	0.249**	0.189**	0.266**	0.690**	0.265	-1.811	0.362*	1.021	0.162**	0.197**	-0.300
Norway	0.171**	1.449	2.653**	1.852**	0.217**	1.627**	0.169	0.175**	n.a.	0.229**	-2.135	0.274**	0.602	0.160**	0.435**	1.333**
Portugal	0.115**	0.174**	0.301**	0.283**	0.223**	0.233**	0.273**	0.134**	0.113**	0.202**	0.553**	0.185**	2.063	0.393**	0.219	0.233**
Spain	0.818	0.236**	0.378	0.353**	0.172**	0.602**	0.198**	0.082**	0.093**	0.420**	-0.324	0.137	0.505	1.948	0.384	0.413
Sweden	0.240**	0.224**	2.152**	1.768**	0.167**	0.195**	0.242**	0.178**	0.512**	0.208**	6.720**	0.377	2.155**	0.182**	0.158**	0.150**
Switzerland	0.811**	0.163**	0.412**	0.202**	0.549**	0.156	0.441**	0.496**	0.060**	0.306**	0.629**	-0.124**	0.110**	0.112*	0.425**	0.087**
Turkey	0.439*	n.a.	0.316**	0.128**	0.195**	0.469**	n.a.	n.a.	n.a.	0.214**	0.641	0.299**	0.769	1.267*	0.214**	0.154**
UK	0.218**	0.299**	1.235**	0.138*	0.227**	0.264**	0.140**	0.212**	0.239	0.912	0.158	-1.547*	0.298	0.155**	0.053	0.178**
USA	0.200	0.607*	3.390**	0.712*	0.086	0.434*	0.110	0.852	0.662	0.247*	0.923	-0.751	2.310*	0.581*	0.161*	1.767

** Significant at 10% level*
*** Significant at 5% level*
Source: Author's calculations.

Moreover, the positive and significant coefficients are all less than one except Norway (1.449). The income elasticities are between 0.183 (Denmark) and 0.755 (Germany) asserting that for most of the countries in our data set maize is a normal good. For 17 countries in the data set, we find statistically significant coefficients for the income elasticity of rice. All the income elasticities are positive yet the trend is not as regular as in wheat and maize. 10 out of 17 significant coefficients ranging between 1.002 (Denmark) and 3.390 (USA) confirm that rice is generally a luxury good. For seven cases, it is found to be a normal good. In this category, the lowest figure belongs to Austria (0.172) and the highest to Korea (0.761). In the case of pulses, again 17 of the income elasticities produce statistically meaningful results. Only in 4 cases (Ireland, Korea, Norway, and Sweden), the income elasticity is greater than unity reaching 1.852 (Norway). The income elasticities for pulses are generally higher in Nordic countries. In 13 cases, the income elasticity fluctuates between 0.128 (Turkey) and 0.745 (Greece).

6.2.2 Meats

The different types of meat have generally low figures of income elasticity. In terms of the income effect, the consumption of poultry and pig meats shows a close resemblance. Income elasticities of bovine and ovine show an evidence of dissimilarity.

The income elasticities for bovine are highly significant, except for Belgium-Luxembourg, Germany, Mexico, and USA with insignificant coefficients. Bovine can be treated as either a normal good or necessity with elasticities varying between 0.023 (Austria) and 0.629 (Italy). Only for Finland (1.221), the elasticity is greater than unity. The composition of income elasticities of ovine is not as clear as in the case of bovine. 16 significant coefficients are identified with high variability between –0.242 and 1.627. The only negative and significant coefficient belongs to the Netherlands. There is only one case (Norway) with the income elasticity greater than unity. For poultry, we have 16 positively significant coefficients out of 22 cases. However, the distribution is more uniform as compared to the previous cases. The low level of income elasticities of poultry points out that poultry is somewhat consumed as a necessity. The rising health consciousness towards the consumption of poultry meat may be accounted for the presence of this situation. For the pig meat, in 17 out 23 cases, our estimation procedures produce positively significant coefficients. The dominant characteristic is that pork meat can be considered as a necessity. The traditional consumption habits also make such a conclusion relevant according to the other findings in the literature. The elasticities range between 0.016 (Ireland) and 0.496 (Switzerland).

6.2.3 Milk and Dairy Products

In terms of income elasticities, this category almost certainly displays the highest variation especially for dry milk and butter.

The income elasticities for milk are significant for 14 cases out of 19. All of the significant coefficients are positive and milk can be treated as a necessity according to the findings. The highest figure belongs to the Netherlands (0.758) whereas lowest to Switzerland (0.060). The income elasticities of cheese are also highly significant where 16 out 25 coefficients are found to be significant. The income elasticities of cheese have a highly uniform distribution fluctuating in a narrow band with the lowest value of 0.154 (France) and the highest of 0.423 (Korea). Therefore, it seems to be a necessity in terms of the values of income elasticities. The coefficients for the dry milk may probably show the most differentiated pattern among the commodities we have analysed. The possible reason for such a behavior might be its widest range of use in the manufacturing of different food products. There are only 9 significant coefficients attaining the lowest value of 0.349 (Austria) and reaching its peak in the case of Sweden (6.720). Thus, for some countries it can be treated as a normal good for the others as a luxury. The most interesting point for income elasticities of butter is the existence of negatively significant income elasticities. Out of 16 significant cases, four cases (Austria, France, Switzerland, and UK) have negatively significant coefficients. The possible reason of such a result might be the negative attitude against the consumption of butter and hydrogenated oils because of the health concerns. Thus, butter can be considered as an inferior good for aforementioned cases. For the rest of our sample the income elasticities are between 0.065 (Denmark) and Germany (0.500).

6.2.4 Oils

The oil consumption is expected to be more associated with the habits than any other category. As a matter of fact, this hypothesis is verified by the data to some extent. The products in the oil category more or less demonstrate the same trend except olive oil. The income effect in the olive oil consumption presents a differentiated structure. Only for 7 cases, the proposed estimation procedures produce significant coefficients. For 3 of those countries, it may be treated as a luxury whereas it seems to be a normal good for 3 countries. The remarkable coefficient belongs to Korea (-0.829). Another interesting point is that the income elasticities are not significant for traditional olive oil producers (Spain, Italy, Turkey, Greece) although, as discussed in chapter 4, olive oil consumption is closely linked with the habit formation. Among the other oil products, sunflower has the lowest number of significant income elasticities. Soy oil is highly significant and income elasticities of soy oil are generally higher than that of the other products. The income elasticities for oils are usually less than unity with few exceptions. Apart from the olive oil, there are only 2 significant coefficients greater than unity; Turkey (soy oil) and Norway (other oils). Finally, it can be concluded that oils appear to be normal goods on average.

6.3 Own-Price Elasticities

Tables 6.6 through 6.8 give the own-price elasticities. As in the case of income elasticities, the estimates from the significant models according to the likelihood ratio tests are presented in Table 6.9. Own-price elasticities are not as significant as the income elasticities. Therefore, it may be concluded that the income effect is more meaningful than the own-price effect.

6.3.1 Cereals and Pulses

Among the commodities in this category, wheat is the least elastic product. The own-price elasticities for 9 countries out 11 significant coefficients are less than 0.5. Moreover, most of the own-price elasticities vary in the interval from 0.1 to 0.2. Therefore, it can be maintained that the wheat demand is vastly inelastic. The estimation results yield only 5 statistically significant coefficients for maize. For 3 countries (Ireland, the Netherlands, and UK), the coefficients signify a highly elastic demand. Moreover, other two significant coefficients belonging to Australia (-0.899) and Austria (-0.891) are very close to unity. For rice and pulses, a more differentiated structure is observed. Own-price elasticities for rice that vary between –0.196 and –5.949, are found to be significant for 13 countries in the data set. Furthermore, most of these coefficients point out that the demand for rice is elastic. What is more interesting is the existence of two positively significant coefficients (Australia and Spain).

Table 6.6: Own-Price Elasticities for the OECD Countries- Rotterdam Model, 1961-1999

Commodity Group/	*Cereals and Pulses*				*Meats*				*Milk&Dairy Products*				*Oils*			
Country	Wheat	Maize	Rice	Pulses	Bovine	Ovine	Poultry	Pig	Milk	Cheese	Dry Milk	Butter	Olive	Soy	Sunflower	Other
Australia	-0.656**	-0.899**	2.164**	0.906	-0.425**	-0.582**	-0.036	-0.098*	-0.008	-0.763**	-2.522**	0.878**	-0.467*	-0.323	0.131	-2.163**
Austria	0.080	-6.030	-0.458**	0.249	-0.023	-0.003	-0.087**	-0.017	-0.012	-0.178	-0.250	-0.022	-0.485**	-3.771**	1.015**	-2.018**
Belgium-Luxembourg	-0.392	0.358	-0.166	-0.985**	-0.013	-0.464**	-0.293**	0.081	-0.202**	-0.338**	-4.848	-2.041	-0.470	-0.524	2.054*	-0.149
Canada	-0.649**	0.158	-0.237**	-1.053	-0.040	-0.401*	-0.109	-0.406**	n.a.	-0.018	-0.026	-0.228**	-0.826**	0.004	-2.458**	-1.761**
Denmark	0.097	-0.199	-0.331	-1.593*	-0.276	0.030	-0.184	-0.106**	-0.216**	-0.929**	0.895	-0.361	-1.447**	-0.052	-0.244	-1.499**
Finland	0.206	-1.263**	-2.160	-0.548	-0.711	n.a.	n.a.	-0.424	-0.087	-0.737	-4.722**	-1.035**	-9.826	-2.237*	-0.484	-2.463
France	-0.262**	-0.903	-0.295	-1.339*	-0.329*	-0.239**	-0.657**	-0.066	-0.095*	-0.140**	0.826	-0.921**	-0.669	-0.727	-0.368	-0.574
Germany	-0.030	-0.309	-0.879	-1.012**	-0.036	-0.112	-0.091	0.061	-0.131*	-0.235**	0.772	-0.512**	-0.460*	-0.086	-0.485*	-0.267*
Greece	-0.991**	-0.124	0.177	-0.088	-0.358	-0.133*	-0.221**	-0.254	-0.071	-0.178**	-0.141	-0.273	-1.641**	0.460	n.a.	-0.491*
Iceland	-0.427	0.030	-0.727**	-0.633*	-0.626	-0.191	n.a.	n.a.	n.a.	-0.174	n.a.	n.a.	-7.015	-0.042	-0.334	-0.303**
Ireland	-0.980**	-2.128**	-0.721**	-1.122**	-0.202	-0.482**	-0.071	-0.102	-0.029*	-0.830	0.611	3.972**	-0.549**	-0.288*	-1.440**	-1.422
Italy	-0.007	-0.403**	-2.125**	-0.023	-0.288**	-0.065	-0.059	-0.181*	-0.113	-0.470**	0.259	-0.549*	-0.920	0.804**	-0.227	-0.162
Japan	-0.073	0.053	-0.540**	0.188	-0.072	0.484	-0.044	-0.004	n.a.	-0.186*	-0.459**	-0.048	-1.603**	-0.057	-1.257*	-0.028
Korea	-0.289	-0.110	0.340**	-0.673**	0.083	-0.731**	-0.161*	-0.186*	n.a.	-0.190	-0.053	0.017	-0.581	0.021	n.a.	-0.164
Mexico	-0.204	-0.386	-0.673	-0.522	-1.614	-0.184	-0.405	-0.185	-0.814	-0.344**	0.368	-0.514	-4.339	-0.192	n.a.	1.850
Netherlands	-0.731*	-0.357	-1.502**	-1.414**	-0.080	-0.537	0.362	-0.020	-0.297**	-0.526*	-1.155	-1.301	-1.914**	-0.523	-0.875	0.288*
New Zealand	-0.276	-0.418	0.128	-1.707	-0.697*	-0.209	-0.183	-0.002	-0.171**	-1.070	-0.642	-0.596**	-0.831*	-0.437*	-1.197**	-0.355
Norway	-0.191	0.006	-0.582**	-0.449**	-0.047	0.080	-0.783**	-0.136	n.a.	-0.356**	-2.077	-0.273	-0.044	0.089	-0.327	-0.374*
Portugal	-0.012	-0.037	-0.482*	-0.334*	-0.062	-0.157*	-0.384**	-0.143	-0.180**	-0.091	-0.788	0.038	-1.307	-0.490	-0.479*	0.230
Spain	-0.451*	-0.111	-0.510*	0.466**	-0.027	-0.084	0.053	-0.204**	-0.096**	-0.228*	-0.654	-2.074**	-0.663**	-1.798*	-0.218**	-0.011
Sweden	-0.787**	-0.353	-1.254**	-0.645**	-0.064	-0.023	-0.034	-0.004	-0.022	-0.036	-3.948**	-0.033	-0.839**	-0.204	-0.370	-0.945
Switzerland	-0.178	-0.154	-1.030**	-1.653**	-0.455**	-0.700*	-0.351*	-0.187**	-0.075**	-0.595**	-1.082	-0.070	-0.519**	0.580	-0.387	-0.227
Turkey	-0.307**	n.a.	-0.139	-0.692**	-0.081	-0.015	n.a.	n.a.	n.a.	-0.021	-2.000**	-0.046	-2.546**	-0.401	-0.260	-0.127
UK	-0.518*	-0.356	-0.226	-1.397**	-0.189*	-0.217*	-0.134	-0.174**	-0.133**	-0.749**	0.396	-0.377	-1.206**	0.120	-0.055	-0.135
USA	-0.127	-0.815*	-0.577	-0.208	-0.140	-1.355*	-0.590	-0.108*	-0.050	-0.434	-2.476	-0.236**	-2.340	-0.570	-0.671*	-0.632**

** Significant at 10% level*
*** Significant at 5% level*
Source: Author's calculations.

Table 6.7: Own-Price Elasticities for the OECD Countries- AIDS Model, 1961-1999

Commodity Group/	*Cereals and Pulses*				*Meats*				*Milk&Dairy Products*				*Oils*			
Country	Wheat	Maize	Rice	Pulses	Bovine	Ovine	Poultry	Pig	Milk	Cheese	Dry Milk	Butter	Olive	Soy	Sunflower	Other
Australia	-0.176**	-0.157	-1.102**	-0.482	-0.159**	-0.300**	-0.205**	-0.181	-0.310*	-0.336	-3.111**	-0.746	-0.898	-0.428	-0.222	-0.434**
Austria	-0.132**	-0.971**	-0.234**	-0.243**	-0.034	-0.146**	-0.128**	-0.434	-0.343**	-0.653*	-0.039	-0.250	-0.264**	-0.898	-0.205**	-0.396**
Belgium-Luxembourg	-0.800	-1.217*	-0.095	-1.548*	-0.010	-0.462	-0.460	-0.031	-0.232**	-0.685**	-1.140**	-0.496**	-0.382	-0.214**	-2.727	-0.325
Canada	-0.136**	0.672	-0.615*	-2.010	-0.047	-0.889*	-0.151	-0.120**	n.a.	-0.092	-0.265	-0.705	-2.106**	-0.299	-0.700**	-2.619*
Denmark	-0.275	-0.142	-1.101*	-4.488*	-0.841	-0.152	-0.445	-0.230**	-0.591**	-1.877*	-2.850	-0.726	-1.499	-0.067	-0.227	-3.149**
Finland	-0.063**	-0.405**	-0.502	-1.759	-0.730**	n.a.	n.a.	-0.197	-0.129	-0.296	-1.211	-2.657	-2.031	-2.189	-0.930	-1.122*
France	-0.609**	1.927	-0.422	-3.731**	-0.778*	-0.064**	-0.164**	-0.062	-0.257*	-0.178	-0.390	-2.272**	-0.457	-2.527*	-0.404	-0.491
Germany	-0.034	-0.737	-2.153	-3.109**	-0.092	-0.128	-0.264	-0.016	-0.424*	-0.446**	-0.646	-0.709**	-0.888	-0.057	-0.121*	-0.704**
Greece	-0.197**	-0.104*	0.166	-0.161	-0.383	-0.307*	0.810	-0.992**	-0.114	-0.137	-0.294	-0.888	-2.686**	-0.654	n.a.	-1.221*
Iceland	-0.185	-0.542	-0.161	-1.152	-0.252	-0.210	n.a.	n.a.	n.a.	-0.884**	n.a.	n.a.	-1.582	-0.052	-0.993**	-1.301**
Ireland	-0.217**	-4.187**	-0.367	-1.436**	-0.138	0.399	-0.241	-0.258	-0.104**	-0.214	0.332**	0.803**	-0.575*	-0.030	-3.345**	-1.108
Italy	-0.077	-1.036**	-4.360**	-0.324	-0.576*	-0.298	-0.188	-0.363	-0.245	-1.053**	-0.639	-1.185	-1.872	-2.464**	-0.180	-0.420
Japan	-0.101	0.504	-0.196**	0.785	-0.034	0.343	-0.011	-0.563**	n.a.	-0.709*	-1.343**	-0.193	-1.753	-0.208	-0.439**	-0.303
Korea	-0.857	-0.326	-0.787**	-1.274	-0.432	-0.711	-0.097**	-0.167	n.a.	-0.599	0.719	-0.356	-0.802	-0.104	n.a.	-0.380
Mexico	-0.729	-0.426	-1.343**	-1.119**	-0.461	-0.957	-0.220**	-0.018	-0.148	-0.249	0.326	-0.579*	-3.162	-0.364	n.a.	-2.365
Netherlands	-1.267	-1.284*	-3.107*	-2.115	-0.636	-0.807	1.221	-0.342	-0.136**	-0.129*	-2.517	-0.943	-3.488**	-1.224	-2.062	0.803*
New Zealand	-0.527	-1.040	0.500	-4.013*	-0.148*	-0.429	-0.470	-0.039	-0.595**	-3.092	-1.388	-1.168**	-0.950	-0.592	-2.674**	-0.318
Norway	-0.193	-1.734	-1.455**	-0.893*	-0.115	0.193	-0.221**	-0.197	n.a.	-0.911**	0.575	-0.693	-0.186	0.351	-0.233*	-0.663
Portugal	-0.025	0.054	-1.392**	-1.268**	-0.206	-0.305	-0.669**	-0.054*	-0.650**	-0.019	-0.809	0.009	-2.236	-1.583	1.304	0.741
Spain	-0.196**	-0.422	0.785	1.458**	-0.180	-0.303	0.117	-0.655**	-0.060**	-0.096	-1.425	-4.544**	-0.829**	-3.098	-0.586**	-0.110
Sweden	-0.321**	-0.444	-2.092**	-0.117	-0.077	-0.087	-0.489*	-0.059*	-0.183**	-0.036	-8.497**	-2.516**	-2.620**	-0.350	-0.177**	-1.714
Switzerland	-0.040	-0.551	-2.327**	-3.697**	-0.104**	-2.320**	-0.963**	-0.175**	-0.217*	-1.269**	-2.370	-0.079	-0.748*	1.513	-0.180**	-0.446
Turkey	-0.133**	n.a.	-0.557	-0.619**	-0.376	-0.338	n.a.	n.a.	n.a.	-0.083	1.247	-0.172	-3.869**	-1.301	-0.123	-0.156
UK	-0.156*	-1.548**	-0.114	-0.202*	-0.538*	-0.404	-0.123**	-0.469*	-0.150**	-2.535**	1.873	-0.784	-0.184	0.697	-0.076	-0.149
USA	-0.364	-0.331	-1.458*	0.171	-0.170*	-0.488*	-2.237	-0.148*	-0.686	-0.162	-2.083*	-0.598	-1.966	-0.079*	-0.440	-0.550*

** Significant at 10% level*
*** Significant at 5% level*
Source: Author's calculations.

Table 6.8: Own-Price Elasticities for the OECD Countries- CBS Model, 1961-1999

Commodity Group/	***Cereals and Pulses***				***Meats***				***Milk&Dairy Products***				***Oils***			
Country	Wheat	Maize	Rice	Pulses	Bovine	Ovine	Poultry	Pig	Milk	Cheese	Dry Milk	Butter	Olive	Soy	Sunflower	Other
Australia	-0.198**	-0.105**	-1.043**	-0.299**	-0.731**	-0.431**	-0.111**	-0.145**	-0.077	-0.601**	-5.680**	1.296**	-0.853	0.295	-0.953	-0.613
Austria	0.031	-0.980	-0.369**	-0.148**	-0.122	-0.086	-0.075	-0.043	-0.217	-0.745	-1.281	-0.270	-0.288**	-1.835**	-0.240**	-1.805**
Belgium-Luxembourg	-0.159	-1.505	-0.476	-2.318**	-0.084	-0.113**	-0.145**	-0.102	-0.198**	-0.786**	-2.170**	-0.787**	-0.297	-0.736	-1.332**	-0.570
Canada	-0.133**	-0.426	-0.976*	-0.652**	-0.047	-0.118*	-0.154	-0.385**	n.a.	-0.164	-0.299	-0.801*	-1.740**	0.126	-2.056	-1.270**
Denmark	-0.283	-0.567	-0.457*	-1.870	-0.796	-0.105	-0.709	-0.236**	-0.818**	-0.645**	2.077	-0.468	-2.950	0.274	-0.803**	-0.851
Finland	0.106	-1.548	-1.664	-0.325**	-0.155	n.a.	n.a.	-0.128	-0.320*	-0.130	-4.120	-0.923	-5.319	-0.784	-0.222	-0.862
France	-0.623**	-0.344	-0.762	-2.383*	-0.606*	-0.220**	-0.227**	-0.077	-0.085*	-0.363**	1.535	-0.334**	-0.554	-0.546	-0.513*	-0.540**
Germany	-0.024	-0.308	-3.513	-3.405**	-0.173	-0.124	-0.505	-0.051	-0.123*	-0.511**	-0.623	-0.273**	-2.081	-0.371	-0.276**	-1.119**
Greece	-0.231**	-0.220	0.212	-0.121	-0.229	-0.401	-0.171**	-0.078	-0.459	-0.303**	-0.530	-0.484	-2.509**	-2.052	n.a.	-2.760*
Iceland	-0.935	-0.178	-0.687	-0.633**	-0.785**	-0.407	n.a.	n.a.	n.a.	-0.320**	n.a.	n.a.	-2.987	-0.128	-1.257	-1.759
Ireland	-0.274**	-2.695**	-0.933**	-0.496**	-0.821	-0.255**	-0.072*	-0.151	-0.236**	-1.227	-0.538*	-0.712	-4.194**	-0.736**	-0.865**	-0.976**
Italy	-0.032	-0.832	-2.895**	-0.380	-0.343**	-0.331	-0.136	-0.519**	-0.108	-0.849**	-2.499*	-0.774*	-3.350	1.517**	-0.211	-0.164
Japan	-0.426	0.368	-0.489**	0.815	-0.044	0.163	-0.020	-0.275**	n.a.	-0.882**	-0.998**	-0.162	-2.035**	-0.078	-0.313*	-0.113
Korea	-0.108	-0.540	-1.037**	-1.996**	-0.829*	-0.274	-0.054*	-0.263*	n.a.	-0.752**	4.255	-1.502	-0.703**	-0.170	n.a.	-0.222
Mexico	-0.774*	-0.128*	-3.694	-0.849*	-0.811	-0.945	-0.300	-0.025	-0.718	-0.144**	-1.528	-0.312	-9.356*	-0.522	n.a.	-2.187
Netherlands	-0.240	-0.975	-4.767*	-1.545*	-0.140	-0.653	0.314	-0.404	-0.268**	-0.178**	-1.125	-0.440	-2.729	-0.445	-0.850**	0.580*
New Zealand	-0.539	-0.372	0.583	-2.397	-0.262	-0.332	-0.605**	-0.169	-0.616**	-3.327	-2.576	-1.290**	-1.525	-1.541**	-0.386	-0.841
Norway	-0.124	-1.790	-2.235**	-1.760**	-0.329	0.388	-0.399**	-0.167	n.a.	-0.557**	-3.283	-1.382	-0.546	0.089	-2.477*	-0.347
Portugal	-0.135	-0.333	-2.109*	-0.429**	-0.339	-0.870	-0.990**	-0.236*	-0.161**	-0.869	-0.577	0.073	-0.622	-0.328	-0.157**	0.658
Spain	-0.125**	-0.387	0.882*	2.437**	-0.112	-0.535	0.150	-0.478**	-0.134**	-0.343	-0.328	-1.183**	-1.617**	-3.029*	-0.306	-0.315
Sweden	-0.406**	-0.513**	-4.300**	-0.954**	-0.061	-0.484	-0.284	-0.040	-0.042	-0.172	-3.366**	-0.704	-2.420**	-0.817*	-0.453**	-1.743
Switzerland	-0.163*	-0.414	-5.949**	-2.157**	-0.630**	-2.674**	-0.356**	-0.136**	-0.062**	-1.579**	-1.544	-0.186**	-3.081	1.825	-0.140	-0.274
Turkey	-0.188**	n.a.	-0.218	-0.601**	-0.323	-0.342	n.a.	n.a.	n.a.	-0.336	5.302	-0.181	-3.371**	-0.905	-0.163	-0.091**
UK	-0.108*	-0.452*	-0.795	-1.508*	-0.407*	-0.144**	-0.132	-0.290**	-0.079**	-2.061**	-1.870	-2.229	-1.988**	-2.288	-0.226**	-0.184
USA	-0.285	-0.412	-0.726	-0.775*	-0.322*	-0.508*	-0.229*	-0.079*	-0.059	-0.124	-1.348	-0.206**	-2.238*	-0.585*	-0.126*	-0.244

** Significant at 10% level*
*** Significant at 5% level*
Source: Author's calculations.

Table 6.9: Own-Price Elasticities for the OECD Countries, 1961-1999

Commodity Group/ Country	*Cereals and Pulses*				*Meats*				*Milk&Dairy Products*				*Oils*			
	Wheat	Maize	Rice	Pulses	Bovine	Ovine	Poultry	Pig	Milk	Cheese	Dry Milk	Butter	Olive	Soy	Sunflower	Other
Australia	-0.656**	-0.899**	2.164**	0.906	-0.425**	-0.582**	-0.036	-0.098*	-0.008	-0.763**	-2.522**	0.878**	-0.467*	-0.323	0.131	-2.163**
Austria	-0.132**	-0.971**	-0.234**	-0.243**	-0.034	-0.146**	-0.128**	-0.434	-0.343**	-0.653*	-0.039	-0.250	-0.264**	-0.898	-0.205**	-0.396**
Belgium-Luxembourg	-0.392	0.358	-0.166	-0.985**	-0.013	-0.464**	-0.293**	0.081	-0.202**	-0.338**	-4.848	-2.041	-0.470	-0.524	2.054*	-0.149
Canada	-0.136**	0.672	-0.615*	-2.010	-0.047	-0.889*	-0.151	-0.120**	n.a.	-0.092	-0.265	-0.705	-2.106**	-0.299	-0.700**	-2.619*
Denmark	-0.283	-0.567	-0.457*	-1.870	-0.796	-0.105	-0.709	-0.236**	-0.818**	-0.645**	2.077	-0.468	-2.950	0.274	-0.803**	-0.851
Finland	0.106	-1.548	-1.664	-0.325**	-0.155	n.a.	n.a.	-0.128	-0.320*	-0.130	-4.120	-0.923	-5.319	-0.784	-0.222	-0.862
France	-0.623**	-0.344	-0.762	-2.383*	-0.606*	-0.220**	-0.227**	-0.077	-0.085*	-0.363**	1.535	-0.334**	-0.554	-0.546	-0.513*	-0.540**
Germany	-0.030	-0.309	-0.879	-1.012**	-0.036	-0.112	-0.091	0.061	-0.131*	-0.235**	0.772	-0.512**	-0.460*	-0.086	-0.485*	-0.267*
Greece	-0.231**	-0.220	0.212	-0.121	-0.229	-0.401	-0.171**	-0.078	-0.459	-0.303**	-0.530	-0.484	-2.509**	-2.052	n.a.	-2.760*
Iceland	-0.935	-0.178	-0.687	-0.633**	-0.785**	-0.407	n.a.	n.a.	n.a.	-0.320**	n.a.	n.a.	-2.987	-0.128	-1.257	-1.759
Ireland	-0.217**	-4.187**	-0.367	-1.436**	-0.138	0.399	-0.241	-0.258	-0.104**	-0.214	0.332**	0.803**	-0.575*	-0.030	-3.345**	-1.108
Italy	-0.032	-0.832	-2.895**	-0.380	-0.343**	-0.331	-0.136	-0.519**	-0.108	-0.849**	-2.499*	-0.774*	-3.350	1.517**	-0.211	-0.164
Japan	-0.101	0.504	-0.196**	0.785	-0.034	0.343	-0.011	-0.563**	n.a.	-0.709*	-1.343**	-0.193	-1.753	-0.208	-0.439**	-0.303
Korea	-0.108	-0.540	-1.037**	-1.996**	-0.829*	-0.274	-0.054*	-0.263*	n.a.	-0.752**	4.255	-1.502	-0.703**	-0.170	n.a.	-0.222
Mexico	-0.729	-0.426	-1.343**	-1.119**	-0.461	-0.957	-0.220**	-0.018	-0.148	-0.249	0.326	-0.579*	-3.162	-0.364	n.a.	-2.365
Netherlands	-1.267	-1.284*	-3.107*	-2.115	-0.636	-0.807	1.221	-0.342	-0.136**	-0.129*	-2.517	-0.943	-3.488**	-1.224	-2.062	0.803*
New Zealand	-0.527	-1.040	0.500	-4.013*	-0.148*	-0.429	-0.470	-0.039	-0.595**	-3.092	-1.388	-1.168**	-0.950	-0.592	-2.674**	-0.318
Norway	-0.193	-1.734	-1.455**	-0.893*	-0.115	0.193	-0.221**	-0.197	n.a.	-0.911**	0.575	-0.693	-0.186	0.351	-0.233*	-0.663
Portugal	-0.025	0.054	-1.392**	-1.268**	-0.206	-0.305	-0.669**	-0.054*	-0.650**	-0.019	-0.809	0.009	-2.236	-1.583	1.304	0.741
Spain	-0.125**	-0.387	0.882*	2.437**	-0.112	-0.535	0.150	-0.478**	-0.134**	-0.343	-0.328	-1.183**	-1.617**	-3.029*	-0.306	-0.315
Sweden	-0.321**	-0.444	-2.092**	-0.117	-0.077	-0.087	-0.489*	-0.059*	-0.183**	-0.036	-8.497**	-2.516**	-2.620**	-0.350	-0.177**	-1.714
Switzerland	-0.163*	-0.414	-5.949**	-2.157**	-0.630**	-2.674**	-0.356**	-0.136**	-0.062**	-1.579**	-1.544	-0.186**	-3.081	1.825	-0.140	-0.274
Turkey	-0.133**	n.a.	-0.557	-0.619**	-0.376	-0.338	n.a.	n.a.	n.a.	-0.083	1.247	-0.172	-3.869**	-1.301	-0.123	-0.156
UK	-0.156*	-1.548**	-0.114	-0.202*	-0.538*	-0.404	-0.123**	-0.469*	-0.150**	-2.535**	1.873	-0.784	-0.184	0.697	-0.076	-0.149
USA	-0.285	-0.412	-0.726	-0.775*	-0.322*	-0.508*	-0.229*	-0.079*	-0.059	-0.124	-1.348	-0.206**	-2.238*	-0.585*	-0.126*	-0.244

** Significant at 10% level*
*** Significant at 5% level*
Source: Author's calculations.

In the cereals and pulses category, the highest number of significant coefficients is perceived for pulses. In other words, the price effect is serious concern in the demand for pulses. However, it is not easy to draw a general conclusion about the elasticity of demand for rice. Almost half of the significant coefficients are greater than unity.

6.3.2 Meats

For the meats, the highest number of significant coefficients is found for poultry and pig meats. Ovine seems to be the least significant product. All the significant elasticities are less than unity with one exception. Demand for ovine in Switzerland is highly elastic with an estimate of -2.674. It is possible to divide the meat products into two categories in terms of own-price elasticities. First category includes bovine and ovine and second poultry and pig. As compared to others, bovine and ovine have more elastic demand. On the other hand, poultry and pig meat demand elasticities have a more uniform distribution and tend to be less elastic. In terms of the countries, there are some notable observations. Portugal has the highest elasticity figure for poultry (-0.669) whereas it has the lowest elasticity for pig meat (-0.054). Such regularity is also observed for Korea. The highest demand elasticity in bovine belongs to Korea (-0.829) yet Korea has the lowest elasticity for poultry (-0.054). Demand for pig meat is especially less elastic in Northern Europe. When one moves to southern Europe and Far East, the demand for pig becomes more elastic on average.

6.3.3 Milk and Dairy Products

In this category, there is an apparent ordering of commodities from inelastic to elastic demand. Milk is the most inelastic product followed by cheese and butter but the demand for dry milk is inelastic. This ordering is more or less same for the number of significant coefficients. The variation in the own-price elasticities is less fluctuating for milk. Another observation is that traditional milk and dairy product producers such as the Netherlands and Germany have relatively inelastic demand for these products. It is noteworthy that demand for cheese is more elastic even there are estimates close to or greater than unity (Norway, Switzerland, and UK). For dry milk 4 of the 5 significant coefficients is greater than unity. The exceptional case is Ireland (0.332) having positive own-price elasticity for dry milk. There are also some remarkable observations for butter. New Zealand, Spain, and Sweden have elastic demand for butter. Moreover, two positive coefficients (Australia and Ireland) stand for butter. The demand for butter will be clearer with the analysis for cross-price elasticities.

6.3.4 Oils

Among the agricultural products analyzed in this study, oils category is the most elastic one. The possible explanation for this issue is that oils may have close substitutes. This point will be investigated in detail in the next section. Another outstanding element of the demand for oils is that the elasticities have the highest variability among the countries.

Only 4 out of 12 significant coefficients for olive oil have a value less than unity. Therefore, it may be concluded that the demand for olive oil is elastic. Especially, traditional olive oil producers (Spain, Greece, and Turkey) have high elasticity values. For the soy oil, the price effect is negligible. The consumption of soy oil is, in fact, very much related with the habits. There are just 3 significant coefficients for this case. The most inelastic demand in this category belongs to sunflower oil. Only 2 (Ireland and New Zealand) out of 12 significant own-price elasticity estimates are greater than unity. There is a uniform distribution of elasticities to some extent except these two cases. For other oils, almost half of the significant coefficients (Australia, Canada, and Greece) present an elastic demand for these products.

6.4 Cross-Price Elasticities

The prices of the products in the same commodity group and one from the other groups were inserted into the equations in estimating demand systems presented by (6.1) through (6.3), for each product. According to a previous study on world food model (Kasnakoğlu et al, 2000), the best related products are determined for each group. By using various statistical techniques, this study verifies that cheese seems to be best candidate for being either a substitute or a complement for cereals and pulses and for meats. Wheat performs better than others for milk and dairy products. Finally, butter is the best choice for oils.

The current study uses these products for individual equations for the current data set since the data set employed by Kasnakoğlu et al (2000) is also a FAOSTAT data set and covering higher number of countries. Therefore, in the demand functions for a given product, price of that product and the prices of all other products in the same group are included as explanatory variables. From the other groups main or representative products are chosen as a result of their relative performance in the estimations and the prices of those products are included in the models. The detailed results on cross-price elasticities and the coefficients for the countries in the data set for three models are presented in the Appendix E.

Table 6.10 is a summary table showing the number of significant coefficients and their signs for each product. The positive signs indicate that the product is a substitute and the negative signs stand for being a complement.

Table 6.10: Number of Substitutes and Complements for Agricultural Products in the OECD Countries, 1961-1999

Commodity	***Cereals and Pulses***				***Meats***				***Milk&Dairy Products***				***Oils***			
Group	Wheat	Maize	Rice	Pulses	Bovine	Ovine	Poultry	Pig	Milk	Cheese	Dry Milk	Butter	Olive Oil	Soy Oil	Sunflower Oil	Other Oil
Wheat	-	2(+),3(-)	8(+),2(-)	1(-)	-	-	-	-	-	3(+),4(-)	-	-	-	-	-	-
Maize	8(+),1(-)	-	6(+),1(-)	6(+),1(-)	-	-	-	-	-	2(+),2(-)	-	-	-	-	-	-
Rice	8(+),2(-)	5(+),3(-)	-	7(+)	-	-	-	-	-	3(+),7(-)	-	-	-	-	-	-
Pulses	6(+),2(-)	6(+)	12(+), 1(-)	-	-	-	-	-	-	4(+),6(-)	-	-	-	-	-	-
Bovine	-	-	-	-	-	5(+),3(-)	6(+)	6(+),1(-)	-	5(+),3(-)	-	-	-	-	-	-
Ovine	-	-	-	-	9(+)	-	7(+)	7(+),4(-)	-	8(+),2(-)	-	-	-	-	-	-
Poultry	-	-	-	-	11(+)	9(+),1(-)	-	4(+),3(-)	-	2(+),6(-)	-	-	-	-	-	-
Pig	-	-	-	-	8(+),2(-)	7(+),5(-)	7(+),1(-)	-	-	4(+),1(-)	-	-	-	-	-	-
Milk	3(+),8(-)	-	-	-	-	-	-	-	-	7(+),1(-)	4(+),1(-)	8(+)	-	-	-	-
Cheese	5(+),8(-)	-	-	-	-	-	-	-	9(+),1(-)	-	6(+)	4(+),1(-)	-	-	-	-
Dry Milk	3(+),3(-)	-	-	-	-	-	-	-	4(+),2(-)	7(+),1(-)	-	4(+),4(-)	-	-	-	-
Butter	2(-)	-	-	-	-	-	-	-	8(+),2(-)	7(+),1(-)	9(+),2(-)	-	-	-	-	-
Olive Oil	-	-	-	-	-	-	-	-	-	-	-	4(+),3(-)	-	5(+),1(-)	3(+)	7(+),6(-)
Soy Oil	-	-	-	-	-	-	-	-	-	-	-	4(+),2(-)	5(+)	-	7(+)	2(+),3(-)
Sunflower Oil	-	-	-	-	-	-	-	-	-	-	-	3(+),6(-)	6(+),2(-)	9(+),1(-)	-	6(+),4(-)
Other Oil	-	-	-	-	-	-	-	-	-	-	-	6(-)	3(+),4(-)	7(+),5(-)	8(+),1(-)	-

Source: Author's calculations.

6.4.1 Cereals and Pulses

For this category, significant substitutability relations are detected. Rice is a substitute for wheat in 8 countries. Only in 2 countries, maize is considered as a substitute for wheat. There are some cases in which complementarity relation between wheat and maize and rice exist. In the case of maize, wheat is found as a substitute for 8 countries. Rice and pulses are significant substitutes for maize in six cases. The most significant relation is between pulses and rice. For 12 countries rice is a substitute for pulses. As an out-category product, cheese is generally complement for the cereals and pulses.

6.4.2 Meats

The number of cross-price with significant coefficients is higher in the case of meats. Moreover, the number of significant complementarity relations is also high for meats. Ovine, poultry, and pig are found as significant substitutes for bovine in 5, 6, and 6 countries respectively. For 3 countries ovine is considered as a complement for bovine. Bovine is a substitute for ovine in 9 countries followed by poultry and pig with 7 significant cases. The highest number of significant coefficients is found for poultry. In conformity with our previous discussion of rising health concerns, there is a strong substitution relation between poultry and other types of meats. Moreover, the mad cow disease fact in 1990s may also be relevant to produce such a relation. For pig meat, the most interesting result is the existence of a complementarity relation with ovine. Cheese seems to be substitute for ovine, bovine, and pig meats yet it is a complement for poultry meat.

6.4.3 Milk and Dairy Products

The highest number of significant coefficients among the products investigated in this study is found for this category. Cheese and butter seems to be important substitutes for milk. Some sort of a complementarity relation exists between dry milk and butter. Finally, the maximum number of significant coefficients with positive signs resulted in the case of butter. Milk is a substitute for butter in 8 countries. The respective figures for cheese and dry milk are 7 and 9. Finally, wheat is a significant complement both for cheese and milk with 8 significant negative coefficients.

6.4.4 Oils

There are significant relations in both directions in the oils category. For some countries other oils are both substitute and complement of the olive oil. The possible reason of such behaviour may be related with the composite character of other oils category. For 7 cases other oils is a substitute for olive oil while for 6 countries the relation is in the opposite direction. Sunflower oil is a substitute for soy oil in 7 countries and for other oils in 8 cases. Olive oil and other oils seem to be substitutes for sunflower oil in 6 countries. The case of butter as an out-category product appears to be somewhat ambiguous especially in the cases of both olive and soy oils. However, it has a tendency of being complement for sunflower and other oils. With the analysis of oils, the demand for butter becomes clear, that it has tend to have negative income elasticity, generally insignificant own-price elasticities, even for some cases with positive and significant price elasticity, and it cannot be definitely treated as a substitute or complement for other types of oils. Therefore, butter presents a distinguished behavior that needs further analysis.

6.5 Concluding Remarks

This chapter provides insights about the numerical values of both income and price elasticities. The first point of departure was to select which model explains the demand relation better. According to a well-developed model-selection procedure by Amemiya (1985), AIDS performs better than both Rotterdam and CBS. However, the number of significant likelihood ratio test results for model selection points out that the difference between AIDS and CBS is not obvious. Therefore, it is possible to conclude that both AIDS and CBS perform better than Rotterdam. This result is not surprising one in the view of the theoretical discussion of previous chapters since both AIDS and CBS appears to be more refined models.

The test results produce notable number of significant income elasticities. The income elasticities for cereals and pulses introduce a two-layer segmented structure. The composition obtained for wheat and maize is different from the one for rice and pulses. The income elasticities for rice and pulses are generally higher than that of wheat and maize and close to or more than unity. The meats generally have low figures of income elasticity. In terms of the income effect, the consumption of poultry and pig meats appears to be similar. There is a more differentiated structure for bovine and ovine. However, all of the significant coefficients are less than one. The income elasticities for milk and dairy products fluctuate more than any other commodity group. The degree of variation is especially higher for dry milk and butter in which the income elasticities are higher than milk and cheese and even greater than unity. For the oils, the highest coefficients of income elasticity are obtained for olive oil. The rest of the products in this category present a more or less similar relation between quantity demanded and income. In sum, with few exceptions, such as rice, pulses, dry milk and olive oil, all the products in our study seem to be normal goods.

Relatively low level of significant coefficients for own-price elasticities makes the income effect more profound than price effect. In the cereals and pulses category, wheat is the least elastic product. Rice and pulses have a more inelastic demand. The meats category can be divided into two-sub categories according to the own-price elasticities; bovine-ovine, and poultry-pig, the demand for the former group being more elastic. The elasticities for milk and dairy products indicate that milk is the least elastic product in this category and the demand for dry milk tends to be inelastic. The substantial result provided by the demand elasticities of oils is that oils category, in general, has the highest own-price elasticities and the largest variability among the products investigated in this study. Olive oil and other oils have more elastic demand than soy and sunflower oils.

The calculated cross-price elasticities displayed significant relations. Among the cereals and pulses, the most significant relations as being substitutes are found for between rice and wheat and rice and pulses. In the meat category, the highest number of significant coefficients is retrieved for poultry. A strong substitution relation is discovered between poultry and other types of meats. For the milk and dairy products, butter has close substitutes than any other product in this category. The oils category demonstrates the most differentiated structure. The relation between demand and prices are significant in both directions that verify the presumption of relevancy of habits in the demand for oils.

Finally, it can be concluded that our procedures to estimate demand systems point out high number of significant relations. However, there are still unearthed factors in the demand relations, such as habit formation, that cannot be captured by this study because of the unavailability of the data for such a number of commodities and countries.

CHAPTER 7

SUMMARY AND CONCLUSIONS

The fundamental nature of the demand systems methodology is based on providing empirical demand analysis that is able to cope with the interdependence of demand among several commodities in a theoretically consistent way. In this respect, it should set a link between the theory of consumer demand and the empirical work. In this study, three models are chosen to reinstate the association between the theory and empirical study, namely the Rotterdam, AIDS, and CBS models. However, all of these models are contrived on the presuppositions of well-known LES model. Against their popularity in the empirical literature, especially before the invention of Rotterdam and other models, the LES model suffers from various deficiencies. First of all, the model does not satisfy the theoretical restrictions. More importantly, it has problems related with the parametrization of LES in which income elasticity is inversely related with the corresponding budget share such as food becomes less of a necessity or more of a luxury with increasing income. All these disadvantages make the model questionable.

The introduction of the Rotterdam model to the agricultural economics literature makes this model a prevalent choice in empirical applications due to its various advantages compared to LES. The Rotterdam model can be used to test the validity of the general restrictions of demand theory. In addition, the model is easy to estimate since the model is linear in the parameters. However, the model still suffers from doubtful behavior of income elasticities as in the case of LES. What is more serious is that the model does not show an evidence of good fit for large systems.

The AIDS model originated in the 1980s, and it became popular in the 1990s. While the Rotterdam and AIDS models appear to be very similar, they lead to different results in some applications. Nevertheless, AIDS has various theoretical and empirical advantages. First, not only the cost function can be considered as a local second-order approximation to the basic cost function, but also the budget share equations have sufficient parameters to be treated as a local first-order approximation to any demand system different from the Rotterdam model. Second, AIDS is a proper tool for testing theory-oriented restrictions. The final advantage of AIDS is the simplicity of estimation.

The CBS model satisfies all the aforementioned restrictions and theoretically it is a well–formed model. It has the same advantages over the Rotterdam model as in the case of AIDS. The major superiority of the CBS model over the AIDS model is the opportunity to impose concavity directly on the matrix of Slutsky coefficients.

As presented by chapter III, the empirical literature is definitely dominated by the applications of the Rotterdam and AIDS models. Another significant inference from the empirics of the demand system is the existence of an extremely sizable literature on US markets. There is a small number of studies on the Europe and on other geographical regions. The main explanation of such bias towards US markets is the availability of the necessary data. Besides, the existence of non-market forces and protectionist restraints makes the application of these models very problematical. The cross-country studies are also few in numbers and the existing studies usually employ more straightforward models like LES, since estimating the Rotterdam and AIDS model becomes complicated and tiresome with large number of commodities and countries. The findings of the empirical applications are dubious on the supremacy of the Rotterdam or AIDS models. The present study prefers to apply the Rotterdam and AIDS models to the OECD data with regard to these findings. Moreover, a rather new model called CBS is also used to estimate demand parameters because of the desirable properties of this model as discussed previously.

The data of this study belongs to OECD countries where those countries as a whole are significant producers of agricultural commodities. The commodity groups include four main category; cereals and pulses, meats, milk and dairy products, and oils. Each group has four individual products. For the production of cereals and pulses, more or less similar fluctuations are observed in the OECD countries on average. However, the fluctuations for maize, rice and pulses are more parallel to each other. The most significant observation is that the production of cereals and pulses became more instable and the frequency of the cycles lessened especially for maize, rice, and pulses during 1990's. Wheat production seems to be more stable in this period. The international trade data show a dissimilar structure for the pulses. For both exports and imports, wheat and maize present comparable trends. The meat production reveals two different groups: poultry and pig, bovine and ovine. Poultry and pig meat production have an upward-sloping straight line with very rare fluctuations, former being more stable. Bovine and ovine meat production follows a smoother path. The trade data for ovine show a different form as compared to other types of meats. The production levels of the milk and dairy products follow closely the same path. The trade data point out a rising rate of specialization of OECD area in the production of cheese. Dry milk and butter demonstrate almost parallel changes in the volume of trade. The most diversified structure of production is noticed for the oil category. Olive exhibits a stable structure because of some sort of monopoly of OECD countries. Soy and sunflower oils present similar trends. Although other oils category seems to be similar with soy and sunflower oils, the production level is less fluctuating as compared to the other categories. Other oils have higher yet a less stable volume of trade. Finally, soy oil fluctuates more than the rest of the oil category.

In this study, three models, specifically Rotterdam, AIDS, and CBS are outlined in detail. Moreover, the econometrics of demand systems is discussed. It is concluded that it is better to estimate these models by SUR. Nevertheless, there are specific data problems. Some of these problems are solved by FAO and the rest of the problems are corrected by this study. Unfortunately, there are still some unsettled data issues that cause us to drop some commodities from the estimations. Against all odds of the data, the study employs comprehensive models and an ample data set as compared to the previous studies.

The estimation results show significant regularities. As a main contribution, this study proposes a test procedure in order to compare the relative performance of models under investigation. The results favour the AIDS model. Nonetheless, the number of significant tests results points out that the difference between AIDS and CBS is not clear-cut. This conclusion is not unexpected since both AIDS and CBS appears to be more refined models compared to Rotterdam.

The outcomes of the tests generate remarkable number of significant income elasticities. The income elasticities for cereals and pulses bring a two-layer segmented structure. The composition obtained for wheat and maize is different from the one for rice and pulses. The income elasticities for rice and pulses are generally higher than that of wheat and maize and close to or more than unity. The meats generally have low figures of income elasticity. In terms of the income effect, the consumption of poultry and pig meats appears to be similar. There is a more differentiated structure for bovine and ovine. However, all of the significant coefficients are less than one. The income elasticities for milk and dairy products fluctuate more than any other commodity group. The degree of variation is especially higher for dry milk and butter in which the income elasticities are higher than milk and cheese and even greater than unity. For the oils, the highest coefficients of income elasticity are obtained for olive oil. The rest of the products in this category present a more or less identical relation between quantity demanded and income. In sum, with few exceptions, such as rice, pulses, dry milk and olive oil, all the products in our study seem to be normal goods. Relatively low number of significant coefficients for own-price elasticities makes the income effect more profound than price effect. In the cereals and pulses category, wheat is the least elastic product. Rice and pulses have a more inelastic demand. The meats category can be divided into two-sub categories according to the own-price elasticities; bovine-ovine, and poultry-pig, the demand for the former group being more elastic. The elasticities for milk and dairy products suggest that milk is the least elastic product in this category and the demand for dry milk tends to be inelastic. The substantial result presented by the demand elasticities of oils is that oils category, in general, has the highest own-price elasticities and the largest variability among the products investigated in this study. Olive oil and other oils have more elastic demand than soy and sunflower oils. From the calculated cross-price elasticities, the significant relations are encountered. Among the cereals and pulses, the most significant relations as being substitutes are found for between rice and wheat and rice and pulses. In the meat category, the highest number of significant coefficients is retrieved for poultry. A strong substitution relation is discovered between poultry and other types of meats. For the milk and dairy products, butter has close substitutes than any other product in this category. The oils category demonstrates the most differentiated structure. The relation between demand and prices are significant in both directions. Such a finding verifies our presumption of relevancy of habits in the demand for oils.

In sum, it can be concluded that our procedures to estimate demand systems suggest significant demand relations for OECD countries. There may still be unexplored factors in the demand relations, such as habit formation, that cannot be captured by this study because of the unavailability of the data for such a number of commodities and countries. In an attempt to search for prospective studies, the main theme might be to explore the dynamics of the demand relation, such as habit formation. For studying such relations, country-specific models with a larger data set may be the best way to deal with the issue. Moreover, there is a need for a comparison of models allowing nonlinearity in coefficients, like non-linear AIDS.

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APPENDICES

Appendix A: Production Levels of Agricultural Products in the OECD Countries, 1961-2000

Appendix B: Trade Levels of Agricultural Products in the OECD Countries, 1961-1999

Appendix C: Parameter Estimates for Agricultural Products in the OECD Countries, 1961-1999

Key for Variables' Abbreviations

P	Price
I	Expenditure (budget) share
B	Bovine meat
O	Ovine meat
P	Poultry meat
G	Pig meat
M	Milk
C	Cheese
D	Dry milk
U	Butter
W	Wheat
Z	Maize
R	Rice
L	Pulses
V	Olive oil
Y	Soy oil
F	Sunflower Oil
T	Other oils

Appendix D: Cross-Price Elasticities for Agricultural Products in the OECD Countries, 1961-1999

APPENDIX E: Turkish Summary (Türkçe Özet)

Tüketici talebi teorisi uzun yıllardır iktisat biliminin ana ilgi alanlarından biri olmuş ve modern iktisat teorisi de anlamlı sayılabilecek bir süredir tüketici talebi konusuyla ilgilenmektedir. Bu çerçevede, klasik tüketici talebi teorisi ekonometrik uygulamaların önemli bir ölçüde yer aldığı alanlardan biri olmuştur ve bu tür uygulamalar da bu çalışmayı şekillendirmiştir. Bu tezin amacı literatürde yaygın olarak kullanılan talep modellerinin göreli başarılarının karşılaştırılmasıdır. Bu bağlamda, çalışmanın temel katkısı Rotterdam, AIDS (İdeale Yakın Talep Sistemi) ve CBS (Hollanda Merkezi Planlama Bürosu Modeli) modellerinin OECD ülkeleri verisi kullanılarak yapılan uygulamasında, bu üç modelin karşılaştırılması için bir test yöntemini kullanmasıdır. Ancak, tüm bunların sonucunda amaçlanan politika önermeleri sunmak değil hangi modelin politika üretmek amaçlı kullanalabileceğini göstermektir.

Talep sistemlerinin tahmin edilmesinde iki farklı yaklaşım sözkonusudur. Klasik yaklaşım tek bir piyasa mekanizması içinde yer alan belirli bir mala olan talebin temel özellikleri üzerinde yoğunlaşmaktadır. 1950'li yıllardan itibaren gelişmeye başlayan ikinci yaklaşımsa tüketiciler tarafından her türlü mala yapılan talebin bir sistem çerçevesinde modellendiği talep denklemlerinin tahmini ile uğraşmaktadır. Bu çalışma ikinci yaklaşımın geleneğini izlemektedir.

Çalışmadaki talep çözümlemesi faydasını azami hale getiren bireylere ilişkin teori ile talep sistemelerinin tahmin edilmesinin biraraya getirilmesinden oluşmaktadır. Nihai amaç tüketim kalıplarındaki ampirik düzenliliklerin ortaya konulmasıdır. Başka bir deyişle, talep çözümlemesindeki sistem yaklaşımı toplam özel tüketimi oluşturan mallara ait harcama ya da tüketim hacminin bütünleşik olarak incelenmesidir. Talep çözümlemesindeki sistem yaklaşımı toplam harcamaların farklı mallardan oluşan bir küme elemanlarına dağıtılma sorunu ile ilgilenmektedir. Talep sistemi çalışmaları herhangi bir veri zaman diliminde ne kadar harcanacağını karar verilmiş olduğunun belirlendiğini varsaymakta ve daha çok bu mallara yapılan harcamanın paylaşımı üzerine yoğunlaşmaktadır.

Artan sayıdaki sistem çalışmaları teorik ve uygulamalı alanlarda bu yaklaşımın avantajlarının doğal bir sonucudur. Bir mala olan talep teoride diğer tüm malların fiyatlarına bağlı olmakla birlikte uygulmadaki veri sorunları tüm fiyatları talep denklemine koymayı imkansız kılmaktadır. Tek denklemli modellemelerde açıklayıcı değişkenler genellikle malın kendi fiyatı, kısıtlı sayıdaki ikame ve birlikte kullanılan malların fiyatları ve gelir ya da toplam harcama ile sınırlı kalmaktadır.

Sistem yaklşımının ise daha güvenilir teorik temelleri vardır. Sistem modellemesinde yer alan her denklem açıklayıcı değişken olarak tüm malların fiyatlarını ve geliri içermektedir. Bu tip sistemlerin kısıtsız olarak tahmin edilmesi tek bir talep denkleminin tahmin edilmesinde olduğu gibi pratik bir yaklaşım değildir. Bununla birlikte tüketici davranışları teorisi sistem denklemlerinin kavramsal olarak sağlaması gereken bir kısıtlar listesi sunmakatdır. Bu kısıtların yarattığı baskı tahmin edilmesi gereken bağımsız fiyat ve gelir katsayılarının miktarını önemli ölçüde azaltmaktadır. Bunun ötesinde bu tip kısıtların sistem tarafından içerilmesi tahmin yönteminin etkinliğini arttırmakta ve daha güvenilir katsayı tahminlerinin yapılmasını sağlamaktadır. Bu bağlamda en önemli nokta kısıtların çoğunun denklemler arası kısıtlar olmasıdır. Başka bir deyişle bu kısıtlar birden fazla denklemin parametrelerini içermektedir. Bu nedenle her bir denklemin ayrı olarak tahmin edildiği bir durumda bu kısıtların içerilmesi mümkün değildir. Sonuçta, tahmin edilen talep denklemleri sistemi tek denklemli modellerle karşılaştırıldığında sistemdeki her bir denklem için daha iyi tahminler üretmektedir.

Talep sistemleri metodolojisinin doğası, teorik olarak tutarlı bir şekilde birbirine bağlı bir çok mala olan talebin ampirik talep çözümlemesinin yapılabilmesine dayalıdır. Bu bağlamda tüketici talebi teorisi ile ampirik çalışma arasında bir bağ kurulmalıdır. Bu çalışmada sözü edilen ilişkiyi ortaya çıkarmak için Rotterdam, AIDS ve CBS modelleri kullanılmıştır. Aslında bu üç model de çok bilinen LES (Doğrusal Harcama Sistemi) modelinin başlangıç varsayımlarını kullanmaktadır. LES modeli, Rotterdam ve diğer modellerin ortaya konulmasından önce ampirik uygulamalarda yoğun bir şekilde kullanılmasına rağmen pek çok sorunu olan bir modeldir. Herşeyden önce LES modeli teorik kıstları sağlamamaktadır. Bundan daha önemli sorunsa LES modelinin parametrizasyonu ile ilgilidir. Burada her bir gelir esnekliğine karşılık gelen bütçe payı ters orantılıdır. Bu durumda örneğin artan gelirle gıda mallarının zorunlu mal olmaktan çıkıp lüks tüketim malı olmasına neden olmaktadır. LES modelinin bu tip olumsuzlukları modelin ciddi anlamda sorgulanmasına yol açmaktadır.

Barten (1964) Rotterdam modelini henüz esnek fonksiyonel formlar ve dualite teorisi ortaya çıkmadan önce önermiştir. Bu bağlamda Rotterdam modeli teorik literatüre önemli bir katkı sağlamıştır. Rotterdam modelinin tarımsal iktisat literatürüne girmesi bu modeli ampirik uygulamalarda çeşitli avantajları nedeniyle tercih edilen bir model haline getirmiştir. Rotterdam modeli talep teorisindeki genel kısıtların geçerliliğini test etmek için kolaylıkla kullanılabilmektedir. Rotterdam modeli diğer esnek fonksiyonel formlar kadar esnek bir yapıya sahiptir. Buna ek olarak, model katsayıları açısından doğrusal olduğu için tahmin edilmesi kolay bir modeldir. Ancak, Rotterdam modelinde de LES modelinde olduğu gibi gelir esnekliklerinin şüpheli davranışı sorunu görülmektedir. Bunun ötesinde modelin büyük sistemler için tatmin edici düzeyde bir tahmin başarısı göstermemesi daha ciddi bir sorundur.

1980'li yıllarda ilk olarak Deaton ve Muellbauer (1980) tarafından ortaya atılan AIDS modeli 1990'lı yıllarda oldukça yaygın olarak kullanılmaya başlanmıştır. AIDS günümüzde de farklı varsayımlar altında en yaygın olarak kullanılan modellerden biridir. Rotterdam ve AIDS modelleri birbirine çok benzer modellermiş gibi gözükmelerine rağmen çoğu uygulamada farklı sonuçlar üretmektedirler. Bununla birlikte AIDS modelinin çeşitli teorik ve ampirik üstünlükleri vardır. Birincisi, Rotterdam modelinden farklı olarak sadece maliyet fonksiyonu temel maliyet fonksiyonuna ikinci dereceden bir yakınsama sağlamakla kalmayıp bunun yanında bütçe payı denklemlerinin de herhangi bir talep sistemine birinci derece yakınsama sağlayacak düzeyde ve yeterli sayıda parametresi bulunmaktadır. İkincisi, AIDS modeli teori bazlı kısıtları sınamak için uygun bir araçtır. Uygulamalarda genelde doğrusal AIDS (LA/AIDS) yakınsanmış şekli kullanılmaktadır. Doğrusal modellerde ideale yakın fiyat endeksi yerine genelde Stone fiyat endeksi kullanılmaktadır. AIDS'in bu yakınsanmış hali de doğrusal olmayan modelin anlamlı bir uzantısıdır. Son avantajı ise, AIDS modelinin kolay tahmin edilebilir olmasıdır. AIDS modelinin ana sorunu içbükeylik kısıtlarının Slutsky katsayıları ile ilişkileri nedeniyle parametre matrisinde kolaylıkla gösterilememesidir.

CBS modeli daha önce sözü edilen tüm kısıtları sağlayan ve teorik olarak iyi şekillendirilmiş bir modeldir. AIDS modelinin Rotterdam modeli üzerindeki tüm üstünlüklerine sahiptir. CBS modelinin AIDS modeli üzerindeki temel üstünlüğü ise

Slutsky katsayıları matrisi üzerine içbükeylik kısıtlarını koyabilmeye olanak vermesidir. AIDS modelinin bu sorunu Keller ve van Driel tarafından (1982, 1985) çözülmüştür. CBS modeli aslında PIGLOG Engel eğrisini Slutsky matrisinin basitliği ile birleştirmiş, bunu yaparken de içbükeylik ve diğer kısıtların yorumlanabilmesini sağlamıştır. Başka bir deyişle, CBS modeli uygun ve esnek bir Engel eğrisi modeli ile fiyat etkilerinin tahmin edilmiş fiyat katsayıları matrisini biraraya getirerek, modelin doğrudan yorumlanabilmesine olanak vermiştir. Tahminler tüketici talebi teorisinin tüm kıstlarını karşılamakta ve kolayca elde edilebilmektedir. Sonuç olarak, CBS modeli esnek ve uygun Engel eğrilerini tahmin edilmiş fiyat katsayıları matrisine basit kısıtlar koyarak üretmektedir.

Bu üç model pek çok açıdan benzerdir. Üçü de ikinci dereceden esnek fonksiyonel formlardır; eşdeğer veri gereksinimleri vardır; parametre sayıları itibarıyla kolaylık sağlamaktadırlar; ve parametreleri açısından doğrusaldırlar. Sözü edilen üstünlükleri nedeniyle bu modeller uygulamalarda diğer modellerden daha çok tercih edilmektedirler. İktisat teorisi gerçekte bu üç model arasında önsel (ex ante) bir tercih ortaya koymamakta ve sonsal (ex post) farklılıklar için de modelin talep yasasına uymaması ya da başka kuvvetli öncül bir inanış gibi kısıtlı karşılaştırma noktaları önermektedir. Basit olarak tahmin yeteneğini ölçen ölçütler de modellerdeki bağımsız değişlenlerin farklı olması nedeniyle çalışmamaktadır. Uygulamalı çalışmalarda sadece bir tek fonksiyonel form tahmin edilmekte böylece de modeller arasındaki seçim önceden daha keyfi bir şekilde yapılmaktadır. Bu çalışmada teorik üstünlükleri nedeniyle bu üç modelden de faydalanılmış ve detaylı bir model seçme yöntemi uygulanmıştır. Model seçilmesi için bu üç modeli de belli kısıtlar altında içeren yuvalanmış bir model tahmin edilmiş ve ilgili hipotez sınamaları yapılarak hangi modelin uygulamada daha iyi çalıştığı saptanmıştır. Bu bağlamda, çalışma tahmin edilen model sayısı, ürün sayısı, ülke sayısı ve en önemlisi önerilen model seçme aracı yönünden özgündür.

Fayda teorisinin ilkeleri ekonometrik talep modellerine kolaylıkla uygulanabilmektedir. Fonksiyonel formun seçimi ile ilgili kısıtlar ya da parametre kısıtları ekonometrik modelleri bireysel fayda maksimizasyonu teorisinin varsayımları ile uygun hale getirebilmek için önerilmektedir. Talep sistemlerinin tahminine yönelik birikimler gerek teorik gerekse uygulamalı çalışmalar sonucunda yeterli düzeye ulaşmıştır. Ancak talebi çözümlemeye çalışan her çalışma tüketici sunulan sonsuz sayıdaki mal ve hizmetin neden olduğu sorunlarla karşılaşmaktadır. Bir çok denklemden oluşan bir talep sistemini incelemek için önemli büyüklükte bir veri setine ihtiyaç vardır. Tahmin yönteminin seçilmesinin yanında en iyi tahmin üreten modelin de tanımlanması önemli bir sorundur. Literatürde üç tip tahmin yönteminin olduğu görülmektedir; tenk denklemli yöntemler, kısıtlı bilgi sistemi (Limited Information System) ve tam bilgi sistemi (Full Information System). Aslında, denklemler arası kısıtlar olmadığı durumlarda tek denklemli yöntemlerle kısıtlı bilgi sistemleri aynı sonuçları vermektedir. Bu çalışma bir tam bilgi sistemi üzerine yoğunlaşmıştır. Burada varolan tahmin yöntemleri incelediğinde, literatürde tahmin sorununun çözüldüğüne ilişkin bir izlenim edinilmiştir, çünkü çalışmaların çoğunda SUR (Görünüşte İlişkisiz Regresyon) yöntemi kullanılmaktadır. Aslında ISUR (Tekrarlamalı Görünüşte İlişkisiz Regresyon) yöntemi daha iyi bir seçenek olarak gözükse de, çalışmada kullanılan veri kümesi bu tahmini yapmak için yeterli değildir. Bunun yanında, parametrelerin doğrusal olmadığı durumlarda ML (En çok Olabilirlik) yöntemi özellikle geniş veri setleri için oldukça iyi sonuçlar üretmektedir. Bu çalışmada göreli üstünlüklerinden ve birtakım veri kısıtlamaları nedeniyle SUR yöntemi tercih edilmiştir. Denklemlerin sağ tarafındaki değişkenler aynı olduğu için ve Barten (1969)'da da belirtildiği üzere gözlem sayısı mal sayısının bir fazlasından daha çok olduğu için ML ve OLS (En Küçük Kareler) yöntemleri aynı sonuçları vermektedir. Başka bir deyişle, ML ve OLS yöntemlerinin belirli durumlarda benzer sonuçlar verdiği görülmüştür. Bu nedenlerden dolayı çalışmada kullanılan sistemler SUR modeli için OLS yöntemi kullanılarak tahmin edilmiştir.

Bu çalışmanın 3. bölümünde de görüldüğü üzere, ampirik literatürde Rotterdam ve AIDS modellerinin uygulamaları oldukça fazladır. Talep sistemlerinin ampirik literatüründe gözlenen bir diğer durumsa, A.B.D. piyasaları üzerine olan çalışmaların sayıca fazla olmasıdır. Avrupa ve diğer coğrafi bölgeler üzerine olan çalışmaların sayısı oldukça kısıtlıdır. A.B.D. piyasalarına ilişkin böylesi bir eğilimin temel açıklaması gerekli verinin sağlanabilir olması ile ilgilidir. Bunun yanında piyasa dışı güçlerin varlığı ve korumacı baskılar talep sistemi modellerinin tahmininde sorun yaratmaktadır. Ülkeler arası çalışmalar sayıca az olmasının yanında LES gibi daha basit modelleri kullanmaktadır. Bunun ana nedeni de Rotterdam ve AIDS gibi modellerin tahmini ülke ve ürün sayısı arttıkça zorlaşmaktadır. Ampirik uygulamaların sonuçlarına bakıldığında, Rotterdam veya AIDS modellerinin göreli üstünlükleri açısından şüpheli sonuçlara rastlanmaktadır. Ampirik literartürden elde edilen sonuçlar ışığında, bu çalışma her iki modeli de OECD verisine uygulamayı tercih etmiştir. Bunun yanında, görece daha yeni bir model olan CBS modeli de daha önce bahsedilen teorik üstünlükleri nedeniyle talep parametrelerini tahmin etmek için kullanılmıştır.

Çoğu uygulamada çalışmalar dar bir çerçevede tanımlanmış mal grupları itibarıyla talebin gelir ve fiyat duyarlılığını saptamaya yönelmiştir. Bu çalışmanın ilgi alanı ise mümkün olduğu ölçülerde geniş toplamları kullanarak tüm piyasanın detaylı bir çözümlemesini yapmaktır. Nihai hedefse farklı OECD üyesi ülkelerdeki tüketim kalıplarında gözlenebilecek ampirik düzenlilikleri ortaya koymak ve bunları hangi modelin açıkladığını saptamaktır. Tüketim verisinin çözümlenmesindeki en ciddi sorun bu verinin farklı para birimleri kullanılarak toparlanmış olmasıdır. Ancak çalışmada kullanılan veri uluslararası fiyatları gözönüne alarak bu sorunun üstesinden gelmiştir. İkinci bir sorunsa, çok sayıda mal için ülkelerarası bir talep denklemleri sisteminin oluşturulmasıdır. Doğal olarak böylesi bir sistemin tüketim alışkanlıkları farklılıklarından dolayı uygulanabilirliği sorgulanabilir. Ancak, çalışma bu farklılıkları yansıtabilmek için mümkün olduğu kadar fazla sayıda mal veya mal grubunu içermektedir. Tüm bu çabalara karşın alışkanlıkların oluşmasıyla ilgili bir dinamik çözümlemeye ihtiyaç vardır.

Bu çalışmada kullanılan veri toplam olarak önemli bir tarımsal üretici konumunda bulunan OECD üyesi ülkelerin verisidir. Veri, FAO (Birleşmiş Milletler Gıda ve Tarım Örgütü) tarafından yayınlanan FAOSTAT2001 veri bankasından alınmıştır. Tüm çabalara rağmen birtakım değişkenlerde ve ülkelerde veri sorunlarıyla karşılaşılmıştır. Bu sorunların bir kısmı FAO tarafından bir kısmı da çalışmanın ilerleyen aşamalarında düzeltilmiştir. Ancak hala çözülemeyen veri sorunları kalmış, bu sorunlarda bazı denklemlerden belirli malların atılmasına neden olmuştur. Tüm bu olumsuzluklara rağmen, çalışma diğer çalışmalarla karşılaştırıldığında oldukça geniş ve gelişkin bir veri kümesi kullanmıştır. Kullanılan mal grupları her biri dört farklı malı içeren dört ana başlığı içermektedir; tahıl ve baklagiller, etler, süt ve süt ürünleri ve yağlar. Tahıl ve baklagiller buğday, mısır, pirinç ve baklagilleri; etler büyükbaş, küçükbaş, kümes hayvanları ve domuz etini; süt ve süt ürünleri süt, peynir, süt tozu ve tereyağını; yağlar ise zeytinyağı, soya yağı, ayçiçek yağı ve diğer yağları kapsamaktadır. Tahıl ve baklagiller mal grubu üretimine bakıldığında OECD üyesi ülkelerde genelde aşağı yukarı benzer dalgalanmaların yaşandığı gözlenmektedir. Ancak bu grup içinde mısır, pirinç ve baklagillerde dalgalanmalar buğdayla karşılaştırıldığında daha benzer özellikler göstermektedir. Özellikle mısır, pirinç ve baklagillerde 1990'lı yıllarda yaşanan istikrarsız yapı ve döngülerin sıklığının azalması daha anlamlı bir gözlemdir. Buğday üretimi bu yıllarda diğerlerine göre daha istikrarlı bir yapıya sahiptir. Uluslararası ticaret verisi ise özelikle baklagillerin farklılaştığı bir durum sergilemektedir. Buğday ve mısır gerek ihracat gerekse ithalat açısından benzer eğilimdedirler. Et üretimi iki farklı gruplaşma ortaya çıkarmaktadır; domuz-kümes hayvanları eti ve büyük-küçükbaş hayvan etleri. Domuz ve kümes hayvanları etleri üretimi çok az sayıda dalgalanma içeren yukarı doğru eğimli bir çizgiyi takip etmektedir. Domuz eti üretimi daha istikrarlı bir yapıdadır. Büyük ve küçükbaş etleri üretimi ise daha düz bir yol izlemektedirler. Küçükbaş hayvan etlerine ait uluslararası ticaret verisi diğer mallardan farklı bir yapıdadır. Süt ve süt ürünlerinin üretim düzeyleri hemen hemen aynı eğilimleri göstermektedir. Uluslararası ticaret verisi, OECD bölgesinin peynir üretiminde artan oranda uzmanlaştığı sonucunu vermektedir. Ticaret hacmi açısından süt tozu ve tereyağı ticareti benzer şekilde değişmektedir. Çalışmadaki tüm mallar içinde en farklılaşmış yapı yağ grubu içinde görülmektedir. Zeytinyağı diğer yağlara kıyasla daha istikrarlı bir yapıdadır. Bu durumun ana nedeni de OECD ülkelerinin zeytinyağı üretimdeki tekelci konumları olabilir. Soya ve ayçiçek yağı daha benzer eğilimlere sahiptir. Diğer yağlar kategorisinin üretimi soya ve ayçiçek yağına benzer gibi görünse de bu gruplardan daha istikrarlı bir durum gözlenmektedir. Diğer yağlar grubunun uluslararası ticaret verisi geri kalan mallardan daha dalgalı bir yapıdadır. Son olaraksa, soya yağındaki dalgalanmalar yağ kategorisi içindeki mallara göre istikrarsız bir yapı sergilemektedir.

Tahmin sonuçları anlamlı düzenlilikler göstermektedir. Daha önce de belirtildiği üzere çalışma modellerin göreli üstünlüklerini karşılaştırabilmek için bir sınama yöntemi önermektedir. Bu sınamanın sonuçları AIDS modelinin genelde daha başarılı bir model olduğunu belirlemektedir. Bununla birlikte sınama sonuçları AIDS ile CBS modelleri arasındaki farkın çok da kesin olmadığını ortaya koymuştur. Aslında bu sonuç, çalışmadaki teorik tartışmalar göz önüne alındığında ve bu iki modelin Rotterdam modeli üzerine teorik üstünlükleri nedeniyle çok da beklenmedik bir sonuç değildir.

Gelir esnekliği ile ilgili hipotez sınamaları oldukça önemli sayıda anlamlı gelir esnekliği katsayılarının varlığına işaret etmektedir. Tahıl ve baklagiller için tahmin edilen gelir esnekliği katsayıları iki katmanlı bir yapı sunmaktadır. Gelir esnekliği katsayılarının dağılımına bakıldığında, buğday ve mısır için hesaplanan katsayıların pirinç ve baklagillerden farklı olduğu görülür. Pirinç ve baklagillerin gelir esneklikleri genelde buğday ve mısırın gelir esnekliklerinden daha fazladır. Ayrıca pirinç ve baklagillerin gelir esnekliklerinin bire yakın ya da daha fazla olduğu da gözlenmiştir. Etlerin gelir esneklikleri genelde düşüktür. Gelir etkisi açısından kümes hayvanları ve domuz eti benzer sonuçlar vermiştir. Büyük ve küçükbaş hayvan etlerinin gelir esneklikleri daha farklılaşmış bir yapıdadır. Bununla birlikte tüm anlamlı katsayılar birden küçüktür. Süt ve süt ürünlerinin gelir esnekliklerindeki dalgalanma diğer mal grupları ile karşılaştırıldığında daha fazladır. Bu farklılaşmanın derecesi özellikle gelir esneklikleri süt ve peynirden daha yüksek ve hatta birden büyük olan süt tozu ve tereyağında artmaktadır. Yağlar arasında en yüksek gelir esnekliği kaysatıları zeytinyağında gözlenmiştir. Bu gruptaki geri kalan yağlarda talep edilen miktarla gelir arasında aşağı yukarı benzer bir ilişki vardır. Özetle, pirinç, baklagiller, süt tozu ve zeytinyağı istisnaları dışında çalışmada kullanılan tüm ürünler normal mal olarak gözükmektedir.

Fiyat esneklikleri için bulunan sayıca daha az anlamlı katsayılar tarım ürünlerine olan talepteki gelir etkisini fiyat etkisinden daha önemli kılmaktadır. Tahil ve baklagiller grubunda, en düşük esneklik değerine sahip ürün buğdaydır. Pirinç ve baklagillere olan talep daha az esnektir. Fiyat esneklikleri açısında etler iki ayrı gruba bölünebilir; büyük-küçükbaş hayvan etleri ve kümes hayvanları-domuz eti. Burada ilk gruba olan talep daha fazla esnektir. Süt ve süt ürünlerinin talep esneklikleri sütün bu grup içindeki en az esnekliğe sahip mal olduğunu göstermektedir. Ayrıca süt tozuna olan talep de esnek değildir. Yağ esneklikleri için ulaşılan sonuçlar, genel olarak yağlara olan talep esnekliğinin diğer mal gruplarıyla karşılaştırıldığında daha yüksek olduğunu saptamaktadır. Bunun ötesinde ülkeler ve mallar itibarıyla en fazla farklılaşma da bu grupta gözlemlenmektedir. Zetinyağı ve diğer mallara olan talep soya ve ayçiçek yağına olan talepten daha esnektir. Hesaplanan çapraz fiyat esneklikleri de anlamlı ilişkiler ortaya koymaktadır. Tahıllar ve baklagiller mal grubunda ikame mallar olarak bulunan en amlamlı ilişkiler pirinç ve buğday ile pirinç ve baklagiller arasındadır. Et mal grubunda ise en çok anlamlı katsayı kümes hayvanları etleri için bulunmuştur. Kümes hayvanları etleri ile diğer tüm etler arasında güçlü bir ikame ilişkisi saptanmıştır. Süt ve süt ürünleri grubunda, en fazla ikame malı olan ürün tereyağdır. Yağlar mal grubu çapraz fiyat esneklikleri itibarıyla da yine en yüksek farklılaşmayı içermektedir. Talep ve fiyatlar arasındaki ilişki her iki yönde de anlamlıdır. Bu sonuçta, yağlara olan talepde daha öncede sözü edildiği gibi alışkanlıkların önemli bir etkiye sahip olduğunun göstergesidir.

Sonuç olarak, talep sistemlerini tahmin etmekde kullandığımız yöntemlerin OECD ülkeleri tarım ürünleri için anlamlı talep ilişkileri ürettiği söylenebilir. Gelişmiş modeller ve geniş bir veri seti kullanılmasına rağmen verinin elde edilememesi nedeniye talep ilişkilerinde hala alışkanlıkların şekillenmesi gibi keşfedilmemiş unsurlar vardır. İleride yapılacak çalışmalara yardımcı olmasına yönelik bir çaba olarak düşünüldüğünde, gelecekteki çalışmaların ana konusunun alışkanlıkların şekillenmesi gibi talep ilişkilerinin dinamikleri üzerine olması gerektiği söylenebilir. Bu tip ilişkileri çalışırken ülke özelindeki modellerin olası en geniş veri kümesi ile tahmin edilmesi, konuyu açıklığa kavuşturabilmek için izlenmesi gereken en iyi yoldur. Bunun yanında katsayıları doğrusal olmayan AIDS gibi modellerin de karşılaştırma amaçlı kullanılması da yararlı olacaktır.

Çalışmanın planına bakıldığında, 2. bölümde öncelikle sistem yaklaşımının tek denklemli yöntemler üzerindeki üstünlükleri tartışılmıştır. Bu bölümde daha sonra literatürde yeralan talep sistemleri sınıflandırılmış ve bunların özellikleri incelenmiştir. Bir sonraki bölümse, bu sistemlerin ampirik uygulamalarının incelenmesine ayrılmıştır. 4. bölüm ise OECD ülkeleri tarım ürünleri için üretim ve dış ticaret yapısını özetlemektedir. Çalışmada kullanılan modellerin detaylı yapıları ve tahmin sorunlarının tartışılması 5.bölümde yer almıştır. Verinin ve veri ile ilgili sorunların ortaya konması 5. bölümü sonlandırmıştır. 6. bölümde tahmin sonuçları sunulmuş ve sonuçlar yorumlanmıştır. Son bölümse, genel sonuçlara ve ileride yapılabilecek çalışmalara yönelik önerilere ayrılmıştır.

Sonuç olarak, talep denklemleri tahmininin istatistiksel ve ekonometrik tekniklerin iktisadi veri için kullanımının ilk örneklerinden biri olduğu söylenebilir. Talep denklemlerinin tahmininde iki farklı yaklaşımdan söz edilebilir. İlk yaklaşım belli malların tek bir piyasadaki özellikleri üzerine yoğunlaşmaktadır. İkinci yaklaşımsa tüketiciler tarafından satın alınan her bir mal grubu için tanımlanmış talep denklemlerini içeren sistemlerin eş anlı tahmini ile ilgilenmektedir. Farklı mallara olan talep davranışındaki karşılıklı ilişki nedeniyle, talep denklemleri sisteminin tahmin edilmesi sistem içindeki her bir denklemin, denklemleri tek başına tahmin etmekten daha iyi tahminler verebileceği en azından teorik olarak geçerlidir. Bu çalışma OECD ülkeleri tarım ürünleri için talep sistemlerinin tahmin edilmesine yöneliktir. İlk olarak, temel tüketici tercihleri teorisi sunulmaktadır. İkinci olarak, bağımsız tercihler ve şartlı talep denklemleri çözümlenmiştir. Daha sonra, Rotterdam Modeli, AIDS ve CBS adıyla anılan üç temsili talep sistemi ve uzantıları sunulmuştur. Son olaraksa, tahmin yöntemleri ve veri tartışılmış ve modeller SUR yöntemi ile tahmin edilmiştir. Çalışmanın ana özgünlüğü model seçiminde önerdiği yöntemle ilgilidir. Bu tahminlerin ve hipotez sınamalarının sonucuda AIDS ve CBS modellerinin Rotterdam modeline göre daha iyi sonuçlar ürettiği görülmüştür.

VITA

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