CANADA

WP 5/84

Agriculture Canada

Canada

WORKING PAPER

Marketing and Economics Branch

Direction générale de la commercialisation et de l'économie

[redacted]

A DEMAND MATRIX FOR MAJOR FOOD COMMODITIES IN CANADA*

(Working Paper 5/84)

S.R. Johnson and A.N. Safyurtlu

Department of Agricultural Economics
University of Missouri
Columbia, Mo. 65211
U.S.A.

March 1984

* This study was undertaken on contract to Food Markets Analysis Division, Marketing and Economics Branch. It has benefitted from the input of Division staff, in particular Dr. Z.A. Hassan.

A DEMAND MATRIX FOR MAJOR FOOD COMMODITIES IN CANADA

S.R. Johnson and A.N. Safyurtlu

1. Introduction

It has now been nine years since the publication of a full set of final demand parameters for major food groups in Canada (Hassan and Johnson, 1976). These estimates were based on annual data from the period 1957-1972. A similar situation exists for the United States which appears empirically to have a final demand structure for food much like that for Canada (George and King, 1971). Subsequent studies of consumer demand for Canada and the United States have focused on similar commodities, meats, dairy products, vegetables, etc. with only a general connection to the full final demand structure for basic food commodities disaggregated to levels of the landmark pieces of 1972 and 1976 (e.g., Chavas, 1983; Pope, Green and Eales, 1980; Hassan and Johnson, 1979). Recent exceptions are the work by Huang and Haidacher (1983) on twelve composite food commodities and non-food with full systems restrictions and Haidacher and Huang (1982) on the demand for red meats, poultry and fish.

Demand parameters from full systems are, however, broadly recognized as necessary inputs for economic policy analysis and for forecasting changes in consumption levels consistent with anticipated price and supply changes. In view of changes in demographics for Canada and the United States and changes in economic conditions since the publication of the two full final demand systems in 1971 and 1976, it is surprising that more updated estimates of demand system parameters have not been forthcoming.

There are a number of reasons for the absence of these updated full demand systems estimates. Included are: (i) the *ad hoc* methods used to estimate the full demand system of 1976, (ii) difficulties of assembling appropriate data and expenditure weights at levels of commodity aggregation consistent with major agricultural and consumption policy issues, (iii) the attraction of the applied researchers to demand systems incorporating strong separability during the late 1970s and early 1980s, and finally, (iv) concern over whether it is reasonable given the theory to estimate full systems at high levels of disaggregation (Deaton and Muellbauer, 1980). The fact remains, however, that most of the demand parameters for Canada used as rules of thumb and, more formally, in evaluating agricultural and food policies are dated both by the data on which they reside and the methods used in their estimation.

The present study has the objective of providing an updated full set of final demand parameters for major food groups in Canada. Data for the period 1960 through 1981 are utilized in estimating the demand parameters. Estimation methods employed are improved over those applied for the full set of final demand elasticities for major food groups in 1976. Specifically, restricted least squares was used to impose the Slutsky conditions jointly with the stochastic restrictions represented by the sample data in estimating the system of final demand elasticities.

The approach used to estimate the system has been available for some time (Court, 1967 and Byron, 1970) and circumvents a major concern with the methods used by George and King and Hassan and Johnson and as well in the earlier demand systems piece by Brandow. In these earlier studies the Slutsky conditions, together with priorly imposed own-price elasticities, income elasticities and selected cross price elasticities were not sufficient to determine uniquely the remaining parameters of the full final demand matrix. The result was that the matrices reported had substantial arbitrary content related to orders in which the restrictions were applied in utilizing the posited income, own-price and selected price elasticities to produce the full final demand matrix.

Aggregate and Disaggregated Systems

The approach used in developing the updated set of demand elasticities for the major food commodities is, in part, sequential. Specifically, the estimation proceeds from a highly aggregated definition of total expenditure to specialized expenditure definitions more narrow but consistent with the total for partial sets of commodities. The result is a full set of final demand elasticities for the major food commodity groups that can be reconciled with final demand estimates at the aggregate levels used in macroeconomic policy analysis.

Data available from Statistics Canada were for income, expenditure on major goods and services, quantity disappearances for food commodities by group, consumer and implicit prices for commodity groups, and estimated population. Expenditure weights (shares) utilized were from the Family Food Expenditure Surveys (1974, 1976, 1978). For the analysis, the quantity, expenditure and income variables were expressed in per capita form.

The scheme used to develop the full system of demand parameter estimates is illustrated in Figure 1. Observe from Figure 1 that estimation proceeds with a specification for the total expenditure elasticity. The total expenditure elasticity relates income as defined in the national accounts to total expenditures. No price elasticity is estimated. This stage of the estimation process is described in Figure 1 as the "one commodity level of disaggregation", Model 1. At the "two commodity level of disaggregation", Model 2, total expenditure is divided between food and nonfood. Both total expenditure and own price and cross price elasticities are estimated for the two aggregated commodity groups.

For the three commodity level, Model 3, food expenditure is further divided between food at home and food away from home. The next commodity, Model 4, level is for quantities of eight food groups, total food expenditure and commodity prices. The eight commodity groups are defined to exhaust total food expenditure. A full set of price and income elasticities for these commodities is estimated.

An advantage of the approach is that for the various levels of disaggregation, prior information from previous levels can be imposed in estimation. With restrictions from more highly aggregated systems, parameters from the disaggregated systems can be interpreted as implied by multi-stage budgeting process. The prior information is in the form of elasticities for particular commodity groups. Other more

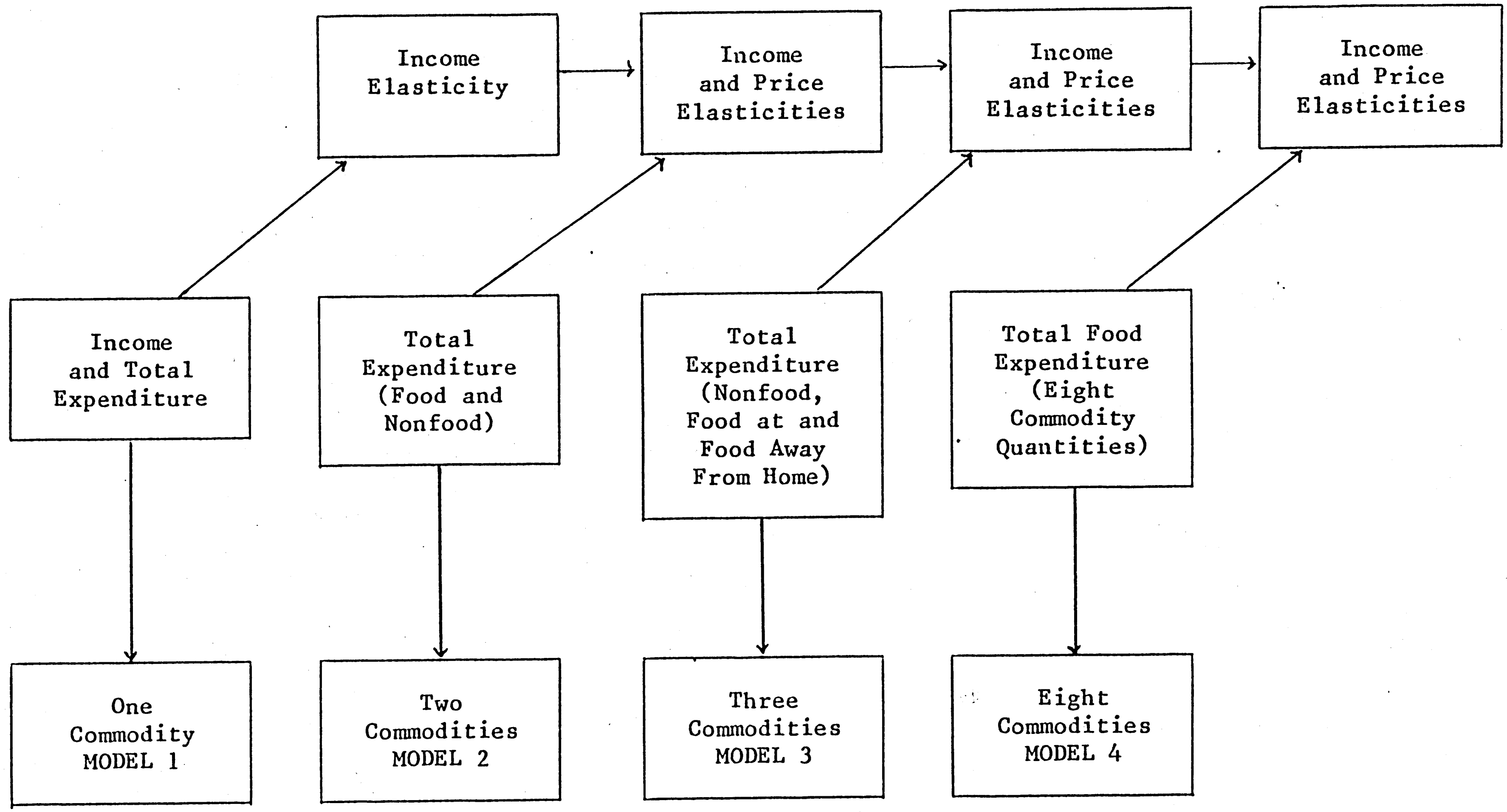

Figure 1. Framework for Estimating the Demand Parameters for Major Food Commodity Groups.

specialized restrictions can be introduced as well. These include selected cross and own price elasticities from other empirical demand analyses.

Organization

The presentation begins with a review of the important theoretical concepts in Section 2. Specifically, in Section 2, the Slutsky conditions are derived for standard demand systems. These Slutsky conditions are linear in the parameters but require information on expenditure proportions. This section is not intended as a complete review of the theory. Instead, it is designed to develop an appropriate notation and to identify specifically the Slutsky restrictions imposed in estimating the full demand system parameters.

Section 3 reviews estimation procedure, functional form and tests of restrictions. Special attention to the estimation procedure is required since the covariance matrices for the full systems are singular by the adding-up restriction and/or the construction of the data sets. This property of the covariance matrix is important for the two and three commodity models.

Data used to estimate the demand parameters are described in Section 4. In this section, the aggregations employed are detailed. The section includes as well explanations for decisions taken on aggregation and the delineation of the two, three, and eight groups. Methods for determining the prices employed are detailed also. Data series used in estimating the demand systems parameters reported are provided in the Appendix.

In Section 5, the expenditure and price elasticities are presented for the one, two, and three commodity models. At the three commodity level, recall that the commodities are nonfood, food at home, and food away from home. Total expenditure is used as the income proxy in the two commodity and three commodity models. Also, selected restrictions linking the demand systems between the levels of aggregation are imposed and evaluated. These restrictions provide an added basis for comparing the results generated by the two commodity and three commodity specifications.

The eight food commodity specification results are reported in Section 6. The eight major commodities are meat, dairy, cereals, eggs, fruits and vegetables, beverages, sugar, and total fat. Quantity data on these commodities are used for estimating the demand system parameters. Concluding remarks are contained in Section 7.

2. Elements of Demand Theory

It is well known that the basic axioms on consumer preferences lead to the possibility of formulating a differentiable utility function

$$U = u(X_1, X_2, \ldots, X_n) \tag{2.1}$$

where X_i, $i = 1, 2, \ldots, n$ represents a finite number of commodity bundles. The consumer is assumed to behave as if to maximize this utility function, subject to a budget constraint

$$\sum_{i=1}^{n} P_i X_i = m \tag{2.2}$$

where P_i represents the price of the i^{th} commodity bundle and m is consumer income or total expenditure. Utility maximization under the budget constraint and appropriate regularity conditions leads to the system of demand equations (Deaton and Muellbauer, 1980; Johnson *et al*., 1983)

$$X_i = f_i(P_1, P_2, \ldots, P_n, m) \; ; \; (i = 1, \ldots, n) \; . \qquad (2.3)$$

The Slutsky Restrictions

Several general restrictions exist for demand equation system (2.3) derived from the consumer utility maximization model (Phlips, 1974). Properties or restrictions on the demand system of primary interest for the present analysis are: (i) homogeneity, (ii) adding-up and (iii) symmetry. These properties together are called the Slutsky conditions (Barten, 1967).

The homogeneity property or restriction is

$$\sum_j P_j \frac{\partial X_i}{\partial P_j} + m \frac{\partial X_i}{\partial m} = 0 \; ; \; (i, j = 1, 2, \ldots, n) \qquad (2.4)$$

or using Court's (1967) notation with the restrictions expressed in demand elasticities,

$$\sum_{j=1}^{n} \frac{P_j}{X_i} \frac{\partial X_i}{\partial P_j} + \frac{m}{X_i} \frac{\partial X_i}{\partial m} = 0 \; .$$

That is,

$$\sum_j e_{ij} + e_{im} = 0 \qquad (i, j = 1, 2, \ldots, n) \; . \qquad (2.5)$$

From the homogeneity property, the sum of the own and cross price elasticities for the j^{th} commodity bundle is equal to the income elasticity. Intuitively, the homogeneity property implies the absence of a monetary illusion. There are n of homogeneity restrictions, one for each demand equation in the system.

The adding-up property or restriction is

$$\sum_i P_i \frac{\partial X_i}{\partial m} = 1 \qquad (i = 1, 2, \ldots, n) \tag{2.6}$$

or in elasticities,

$$\sum_{i=1}^{n} \frac{P_i X_i}{m} \cdot \frac{m}{X_i} \frac{\partial X_i}{\partial m} = 1 \ .$$

That is,

$$\sum_i w_i e_{im} = 1 \qquad (i = 1, \ldots, n) \tag{2.7}$$

where w_i is the expenditure proportion for the i^{th} commodity. It is apparent that (2.7) requires the sum, weighted by their respective budget proportions, of the income elasticities to equal one. This condition follows from the fact that by assumption the budget is completely allocated to the n commodity bundles. There is one adding-up restriction for the demand system.

The symmetry property applies to off-diagonal elements in the demand system parameter matrix,

$$\frac{\partial X_i}{\partial P_j} + \frac{\partial X_i}{\partial m} X_j = \frac{\partial X_j}{\partial P_i} + \frac{\partial X_j}{\partial m} X_i \qquad (i, j = 1, \ldots, n) \tag{2.8}$$

or more simply,

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

In elasticity form, the symmetry restrictions are,

$$\frac{\frac{P_j}{X_i}\frac{\partial X_i}{\partial P_j}}{\frac{P_j X_j}{m}} + \frac{m}{X_i}\frac{\partial X_i}{\partial m} = \frac{\frac{P_i}{X_j}\frac{\partial X_j}{\partial P_i}}{\frac{P_i X_i}{m}} + \frac{m}{X_j}\frac{\partial X_j}{\partial m}$$

or

$$\frac{e_{ij}}{w_j} + e_{im} = \frac{e_{ji}}{w_i} + e_{jm} \qquad (i, j = 1, \ldots, n) . \qquad (2.9)$$

These restrictions link the income and cross price elasticities between pairs of commodities. They show that the observed cross price effects include both income and substitution terms and that the importance of the income effect is related to the expenditure proportions.

Estimation and the Slutsky Restrictions

The Slutsky restrictions, equations (2.5), (2.7) and (2.9) as expressed in elasticity form are for the "representative" consumer. Data available for estimating demand systems and evaluating the restrictions are, however, aggregates. The question of whether the restrictions on the demand system for the representative consumer, in fact, carry over under reasonable assumptions to the aggregated data has been the subject of extensive research (Deaton and Muellbauer, 1980). In general, this research has shown that strong separability and/or highly specialized utility function assumptions are required to assure that the demand restrictions for the representative consumer apply in the aggregated data.

The class of utility functions that permit application of the Slutsky restrictions in aggregate per capita data is identified with Klein and Rubin (Deaton and Muellbauer, 1980). The Klein-Rubin utility function is strongly separable. These separability assumptions result in cross price elasticities of demand that are highly restricted. Thus, the intuitive reason that the Klein-Rubin utility function admits the Slutsky conditions in the aggregated per capita data is the restrictions on the cross price elasticities or alternatively, consumers responses to changes in relative prices. The nature of these restrictions is evident for the linear expenditure system, for example. For the linear expenditure system, the full set of price and income elasticities can be obtained on the basis of 2n-1 parameters, adjusting for the automatic fulfillment of the adding up restriction (Phlips, 1974).

Application of the Slutsky restrictions for estimating price and income elasticities in aggregate data as for example in the case of Brandow (1961), George and King (1971) and Hassan and Johnson (1976), required strong and not easily identifiable assumptions about aggregation conditions. These assumptions are important even abstracting from the fact that the restrictions themselves together with the prior estimates of price and income elasticities were not sufficient to determine uniquely the parameters for the full system. The authors of these publications were assuming that 1) the restrictions on the demand system for the individual consumer applied in the aggregate data or 2) an aggregate specification that was only loosely linked to the theory. Their assumption was obviously the latter, since for a full system and the former, the integrability conditions for the double log systems applied identify all the parameters (LaFrance, 1983).

For the applied researcher, a dilemma presented by the available aggregated data, the restrictions that follow for the representative consumer, and the strong separability assumptions required for their reconciliation is difficult. Obviously, the strong separability conditions required for applying the restrictions from the theory in the context of aggregated data are not consistent with the intended uses of the resulting demand system parameters. That is, the demand parameters used in commodity policy and forecasting are required at disaggregated levels. An alternative incorporated in estimating the demand system is to view the system as a "local approximation".

Local Approximations of Demand Systems

One approach to developing a demand system for the representative consumer appropriate in aggregated data is to approximate the utility function. This approach was not taken in the present context. However, it is useful to review the method to introduce the approximation utilized ultimately. The latter is for the demand equations themselves. Consider again the utility function (2.1). The first order Taylor series approximation for the utility function is

$$U = f(X_1, \ldots, X_n) \doteq f(X_1^0, \ldots, X_n^0)$$

$$+ \sum_{i=1}^{n} \frac{\partial u}{\partial X_i}\bigg|_{X_i^0} (X_i - X_i^0) \tag{2.10}$$

where $(\partial f/\partial X_i)|_{X_i^0}$ is the partial derivative of the utility function f, evaluated at X_i^0. The utility function, or more properly, the local approximation to the utility function (2.10) is linear in the X_i, i = 1, 2, ..., n. Thus, the approximate utility function is directly additive. For this approximate utility function, the Slutsky conditions apply in the aggregate data. The local approximation to the utility function, however, limits severely the implied consumer behavior. The cross partials of the additive linear utility function approximation are zero.

The second approach to developing a local approximation is to deal with the demand systems themselves. The Slutsky conditions hold for the demand system (2.3). Moreover, as is evident from equations (2.5), (2.7) and (2.9), the Slutsky conditions hold at specific budget proportions. Thus, the Slutsky restrictions will be different depending on the budget proportions. Also, unless the functional form for the demand system is highly restrictive, the Slutsky conditions will be appropriate for the demand system of the representative consumer at only one set of prices and quantities. It is natural then to develop methods that have these Slutsky conditions applying only approximately at the aggregated data.

As for the utility function, a simple Taylor series approximation is employed in approximating the Slutsky restrictions. The homogeneity condition (2.5) requires reference values of prices and income. These are necessary for calculating the elasticities as is shown in equation (2.5).

The local approximation to the Engel aggregation condition, that the weighted sum of the income elasticities equal one, is obtained by taking the Taylor series approximation of equation (2.7). Specifically,

$$\sum_i w_i^* e_{im} - 1 + \sum_i e_{im}(w_i^* - w_i) + \ldots \doteq 0 \qquad (2.11)$$

where w_i^* is assumed the mean expenditure proportion. The first term in equation (2.11) is the value of the Engel aggregation restriction at the mean expenditure proportion. The second is the second term in a standard Taylor series approximation.

Lastly, for the symmetry restriction, (2.9) where again w_j^* is the mean expenditure proportion, setting k_{ij} equal to k_{ji} or imposing the symmetry restrictions, the expression can be written

$$k_{ii} \doteq e_{im} + \frac{e_{ij}}{w_j^*} - \frac{e_{ij}}{w_j^{*2}} (w_j^* - w_j) + \ldots \qquad (2.12)$$

where the third and higher order terms of the Taylor series approximation have been omitted. The assumption in applying the Engel aggregation, homogeneity, and symmetry restrictions is that the demand system obeys these restrictions only in the locality of the values selected for the approximation.

The final approach is to take an approximation of the full demand system at reference sets of prices and income, equation (2.3). A simple Taylor series approximation of this demand system can be obtained. Then, the integrability conditions can be used to determine the utility function corresponding to the approximate system. This approach has not been undertaken in the present analysis but holds out the possibility of developing demand systems approximations that can be linked to approximate utility functions. These approximations would be like the Rotterdam model which was specified and estimated before the corresponding utility function was known.

3. Estimation

Estimation of the demand system using the Slutsky conditions approximated at the sample means involves consideration of three important problems. These include: (i) the restrictions themselves and the restricted least squares methods specialized to the estimation problem, (ii) the implications of the restrictions and the construction of the data set for the variance-covariance matrix for the equation system and (iii) the choice of functional form. Only one of these considerations represents a special problem for the demand system to be estimated. It is the conditioning of the variance-covariance matrix.

Restricted Least Squares Estimation

There are n homogeneity restrictions, $(n^2-n)/2$ symmetry restrictions and one Engel aggregation restriction to be placed on the parameters of the demand system. Moreover, these restrictions are linear in the parameters of the system, given the expenditure proportions or budget shares, w_i^*. Thus, the estimation problem is of standard restricted least squares form. The sample observations on the full demand system is denoted,

$$\underline{y} = X\underline{\beta} + \underline{\varepsilon} \tag{3.1}$$

where $\underline{y}$ is a stacked vector, $\underline{y}' = (\underline{y}_1', \underline{y}_2', \ldots, \underline{y}_n')$ with $\underline{y}_i$ the set of sample observations on the dependent variable in the i^{th} equation; X is a block diagonal matrix with the explanatory variables for the demand equations, $X_i = X_j$ (i, j = 1, 2, ..., n), forming the diagonal matrices; and $\underline{\beta}$ and $\underline{\varepsilon}$ are conformably defined parameter and disturbance vectors, respectively. For sample size T, $\underline{y}$ is nT by 1, X is nT by n^2, $\underline{\beta}$ is n^2x1 and $\underline{\varepsilon}$ is of course of the dimension as $\underline{y}$.

The linear Slutsky restrictions can be written

$$\underline{r} = R\underline{\beta} , \tag{3.2}$$

where $\underline{r}$ is of dimension $(n^2 - n)/2 + n+1$ by 1 and R is $(n^2 - n)/2 + n$ by n^2. The restricted least squares estimator for $\underline{\beta}$, incorporating the sample information (3.1) and the exact parameter restrictions (3.2) is

$$\tilde{\underline{\beta}} = \hat{\underline{\beta}} + (X'X)^{-1}R'(R(X'X)^{-1}R')^{-1}(\underline{r} - R\hat{\underline{\beta}}) \tag{3.3}$$

where $\tilde{\underline{\beta}}$ is the restricted least squares estimator and $\hat{\beta}$ is the ordinary least squares estimator obtained by omitting the restrictions (3.2). If for equation (3.1), it is assumed $\underline{\varepsilon} \sim N(\underline{0}, \sigma^2 I)$, i.e., the disturbances are independently and identically distributed, the covariance matrix for $\tilde{\beta}$ is,

$$\text{Var}(\tilde{\underline{\beta}}) \doteq \sigma^2((X'X)^{-1}R'(R(X'X)^{-1}R')^{-1}R(X'X)^{-1}) . \tag{3.4}$$

Comparison of (3.4) to Var($\hat{\underline{\beta}}$) shows that the addition of the nonstochastic restrictions makes $\tilde{\underline{\beta}}$ more efficient.

For this standard restricted least squares model, hypothesis tests for evaluating the restrictions can be conventionally formulated. The restrictions can be evaluated individually or as a set and the tests can utilize variance or mean squared error norms (Judge et al., 1980).

Covariance Matrix

The covariance matrix for the full demand system expressed in expenditure form is singular. This singularity of the contemporaneous covariance occurs because of an adding-up condition implicit in the data set construction or the Slutsky restrictions. The sum of the expenditures on the individual commodity groups is equal to total expenditures. The fact that this condition implies singularity of the covariance matrix is easily demonstrated clearly (Barten, 1969 and Berndt and Savin, 1975).

The singularity of the covariance matrix can be handled by omitting one of the demand equations from the system or positing *a priori*, the parameters for one equation. The result is a demand system of n-1 equations. Of course, the corresponding symmetry, homogeneity, and adding-up restrictions must be omitted or incorporate the extraneous prior information as well. In the first case, these restrictions are used in calculating, residually the parameters of the omitted equation.

As shown by Barten (1969), the parameters estimated from the system of equations if the variance-covariance matrix is only contemporaneously correlated are invariant to the choice of the equation omitted from the system. This is for systems that do not impose on general parametric demand functions, the cross equation restrictions. Also, if autocorrelation in the disturbances exists, more complex rules apply on the omission of equations from the system and the restrictions the singularity conditions impose on the vector valued autocorrelation process (Berndt and Savin, 1975).

Functional Form

The Slutsky conditions can be readily applied to demand systems using restricted least squares. Many researchers have employed linear or logarithmic functional forms when studying demand equations for meat. Although the Slutsky conditions may imply strong parameter restrictions, there is no *a priori* rationale for the choice of one or the other form in aggregate data. The choice of functional form may have implications that are either highly restrictive or inconsistent with theory or actual experience. For example, a linear form implies the income elasticity of demand for meat is rising and tends toward unity, with increasing income levels, if it is less than unity. The converse is also a property of linear functions. On the other hand, a logarithmic form implies that the income and price elasticities of demand for meat are constant for all levels of income and prices. The double log functional form with constant elasticities was used for the present study. It must be rationalized on the basis of the local approximation to the complete demand system. If it were not and the Slutsky restrictions applied exactly, all the parameters would be known (LaFrance, 1983).

4. Data

This section provides documentation for the data sources utilized in estimating the demand systems models and a discussion of selected descriptive statistics for these series. In the latter case, the statistics are presented to provide added perspective for the empirical results in Sections 4 through 8.

Data and Sources

Data necessary to estimate the parameters for Model 1, Model 2 and Model 3 are per capita expenditures, implicit price deflators, and expenditure proportions. Personal consumption expenditure data for food away from home, food at home, and total food and services are available from Statistics Canada. These data are converted to a per capita basis using population estimates for mid-year (June 1). The implicit price indices (1971 = 100) are derived by dividing expenditure in current dollars by expenditure in constant dollars.

For estimating the parameters of Model 4, both the time series and cross section data are utilized. Time series (1960-1981) data on retail prices, per capita food consumption and per capita disposable income are obtained from the Handbook (1983). The annual price indices (1971 = 100) used in statistical analysis are simple averages of selected reported monthly prices for commodities assumed to reflect the composites. Expenditure proportions for the individual commodities are simple averages of Family Food Expenditure Survey of 1974, 1976, and 1978.

Descriptive Statistics

Data for the analysis are provided in the Appendix. Data for Models 1, 2, and 3 are summarized in Tables T1 (per capita income and expenditures, T2 (implicit price deflators, T3 (per capita disposable income and expenditures in constant dollars). Data for Model 4 are listed in Tables T4 and T5 (quantity data in pounds for the eight commodity model and price data per pound for the eight commodity model, respectively).

Model 1: Dependent variables of this model are total expenditures in current dollars (TE) and total expenditures in constant dollars (TEC). These variables are converted to per capita basis using population variable (POPJN). The converted variables are per capita total expenditures in current dollars (PCTE) and per capita total expenditure in constant dollars (PCTEC). Income variables for this model are personal disposable income (PDI) and per capita personal disposable income (INCOMEPC).

Model 2: Variables for this model are per capita food expenditure in constant dollars (PCFDEC), per capita nonfood expenditures in constant dollars (PCNFEC), per capita total expenditures in constant dollars (PCTEC) and implicit price deflators for food and nonfood. The implicit price deflators were calculated as

$$IPFD1 = \frac{IPFD}{IPTE} = \frac{FDE/FDEC}{TE/TEC}$$

for food, and

$$IPNF1 = \frac{IPNF}{IPTE} = \frac{NFE/NFEC}{TE/TEC}$$

for nonfood, where FDE and FDEC are defined as food expenditures in current and constant dollars, respectively; NFC and NFEC are nonfood expenditures in current and constant dollars, respectively; and TE and TEC are as previously defined.

Model 3: Variables for Model 3 are per capita food away home expenditures in constant dollars (PCFAHEC), per capita food home expenditures in constant dollars (PCFHEC), per capita nonfood expenditures in constant dollars (PCNFEC), per capita total expenditure in constant dollars, and implicit price deflators for food away home, food home, and nonfood. The implicit price deflators were calculated as

$$IPFAH1 = \frac{IPFAH}{IPTE} = \frac{FAHE/FAHEC}{TE/TEC}$$

for food away home,

$$IPFH1 = \frac{IPFH}{IPTE} = \frac{FHE/FHEC}{TE/TEC}$$

for food home, and similarly for IPFN1, nonfood. Variables FAHE and FAHEC are food away home expenditures in current and constant dollars respectively, and variables FHE and FHEC represent food home expenditures in current and constant dollars respectively.

Model 4: The dependent variables for Model 4 are per capita consumption of eight commodities. These commodities are all meats (QM), total dairy (QD), breakfast foods and cereals (QBC), eggs (QE), fruits and vegetables (QFV), beverages (QBEV), sugar (QS), and fats and oils (QFO). Price variables are per pound price of all meats (PMEATS), powder skim milk (PPOWSKM), white flour (PWFLOUR), eggs

(PEGG), fruits and vegetables (PFRVEG), beverages (PBEV), sugar (PSUGAR), and total fat (PTFAT). The "income" variable used is total food expenditure in current dollars (FDE).

5. Empirical Results; Expenditure Models

The demand systems results reported in this section are estimated with commodity groups or dependent variables defined by total expenditures; Models 1, 2, 3. The income variable is defined as indicated in Section 4. Total expenditures are from the national accounts and prices are implicitly determined. The emphasis is on the relationship between income, own and cross price elasticities for food and nonfood. The food expenditures were further disaggregated in Model 3 to food at home and food away from home.

Total Expenditure Elasticity (Model 1)

The total expenditure elasticity was obtained by regressing total expenditures on income. Both total and per capita models were used. Since the models are algebraically identical, the difference involves the implied transformation of the disturbances. Results for the total expenditure parameters and elasticities (Model 1) are contained in Table 1. These results show that the total expenditure elasticity for income was approximately .98. That is, an increase in income of one percent corresponded to a .98 percentage increase in total expenditures. This elasticity is not consistent with marginal propensities that have been estimated in consumption function analyses with survey data. For example, the marginal propensities (shown also in Table 1) estimated by Goddard (1983) were about .84 when a linear

Table 1

ESTIMATED TOTAL EXPENDITURE ELASTICITIES USING ALTERNATIVE EXPRESSIONS FOR THE CONSUMPTION FUNCTION (MODEL 1)

Expenditure	Personal Disposable Income	Per Capita Personal Disposable Income
Total	.9916	--
Total (Constant Dollars)	.9801	--
Per Capita Total	--	.9883
Per Capita Constant Dollars from LES (Goddard)[a]	.84	--
Per Capita Total (Constant Dollars)	--	.9719

[a]Marginal propensity from an estimated linear expenditure system (Goddard, 1983).

expenditure system was applied. The estimate by Goddard implies an elasticity that is lower than those reported in Table 1.

Elasticities for Food and Nonfood (Model 2)

The estimates of elasticities for own price, cross price, and income elasticities for commodities disaggregated to food and nonfood groups are contained in Table 2. Recall that the estimators are based on a double log functional form. The results from this restricted model suggest that the own price price elasticity of demand for total food is approximately -.35 while the own price elasticity of demand for nonfood was approximately -.94. The income elasticity for food of .58 is high by comparison to other studies but includes food away from home. Cross price elasticities small relative to the own price elasticities. The cross price elasticity of food with nonfood is higher than the cross elasticity for nonfood with food.

Food at Home, Away from Home and Nonfood (Model 3)

Initial results for the demand system with three commodities, food away from home, food at home, and nonfood are contained in Table 3. A non-diagonal contemporaneous variance covariance matrix is again assumed. The weights used, based on sample averages, are provided in Table 3 as well. The results for the three commodity system were more plausible. Own price elasticities for food away from home and nonfood were higher than the own price elasticity for food. The own price elasticity for food at home is .54. All of the cross price elasticities for the restricted system reported in Table 3 were negative except those between food at home and food away from home.

Table 2

ESTIMATED OWN PRICE, CROSS PRICE AND INCOME ELASTICITIES FOR A DEMAND SYSTEM WITH TWO COMMODITY GROUPS (MODEL 2)

Expenditure Groups and Weights	Elasticity Estimates With Slutsky Restrictions		
	Food	Nonfood	Income
Food	-.35	-.24	.58
Nonfood	-.17	-.94	1.10
Weights	.200157	.799833	

Table 3

ESTIMATED OWN PRICE, CROSS PRICE, AND INCOME ELASTICITIES FOR A DEMAND SYSTEM WITH THREE COMMODITY GROUPS (MODEL 3)

	Elasticity Estimates With Slutsky Restrictions			
	Food Away From Home	Food at Home	Nonfood	Income
Food Away From Home	-.77	.57	-.92	1.13
Food at Home	.20	-.54	-.05	.38
Nonfood	-.05	-.12	-.94	1.11
Weights	.0462526	.15	.799833	

These values were positive. This simply indicates that if individuals consumed more food at home they were likely to have consumed less food away from home.

Comparing the results in Table 2 to those in Table 3, note that the price elasticity for food at home is -.54 compared to food price elasticity of -.35. The food away from home own price elasticity from Table 3 is -.77. The income elasticities between food and food at home and away from home are more comparable to Table 2. Weighted by their expenditure proportions, the food at home income elasticity, .38, and the food away from home elasticity, 1.13, are about equal to the income elasticity for food in the two commodity model, .58.

Additional results for the three commodity system are provided in Table 4. These results are similar to those in Table 3 except that restrictions from the model from Table 2 were incorporated in the estimation of the demand system parameters for Table 4. These restrictions were introduced in addition to the Slutsky restrictions. The result is that the parameter estimates reported in Table 4 can be reconciled with Table 2. That is, the income elasticities for food away from home and food at home, for example, multiplied by their expenditure weights in Table 4 are equal to the income elasticity for total food in Table 2.

Comparing the results in Table 4 with those for the restricted system in Table 3 suggests several conclusions. Generally, the result of applying the restrictions from Table 2 was to significantly increase the cross-price elasticities between food and nonfood. The income elasticities, however, as anticipated by the earlier discussion

Table 4

ESTIMATED OWN PRICE, CROSS PRICE, AND INCOME ELASTICITIES FOR A DEMAND SYSTEM WITH THREE COMMODITIES (MODEL 3) AND RESTRICTIONS THAT ESTIMATES SATISFY THE SLUTSKY CONDITIONS AND AGGREGATE TO THOSE FOR THE TWO COMMODITY CASE

	Elasticity Estimates With Exact Priors			
	Food Away From Home	Food at Home	Nonfood	Income
Food Away From Home	-.76	.76	-1.18	1.18
Food at Home	.26	-.71	.04	.40
Nonfood	-.07	-.10	-.93	1.10
Weights	.0462526	.153911	.799833	

of Table 3, remained relatively constant between specifications. The result was then to increase own price elasticity for food at home substantially.

Based on the comparison of the elasticity estimates with the Slutsky conditions imposed in Table 3 and elasticities for the same system in Table 4 but with the two commodity restrictions imposed in addition to the Slutsky restrictions, the conclusion is that the less unrestricted system is the more appropriate. The reason for this conclusion is that the imposition of the restrictions from the two commodity case resulted in much closer values of the parameter estimates for the own price elasticities for food at home and food away from home, -.71 and -.76, respectively. Thus, for the three commodity case, including food away from home, food at home, and nonfood, the elasticities that proved the most plausible were for the three commodity case with the Slutsky restrictions in Table 3.

6. The Eight Commodity System for Food

The eight commodity system was estimated with quantities of eight major food commodities and total food expenditures. Slutsky restrictions were imposed exactly in the estimation process. These estimates are presented in Table 5. Comparable estimates for food commodities obtained by Brandow (1961), George and King (1971), Hassan and Johnson (1976) and Huang and Haidacher (1983) are summarized in Table 6. The estimates in Table 6 provide information on own price elasticities and income elasticities. These estimates are comparable to those presented in Table 5; the diagonals of Table 5 in the case of

Table 5

ESTIMATED DEMAND MATRIX: EIGHT FOOD COMMODITIES
AND TOTAL FOOD EXPENDITURE

Food Commodities/ Total Food	Food Commodity							
	Meat	Dairy	Cereals	Eggs	Fruits and Vegetables	Beverages	Sugar	Total Fat
Meat (PM)	-0.68	0.16	-0.18	0.23	-0.28	-0.45	0.14	-1.03
Dairy (PPOWSKM)	-0.06	-0.44	-0.30	-0.14	-0.12	-0.04	-0.36	0.55
Cereals (PC)	-0.12	-0.19	-0.13	-0.29	-0.07	-0.08	-0.32	0.20
Eggs (PE)	-0.01	-0.03	-0.07	-0.12	-0.01	-0.06	-0.06	0.22
Fruits and Vegetables (PFV)	-0.19	0.01	-0.02	0.20	-0.77	0.60	0.30	-1.41
Beverages (PB)	-0.14	-0.02	-0.07	-0.16	0.10	-0.33	-0.15	-0.06
Sugar (PS)	-0.01	-0.04	-0.05	-0.03	0.01	-0.03	-0.09	0.03
Total Fat (PF)	-0.06	0.14	0.08	0.31	-0.14	0.02	0.08	-0.33
Total Food Expenditures (INCFDE)	1.27	0.40	0.73	0.00	1.28	0.38	0.45	1.84
Weights	.36167	.1477	.11297	.02155	.24771	.0666	.0154	.0264

own price elasticities and the entries in the next to the last row for the income elasticities. The discussion of the results for the eight food commodities is divided into two sections. First, the estimated demand parameters are discussed and evaluated. Then, comparison is made to the other similar results, Table 6. The comparison is to the previous food demand system for Canada and more recent estimates for Canada and the United States.

Eight Food Commodity Estimates

Estimated demand parameters for the eight food commodities reported in Table 5 have general characteristics that are encouraging for the estimation approach utilizing the Slutsky restrictions. Specifically, all of the own price elasticities for the eight food commodities are negative. The income elasticities are positive. Signs on the cross elasticities are generally consistent with prior perceptions regarding substitution effects. For example, cross price elasticities between dairy, eggs, sugar and meat are positive. Cross price elasticities between cereals, fruits and vegetables and beverages as well as total fat with meat are negative. Positive cross price elasticities indicate the substitution of dairy, eggs and, interestingly, sugar products for meat as the price increases. Negative cross price elasticities for cereals, fruits and vegetables, beverages and total fat are likely more related to the impact of increases in meat prices on total food expenditure. Similar interpretations can be made for the other commodities.

In evaluating the own price elasticities, the highest price elasticities were for meat (-0.68), fruits and vegetables (-0.77), and

Table 6

REPRESENTATIVE OWN PRICE ELASTICITIES AND INCOME ELASTICITIES ESTIMATES FROM FULL DEMAND SYSTEMS STUDIES FOR CANADA AND THE UNITED STATES

		Food Commodity Groups								
Study	Elasticity	Meat	Dairy	Cereals	Eggs	Fruits	Vegetables	Beverages	Sugar	Fats
Barewal and Goddard (1984)	Price	-.698	-.587	-.654	-.287	-.433*				-.479
	Income	.212	.139	.165	.154	.182*				.295
Barewal and Goddard (1984)**	Price	-.700	-.602	-.359	-.126	-.224*				-.571
	Income	.222	.112	.151	.146	.193*				.195
Hassan and Johnson (1976)	Price	-.852	-.439	-.2	-.121	-.454	-.24	-.37	-.24	-.858
	Income	.505	.205	.045	0	.225	.09	.154	.117	.287
Huang and Haidacher (1983)	Price	-.526 N	-.305	-.354	-.143	-.37	-.21	-.328	-.114	-.146
	Income	.359 N	.183	-.289	-.069	-.63	.21	.144	.439	.575

*Fruits and vegetables.
**With socioeconomic and demographic scale.
N denotes a narrower commodity group definition than used for Table 5.

dairy products (-0.44). The lower own price elasticities, not unsurprisingly, were for total fat (-0.33), sugar (-.09), and cereals (-.13). These results show, in general, that consumption levels of meats, dairy products, and fruits and vegetables respond more to changes in relative prices than do consumption levels for cereals, sugar, and total fat.

For the total food expenditure elasticities, the highest estimates were for meat (1.27), fruits and vegetables (1.28), and total fat (1.84). The estimator for total fat is considerably larger than anticipated. It is true, however, that as total food expenditure has increased, the fat content of the diet of the Canadian population has increased. The high total food expenditure elasticities for meat and fruits and vegetables, were anticipated. The low income elasticities for dairy, eggs, beverages and sugar are consistent with consumption trends for these commodities. Generally, they are not highly responsive to increases in total food expenditures and/or increases in income.

These total expenditure elasticities can be converted to income elasticities by simply multiplying the value by the elasticity for total food expenditure with respect to total expenditure, i.e.,

$$\frac{\partial Q_i}{\partial \text{INCFDE}} \cdot \frac{\partial \text{INCFDE}}{\partial \text{PCNFEC}} = \frac{\partial Q_i}{\partial \text{PCNFEC}}$$

where the variables are as defined in the data section. These partials are converted to elasticities by multiplying and dividing by PCNFEC at the selected reference value. For the double log specification the elasticities are constant.

The total food expenditure elasticities from Table 2 is .58 while for food at home from Table 3 it is .38. Comparisons of these total food expenditure elasticities can be converted to total expenditure elasticities by multiplying them by, say, .40. With this multiplication, these elasticities become more consistent with those reported in other studies (discussed subsequently).

In reviewing the general set of estimates provided in Table 5, possibly the most interesting are those for total fat. Notice that total fat, like sugar and eggs, had a relatively small expenditure proportion. Perhaps the apparent erratic results obtained with total fat, for example a large cross price elasticity with fruits and vegetables (-1.41) and the large negative cross price elasticity with meat (-1.03), are related to the sensitivity of the estimation procedure to the magnitude of the expenditure weight. These expenditure weights have a critical role in the Slutsky restrictions imposed exactly. Moreover, commodities with small expenditure weights are likely to be ones where the expenditure weights have varied in relative terms, substantially through the sample period. If this is true, then these Slutsky restrictions are the most at variance with the individual demand model for these commodities. That is, the restrictions for the commodities with small weights are the poorest local approximations of the Slutsky restrictions for the representative consumer. An approach that might be tried for the Slutsky restrictions would be to allow stochastic restrictions for commodity groups with relatively small expenditure proportions.

Comparisons to Other Studies

The price elasticity estimates from Table 5, the diagonal elements, are directly comparable to those for other studies. The own price elasticity estimates provided in Table 6 are for other studies of Canada using demand systems approaches. For example, the own price elasticities for meat estimated by Barewal and Goddard (1984) were -1.98 and -.70 for an almost ideal demand system with and without socioeconomic variables, respectively. This compares to the own price elasticity estimate for meat from in the present analysis of -.68. Own price elasticities reported in two other studies in Table 6 are -.526 by Huang and Haidacher (1963) and -.852 by Hassan and Johnson (1976). It should be noted that the commodity definitions for meat in the latter two studies were more narrow than the commodity definition used for this current analysis and by Barewal and Goddard (1984). Specifically, for both the Huang and Haidacher and Hassan and Johnson studies the elasticities reported in Table 6 are for beef. Since beef generally has a higher price elasticity of demand than total meats, Canadian own price elasticity of -.68 as compared to -.526 for Huang and Haidacher (1983) for the U.S. is significant.

Similar comparisons of own price elasticities for the other commodities are available by contrasting the information in Table 6 with that in Table 5. These will not be discussed in detail. However, there are selected commodities for which additional comparisons may be useful. Specifically, since the total fat commodity group appeared to generate erratic results in the present analysis, it is interesting to review our results compared to the other studies reported in Table 6. The own price elasticity for total fat reported in the current study is -.33. This estimate is lower than the estimated own price elasticities for total fat in Table 6. It is sharply different than the own price elasticity reported by Hassan and Johnson (1976) for Canada, -.86. Generally, these price elasticity estimates for fat support our earlier argument. That is, the estimates for price elasticities of fats since the commodity group is small in terms of expenditure proportions tend, to be erratic.

A second area where the estimation procedures tend to be stressed because of consumption and income trends is for eggs. The eggs own price elasticity in the current analysis was -.12. This compares favorably estimates that were obtained in the other studies as shown in Table 6. Interestingly, the Barewal and Goddard (1984) estimates which did not include socioeconomic variables was appreciably higher, -.29 compared to -.13.

Recall that for the income or total expenditure elasticities, the estimators reported in Table 6 are, in fact, different than the total food expenditure elasticity estimates in the next to the last row of Table 5. The total food expenditure elasticities should be multiplied by .40 to convert them to a basis consistent with the income (total expenditure) elasticities reported in Table 6. Evaluating the results in Table 6 compared to Table 5 in relative terms is, however, of interest in itself.

Comparing the results in Table 5 to those of Barewal and Goddard (1984) in Table 6, observe that the highest income elasticities obtained were for meat, fruits and vegetables and fat. These were near .2 and low by comparison to Hassan and Johnson (1976), especially for meat. The present analysis, Table 5, also obtained the largest income elasticities for meats, fruits and vegetables, and fats. A similar trend is present for the remainder of the income elasticities reported in Table 6. That is, aside from dairy products, the highest income elasticities are for meats, fruits and vegetables and for fats. Thus, the "curious" result obtained for fats in the present analysis is one that has appeared in other applications of demand systems methods at disaggregated levels for food commodities.

In general, in absolute terms both the income and price elasticity estimates compare favorably to those reported in Table 6 and are relatively consistent with the most recent study for the U.S. by Huang and Haidacher (1983). The major difference between these results and the more recent estimates by Huang and Haidacher relate to the negative income elasticities that they found for the food commodity groups, cereals, eggs, and fruits. These negative income elasticities are at variance with observed consumption patterns. They are also at variance with income elasticities that have been reported in the other three demand systems for Canada shown in Table 6. Their income elasticity estimate for fruits is most at variance with the results reported in Table 5.

7. Conclusions

The estimated demand matrices presented have ranged from two to eight commodities, with the latter for eight food commodities and total food expenditures. The income elasticities and total expenditure elasticities developed from the one, two and three commodity models can be used to "translate" the total food expenditure elasticities from the eight commodity model to the appropriate income base for policy analysis and forecasting. For the two, three and eight commodity models, the Slutsky restrictions were imposed exactly. As indicated in reviewing the results from the eight commodity model, imposing these restrictions exactly may have some limitations when important changes in relative prices and expenditure shares have occurred over the sample period.

The results obtained, especially for the eight commodity case, represent an important advance over those available for Canada to date. Specifically, the full demand systems estimates for food commodities available for Canada (Barewal and Goddard, 1984) utilized more aggregated commodity definitions or less systematic estimation methods (Hassan and Johnson, 1976) than those employed in the current analysis. In addition, the current analysis, although employing Slutsky restrictions similarly to Huang and Haidacher (1983), generated results that were more plausible, especially for the estimated income elasticities.

It is only fair to indicate that in the development of these estimates, the selection of "appropriate" prices is an important consideration. That is, for example, in the case of dairy products, the results obtained were quite sensitive to the selection of the specific dairy commodity price utilized. Clearly, time series household level data would be superior to those currently being utilized for estimating demand systems. They would permit, for example, closer identification of prices and quantities as well as translations and scalings of the demand functions based on household characteristics. In this context, the comparability of our results to those of Barewal and Goddard (1984) is especially encouraging since the latter were obtained by pooling cross-sectional data for selected years.

For the future, the direction for demand analysis appears clearly to be to integrate more directly the results from the theory with applied studies. These results may be integrated through the use of more flexible functional forms than were applied in the present case and/or the application of the Slutsky restrictions stochastically. In either case, the bridge between the theory of consumer behavior and the restrictions that apply at the representative consumer level and aggregate data available on the time series data must be improved. The approach used to make this bridge in the present analysis was to view the Slutsky restrictions as locally applicable. The analysis could be strengthened by demonstrating more clearly the sense in which the exact Slutsky restrictions applied in the current analysis were local.

REFERENCES

Agriculture Canada, Handbook of Food Expenditures, Prices and Consumption, 1983.

Barewal, S. and D. Goddard, The Parameters of Consumer Food Demand in Canada, Economics Branch Publication, Agriculture Canada, Ottawa, forthcoming 1984.

Barten, A.P., "Evidence on the Slutsky Conditions for Demand Equations," Review of Economics and Statistics 49 (1967):78-84.

Barten, A.P., "Maximum Likelihood Estimation of a Complete System of Demand Equations," European Economic Review 1 (1969):7-73.

Berndt, E.R. and N.E. Savin, "Estimation and Hypothesis Testing in Singular Equation Systems with Autoregressive Disturbances," Econometrica 43 (1975):937957.

Brandow, G.E., Interrelationships Among Demands for Farm Products and Implications for Control of Market Supply, Pennsylvania Agricultural Experiment Station Bulletin 680, University Park, 1961.

Byron, R.P., "The Restricted Aitken Estimation of Sets of Demand Relations," Econometrica 38 (November 1970):816-830.

Chang, H., "Functional Forms and the Demand for Meat in the U.S.," Review of Economics and Statistics 59 (1977):355-359.

Chavas, J.P., "Structural Change in the Demand for Meat," American Journal of Agricultural Economics 65 (1983):148-153.

Court, R.H., "Utility Maximization and Demand for New Zealand Meats," Econometrica 35(1967):424-446.

Deaton, A. and J. Muellbauer, Economics of Consumer Behavior, Cambridge University Press, 1980.

George, P.S. and G.A. King, Consumer Demand for Food Commodities in the United States with Projections for 1980, Giannini Foundation Monograph 26, University of California, Davis, 1971.

Goddard, D., "An Analysis of Aggregate Canadian Demand for Food at Home and Away from Home," Canadian Journal of Agricultural Economics 31 (1983):289-318.

Haidacher, R.C., J.A. Craven, K.S. Huang, D.M. Smallwood and J.R. Blaylock, Consumer Demand for Red Meats, Poultry and Fish, NED/ERS/USDA, ERS Staff Report No. AGES820818, September 1982.

Hassan, Z.A. and S.R. Johnson, Family Expenditure Patterns in Canada: A Statistical Analysis of Structural Homogeneity, Economics Branch Publication 76/3, Agriculture Canada, Ottawa, June 1976.

Huang, Kuo S. and Richard D. Haidacher, "Estimation of a Composite Food Demand System for the United States," Journal of Business and Economic Studies 1(4) (1983):285-291.

Johnson, S.R., Z.A. Hassan, and R.D. Green, Demand Systems Estimation--Methods and Applications, Ames: Iowa State Press, forthcoming 1984.

LaFrance, J.T., "The Structure of Constant Elasticity Demand Models," Staff Paper 84-2, Department of Agricultural Economics and Economics, Montana State University, 1984.

Phlips, L., Applied Consumption Analysis, Amsterdam: North Holland Publishing Company, 1974.

Pope, R., R. Green and J. Eales, "Testing for Homogeneity and Habit Formation in a Flexible Demand Specification of U.S. Meat Consumption," American Journal of Agricultural Economics 62 (1980):778-784.

APPENDIX

Table T1

POPULATION, PER CAPITA INCOME AND EXPENDITURES

OBS	YEAR	POPJN	INCOMEPC	PCFAHEC	PCFHE	PCFHEC	PCFDE	PCFDEC	PCNFEC	PCTE	PCTEC
1	1960	17.87	1487	88.019	267.25	341.382	7508.6	10056.5	1439.23	1425.81	1668.63
2	1961	18.24	1475	88.717	263.78	333.613	7564.8	10029.7	1428.60	1421.61	1850.93
3	1962	18.58	1579	93.046	269.61	333.837	7806.9	10190.8	1471.50	1477.51	1898.39
4	1963	18.93	1646	93.603	277.72	333.740	8068.0	10239.5	1526.80	1543.85	1954.15
5	1964	19.29	1713	94.189	288.42	343.292	8426.6	10543.7	1595.59	1627.24	2033.07
6	1965	19.64	1846	98.116	299.65	346.802	8771.0	10709.5	1673.51	1728.49	2118.43
7	1966	20.02	1994	98.556	313.37	341.808	9073.5	10462.3	1746.35	1842.65	2186.71
8	1967	20.38	2116	90.888	326.06	356.168	9359.5	10453.7	1803.34	1961.35	2250.39
9	1968	20.70	2262	90.652	334.56	354.628	9379.7	10152.5	1880.23	2111.29	2325.51
10	1969	21.00	2424	89.505	354.55	360.514	9685.3	10019.7	1947.74	2261.52	2397.76
11	1970	21.30	2536	87.315	372.00	375.052	9938.3	10083.0	1956.69	2362.77	2419.06
12	1971	21.57	2779	109.666	396.56	396.203	10927.0	10915.9	2072.33	2578.40	2578.40
13	1972	21.80	3121	116.807	435.71	402.720	11779.5	10894.7	2225.47	2853.60	2745.00
14	1973	22.04	3608	122.604	502.63	400.390	12898.0	10330.3	2375.33	3234.02	2898.32
15	1974	22.36	4212	120.367	578.52	397,822	13573.9	9331.9	2485.39	3729.33	3003.58
16	1975	22.70	4868	122.872	669.86	411.877	14456.5	8841.2	2577.37	4272.89	3112.11
17	1976	22.99	5459	133.267	714.07	433.723	14757.9	8776.7	2703.13	4856.79	3270.12
18	1977	23.29	5937	137.334	767.30	428.875	14981.8	8218.5	2740.32	5305.50	3306.53
19	1978	23.53	6601	143.553	850.58	410.922	15625.1	7552.7	2804.56	5802.47	3359.03
20	1979	23.77	7340	140.930	945.52	404.745	16036.3	6874.5	2845.45	6398.32	3391.12
21	1980	24.06	8119	143.308	1036.80	400.133	16190.5	6285.2	2857.68	7075.46	3401.12
22	1981	24.34	9284	141.413	1161.33	400.715	16224.6	5658.0	2866.29	7948.94	3408.42

Per Capita Income and Expenditures

	Current Dollars	Constant Dollars
Food-Away-Home		PCFAHEC
Food-At-Home	PCFHE	PCFHEC
All-Food	PCFDE	PCFDEC
Non-Food		PCNFEC
Total	PCTE	PCTEC
Income	INCOMEPC	

POPJN = Population

Table T2

IMPLICIT PRICE DEFLATORS

OBS	YEAR	IPFAH	IPFH	IPFD	IPNF	IPTE	IPFAH1	IPFH1	IPFD1	IPNF1
1	1960	0.60627	0.78284	0.74664	0.76791	0.76303	0.79456	1.02596	0.97853	1.00641
2	1961	0.61717	0.79069	0.75424	0.77213	0.76805	0.80355	1.02947	0.98201	1.00532
3	1962	0.61708	0.80760	0.76507	0.78184	0.77830	0.79285	1.03765	0.98429	1.00456
4	1963	0.63028	0.83214	0.78793	0.79063	0.79004	0.79779	1.05329	0.99733	1.00075
5	1964	0.64990	0.84017	0.79921	0.80071	0.80039	0.81198	1.04971	0.99853	1.00040
6	1965	0.65973	0.86405	0.81699	0.81511	0.81595	0.80856	1.05898	1.00375	0.99900
7	1966	0.69540	0.91681	0.86725	0.83645	0.84266	0.82525	1.08799	1.02919	0.99264
8	1967	0.81639	0.91548	0.89534	0.86567	0.87156	0.93670	1.05039	1.02728	0.99324
9	1968	0.84754	0.94340	0.92388	0.90409	0.90788	0.93353	1.03912	1.01762	0.99583
10	1969	0.89886	0.98345	0.96663	0.93776	0.94318	0.95301	1.04269	1.02486	0.99426
11	1970	0.95892	0.99186	0.98564	0.97462	0.97673	0.98177	1.01549	1.00912	0.99784
12	1971	1.00148	1.00089	1.00102	0.99975	1.00000	1.00148	1.00089	1.00102	0.99975
13	1972	1.07882	1.08191	1.08121	1.02984	1.03956	1.03776	1.04073	1.04007	0.99065
14	1973	1.22637	1.25535	1.24856	1.08660	1.11583	1.09907	1.12504	1.11895	0.97381
15	1974	1.45575	1.45423	1.45458	1.19723	1.24163	1.17245	1.17123	1.17151	0.96424
16	1975	1.66456	1.62636	1.63514	1.31860	1.37299	1.21237	1.18454	1.19093	0.96039
17	1976	1.79584	1.64637	1.68150	1.44403	1.48520	1.20916	1.10851	1.13217	0.97228
18	1977	1.92862	1.78911	1.82295	1.55943	1.60456	1.20197	1.11502	1.13611	0.97188
19	1978	2.06555	2.06993	2.06880	1.65993	1.72742	1.19574	1.19828	1.19762	0.96093
20	1979	2.32311	2.33607	2.33273	1.80127	1.88679	1.23126	1.23812	1.23635	0.95467
21	1980	2.53370	2.59114	2.57599	1.98607	2.08033	1.21793	1.24554	1.23626	0.95469
22	1981	2.78077	2.89815	2.86753	2.23088	2.33215	1.19236	1.24270	1.22957	0.95658

<u>Implicit Price Deflators</u>

	Current Dollars	Constant Dollars
Food-Away-Home	IPFAH	IPFAH1
Food-At-Home	IPFH	IPFH1
All-Food	IPFD	IPFD1
Non-Food	IPNF	IPNF1
Total	IPTE	

Table T3

PERSONAL DISPOSABLE INCOME AND EXPENDITURES IN CURRENT AND CONSTANT DOLLARS

OBS	YEAR	PDI	FHE	FHEC	FAHE	FAHEC	FDE	FDEC	NFE	NFEC	TE	TEC
1	1960	26567	4775.7	6100.5	953.6	1572.9	5729.3	7673.4	19750	25719.0	25479	33392.4
2	1961	26904	4811.4	6085.1	993.7	1618.2	5810.1	7703.3	20120	26057.7	25930	33761.0
3	1962	29340	5009.3	6202.7	1066.8	1728.8	6076.1	7931.5	21376	27340.5	27452	35272.0
4	1963	31168	5257.2	6317.7	1116.8	1771.9	6374.0	8089.6	22851	28902.4	29225	36992.0
5	1964	33049	5563.7	6622.1	1180.8	1816.9	6744.5	8439.0	24645	30779.0	31389	39218.0
6	1965	36263	5885.2	6811.2	1271.3	1927.0	7156.5	8738.2	26791	32867.8	33947	41606.0
7	1966	39901	6273.7	6843.0	1372.1	1973.1	7645.8	8816.1	29244	34961.9	36890	43778.0
8	1967	43123	6645.2	7258.7	1512.2	1852.3	8157.4	9111.0	31815	36752.0	39972	45863.0
9	1968	46820	6925.3	7340.8	1590.4	1876.5	8515.7	9217.3	35188	38920.7	43704	48138.0
10	1969	50911	7445.5	7570.8	1689.5	1879.6	9135.0	9450.4	38357	40902.6	47492	50353.0
11	1970	54009	7923.6	7988.6	1783.4	1859.8	9707.0	9848.4	40620	41677.6	50327	51526.0
12	1971	59943	8553.7	8546.1	2373.3	2369.8	10927.0	10915.9	44689	44700.1	55616	55616.0
13	1972	68100	9498.4	8779.3	2747.1	2546.4	12245.5	11325.7	49963	48515.3	62208	59841.0
14	1973	79719	11078.0	8824.6	3313.9	2702.2	14391.9	11526.8	56886	52352.2	71278	63879.0
15	1974	94545	12935.8	8895.3	3918.0	2691.4	16853.8	11586.7	66534	55573.3	83388	67160.0
16	1975	110996	15205.8	9349.6	4642.8	2789.2	19848.6	12138.8	77146	58506.2	96995	70645.0
17	1976	125510	16416.4	9971.3	5502.1	3063.8	21918.5	13035.1	89739	62144.9	111657	75180.0
18	1977	138094	17870.5	9988.5	6168.7	3198.5	24039.2	13187.0	99526	63822.0	123565	77009.0
19	1978	154975	20014.2	9669.0	6977.0	3377.8	26991.2	13046.8	109541	65991.2	136532	79038.0
20	1979	173810	22474.9	9620.8	7782.2	3349.9	30257.1	12970.7	121831	67636.3	152088	80607.0
21	1980	195338	24945.4	9627.2	8736.2	3448.0	33681.6	13075.2	136554	68755.8	170236	81831.0
22	1981	225989	28266.8	9753.4	9571.4	3442.0	37838.2	13195.4	155639	69765.6	193477	82961.0

<u>Expenditures</u>

Expenditures	Current Dollars	Constant Dollars
Food-Away-Home	FAHE	FAHEC
Food-At-Home	FHE	FHEC
All-Food	FDE	FDEC
Non-Food	NFE	NFEC
Total	TE	TEC

PDI = Personal Disposable Income

Table T4

PER CAPITA QUANTITY DATA IN POUNDS FOR EIGHT COMMODITY MODEL

OBS	YEAR	QM	QD	QBC	QE	QFV	QBEV	QS	QFO
1	1960	168.874	867.832	149.892	34.4583	481.357	10.7586	96.496	21.7596
2	1961	172.953	849.768	140.324	33.9071	458.495	11.1333	97.312	22.4651
3	1962	174.275	835.512	143.168	33.6646	487.596	11.4199	100.244	23.2147
4	1963	176.678	823.433	154.522	32.1434	475.978	11.6404	95.813	23.1044
5	1964	184.395	817.723	130.822	32.0332	469.519	11.2436	97.577	23.2367
6	1965	186.886	801.813	160.805	31.7466	462.420	11.1113	99.847	22.3549
7	1966	188.760	793.834	137.106	30.7104	465.374	10.3838	104.235	24.7133
8	1967	197.336	773.393	136.715	31.2616	489.382	11.1113	100.553	28.4396
9	1968	198.041	768.814	139.310	31.5482	478.690	12.0372	102.030	29.8285
10	1969	198.637	776.179	144.028	32.0773	503.624	11.0893	101.765	30.8427
11	1970	205.317	748.441	142.727	32.4741	488.214	11.7947	101.523	30.3577
12	1971	212.856	715.579	135.342	32.0111	501.309	11.3759	101.876	30.1813
13	1972	219.250	718.297	141.449	30.9529	493.571	11.5743	100.950	33.0693
14	1973	213.363	674.692	144.116	29.5860	517.183	11.7947	106.571	34.3480
15	1974	217.839	664.584	140.390	29.2774	514.559	12.3018	93.300	35.4724
16	1975	219.007	702.682	142.749	29.1010	533.872	11.9931	90.301	36.9054
17	1976	233.249	673.310	147.291	28.7262	541.742	12.2136	94.975	38.3163
18	1977	229.545	679.657	143.014	27.7782	554.529	10.3397	95.284	39.2643
19	1978	225.070	661.821	141.206	27.2932	565.971	11.5743	94.600	38.9336
20	1979	222.579	657.899	137.701	28.3515	587.378	12.0813	91.955	37.7431
21	1980	225.621	677.049	145.659	27.9326	574.084	12.1475	90.522	39.1982
22	1981	224.166	681.786	138.693	27.4476	574.084	12.5664	85.870	40.5871

Table T5

PRICE DATA PER POUND FOR EIGHT COMMODITY MODEL

OBS	YEAR	PMEAT	PPOWSKM	PWFLOUR	PEGG	PFRVEG	PBEV	PSUGAR	PTFAT
1	1960	75.0	76.22	74.2	110.9	75.0	74.70	77.2	83.0
2	1961	76.4	71.50	76.2	114.5	76.6	88.00	78.8	88.8
3	1962	80.7	67.50	83.3	103.4	79.6	90.08	78.6	87.3
4	1963	80.4	62.40	87.1	118.8	84.0	89.48	129.2	85.6
5	1964	78.4	73.10	92.2	103.2	86.6	98.50	116.2	87.9
6	1965	82.7	84.70	92.9	110.5	89.5	99.22	81.1	96.1
7	1966	92.4	84.80	96.9	130.6	89.7	99.48	78.5	100.5
8	1967	91.7	90.60	100.3	110.1	89.0	97.04	76.9	98.5
9	1968	92.7	92.10	101.7	113.3	98.2	96.60	77.7	95.0
10	1969	99.9	91.70	102.3	125.9	96.0	94.90	89.0	93.8
11	1970	102.1	93.10	101.7	113.4	97.2	100.78	92.4	98.2
12	1971	100.0	100.00	100.0	100.0	100.0	100.00	100.0	100.0
13	1972	112.8	112.50	102.7	108.5	107.0	100.65	125.9	101.1
14	1973	139.5	122.60	114.6	156.3	126.7	105.07	130.7	106.5
15	1974	152.0	123.60	145.6	173.2	143.9	118.81	339.2	155.3
16	1975	159.3	139.80	155.3	172.0	156.3	135.04	320.6	185.4
17	1976	159.1	148.00	161.9	187.8	161.7	172.88	211.0	167.4
18	1977	163.6	164.70	172.7	189.8	192.1	302.13	165.5	178.8
19	1978	211.0	229.40	187.2	192.7	236.6	335.07	200.9	201.5
20	1979	253.3	292.70	246.2	208.9	258.6	329.28	233.7	217.7
21	1980	269.5	334.20	291.8	230.7	278.8	356.70	501.6	234.2
22	1981	293.5	378.10	399.3	264.8	320.8	339.78	413.9	244.2

LIST OF WORKING PAPERS PUBLISHED IN 1984

No. 1 Revision of the Forecasting Model for the Consumer Price Index for Food. A. Pierre Cloutier

No. 2 Plant Breeders' Rights: Some Economic Considerations - A Preliminary Report. Pamela Cooper. March 1984

No. 3 The Development of an Investment Planning Tool for the Meat Packing, Processing and Distribution Industry. Deloitte, Haskins & Sells, Associates. March 1984

No. 4E Structure and Economic Importance of the Canadian Food and Beverage Manufacturing Sector: Highlights of 1970 to 1981. Yvan Loubier. March 1984

No. 4F Importance économique et structure du secteur canadien des aliments et boissons: Les faits saillants de 1970 à 1981. Yvan Loubier. Mars 1984

No. 5 A Demand Matrix for Major Food Commodities in Canada. S.R. Johnson and A.N. Safyurtlu

Available From:

André Trempe
Services Division
Marketing & Economics Branch
Sir John Carling Bldg.
Ottawa, Ontario
K1A 0C5

(613) 995-5880