A MULTISTAGE COMPLETE SYSTEM ESTIMATION OF U.S. FOOD DEMAND ELASTICITIES

by

HAOBO LUO

(Under the Direction of Chung L. Huang)

ABSTRACT

We revisit the complete system of U.S. demand for food by employing a differential form demand system approach. Price and expenditure elasticities at retail level for 37 food commodities and one nonfood sector are estimated covering the period 1953-2008. We find that the estimated composite own-price elasticities of food groups have increased and the estimated composite cross-price elasticities of food groups have decreased in absolute magnitudes as compared with the earlier study. In addition, this study shows that there are considerable differences in the complementary and substitution relationships among some of food groups as compared with earlier study. These changes in the food demand relationship reflect changes in consumption behavior or lifestyle, which would be useful to researchers and policy makers alike for forecasting future demands and in appraising the likely outcomes of potential changes in national food programs.

INDEX WORDS: Differential Form Demand System, Own-Price Elasticity, Cross-Price Elasticity, Expenditure Elasticity

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HAOBO LUO

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HAOBO LUO

Major Professor: Chung L. Huang

Committee: Michael E. Wetzstein

Wojciech J. Florkowski

Electronic Version Approved:

Maureen Grasso

Dean of the Graduate School

The University of Georgia

May 2012

DEDICATION

I would like to dedicate this work to my loving husband and daughter, who always encourage all of my pursuits. It is your love and supports that make all this possible.

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CHAPTER 1

INTRODUCTION

1.1 Background

Food demand system is an effective instrument to provide commodity forecasts and to conduct analysis of program effects. With the development of agriculture and industry over the decades, the United States along with other developed countries are expected to undergo changing in food consumption. Nowadays, consumer demands for food have become more diversified. To simply meet consumers' daily diet with old fashion commodities is not enough. New food products, new packaging, more convenience, safer and more nutritious foods are desired. Increasing in disposable income and changes in food prices may have shifted consumption patterns. The changes in tastes, occupations, lifestyles and government programs are also likely to have significant influences on food demand. Moreover, government intervention in the domestic food market may have resulted in changing in food supply or management. Besides, since there is growing prevalence of obesity in the U.S. over the last several decades, food choice has been considered as one of factors that influence the health and well beings.

There are a lot of factors that may shape the future of the U.S. food system and change consumption patterns in the United States. Hence, it is very important to understand the interrelationships among food commodities and consumption patterns. For producers, information about changes in prices and income can be used to forecast food quantities demanded. Price elasticity estimates are used to derive demand functions for given products, which provide information for producers to forecast quantities that consumers will buy at given food prices and income. Furthermore, changes in consumer demand and food choices also provide challenges and opportunities for food producers because they will influence the types of crops that farmers produce, the prices they receive, and the way in which various commodities are transformed into food products. For example, in the United States, rising demand for organic products has resulted in an expansion of area planted to organic crops from 1.3 million acres in 1997 to 2.3 million acres in 2001 (Greene and Kremen 2003). Therefore, understanding the changes in consumer demand will help food producers and suppliers to differentiate their products to meet specific demands of consumers.

For consumers, changes in food prices and per capita income are influential determinants of food demand among other factors. If consumer behaves rationally as indicated by demand theory, then individuals will substitute to less expensive foods as certain food prices increasing. For researchers, knowledge of price and income elasticities for food products is also very useful. It is very important for them to understand how price changes affect demands for various foods. For instance, good estimates for price elasticities provide guidance for researchers or policy makers to understand how price changes will affect demands for food products by shifting food prices. For a program analysis, various scenarios of changes in prices and income can be used to evaluate the program effects on food quantities demanded. Thus, food demand is a critical component in the economic analyses of national food program.

There has been an increasing concern in forecasting future food demand in the United States. Food consumption patterns in the U.S. have changed because of changes in population and its characteristics, consumer preference, personal income and education level, social structures, government intervention, and health and diet concerns. Thus, demand analyses of food are deemed important to provide up-to-date indications of the food demand and consumer behavior in future.

A complete demand system recognizes the interdependent relationships among all foods. It indicates the amounts consumers will buy at given food prices and income and is useful for forecasting changes in food quantities demanded in response to changes in food prices and income. Empirical estimates of the demand structure are also essential for providing information for commodity forecasts and analyzing the effects of changes in commodity prices and income. Thus, it is an effective model for forecasting food consumption and analyzing the effects of retail price changes on quantities of food purchased.

In the United States, Economic Research Service (ERS) has estimated three sets of U.S. complete food demand systems covering 39 food categories and an aggregate nonfood sector (Huang 1991; Huang 1993; Huang 1997). They are ordinary food demand system, which shows the amounts consumers will buy at given food prices and income; inverse food demand system, which shows the food prices consumers will pay at given food quantities and income; nutrient food demand system, which shows the effects of food prices and income on the nutrient content of diets.

1.2 Problem Statement

Consumer behavior or consumer demand may have changed over the decades. There is no doubt that advanced technology and technical innovations have made agricultural production more efficient. Consequently, producers are able to expand food supply and lower the price of food products. Besides, technological change may have also affected the life style and working habits of the population by engaging increasingly in more sedentary occupations and reduced physical activities. Thus, a better understanding and knowledge of the consumer demand and its associated effects of prices and income changes on the quantity demanded is useful for forecasting future food demands and in appraising the likely outcome of potential changes in national food programs. To investigate changes in demand for food commodities, an understanding of the consumer behavior can be provided to help food suppliers to promote their products as efficiently and effectively as possible and to decide on quantities to produce or offer for sale to maximize profit.

Empirical studies like Huang (1993) that presents estimates of a complete demand system for food commodities in the United States and with a highly disaggregated food system are very rare. In spite of the series of studies that are related to demand analysis or estimation of food demand system, the number of food products involved in most early demand works is very limited. Most early studies involved only one or two groups, or a small number of food products. However, Huang's (1993) study, which is considered as the most completed food demand analysis in the United States, is outdated since the time series data applied in that study only covered the period from1953 to 1990. Therefore a comprehensive and updated study to provide the new information about interdependent relationship among food commodities is needed. The demand elasticities need to be re-examined and updated regularly based on the most recent data available.

1.3 Objectives

The main objective of the study is to estimate a complete system of demand interrelationships among 7 major groups, which includes 37 food items and one nonfood sector. This study will update estimates of demand elasticities reported in Huang (1993) based on the most recent data available. We intend to revise and update the data series in accordance with the most recently published data sources, which covered time period from 1953 through 2008. Besides, by estimating the food demand elasticity, an understanding of the consumer behavior can be provided, which would be useful for researchers and policy makers to forecast future demands and appraise the likely outcomes of potential changes in national food programs.

1.4 Organization

The thesis is divided into 6 chapters. Chapter 1 is an introduction to food demand system. Chapter 2 is a review of literature. Relevant studies concerning methodology of food demand system, consumer behavior and food demand analysis will be summarized in this chapter. Chapter 3 provides detailed descriptions of theoretical foundation of the demand system and methodology used in this study. The differential-form of the empirical demand model used in the analysis is depicted first. Then the procedures of within-group parameter estimation and cross-group parameter estimation are presented. Finally, the procedure of obtaining parameter estimates on nonfood sector is depicted. Chapter 4 describes the data utilized in the empirical analysis, followed by Chapter 5 that presents the empirical results and discussion. The estimated parameters for 37 food categories and one nonfood sector are presented and discussed in this section. Chapter 6 provides the conclusion with some remarks regarding the important findings obtained from the estimation of the complete demand system.

CHAPTER 2

LITERATURE REVIEW

In general, all the demand systems are derived from some assumed functional form of utility, indirect utility or cost function. The representative examples are linear expenditure system (Stone 1954), the indirect translog model (Christensen et al. 1975), the almost ideal demand system (Deaton and Muellbauer 1980), the Rotterdam system (Theil 1965), and differential-form demand systems (Huang and Haidacher1983; Huang 1993).

One of the early pioneer works is Schultz's (1938) study. He conducted a quantitative study on the application of demand theory to U.S. food commodities. He adjusted the time-series data for demand shift factors and then used the OLS (ordinary least squares) to estimate quantity demand as a function of price and income. But it is just a partial demand analysis because only food price and per capita income were considered as major determinant variables in the demand equation. Brandow (1961) was the first who applied a synthetic method to estimate the demand elasticity matrix for a large number of agricultural commodities that included 24 food products and one nonfood group. Following Brandow's approach, George and King (1971) constructed a demand matrix for 49 food commodities and one nonfood sector. However, many demand elasticities reported in their study were not estimated directly from sample observations and the generated parameter estimates suffered from a major shortcoming of not being invariant to the ordering of the commodities in the demand system. Thus, their food demand system might not provide a reliable model for food consumption forecasting and policy analysis.

Two similar studies that were conducted by Court (1967) and Byron (1970), respectively, generated equivalent results by imposing the restricted conditions. But all parameters in their studies must be estimated directly. Thus, the estimation of the demand systems could be time consuming if the number of items included in the system is very large. Price and Mittelhammer (1979) estimated demand elasticities at the farm level for 14 fresh fruits by mixed two-stage least squares. But this study is not within the framework of a complete demand system.

To overcome the major drawbacks in earlier studies, Huang and Haidacher (1983) developed statistical procedures for estimating the parameters of a demand system based on the time-series data for the period 1950-1981. The empirical demand system in which all direct, cross-price, and income elasticities was estimated in a system framework, which gives information about the complete interdependent nature of demand for food at the aggregated level. Their estimation of the complete demand system that incorporates the theoretical demand constraints of symmetry, homogeneity, and Engel aggregation yielded a 13 by 14 demand elasticity matrix. The complete matrix in their studies includes 12 food groups and one nonfood sector. They found that, in most cases, the elasticity measures appear to have acceptable signs and magnitudes as to be expected.

Recognizing the need for a complete food demand analysis at disaggregate level, Huang (1993) updated and revised the demand elasticity estimates for his earlier study with an extension of time-series data from 1953 to 1990. He estimated a large demand system of 39 food commodities plus one nonfood group by employing two sequential statistical procedures to show that it is possible to estimate the demand parameters directly using only the Engel aggregation, homogeneity, and symmetry conditions. A complete matrix of direct, cross-price and expenditure elasticities for 39 food items and one nonfood sector are obtained in that study. The results provided an effective instrument for assessing the effects of changes in food demand in the United States.

Raper et al. (2002) analyzed food expenditures and subsistence quantities of poverty status and non–poverty status of U.S. households based on a linear expenditure system. They obtained expenditure elasticities, own–price elasticities and subsistence quantities for each income group across nine food commodity groups. Furthermore, they found elasticity estimates and subsistence quantity estimates differ across income groups, which supported the premise that policies targeted at specific income groups should be based on the target group's elasticity estimates rather than average population elasticities.

Lee et al. (1992) estimates the demand relationships among selected fresh fruit and juice in Canada for the time period from 1960 through 1987 based on the Rotterdam model. Results show that if Canadian consumers spent larger portions of their budgets on the consumption of fresh fruit and juices, expenditure shares on oranges and apples would increase, with fresh oranges benefitting the most. Besides, they found oranges and grapefruit are substitutes for apples. Thus, an increase in the price of fresh apples would increase the consumption of citrus and hence increasing citrus imports. Clements and Qiang (2003) provided a review of Theil's path-breaking research on cross-country demand and investigated the extent to which tastes are similar internationally and differences in incomes and prices explain international consumption patterns. They found that more than 99% of the variation in international consumption patterns could be explained by differences in incomes and relative prices. Thus, it might be appropriate to allow the coefficients of cross-country demand equations to vary with country groups.

During the last decade, agricultural economists have increasingly adopted the almost ideal demand system (AIDS) and the Rotterdam model (RM) as the demand systems of choice in many empirical applications. Pashardes (1993) examined how the parameters of the linear approximate AIDS are affected by the use of Stone index. By comparing analytical expressions and empirical findings obtained from the model with and without the Stone index approximation, he shows that the approximation can result in biased parameter estimates especially when the AIDS model is applied to microdata. Moschini (1995) found that the Stone index typically used in estimating a linear AIDS model is not invariant to changes in units of measurement, which may seriously affect the approximation properties of the model. In addition, the results suggested that a modification to the Stone index or use of a regular price index instead is a desirable practice in estimating linear AIDS models.

Green and Alston (1990; 1991) presented correct method of calculating elasticities for the linear approximate AIDS (LA/AIDS). However, Hahn (1994) discovers that the LA/AIDS itself lacks merit after checking the implication of treating the LA/AIDS as a system in its own right. Asche and Wessells (1997) showed that the AIDS and LA/AIDS representations are identical at the point of normalization if the prices in the system are normalized to one. Besides, they suggest that the expressions for price and expenditure elasticities from both systems are identical at the point of normalization.

Using U.S. meat demand data, Alston and Chalfant (1993) developed a test of comparing LA/AIDS and Rotterdam model. The results indicated the fact that the LA/AIDS was rejected should not be interpreted as evidence that RM is superior in any general way. Akbay et al. (2007) analyzed Turkish household food consumption data obtained from the 2003 Turkish Household Expenditure Survey using the LA/AIDS with a two-stage estimation technique. They found the highest expenditure elasticity is for the meat and meat products groups, which suggest that the demand for meat and meat products will grow faster than for other food products as the economy develops and income increases.

Andersen and Caicedo (1978) estimated nutritional and food demand implications of changing consumer income distribution. The results in their study suggest that changes in income distribution can effectively improve human nutrition even in the absence of food supply expansions and these same changes also have a large impact on the demand for individual food commodities. Capps and Havlicek (1984) investigated national and regional demand patterns for meat, poultry, and seafood in the United States. The results show that meat, poultry, and seafood purchases were very sensitive to changes in own-price, total expenditure and household size, and were less sensitive to cross-price changes, regional differences, and differences in degree of urbanization.

Fulponi (1989) showed the results from estimating an AIDS for food and meat for France, as well as examined possible changes in patterns of demand behavior at different points by calculating mean values of income and price elasticities. Mergos and Donatos (1989) estimated a complete matrix of price and income elasticities for various food commodity groups for Greece. The empirical results indicate that meat and other livestock products have acquired in the diet of Greek consumers during a period of high-income growth and rising living standards and further increase in meat and milk demand is expected to take place as long as incomes keep rising. Capps and Schmitz (1991) analyzed the demands for beef, pork, poultry and fish based on a theoretical framework in which to formally consider health and nutrition factors.

To develop improved methods for analyzing demand relationships for food and other commodities, several alternative model specifications are analyzed by Blanciforti et al. (1986). They estimated the demand system for U.S. consumer expenditures for 11 aggregate commodity groups and 4 food groups for the period 1948-1978. Park et al. (1996) estimated own-price and income elasticities for 12 food commodity groups according to household poverty status. They concluded that it is not likely to be successful to use average estimates of price and income elasticities for the population as a whole for the projection of individual commodity demands if notable changes are evident in income distribution.

You et al. (1996) estimated demand in the U.S. at retail level for 11 fresh fruits and 10 fresh vegetables by employing a composite demand system approach developed by Huang (1993). Variyam and Golan (2002) investigate how health information is reshaping consumer food preferences along with the nation's food and agricultural sectors. Davis and Stewart (2002) examine changing consumer demands over the decades and analyze how changing consumption patterns create opportunities for U.S. food system. As obesity has been considered as an economic phenomenon, several studies (Lakdawalla and Philipson 2002; Cutler et al. 2003; Chou et al. 2004; Finkelstein et al. 2005; Gelbach et al. 2007) were conducted to investigate relationships between food consumption and obesity. Luo and Huang (2010) show that healthful food is more expensive than unhealthful food, and consequently unhealthful food is more likely to be purchased and consumed in substitution for healthful food.

Using the AIDS and family expenditure data, Asano and Fiuza (2003) estimated the Brazilian consumer demand system, which covered seven broad categories of consumption goods and services. Dong et al. (2004) developed an estimable household demand system to analyze 12 food commodities based on a random sample of urban Mexican households. Reed et al. (2005) proposed nineteen food items to be aggregated into five at-home food composites. They presented estimates of composite demand elasticities of five at-home food composites, food away from home sector and one nonfood sector. Although they included more food groups in their study than You et al. (1996), the number of food categories involved in this study is still limited. Tey et al. (2008) analyzed the effects of demographic and socio-economic factors on food demand in Malaysia by applying the LA/AIDS model. Jabarin and Karablieh (2011) most recently estimated the different types of demand elasticities for the main fresh vegetables consumed in Jordan.

CHAPTER 3

METHODOLOGY

To estimate a complete demand system and update the demand elasticities, we follow the differential-form demand systems and the estimation procedures developed in Huang and Haidacher (1983), and Huang (1993). The application of the differential-form demand system has certain advantages as compared with other methods. First of all, time series data on expenditure shares are not required by the demand system (Huang and Haidacher 1983). Secondly, the specification of the demand system yields conveniently the demand elasticities as the results of the statistical estimation. So one can directly interpret demand parameters as elasticities. Thirdly, since the demand system is linear in parameters it can be easily estimated by using the OLS procedure, and the computational burden is reduced considerably. To remain compatible, we estimate the same demand system model with similar food and nonfood classifications developed in Huang (1993) and based on the data that cover the period from 1953 through 2008.

3.1 Modeling Ordinary Demand Systems

Based on utility maximization, the Marshallian demand can be specified as a function of prices and income:

$$q_i = f_i(p, y) \quad i = 1, 2, \ldots, n, \tag{1}$$

where q_i denotes quantity demanded for commodity i; and p and y represent a collection of all commodity prices and total expenditure or income, respectively.

Following Huang (1993) and applying the first-order differential approximation of the conceptual demand model, the demand system can be expressed as follows:

$$dq_i = \sum_{j=1}^{n}\left(\partial q_i/\partial p_j\right)dp_j + (\partial q_i/\partial y)dy, \quad i = 1, 2, \ldots, n, \tag{2}$$

where dq_i and dp_i are n x 1 vectors of some changes in price and quantity; $\sum_{j=1}^{n}(\partial q_i/\partial p_j)$ is the n x n matrix of price slope, the i th row of which consists of elements $\partial q_i/\partial p_j$, j = 1, 2, …, n; $\partial q_i/\partial y$, i = 1, 2, …, n, are expenditure slopes for the i th row. Alternatively, we can rewrite equation (2) in terms of elasticities, and thus obtain the differential-form demand system:

$$dq_i/q_i = \sum_{j=1}^{n} e_{ij}(dp_j/p_j) + \eta_i(dy/y), \quad i = 1, 2, \ldots, n, \tag{3}$$

where $e_{ij} = (\partial q_i/\partial p_j)(p_j/q_i)$ is the price elasticity of the i th commodity with respect to a price change of the j th commodity, and $\eta_i = (\partial q_i/\partial y)(y/q_i)$ is an income elasticity which measures the effect of changes in quantity demanded for the i th commodity in response to a change in per capita expenditure. Given a demand structure consisting of G food categories and one nonfood sector (i.e., n = G + 1), we can rewrite the complete demand system of a representative consumer as a set of linear equations with n x (n + 1) parameters:

$$\begin{aligned}
\dot{q}_1 &= \mathrm{e}_{11}\dot{p}_1 + \mathrm{e}_{12}\dot{p}_2 + \cdots + \mathrm{e}_{1G}\dot{p}_G + \mathrm{e}_{1n}\dot{p}_n + \eta_1\dot{y} \\
&. \\
&. \\
\dot{q}_G &= \mathrm{e}_{G1}\dot{p}_1 + \mathrm{e}_{G2}\dot{p}_2 + \cdots + \mathrm{e}_{GG}\dot{p}_G + \mathrm{e}_{Gn}\dot{p}_n + \eta_G\dot{y} \\
\dot{q}_n &= \mathrm{e}_{n1}\dot{p}_1 + \mathrm{e}_{n2}\dot{p}_2 + \cdots + \mathrm{e}_{nG}\dot{p}_G + \mathrm{e}_{nn}\dot{p}_n + \eta_n\dot{y}.
\end{aligned} \tag{4}$$

Equation (4) can be compactly written as follow:

$$\dot{q} = \mathrm{E}_p\dot{p} + \eta\dot{y}, \tag{5}$$

where $\dot{q},\ \dot{p},\ and\ \dot{y}$ represent n x 1 vectors of relative change in quantity, price, and expenditure index, respectively, E_p is a n x n matrix of price elasticities, and η is a n x 1 vector of income elasticities.

3.2 Parametric Constraints of Ordinary Demand Systems

To be consistent with the demand properties derived from the classical demand theory, the theoretical demand constraints of Engel aggregation, homogeneity and symmetry are imposed in the estimation process. These theoretical properties expressed in elasticity terms are presented as follows:

$$\sum_{i=1}^{n} w_i \eta_i = 1, \qquad \text{Engel aggregation} \qquad (6)$$

$$\sum_{j=1}^{n} e_{ij} = -\eta_i, \qquad \text{for } i = 1, 2, \ldots, n, \qquad \text{Homogeneity} \qquad (7)$$

$$\left(\frac{e_{ji}}{w_i}\right) + \eta_j = \left(\frac{e_{ij}}{w_j}\right) + \eta_i, \qquad \text{for } i = 1, 2, \ldots, n\ (i \neq j), \qquad \text{Symmetry} \qquad (8)$$

where $w_i = p_i q_i / y$ is the expenditure weight of the i^{th} commodity. Instead of applying a constrained maximum likelihood method (Huang and Haidacher 1983; Huang 1993), the demand system of equation (5) and the theoretical constraints of equations (6) - (8) are estimated by employing the iterative seemingly unrelated regression procedure (ISUR) from SAS.

As noted previously, the estimation of the demand system yields the price and income elasticities directly. The own-price and cross-price elasticities obtained are known as uncompensated (Marshallian) price elasticities. To obtain the compensated (Hicksian) elasticities, we apply the Slutsky equation, which states

$$e_{ij}^{h} = e_{ij}^{m} + \eta_i w_j, \qquad (9)$$

where e_{ij}^{h} is the compensated or Hicksian price elasticity, e_{ij}^{m} is the uncompensated or Marshallian price elasticity, and η_i and w_j are income elasticity and budget share, respectively, as previously defined. The compensated price elasticities serve as a more accurate and appropriate measures for discussing the nature of demand in relation to cross-price effects. Empirically, it is not uncommon to observe that two commodities are found to be substitutes based on compensated cross-price elasticity while they are considered as complements based on the uncompensated cross-price elasticity. The compensated elasticities measure the net effect of a change in price excluding the income effect. Thus, it would be more appropriate to classify whether two commodities are substitutes or complements based on compensated cross-price elasticities than uncompensated cross-price elasticities.

3.3 Estimation Procedures

Actual estimation procedures were carried out in steps in this study. The first step is to obtain statistically efficient estimates of the major food group demand parameters. The food commodities that include 37 categories and one nonfood sector were partitioned into 6 groups with corresponding aggregate prices and quantities. A composite food demand system of 6 food groups plus one nonfood group, subject to Engel aggregation, homogeneity, and symmetry, was first estimated to obtain the composite cross-price estimates at the aggregate level. The demand system in equation 5 can be represented as a set of $n = (G + 1)$ equation in matrix form as shown in Figure 1:

$$\begin{bmatrix} \dot{Q}_1 \\ \dot{Q}_2 \\ \vdots \\ \dot{Q}_G \\ \dot{Q}_n \end{bmatrix} = \begin{bmatrix} E_{11} & E_{12} & \cdots & E_{1G} & E_{1n} \\ E_{21} & E_{22} & & E_{2G} & E_{2n} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ E_{G1} & E_{G2} & \cdots & E_{GG} & E_{Gn} \\ E_{n1} & E_{n2} & & E_{nG} & E_{nn} \end{bmatrix} \times \begin{bmatrix} \dot{P}_1 \\ \dot{P}_2 \\ \vdots \\ \dot{P}_G \\ \dot{P}_n \end{bmatrix} + \begin{bmatrix} \Theta_1 \\ \Theta_2 \\ \vdots \\ \Theta_G \\ \Theta_n \end{bmatrix} \dot{Y}$$

Figure 1. A Matrix Representation of the Composite Demand System

where $\dot{Q}_i$ and $\dot{P}_i$, are relative changes of aggregate quantities and prices for composite food groups and nonfood group, $i = 1, 2, \ldots, G, n$; $\dot{Y}$ are relative changes of total expenditure; and E_{ij} and Θ_i are the price and income elasticities, respectively, for the composite demand system. The specification and estimation of the composite food demand system is designed to facilitate the ultimate estimation of the large demand system that consists of individual or disaggregate food products. The demand elasticities obtained from the estimation of the composite food demand system will be used to make quantity adjustments for within-group and cross-group estimations in the following steps.

In the second step, the estimation of within-group demand parameters was based on adjusted quantities. The process uses the estimated composite cross-price estimates obtained from the composite food demand system as prior information to adjust within-group quantities so that the impacts of those commodity prices outside the group can be excluded. In this way, the process effectively reduces the number of parameters to be estimated to a manageable magnitude that includes only those disaggregate food products in group. It is important to note that the process of quantity adjustment makes use of the same aggregate estimates as prior information and they are not affected by the ordering of commodity groups. Thus, the estimations of the within-group demand parameters are invariant of the ordering of the commodity groups. This stage of within-group estimation procedure is illustrated in Figure 2, where the demand matrix of the disaggregate food items was represented by the shaded sub-matrix on the diagonal blocks. The estimation was carried out block by block based on the broader aggregate food groups obtained from estimation of the composite food demand system.

e_{11} e_{12} e_{13} e_{21} e_{22} e_{23} e_{31} e_{32} e_{33}	E_{12}	E_{13}	$\cdots$	E_{1G}	E_{1n}	η_1 η_2 η_3
E_{21}	e_{44} e_{45} e_{54} e_{55}	E_{23}	$\cdots$	E_{2G}	E_{2n}	η_4 η_5
E_{31}	E_{32}	e_{66} e_{67} e_{76} e_{77}	$\cdots$	E_{3G}	E_{3n}	η_6 η_7
$\cdots$	$\cdots$	$\cdots$	$\cdots$	$\cdots$	$\cdots$	$\cdots$
E_{G1}	E_{G2}	E_{G3}	$\cdots$	E_{GG}	E_{Gn}	η_G
E_{n1}	E_{n2}	E_{n3}	$\cdots$	E_{nG}	E_{nn}	η_n

Figure 2. Within-Group Estimation of Demand Parameters

The parameter estimates within each food group including expenditure elasticities were estimated only subject to symmetry constraint. Assuming that there are three food items in the first food group as shown in Figure 2, the within-group demand parameter estimates are obtained by equation (10):

$$\ddot{q}_1 = e_{11}\dot{p}_1 + e_{12}\dot{p}_2 + e_{13}\dot{p}_3 + \eta_1\dot{y}$$

$$\ddot{q}_2 = e_{21}\dot{p}_1 + e_{22}\dot{p}_2 + e_{23}\dot{p}_3 + \eta_2\dot{y} \quad (10)$$

$$\ddot{q}_3 = \mathrm{e}_{31}\dot{p}_1 + \mathrm{e}_{32}\dot{p}_2 + \mathrm{e}_{33}\dot{p}_3 + \eta_3\dot{y}$$

where $\ddot{q}_i = \dot{q}_i - \sum_{j=2}^{G} E_{Ij}\dot{p}_j - E_{In}\dot{p}_n$, i = 1, 2, and 3. The dependent variables, $\ddot{q}_i$, in equation (10) are adjusted quantities obtained by subtracting the price effects of those food products and nonfood category outside the food group in equation; and all the independent variables are the same as previously defined. Equation (10) is to be estimated as a simultaneous system of equations subject to the symmetry condition of equation (8).

The third step for completing the estimation of the demand elasticities matrix is to estimate the cross-groups demand parameters. The parameter estimates for each pair of cross-groups is not affected by the ordering of commodity groups. Figure 3 illustrates the procedure of the estimation of cross-groups demand elasticities.

As illustrated in Figure 3, one may start with the first cross-group in the shaded first block of rows and its symmetric pair in the shaded first block of columns, and complete the cross-price elasticities of food commodities in the group in that row and column. The cross-price elasticities in each pair of cross-groups will be estimated simultaneously by applying the symmetry condition. By continuing such a row-column operation sequentially, all the cross-price elasticities of food commodities can be obtained group by group.

Prior to the estimation of the model, the homogeneity condition was first introduced to adjust the relative changes of all food commodity prices and expenditure by subtracting the relative change of nonfood price from all food prices and dropping the nonfood group from the estimation. The adjustment process is equivalent to deflating all prices and expenditure of a demand equation by the nonfood price, leaving no change in the quantity demanded. The quantities demanded were adjusted again by using within-group parameter estimates obtained in the second step and combined with the exclusions of composite cross-price effects for those commodity prices outside the corresponding cross-group.

e_{11}	e_{12}	e_{13}	e_{14}	e_{15}						η_1
e_{21}	e_{22}	e_{23}	e_{24}	e_{25}	E_{13}		$\cdots$	E_{1G}	E_{1n}	η_2
e_{31}	e_{32}	e_{33}	e_{34}	e_{35}						η_3
e_{41}	e_{42}	e_{43}	e_{44}	e_{45}	E_{23}		$\cdots$	E_{2G}	E_{2n}	η_4
e_{51}	e_{52}	e_{53}	e_{54}	e_{55}						η_5
E_{31}			E_{32}		e_{66}	e_{67}	$\cdots$	E_{3G}	E_{3n}	η_6
					e_{76}	e_{77}				η_7
$\cdots$			$\cdots$		$\cdots$		$\cdots$	$\cdots$	$\cdots$	$\cdots$
E_{G1}			E_{G2}		E_{G3}		$\cdots$	E_{GG}	E_{Gn}	η_G
E_{n1}			E_{n2}		E_{n3}		$\cdots$	E_{nG}	E_{nn}	η_n

Figure 3. Cross-Group Estimation of Demand Parameters

Assuming that there are two food products in group 2 as shown in Figure 3, the demand equations for individual food items to be estimated for the first pair of the cross-groups *i* and *j* can be represented as:

$$\ddot{q}_i = \mathrm{e}_{i4}(\dot{p}_4 - \dot{p}_n) + \mathrm{e}_{i5}(\dot{p}_5 - \dot{p}_n), \qquad i = 1, 2, \text{ and } 3, \qquad (11)$$

where $\ddot{q}_i = \dot{q}_i - \sum_{j=1}^{3} \mathrm{e}_{ij}\left(\dot{p}_j - \dot{p}_n\right) - \sum_{j=3}^{G} E_{1j}\left(\dot{P}_j - \dot{P}_n\right) - \eta_i(\dot{y} - \dot{p}_n)$,

and

$$\ddot{q}_j = \mathrm{e}_{j1}(\dot{p}_1 - \dot{p}_n) + \mathrm{e}_{j2}(\dot{p}_2 - \dot{p}_n) + \mathrm{e}_{j3}(\dot{p}_3 - \dot{p}_n), \qquad j = 4 \text{ and } 5, \qquad (12)$$

where $\ddot{q}_j = \dot{q}_j - \sum_{i=4}^{5} \mathrm{e}_{ij} (\dot{p}_i - \dot{p}_n) - \sum_{j=3}^{G} E_{2j} (\dot{P}_j - \dot{P}_n) - \eta_j(\dot{y} - \dot{p}_n)$.

Equations (11) and (12) comprise a system of 5 equations to be estimated for the first pair of cross-groups estimation. The cross-price elasticities in equations (11) and (12) are estimated simultaneously again by applying the symmetry condition of equation (8).

The final step in the estimation of the full demand matrix is to estimate the demand elasticities associated with the nonfood group, i.e., the own-price, cross-price, and expenditure elasticity of the nonfood group. At this stage, we basically have filled out all the elements in the demand matrix except for the row and column associated with the nonfood group as shown in the shaded areas in Figure 4.

Given the estimated own-price elasticities, cross-price elasticities, and expenditure elasticities of food categories the parameter estimates for the nonfood sector can be obtained by the following procedures. Firstly, the expenditure elasticity of nonfood (cell (1) in Figure 4) is computed by applying the Engel aggregation of equation (6). Secondly, the cross-price elasticities of nonfood with respect to each food items (shaded area (2) in Figure 4) are obtained using homogeneity condition of equation (7). Thirdly, symmetry restriction of equation (8) is applied to derive the cross-price elasticities of each food item with respect to nonfood price (shaded area (3) in Figure 4). Finally, homogeneity is applied again to calculate the own-price elasticities for nonfood (cell (4) in Figure 4).

Food Items	1	2	⋯	37	Nonfood	Expenditure
1	e_{11}	e_{12}	⋯	e_{137}		η_1
2	e_{21}	e_{22}	⋯	e_{237}		η_2
⋮	⋮	⋮	⋮	⋮	(2)	⋮
37	e_{371}	e_{372}	⋯	e_{3737}		η_{37}
Nonfood		(3)			(4)	(1)
Weight	w_1	w_2	⋯	w_{37}	w_{38}	NA

Figure 4. Steps Used in the Estimation of Demand Elasticities for Nonfood Group

The methodology and procedures described in this chapter allow us to estimate a large-scale demand system that contains a total of 1,482 demand elasticities in sequential steps. The estimation procedures allow the estimation of various subgroups of food commodities without invoking any separability assumptions of the utility function. The sequential procedures, by and large, help to avoid the potential degree of freedom problems associated with a large number of commodities in a demand system, while the demand properties were strategically imposed at various stages. As it can be easily verified, the empirical demand matrix represented by Figure 4 satisfies the theoretical properties of the demand functions as suggested by the theory.

CHAPTER 4

DATA

Estimation of the complete food demand system for the United States in this study is based on time series data of food prices, quantities, per capita total expenditure and a set of fixed values of expenditure weights represented for the sample period. The basic data that are applied in the estimation of the complete food system is relative change of price index, relative change of quantity index, per capita total expenditure for the period from 1953 through 2008 and a set of fixed values of expenditure weights.

The quantity data used for estimating the demand systems are retail-weight equivalents of civilian food disappearance. We obtained quantities for individual food commodity from several sources such as the U.S. Department of Agriculture, Economic Research Service, Food Availability (Per Capita) Data System; Agricultural Statistics; Fruit and Tree Nuts Situation and Outlook Yearbook; Food Consumption, Prices, and Expenditures (Putnam and Allshouse 1999); U.S. fresh market vegetable statistics; Bureau of Labor Statistics; Vegetables and Melons Yearbook; and Oil Crops Situation and Outlook Yearbook. The nonfood quantity is computed from the current value of per capita expenditure on nonfood divided by CPI of all items less food.

The sources that we obtained retail prices or price indexes for individual food commodity are the U.S. Department of Commerce, Bureau of Economic Analysis; the U.S. Department of Labor, Bureau of Labor Statistics; Agricultural Prices Summary; Vegetables and Melons Yearbook; Fruit and Tree Nuts Situation and Outlook Yearbook; Tree Nuts; Frozen Fruits and Vegetables Expenditure; Food Consumption, Prices, and Expenditures (Putnam and Allshouse

1999); Red Meat Yearbook; and Dairy Yearbook. Worth to mention is the price and quantity data may not correspond exactly because not all food is sold through retail food stores and the data source is limited. However, it was the best one could achieve.

Per capita total expenditure was calculated by dividing the personal consumption expenditures (obtained from the U.S. Department of Commerce, Bureau of Economic Analysis, National Economic Accounts) by the civilian population (obtained from the U.S. Census Bureau, Population Division) of the United States on July 1 from 1953 through 2008. With respect to expenditure weights, we apply mean values of 1982-1984, which is about the mid-point of the sample period, as a set of fixed values of expenditure weights in the estimation procedures. The composite food expenditure weights used for the estimation of the empirical model are calculated from personal consumption expenditures by major food products. However, the time series data on personal consumption expenditures by food products published by U.S. Department of Commerce, Bureau of Economic Analysis include food at home only. Thus, to make the food expenditure weights more accurate one needs to count the proportion of food away from home into total expenditures on food. We calculate composite food expenditure weights for food at home first. Then, we proportionally allocated personal consumption expenditures on food away from home to each composite food group according to the expenditure weight for food at home. Given the expenditure weight for total food, the weight is proportionally allocated to each composite food category in accordance with its value in 1982-1984. The expenditure weights for disaggregate food items are then obtained by taking the product of their within-group expenditure weights and composite food expenditure weights.

Because of the wide range of time series covered in this study and the limited availability of data sources the retail prices or price indexes for fresh and frozen fish, canned and cured fish, cheese, wheat flours, rice, other fresh vegetables, peanuts and tree nuts, frozen vegetables, and ice cream and other frozen dairy products in 1953-1977 are unavailable, as well as other fresh fruits and canned fruit cocktails in 1953-1979. With respect to quantity data, potatoes, lettuce, other fresh vegetables, and canned peas in 1953-1969 are unavailable neither. However, to compare the index numbers for individual food commodity in Huang (1993) with those we collected in this study, we find they are almost matched. Thus, to remain relevant and to be consistent with Huang (1993) it is reasonable to utilize the index numbers applied in his study to replenish missing values in our study.

The food classification in this study is slightly different from Huang (1993). The breakdown of food groups and food classification in this study was based on data availability and the practical use of food categories. In general, the number of food categories in the complete demand system has been reduced from 39 in Huang (1993) to 37. We combine butter, margarine, and other fats and oils as one food category, and have it included in the staples group. In addition, we delete other processed fruits and vegetables from food categories and aggregate frozen fruits and frozen juice into one food commodity. Specifically, the detailed food items included in each aggregate food group are:

(1) Meats: beef and veal, pork, other meats, chicken, turkey, fresh and frozen fish, canned and cured fish, eggs, and cheese.
(2) Staples: fluid milk, evaporated and dry milk, wheat flour, rice, potatoes, fats and oils.
(3) Fresh fruits: apples, oranges, bananas, grapes, grapefruits, and other fresh fruits.
(4) Fresh vegetables: lettuce, tomatoes, celery, onions, carrots, and other fresh vegetables.
(5) Processed fruits and vegetables: frozen fruits and juice, canned tomatoes, canned peas, canned fruits cocktail, peanuts and tree nuts, and frozen vegetables.

(6) Desserts: coffee and tea, ice cream and other frozen dairy products, sugar, and sweeteners.

(7) Nonfood: all items less food.

The basic data that are applied in the estimation of the complete food system are index numbers, which are measured with a base of 1982-1984 = 100. Price and quantity indexes for food groups are constructed from individual index numbers and with-in group expenditure weights of individual food commodity. To estimate a composite food demand system, we need to calculate the composite food index numbers. We compute the composite food index numbers based on the disaggregated food index numbers and within-group expenditure weights. Corresponding price and quantity index numbers are constructed from detailed individual food commodity prices and quantities. More specifically, the procedures that we obtained the composite food price index numbers are as follows: first, given the disaggregate food quantities and retail prices, we computed the within-group expenditure weights for each disaggregate food items by taking the ratio of disaggregate expenditures and aggregate expenditures. Second, we multiplied price index by within-group expenditure weight for individual items that we obtained from the first step. Finally, we obtained the composite food price index by computing the sum of products described in the previous step. The composite food quantity index is obtained by applying the same procedures. The quantity index for nonfood sector is calculated by dividing the current value of per capita expenditure on nonfood by the CPI of all items less food.

CHAPTER 5

EMPIRICAL RESULTS AND DISCUSSION

5.1 Aggregate Food Demand System

Overall, the statistical results obtained based on time periods 1953-2008 suggest the data fits the model quiet well with the system weighted R^2 = 0.7139. Table 1 gives the demand elasticities for the food groups and the nonfood sector estimated in this study along with those reported in Huang (1993). As shown in the diagonal entries of Table 1, all the estimated own-price elasticities are negative and less than one as expected, which indicate the demand for food is price inelastic. The estimated own-price elasticities are all statistically significantly different from zero, suggesting that changes in the price of each food group had significant effects on their quantity demand.

On average, the own-price elasticities have increased in absolute terms from a range of -0.9794 to -0.1049 in Huang (1993) excluding fats and oils, which is aggregated into staples group in this study, to a range of -0.9848 to -0.1087 in this study. For nonfood group, we also found it has become relatively more responsive to price changes with the own-price elasticity increased from -0.9794 to -0.9848 in absolute terms. In general, the estimated own-price elasticities are quite close in terms of magnitude from that reported in Huang (1993). In agreement with Huang (1993), we found that meat and processed fruits and vegetables to be most responsive to their own price changes. The estimated own-price elasticities of meat and processed fruits and vegetables in this study are -0.3613 and -0.3009, respectively, which are quite close in terms of magnitude from that reported in Huang (1993). The estimated own-price elasticities of meat and processed fruits and vegetables in Huang (1993) are -0.3611 and -0.2876, respectively.

The cross-price elasticities in terms of absolute magnitude have decreased from a range of -0.3599 to 0.3908 in Huang (1993) to a range of -0.2104 to 0.221 in this study and exhibit considerable differences in the complementary and substitution relationships among some of food groups (Table 1). For example, the relationships between fruits and vegetables are substitution in the earlier study. However, their relationships are complementary in this study, which imply that Americans increase varied diets toward more fruits. Our results also show different relationships between meats and vegetables. In this study, we found that meats and vegetables to be substitutes instead of complements as reported in the earlier study. However, the cross-price elasticities in the two studies also suggest same complementary and substitution relationships among fruits, processed fruits and vegetables, and desserts groups. More specifically, fresh fruits are significant complements for processed fruits and vegetables, while they are significant substitutes for desserts in both studies.

With respect to expenditure elasticities, we found they have decreased, in absolute terms, from a range of -0.3840 to 1.1500 in Huang (1993) to a range of -0.0284 to 1.1165 in this study. However, similar to Huang (1993), the results in Table 1 show that all estimated elasticities for food groups, except for fresh fruits, are positive and less than one, suggesting that most food categories are normal goods as to be expected. Similar to Huang (1993), we also found the expenditure elasticity for the fresh fruits group to be negative but statistically insignificant. The nonfood category is considered as a luxury goods, which is consistent with the finding of Huang (1993). Furthermore, both of our results as well as that of Huang's (1993) study show that meats, among all food groups, are most responsive to changes in income. And meats and staples are found to have become more responsive to changes in income because they have larger magnitudes of estimated income elasticities as compared with Huang (1993). On the other hand, fresh vegetables, processed fruits and vegetables, desserts and nonfood are found to be less responsive to changes in income because of their estimated expenditure elasticities appear to be smaller in magnitudes as compared with Huang (1993).

With respect to expenditure weights, we found meats, fresh fruits, processed fruits and vegetables and desserts have smaller magnitudes while staples, fresh vegetables and nonfood have larger magnitudes as compared with Huang (1993). There are several factors that may have contributed to the differences. Firstly, the base years used in the two studies are different. Expenditure weights reported in Huang (1993) were based on the means of 1967-1969. However, the expenditure weights used in this study are the means of 1982-1984, which indicate expenditure shares for food commodities have changed over the decades. Secondly, food items included in this study are slightly different from that in Huang (1993). Although we include less food categories in this study and they are not exactly the same as in Huang (1993) due to data limitations and availabilities, we have tried to match the food items in Huang (1993) as close as possible. Taking staples group as an example, fats and oils are included in this group in addition to fluid milk, evaporated and dry milk, wheat flour, rice and potatoes that were included in Huang (1993). Thus, it is reasonable that expenditure share of staples group in this study has a larger magnitude than that in Huang (1993). Thirdly, consumers are likely to pay more attention to diet and health issues as they become more educated. Raunikar et al. (1985) and Blisard et al. (2002) suggest that the effect of increased education levels is expected to increase consumption of vegetables while decrease consumption of cereals, red meats and starchy vegetables. As indicated in Pollack (2001), increased domestic production, product convenience, technological improvements and concern for health and diet have make vegetables consumption in the U.S. increased over the past two decades along with the nation's prosperity. As income increases, consumers are likely to include more protein and animal products in their diets, and change the types of products they consume to include more perishable fruits and vegetables.

One of the purposes of this study is to investigate if there has been a structural change in food consumption over the decades. One method to examine the existence of structural change is to test for significant time trends in the demand equation (3). Given the use of a demand system in differential forms, the intercepts imply trends in per capita consumption. A positive and statistically significant intercept implies an increase in consumption of a commodity over time. On the other hand, a negative and statistically significant intercept implies a decrease in consumption of commodity over years. The estimated constants in this study indicate significant decreasing consumption trends for meats and desserts. Similarly, meats and desserts also have negative signs in Huang (1993) among the statistically significant estimates of constants, suggesting the per capita consumption of these two food groups is decreasing over the decades. However, there are no significant trend effects found in the demands for staples, fresh fruits, fresh vegetables, and processed fruits and vegetables. In contrast, processed fruits and vegetables are found to be increasing in consumption in Huang (1993). To investigate if there has been a structural change in the demand for food since the earlier study by Huang (1993), a dummy variable was used to identify the post Huang's (1993) study time period from 1991 to 2008. A preliminary analysis shows that the dummy variable was statistically significant only for the staples group. It may due to fats and oils are included in the staples group in this study.

It should be noted that the own-price and cross-price elasticities reported in Table 1 are uncompensated elasticities. Thus, the cross-price relationships among food groups are considered as either gross substitution or gross complement, while the Hicksian or compensated elasticities represent a net substitution or complement relationship. The Hicksian or compensated price elasticities are obtained by using equation (9) and the results are presented in Table 2.

As shown in Table 2, the compensated elasticities imply that staples, fresh fruits and fresh vegetables are substitutes for meats, while processed fruits and vegetables and desserts are considered complements. Except for the nonfood group, the relationships among food groups are fairly consistent as defined by compensated and uncompensated cross-price elasticities. In particular, Table 2 shows that nonfood is a net substitute to all food groups, while it is considered as a complement to most food groups in Table 1.

5.2 Disaggregate Food Demand Systems

The parameter estimates of the complete food demand system for 37 food items and one nonfood sector are presented in the Appendix, which includes both the estimates of uncompensated and compensated demand elasticities. The complete demand system is very large and consisting a total of 1,482 and 1,444 demand elasticities in uncompensated and compensated demand matrixes, respectively. It is neither possible nor feasible to discuss the empirical results in detail. For the sake of brevity, the estimated own-price elasticities and expenditure elasticities for disaggregate food products are summarized in Table 3.

As shown in Table 3, our results suggest that, in general, demand for food has become more inelastic in recent years as own-price elasticities are smaller in magnitudes in comparison with earlier estimates reported in Huang (1993). The own-price elasticity for individual categories has decreased in absolute magnitudes from a range of -1.8739 to -0.0087 in Huang (1993) to a range of -1.1352 to 0.0013 in this study. The results show that most of the estimated own-price elasticities, with the exception of rice, canned tomatoes, frozen vegetables and sweeteners, are negative as expected and statistically significantly different from zero. Although the signs of coefficient for rice, canned tomatoes, frozen vegetables and sweeteners are found to be positive, they are not statistically significant. All of food items are found to be price inelastic except turkey in this study, while other meats are price elastic in the study of Huang (1993). According to Table 3, turkey (-1.1352) is most responsive to its own price changes followed by oranges (-0.9605) and other meats (-0.9012). In contrast, other meats (-1.8739) are found to be most responsive to its own price changes followed by oranges (-0.8486) and canned fruit cocktail (-0.7400) in Huang (1993).

With respect to own-price elasticities within food group, eggs are found to be least responsive to their own price changes within the meats group in this study, which is similar to Huang (1993). Within the staples group, we found that evaporated and dry milk are most responsive to their own price changes, which is similar to Huang (1993). Within the fresh fruits group, the results suggest that oranges are most responsive to their own price changes followed by grapefruits and grapes. However, food commodities that are found to be most responsive to their own price changes in Huang (1993) are grapes followed by oranges. Within the fresh vegetables group, we found carrots are most responsive to their own price changes followed by tomatoes. In contrast, Huang (1993) found tomatoes to be most responsive to their own price changes followed by carrots. Within the processed fruits and vegetables group, our results suggest that canned peas are most responsive to their own price changes. In comparison, canned fruits cocktail are found to be most responsive to its own price changes in Huang (1993). Within the desserts group, we found that ice cream and other frozen dairy products are most responsive to their own price changes followed by coffee and tea. However, coffee and tea are found to be most responsive to their own price changes followed by ice cream and other frozen dairy products in Huang (1993).

Overall, the expenditure elasticities have decreased from a range of 1.2917 to -0.5737 in Huang (1993) to a range of 0.8328 to -0.4680 (Table 3). According to Huang (1993), the expenditure elasticities for food vary from -0.5737(other meats) to 1.2917 (other fresh vegetables). In comparison, we find the demand for food tends to become less responsive to income changes with estimated income elasticities vary from -0.4680 (grapefruits) to 0.8328 (coffee and tea). Furthermore, our study shows that the expenditure elasticities for all food items are less than one in absolute magnitudes, suggesting all food products are normal goods. Although expenditure elasticities of evaporated and dry milk, apples, oranges, grapefruits, other fresh fruits, peanuts and tree nuts, and sugar are found to be negative, they are not statistically significantly different from zero. In the study of Huang (1993), expenditure elasticities of apples, oranges and grapefruits are also found to be negative but not statistically significantly different from zero.

With respect to expenditure elasticities within each food group, our results indicate that cheese is most responsive to changes of income followed by pork, while eggs are least responsive to changes of income. The estimated expenditure elasticity of cheese is 0.6030, which suggests that cheese consumption is expected to increase 6.03 percent as consumers' income increases by 10 percent. This may because expenditure share in this study includes expenditure on food at home and food away from home. As we know, cheese is an essential ingredient of most fast food like burgers and pizzas. Thus, rising incomes and population growth are expected to continue to stimulate the growth of the away-from-home food market as suggested by Blisard et al. (2002). In comparison, Huang (1993) reported that pork was most responsive to changes in income followed by fresh and frozen fish, while chicken was least responsive to income changes. In addition, we found expenditure weights in the meats group have decreased as compared with Huang (1993), except for fresh and frozen fish, and cheese. The expenditure weights for fresh and frozen fish, and cheese increased 38.9 percent and 72.2 percent, respectively. Blisard et al. (2002) suggest that the largest increases for per capita expenditures on at-home food are anticipated for fish up 6.2 percent from 2000 to 2020. Their results show that per capita consumption of fish is expected to increase 6.5 percent, while consumptions of beef and pork are expected to decrease during the same time period.

Within the staples group, the results suggest that rice is most responsive to changes in income followed by fats and oils, while potatoes are least responsive to income changes. In contrast, butter is found most responsive to changes in income followed by evaporated and dry milk, while Huang (1993) also found potatoes to be least responsive to changes in income. Within the fresh fruits group, only estimated coefficients of bananas and grapes are found to be positive and less than one as expected. Although negative expenditure elasticities for apples, oranges, grapefruits and other fresh fruits are found in this study, their magnitudes are statistically insignificant. Similar to Huang (1993), we found grapes are most responsive to changes in income followed by bananas. It should be noted that the expenditure elasticities for individual fruits have decreased from a range of -1.797 to 0.9298 in You et al. (1996) to a range of -0.468 to 0.5735 in this study, suggesting that demands for individual fresh fruits have become less responsive to changes in income. You et al. (1996) suggest that total income is expected to have little effects on the demands for individual fresh fruits. Therefore, as income rises in the future their consumption levels would not have significantly increased. Our findings of smaller income elasticities for fresh fruits seem to support their contentions. Expenditure weights for fresh fruits have decreased from 0.0077 in Huang (1993) to 0.0059 in this study further support the findings of You et al. (1996).

Within the fresh vegetables group, we found lettuce to be most responsive to changes in income followed by celery. In contrast, Huang (1993) found other fresh vegetables to be most responsive to changes in income followed by tomatoes and celery. Furthermore, we found that the expenditure elasticities have decreased from a range of 1.212 to 0.0834 in You et al. (1996) to a range of 0.6064 to 0.2195, which indicate individual fresh vegetables have become less responsive to changes in income. These results are consistent with the findings of You et al. (1996), which suggested that total income was not an important factor in determining fresh vegetable consumption levels. Within the processed fruits and vegetables group, canned fruits cocktail is found to be most responsive to changes in income followed by canned peas. However, canned tomatoes are found to be most responsive to changes in income followed by canned fruits cocktail in Huang (1993).

Within the desserts group, coffee and tea are found to be most responsive to changes in income, which is similar to Huang (1993). Our results show that the expenditure elasticities of individual food products in the desserts group vary from -0.0402 (sugar) to 0.8328 (coffee and tea) as compared to the range of 0.0059 (sugar) to 0.8176 (coffee and tea) reported in Huang (1993). Although the estimated expenditure elasticity for sugar is found to be negative, it is not statistically significant. Similarly, Huang (1993) also found the expenditure elasticity for sugar to be statistically insignificantly different from zero. In what follows, the estimation results of within-group food commodities will be presented and discussed in turn.

The meats group

There are nine commodities included in the meats group. They are beef and veal, pork, other meats, chicken, turkey, fresh and frozen fish, canned and cured fish, eggs, and cheese. Table 4 presents the estimated compensated own-price and cross-price elasticities within the meats group.

In general, we found the cross-price elasticities exhibit considerable different net complement and substitution relationships among food categories except beef and veal as compared with Huang (1993). As shown in Table 4, beef and veal, other meats, chicken, turkey, fresh and frozen fish, canned and cured fish and cheese are net substitutes for pork, and eggs are net complements. However, eggs are net substitutes for pork while cheese is net complement in Huang (1993). With respect to other meats, eggs are net substitute in this study while they are net complements in Huang (1993). For chicken, beef and veal, pork, turkey, fresh and frozen fish are net substitutes, and canned and cured fish, eggs and cheese are net complements. The cross-price relationships between turkey and chicken, and fresh and frozen fish and chicken found in this study suggest that they are substitutes for each other, while their relationships are found to be complementary in Huang (1993).

Our results seem consistent with earlier studies in reflecting the changes in consumer attitudes toward meat consumption. Raunikar et al. (1985) found that as people tend to counter the problem of obesity and overweight with dietary constraints on energy intake, the consumption of leafy fresh vegetables and poultry is expected to increase, while consumption of cereals and red meat decreases. In general, food can be classified into two categories: healthful food and unhealthful food. In Luo and Huang (2010), poultry and fresh fish are classified as healthful food. Thus, the changed substitution and complement relationship between turkey and chicken, fresh and frozen fish and chicken may reflect health and dietary concerns.

The staples group

There are six commodities included in the staples group. They are fluid milk, evaporated and dry milk, wheat flour, rice, potatoes, fats and oils. In general, the cross-price elasticities exhibit considerable different net complement and substitution relationships among food categories as compared with Huang (1993).

As shown in Table 5, evaporated and dry milk, wheat flour, potatoes, fats and oils are net substitutions for fluid milk with the exception of rice. Fluid milk, wheat flour, potatoes are net substitutes for evaporated and dry milk while rice and fats and oils are net complements. In contrast, fluid milk and potatoes are found to be net complements for evaporated and dry milk in Huang (1993). Similar to Huang (1993), fluid milk, evaporated and dry milk and rice are net substitutes for wheat flour, while potatoes and fats and oils are considered to be net complements. As compared with Huang (1993), the results indicate the same net substitution and complementary relationships between rice and other food categories in the staple group with the exception of potatoes.

The positive compensated cross-price elasticity of potatoes suggests the net substitution relationship between potatoes and rice. The growing ethnic diversity is considered as one of the major factors that may contribute to changes in food consumption patterns. Thus, the net substitution relationship between potatoes and rice may due to increasing in the Asian populations in U.S. over the decades. The culture and food custom and habits differ greatly between Asians and Americans. Unlike the U.S., in most of Asian countries, rice is the staple food while potatoes are consumed as side dishes. Taking the increasing proportion of Asian population into account, it is not surprising that we found the cross-price relationship between rice and potatoes has changed as compared to previous study.

The fresh fruits group

There are six commodities included in fresh fruits group. They are apples, oranges, bananas, grapes, grapefruits, and other fresh fruits. The compensated own-price and cross-price elasticities are presented in Table 6.

The results in this study suggest considerable different net substitution and complement relationships among food categories within the fresh fruits group as compared with Huang (1993) and You et al. (1996). First, we found that grapefruits and other fresh fruits are net substitutes for apples instead of gross complements (You et al. 1996) or net complements (Huang 1993). Secondly, our results show that both bananas and grapes are net substitutes for oranges. In contrast, they are found to be complements in Huang (1993) and You et al. (1996). In addition, we found the cross-price relationships between oranges and grapefruits, bananas and grapefruits, and grapes and grapefruits are net substitutes, which are different from the results in Huang (1993). Moreover, we found oranges are net substitutes for both bananas and grapes. Huang (1993) and You et al. (1996), on the other hand, found them to be complements instead.

The fresh vegetables group

There are six commodities in the fresh vegetables group. They include lettuce, tomatoes, celery, onions, carrots, and other fresh vegetables. The compensated cross-price elasticities presented in Table 7 exhibit considerable different net substitution and complement relationships as compared with Huang (1993) except other fresh vegetables. Take lettuce as an example, tomatoes and onions are net substitutes for lettuce and celery, carrots and other fresh vegetables are net complements. However, celery and carrots are found to be net substitutes in Huang (1993). Our results show that the compensated cross-price elasticities have decreased from a range of -0.2793 to 0.3303 in Huang (1993) to a range of -0.1651 to 0.1472, which indicate that the demand for individual fresh vegetables has become less responsive to changes in the price of other items within the fresh vegetables group. Thus, we may conclude that market has become less competitive over the decades and price reduction may not be an effective strategy for agricultural industry to gain their market share. Different from You et al. (1996) they suggest that agricultural industry of a specific type of fresh produce may have to rely primarily on price reduction to gain its market share.

With the exception of tomatoes and onions, we found the expenditure weights of individual fresh vegetable and the total expenditure weight of the fresh vegetables group have increased as compared with Huang (1993) and You et al. (1996). The results seem consistent with the analysis of Blisard et al. (2002). In their projection of how much per capita food expenditures and consumption will change between 2000 and 2020, Blisard et al. (2002) conclude that the largest increases for per capita expenditures on at-home food are anticipated for vegetables up by 7.2 percent.

The processed fruits and vegetables group

There are six commodities included in the processed fruits and vegetables group. They are frozen fruits and juice, canned tomatoes, canned peas, canned fruits cocktail, peanuts and tree nuts and frozen vegetables. The entries showed in Table 8 are compensated own-price and cross-price elasticities within the processed fruits and vegetable group.

Similar to Huang (1993), the estimated compensated demand elasticities indicate that canned tomatoes, canned peas, canned fruits cocktail, peanuts and tree nuts are net substitutes for frozen fruits and juice, and frozen vegetables are net complements for frozen fruits and juice. In addition, frozen fruits and juice, canned tomatoes, canned peas, canned fruits cocktail, peanuts and tree nuts are net complements for frozen vegetables, which is consistent with the results obtained in Huang (1993).

Considerable different net substitution and complement relationships are found in this study as compared with Huang (1993). We found the relationship between peanuts and tree nuts and canned tomatoes to be net complement as oppose to net substitution reported in Huang (1993). Furthermore, the results in this study show that the relationships between canned fruits cocktail and canned peas, and peanuts and tree nuts and canned fruits cocktail are net substitution. Huang (1993), on the other hand, suggests their relationships are net complements.

The desserts group

There are four commodities included in the desserts group. They are coffee and tea, ice cream and other frozen dairy products, sugar, and sweeteners. Compensated demand elasticities for individual commodities within desserts group are showed in Table 9.

In general, the net substitution and complement relationships among individual food commodities within the desserts group are similar to Huang (1993) with the exception of sugar and sweeteners. In Huang's (1993) study, sweeteners are net substitutes for sugar and sugar is a net substitute for sweeteners. However, we found the relationship between sugar and sweeteners to be net complement. In addition, the compensated cross-price elasticity within the desserts group has increased from a range of -0.0948 to 0.0798 reported in Huang (1993) to a range of -0.1900 to 0.1041 found in this study. As shown in Table 9, consumption of coffee and tea is found to be most responsive to changes in the price of sweeteners. Similarly, consumption of sweeteners is also found to be most responsive to changes in the price of coffee and tea, but the magnitude of the cross-price elasticity is slightly less than half of those sweeteners on coffee and tea.

In this study, we found the total expenditure weight for desserts has decreased from 0.0293 in Huang (1993) to 0.0188. The change in expenditure proportion of this food group reflects changing patterns of food consumption. As information has played an important role in influencing consumer food choices, consumer demand is expected to be affected differently with different education levels. Consumers with higher education level are more likely to consume food with low-fat and less sugar since educational attainment has enhanced their awareness and knowledge of diet. However, consumers with lower education level are more likely to consume energy-dense or sugar-dense foods (Blisard et al. 2002; Variyam and Golan 2002).

The nonfood sector

With respect to the nonfood sector, expenditure elasticity is found to be positive and greater than one as expected, suggesting nonfood is a luxury good. However, expenditure elasticity of nonfood in this study is smaller in magnitude as compared with earlier study. In addition, we found the total expenditure weight of food decrease from 18.63% to 15.38% and the expenditure weight of nonfood increased from 81.37% to 84.62% as compared with those reported in Huang (1993). As personal income have been increasing over the past two decades, the reducing proportion of expenditure on food consumption is reasonable and to be expected. Nowadays, consumer demand for durable goods has become more diversified as well. Consumer spend money on various of durable goods as their income increased such as entertainment, health care, housing, travel, cosmetics, auto, education, jewelry and clothing. As indicated by Engel's Law, the proportion of total expenditure devoted to food declines as income rises. The results obtained in this study show that expenditure weight of food has decreased while expenditure weight of nonfood has increased over the two decades, which are consistent with the Law.

Table 1. Comparison of uncompensated elasticity for food groups and nonfood sector in this study and Huang (1993)

	Price								
Quantity	Meats	Staples	Fruits	Vege	Pro.fv	Desserts	Nonfood	Expend	Constant
Meats	**-0.3613**	0.0255	0.0078	0.0090	-0.0173	-0.0281	**-0.1626**	**0.5270**	**-0.8700**
	(**-0.3611**)	(-0.0004)	(0.0107)	(-0.0060)	(-0.0097)	(**-0.0333**)	(-0.1219)	(**0.5157**)	(**-0.0109**)
Staples	0.0375	**-0.1476**	-0.0218	**-0.0337**	-0.0297	-0.0123	-0.0550	**0.2624**	-0.5377
	(0.0300)	(**-0.1508**)	(-0.0411)	(0.0241)	(0.0314)	(0.0007)	(0.0202)	(0.1186)	(-0.0045)
Fruits	0.0973	-0.1887	**-0.1993**	-0.0080	-0.0928	**0.2210**	0.1987	-0.0284	0.2880
	(0.1773)	(-0.2016)	(**-0.1954**)	(**0.1694**)	(**-0.1571**)	(**0.2276**)	(0.3908)	(-0.3840)	(0.0064)
Vege	0.0630	**-0.2049**	-0.0070	**-0.1609**	-0.0301	0.0556	-0.0075	0.2918	-0.0995
	(-0.0660)	(0.1502)	(**0.2043**)	(-0.1348)	(-0.0811)	(0.0062)	(**-0.3599**)	(**0.4079**)	(-0.0036)
Pro.fv	-0.0661	-0.1402	**-0.0464**	-0.0233	**-0.3009**	0.0425	0.1198	0.4145	0.2776
	(-0.0506)	(0.0859)	(**-0.0979**)	(-0.0383)	(**-0.2876**)	(-0.0514)	(-0.0821)	(**0.4341**)	(**0.0091**)
Desserts	-0.0656	-0.0382	**0.0674**	0.0272	0.0297	**-0.1087**	-0.2104	**0.2985**	**-0.9835**
	(**-0.0784**)	(-0.0106)	(**0.0538**)	(0.0014)	(-0.0227)	(**-0.1049**)	(**-0.2281**)	(**0.3947**)	(**-0.0168**)
Nonfood	**-0.0406**	**-0.0510**	**-0.0054**	**-0.0077**	**-0.0070**	**-0.0201**	**-0.9848**	**1.1165**	**-0.3088**
	(**-0.0606**)	(**-0.0420**)	(**-0.0081**)	(**-0.0073**)	(**-0.0108**)	(**-0.0303**)	(**-0.9794**)	(**1.1500**)	(**-0.0015**)
Weight	0.0519	0.0555	0.0059	0.0092	0.0125	0.0188	0.8462	NA	NA
	(0.0773)	(0.0417)	(0.0077)	(0.0062)	(0.0132)	(0.0293)	(0.8137)	NA	NA

Note: Bold-face numbers indicate statistical significance at least at the 90% level of statistical certainty. The upper part of the entries is the uncompensated elasticities in this study and the lower part of numbers in parentheses is the uncompensated elasticities in Huang (1993). The abbreviated notations are Fruits—fresh fruits; Vege—fresh vegetables; Pro.fv—processed fruits and vegetables; Weight—expenditure weights; NA—not applicable; and Expend—total expenditure.

Table 2. Compensated elasticity for food groups and nonfood sector

	Price						
Quantity	Meats	Staples	Fruits	Vege	Pro.fv	Desserts	Nonfood
Meats	-0.3339	0.0547	0.0109	0.0138	-0.0107	-0.0181	0.2833
Staples	0.0511	-0.1330	-0.0202	-0.0313	-0.0264	-0.0073	0.1671
Fruits	0.0959	-0.1903	-0.1994	-0.0082	-0.0931	0.2205	0.1747
Vege	0.0781	-0.1887	-0.0053	-0.1583	-0.0265	0.0611	0.2394
Pro.fv	-0.0446	-0.1172	-0.0440	-0.0195	-0.2957	0.0503	0.4705
Desserts	-0.0501	-0.0216	0.0692	0.0299	0.0334	-0.1031	0.0422
Nonfood	0.0174	0.0110	0.0012	0.0026	0.0070	0.0009	-0.0400
Weight	0.0519	0.0555	0.0059	0.0092	0.0125	0.0188	0.8462

Note: The abbreviated notations are Fruits—fresh fruits; Vege—fresh vegetables; Pro.fv—processed fruits and vegetables; and Weight—expenditure weights.

Table 3. Summary of own-price elasticities for food categories and nonfood sector

Category	Price Elasticity		Expenditure Elasticity	
		Meats		
Beef and veal	**-0.5159**	(0.0575)	**0.4037**	(0.1446)
Pork	**-0.7573**	(0.0476)	**0.5236**	(0.1666)
Other meats	**-0.9012**	(0.4377)	0.1203	(0.4481)
Chicken	**-0.4042**	(0.1177)	0.2108	(0.1925)
Turkey	**-1.1352**	(0.5317)	0.2648	(0.3550)
Fresh and frozen fish	-0.1271	(0.1455)	0.3898	(0.3139)
Canned and cured fish	-0.2638	(0.1649)	0.5132	(0.3640)
Eggs	**-0.0756**	(0.0249)	0.1194	(0.1089)
Cheese	**-0.1613**	(0.0861)	**0.6030**	(0.1775)
		Staples		
Fluid milk	**-0.1651**	(0.0498)	0.1008	(0.0676)
Evaporated and dry milk	-0.2880	(0.3565)	-0.3274	(0.3132)
Wheat flour	-0.0398	(0.0903)	**0.2361**	(0.1274)
Rice	0.2823	(0.2578)	0.8292	(0.7808)
Potatoes	**-0.1158**	(0.0577)	0.0816	(0.3038)
Fats and oils	-0.0761	(0.0747)	0.2886	(0.2331)
		Fresh fruits		
Apples	-0.1338	(0.1330)	-0.1642	(0.4277)
Oranges	**-0.9605**	(0.0984)	-0.4368	(0.5823)
Bananas	**-0.4017**	(0.1090)	0.3139	(0.3029)
Grapes	**-0.6433**	(0.1793)	0.5735	(0.5665)
Grapefruits	**-0.7694**	(0.1469)	-0.4680	(0.5798)
Other fresh fruits	-0.0458	(0.2499)	-0.1241	(0.3967)
		Fresh vegetables		
Lettuce	-0.1213	(0.0847)	**0.6064**	(0.3261)
Tomatoes	**-0.3558**	(0.0758)	**0.3735**	(0.1897)
Celery	-0.0085	(0.0483)	**0.5072**	(0.2316)
Onions	**-0.1851**	(0.0410)	0.2195	(0.2707)
Carrots	**-0.5171**	(0.1782)	0.3525	(0.5633)
Other fresh vegetables	-0.1138	(0.1578)	0.3257	(0.3221)
		Processed fruits and vegetables		
Frozen fruits and juice	**-0.3527**	(0.0769)	0.4543	(0.5345)
Canned tomatoes	0.0486	(0.0936)	0.3243	(0.3387)
Canned peas	**-0.6046**	(0.2136)	0.4803	(0.5043)
Canned fruits cocktail	-0.3515	(0.3774)	0.6193	(0.5999)
Peanuts and tree nuts	-0.0997	(0.0641)	-0.0157	(0.3326)
Frozen vegetables	0.0015	(0.1445)	0.0814	(0.2878)

Table 3. Continued.

Category	Price Elasticity		Expenditure Elasticity	
		Desserts		
Coffee and tea	**-0.1729**	(0.0323)	**0.8328**	(0.2242)
Frzn.D	**-0.2598**	(0.1274)	0.2561	(0.1744)
Sugar	-0.0204	(0.0233)	-0.0402	(0.1643)
Sweeteners	0.0013	(0.0994)	0.3064	(0.2824)
Nonfood	**-0.9100**	(0.0167)	**1.1276**	(0.0099)

Note: Bold-face numbers indicate statistical significance at least at the 90% level of statistical certainty. The values in the parentheses are the standard errors of estimates. The abbreviated notation in the table is Frzn.D—ice cream and other frozen dairy products.

Table 4. Compensated demand elasticities within the meats group.

Category	Beef and veal	Pork	Other meats	Chicken	Turkey	Fish	C.fish	Eggs	Cheese
Beef and veal	-0.5069	0.1221	0.0078	0.0171	0.0132	-0.0144	0.0037	0.0089	-0.0084
Pork	0.2556	-0.7517	0.0026	0.0338	0.0294	0.0473	0.0153	-0.0087	0.0611
Other meats	0.5858	0.0928	-0.9012	1.4330	-1.7440	-0.6182	0.1634	0.0073	0.2612
Chicken	0.0868	0.0822	0.0977	-0.4033	0.1356	0.0115	-0.0974	-0.0023	-0.0149
Turkey	0.2465	0.2624	-0.4360	0.4974	-1.1349	0.1292	0.1579	0.0790	-0.0241
Fish	-0.1287	0.2025	-0.0742	0.0203	0.0620	-0.1261	0.1016	-0.0639	0.0999
C.fish	0.0635	0.1260	0.0377	-0.3298	0.1457	0.1953	-0.2631	0.0176	-0.0745
Eggs	0.0686	-0.0322	0.0008	-0.0035	0.0327	-0.0551	0.0079	-0.0753	-0.0045
Cheese	-0.0302	0.1054	0.0126	-0.0106	-0.0047	0.0403	-0.0156	-0.0021	-0.1576

Note: The abbreviated notations in the table are Fish—fresh and frozen fish; C.fish—canned and cured fish.

Table 5. Compensated demand elasticities within the staples group

Category	Fluid milk	E.milk	Wheat flour	Rice	Potatoes	Fats and oils
Fluid milk	-0.1637	0.1046	0.0343	-0.0507	0.0071	0.0709
E.milk	0.3427	-0.2893	0.0998	-0.1138	0.0263	-0.0765
Wheat flour	0.0424	0.0377	-0.0373	0.0317	-0.0093	-0.0628
Rice	-0.3687	-0.2528	0.1870	0.2838	0.0086	-0.1371
Potatoes	0.0223	0.0251	-0.0234	0.0037	-0.1154	-0.0471
Fats and oils	0.0428	-0.0141	-0.0307	-0.0114	-0.0091	-0.0698

Note: The abbreviated notation in the table is E.milk—evaporated and dry milk.

Table 6. Compensated demand elasticities within the fresh fruits group

Category	Apples	Oranges	Bananas	Grapes	Grapefruits	Other fresh fruits
Apples	-0.1341	0.0586	0.1418	0.0326	0.0340	0.0502
Oranges	0.1172	-0.9608	0.0428	0.0064	0.0744	0.2794
Bananas	0.1986	0.0300	-0.4014	-0.0065	0.0431	-0.0593
Grapes	0.0571	0.0056	-0.0081	-0.6429	0.0267	0.2869
Grapefruits	0.1588	0.1736	0.1437	0.0712	-0.7695	-0.3964
Other fresh fruits	0.0414	0.1150	-0.0349	0.1350	-0.0699	-0.0460

Table 7. Compensated demand elasticities within the fresh vegetables group

Category	Lettuce	Tomatoes	Celery	Onions	Carrots	Other fresh vegetables
Lettuce	-0.1198	0.0158	-0.0162	0.0247	-0.0159	-0.1076
Tomatoes	0.0223	-0.3552	-0.0115	-0.0001	0.0346	0.1225
Celery	-0.0647	-0.0326	-0.0082	-0.0476	-0.0293	0.1237
Onions	0.0847	-0.0002	-0.0408	-0.1850	0.0384	0.1379
Carrots	-0.0956	0.1472	-0.0439	0.0672	-0.5169	-0.1651
Other fresh vegetables	-0.0759	0.0612	0.0218	0.0284	-0.0194	-0.1127

Table 8. Compensated demand elasticities within the processed fruits and vegetables group

Category	F.FRUT	C.TOMA	C.PEA	COCKTL	NUTS	F.VEGE
F.FRUT	-0.3501	0.0055	0.0028	0.0052	0.0008	-0.0320
C.TOMA	0.0166	0.0492	0.0282	-0.0088	-0.0014	-0.0417
C.PEA	0.0526	0.1784	-0.6045	0.1136	0.0908	-0.1772
COCKTL	0.0740	-0.0417	0.0852	-0.3513	0.0082	-0.2717
NUTS	0.0441	-0.0262	0.2724	0.0329	-0.0997	-0.3023
F.VEGE	-0.0445	-0.0193	-0.0130	-0.0265	-0.0074	0.0018

Note: The abbreviated notations in the table are F.FRUT—frozen fruits and juice; C.TOMA—canned tomatoes; C.PEA—canned peas; COCKTL—canned fruits cocktail; NUTS—peanuts and tree nuts; and F.VEGE—frozen vegetables.

Table 9. Compensated demand elasticities within the desserts group

Category	Coffee and tea	Ice cream and other frozen dairy products	Sugar	Sweeteners
Coffee and tea	-0.1702	-0.0428	0.0222	-0.1900
Ice cream and other frozen dairy products	-0.0343	-0.2588	0.0159	0.1041
Sugar	0.0182	0.0163	-0.0205	-0.0683
Sweeteners	-0.0790	0.0541	-0.0346	0.0036

CHAPTER 6

CONCLUSIONS

We revisit the study conducted by Huang (1993) using the same demand system model and extend the data set to include the most recent data available with the purpose of providing updated elasticity estimates. The updated complete system of demand relationships cover the time period from 1953-2008. The demand system was first estimated at the aggregate level followed by the estimation of 37 individual food products and one nonfood at the disaggregate level.

The estimation of the demand elasticities was accomplished in four sequential steps. First, a composite food demand system consisting of six food groups and one nonfood sector, subject to Engel aggregation, homogeneity and symmetry, was estimated. Second, subject to symmetry constraint, the parameter estimates obtained from the composite food demand system were then used in the estimation of within-group subsystems to exclude the price effects of other food groups and the nonfood sector. Third, to obtain cross-group demand elasticities, the homogeneity constraint was first introduced to adjust the relative changes of all food commodity price and expenditure by subtracting the relative change of nonfood price from all food prices and deleting the cross-price elasticities of nonfood from the estimation. The quantity demanded were adjusted again by using within-group parameter estimates obtain in the second step in addition to the composite cross-price effects to exclude the impacts of those commodity prices outside the corresponding cross-groups. Then, the cross-price elasticities in each pair of cross-group were estimated simultaneously by imposing the symmetry condition. Finally, parameter estimates of nonfood sector were obtained by applying the Engel aggregation, homogeneity and symmetry constraints.

With respect to composite food demand system, our efforts to duplicate the demand parameters at aggregate level reported by Huang (1993) are successful considering the fairly close in the magnitudes of most demand elasticities between two studies. Similar to Huang (1993), all own-price elasticities are negative and less than one, and all foods are normal goods as expected. Although the estimated cross-price elasticities between two studies exhibit considerable differences in the complementary and substitution relationships among food groups, they are reasonable and expected. The changes in the complementary and substitution relationships manifest changes in consumer behavior and consumption patterns. The study also provides evidence to support analyses in some early studies such as Raunikar et al. (1985) and Blisard, et al. (2002).

With respect to disaggregate food demand subsystems, we consider the estimation based on the annual data to be satisfactory with certain degree of success. Our results suggest that most food items are considered as normal goods. Although unexpected negative signs of expenditure elasticities are found for some commodities such as evaporated and dry milk, apples, oranges, grapefruits, other fresh fruits, peanuts and tree nuts, and sugar, their parameter estimates are not statistically significant. In addition, we find the demand for food tends to become less responsive to income changes with expenditure elasticities vary from -0.4680 (grapefruits) to 0.8328 (coffee and tea). Overall, the differences observed in expenditure elasticities reflect the changes in consumption behavior or lifestyle that may affect the allocation of food dollars to different food groups or items as consumer's income increases over time.

There are a few implications could be drawn from the empirical results. First, increasing population has driven up demand for food. By 2020, the United States is expected to add between 50 and 80 million people and food expenditures are projected to rise 26 percent between 2000 and 2020 (Blisard et al. 2002). According to Blisard et al. (2002), the projected increases in U.S. population will boost food sales by $208 billion. Thus, an understanding of food demand interdependent relationships and the demand elasticities would provide the producers and policy makers a useful tool and guidance for projecting food demand and managing food supply in the future. The changing age compositions of the population and growing ethnic diversity is also expected to affect per capita food consumption as pointed out by Raunikar et al. (1985). For example, increasing in the Hispanic population is expected to decrease per capita consumption of dairy products. And age increases, the consumption of milk usually decreases. Our results show that expenditure share on milk consumption decreased from 1.65% to 1.31%, which is consistent with Raunikar et al. (1985) as expected.

Like changes in population, Americans' food habits and lifestyle have changed considerably in the past two decades. The changes in substitution and complementary relationships among food groups and individual categories observed in this study reflect changes in food consumption patterns and lifestyle. People used to consume a great amount of red meats such as beef and veal and pork have shifted to consume more turkey and fish mainly because of healthy consideration (Raunikar et al. 1985). Davis and Stewart (2002) reported that Americans have accustomed to eat out more frequently as their income increased. Furthermore, they suggest that consumers with higher income are more likely to choose convenience and healthful food. Thus, foodservice industry will continue to benefit from consumers' demand for convenience and healthful food by providing a greater variety of food products and a variety of further processed, ready-to-cook, and ready-to-eat foods. Our results show that expenditures on processed food products such as frozen fruits and fruit juice, canned tomatoes and canned fruits cocktail have increased over the study period. And as income increases, consumers are expected to be more health conscientious by changing their diets to consume more fruits and vegetables and less beef, pork and other meats, which provide evidence to support earlier studies such as Raunikar et al. (1985), Davis and Stewart (2002) and Blisard et al. (2002). Last but not least, the physical work requirements in the United States have diminished and thereby there is growing prevalence of obesity over the last several decades. The reduction in consumption on food with high energy and caloric has been manifested in recent years. The results in our study show that expenditure weight of red meats and desserts have decreased, which also manifest the tendency.

The results in our study reflect changes influenced by those factors. And most importantly, the analysis of interdependent relationships and the empirical results presented in our study would provide useful information to assist producers and policy makers in planning their marketing strategies and managing the food supply in the future.

REFERENCES

Akbay, C., I. Boz, and W. S. Chern. 2007. Household Food Consumption in Turkey. *European Review of Agricultural Economics* 34(2): 209-231.

Alston, A. M., and J. A. Chalfant. 1993. The Silence of the Lambdas: A Test of the Almost Ideal and Rotterdam Models. *American Journal of Agricultural Economics* 75(2): 304-313.

Andersen, P. P., and E. Caicedo. 1978. The Potential Impact of Changes in Income Distribution on Food Demand and Human Nutrition. *American Journal of Agricultural Economics* 60(3): 402-415.

Asano, S., and E. P. S. Fiuza. 2003. Estimation of the Brazilian Consumer Demand System. *Brazilian Review of Econometrics* 23(2): 255-294.

Asche, F., and C. R. Wessells. 1997. On Price Indices in the Almost Ideal Demand System. *American Journal of Agricultural Economics* 79(4): 1182-1185.

Blanciforti, L. A., R. D. Green, and G. A. King. 1986. U.S. Consumer Behavior over the Postwar Period: An Almost Ideal Demand System Analysis. *Giannini Foundation Monograph No. 40*, University of California.

Blisard, N., B. Lin, J. Cromartie, and N. Ballenger. 2002. America's Changing Appetite: Food Consumption and Spending to 2020. U.S. Department of Agricultural, Economic Research Service. *FoodReview* 25(1): 2-9.

Brandow, G. E. 1961. Interrelationships among Demands for Farm Products and Implications for Control of Market Supply. *Technical Bulletin 680*, Pennsylvania State University.

Byron, R. P. 1970. The Restricted Aitken Estimation of Sets of Demand Relations. *Econometrica* 38(6): 816-830.

Capps, O., and J. Havlicek. 1984. National and Regional Household Demand for Meat, Poultry and Seafood: A Complete System Approach. *Canadian Journal of Agricultural Economics* 32(1): 93-108.

Capps, O., and J. D. Schmitz. 1991. A Recognition of Health and Nutrition Factors in Food Demand Analysis. *Western Journal of Agricultural Economics* 16(1): 21-35.

Chou, S., M. Grossman, and H. Saffer. 2004. An Economic Analysis of Adult Obesity: Results from the Behavioral Risk Factor Surveillance System. *Journal of Health Economics* 23(3): 565-587.

Christensen, L. R., D. W. Jorgenson, and L. J. Lau. 1975. Transcendental Logarithmic Utility Functions. *American Economic Review* 65(3): 367-383.

Clements, K. W., and Y. Qiang. 2003. The Economics of Global Consumption Patterns. *Journal of Agricultural and Applied Economics* 35(Supplement): 21-37.

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

Cutler, D. M., E. L. Glaeser, and J.M. Shapiro. 2003. Why Have Americans become more Obese? *Journal of Economic Perspectives* 17(3): 93-118.

Davis, E. D., and H. Stewart. 2002. Changing Consumer Demands Create Opportunities for U.S. Food System. U.S. Department of Agricultural, Economic Research Service. *FoodReview* 25(1): 19-23.

Deanton, A. J., and J. Muellbauer. 1980. An Almost Ideal Demand System. *American Economic Review* 70: 312-326.

Dong, D., B. W. Gould, and H. M. Kaiser. 2004. Food Demand in Mexico: An Application of the Amemiya-Tobin Approach to the Estimation of a Censored Food System. *American Journal of Agricultural Economics* 86(4): 1094-1107.

Finkelstein, E. A., C. J. Ruhm, and K. M. Kosa. 2005. Economic Causes and Consequences of Obesity. *Annual Review of Public Health* 26: 239-257.

Fulponi, L. 1989. The Almost Ideal Demand System: An Application to Food and Meat Groups for France. *Journal of Agricultural Economics* 40(1): 82-92.

Gelbach, J. B., J. Klick, and T. Stratmann. 2007. Cheap Donuts and Expensive Broccoli: The Effect of Relative Prices on Obesity. Electronic copy of this paper is available at: http://ssrn.com/abstract=976484.

George, P. S., and G. A. King. 1971. Consumer Demand for Food Commodities in the United States with Projections for 1980. *Giannini Foundation Monograph No. 26*, University of California.

Green, R., and J. M. Alston. 1990. Elasticities in AIDS Models. *American Journal of Agricultural Economics* 72(2): 442-445.

Green, R., and J. M. Alston. 1991. Elasticites in AIDS Models: A Clarification and Extension. *American Journal of Agricultural Economics* 73(3): 874-875.

Greene, C., and A. Kremen. 2003. U.S. Organic Farming in 2000-2001: Adoption of Certified Systems. U.S. Department of Agricultural, Economic Research Service. *Agriculture Information Bulletin No. 780.*

Hahn, W. F. 1994. Elasticities in AIDS Models: Comment. *American Journal of Agricultural Economics* 76(3): 874-875.

Huang, K. S. 1991. U.S. Demand for Food: A Complete System of Quantity Effects on Prices. U.S. Department of Agricultural, Economic Research Service. *Technical Bulletin Number 1795.*

Huang, K. S. 1993. A Complete System of U.S. Demand for Food. U.S. Department of Agricultural, Economic Research Service. *Technical Bulletin Number 1821.*

Huang, K. S. 1997. How Economic Factors Influence the Nutrient Content of Diets. U.S. Department of Agricultural, Economic Research Service. *Technical Bulletin Number 1864*.

Huang, K. S., and R. C. Haidacher. 1983. Estimation of a Composite Food Demand System for the United States. *Journal of Business & Economic Statistics* 1(4): 285-291.

Jabarin, A. S., and E. K. AL-Karablieh. 2011. Estimating the Fresh Vegetables Demand System in Jordan: A Linear Approximate Almost Ideal Demand System. *Journal of Agricultural Science and Technology* 5(3): 322-331.

Lakdawalla, D., and T. Philipson. 2002. The Growth of Obesity and Technological Change: A Theoretical and Empirical Examination. National Bureau of Economic Research Working Paper No. 8946.

Lee, J. Y., M. G. Brown, and J. L. Seale, Jr. 1992. Demand Relationships among Fresh Fruit and Juices in Canada. *Applied Economic Perspectives and Policy* 14(2): 254-262.

Luo, H., and C. L. Huang. 2010. Demand for Healthful and Unhealthful Food: Implications on Obesity. Contributed paper presented at a special symposium at the 51st annual conference of the Food Distribution Research Society in Destin, FL, October 19, 2010.

Mergos, G. J., and G. S. Donatos. 1989. Demand for food in Greece: An Almost Ideal Demand System Analysis. *Journal of Agricultural Economics* 40(2): 178-184.

Moschini, G. 1995. Units of Measurement and the Stone Index in Demand System Estimation. *American Journal of Agricultural Economics* 77(1): 63-68.

Park, J. L., R. B. Holcomb, K. C. Raper, and O. Capps. 1996. A Demand Systems Analysis of Food Commodities by U.S. Households Segmented by Income. *American Journal of Agricultural Economics* 78(2): 290-300.

Pashardes, P. 1993. Bias in Estimating the Almost Ideal Demand System with the Stone Index Approximation. *The Economic Journal* 103(July): 908-915.

Pollack, S. L. 2001. Consumer Demand for Fruit and Vegetables: The U.S. Example. In Changing Structure of Global Food Consumption and Trade. Page 49–54. U.S. Department of Agriculture, Economic Research Service.

Price, D. W., and R. C. Mittelhammer. 1979. A Matrix of Demand Elasticities for Fresh Fruit. *Western Journal of Agricultural Economics* 4(1): 69-86.

Putnam, J. J., and J. E. Allshouse. 1999. Food Consumption, Prices, and Expenditures, 1970-97. U.S. Department of Agriculture, Economic Research Service. *Statistical Bulletin No. 965.*

Raper, K. C., M. N. Wanzala, and R. M. Naya. 2002. Food Expenditures and Household Demographic Composition in the US: A Demand System Approach. *Applied Economics* 34: 981-992.

Raunikar, R., C. L. Huang, and J. C. Purcell. 1985. The Changing United States Food Market. *Journal of Agribusiness* 3(1): 42-45.

Reed, A. J., J. W. Levedahl, and C. Hallahan, 2005. The Generalized Composite Commodity Theorem and Food Demand Estimation. *American Journal of Agricultural Economics* 87(1): 28-37.

Schultz, H. 1938. The Theory and Measurement of Demand. *The University of Chicago Press.*

Stone, J. R. N. 1954. Linear Expenditure System and Demand Analysis: An Application to the Pattern of British Demand. *Economic Journal* 64: 511-527.

Tey, Y. S., M. N. Shamsudin, and Z. Mohamed. 2008. Demand Analyses of Food in Malaysia: Effects of Model Specification and Demographic Variables. *Munish Personal RePEc Archive. No.15063.*

Theil, H. 1965. The Information Approach to Demand Analysis. *Econometrica* 33: 67-87.

U.S. Fresh Market Vegetable Statistics, 1949-75. 1976. U.S. Department of Agriculture, Economic Research Service. *Statistical Bulletin No. 558.*

U.S. Department of Agriculture, Economic Research Service. *Vegetables and Melons Yearbook*. Various issues.

U.S. Department of Agriculture, Economic Research Service. *Tree Nuts*. Various issues.

U.S. Department of Agriculture, Economic Research Service. *Frozen Fruits and Vegetables Expenditure*. Various issues.

U.S. Department of Agriculture, Economic Research Service. *Red Meat Yearbook*. Various issues.

U.S. Department of Agriculture, Economic Research Service. *Dairy Yearbook*. Various issues.

U.S. Department of Agriculture, Economic Research Service. *Fruit and Tree Nuts Situation and Outlook Yearbook*. Various issues.

U.S. Department of Agriculture, Economic Research Service. *Oil Crops Situation and Outlook Yearbook*. Various issues.

U.S. Department of Agriculture, National Agricultural Statistics Service. *Agricultural Prices Summary*. Various issues.

U.S. Department of Agriculture, National Agricultural Statistics Service. *Agricultural Statistics*. Various issues.

Variyam, J. N., and E. Golan. 2002. New Health Information is Reshaping Food Choices. U.S. Department of Agricultural, Economic Research Services. *FoodReview* 25(1): 13-18

You, Z., J. E. Epperson, and C. L. Huang. 1996. A Composite System Demand Analysis for Fresh Fruits and Vegetables in the United States. *Journal of Food Distribution Research* 27(3): 11-22.

APPENDIX A

UNCOMPENSATED DEMAND ELASTICITIES

To present the estimation results, the matrix of parameter estimates is partitioned into sixteen blocks and illustrated in a sequential table ordering as A11, A21, A31, A41, A12, A22, A32, A42, A13, A23, A33, A43, A14, A24, A34, and A44. The upper part for each pair of estimates in the tables is the estimated elasticity, and the lower part is the standard error. Bold-face numbers in the tables indicate statistical significance at least at the 90% level of statistical certainty. The notations in the tables are BEEF.V—beef and veal; O.MEAT—other meats, CHICKN—chicken; FISH—fresh and frozen fish; C.FISH—canned and cured fish; F.MILK—fluid milk; E.MILK—evaporated and dry milk; FLOUR—wheat flour; F.OIL—fats and oils; GRAFRU—grapefruits; O.FRUIT—other fresh fruits; O.VEGE—other fresh vegetables; F.FRUT—frozen fruits and juice; C.TOMA—canned tomatoes; C.PEAS—canned peas; COCKTL—canned fruits cocktail; NUTS—peanuts and tree nuts; F.VEGE—frozen vegetables; C.TEA—coffee and tea; FRZN.D—ice cream and other frozen dairy products; SWEET—sweeteners; N.FOOD—nonfood; EXPEND—expenditure; CONST—constant term; WEIGHT—expenditure weight; and NA—not applicable.

Partition of Uncompensated Elasticity Matrix

A11	A12	A13	A14
A21	A22	A23	A24
A31	A32	A33	A34
A41	A42	A43	A44

Appendix table A. Uncompensated demand elasticities in the U.S. (Matrix partition A11)

CATEGORY	BEEF.V	PORK	O.MEAT	CHICKN	TURKEY	FISH	C.FISH	EGG	CHEESE	F.MILK
BEEF.V	**-0.5159**	**0.1178**	**0.0077**	0.0153	0.0127	-0.0154	0.0032	0.0077	-0.0109	-0.0036
	(0.0575)	(0.0260)	(0.0034)	(0.0148)	(0.0081)	(0.0133)	(0.0079)	(0.0053)	(0.0183)	(0.0139)
PORK	**0.2439**	**-0.7573**	0.0024	0.0315	**0.0288**	**0.0460**	0.0146	-0.0102	**0.0578**	0.0027
	(0.0548)	(0.0476)	(0.0048)	(0.0231)	(0.0123)	(0.0214)	(0.0130)	(0.0085)	(0.0292)	(0.0215)
O.MEAT	**0.5831**	0.0916	**-0.9012**	**1.4325**	**-1.7442**	**-0.6185**	0.1633	0.0070	0.2605	0.6693
	(0.2510)	(0.1702)	(0.4377)	(0.4995)	(0.5852)	(0.2095)	(0.1770)	(0.0927)	(0.2151)	(0.4527)
CHICKN	0.0821	0.0799	**0.0976**	**-0.4042**	0.1354	0.0110	**-0.0977**	-0.0029	-0.0162	0.0916
	(0.0753)	(0.0557)	(0.0341)	(0.1177)	(0.1220)	(0.0536)	(0.0417)	(0.0241)	(0.0633)	(0.0664)
TURKEY	0.2406	**0.2596**	**-0.4361**	0.4962	**-1.1352**	0.1285	0.1575	0.0782	-0.0258	-0.0403
	(0.1508)	(0.1093)	(0.1463)	(0.4474)	(0.5317)	(0.1554)	(0.1431)	(0.0761)	(0.1662)	(0.2248)
FISH	-0.1375	**0.1983**	**-0.0743**	0.0186	0.0615	-0.1271	0.1011	-0.0650	0.0975	0.0153
	(0.1192)	(0.0908)	(0.0251)	(0.0944)	(0.0745)	(0.1455)	(0.0776)	(0.0450)	(0.1235)	(0.1021)
C.FISH	0.0520	0.1206	0.0376	**-0.3320**	0.1451	0.1940	-0.2638	0.0161	-0.0777	0.1302
	(0.1352)	(0.1060)	(0.0408)	(0.1413)	(0.1320)	(0.1492)	(0.1649)	(0.0676)	(0.1634)	(0.1777)
EGG	0.0659	-0.0334	0.0007	-0.0041	0.0325	-0.0554	0.0077	**-0.0756**	-0.0052	**0.0727**
	(0.0407)	(0.0312)	(0.0096)	(0.0366)	(0.0316)	(0.0389)	(0.0304)	(0.0249)	(0.0471)	(0.0431)
CHEESE	-0.0437	**0.0989**	0.0125	-0.0132	-0.0054	0.0388	-0.0164	-0.0038	**-0.1613**	-0.0124
	(0.0658)	(0.0497)	(0.0104)	(0.0448)	(0.0320)	(0.0497)	(0.0342)	(0.0219)	(0.0861)	(0.0502)
F.MILK	0.0007	0.0067	0.0153	0.0312	-0.0035	0.0037	0.0135	**0.0161**	-0.0028	**-0.1651**
	(0.0238)	(0.0176)	(0.0104)	(0.0223)	(0.0206)	(0.0195)	(0.0176)	(0.0095)	(0.0238)	(0.0498)

Continued

Appendix table A. Uncompensated demand elasticities in the U.S. (Matrix partition A21)

CATEGORY	BEEF.V	PORK	O.MEAT	CHICKN	TURKEY	FISH	C.FISH	EGG	CHEESE	F.MILK
E.MILK	0.1492	**0.2077**	**-0.1378**	0.0828	0.0706	-0.1510	-0.0674	0.0317	-0.0631	**0.3469**
	(0.1211)	(0.0880)	(0.0578)	(0.1177)	(0.1094)	(0.1019)	(0.0936)	(0.0505)	(0.1187)	(0.2017)
FLOUR	-0.0549	**0.0499**	0.0047	-0.0395	0.0226	-0.0042	-0.0078	0.0137	-0.0333	0.0393
	(0.0389)	(0.0291)	(0.0100)	(0.0287)	(0.0204)	(0.0308)	(0.0238)	(0.0150)	(0.0415)	(0.0506)
RICE	**0.5214**	**0.2898**	0.0289	**-0.2826**	-0.0559	-0.1722	-0.0339	**-0.1007**	**0.2654**	**-0.3795**
	(0.2408)	(0.1607)	(0.0283)	(0.1127)	(0.0595)	(0.1074)	(0.0752)	(0.0502)	(0.1602)	(0.1677)
POTATO	-0.1031	**-0.1505**	-0.0051	**0.0506**	-0.0009	0.0246	0.0131	-0.0055	-0.0264	0.0212
	(0.0799)	(0.0491)	(0.0056)	(0.0277)	(0.0119)	(0.0234)	(0.0150)	(0.0107)	(0.0374)	(0.0364)
F.OIL	0.0310	-0.0244	**-0.0059**	0.0195	-0.0022	0.0003	0.0094	0.0046	-0.0132	**0.0390**
	(0.0379)	(0.0225)	(0.0024)	(0.0121)	(0.0051)	(0.0102)	(0.0065)	(0.0046)	(0.0164)	(0.0154)
APPLE	0.1554	-0.0332	0.0067	-0.0252	**0.1378**	-0.0320	0.1028	-0.0066	-0.0995	-0.1042
	(0.1631)	(0.1160)	(0.0307)	(0.0887)	(0.0613)	(0.1033)	(0.0762)	(0.0467)	(0.1419)	(0.1443)
ORANGE	0.0730	**-0.2810**	0.0190	0.1223	-0.0616	0.1234	0.0262	-0.0401	0.1383	**-0.3192**
	(0.2316)	(0.1601)	(0.0393)	(0.1134)	(0.0779)	(0.1240)	(0.0929)	(0.0559)	(0.1746)	(0.1552)
BANANA	-0.0918	**-0.1510**	**-0.1004**	**-0.2950**	**0.2124**	-0.0392	0.0949	-0.0262	**0.3288**	0.2063
	(0.1169)	(0.0883)	(0.0539)	(0.1068)	(0.1001)	(0.1154)	(0.1057)	(0.0568)	(0.1340)	(0.1518)
GRAPE	-0.2211	**0.2945**	-0.0472	**0.3644**	0.0983	-0.1865	**0.2132**	**0.1444**	**-0.5543**	-0.0998
	(0.2230)	(0.1625)	(0.0458)	(0.1348)	(0.0920)	(0.1578)	(0.1169)	(0.0728)	(0.2185)	(0.1640)
GRAFRU	-0.1434	0.0361	**0.1911**	-0.2031	0.2523	0.1971	0.1980	-0.1329	0.2556	**0.8987**
	(0.2580)	(0.1925)	(0.1050)	(0.2187)	(0.2003)	(0.2452)	(0.2189)	(0.1225)	(0.2876)	(0.3317)

Continued

Appendix table A. Uncompensated demand elasticities in the U.S. (Matrix partition A31)

CATEGORY	BEEF.V	PORK	O.MEAT	CHICKN	TURKEY	FISH	C.FISH	EGG	CHEESE	F.MILK
O.FRUT	-0.0995	-0.1290	**-0.0927**	0.0081	-0.0952	-0.1194	-0.1744	**0.1005**	0.2065	0.0896
	(0.1277)	(0.0957)	(0.0522)	(0.1100)	(0.0970)	(0.1246)	(0.1105)	(0.0604)	(0.1447)	(0.1828)
LETTUCE	0.0390	-0.0020	0.0136	-0.0035	-0.0420	0.0620	0.0043	-0.0249	0.0011	**-0.1592**
	(0.1152)	(0.0777)	(0.0149)	(0.0567)	(0.0315)	(0.0571)	(0.0360)	(0.0261)	(0.0793)	(0.0721)
TOMATO	**-0.1258**	**0.1226**	0.0062	**0.2564**	**-0.1080**	-0.0420	0.0510	-0.0524	0.0667	0.0846
	(0.0655)	(0.0502)	(0.0271)	(0.0627)	(0.0552)	(0.0672)	(0.0553)	(0.0332)	(0.0739)	(0.0995)
CELERY	0.1006	**-0.1975**	-0.0530	0.0349	-0.0455	**-0.1962**	**0.1678**	**0.1159**	0.1304	**0.3608**
	(0.0906)	(0.0690)	(0.0395)	(0.0878)	(0.0790)	(0.0933)	(0.0776)	(0.0457)	(0.1048)	(0.1361)
ONION	-0.0138	**0.1412**	0.0246	0.0369	-0.0826	0.0795	0.0253	**0.0807**	**-0.2133**	-0.0759
	(0.1091)	(0.0788)	(0.0245)	(0.0756)	(0.0503)	(0.0870)	(0.0589)	(0.0417)	(0.1068)	(0.1070)
CARROT	0.2049	-0.1180	**0.2514**	0.0267	-0.1058	-0.3228	0.2407	0.1481	**-0.4693**	0.2203
	(0.2507)	(0.1897)	(0.0889)	(0.2156)	(0.1808)	(0.2472)	(0.1947)	(0.1198)	(0.2818)	(0.3236)
O.VEGE	-0.0027	**0.1414**	-0.0186	-0.0092	0.0501	-0.0188	0.0224	-0.0082	-0.0134	-0.0320
	(0.1062)	(0.0738)	(0.0200)	(0.0621)	(0.0411)	(0.0696)	(0.0452)	(0.0320)	(0.0876)	(0.0910)
F.FRUT	-0.0535	-0.0261	0.0005	0.0154	**-0.0146**	0.0074	0.0002	**-0.0103**	-0.0024	0.0051
	(0.0610)	(0.0342)	(0.0033)	(0.0150)	(0.0073)	(0.0138)	(0.0073)	(0.0061)	(0.0224)	(0.0164)
C.TOMA	**0.1989**	-0.0367	0.0015	0.0265	-0.0122	**-0.1797**	-0.0090	0.0335	0.1376	0.0322
	(0.1087)	(0.0752)	(0.0234)	(0.0652)	(0.0464)	(0.0759)	(0.0461)	(0.0316)	(0.0996)	(0.0902)
C.PEA	0.1149	-0.0348	-0.2996	-0.3038	0.0072	0.0489	-0.1265	0.1194	0.1353	-0.0244
	(0.1995)	(0.1524)	(0.2063)	(0.3183)	(0.3578)	(0.2249)	(0.2314)	(0.1101)	(0.2338)	(0.3881)

Continued

Appendix table A. Uncompensated demand elasticities in the U.S. (Matrix partition A41)

CATEGORY	BEEF.V	PORK	O.MEAT	CHICKN	TURKEY	FISH	C.FISH	EGG	CHEESE	F.MILK
COCKTL	0.1927	0.0508	-0.0895	0.0520	0.0696	0.1291	**-0.4209**	0.0733	0.1845	0.4629
	(0.2257)	(0.1671)	(0.2382)	(0.3819)	(0.4246)	(0.2462)	(0.2435)	(0.1231)	(0.2615)	(0.4355)
NUTS	-0.0047	**0.2303**	0.1072	0.4442	-0.5221	-0.1196	0.0304	-0.0600	0.2193	-0.2627
	(0.1571)	(0.1110)	(0.2279)	(0.3319)	(0.3850)	(0.1597)	(0.1645)	(0.0767)	(0.1630)	(0.3000)
F.VEGE	-0.0683	**0.2148**	-0.0012	-0.0458	0.0110	-0.0214	**0.0877**	0.0226	0.0993	-0.1040
	(0.1084)	(0.0778)	(0.0233)	(0.0638)	(0.0455)	(0.0719)	(0.0438)	(0.0307)	(0.0958)	(0.0868)
C.TEA	-0.0678	**-0.0946**	-0.0034	-0.0082	-0.0147	**-0.0478**	0.0191	-0.0007	-0.0004	0.0397
	(0.0688)	(0.0455)	(0.0068)	(0.0281)	(0.0146)	(0.0259)	(0.0158)	(0.0107)	(0.0388)	(0.0339)
FRZN.D	**-0.1032**	0.0526	-0.0244	-0.0994	0.0340	0.0043	-0.0602	0.0200	-0.0785	**-0.3051**
	(0.0564)	(0.0422)	(0.0381)	(0.0700)	(0.0731)	(0.0623)	(0.0587)	(0.0300)	(0.0650)	(0.0992)
SUGAR	**0.1352**	-0.0162	0.0003	-0.0191	-0.0024	-0.0287	0.0000	-0.0110	0.0319	**0.0467**
	(0.0542)	(0.0354)	(0.0058)	(0.0224)	(0.0122)	(0.0210)	(0.0126)	(0.0085)	(0.0304)	(0.0239)
SWEET	-0.1093	-0.0027	-0.0037	-0.0282	-0.0191	0.0024	-0.0102	-0.0097	-0.0013	**-0.0770**
	(0.0815)	(0.0521)	(0.0075)	(0.0311)	(0.0161)	(0.0287)	(0.0171)	(0.0117)	(0.0417)	(0.0319)
N.FOOD	**-0.0164**	-0.0014	-0.0004	-0.0040	-0.0010	-0.0018	-0.0008	**-0.0054**	**-0.0086**	**-0.0135**
	(0.0047)	(0.0027)	(0.0006)	(0.0019)	(0.0015)	(0.0017)	(0.0012)	(0.0007)	(0.0022)	(0.0023)
WEIGHT	0.0224	0.0107	0.0003	0.0044	0.0012	0.0025	0.0013	0.0029	0.0062	0.0131

Continued

Appendix table A. Uncompensated demand elasticities in the U.S. (Matrix partition A12)

CATEGORY	E.MILK	FLOUR	RICE	POTATO	F.OIL	APPLE	ORANGE	BANANA	GRAPE	GRAFRU
BEEF.V	0.0237	-0.0278	**0.0427**	-0.0207	0.0276	0.0089	0.0017	-0.0042	-0.0078	-0.0022
	(0.0216)	(0.0184)	(0.0194)	(0.0150)	(0.0367)	(0.0102)	(0.0072)	(0.0052)	(0.0080)	(0.0035)
PORK	**0.0742**	0.0464	**0.0493**	**-0.0609**	-0.0545	-0.0053	-0.0191	**-0.0143**	**0.0221**	0.0007
	(0.0329)	(0.0288)	(0.0270)	(0.0193)	(0.0455)	(0.0152)	(0.0105)	(0.0083)	(0.0122)	(0.0054)
O.MEAT	**-1.8395**	0.1690	0.1748	-0.0717	**-0.4214**	0.0307	0.0439	**-0.3345**	-0.1256	**0.1909**
	(0.7711)	(0.3540)	(0.1697)	(0.0782)	(0.1733)	(0.1433)	(0.0918)	(0.1795)	(0.1221)	(0.1050)
CHICKN	0.0732	-0.0949	**-0.1145**	**0.0478**	**0.0980**	-0.0085	0.0190	**-0.0670**	**0.0665**	-0.0141
	(0.1070)	(0.0692)	(0.0461)	(0.0264)	(0.0596)	(0.0282)	(0.0180)	(0.0243)	(0.0245)	(0.0149)
TURKEY	0.2328	0.1992	-0.0828	-0.0041	-0.0399	**0.1601**	-0.0364	**0.1770**	0.0658	0.0629
	(0.3647)	(0.1806)	(0.0892)	(0.0417)	(0.0918)	(0.0715)	(0.0454)	(0.0834)	(0.0614)	(0.0501)
FISH	-0.2444	-0.0193	-0.1232	0.0400	0.0000	-0.0187	0.0340	-0.0157	-0.0595	0.0234
	(0.1630)	(0.1305)	(0.0774)	(0.0393)	(0.0883)	(0.0578)	(0.0347)	(0.0461)	(0.0505)	(0.0294)
C.FISH	-0.2107	-0.0666	-0.0464	0.0406	0.1515	0.1098	0.0135	0.0728	**0.1313**	0.0454
	(0.2881)	(0.1943)	(0.1041)	(0.0485)	(0.1079)	(0.0820)	(0.0500)	(0.0813)	(0.0720)	(0.0505)
EGG	0.0419	0.0515	**-0.0612**	-0.0081	0.0378	-0.0036	-0.0101	-0.0089	**0.0402**	-0.0139
	(0.0697)	(0.0547)	(0.0312)	(0.0155)	(0.0347)	(0.0226)	(0.0135)	(0.0196)	(0.0201)	(0.0127)
CHEESE	-0.0444	-0.0607	**0.0775**	-0.0201	-0.0530	-0.0236	0.0149	**0.0527**	**-0.0715**	0.0120
	(0.0766)	(0.0709)	(0.0465)	(0.0253)	(0.0574)	(0.0321)	(0.0197)	(0.0216)	(0.0282)	(0.0139)
F.MILK	**0.1042**	0.0332	**-0.0508**	0.0067	**0.0687**	-0.0115	**-0.0174**	0.0160	-0.0057	**0.0204**
	(0.0618)	(0.0407)	(0.0228)	(0.0116)	(0.0252)	(0.0154)	(0.0083)	(0.0116)	(0.0100)	(0.0076)

Continued

Appendix table A. Uncompensated demand elasticities in the U.S. (Matrix partition A22)

CATEGORY	E.MILK	FLOUR	RICE	POTATO	F.OIL	APPLE	ORANGE	BANANA	GRAPE	GRAFRU
E.MILK	-0.2880	0.1033	-0.1132	0.0277	-0.0694	0.1090	-0.0096	-0.0259	-0.0854	-0.0404
	(0.3565)	(0.1899)	(0.1024)	(0.0510)	(0.1129)	(0.0853)	(0.0435)	(0.0669)	(0.0641)	(0.0411)
FLOUR	0.0367	-0.0398	0.0313	-0.0103	-0.0679	**-0.0747**	0.0048	-0.0064	0.0139	-0.0045
	(0.0720)	(0.0903)	(0.0431)	(0.0213)	(0.0482)	(0.0307)	(0.0152)	(0.0198)	(0.0234)	(0.0118)
RICE	-0.2562	0.1781	0.2823	0.0052	-0.1551	0.1406	0.0170	0.1141	-0.0446	-0.0193
	(0.2282)	(0.2546)	(0.2578)	(0.1236)	(0.2946)	(0.1458)	(0.0584)	(0.0843)	(0.0729)	(0.0346)
POTATO	0.0247	-0.0242	0.0036	**-0.1158**	-0.0489	-0.0088	0.0035	0.0060	0.0017	-0.0047
	(0.0486)	(0.0540)	(0.0528)	(0.0577)	(0.0961)	(0.0450)	(0.0152)	(0.0121)	(0.0186)	(0.0072)
F.OIL	-0.0153	-0.0337	-0.0119	-0.0103	-0.0761	-0.0031	-0.0040	-0.0009	-0.0103	-0.0011
	(0.0207)	(0.0236)	(0.0242)	(0.0184)	(0.0747)	(0.0191)	(0.0065)	(0.0053)	(0.0082)	(0.0031)
APPLE	0.3109	**-0.5614**	0.1825	-0.0254	-0.0381	-0.1338	0.0587	**0.1420**	0.0328	0.0341
	(0.2437)	(0.2323)	(0.1875)	(0.1350)	(0.2967)	(0.1330)	(0.0581)	(0.0652)	(0.0820)	(0.0388)
ORANGE	-0.0546	0.0797	0.0460	0.0232	-0.1094	0.1178	**-0.9605**	0.0433	0.0068	0.0745
	(0.2488)	(0.2295)	(0.1501)	(0.0913)	(0.2016)	(0.1163)	(0.0984)	(0.0782)	(0.0977)	(0.0472)
BANANA	-0.1063	-0.0682	-0.0878	0.0243	-0.0193	**0.1981**	0.0298	**-0.4017**	-0.0068	0.0430
	(0.2676)	(0.2102)	(0.1091)	(0.0510)	(0.1141)	(0.0912)	(0.0547)	(0.1090)	(0.0787)	(0.0507)
GRAPE	-0.4308	0.1806	0.1808	0.0066	-0.2865	0.0563	0.0052	-0.0087	**-0.6433**	0.0265
	(0.3206)	(0.3104)	(0.2007)	(0.0977)	(0.2216)	(0.1436)	(0.0854)	(0.0985)	(0.1793)	(0.0594)
GRAFRU	-0.5383	-0.1503	-0.1137	-0.0639	-0.0605	0.1594	0.1739	0.1442	0.0716	**-0.7694**
	(0.5484)	(0.4155)	(0.2078)	(0.1009)	(0.2232)	(0.1810)	(0.1100)	(0.1692)	(0.1584)	(0.1469)

Continued

Appendix table A. Uncompensated demand elasticities in the U.S. (Matrix partition A32)

CATEGORY	E.MILK	FLOUR	RICE	POTATO	F.OIL	APPLE	ORANGE	BANANA	GRAPE	GRAFRU
O.FRUT	-0.0893	**0.4272**	**-0.3394**	0.0743	0.0715	0.0416	0.1151	-0.0348	0.1351	-0.0699
	(0.2950)	(0.2457)	(0.1299)	(0.0634)	(0.1408)	(0.1132)	(0.0747)	(0.0922)	(0.0933)	(0.0593)
LETTUCE	-0.1418	-0.1688	0.0572	0.0601	-0.0295	-0.0070	**0.0872**	**-0.0518**	0.0134	-0.0837
	(0.1057)	(0.1086)	(0.0782)	(0.0511)	(0.1159)	(0.0487)	(0.0285)	(0.0285)	(0.0408)	(0.0773)
TOMATO	-0.2436	0.1052	-0.0556	-0.0031	-0.1096	0.0223	**-0.0561**	-0.0196	-0.0139	0.0380
	(0.1564)	(0.1305)	(0.0678)	(0.0336)	(0.0740)	(0.0509)	(0.0286)	(0.0467)	(0.0461)	(0.0472)
CELERY	**-0.7770**	**0.2793**	0.0364	0.0241	**-0.1940**	**0.1171**	-0.0218	-0.0422	-0.0620	**-0.1011**
	(0.2116)	(0.1686)	(0.0854)	(0.0406)	(0.0907)	(0.0639)	(0.0380)	(0.0636)	(0.0569)	(0.0563)
ONION	0.0221	-0.0440	0.0783	-0.0381	**-0.1781**	0.0560	0.0228	**-0.1331**	0.0144	**-0.1478**
	(0.1626)	(0.1612)	(0.0901)	(0.0477)	(0.1021)	(0.0599)	(0.0340)	(0.0461)	(0.0548)	(0.0588)
CARROT	0.0745	-0.3655	0.0719	0.0617	-0.0347	-0.0606	-0.0678	**-0.2836**	0.1020	**-0.2333**
	(0.4967)	(0.4133)	(0.2125)	(0.1014)	(0.2239)	(0.1563)	(0.0905)	(0.1461)	(0.1421)	(0.1368)
O.VEGE	**0.2744**	-0.2173	-0.0504	-0.0658	-0.0425	-0.0562	0.0337	0.0126	-0.0420	-0.0508
	(0.1345)	(0.1350)	(0.0862)	(0.0561)	(0.1156)	(0.0575)	(0.0335)	(0.0375)	(0.0494)	(0.0804)
F.FRUT	0.0231	0.0056	-0.0225	-0.0354	-0.0753	-0.0162	-0.0143	-0.0060	**0.0184**	-0.0045
	(0.0241)	(0.0285)	(0.0305)	(0.0278)	(0.0950)	(0.0137)	(0.0093)	(0.0067)	(0.0093)	(0.0039)
C.TOMA	-0.0022	0.2003	**-0.2167**	**0.1172**	-0.0921	**0.1542**	-0.0256	-0.0160	0.0829	0.0115
	(0.1390)	(0.1413)	(0.0899)	(0.0494)	(0.1096)	(0.0632)	(0.0384)	(0.0425)	(0.0534)	(0.0248)
C.PEA	0.1402	**0.7559**	**-0.2981**	-0.0501	-0.0136	**0.2909**	-0.0959	**0.3591**	-0.1195	0.1258
	(0.6298)	(0.3566)	(0.1700)	(0.0757)	(0.1689)	(0.1249)	(0.0786)	(0.1498)	(0.1063)	(0.0895)

Continued

Appendix table A. Uncompensated demand elasticities in the U.S. (Matrix partition A42)

CATEGORY	E.MILK	FLOUR	RICE	POTATO	F.OIL	APPLE	ORANGE	BANANA	GRAPE	GRAFRU
COCKTL	-0.0535	**0.7466**	-0.1351	0.0420	-0.2409	0.0756	**-0.2012**	**-0.3373**	**-0.3301**	-0.1356
	(0.7051)	(0.3925)	(0.1904)	(0.0856)	(0.1910)	(0.1459)	(0.0915)	(0.1758)	(0.1243)	(0.1052)
NUTS	0.4166	**-0.5694**	0.0543	-0.0181	0.1865	0.0808	**0.1294**	-0.0714	-0.0118	0.0204
	(0.4847)	(0.2402)	(0.1141)	(0.0505)	(0.1128)	(0.0919)	(0.0579)	(0.1150)	(0.0773)	(0.0686)
F.VEGE	-0.0740	**-0.2632**	-0.0017	**0.1090**	0.0823	-0.0159	0.0423	-0.0133	0.0075	-0.0045
	(0.1275)	(0.1256)	(0.0795)	(0.0420)	(0.0929)	(0.0500)	(0.0303)	(0.0373)	(0.0430)	(0.0218)
C.TEA	**0.0942**	-0.0209	0.0034	-0.0302	-0.0050	0.0004	-0.0134	0.0086	0.0261	0.0023
	(0.0483)	(0.0495)	(0.0410)	(0.0301)	(0.0678)	(0.0243)	(0.0157)	(0.0126)	(0.0190)	(0.0077)
FRZN.D	0.1397	**0.2077**	-0.0712	0.0210	-0.0262	0.0049	-0.0076	**0.1080**	-0.0325	-0.0147
	(0.1588)	(0.1044)	(0.0513)	(0.0232)	(0.0518)	(0.0445)	(0.0269)	(0.0459)	(0.0391)	(0.0289)
SUGAR	-0.0006	-0.0136	0.0070	0.0396	-0.0652	0.0194	-0.0106	0.0003	**0.0270**	-0.0047
	(0.0396)	(0.0418)	(0.0502)	(0.0236)	(0.0575)	(0.0194)	(0.0125)	(0.0104)	(0.0154)	(0.0063)
SWEET	**-0.1056**	-0.0002	0.0624	0.0260	-0.0625	**0.0542**	0.0275	0.0024	0.0034	0.0024
	(0.0528)	(0.0538)	(0.0735)	(0.0341)	(0.0882)	(0.0266)	(0.0171)	(0.0138)	(0.0208)	(0.0084)
N.FOOD	**-0.0092**	**-0.0172**	-0.0027	-0.0089	**-0.0403**	-0.0030	-0.0016	-0.0020	-0.0009	-0.0008
	(0.0035)	(0.0031)	(0.0024)	(0.0019)	(0.0067)	(0.0014)	(0.0008)	(0.0009)	(0.0010)	(0.0005)
WEIGHT	0.004	0.0107	0.0018	0.0042	0.0217	0.0014	0.0007	0.001	0.0008	0.0003

Continued

Appendix table A. Uncompensated demand elasticities in the U.S. (Matrix partition A13)

CATEGORY	O.FRUT	LETTUCE	TOMATO	CELERY	ONION	CARROT	O.VEGE	F.FRUT	C.TOMA	C.PEA
BEEF.V	-0.0085	0.0047	**-0.0096**	0.0028	-0.0006	0.0036	-0.0007	-0.0133	**0.0167**	0.0016
	(0.0097)	(0.0123)	(0.0050)	(0.0024)	(0.0034)	(0.0045)	(0.0161)	(0.0155)	(0.0092)	(0.0027)
PORK	-0.0216	-0.0002	**0.0192**	**-0.0111**	**0.0090**	-0.0045	**0.0443**	-0.0143	-0.0069	-0.0010
	(0.0152)	(0.0174)	(0.0080)	(0.0039)	(0.0052)	(0.0071)	(0.0234)	(0.0182)	(0.0134)	(0.0043)
O.MEAT	**-0.5256**	0.1103	0.0357	-0.1057	0.0576	**0.3353**	-0.2106	0.0107	0.0100	-0.2995
	(0.2960)	(0.1194)	(0.1535)	(0.0790)	(0.0571)	(0.1185)	(0.2271)	(0.0621)	(0.1479)	(0.2063)
CHICKN	0.0026	-0.0009	**0.0993**	0.0049	0.0059	0.0025	-0.0067	0.0214	0.0116	-0.0206
	(0.0425)	(0.0309)	(0.0242)	(0.0120)	(0.0120)	(0.0196)	(0.0480)	(0.0194)	(0.0282)	(0.0217)
TURKEY	-0.1355	-0.0833	**-0.1529**	-0.0226	**-0.0482**	-0.0352	0.1421	**-0.0684**	-0.0193	0.0019
	(0.1374)	(0.0631)	(0.0782)	(0.0395)	(0.0293)	(0.0603)	(0.1164)	(0.0347)	(0.0734)	(0.0895)
FISH	-0.0821	0.0600	-0.0286	**-0.0470**	0.0221	-0.0517	-0.0258	0.0172	**-0.1367**	0.0059
	(0.0847)	(0.0548)	(0.0457)	(0.0224)	(0.0243)	(0.0396)	(0.0946)	(0.0314)	(0.0577)	(0.0270)
C.FISH	-0.2292	0.0081	0.0664	**0.0775**	0.0134	0.0740	0.0581	0.0005	-0.0135	-0.0292
	(0.1446)	(0.0665)	(0.0723)	(0.0358)	(0.0317)	(0.0599)	(0.1182)	(0.0319)	(0.0674)	(0.0534)
EGG	**0.0585**	-0.0194	-0.0303	**0.0242**	0.0195	0.0205	-0.0089	-0.0183	0.0223	0.0125
	(0.0354)	(0.0216)	(0.0195)	(0.0095)	(0.0101)	(0.0165)	(0.0375)	(0.0119)	(0.0207)	(0.0114)
CHEESE	0.0554	0.0004	0.0179	0.0126	**-0.0243**	**-0.0304**	-0.0083	-0.0031	0.0416	0.0065
	(0.0397)	(0.0307)	(0.0203)	(0.0101)	(0.0121)	(0.0182)	(0.0480)	(0.0206)	(0.0305)	(0.0113)
F.MILK	0.0112	**-0.0279**	0.0114	**0.0168**	-0.0040	0.0068	-0.0075	0.0042	0.0051	-0.0004
	(0.0237)	(0.0132)	(0.0129)	(0.0062)	(0.0057)	(0.0099)	(0.0236)	(0.0071)	(0.0131)	(0.0089)

Continued

Appendix table A. Uncompensated demand elasticities in the U.S. (Matrix partition A23)

CATEGORY	O.FRUT	LETTUCE	TOMATO	CELERY	ONION	CARROT	O.VEGE	F.FRUT	C.TOMA	C.PEA
E.MILK	-0.0376	-0.0829	-0.1023	**-0.1160**	0.0042	0.0077	**0.2355**	0.0374	0.0002	0.0108
	(0.1254)	(0.0634)	(0.0665)	(0.0317)	(0.0285)	(0.0497)	(0.1143)	(0.0344)	(0.0660)	(0.0472)
FLOUR	**0.0679**	-0.0373	0.0171	**0.0160**	-0.0029	-0.0137	-0.0694	0.0042	0.0361	**0.0215**
	(0.0394)	(0.0246)	(0.0209)	(0.0095)	(0.0106)	(0.0156)	(0.0433)	(0.0153)	(0.0253)	(0.0101)
RICE	**-0.3222**	0.0758	-0.0533	0.0119	0.0300	0.0158	-0.0968	-0.0732	**-0.2296**	-0.0042
	(0.1227)	(0.1043)	(0.0641)	(0.0285)	(0.0350)	(0.0472)	(0.1628)	(0.0965)	(0.0948)	(0.0647)
POTATO	0.0297	0.0356	-0.0008	0.0037	-0.0062	0.0060	-0.0525	-0.0459	**0.0535**	-0.0035
	(0.0257)	(0.0292)	(0.0136)	(0.0058)	(0.0080)	(0.0097)	(0.0454)	(0.0377)	(0.0224)	(0.0054)
F.OIL	0.0049	-0.0025	-0.0084	**-0.0052**	**-0.0058**	-0.0006	-0.0065	-0.0188	-0.0080	-0.0001
	(0.0110)	(0.0128)	(0.0058)	(0.0025)	(0.0033)	(0.0041)	(0.0181)	(0.0250)	(0.0096)	(0.0023)
APPLE	0.0505	-0.0101	0.0280	**0.0506**	0.0282	-0.0171	-0.1348	-0.0625	**0.2102**	**0.0625**
	(0.1376)	(0.0834)	(0.0618)	(0.0274)	(0.0300)	(0.0447)	(0.1397)	(0.0558)	(0.0858)	(0.0268)
ORANGE	0.2801	**0.3014**	**-0.1350**	-0.0181	0.0232	-0.0384	0.1663	-0.1111	-0.0680	-0.0408
	(0.1817)	(0.0977)	(0.0695)	(0.0326)	(0.0340)	(0.0517)	(0.1629)	(0.0761)	(0.1043)	(0.0337)
BANANA	-0.0598	**-0.1236**	-0.0332	-0.0252	**-0.0932**	**-0.1134**	0.0430	-0.0331	-0.0303	**0.1078**
	(0.1567)	(0.0685)	(0.0794)	(0.0381)	(0.0323)	(0.0584)	(0.1274)	(0.0382)	(0.0808)	(0.0449)
GRAPE	0.2859	0.0403	-0.0298	-0.0466	0.0124	0.0509	-0.1793	**0.1303**	0.1964	-0.0448
	(0.1983)	(0.1225)	(0.0979)	(0.0426)	(0.0480)	(0.0711)	(0.2100)	(0.0660)	(0.1268)	(0.0398)
GRAFRU	-0.3956	-0.0067	0.0044	-0.0022	**-0.0043**	-0.0040	-0.0053	-0.0808	0.0742	0.1261
	(0.3362)	(0.0086)	(0.0037)	(0.0016)	(0.0019)	(0.0025)	(0.0126)	(0.0742)	(0.1571)	(0.0895)

Continued

Appendix table A. Uncompensated demand elasticities in the U.S. (Matrix partition A33)

CATEGORY	O.FRUT	LETTUCE	TOMATO	CELERY	ONION	CARROT	O.VEGE	F.FRUT	C.TOMA	C.PEA
O.FRUT	-0.0458	-0.0681	0.0403	-0.0062	-0.0069	**0.1265**	-0.0248	0.0283	-0.0357	-0.0545
	(0.2499)	(0.0828)	(0.0840)	(0.0380)	(0.0359)	(0.0630)	(0.1466)	(0.0464)	(0.0879)	(0.0453)
LETTUCE	-0.0495	-0.1213	0.0148	-0.0165	0.0243	-0.0162	-0.1096	**0.0726**	0.0039	0.0076
	(0.0587)	(0.0847)	(0.0366)	(0.0163)	(0.0197)	(0.0256)	(0.0983)	(0.0360)	(0.0468)	(0.0132)
TOMATO	0.0395	0.0214	**-0.3558**	-0.0117	-0.0003	0.0345	0.1212	**-0.0653**	**-0.1072**	**0.0762**
	(0.0840)	(0.0517)	(0.0758)	(0.0255)	(0.0238)	(0.0407)	(0.0986)	(0.0215)	(0.0447)	(0.0246)
CELERY	-0.0186	-0.0659	-0.0335	-0.0085	-0.0480	-0.0295	0.1219	-0.0244	-0.0422	0.0358
	(0.1076)	(0.0653)	(0.0723)	(0.0483)	(0.0306)	(0.0540)	(0.1231)	(0.0303)	(0.0616)	(0.0355)
ONION	-0.0173	0.0841	-0.0006	-0.0410	**-0.1851**	0.0383	0.1371	0.0157	0.0176	0.0209
	(0.0873)	(0.0677)	(0.0578)	(0.0262)	(0.0410)	(0.0418)	(0.1257)	(0.0356)	(0.0653)	(0.0227)
CARROT	**0.5369**	-0.0964	0.1466	-0.0442	0.0670	**-0.5171**	-0.1663	0.0405	0.0961	0.0716
	(0.2676)	(0.1539)	(0.1733)	(0.0810)	(0.0731)	(0.1782)	(0.2915)	(0.0673)	(0.1469)	(0.0791)
O.VEGE	-0.0132	-0.0767	0.0607	0.0216	0.0282	-0.0196	-0.1138	**-0.0818**	0.0450	**-0.0320**
	(0.0733)	(0.0693)	(0.0493)	(0.0217)	(0.0258)	(0.0342)	(0.1578)	(0.0354)	(0.0535)	(0.0176)
F.FRUT	0.0074	**0.0309**	**-0.0196**	-0.0025	0.0018	0.0028	**-0.0493**	**-0.3527**	0.0047	0.0026
	(0.0138)	(0.0152)	(0.0064)	(0.0032)	(0.0044)	(0.0047)	(0.0211)	(0.0769)	(0.0150)	(0.0033)
C.TOMA	-0.0327	0.0056	**-0.0958**	-0.0132	0.0064	0.0202	0.0805	0.0147	0.0486	0.0281
	(0.0786)	(0.0591)	(0.0400)	(0.0195)	(0.0241)	(0.0309)	(0.0958)	(0.0446)	(0.0936)	(0.0232)
C.PEA	-0.3101	0.0611	**0.4317**	0.0716	0.0487	0.0955	**-0.3636**	0.0498	0.1774	**-0.6046**
	(0.2569)	(0.1053)	(0.1393)	(0.0710)	(0.0529)	(0.1054)	(0.1995)	(0.0620)	(0.1470)	(0.2136)

Continued

Appendix table A. Uncompensated demand elasticities in the U.S. (Matrix partition A43)

CATEGORY	O.FRUT	LETTUCE	TOMATO	CELERY	ONION	CARROT	O.VEGE	F.FRUT	C.TOMA	C.PEA
COCKTL	**0.7562**	-0.0989	-0.2566	-0.0891	-0.0255	-0.0373	0.1140	0.0705	-0.0429	0.0850
	(0.2979)	(0.1247)	(0.1650)	(0.0822)	(0.0621)	(0.1239)	(0.2370)	(0.0721)	(0.1616)	(0.1778)
NUTS	-0.1478	0.0146	0.0036	-0.0283	-0.0295	0.1148	0.1638	0.0442	-0.0262	**0.2724**
	(0.1917)	(0.0837)	(0.1154)	(0.0584)	(0.0416)	(0.0868)	(0.1603)	(0.0403)	(0.0966)	(0.1282)
F.VEGE	-0.0684	0.0349	0.0342	0.0113	-0.0066	0.0440	0.1291	-0.0450	-0.0195	-0.0130
	(0.0679)	(0.0492)	(0.0359)	(0.0180)	(0.0206)	(0.0272)	(0.0804)	(0.0362)	(0.0577)	(0.0214)
C.TEA	**0.0530**	0.0031	0.0055	-0.0024	-0.0072	-0.0083	-0.0247	0.0044	-0.0102	0.0062
	(0.0270)	(0.0282)	(0.0143)	(0.0058)	(0.0082)	(0.0099)	(0.0425)	(0.0264)	(0.0247)	(0.0054)
FRZN.D	0.0188	0.0325	0.0194	-0.0089	**0.0535**	-0.0016	-0.0355	0.0021	-0.0251	0.0058
	(0.0841)	(0.0344)	(0.0426)	(0.0211)	(0.0171)	(0.0328)	(0.0643)	(0.0176)	(0.0385)	(0.0295)
SUGAR	0.0183	0.0156	0.0045	**0.0113**	0.0046	0.0047	0.0299	0.0103	-0.0072	0.0023
	(0.0219)	(0.0220)	(0.0116)	(0.0047)	(0.0066)	(0.0081)	(0.0342)	(0.0206)	(0.0199)	(0.0046)
SWEET	-0.0391	0.0224	0.0110	**-0.0137**	-0.0045	-0.0044	-0.0026	0.0474	-0.0440	-0.0066
	(0.0293)	(0.0306)	(0.0156)	(0.0063)	(0.0087)	(0.0108)	(0.0462)	(0.0324)	(0.0271)	(0.0059)
N.FOOD	**-0.0051**	**-0.0038**	**-0.0019**	**-0.0011**	**-0.0013**	-0.0009	-0.0090	**-0.0093**	**-0.0028**	-0.0008
	(0.0017)	(0.0014)	(0.0009)	(0.0004)	(0.0005)	(0.0007)	(0.0022)	(0.0038)	(0.0013)	(0.0005)
WEIGHT	0.0017	0.0024	0.0017	0.0006	0.0007	0.0004	0.0034	0.0057	0.0019	0.0003

Continued

Appendix table A. Uncompensated demand elasticities in the U.S. (Matrix partition A14)

CATEGORY	COCKTL	NUTS	F.VEGE	C.TEA	FRZN.D	SUGAR	SWEET	N.FOOD	EXPEND	CONST
BEEF.V	0.0035	-0.0001	-0.0138	-0.0083	**-0.0190**	**0.0218**	-0.0383	-0.0069	**0.4037**	-0.2156
	(0.0040)	(0.0007)	(0.0198)	(0.0098)	(0.0101)	(0.0094)	(0.0280)	(0.1771)	(0.1446)	(0.8616)
PORK	0.0019	**0.0021**	**0.0805**	**-0.0273**	0.0186	-0.0081	-0.0036	-0.2994	**0.5236**	**-1.6282**
	(0.0062)	(0.0010)	(0.0298)	(0.0136)	(0.0158)	(0.0129)	(0.0375)	(0.2148)	(0.1666)	(0.9869)
O.MEAT	-0.1192	0.0357	-0.0164	-0.0345	-0.3250	0.0029	-0.0947	3.2529	0.1203	0.1690
	(0.3176)	(0.0760)	(0.3179)	(0.0721)	(0.5075)	(0.0749)	(0.1913)	(1.7507)	(0.4481)	(2.3627)
CHICKN	0.0049	0.0101	-0.0432	-0.0040	-0.0902	-0.0179	-0.0486	-0.1239	0.2108	1.9265
	(0.0347)	(0.0075)	(0.0595)	(0.0204)	(0.0636)	(0.0199)	(0.0545)	(0.3675)	(0.1925)	(1.0813)
TURKEY	0.0233	-0.0435	0.0367	-0.0373	0.1133	-0.0091	-0.1224	-0.2625	0.2648	1.2906
	(0.1415)	(0.0321)	(0.1554)	(0.0388)	(0.2436)	(0.0397)	(0.1034)	(1.0859)	(0.3550)	(1.8928)
FISH	0.0207	-0.0048	-0.0363	**-0.0598**	0.0064	-0.0465	0.0068	0.2853	0.3898	-0.3994
	(0.0394)	(0.0064)	(0.1179)	(0.0331)	(0.0996)	(0.0327)	(0.0884)	(0.5695)	(0.3139)	(1.6458)
C.FISH	**-0.1295**	0.0023	**0.2747**	0.0479	-0.1863	-0.0021	-0.0618	-0.7476	0.5132	-2.6919
	(0.0749)	(0.0127)	(0.1382)	(0.0389)	(0.1807)	(0.0377)	(0.1011)	(0.7823)	(0.3640)	(1.8755)
EGG	0.0103	-0.0021	0.0318	0.0015	0.0281	-0.0154	-0.0244	-0.3014	0.1194	-0.5406
	(0.0170)	(0.0026)	(0.0434)	(0.0118)	(0.0414)	(0.0115)	(0.0310)	(0.2139)	(0.1089)	(0.5830)
CHEESE	0.0119	0.0035	0.0635	0.0005	-0.0521	0.0176	-0.0039	-0.4901	**0.6030**	0.1862
	(0.0169)	(0.0026)	(0.0633)	(0.0200)	(0.0419)	(0.0191)	(0.0517)	(0.3035)	(0.1775)	(0.9598)
F.MILK	0.0143	-0.0020	-0.0326	0.0120	**-0.0925**	**0.0133**	**-0.0436**	-0.0650	0.1008	**-1.0201**
	(0.0133)	(0.0023)	(0.0272)	(0.0083)	(0.0303)	(0.0071)	(0.0188)	(0.1480)	(0.0676)	(0.3795)

Continued

Appendix table A. Uncompensated demand elasticities in the U.S. (Matrix partition A24)

CATEGORY	COCKTL	NUTS	F.VEGE	C.TEA	FRZN.D	SUGAR	SWEET	N.FOOD	EXPEND	CONST
E.MILK	-0.0050	0.0104	-0.0742	**0.0790**	0.1421	0.0005	**-0.1983**	0.3381	-0.3274	0.7866
	(0.0705)	(0.0121)	(0.1307)	(0.0386)	(0.1588)	(0.0386)	(0.1017)	(0.7380)	(0.3132)	(1.7086)
FLOUR	**0.0283**	**-0.0054**	**-0.1024**	-0.0044	**0.0785**	-0.0061	0.0004	-0.1382	0.2361	-0.7075
	(0.0148)	(0.0023)	(0.0486)	(0.0149)	(0.0394)	(0.0154)	(0.0391)	(0.2413)	(0.1274)	(0.7502)
RICE	0.1028	0.0029	-0.0069	0.0060	-0.1606	**0.0977**	**-0.3332**	-0.2349	0.8292	-0.3089
	(0.0968)	(0.0063)	(0.1812)	(0.0728)	(0.1141)	(0.0518)	(0.1366)	(1.1282)	(0.7808)	(4.5994)
POTATO	0.0042	-0.0004	**0.1064**	-0.0206	0.0207	0.0363	0.0494	0.0479	0.0816	-0.7591
	(0.0082)	(0.0012)	(0.0410)	(0.0229)	(0.0221)	(0.0219)	(0.0625)	(0.3770)	(0.3038)	(1.8038)
F.OIL	-0.0043	0.0008	0.0147	0.0010	-0.0050	-0.0130	-0.0220	-0.1011	0.2886	0.3768
	(0.0035)	(0.0005)	(0.0175)	(0.0100)	(0.0096)	(0.0103)	(0.0313)	(0.2610)	(0.2331)	(1.3901)
APPLE	0.0219	0.0058	-0.0455	0.0042	0.0157	0.0546	**0.3015**	-0.5039	-0.1642	-0.8753
	(0.0417)	(0.0066)	(0.1465)	(0.0556)	(0.1270)	(0.0540)	(0.1463)	(0.8452)	(0.4277)	(2.6551)
ORANGE	**-0.1145**	**0.0185**	0.2496	-0.0572	-0.0404	-0.0576	0.3078	0.7039	-0.4368	5.5485
	(0.0523)	(0.0083)	(0.1773)	(0.0719)	(0.1537)	(0.0696)	(0.1882)	(0.9735)	(0.5823)	(3.6517)
BANANA	**-0.1348**	-0.0072	-0.0555	0.0291	**0.4316**	-0.0003	0.0184	0.0220	0.3139	-1.8415
	(0.0703)	(0.0115)	(0.1531)	(0.0404)	(0.1837)	(0.0405)	(0.1065)	(0.7253)	(0.3029)	(1.7562)
GRAPE	**-0.1650**	-0.0015	0.0365	0.1053	-0.1640	**0.1293**	0.0310	-0.0534	0.5735	-1.5758
	(0.0622)	(0.0097)	(0.2202)	(0.0759)	(0.1957)	(0.0750)	(0.1998)	(1.0940)	(0.5665)	(3.4637)
GRAFRU	-0.1804	0.0068	-0.0593	0.0288	-0.1929	-0.0588	0.0685	0.7470	-0.4680	3.7775
	(0.1403)	(0.0229)	(0.2978)	(0.0817)	(0.3848)	(0.0823)	(0.2150)	(1.4211)	(0.5798)	(3.4112)

Continued

Appendix table A. Uncompensated demand elasticities in the U.S. (Matrix partition A34)

CATEGORY	COCKTL	NUTS	F.VEGE	C.TEA	FRZN.D	SUGAR	SWEET	N.FOOD	EXPEND	CONST
O.FRUT	**0.1782**	-0.0087	-0.1641	**0.1028**	0.0457	0.0424	-0.1738	0.1228	-0.1241	-0.2979
	(0.0701)	(0.0113)	(0.1639)	(0.0507)	(0.1979)	(0.0502)	(0.1325)	(0.8545)	(0.3967)	(2.3369)
LETTUCE	-0.0165	0.0005	0.0574	0.0049	0.0528	0.0228	0.0696	-0.2319	**0.6064**	-1.6272
	(0.0208)	(0.0035)	(0.0841)	(0.0376)	(0.0574)	(0.0357)	(0.0983)	(0.5033)	(0.3261)	(1.9954)
TOMATO	-0.0603	0.0002	0.0814	0.0118	0.0453	0.0087	0.0494	-0.1859	**0.3735**	0.0462
	(0.0388)	(0.0068)	(0.0866)	(0.0268)	(0.1003)	(0.0266)	(0.0707)	(0.4403)	(0.1897)	(1.1253)
CELERY	-0.0594	-0.0048	0.0752	-0.0119	-0.0602	**0.0713**	**-0.1771**	0.0956	**0.5072**	**-2.9019**
	(0.0548)	(0.0097)	(0.1229)	(0.0308)	(0.1405)	(0.0309)	(0.0809)	(0.5740)	(0.2316)	(1.3861)
ONION	-0.0144	-0.0042	-0.0395	-0.0309	**0.3058**	0.0243	-0.0488	-0.1367	0.2195	0.4620
	(0.0355)	(0.0059)	(0.1208)	(0.0373)	(0.0976)	(0.0366)	(0.0960)	(0.5489)	(0.2707)	(1.6308)
CARROT	-0.0372	0.0287	0.4501	-0.0649	-0.0164	0.0443	-0.0841	-0.1486	0.3525	1.5990
	(0.1239)	(0.0217)	(0.2787)	(0.0790)	(0.3282)	(0.0793)	(0.2086)	(1.4000)	(0.5633)	(3.3866)
O.VEGE	0.0135	0.0048	0.1546	-0.0217	-0.0420	0.0328	-0.0059	-0.1871	0.3257	-0.5532
	(0.0279)	(0.0047)	(0.0970)	(0.0400)	(0.0756)	(0.0392)	(0.1047)	(0.5473)	(0.3221)	(1.9229)
F.FRUT	0.0050	0.0007	-0.0339	0.0037	0.0007	0.0051	0.0629	0.0807	0.4543	1.3199
	(0.0051)	(0.0007)	(0.0264)	(0.0148)	(0.0123)	(0.0141)	(0.0438)	(0.5611)	(0.5345)	(1.3292)
C.TOMA	-0.0089	-0.0014	-0.0431	-0.0155	-0.0531	-0.0163	-0.1786	-0.4759	0.3243	-0.6544
	(0.0340)	(0.0051)	(0.1248)	(0.0416)	(0.0810)	(0.0409)	(0.1097)	(0.5577)	(0.3387)	(1.9712)
C.PEA	0.1134	**0.0907**	-0.1792	0.0673	0.0759	0.0281	-0.1703	-0.8950	0.4803	-3.6896
	(0.2371)	(0.0427)	(0.2929)	(0.0573)	(0.3935)	(0.0602)	(0.1514)	(1.4547)	(0.5043)	(2.7671)

Continued

Appendix table A. Uncompensated demand elasticities in the U.S. (Matrix partition A44)

CATEGORY	COCKTL	NUTS	F.VEGE	C.TEA	FRZN.D	SUGAR	SWEET	N.FOOD	EXPEND	CONST
COCKTL	-0.3515	0.0082	-0.2742	0.0012	0.1874	0.0357	-0.0499	-0.7866	0.6193	-1.9793
	(0.3774)	(0.0502)	(0.3632)	(0.0739)	(0.4707)	(0.0767)	(0.1950)	(1.6904)	(0.5999)	(3.2617)
NUTS	0.0329	-0.0997	-0.3023	**-0.0686**	0.1184	**-0.0738**	0.1082	-0.3603	-0.0157	2.1202
	(0.2007)	(0.0641)	(0.2068)	(0.0378)	(0.2665)	(0.0393)	(0.1004)	(1.1330)	(0.3326)	(1.8087)
F.VEGE	-0.0265	-0.0074	0.0015	-0.0015	-0.0081	-0.0224	0.0814	-0.2625	0.0814	2.1219
	(0.0354)	(0.0050)	(0.1445)	(0.0349)	(0.0780)	(0.0345)	(0.0920)	(0.4984)	(0.2878)	(1.5989)
C.TEA	0.0001	**-0.0022**	-0.0050	**-0.1729**	**-0.0462**	0.0190	**-0.1965**	-0.3351	**0.8328**	**-3.2495**
	(0.0092)	(0.0012)	(0.0448)	(0.0323)	(0.0275)	(0.0215)	(0.0633)	(0.2976)	(0.2242)	(1.3064)
FRZN.D	0.0189	0.0029	-0.0090	-0.0351	**-0.2598**	0.0149	**0.1021**	0.0787	0.2561	-0.1654
	(0.0471)	(0.0067)	(0.0799)	(0.0220)	(0.1274)	(0.0238)	(0.0600)	(0.4083)	(0.1744)	(0.9082)
SUGAR	0.0039	**-0.0019**	-0.0231	0.0184	0.0164	-0.0204	-0.0680	-0.1148	-0.0402	0.4093
	(0.0079)	(0.0010)	(0.0363)	(0.0177)	(0.0246)	(0.0233)	(0.0516)	(0.2311)	(0.1643)	(0.9570)
SWEET	-0.0025	0.0014	0.0424	**-0.0800**	**0.0529**	-0.0358	0.0013	-0.0033	0.3064	-0.8580
	(0.0101)	(0.0013)	(0.0490)	(0.0261)	(0.0310)	(0.0258)	(0.0994)	(0.3702)	(0.2824)	(1.6066)
N.FOOD	**-0.0008**	**-0.0002**	**-0.0079**	**-0.0033**	**-0.0078**	**-0.0081**	**-0.0136**	**-0.9100**	**1.1276**	**-0.3088**
	(0.0008)	(0.0001)	(0.0024)	(0.0011)	(0.0019)	(0.0011)	(0.0034)	(0.0167)	(0.0099)	(0.0895)
WEIGHT	0.0004	0.0001	0.0041	0.0032	0.004	0.0039	0.0077	0.8462	NA	NA

APPENDIX B

COMPENSATED DEMAND ELASTICITIES

The matrix of compensated demand elasticities is partitioned into eight blocks and presented in a sequential table ordering as B11, B21, B12, B22, B13, B23, B14, and B24. The notations in the tables are BEEF.V—beef and veal; O.MEAT—other meats; CHICKN—chicken; FISH—fresh and frozen fish; C.FISH—canned and cured fish; F.MILK—fluid milk; E.MILK—evaporated and dry milk; FLOUR—wheat flour; F.OIL—fats and oils; GRAFRU—grapefruits; O.FRUIT—other fresh fruits; O.VEGE—other fresh vegetables; F.FRUT—frozen fruits and juice; C.TOMA—canned tomatoes; C.PEAS—canned peas; COCKTL—canned fruits cocktail; NUTS—peanuts and tree nuts; F.VEGE—frozen vegetables; C.TEA—coffee and tea; FRZN.D—ice cream and other frozen dairy products; SWEET—sweeteners; and N.FOOD—nonfood.

Partition of Compensated Elasticity Matrix

B11	B12	B13	B14
B21	B22	B23	B24

Appendix table B. Compensated demand elasticities in the U.S. (Matrix partition B11)

CATEGORY	BEEF.V	PORK	O.MEAT	CHICKN	TURKEY	FISH	C.FISH	EGG	CHEESE	F.MILK
BEEF.V	-0.5069	0.1221	0.0078	0.0171	0.0132	-0.0144	0.0037	0.0089	-0.0084	0.0017
PORK	0.2556	-0.7517	0.0026	0.0338	0.0294	0.0473	0.0153	-0.0087	0.0611	0.0096
O.MEAT	0.5858	0.0928	-0.9012	1.4330	-1.7440	-0.6182	0.1634	0.0073	0.2612	0.6709
CHICKN	0.0868	0.0822	0.0977	-0.4033	0.1356	0.0115	-0.0974	-0.0023	-0.0149	0.0943
TURKEY	0.2465	0.2624	-0.4360	0.4974	-1.1349	0.1292	0.1579	0.0790	-0.0241	-0.0368
FISH	-0.1287	0.2025	-0.0742	0.0203	0.0620	-0.1261	0.1016	-0.0639	0.0999	0.0205
C.FISH	0.0635	0.1260	0.0377	-0.3298	0.1457	0.1953	-0.2631	0.0176	-0.0745	0.1369
EGG	0.0686	-0.0322	0.0008	-0.0035	0.0327	-0.0551	0.0079	-0.0753	-0.0045	0.0742
CHEESE	-0.0302	0.1054	0.0126	-0.0106	-0.0047	0.0403	-0.0156	-0.0021	-0.1576	-0.0045
F.MILK	0.0030	0.0078	0.0154	0.0317	-0.0034	0.0039	0.0136	0.0164	-0.0021	-0.1637
E.MILK	0.1419	0.2042	-0.1379	0.0814	0.0702	-0.1518	-0.0678	0.0307	-0.0651	0.3427
FLOUR	-0.0496	0.0524	0.0048	-0.0385	0.0229	-0.0036	-0.0075	0.0144	-0.0318	0.0424
RICE	0.5400	0.2987	0.0292	-0.2789	-0.0549	-0.1701	-0.0328	-0.0983	0.2705	-0.3687
POTATO	-0.1013	-0.1497	-0.0051	0.0510	-0.0008	0.0248	0.0132	-0.0053	-0.0259	0.0223
F.OIL	0.0375	-0.0213	-0.0058	0.0208	-0.0019	0.0010	0.0097	0.0054	-0.0114	0.0428
APPLE	0.1518	-0.0350	0.0066	-0.0259	0.1376	-0.0324	0.1026	-0.0071	-0.1006	-0.1064
ORANGE	0.0632	-0.2857	0.0189	0.1204	-0.0622	0.1223	0.0257	-0.0414	0.1356	-0.3249
BANANA	-0.0848	-0.1476	-0.1003	-0.2937	0.2128	-0.0384	0.0953	-0.0253	0.3308	0.2104
GRAPE	-0.2083	0.3006	-0.0471	0.3669	0.0990	-0.1850	0.2140	0.1461	-0.5507	-0.0923
GRAFRU	-0.1539	0.0311	0.1909	-0.2052	0.2517	0.1959	0.1974	-0.1343	0.2527	0.8925

Continued

Appendix table B. Compensated demand elasticities in the U.S. (Matrix partition B21)

CATEGORY	BEEF.V	PORK	O.MEAT	CHICKN	TURKEY	FISH	C.FISH	EGG	CHEESE	F.MILK
O.FRUT	-0.1023	-0.1303	-0.0927	0.0075	-0.0954	-0.1197	-0.1746	0.1001	0.2057	0.0880
LETTUCE	0.0526	0.0045	0.0138	-0.0008	-0.0413	0.0635	0.0051	-0.0231	0.0049	-0.1512
TOMATO	-0.1175	0.1266	0.0063	0.2580	-0.1076	-0.0410	0.0515	-0.0513	0.0690	0.0895
CELERY	0.1119	-0.1921	-0.0528	0.0371	-0.0449	-0.1949	0.1685	0.1174	0.1336	0.3675
ONION	-0.0089	0.1435	0.0247	0.0379	-0.0823	0.0800	0.0255	0.0813	-0.2119	-0.0730
CARROT	0.2128	-0.1142	0.2515	0.0282	-0.1054	-0.3219	0.2411	0.1491	-0.4671	0.2249
O.VEGE	0.0046	0.1449	-0.0185	-0.0078	0.0505	-0.0180	0.0229	-0.0072	-0.0114	-0.0277
F.FRUT	-0.0433	-0.0212	0.0006	0.0174	-0.0141	0.0085	0.0008	-0.0089	0.0004	0.0110
C.TOMA	0.2061	-0.0333	0.0016	0.0279	-0.0119	-0.1789	-0.0086	0.0344	0.1396	0.0365
C.PEA	0.1256	-0.0297	-0.2995	-0.3016	0.0078	0.0501	-0.1259	0.1208	0.1383	-0.0181
COCKTL	0.2065	0.0575	-0.0894	0.0548	0.0703	0.1307	-0.4201	0.0751	0.1884	0.4710
NUTS	-0.0051	0.2301	0.1072	0.4441	-0.5222	-0.1197	0.0304	-0.0601	0.2192	-0.2629
F.VEGE	-0.0664	0.2157	-0.0012	-0.0454	0.0111	-0.0211	0.0878	0.0229	0.0998	-0.1030
C.TEA	-0.0491	-0.0857	-0.0032	-0.0046	-0.0137	-0.0457	0.0201	0.0017	0.0048	0.0506
FRZN.D	-0.0975	0.0553	-0.0243	-0.0983	0.0343	0.0050	-0.0599	0.0207	-0.0770	-0.3017
SUGAR	0.1343	-0.0166	0.0003	-0.0193	-0.0025	-0.0288	0.0000	-0.0111	0.0317	0.0461
SWEET	-0.1024	0.0006	-0.0037	-0.0269	-0.0188	0.0032	-0.0098	-0.0088	0.0006	-0.0729
N.FOOD	-0.0164	-0.0026	-0.0003	-0.0032	-0.0008	-0.0018	-0.0009	-0.0046	-0.0045	-0.0095

Continued

Appendix table B. Compensated demand elasticities in the U.S. (Matrix partition B12)

CATEGORY	E.MILK	FLOUR	RICE	POTATO	F.OIL	APPLE	ORANGE	BANANA	GRAPE	GRAFRU
BEEF.V	0.0253	-0.0234	0.0434	-0.0190	0.0363	0.0095	0.0020	-0.0038	-0.0074	-0.0021
PORK	0.0763	0.0520	0.0502	-0.0588	-0.0432	-0.0046	-0.0187	-0.0138	0.0225	0.0009
O.MEAT	-1.8390	0.1702	0.1750	-0.0712	-0.4188	0.0308	0.0440	-0.3343	-0.1255	0.1909
CHICKN	0.0740	-0.0926	-0.1141	0.0487	0.1025	-0.0082	0.0191	-0.0667	0.0667	-0.0140
TURKEY	0.2339	0.2020	-0.0823	-0.0030	-0.0341	0.1605	-0.0363	0.1773	0.0660	0.0629
FISH	-0.2429	-0.0152	-0.1225	0.0416	0.0085	-0.0182	0.0342	-0.0154	-0.0592	0.0235
C.FISH	-0.2086	-0.0611	-0.0455	0.0428	0.1626	0.1105	0.0138	0.0733	0.1317	0.0455
EGG	0.0424	0.0528	-0.0610	-0.0076	0.0404	-0.0034	-0.0100	-0.0087	0.0403	-0.0139
CHEESE	-0.0420	-0.0543	0.0785	-0.0176	-0.0399	-0.0227	0.0153	0.0533	-0.0711	0.0122
F.MILK	0.1046	0.0343	-0.0507	0.0071	0.0709	-0.0114	-0.0174	0.0161	-0.0056	0.0204
E.MILK	-0.2893	0.0998	-0.1138	0.0263	-0.0765	0.1086	-0.0099	-0.0263	-0.0857	-0.0405
FLOUR	0.0377	-0.0373	0.0317	-0.0093	-0.0628	-0.0744	0.0050	-0.0061	0.0141	-0.0044
RICE	-0.2528	0.1870	0.2838	0.0086	-0.1371	0.1417	0.0176	0.1149	-0.0439	-0.0191
POTATO	0.0251	-0.0234	0.0037	-0.1154	-0.0471	-0.0087	0.0036	0.0061	0.0017	-0.0047
F.OIL	-0.0141	-0.0307	-0.0114	-0.0091	-0.0698	-0.0027	-0.0038	-0.0006	-0.0101	-0.0010
APPLE	0.3102	-0.5631	0.1822	-0.0261	-0.0416	-0.1341	0.0586	0.1418	0.0326	0.0340
ORANGE	-0.0563	0.0750	0.0452	0.0214	-0.1189	0.1172	-0.9608	0.0428	0.0064	0.0744
BANANA	-0.1051	-0.0648	-0.0872	0.0256	-0.0125	0.1986	0.0300	-0.4014	-0.0065	0.0431
GRAPE	-0.4285	0.1868	0.1818	0.0091	-0.2740	0.0571	0.0056	-0.0081	-0.6429	0.0267
GRAFRU	-0.5402	-0.1553	-0.1145	-0.0659	-0.0707	0.1588	0.1736	0.1437	0.0712	-0.7695

Continued

Appendix table B. Compensated demand elasticities in the U.S. (Matrix partition B22)

CATEGORY	E.MILK	FLOUR	RICE	POTATO	F.OIL	APPLE	ORANGE	BANANA	GRAPE	GRAFRU
O.FRUT	-0.0898	0.4258	-0.3396	0.0738	0.0688	0.0414	0.1150	-0.0349	0.1350	-0.0699
LETTUCE	-0.1394	-0.1624	0.0583	0.0627	-0.0163	-0.0061	0.0876	-0.0512	0.0139	-0.0835
TOMATO	-0.2421	0.1092	-0.0549	-0.0015	-0.1015	0.0229	-0.0559	-0.0192	-0.0136	0.0381
CELERY	-0.7750	0.2847	0.0373	0.0263	-0.1830	0.1178	-0.0214	-0.0417	-0.0616	-0.1009
ONION	0.0229	-0.0416	0.0787	-0.0371	-0.1734	0.0563	0.0229	-0.1329	0.0146	-0.1477
CARROT	0.0759	-0.3617	0.0726	0.0632	-0.0270	-0.0601	-0.0676	-0.2832	0.1023	-0.2332
O.VEGE	0.2757	-0.2138	-0.0498	-0.0645	-0.0354	-0.0557	0.0339	0.0130	-0.0417	-0.0507
F.FRUT	0.0250	0.0105	-0.0216	-0.0335	-0.0655	-0.0156	-0.0140	-0.0055	0.0187	-0.0044
C.TOMA	-0.0009	0.2037	-0.2161	0.1186	-0.0850	0.1546	-0.0254	-0.0156	0.0831	0.0116
C.PEA	0.1421	0.7611	-0.2972	-0.0481	-0.0032	0.2916	-0.0956	0.3596	-0.1191	0.1259
COCKTL	-0.0510	0.7532	-0.1340	0.0446	-0.2274	0.0765	-0.2007	-0.3367	-0.3296	-0.1354
NUTS	0.4165	-0.5696	0.0542	-0.0181	0.1862	0.0807	0.1293	-0.0714	-0.0118	0.0204
F.VEGE	-0.0737	-0.2623	-0.0015	0.1093	0.0841	-0.0158	0.0423	-0.0132	0.0076	-0.0045
C.TEA	0.0975	-0.0120	0.0049	-0.0268	0.0131	0.0016	-0.0128	0.0094	0.0268	0.0026
FRZN.D	0.1408	0.2105	-0.0708	0.0220	-0.0206	0.0053	-0.0074	0.1082	-0.0323	-0.0146
SUGAR	-0.0008	-0.0140	0.0069	0.0394	-0.0660	0.0194	-0.0106	0.0002	0.0270	-0.0047
SWEET	-0.1043	0.0030	0.0629	0.0273	-0.0558	0.0546	0.0277	0.0027	0.0037	0.0025
N.FOOD	-0.0029	-0.0077	-0.0013	-0.0030	-0.0157	-0.0010	-0.0005	-0.0007	-0.0006	-0.0002

Continued

Appendix table B. Compensated demand elasticities in the U.S. (Matrix partition B13)

CATEGORY	O.FRUT	LETTUCE	TOMATO	CELERY	ONION	CARROT	O.VEGE	F.FRUT	C.TOMA	C.PEA
BEEF.V	-0.0078	0.0056	-0.0089	0.0030	-0.0003	0.0038	0.0007	-0.0110	0.0175	0.0017
PORK	-0.0207	0.0010	0.0201	-0.0108	0.0094	-0.0043	0.0460	-0.0113	-0.0059	-0.0008
O.MEAT	-0.5253	0.1106	0.0359	-0.1056	0.0576	0.3354	-0.2102	0.0114	0.0102	-0.2995
CHICKN	0.0029	-0.0004	0.0997	0.0051	0.0060	0.0026	-0.0060	0.0226	0.0120	-0.0206
TURKEY	-0.1351	-0.0826	-0.1524	-0.0225	-0.0480	-0.0351	0.1430	-0.0669	-0.0188	0.0020
FISH	-0.0814	0.0610	-0.0279	-0.0468	0.0224	-0.0515	-0.0245	0.0194	-0.1359	0.0060
C.FISH	-0.2283	0.0093	0.0673	0.0778	0.0138	0.0742	0.0598	0.0035	-0.0125	-0.0291
EGG	0.0587	-0.0191	-0.0301	0.0243	0.0196	0.0206	-0.0085	-0.0176	0.0225	0.0125
CHEESE	0.0564	0.0019	0.0189	0.0129	-0.0239	-0.0301	-0.0062	0.0004	0.0428	0.0067
F.MILK	0.0114	-0.0277	0.0116	0.0168	-0.0039	0.0069	-0.0072	0.0048	0.0053	-0.0004
E.MILK	-0.0382	-0.0836	-0.1029	-0.1162	0.0040	0.0076	0.2344	0.0356	-0.0005	0.0107
FLOUR	0.0683	-0.0368	0.0175	0.0161	-0.0027	-0.0136	-0.0686	0.0056	0.0365	0.0215
RICE	-0.3208	0.0778	-0.0519	0.0124	0.0306	0.0161	-0.0940	-0.0685	-0.2281	-0.0039
POTATO	0.0299	0.0358	-0.0006	0.0038	-0.0062	0.0060	-0.0522	-0.0455	0.0537	-0.0034
F.OIL	0.0054	-0.0018	-0.0080	-0.0051	-0.0056	-0.0005	-0.0055	-0.0172	-0.0074	0.0000
APPLE	0.0502	-0.0105	0.0278	0.0505	0.0281	-0.0172	-0.1353	-0.0634	0.2099	0.0625
ORANGE	0.2794	0.3004	-0.1357	-0.0184	0.0229	-0.0386	0.1648	-0.1136	-0.0689	-0.0410
BANANA	-0.0593	-0.1229	-0.0326	-0.0250	-0.0930	-0.1133	0.0441	-0.0313	-0.0297	0.1079
GRAPE	0.2869	0.0416	-0.0288	-0.0462	0.0128	0.0511	-0.1774	0.1335	0.1974	-0.0447
GRAFRU	-0.3964	-0.0078	0.0036	-0.0025	-0.0046	-0.0042	-0.0068	-0.0834	0.0733	0.1259

Continued

Appendix table B. Compensated demand elasticities in the U.S. (Matrix partition B23)

CATEGORY	O.FRUT	LETTUCE	TOMATO	CELERY	ONION	CARROT	O.VEGE	F.FRUT	C.TOMA	C.PEA
O.FRUT	-0.0460	-0.0684	0.0401	-0.0063	-0.0070	0.1265	-0.0253	0.0276	-0.0359	-0.0546
LETTUCE	-0.0484	-0.1198	0.0158	-0.0162	0.0247	-0.0159	-0.1076	0.0761	0.0051	0.0078
TOMATO	0.0401	0.0223	-0.3552	-0.0115	-0.0001	0.0346	0.1225	-0.0631	-0.1064	0.0763
CELERY	-0.0178	-0.0647	-0.0326	-0.0082	-0.0476	-0.0293	0.1237	-0.0215	-0.0412	0.0359
ONION	-0.0169	0.0847	-0.0002	-0.0408	-0.1850	0.0384	0.1379	0.0169	0.0180	0.0210
CARROT	0.5375	-0.0956	0.1472	-0.0439	0.0672	-0.5169	-0.1651	0.0425	0.0968	0.0718
O.VEGE	-0.0126	-0.0759	0.0612	0.0218	0.0284	-0.0194	-0.1127	-0.0800	0.0456	-0.0319
F.FRUT	0.0082	0.0320	-0.0188	-0.0023	0.0021	0.0030	-0.0477	-0.3501	0.0055	0.0028
C.TOMA	-0.0321	0.0064	-0.0952	-0.0130	0.0066	0.0204	0.0816	0.0166	0.0492	0.0282
C.PEA	-0.3093	0.0623	0.4325	0.0718	0.0490	0.0957	-0.3620	0.0526	0.1784	-0.6045
COCKTL	0.7573	-0.0974	-0.2556	-0.0888	-0.0251	-0.0371	0.1161	0.0740	-0.0417	0.0852
NUTS	-0.1479	0.0145	0.0035	-0.0283	-0.0295	0.1147	0.1638	0.0441	-0.0262	0.2724
F.VEGE	-0.0683	0.0351	0.0344	0.0113	-0.0066	0.0441	0.1293	-0.0445	-0.0193	-0.0130
C.TEA	0.0544	0.0051	0.0069	-0.0019	-0.0066	-0.0080	-0.0219	0.0091	-0.0086	0.0065
FRZN.D	0.0192	0.0331	0.0199	-0.0087	0.0537	-0.0015	-0.0346	0.0036	-0.0246	0.0058
SUGAR	0.0183	0.0155	0.0044	0.0113	0.0045	0.0047	0.0297	0.0101	-0.0073	0.0023
SWEET	-0.0386	0.0231	0.0116	-0.0135	-0.0043	-0.0042	-0.0015	0.0491	-0.0435	-0.0065
N.FOOD	-0.0012	-0.0017	-0.0012	-0.0004	-0.0005	-0.0003	-0.0025	-0.0041	-0.0014	-0.0002

Continued

Appendix table B. Compensated demand elasticities in the U.S. (Matrix partition B14)

CATEGORY	COCKTL	NUTS	F.VEGE	C.TEA	FRZN.D	SUGAR	SWEET	N.FOOD
BEEF.V	0.0037	0.0000	-0.0122	-0.0070	-0.0174	0.0234	-0.0352	0.3347
PORK	0.0021	0.0022	0.0826	-0.0256	0.0207	-0.0061	0.0004	0.1436
O.MEAT	-0.1191	0.0357	-0.0159	-0.0341	-0.3245	0.0034	-0.0937	3.3547
CHICKN	0.0050	0.0101	-0.0423	-0.0033	-0.0893	-0.0171	-0.0470	0.0545
TURKEY	0.0234	-0.0435	0.0378	-0.0364	0.1144	-0.0081	-0.1204	-0.0384
FISH	0.0209	-0.0048	-0.0347	-0.0585	0.0080	-0.0450	0.0098	0.6152
C.FISH	-0.1293	0.0023	0.2768	0.0496	-0.1843	-0.0001	-0.0578	-0.3134
EGG	0.0104	-0.0021	0.0323	0.0019	0.0286	-0.0149	-0.0234	-0.2004
CHEESE	0.0122	0.0035	0.0660	0.0025	-0.0497	0.0199	0.0007	0.0202
F.MILK	0.0144	-0.0020	-0.0322	0.0124	-0.0921	0.0137	-0.0429	0.0203
E.MILK	-0.0051	0.0104	-0.0756	0.0780	0.1408	-0.0008	-0.2008	0.0610
FLOUR	0.0284	-0.0054	-0.1015	-0.0036	0.0794	-0.0051	0.0022	0.0616
RICE	0.1031	0.0030	-0.0035	0.0087	-0.1573	0.1010	-0.3268	0.4667
POTATO	0.0043	-0.0004	0.1067	-0.0204	0.0210	0.0366	0.0500	0.1169
F.OIL	-0.0042	0.0009	0.0159	0.0019	-0.0038	-0.0119	-0.0198	0.1432
APPLE	0.0219	0.0058	-0.0461	0.0036	0.0151	0.0540	0.3002	-0.6428
ORANGE	-0.1147	0.0185	0.2478	-0.0586	-0.0421	-0.0593	0.3045	0.3343
BANANA	-0.1347	-0.0071	-0.0542	0.0301	0.4328	0.0009	0.0208	0.2876
GRAPE	-0.1648	-0.0015	0.0389	0.1072	-0.1617	0.1315	0.0354	0.4319
GRAFRU	-0.1806	0.0068	-0.0613	0.0273	-0.1947	-0.0607	0.0649	0.3510

Continued

Appendix table B. Compensated demand elasticities in the U.S. (Matrix partition B24)

CATEGORY	COCKTL	NUTS	F.VEGE	C.TEA	FRZN.D	SUGAR	SWEET	N.FOOD
O.FRUT	0.1782	-0.0087	-0.1646	0.1024	0.0452	0.0419	-0.1748	0.0178
LETTUCE	-0.0162	0.0006	0.0599	0.0068	0.0552	0.0251	0.0743	0.2812
TOMATO	-0.0601	0.0002	0.0829	0.0130	0.0468	0.0102	0.0523	0.1301
CELERY	-0.0592	-0.0047	0.0773	-0.0103	-0.0582	0.0732	-0.1732	0.5248
ONION	-0.0143	-0.0042	-0.0386	-0.0302	0.3066	0.0252	-0.0471	0.0491
CARROT	-0.0371	0.0287	0.4516	-0.0638	-0.0150	0.0457	-0.0814	0.1497
O.VEGE	0.0137	0.0048	0.1560	-0.0206	-0.0407	0.0341	-0.0034	0.0886
F.FRUT	0.0052	0.0008	-0.0320	0.0051	0.0025	0.0069	0.0664	0.4651
C.TOMA	-0.0088	-0.0014	-0.0417	-0.0145	-0.0518	-0.0150	-0.1761	-0.2015
C.PEA	0.1136	0.0908	-0.1772	0.0689	0.0779	0.0299	-0.1666	-0.4885
COCKTL	-0.3513	0.0082	-0.2717	0.0032	0.1899	0.0381	-0.0451	-0.2625
NUTS	0.0329	-0.0997	-0.3023	-0.0687	0.1183	-0.0739	0.1081	-0.3736
F.VEGE	-0.0265	-0.0074	0.0018	-0.0012	-0.0078	-0.0221	0.0820	-0.1936
C.TEA	0.0004	-0.0021	-0.0015	-0.1702	-0.0428	0.0222	-0.1900	0.3696
FRZN.D	0.0190	0.0030	-0.0080	-0.0343	-0.2588	0.0159	0.1041	0.2954
SUGAR	0.0039	-0.0019	-0.0232	0.0182	0.0163	-0.0205	-0.0683	-0.1488
SWEET	-0.0023	0.0014	0.0437	-0.0790	0.0541	-0.0346	0.0036	0.2560
N.FOOD	-0.0003	-0.0001	-0.0030	-0.0023	-0.0029	-0.0028	-0.0056	-1.1734