IMPORT DEMAND FOR EDIBLE OILS IN INDIA: AN APPLICATION OF SOURCE- DIFFERENTIATED MODELS, AND CONSUMER DEMAND FOR BEEF VARIETY

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CHAPTER 1

IMPORT DEMAND FOR EDIBLE OILS IN INDIA: AN APPLICATION OF SOURCE-DIFFERENTIATED MODELS

Abstract

The source-differentiated import demand for edible oils in India is estimated using different versions of the differential demand model; including the Rotterdam, the almost ideal demand system (AIDS), the Central Bureau of Statistics (CBS), the National Bureau of Research (NBR), and General specifications. The General model that nests all the other models is estimated to determine the model that best fits the data. Based on the nested tests, the General model is found to best fit the data. Additionally, the tests for weak separability and product aggregation support the estimation of source differentiated models including all three edible oil types (palm oils, soybean oils, and other oils). Results indicate that soybean oils have larger own-price (in absolute values) elasticities than palm oils. They also indicate that Malaysia and the U.S. have the largest expenditure elasticities in the palm and soybean oil import markets, respectively. Moreover, strong substitute relationships are found between Indonesian palm oil and Brazilian soybean oil, and between Malaysian palm oil and Argentine soybean oil. The strong substitute relationships between palm and soybean oils imply that the tariff differences between these two oils could affect the market shares of these oils in the Indian edible oil import market significantly.

Keywords: Differential demand systems, Barten's model selection method, Indian edible oil import demand, source-diffentiation.

Introduction

India is one of the leading importers of edible oils in the world, accounting for about 11 percent of world edible oil imports in 2005. More specifically; in 2005, India accounted for approximately 11 and 20 percent of world palm and soybean oil imports, respectively (USDA-FAS 2007). In recent years, imports have accounted for a notable share of agricultural consumption—accounting for about 40 percent of India's edible oil consumption and about 30 percent of its total value of agricultural imports in 2005 (USDA-FAS 2007; FAOSTAT 2007). With a population of more than one billion and an economy that is expected to grow at a high rate, edible oil imports are likely to increase in the coming years.

India grew rapidly from a relatively small importer of edible oils in the 1990s to one of the leading importers since 1998 (Dohlman, Persaud, and Landes 2003). To protect domestic oilseed producers, the government of India instituted an import quota for edible oils in 1988. The quota lasted until 1994, when the edible oils market became liberalized with the membership of India into the WTO (Dohlman, Persaud, and Landes 2003). Imports were very low during the quota period (1988-1994). In 1994, India replaced quantitative restrictions with tariffs and started allowing private traders to import unlimited quantities of oils (Dohlman, Persaud, and Landes 2003). Currently (2008), the tariff policy is still in effect.

As a result of the shift in import policy; total edible oil imports, consisting of mostly palm and soybean oils, increased from an annual average of about 0.39 million metric tons during 1988 -1994 to 4.26 million metric tons during 1998 – 2005 (FAOSTAT 2007). The pattern of edible oil consumption also has changed in India over the past three decades. During the period 1972-74, peanut oil, rapeseed oil (canola oil), and cotton seed oil dominated the Indian edible oil market; accounting for an annual average of about 53, 25, and 9 percent, respectively. However, during 2003-05, the palm and soybean oils accounted for an annual average of about 30 and 21 percent of total edible oil consumption in India (USDA-FAS 2007).

Regarding imported oils, palm and soybean oils are dominant, accounting for 62 and 33 percent of the import market share in 2005. Almost all the palm oil consumed in India is satisfied by imports, and about 55 percent of soybean oil consumed is satisfied by imports (FAOSTAT 2007). Indonesia and Malaysia, large palm oil exporters in the global markets; dominate the market in India, accounting for 79 and 20 percent of the total Indian palm oil imports in 2005, respectively. In the soybean oil import market, Argentina and Brazil dominate as large exporters, accounting for 70 and 21 percent of the total Indian soybean oil import market share in 2005. The U.S. only accounted for 2 percent of India's total soybean oil imports in 2005 (GTIS 2007). The higher price of U.S. soybean oil compared to those of Argentina and Brazil could be the reason for the low U.S. market share in India (Dohlman, Persaud, and Landes 2003). In 2005 the average price (unit value including import tariff) of soybean oil from U.S. was Rs. 54.15 per kg, while those of soybean oils from Argentina and Brazil were Rs. 35.60 and Rs. 35.80 respectively (GTIS 2007; SAI 2007).

Even though India plays a significant role in the global markets for edible oils, very little published research is available regarding the analysis of import demand for edible oils in India. The few studies that are available are either descriptive, or have used a single equation approach to estimate the domestic demand for edible oils in India (Dohlman, Persaud, and Landes 2003; Persaud and Landes 2006).

With the rapid globalization of India's edible oil market, understanding the interrelated demands for various edible oils and the factors shaping them would help in understanding this market. More specifically, an understanding of source-differentiated import demand elasticities and the factors underlying them can provide valuable information to the exporting countries, in developing effective marketing programs aimed at expanding sales and market shares in India. For example, this information can be especially useful to U.S. exporters. This is because, despite the significant growth in the Indian imports of edible oils since early 1990s, the U.S. has not been successful in increasing its soybean oil sales to India. This has been attributed to the stiff competition U.S. soybean oil faces from Malaysian and Indonesian palm oils and Argentine and Brazilian soybean oils (Dohlman, Persaud, and Landes 2003). Reliable estimates of elasticities are also needed for policy evaluations in India, such as the tariff policy and welfare analysis.

Objectives

The general objective of this study is to determine the demand for source and type differentiated edible oil imports in India. More specifically, the objective of this study is to determine the impact of economic factors (prices and expenditures) and non-economic factors (seasonality) on competitiveness of various supplying countries in the Indian edible oil import market. Moreover, the objective is to provide reliable estimates of import demand elasticities in this market by selecting a model that best fits the Indian edible oils import data.

Literature Review

Published studies on edible oil demand in India have been limited. Dohlman, Persaud, and Landes (2003), using a descriptive method, studied Indian edible oil import demand during 1980-2002. They argued that prices played a dominant role in India's edible oil import demand. Dutta and Ahmed (2001), using cointegration and an error correction model, studied the behavior of Indian aggregate imports (both agricultural and non-agricultural) during 1971-1995. They found that India's import demand was largely affected by real GDP, and was not very sensitive to the changes in import prices.

Regarding the analysis of the soybean and its products markets, various studies have analyzed the impact of domestic and trade policies of major exporters on the world markets. Williams and Thompson (1984) studied the impact of Brazilian soybean policies during 1960-78 on the world soybean market, using a simultaneous equations model and a dynamic simulation analysis. Their results showed that the intervention policies by the Brazilian government such as soybean price ceilings, and export restrictions aimed at promoting the crushing of soybeans locally, reduced the producer price of soybeans. It was concluded that the U.S. soybean industry benefitted as a result of Brazil's restrictive export policy. Moreover, it was concluded that policies designed to encourage exports of value added soybeans, such as tax advantages for soybean product exports unavailable for domestic sales of soybean products or for exports of soybeans increased world prices of soybeans, while decreasing world prices of soybean products. Andino, Mulik, and Koo (2005), using an error component three stage least squares procedure, found that the depreciation of currencies in Argentina and Brazil during 1994-2003 decreased soybean exports from the U.S.

Regarding the global market analysis for palm oil; Othman and Alias (2000), used a single equation import demand model to study the demand for Malaysian palm oil in the European Union (EU) and U.S. markets during 1980-1995. They found that palm oil and soybean oil prices were very significant in affecting the U.S. and the EU palm oil imports from Malaysia. Talib and Darawi (2002) analyzed the Malaysian palm oil market during 1970-1999, using a 2SLS procedure. Their results indicated that palm oil exports were dependent on world population, level of world economic activity (used industrial production index of industrialized countries), palm oil price, and soybean oil price.

Regarding the empirical developments in modeling import demands; a wide variety of models have been utilized in the literature, which have been applied to a variety of agricultural commodities and countries. Yang and Koo (1994) estimated the import demand for meats in Japan using a restricted source differentiated almost ideal demand system (RSDAIDS) model, assuming separability between domestic and imported meats. Henneberry and Hwang (2007) estimated the import demand for meats in South Korea using a RSDAIDS model, including both domestic and imported meats. Fabiosa and Ukhova (2000) estimated the import demand for pork in Japan using a two-stage version of the almost ideal demand system (AIDS) model. In their study they allowed for the substitution between domestic and imported pork products. Seale, Sparks, and Buxton (1992) used a source differentiated Rotterdam model to estimate the import demand for U.S. apples in Canada, Singapore, Hong Kong, and United Kingdom. They assumed block independence between domestic and imported products. Mutondo and Henneberry (2007) used a source differentiated Rotterdam model to estimate the demand for meats in U.S. Similar to Seale, Sparks, and Buxton (1992), Mutondo and Henneberry (2007) did not assume separability between domestic and imported meats. Schmitz and Seale (2002) estimated the import demand for disaggregated fresh fruits in Japan using Rotterdam, AIDS, Central Bureau of Research (CBS), and National Bureau of Research (NBR) models. Following Barten (1993) they also tested the models against the General model that nested all the four models. They found that for a five-good case the test did not reject Rotterdam, and CBS models, while for a six good case the test only did not reject the Rotterdam model. Agobola and Damoense (2005), using a Stock Watson Dynamic OLS model, estimated a long run import demand for chickpeas, pulses, and lentils in India. However, there has been no study that had estimated the import demand for edible oils in India. In this study, following Barten (1993), the factors shaping the Indian edible oil import demand are determined by using differential demand models.

Conceptual Framework

In order to select the appropriate theory, it is important to determine whether the imported good is directly consumed by the consumers or it is an input in a production process. In India, the imported edible oils are sold after repackaging, refining, hydrogenating, or blending with other oils (Dohlman, Persaud, and Landes 2003).

In this study, following Davis and Jensen (1994), it is assumed that the firms that import edible oils are multi product firms that utilize imported edible oils as a factor to produce different edible oil products. It is also assumed that these firms deal exclusively with imported edible oils. In this framework, the importing firm first decides on the quantity of edible oils that needs to be imported, and then on the quantity that needs to be imported from different sources.

Therefore; given this assumption, an input demand system based on the production theory, with the firm's profit maximization or cost minimization as an objective, may be the appropriate theory to be used here to derive source differentiated edible oil demand, rather than deriving demands based on the consumer theory (Mutondo and Henneberry 2007). Nevertheless, Davis and Jensen (1994) show that a second stage Marshallian input demand system derived from a two-stage profit maximization problem is analogous to a Marshallian demand system derived from a two-stage utility maximization problem. Therefore a model based on consumer theory can be justified to be used in this study to estimate the import demand.

Following Davis and Jensen (1994), the Marshallian demand function for edible oil *i* from source *h* can be expressed as:

(1) $$q_{ih} = q_{ih}\,(\,p_{ih}\,, E)$$

where q_{ih} is the edible oil i imported from source h, p_{ih} is the price of edible oil i from source h, and E is the total expenditure spent on imported edible oils.

Assuming edible oils are normal goods, it can be hypothesized that own-price would have a negative impact, while expenditure would have a positive impact on the quantity demanded.

The Empirical Model

The Rotterdam and the almost ideal demand system (AIDS) are the two most popular model specifications that are used in the literature to estimate import demands for agricultural commodities (Seale, Sparks, and Buxton 1992; Yang and Koo 1994; Henneberry and Hwang 2006; Mutondo and Henneberry 2007). As different functional forms may result in different elasticity estimates, which in turn may result in contrasting policy evaluations, it is important to choose a functional form that best fits the data.

In this study the source differentiated import demand for edible oils in India is estimated by four separate versions of the differential demand model. The four model specifications used in this study are Rotterdam, AIDS (Almost Ideal Demand System), NBR (National Bureau of Research), and CBS (Central Bureau of Statistics). These models differ from one another in the ways they are parameterized. The NBR and the CBS models are the hybrid versions of the Rotterdam and the AIDS models. The General model which is a demand model by itself that nests all the four models is also estimated to determine the model that best fits the data (Barten 1993).

The Rotterdam Model

The absolute price version of the Rotterdam model is derived by totally differentiating a Marshallian demand function (Barten 1964; Theil 1965). It can be specified by adding an intercept to capture changes in tastes and preferences and a quarterly dummy variable for seasonality as follows:

(2) $$w_{ih}\, d\log q_{ih} = \alpha_{ih} + \theta_{ih}\, d\log Q + \sum_j \sum_k \pi_{ih\,jk}\, d\log p_{jk} + \sum_l \alpha_{ih\,l} D_l$$

$i,j=1,2,\ldots,m$;(when $i \neq j$) $h=1,2,\ldots,n,$ and $k=1,2,\ldots,s$; and $l=1,3,4$

where subscript i and j indicate edible oil types (palm oil, soybean oil, other oils), and h and k indicate supply sources(country of origin); $w_{ih}=(w_{ih\,t} + w_{ih,\,t-1})/2$ is the average expenditure share for edible oil i from source h, $w_{ih} = p_{ih}q_{ih}/E$; p_{ih} is the price of edible oil i from source h; q_{ih} is the quantity of edible oil i from source h; E is the total expenditure spent on edible oil imports, t is the time subscript; $d\log q_{ih}=\log(q_{ih\,t})-\log(q_{ih,t-1})$; $d\log Q = \sum_i \sum_h w_{ih}\, d\log q_{ih}$ is the Divisia quantity index; $d\log p_{jk}=\log(p_{jk\,t})-$

$\log(p_{jk,t-1})$; D_l is a quarterly dummy variable ; and α_{ih}, θ_{ih}, $\pi_{ih\,jk}$, and $\alpha_{ih\,l}$ are the parameters of the model that need to be estimated. The expenditure coefficient $\theta_{ih} = p_{ih}$ $(\partial q_{ih}/\partial E)$ is the marginal propensity to spend on edible oil i from source h if the total expenditure on edible oil imports were to be increased (marginal budget share); and $\pi_{ih\,jk}$ $= (p_{ih}p_{jk}/E)s_{ih\,jk}$, is the compensated price effect (Slutsky terms), $s_{ij} = \partial q_{ih}/\partial p_{jk} +$ $q_{jk}\partial q_{ih}/\partial E$, is the $(i,j)^{th}$ element of the Slutsky substitution matrix .

The theoretical restrictions such as homogeneity and symmetry can be imposed and tested easily. Also, if the estimated model satisfies concavity it does so globally. Theoretical restrictions of adding-up, homogeneity, and symmetry as shown below will be imposed on the model parameters.

(3) Adding-up $\sum_i \sum_h \alpha_{ih} = 0$,$\sum_i \sum_h \theta_{ih} = 1$, $\sum_i \sum_h \pi_{ihjk} = 0$, and $\sum_i \sum_h \alpha_{ih\,l} = 0$;

(4) Homogeneity $\sum_j \sum_k \pi_{ih\,jk} = 0$; and

(5) Symmetry $\pi_{ih\,jk} = \pi_{jk\,ih}$

Elasticities are calculated using the following formulas (Barten 1993), where the expenditure elasticity is given by

(6) $\eta_{ih} = \theta_{ih} / w_{ih}$,

Slutsky (compensated) elasticities are calculated using

(7) Own price elasticity : $\zeta_{ih\,ih} = \pi_{ih\,ih} / w_{ih}$

(8) Cross price elasticity : $\zeta_{ihjk} = \pi_{ih\,jk} / w_{ih}$ ($i=j$ is possible)

Cournot (uncompensated) elasticities are calculated using

(9) Own price elasticity : $\varepsilon_{ih\,ih} = \pi_{ih\,ih} / w_{ih} - \theta_{ih}$ or $\varepsilon_{ih\,ih} = \zeta_{ih\,ih} - \eta_{ih}\, w_{ih}$

(10) Cross price elasticity : $\varepsilon_{ih\,jk} = (\pi_{ih\,jk} - \theta_{ih}\, w_{jk})/w_{ih}$ or $\varepsilon_{ih\,jk} = \zeta_{ih\,jk} - \eta_{ih}\, w_{jk}$

All the elasticities are calculated at mean expenditure shares. The variances of expenditure elasticities, Slutsky own and cross-price elasticities, and Cournot own and cross-price elasticities can be calculated using the equations (11),(12), and(13) respectively

(11) $$\text{var}(\eta_{ih}) = \text{var}(\theta_{ih}) / w^2_{ih}\,;$$

(12) $$\text{var}(\zeta_{ih\,ih}) = \text{var}(\pi_{ih\,ih}) / w^2_{ih}\,,$$

$$\text{var}(\zeta_{ih\,jk}) = \text{var}(\pi_{ih\,jk}) / w^2_{ih}\,;\text{ and}$$

(13) $$\text{var}(\varepsilon_{ih\,ih}) = \text{var}(\zeta_{ih\,ih}) + w^2_{ih}\,\text{var}(\eta_{ih}) - 2\,w_{ih}\,\text{cov}\,(\zeta_{ih\,ih}, \eta_{ih}),$$

$$\text{var}(\varepsilon_{ih\,jk}) = \text{var}(\zeta_{ih\,jk}) + w^2_{jk}\,\text{var}(\eta_{ih}) - 2\,w_{jk}\,\text{cov}\,(\zeta_{ih\,jk}, \eta_{ih}).$$

The CBS Model

In the Rotterdam model, marginal budget shares (θ_{ih}), and Slutsky terms ($\pi_{ih\,jk}$) are assumed to be constant. This leads to the assumption that the marginal budget shares do not change with total expenditures. An alternative model that would allow marginal budget shares to vary was developed by Keller and Van Driel (1985) based on the model developed by Working (1943). The Working model can be specified as

(14) $$w_{ih} = \alpha_{ih} + \beta_{ih} \log E$$

where $\sum_i \sum_h \alpha_{ih} = 1$, and $\sum_i \sum_h \beta_{ih} = 0$. The marginal budget share can be derived by multiplying equation (14) by E and differentiating with respect to E, which would result in

(15) $$(\partial\, p_{ih}\, q_{ih} / \partial E) = \alpha_{ih} + \beta_{ih}\,(1 + \log E\,)$$

$$= w_{ih} + \beta_{ih}$$

Equation (15) shows that the marginal budget share of good *i* from source *h* differs from the budget share by β_{ih}. As the budget share is not constant with respect to the total expenditure, the marginal budget share also changes with total expenditure.

Substituting Equation (15) for θ_{ih} in Equation (2) would result in CBS model as follows

(16) $$w_{ih}\,(d \log q_{ih} - d \log Q\,) = \alpha_{ih} + \beta_{ih}\, d \log Q + \sum_j \sum_k \pi_{ih\,jk}\, d \log p_{jk} + \sum_l \alpha_{ih\,l}\, D_l$$

where β_{ih}, and $\pi_{ih\,jk}$ are constant coefficients. This model has the AIDS expenditure coefficients and the Rotterdam price coefficients. This implies that the expenditure parameters are interpreted as they are in the AIDS Model and the price parameters are interpreted as they are in the Rotterdam model. Like the Rotterdam model this model also would allow testing for and imposing theoretical restrictions easily and would satisfy concavity globally as the price parameters are Slutsky terms. The theoretical restrictions are

(17) Adding-up $\sum_i \sum_h \alpha_{ih} = 0$, $\sum_i \sum_h \beta_{ih} = 0$, $\sum_i \sum_h \pi_{ihjk} = 0$, and $\sum_i \sum_h \alpha_{ih\,l} = 0$;

(18) Homogeneity $\sum_j \sum_k \pi_{ih\,jk} = 0$; and

(19) Symmetry $\pi_{ih\,jk} = \pi_{jk\,ih}$

The expenditure elasticity is calculated using the expression (Barten 1993):

(20) $$\eta_{ih} = 1 + \beta_{ih} / w_{ih} \quad \text{or} \quad \eta_{ih} = \theta_{ih} / w_{ih}$$

Slutsky (compensated) elasticities are calculated using:

(21) Own price elasticity : $\zeta_{ih\,ih} = \pi_{ih\,ih} / w_{ih}$

(22) Cross price elasticity : $\zeta_{ih\,jk} = \pi_{ih\,jk} / w_{ih}$ (i=j is possible)

Cournot (uncompensated) elasticities are calculated using:

(23) Own price elasticity : $\varepsilon_{ih\,ih} = \pi_{ih\,jk} / w_{ih} - (w_{ih} + \beta_{ih})$ or $\varepsilon_{ih\,ih} = \zeta_{ih\,ih} - \eta_{ih}\, w_{ih}$

(24) Cross price elasticity : $\varepsilon_{ih\,jk} = (\pi_{ih\,jk} - \beta_{ih}\, w_{jk}) / w_{ih} - w_{jk}$ or $\varepsilon_{ihjk} = \zeta_{ih\,jk} - \eta_{ih}\, w_{jk}$

The AIDS Model

The AIDS model is derived from an expenditure function representing Price Independent Generalized Logarithmic (PIGLOG) preferences. It is flexible and would satisfy exact aggregation over consumers without invoking parallel linear Engel curves (Deaton and Muellbauer 1980). It can be specify by adding a quarterly dummy variable for seasonality as follows:

(25) $$w_{ih} = \alpha_{ih} + \sum_j \sum_k \lambda_{ih\,jk} \log p_{jk} + \beta_{ih} \log(E/P) + \sum_l \alpha_{ih\,l} D_l$$

where P is the price index and can be defined as:

(26) $$\log P = \alpha_0 + \sum_i \sum_h \log p_{ih} + ½ \sum_i \sum_j \sum_h \sum_k \lambda_{ih\,jk} \log p_{ih} \log p_{jk}$$

The linear approximation is provided by Stone's index which can be expressed as:

(27) $$\log P = \sum_i \sum_h w_{ih} \log p_{ih}$$

By substituting Divisia Price index $\sum_i \sum_h w_{ih}\, d \log p_{ih}$ for the differential form of Stone's index ($d \log P$) , Equation(25) can be expressed in differential form as follows(Barten, 1993):

(28) $$dw_{ih} = \alpha_{ih} + \beta_{ih}\, d \log Q + \sum_j \sum_k \lambda_{ih\,jk}\, d \log p_{jk} + \sum_l \alpha_{ih\,l} D_l$$

where $dw_{ih} = w_{ih} (d \log p_{ih} + d \log q_{ih} - d \log E)$, and $d \log E = d \log P + d \log Q$

Equation (28) can also be expressed as (Barten, 1993):

(29) $$w_{ih} d \log q_{ih} = \alpha_{ih} + (w_{ih} + \beta_{ih})\, d \log Q + \sum_j \sum_k [\lambda_{ih\,jk} - w_{ih} (\delta_{ih\,jk} - w_{jk})] d \log p_{jk} + \sum_l \alpha_{ih\,l} D_l$$

where $\delta_{ih\,jk}$ is the Kronecker delta which is equal to 1 if i is equal to j, and h is equal to k; otherwise it is equal to zero. Barten (1993) also shows that:

(30) $$\beta_{ih} = \theta_{ih} - w_{ih},$$ and

(31) $$\lambda_{ih\,jk} = \pi_{ih\,jk} + w_{ih}\, \delta_{ih\,jk} - w_{ih} w_{jk}$$

Similar to the Rotterdam model, this model also would allow testing for and imposing restrictions such as homogeneity and symmetry using the model parameters. However, this model would satisfy concavity only locally as the Slutsky term depends on budget shares. Theoretical restrictions can be imposed on the parameters as follows:

(32) Adding-up $\sum_i \sum_h \alpha_{ih} = 0$, $\sum_i \sum_h \beta_{ih} = 0$, $\sum_i \sum_h \lambda_{ih\,jk} = 0$, and $\sum_i \sum_h \alpha_{ih\,l} = 0$;

(33) Homogeneity $\sum_j \sum_k \lambda_{ih\,jk} = 0$; and

(34) Symmetry $\lambda_{ih\,jk} = \lambda_{jk\,ih}$

The expenditure elasticity is calculated using the formula (Barten 1993):

(35) $\eta_{ih} = 1 + \beta_{ih} / w_{ih}$ or $\eta_{ih} = \theta_{ih} / w_{ih}$

Slutsky elasticities are calculated as follows:

(36) Own price elasticity : $\zeta_{ih\,ih} = -1 + \lambda_{ih\,ih} / w_{ih} + w_{ih}$ or $\zeta_{ih\,ih} = \pi_{ih\,jk} / w_{ih}$

(37) Cross price elasticity : $\zeta_{ih\,jk} = \lambda_{ih\,jk} / w_{ih} + w_{jk}$ or $\zeta_{ih\,jk} = \pi_{ih\,jk} / w_{ih}$ (i=j is possible)

Cournot elasticities are calculated as follows:

(38) Own price elasticity : $\varepsilon_{ih\,ih} = -1 + \lambda_{ih\,ih} / w_{ih} - \beta_{ih}$ or $\varepsilon_{ih\,ih} = \zeta_{ih\,ih} - \eta_{ih}\, w_{ih}$

(39) Cross price elasticity : $\varepsilon_{ih\,jk} = \lambda_{ihjk} / w_{ih} - \beta_{ih}\, w_{jk} / w_{ih}$ or $\varepsilon_{ih\,jk} = \zeta_{ih\,jk} - \eta_{ih}\, w_{jk}$

The NBR Model

The NBR model developed by Neves (1987) is another hybrid version of the Rotterdam and the AIDS models. It can be derived by substituting θ_{ih} - w_{ih} for β_{ih} in Equation (28) and can be expressed as:

(40) $dw_{ih} + w_{ih} d \log Q = \alpha_{ih} + \theta_{ih}\, d \log Q + \sum_j \sum_k \lambda_{ih\,jk}\, d \log p_{jk} + \sum_l \alpha_{ihl} D_l$

Equation (40) can also be expressed as (Barten 1993):

(41) $w_{ih}\, d \log q_{ih} = \alpha_{ih} + \theta_{ih}\, d \log Q + \sum_j \sum_k [\lambda_{ih\,jk} - w_{ih} (\delta_{ih\,jk} - w_{jk})] d \log p_{jk} + \sum_l \alpha_{ih\,l} D_l$

The NBR model has Rotterdam expenditure coefficients and AIDS price coefficients. This implies that the expenditure coefficients are interpreted as they are in the Rotterdam model, and the price coefficients are interpreted as they are in the AIDS model. As this model has AIDS price coefficients it can satisfy concavity only locally. Theoretical restrictions can be imposed as follows:

(42) Adding-up $\sum_i \sum_h \alpha_{ih} = 0$,$\sum_i \sum_h \theta_{ih} = 1$, $\sum_i \sum_h \lambda_{ih\,jk} = 0$, and $\sum_i \sum_h \alpha_{ih\,l} = 0$;

(43) Homogeneity $\sum_j \sum_k \lambda_{ih\,jk} = 0$; and

(44) Symmetry $\lambda_{ih\,jk} = \lambda_{jk\,ih}$

The expenditure elasticity is calculated using the formula (Barten,1993):

(45) $\eta_{ih} = \theta_{ih} / w_{ih}$

Slutsky elasticities are calculated as follows:

(46) Own price elasticity : $\zeta_{ih\,ih} = -1 + \lambda_{ih\,ih} / w_{ih} + w_{ih}$ or $\zeta_{ih\,ih} = \pi_{ih\,jk} / w_{ih}$

(47) Cross price elasticity : $\zeta_{ih\,jk} = \lambda_{ihjk} / w_{ih} + w_{jk}$ or $\zeta_{ih\,jk} = \pi_{ih\,jk} / w_{ih}$ (i=j is possible)

Cournot elasticities are calculated as follows:

(48) Own price elasticity : $\varepsilon_{ih\,ih} = -1 + \lambda_{ih\,ih} / w_{ih} - \theta_{ih}$ or $\varepsilon_{ih\,ih} = \zeta_{ih\,ih} - \eta_{ih}\, w_{ih}$

(49) Cross price elasticity : $\varepsilon_{ih\,jk} = (\lambda_{ih\,jk} - \theta_{ih} w_{jk}) / w_{ih} + w_{jk}$ or $\varepsilon_{ih\,jk} = \zeta_{ih\,jk} - \eta_{ih}\, w_{jk}$

The General Model

All the models presented above[1] have the same left-hand side variable $w_{ih}\, d \log q$ and the right-hand side variables $d \log Q$ and $d \log p_{jk}$. The Rotterdam and the NBR models are assumed to have constant marginal budget shares (i.e., θ_{ih}), and the AIDS and the CBS models are assumed to have variable ones (i.e., $w_{ih} + \beta_{ih}$). The Rotterdam and the CBS

[1] All the model specifications including the General model and the theoretical restrictions are presented in Appendix I-A.

models are assumed to have constant Slutsky terms (i.e., $\pi_{ih\,jk}$), and the AIDS and the NBR are assumed to have variable ones (i.e., $\lambda_{ih\,jk}$ - w_{ih} $\delta_{ih\,jk}$ +$w_{ih}w_{jk}$).

Following Barten (1993), Schmitz and Seale developed a General model that nests all the four models. More specifically, any of the above four models could be obtained by imposing appropriate restrictions on the nesting parameters of the General model. This model is developed to determine which of the above four models best fits the data. It is specified incorporating an intercept to capture changes in tastes and preferences and a quarterly dummy variable for seasonality as follows:

(50) $$w_{ih}\, d \log q_{ih} = \alpha_{ih} + (d_{ih} + \delta_1 w_{ih})\, d \log Q + \sum_j \sum_k [e_{ih\,jk} + \delta_2 w_{ih} (\delta_{ih\,jk} - w_{jk})] d \log p_{jk} + \sum_l \alpha_{ih\,l} D_l$$

where δ_1, and δ_2 are nesting parameters that need to be estimated. The expenditure and price coefficients can be expressed as (Barten 1993):

(51) $$d_{ih} = \delta_1 \beta_{ih} + (1- \delta_1)\, \theta_{ih}$$

(52) $$e_{ih\,jk} = (1+ \delta_2)\, \pi_{ih\,jk} - \delta_2\, \lambda_{ih\,jk}$$

Equation (50) can also be expressed as:

(53) $$w_{ih}\, d \log q_{ih} = \alpha_{ih} + d_{ih}\, d \log Q + \delta_1 w_{ih}\, d \log Q + \sum_j \sum_k e_{ih\,jk}\, d \log p_{jk} + \delta_2 (d \log p_{ih} - d \log \mathrm{P}) + \sum_l \alpha_{ih\,l} D_{lt}$$

If $\delta_1 = 0$ and $\delta_2 = 0$ then Equation (53) becomes Rotterdam; if $\delta_1 = 1$ and $\delta_2 = -1$ it becomes AIDS; if $\delta_1 = 1$ and $\delta_2 = 0$ it becomes CBS; and if $\delta_1 = 0$ and $\delta_2 = -1$ it becomes NBR. Theoretical restrictions can be imposed as follows:

(54) Adding-up $\sum_i \sum_h \alpha_{ih} = 0$ $\sum_i \sum_h d_{ih} = 1- \delta_1$, $\sum_i \sum_h e_{ih\,jk} = 0$, and $\sum_i \sum_h \alpha_{ihl} = 0$;

(55) Homogeneity $\sum_j \sum_k e_{ih\,jk} = 0$; and

(56) Symmetry $e_{ih\,jk} = e_{jk\,ih}$

The expenditure elasticity is calculated using the formula (Barten 1993):

(57) $\eta_{ih} = d_{ih} / w_{ih} + \delta_1$ or $\eta_{ih} = \theta_{ih} / w_{ih}$

Slutsky elasticities are calculated as follows:

(58) Own price elasticity : $\zeta_{ih\,ih} = e_{ih\,ih} / w_{ih} + \delta_2 (1 - w_{ih})$ or $\zeta_{ih\,ih} = \pi_{ih\,ih} / w_{ih}$

(59) Cross price elasticity : $\zeta_{ih\,jk} = e_{ih\,jk} / w_{ih} - \delta_2 w_{jk}$ or $\zeta_{ihjk} = \pi_{ih\,jk} / w_{ih}$

(where $i=j$ is possible)

Cournot elasticities are calculated as follows:

(60) Own price elasticity : $\varepsilon_{ih\,ih} = e_{ih\,ih} / w_{ih} - d_{ih} + \delta_2 - w_{ih}(\delta_1 + \delta_2)$ or $\varepsilon_{ih\,ih} = \zeta_{ih\,ih} - \eta_{ih} w_{ih}$

(61) Cross price elasticity : $\varepsilon_{ih\,jk} = (e_{ih\,jk} - w_{jk} d_{ih}) / w_{ih} - w_{jk}(\delta_1 + \delta_2)$

or $\varepsilon_{ih\,jk} = \zeta_{ih\,jk} - \eta_{ih} w_{jk}$

Test for Symmetric Weak Separability

This test is conducted to determine if the three studied edible oil groups (soybean oil, palm oil, and other oils) are weakly separable. If these three groups are found to be weakly separable, then the marginal rate of substitution between any two commodities in a group is independent of quantities demanded in other groups. The results of this test would help in making correct policy decisions. If the groups are weakly separable and if the model is estimated without taking this into consideration, then the estimates of elasticities might be biased resulting in wrong policy decisions (Eales and Wessels 1999).

Although different tests are available to test for separabilty, Pudney (1981) shows that different specifications make little difference to the empirical results. This study uses the separability test suggested by Moshini, Moro, and Green (1994). The restriction to conduct this test for the General system is specified as (Eales and Wessels 1999):

(63) $$e_{ih\,jk} = \frac{(d_{ih} + w_{ih}\delta_1)}{(d_{in} + w_{in}\delta_1)}(e_{in\,jk} - w_{in}w_{jk}\delta_2) + w_{ih}w_{jk}\delta_2$$

for $(ih, in) \in A$ and $jk \in B$

where *A* and *B* represent edible oil groups. As the test is symmetric, if groups A and B are found to be separable then group B is separable from group A, and group A is separable from group B.

The restriction for the Rotterdam model can be derived by substituting δ_1=0 and δ_2 =0 in equation (63), for AIDS by substituting δ_1=1and δ_2 =-1, for NBR by substituting δ_1=0 and δ_2 =-1, and for CBS model by substituting δ_1=1and δ_2 =0.

For each model a total of sixteen nonlinear restrictions are necessary to conduct this test. There will be only three independent off-diagonal Slutsky price coefficients corresponding to the substitution possibilities among the three groups rather than the twenty eight coefficients. As Wald test is not invariant to the reformulations of nonlinear restrictions, a likelihood ratio test is used to conduct this test. As the restrictions for Rotterdam model depend only upon coefficients the results are global. For all the other models the results are only local as the restrictions are imposed using mean budget shares.

Test for Product Aggregation

The product aggregation test is conducted in order to determine if the supply source differentiation is necessary for both palm and soybean oils. This is done by testing if the expenditure coefficients and the own and cross-price coefficients of the source differentiated model are same as those of the non-source differentiated model (Hayes, Wahl, and Williams 1990; Yang and Koo 1994). The restrictions to conduct this test for all the five models can be specified as:

(62)
$$\varphi_{ih} = \varphi_i \quad \forall\ h \in i,$$
$$\Psi_{ih\,jk} = \Psi_{ij} \quad \forall\ h,k \in i,j.$$

where $\varphi_{ih,}$ and $\Psi_{ih\,jk}$ are the terms that represent the expenditure, and own and cross-price parameters from the source differentiated models, and $\varphi_{i\,,}$ and Ψ_{ij} are the terms that represent the expenditure , and own and cross-price parameters from the non-source differentiated models. For the General model nesting coefficients are also included in the restrictions. A Wald test is used to conduct this test.

Test for Homogeneity and Symmetry

The theoretical restrictions of homogeneity and symmetry are tested for all the models by using the appropriate restrictions. The homogeneity is tested separately and symmetry is tested jointly with homogeneity. A Wald test is used to conduct this test.

Test for Homothetic Preferences

The preferences are homothetic if the marginal budget shares are equal to the corresponding budget shares (unitary expenditure elasticities). If the preferences are found to be homothetic, then it can be concluded that the budget shares do not depend on the total expenditure and the import demand depends only on relative prices changes. For the General model the appropriate restrictions to conduct this test are δ_1=1 and d_{ih} =0 for all i and h, for Rotterdam and NBR it is $\theta_{ih} = w_{ih}$, and for AIDS and CBS it is β_{ih} =0. A Wald test is used to conduct this test.

The results are local for Rotterdam and NBR models as the restrictions are imposed using mean budget shares. For these models budget shares must be constant for homotheticity to hold globally.

Test for Endogeneity

The $d \log Q$ (expenditure) and disturbance terms in the differential demand systems may not be independent of each other resulting in an expenditure endogeneity problem. The theory of random rational behavior is used to test for endogeneity (Theil 1975). According to this theory, if $d \log Q$ is exogenous, then the covariance of the error terms would be proportional to the Slutsky terms. It can be expressed as follows (Lee, Brown, and Seale 1994):

(64) $$\text{cov}(v_{ih,} v_{jk}) = \mu \; \pi_{ih\,jk}$$

where v_{ih} and v_{jk} are error terms, and μ is the factor of proportionality. If a regression of $\text{cov}(v_{ih,} v_{jk})$ on constant and $\pi_{ih\,jk}$ resulted in an insignificant constant and a significant slope term, it can be concluded that the term $d \log Q$ is exogenous.

Data

This study used quarterly data from 1999 (quarter I) to 2006 (quarter III). The data period begins after the elimination of import quota for edible oils that was in place from 1988 to 1994. Data on wholesale prices of imported edible oils are not available. In this study, unit values which are calculated by dividing the value of imports by the volume of imports are used to calculate the wholesale prices. Data on import value in kilograms and volume in U.S. dollars are obtained from Global Trade Information Services (2007).

In India, the import tariff structure for edible oils is very complicated. The rates differ among different edible oils (palm versus soybean oil) and for some edible oils the rates differ between different fractions (crude versus refined oils). For example, during February 2005-August 2006, the tariff rates for crude and refined palm oils were 88.8 and 99.4 percent respectively. During the same period the tariff rate for both crude and refined soybean oils was 50.8 percent.

A common problem with the tariff application in India has been the understatement of actual prices for invoicing purposes by importers to pay lower tariffs. In order to prevent under invoicing, India introduced a tariff value system for palm oil in August 2001, and soybean oil in September 2002. This system requires that the tariffs are calculated as a percentage of the reference prices established by the Government for the imported edible oils and not the prices stated by the importers. Although the reference prices are changed frequently to make sure that they reflect the actual market prices, sometimes the delays in making the appropriate changes have resulted in charging tariffs that are higher or lower than the rates that would have been charged if the tariffs had been charged using actual market prices (Dohlman, Persaud, and Landes 2003). The data on tariff rates and reference prices are obtained from the Solvent Extractors Association of India (2007). As the data on tariffs are available only from December 1999, the rates that were prevalent in December 1999 are applied to January 1999-December 1999.

The data used are aggregates of different fractions (crude and refined). Out of the total palm oil imported during November 2001-October 2006, an annual average of about 90 percent was crude oil. Out of the total soybean oil imported during the same period an annual average of about 99 percent was crude oil. During November 2001-October 2005 no refined sunflower seed oil was imported and during November 2005-October 2006 about 1 percent of the total sunflower seed oil imported was refined oil (Solvent

Extractors Association of India 2007). All of rapeseed oil, peanut oil, palm kernel oil, coconut oil, and cottonseed oil imported during November 2001-October 2006 were crude oils. The data on different fractions of oils imported prior to November 2001 are not available.

For some oils, crude oils are subject to a different tariff rate compared to refined oils. More specifically; for soybean oil, since September 2004, the same tariff rates have been applied to both crude and refined oils. Even prior to September 2004, there was not a large difference between the tariff rates applied to crude and refined oils. As the refined oil constitutes only about 1 percent of the total soybean oil imports, and as there is not much difference in the tariff rates between crude and refined soybean oils, for the tariff calculation purposes, all the imported soybean oils are categorized as crude for this study. As refined oil constitutes just 1 percent of the total sunflower seed oil imports and that too only during November 2005-October 2006; all of sunflower seed oil is considered as crude oil along with rapeseed oil, peanut oil, palm kernel oil, coconut oil, and cottonseed oil for calculating tariffs. For palm oil, weighted tariff rates are used for calculating appropriate tariffs. Even though the data on percentage of different fractions of edible oils imported are available at the aggregate level (e.g., percentage of crude palm oil in total palm oil imports), they are not available by supply sources. However it is known that in the palm oil group India has been importing most of its refined palm oil from Malaysia (Subramani 2005). So, it is assumed that out of the total refined palm oil imported 90 percent was from Malaysia and the rest was from Indonesia. As the data on different fractions of palm oil imported prior to November 2001 are not available it is assumed that 10 percent of the total palm oil imported during Jan 1999-October 2001 was refined oil.

This assumption is made based on the percentage of refined palm oil imported during November 2001-October 2006. All of the palm oil imported from rest of the world is consider as crude oil for calculating tariffs.

After adding the tariffs to unit import values to represent wholesale prices; the prices are converted from U.S. dollars to Indian rupees, using the current exchange rate between the U.S. dollar and the Indian rupee. Data on exchange rate is obtained from the Reserve Bank of India (2007). Major exporters of the studied oils are considered as individual supply sources, while all other exporters are summed into the Rest-of-the-World category. For palm oil; as Indonesia accounts for 57 percent of the total palm oil import mean expenditure share [1999 (quarter I) to 2006 (quarter III)] and Malaysia for 42 percent, they are included in this study as two sources of supply for palm oil. All the other sources that supply palm oil are aggregated as the ROW. For soybean oil; Argentina, Brazil, and the U.S. account for 68 percent, 22 percent, and 6 percent of the total soybean oil import mean expenditure share, respectively; and are considered as separate supply sources. Even though the U.S. accounts for just 6 percent of the total soybean oil import mean expenditure share, it is considered as a separate supply source because the U.S. has been a consistent supplier of soybean oil to India during the period of this study. All the other sources that supply soybean oils are aggregated as the ROW. The other edible oils , including sunflower oil, rapeseed oil, peanut oil, palm kernel oil, coconut oil, and cottonseed oil account for just 8 percent of the total edible oil import mean expenditure share, and therefore are aggregated as one category called Other Oils. The budget shares of the imported edible oils for 1999, sample mean, and 2006 are presented in Table I-1. An overview of the data shows that the budget share of palm oil from Malaysia has decreased from 49 percent in 1999 to 8 percent in 2006 (average of first three quarters), while those for palm oil from Indonesia and soybean oil from Argentina have increased from 17 and 9 percent to 47 and 31 percent respectively during the same period. The share of other oils has decreased from 12 to 7 percent and there have not been any significant changes in the allocation of budget shares to rest of the oils during the data period.

Misspecification Tests, Estimation Procedures, and Model Selection

The parameters of all the models are estimated, with homogeneity and symmetry imposed and using iterative seemingly unrelated regression (ITSUR). The demand system includes soybean oils from Brazil, Argentina, the U.S., and the rest of the world (ROW); palm oils from Malaysia, Indonesia, and ROW; and other oils. Because of the singularity of the contemporaneous covariance matrix due to adding-up restrictions, the models are estimated after omitting the other oils equation. The parameters of the dropped equation are estimated by dropping another equation and re-estimating the systems.

The Henze-Zirkler system test is conducted to test for normality of the error terms. The joint mean test (no autocorrelation, linear functional form, and parameter stability) and the joint variance test (static homoskedasticity, dynamic homoskedasticity, and variance stability), as suggested by McGuirk et al. (1995), are also conducted. The results of the misspecification tests are presented in Table I-2.

The results indicate that the null hypothesis of normality cannot be rejected at the 5 percent significance level for General, AIDS, and CBS models, and at the 10 percent significance level for Rotterdam and NBR models. The results of the overall joint conditional mean test show that the null hypothesis of no autocorrelation, linearity (functional form is linear in the parameters), and no structural change (parameters are stable) can be rejected at the 1 percent significance level for General, Rotterdam, and NBR models, while it cannot be rejected at the 1 percent level for AIDS and CBS models. The results of the overall joint conditional variance test show that the null hypothesis of static homoskedasticity (variance of the error term is constant), dynamic homoskedasticity (variance of the error term does not depend on the previous disturbance), and variance stability can be rejected at the 1 percent significance level for all the models.

As the General model nests all the other models and it is used to determine the model that best fits the data it is imperative that this model is first corrected for misspecifications. Even though the overall joint variance test for General model is rejected at the 1 percent significance level, the individual components of the test show that the null hypothesis of static homoskedasticity cannot be rejected at the 1 percent significance level, and the null hypotheses of dynamic homoskedasticity and variance stability cannot be rejected at the 5 percent significance level. The individual components of the joint mean test show that there is a problem with autocorrelation as the null hypothesis of no autocorrelation is rejected at the 1 percent significance level. They also show that the null hypothesis of linearity cannot be rejected at the 10 percent significance level and the null hypothesis of no structural change cannot be rejected at the 1 percent significance level. Based on the results of misspecification tests we decided to correct for autocorrelation by specifying a first-order autocorrelation (AR1) model as suggested by Berndt and Savin (1975).

The General model corrected for autocorrelation is used to select the model that best fits the data. A Wald test is conducted to test Rotterdam, AIDS, NBR, and CBS models against the General model using appropriate restrictions. The results are presented in Table I-3. The results show that when tested against the general model all the models are rejected at the 1 percent significance level implying that the general model best fits the data.

Although Rotterdam, AIDS, NBR, and CBS models are rejected they are also estimated to compare the elasticities across the different models. These models are also corrected for first order autocorrelation.

Results and Discussion

Endogeneity, Theoretical Restrictions, Homotheticity, Separability, and Product Aggregation

Test results for endogeneity are presented in Table I-4. The slope terms (parameters of Slutsky terms) are significant at the 1 percent significance level for General, Rotterdam, and NBR models, and they are significant at the 5 percent significance level for AIDS and CBS models. The intercept terms are insignificant at the 10 percent significance level for all the models. The results of the endogeneity tests suggest that the term $d \log Q$ is exogenous in all the models.

The test results for theoretical restrictions of homogeneity and symmetry are presented in Table I-5, along with those for homotheticity. The results show that the null hypothesis of homogeneity cannot be rejected for all the models at the 10 percent significance level, and that of symmetry can be rejected at the 1 percent significance level for all the models. Even though the symmetry does not hold, all the models are estimated with both homogeneity and symmetry imposed as required by the theory (Henneberry, Piewthongngam, and Qiang 1999). Moreover, the symmetry must always be imposed for the Rotterdam model because the Slutsky substitution matrix must be symmetric (Schmitz and Seale 2002). As the General model nests all the other models including Rotterdam, and also for reasons of comparability homogeneity and symmetry are imposed for all the models (Barten 1993).

The test results for homotheticity show that the null hypothesis of homothetic preferences can be rejected at the 10 percent significance level or less for General, Rotterdam, and NBR models (Table I-5). However, it cannot be rejected at the 10 percent level for AIDS and CBS models. As the General model is found to be the one that best fits the data, it is only appropriate to draw a conclusion based on this model. As the General model rejects homothetic preferences at the 10 percent level (p-value=0.0723) it can be concluded that there is a weak evidence for homothetic preferences. To see how the results change when assuming homothetic preferences, the General model was estimated with homotheticity imposed. This model resulted in positive and significant own-price Slutsky terms (at mean budget shares) violating the negativity condition. Because the imposition of homotheticity resulted in the significant violation of negativity (the General system satisfies negativity only locally), and also the fact that the evidence for homothetic preferences was found to be weak; homotheticity was not imposed.

Test results for symmetric weak separability and product aggregation are presented in Table I-6. The null hypothesis that the three edible oil groups are weakly separable is rejected at the 1 percent significance level for all the models. These results support the estimation of source-differentiated models including all three edible oil groups. The null hypothesis of no source differentiation for both palm and soybean oils is rejected at the 1 percent significance level for all the models. The results support the estimation of source differentiated models.

Parameter Estimates

The marginal budget shares, Slutsky terms (compensated price effects), and the other parameters estimated from General, Rotterdam, NBR, AIDS, and CBS models are presented in Tables I-7, I-8, I-9, I-10, and I-11 respectively. For the General model, equations (51) and (52) are used to calculate the marginal budget shares and the Slutsky terms respectively. For the Rotterdam model; the expenditure and price coefficients are the marginal budget shares and the Slutsky terms, respectively. For the NBR model; the expenditure coefficients are the marginal budget shares, and the Slutsky terms are calculated using equation (31). For the AIDS model; the equations (30) and (31) are used to calculate marginal budget shares and the Slutsky terms, respectively. For the CBS model; the price coefficients are the Slutsky terms, and the marginal budget shares are calculated using equation (15). The marginal budget shares and Slutsky terms are calculated using the mean budget shares for the models that do not estimate them directly as it may be difficult to interpret the model parameters directly.

Because the Rotterdam, AIDS, NBR, and CBS models are rejected, the discussion will focus on the General Model. As required by the economic theory the own-price Slutsky terms for all the oils are negative, except for the palm oil from the ROW which is positive and insignificant at the 10 percent significance level. The own-price Slutsky terms for Malaysian palm oil and other oils are also not statistically different from zero at the 10 percent significance level. The own-price Slutsky terms for soybean oils from

Argentina, U.S., and the ROW are statistically significant at the 1 percent significance level and those for soybean oil from Brazil and palm oil from Malaysia are statistically different from zero at the 10 percent significance level. Out of the 56 cross-price Slutsky terms; 6 are statistically different from zero at the 1 percent significance level, 6 are significant at the 5 percent significance level, and 4 are significant at the 10 percent significance level. Out of the 16 statistically significant cross price terms 10 are positive and 6 are negative.

As required by the economic theory, the marginal budget shares of all the oils are positive, except for soybean oil from the ROW which is negative and statistically not different from zero at the 10 percent significance level. The marginal budget shares of palm oil from ROW and soybean oil from Brazil are also not statistically different from zero at the 10 percent significance level. The marginal budget shares of Malaysian and Indonesian palm oils and Argentine soybean oil are statistically significant at the 1 percent significance level, and those of other oils and U.S. soybean oil are significant at the 5 and 10 percent significance levels, respectively. The marginal budget share of Malaysian palm oil is the largest (0.410) followed by those of Indonesian palm oil (0.224) and Argentine soybean oil (0.207). This implies that if the total expenditure on edible oil imports is increased by Re. 1 then the largest proportion (41 paise) would go to Malaysian palm oil.

The marginal budget shares are not constant over time in the General model. To show the trend in the marginal budget shares of the imported edible oils during the data period, they are presented for 1999 and 2006 along with those for sample mean (see Table I- 12). The marginal budget share of Malaysian palm oil has decreased significantly from 0.569 in 1999 to 0.270 in 2006, while those of Indonesian palm oil and Argentine soybean oil have increased significantly from 0.079 and 0.142 to 0.296 and 0.304 respectively during the same period. However, the marginal budget share of Indonesian palm oil in 1999 was not statistically different from zero at the 10 percent level. Also, the marginal budget share of U.S. soybean oil and other oils have decreased marginally from 0.052 and 0.113 to 0.034 and 0.072 respectively. The marginal budget shares are larger than the corresponding budget shares for Malaysian palm oil and U.S. soybean oil, while they are smaller for Indonesian palm oil. This shows that Indian importers prefer Malaysian palm oil and U.S. soybean oil more than Indonesian palm oil. For soybean oil imported from Argentina, the marginal budget share was larger than the corresponding budget share in 1999, but they were almost identical in 2006. This shows that the preferences for Argentine soybean oil have decreased during the data period. The marginal budget shares are similar to the corresponding budget shares for other oils.

In this study, it is hypothesized that seasonality affects oil demand in India. The model estimated in this study includes a quarterly seasonal dummy variable, incorporated as an intercept shifter. The estimation results show that out of the 24 coefficients associated with seasonal dummy variables, the one that is associated with the dummy variable representing the 4th quarter in the Malaysian palm oil equation is positive and significant at the 5 percent significance level, and the ones that are associated with the dummy variables representing 3rd and 4th quarters in the other oils equation are positive and are different from zero at the 10 and 5 percent significance levels respectively. This implies that the allocation decisions are affected by seasonal factors for these two oils. These results are consistent with what is expected based on Indian consumer food culture.

The 4th quarter coincides with a festival season in India, during which consumers purchase more refined oils to make sweets. The reason for increased consumption of Malaysian palm oil during the 4th quarter could be explained from the fact that India imports most of its refined palm oil from Malaysia. As the other oil category is the aggregate of several oils it is hard to explain the seasonal allocation pattern for this oil.

The intercept term in the other oil equation is negative and is statistically significant at the 10 percent significance. As the intercept terms in the differential systems represent trends, the significant negative intercept term suggests that there has been a negative trend in the allocation of budget share for other oils. This could be because of the shift in budget allocation from other oils to some of the rest of the oils.

The first order auto correlation coefficient is negative and statistically significant at the 1 percent significance level implying that the AR1 specification is appropriate. The nesting parameters are statistically different from zero at the significance level of 1 percent.

Comparion of Marginal Budget Shares and Own-Price Slutsky Terms across the Models

The marginal budget shares and own-price Slutsky terms from all the models are presented in Table I-13. The results indicate that the marginal budget shares from all the models are similar. The marginal budget shares from the Rotterdam and NBR models are very similar and so are the ones from the AIDS and CBS models. Recall that Rotterdam and NBR are assumed to have constant marginal budget shares, and AIDS and CBS are assumed to have variable ones. The marginal budget shares from the General model are more similar to those from the AIDS and CBS, than to those from the Rotterdam and NBR. This is because of the fact that the estimate of the nesting parameter δ_1 in the

General model that tests the income structures, is closer to 1 (0.730) than to 0. Recall that the restriction on δ_1 is 1 for the General model to become either AIDS or CBS. The results show that the AIDS and CBS-type expenditure responses better fit the data than do Rotterdam and NBR models.

The own-price Slutsky terms from the Rotterdam and NBR are similar, and those from the AIDS and CBS are similar. The results are interesting as the Rotterdam and CBS are assumed to have constant price parameters, and the AIDS and NBR are assumed to have variable ones. The own-price Slutsky term for Brazilian soybean oil is significant only in the General model and that for Malaysian palm oil is significant only in the Rotterdam and NBR models. The own-price Slutsky term for Indonesian palm oil from the General model is smaller in absolute value than those from the Rotterdam and NBR models. The own-price Slutsky terms for soybean oil from Argentina, Brazil, U.S., and ROW from the General model are larger in absolute values than those from the other models.

Elasticity Estimates

The expenditure elasticities, and Slutsky (compensated) and Cournot (uncompensated) price elasticities are calculated at the mean budget shares for all the models and are presented in Tables I-14, I-15, I-16, I-17 and I-18. The following discussion regarding the elasticities will focus on the General model.

Expenditure Elasticities

The expenditure elasticities for all the oils are positive except for the soybean oil from the ROW, which is negative and insignificant at the 10 percent significance level. In the palm oil import market the expenditure elasticities for palm oil from Indonesia and Malaysia are statistically significant at the 1 percent significance level. The expenditure elasticity estimate for Malaysian palm oil is greater than one (1.480) and is more than twice than that for Indonesian palm oil (0.598). This implies that if the total expenditure on edible oil imports is increased by 1% then the demand for palm oil from Malaysia will increase by more than 1%. This might indicate the Indian importers preference for refined palm oil from Malaysia which has the lion's share of India's refined palm oil import market.

In the soybean oil import market, expenditure elasticities for soybean oils from Argentina and the U.S. are greater than one and are statistically significant at the 1 and 10 percent significance levels respectively. As the expenditure elasticity estimate for U.S. soybean oil (2.590) is twice as large as that for Argentine soybean oil (1.191), an increase in the total expenditure would increase the demand for U.S. soybean more than that for Argentine soybean oil. This again might indicate the preference of Indian importers for U.S. soybean oil which is considered to be superior in quality compared with Argentine soybean oil (Dohlman, Pesrsaud, and Landes, 2003). The expenditure elasticity for other oils is greater than one and is significant at the 5 percent significance level.

Price Elasticities

The Slutsky (compensated) price elasticities indicate the percentage change in quantities demanded in response to a 1% change in price keeping the real expenditure constant. These reflect only the substitution effects. The Slutsky own-price elasticity estimates for all the oils are negative except for palm oil from the ROW which is positive and insignificant at the 10 percent significance level. In the palm oil import market the Slutsky own-price elasticity for Indonesian palm oil is greater than one in absolute value(-1.579) and is statistically different from zero at the 10 percent significance level.

This implies that the demand for Indonesian palm oil is responsive to its own-price and is elastic.

In the soybean oil import market the Slutsky own-price elasticity estimates for soybean oils from Argentina, U.S., and ROW are statistically significant at the 1 percent significance level, and that for soybean oil from Brazil is significant at the 10 percent significance level. The own-price elasticity estimates for soybean oils from all the sources are greater than one implying that the demand for soybean oil is own-price elastic. The own-price elasticity estimates are similar in magnitude for soybean oils from Brazil (-4.357) and U.S. (-4.233), and for soybean oils from Argentina (-2.517) and the ROW (-2.333). This implies that for a 1% change in own-price the demand responsiveness would be similar for soybean oils from Brazil and U.S. and for soybean oils from Argentina and ROW. As the Slutsky own-price elasticity estimates for soybean oils from Brazil and U.S. are higher than those for soybean oils from Argentina and the ROW, a 1% change in own- price would impact the demand for soybean oils from Brazil and U.S. more than that for soybean oils from Argentina and ROW. There are statistically significant substitute relationships between Indonesian palm oil and Brazilian soybean oil, Malaysian palm oil and Argentine soybean oil, palm oil from ROW and Argentine soybean oil, Malaysian palm oil and soybean oil from ROW, and Argentine soybean oil and other oils at the 10 percent significance level or less. The substitute relationships between Indonesian palm oil and Brazilian soybean oil is highly asymmetric .The demand for Brazilian soybean oil is more sensitive to the Indonesian price (10.688) than the demand for Indonesian palm oil to Brazilian price (1.608). The relationships involving either soybean oil or palm oil from ROW are also asymmetric. There are statistically significant complementary relationships between Indonesian palm oil and Argentine soybean oil, Indonesian palm oil and soybean oil from ROW and Malaysian palm oil and Brazilian soybean oil at the 10 percent significance level or less.

The Cournot (uncompensated) price elasticities indicate the percentage change in quantities demanded to a 1 % change in price, keeping the nominal expenditure constant. They reflect both substitution and income effects. The Cournot own-price elasticities for all the oils are slightly larger than the Slutsky ones except for soybean oil from ROW which is smaller than the Slutsky one in absolute value because of its negative expenditure elasticity. Thus, the demand responsiveness of own-price changes for Cournot elasticities would be slightly different from that for the Slutsky ones. The Cournot cross-price elasticities are slightly larger in absolute values for complementary relationships and smaller for substitute relationships than the Slutsky ones; except for the substitute relationship between Malaysian palm oil and soybean oil from the ROW, which is slightly larger than the Slutsky elasticity. Also the Cournot cross-price elasticity of soybean from ROW with respect to palm oil from Indonesia is insignificant while the Slutsky one is significant at the 10 percent significance level. The results show that accounting for real expenditure effect does not significantly affect the demand responsiveness to own or cross-price changes.

Comparison of Expenditure and Price Elasticities across the Models

The expenditure elasticities, and Slutsky and Cournot own-price elasticities from all the models are presented in Table I-19. The expenditure elasticities from all the models are similar for all the oils, except for the other oils which are more than unity and significant at the 5 percent significance level in General, AIDS, and CBS models and less than unity and insignificant at the 10 percent significance level in Rotterdam and NBR models. The expenditure elasticities from NBR and Rotterdam are very similar, and so are the ones from AIDS and CBS. The expenditure elasticities from the General model are more similar to those from AIDS and CBS than to those from Rotterdam and NBR.

The own-price Slutsky and Cournot elasticities from Rotterdam and NBR models are similar and so are the ones from AIDS and CBS. The own-price elasticity estimates for all the oils from the General model are bigger in absolute values than those from the other models, except for Indonesian palm oil which is smaller than those from Rotterdam and NBR. The own-price elasticity estimate for Brazilian soybean oil is significant only in the General Model and that for Malaysian palm oil is significant only in Rotterdam and NBR models.

Regarding the cross-price elasticities, the results from Rotterdam and NBR models show statistically significant substitute relationship between palm oils from Indonesia and Malaysia (Tables I-15 and I-16) at the 5 percent significance level or less. Although the results from other models show substitute relationships between these two oils, they are not statistically significant at the 10 percent significance level.

The differences in price elasticities across the models show the importance of choosing the correct functional form. For example the own-price Slutsky elasticity for Malaysian palm oil from the Rotterdam model is highly elastic (-4.004) and significant at the 5 percent significant level, while that from the AIDS model is inelastic (-0.474) and insignificant at the 10 percent significance level.

Summary and Implications

This study estimated the source differentiated import demand for edible oils in India using a family of differential demand systems. The method suggested by Barten (1993) was used to choose the model that best fit the data. Rotterdam, NBR, AIDS, and CBS systems were rejected when tested against the General system implying that the General system best fit the data. The test results of weak separability and product aggregation support the estimation of source differentiated models with all the studied oils included in the system.

If an exporting country has a higher expenditure elasticity compared to the other countries, then it can be assumed that the importers perceive the edible oil from that country to be superior in quality compared to the edible oils from other countries. If it also faces an own-price inelastic demand, then it can be considered as having a competitive advantage in the Indian edible oil import market (Yang and Koo 1994; Mutondo and Henneberry 2007). In the palm oil import market; Malaysia has the largest expenditure elasticity, while it is U.S. that has the largest expenditure elasticity in the soybean oil import market. In the overall market, the expenditure elasticity for U.S. soybean oil is the largest followed by that for Malaysian palm oil. This implies that if the expenditure on edible oil imports were to be increased in India, the demand for U.S. soybean oil will increase more than that for rest of the oils.

In the palm oil import market, the demand for Indonesian palm oil is own-price elastic. As the own-price elasticity for Malaysian palm oil from the General system is not statistically different from zero at the 10 percent significance level, it is difficult to conclude which country has competitive advantage in the palm oil import market.

However; a comparison of the own-price elasticity estimates for Malaysian palm oil from the Rotterdam (-4.006) and the NBR (-3.966) models, shows that the demand for Malaysian palm oil is highly own-price elastic and is about twice as large as the own-price elasticity for the Indonesian palm oil. These elasticities may imply that Malaysia could experience a loss in its market share if it increased its price relative to the other suppliers, despite having the largest expenditure elasticity in the palm oil import market.

In the soybean oil import market the demand is own-price elastic for soybean oils from all the sources. The own-price elasticity estimates for soybean oils from the U.S. and Brazil are similar and larger in absolute value than those for soybeans oils from Argentina and the ROW, which are similar in their magnitudes. Even though the U.S. has the largest expenditure elasticity, its low market share could be because of its high own-price elasticity because an increase in price would significantly decrease its market share. The low market share of Brazil also could be attributed to its high own-price elasticity. In the soybean oil import market, even though Argentina has smaller expenditure elasticity than the U.S., its relatively large market share could be because of its relatively small own-price elasticity compared to that of the U.S. This implies that U.S. and Brazil could increase their market shares significantly by reducing their prices. If the tariff rates for soybean oils are decreased, then the soybean oil exporters in the U.S. and Brazil will benefit more than those in Argentina and ROW.

Finally, the results show that there are strong substitute relationships between Indonesian palm oil and Brazilian soybean oil and Malaysian palm oil and Argentine soybean oil. Given the strong substitute relationships between palm and soybean oils, the differences in tariff rates between these oils could play a significant role in determining the market shares of these oils in the Indian edible oil import market. As the substitution relationship between Brazilian and Indonesian soybean oils is asymmetric, a change in the tariff rates of palm oil will have more impact on the Brazilian soybean oil than a change in the tariff rates of soybean oil on Indonesian palm oil. As the tariff rates for palm oils are higher that that for soybean oils, the palm oil exporting countries have been requesting the Indian Government to reduce the import tariffs for palm oils. If the Indian Government agreed to their requests, then the demand for soybean oil imports in India is expected to decrease.

Although the results from the General system do not show any statistically significant relationship between Malaysian and Indonesian palm oils, the Rotterdam and NBR systems show strong substitute relationship between these two oils. This is important to note, considering the fact that Indonesia and Malaysia are the largest exporters of palm oil in the world and Malaysia has been gradually losing its market share to Indonesia in India. The substitution relationship between Indonesian and Malaysian palm oils show that the tariff differences between crude and refined palm oils could play a significant role in determining the market shares of Malaysian and Indonesian palm oils in the Indian palm oil import market. This is because India imports most of its refined palm oil from Malaysia and the tariff rates for refined palm oil are higher than that for crude palm oil.

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Table I-1. Budget Shares of Imported Edible Oils, 1999 (I Quarter) through 2006 (III Quarter)

Year	Palm Oil			Soybean Oil				Other Oil
	Indo	Malay	ROW	Arg	Brazil	U.S.	ROW	
1999	0.1745	0.4863	0.0055	0.0911	0.0605	0.0363	0.0263	0.1196
Mean	0.3746	0.2769	0.0097	0.1737	0.0564	0.0144	0.0120	0.0824
2006[a]	0.4730	0.0836	0.0105	0.3073	0.0438	0.0103	0.0055	0.0660

[a] Average of first three quarters.

Table I-2. **Misspecification Test Results**

Test	Model				
	General	Rotterdam	NBR	AIDS	CBS
Normality	0.0550[a]	0.2040	0.2343	0.0623	0.0718
Joint Conditional Mean					
Linear Functional From	0.2227	0.0167	0.0244	0.0129	0.0118
No Autocorrelation	0.0004	0.0162	0.0074	0.0540	0.0460
No Structural Change	0.0461	0.7626	0.7871	0.8025	0.7021
Overall Joint Mean	0.0026	0.0013	0.0012	0.0411	0.0282
Joint Conditional Variance					
Static Homoskedasticity	0.0258	0.0563	0.0547	0.0001	0.0001
Dynamic Homoskedasticity	0.0732	0.0013	0.0197	0.0001	0.0001
No Structural Change	0.0513	0.0002	0.0003	0.0005	0.0040
Overall Joint Variance	0.0031	0.0001	0.0001	0.0001	0.0001

[a] P-values

Table I-3. Results of the Nested Test between the General Model and the other Models

Model	Restrictions		P-value
	δ_1	δ_2	
Rotterdam	0	0	0.0001
NBR	0	-1	0.0001
AIDS	1	-1	0.0001
CBS	1	0	0.0001

Table I-4. Test Results for Endogeneity

Model	P-value	
	Intercept	Slope
General	0.4967	0.0025
Rotterdam	0.5824	0.0001
NBR	0.6030	0.0001
AIDS	0.4112	0.0262
CBS	0.3990	0.0258

Table I-5. Test Results for Homogeneity, Symmetry, and Homotheticity

	Restriction		
Model	Homogeneity	Symmetry[b]	Homotheticity
General	0.7300[a]	0.0001	0.0723
Rotterdam	0.9755	0.0003	0.0172
NBR	0.9868	0.0003	0.0231
AIDS	0.9803	0.0001	0.1411
CBS	0.9326	0.0001	0.1186

[a] P-values
[b] Symmetry is jointly tested with homogeneity.

Table I-6. Test Results for Weak Separability and Product Aggregation

	Model				
Test	General	Rotterdam	NBR	AIDS	CBS
Weak Separability[a]	0.0008	0.0006	0.0007	0.0001	0.0001
Product Aggregation					
Palm Oil	0.0001[b]	0.0001	0.0001	0.0001	0.0001
Soybean Oil	0.0001	0.0001	0.0001	0.0001	0.0001
Joint test	0.0001	0.0001	0.0001	0.0001	0.0001

[a] The test was conducted using likelihood ratio test.
[b] P-values

Table I-7. Parameter Estimates from the General Model

Independent variable	Dependent Variable: Palm Oil: Indo	Malay	ROW	Soybean Oil: Arg	Brazil	U.S.	ROW	Other Oil
Intercept	0.042	-0.034	0.009	0.008	0.020	-0.010	0.002	-0.031*
	(0.028)	(0.033)	(0.009)	(0.011)	(0.023)	(0.009)	(0.007)	(0.016)
Price of[a]:								
IndoPalm	-0.591*	0.319	-0.006	-0.274**	0.602***	0.051	-0.044*	-0.056
	(0.288)	(0.276)	(0.075)	(0.121)	(0.146)	(0.040)	(0.024)	(0.087)
MalayPalm		-0.313	-0.059	0.402***	-0.388**	-0.012	0.051*	-0.001
		(0.532)	(0.079)	(0.132)	(0.153)	(0.040)	(0.026)	(0.094)
ROWPalm			0.019	0.086*	-0.057	0.012	0.003	0.003
			(0.041)	(0.043)	(0.052)	(0.014)	(0.008)	(0.036)
ArgSoy				-0.437***	0.078	0.027	-0.020	0.139**
				(0.098)	(0.094)	(0.023)	(0.016)	(0.054)
BrazilSoy					-0.246*	-0.012	0.022	0.000
					(0.137)	(0.030)	(0.017)	(0.070)
U.S.Soy						-0.061***	0.005	-0.008
						(0.013)	(0.006)	(0.020)
ROWSoy							-0.028***	0.011
							(0.006)	(0.013)
Other Oil								-0.088
								(0.066)
Expenditure[b]	0.224***	0.410***	0.004	0.207***	0.040	0.037*	-0.006	0.084**
	(0.064)	(0.076)	(0.021)	(0.048)	(0.051)	(0.019)	(0.017)	(0.034)
I Quarter	0.011	-0.001	-0.017	-0.010	-0.054	0.011	-0.009	0.032
	(0.046)	(0.054)	(0.015)	(0.028)	(0.038)	(0.014)	(0.012)	(0.025)
III Quarter	-0.037	-0.041	-0.007	0.020	0.012	0.007	-0.001	0.041***
	(0.043)	(0.050)	(0.014)	(0.024)	(0.035)	(0.013)	(0.011)	(0.023)
IV Quarter	-0.073	0.135**	-0.012	-0.050	-0.050	0.014	-0.006	0.051**
	(0.045)	(0.053)	(0.015)	(0.030)	(0.037)	(0.013)	(0.011)	(0.024)
ρ[c]	-0.296***							
	(0.086)							
δ_1	0.730***							
	(0.152)							
δ_2	-3.418***							
	(0.583)							

Notes: Single, double, and triple asterisks indicate significance at the 10%, 5%, and 1% levels respectively. Numbers in parentheses are standard errors. The variances of own price slutsky terms are calculated as $\mathrm{var}(\pi_{ih\,ih})=\mathrm{var}(e_{ih\,ih})+w^2_{ih}(1-w_{ih})^2\,\mathrm{var}(\delta_2)+2\,w_{ih}(1-w_{ih})\,\mathrm{cov}(e_{ih\,ih},\delta_2)$, those of cross price slutsky terms are calculated as $\mathrm{var}(\pi_{ih\,jk})=\mathrm{var}(e_{ih\,jk})+w^2_{ih}\,w^2_{jk}\,\mathrm{var}(\delta_2)-2\,w_{ih}\,w_{jk}\,\mathrm{cov}(e_{ih\,jk},\delta_2)$, and those of marginal shares are calculated as $\mathrm{var}(\theta_{ih})=\mathrm{var}(d_{ih})+w^2_{ih}\mathrm{var}(\delta_1)+2w_{ih}\,\mathrm{cov}(d_{ih},\delta_1)$.

[a] Slutsky terms calculated at the mean budget shares using the model price parameters.

[b] Marginal budget shares calculated at the mean budget shares using the model expenditure parameters.

[c] Autocorrelation coefficient.

Table I-8. **Parameter Estimates from the Rotterdam Model**

	Dependent Variable							
Independent	Palm Oil			Soybean Oil				
variable	Indo	Malay	ROW	Arg	Brazil	U.S.	ROW	Other Oil
Intercept	0.037	-0.040	0.008	0.013	0.015	-0.005	0.003	-0.031
	(0.030)	(0.042)	(0.009)	(0.025)	(0.022)	(0.010)	(0.007)	(0.018)
Price of[a]:								
IndoPalm	-0.726**	0.832**	-0.187**	-0.283**	0.568***	0.030	-0.041*	-0.193**
	(0.330)	(0.329)	(0.076)	(0.128)	(0.150)	(0.042)	(0.027)	(0.092)
MalayPalm		-1.109**	0.117	0.435**	-0.387**	0.007	0.045	0.060
		(0.408)	(0.087)	(0.168)	(0.170)	(0.051)	(0.031)	(0.113)
ROWPalm			0.025	0.031	-0.015	0.014	-0.005	0.020
			(0.038)	(0.043)	(0.048)	(0.014)	(0.008)	(0.035)
ArgSoy				-0.343***	0.035	0.028	-0.013	0.109*
				(0.111)	(0.096)	(0.028)	(0.018)	(0.062)
BrazilSoy					-0.211	-0.022	0.020	0.011
					(0.129)	(0.030)	(0.017)	(0.074)
U.S.Soy						-0.053***	0.009	-0.013
						(0.016)	(0.007)	(0.025)
ROWSoy							-0.016**	0.001
							(0.006)	(0.015)
Other Oil								0.004
								(0.076)
Expenditure[b]	0.234***	0.432***	-0.009	0.220***	0.038	0.044*	-0.009	0.051
	(0.061)	(0.096)	(0.020)	(0.057)	(0.050)	(0.022)	(0.017)	(0.040)
I Quarter	0.021	0.003	-0.015	0.017	-0.044	0.004	-0.009	0.024
	(0.041)	(0.067)	(0.014)	(0.040)	(0.036)	(0.016)	(0.012)	(0.030)
III Quarter	-0.042	-0.027	-0.005	0.013	0.020	-0.003	0.001	0.043
	(0.039)	(0.063)	(0.013)	(0.038)	(0.033)	(0.015)	(0.011)	(0.027)
IV Quarter	-0.066	0.149**	-0.014	-0.061	-0.051	0.013	-0.010	0.040
	(0.042)	(0.067)	(0.014)	(0.040)	(0.035)	(0.016)	(0.011)	(0.028)
ρ[c]	-0.270***							
	(0.088)							

Notes: Single, double, and triple asterisks indicate significance at the 10%, 5%, and 1% levels respectively. Numbers in parentheses are standard errors.

[a] Model price coefficients are slutsky terms

[b] Model expenditure coefficients are marginal budget shares.

[c] Autocorrelation coefficient.

Table I-9. Parameter Estimates from the NBR Model

Independent variable	Dependent Variable							
	Palm Oil			Soybean Oil				
	Indo	Malay	ROW	Arg	Brazil	U.S.	ROW	Other Oil
Intercept	0.038	-0.038	0.008	0.013	0.016	-0.006	0.002	-0.032*
	(0.025)	(0.042)	(0.009)	(0.025)	(0.022)	(0.009)	(0.007)	(0.017)
Price of[a]:								
IndoPalm	-0.758**	0.838**	-0.186**	-0.276**	0.567***	0.032	-0.036	-0.181*
	(0.316)	(0.315)	(0.074)	(0.125)	(0.148)	(0.041)	(0.023)	(0.088)
MalayPalm		-1.098**	0.117	0.435**	-0.386**	0.002	0.045	0.047
		(0.395)	(0.085)	(0.165)	(0.168)	(0.049)	(0.031)	(0.109)
ROWPalm			0.022	0.033	-0.018	0.013	-0.005	0.023
			(0.038)	(0.042)	(0.049)	(0.014)	(0.008)	(0.034)
ArgSoy				-0.361***	0.034	0.029	-0.011	0.119*
				(0.110)	(0.096)	(0.027)	(0.017)	(0.060)
BrazilSoy					-0.216	-0.017	0.021	0.015
					(0.129)	(0.030)	(0.017)	(0.072)
U.S.Soy						-0.055***	0.008	-0.012
						(0.015)	(0.007)	(0.024)
ROWSoy							-0.019***	-0.001
							(0.006)	(0.014)
Other Oil								-0.009
								(0.072)
Expenditure[b]	0.234***	0.434***	-0.009	0.216***	0.037	0.042*	-0.008	0.053
	(0.058)	(0.096)	(0.020)	(0.056)	(0.050)	(0.021)	(0.017)	(0.038)
I Quarter	0.019	0.001	-0.015	0.017	-0.046	0.005	-0.010	0.029
	(0.041)	(0.068)	(0.014)	(0.040)	(0.036)	(0.015)	(0.012)	(0.028)
III Quarter	-0.042	-0.031	-0.005	0.013	0.018	-0.000	0.001	0.046*
	(0.038)	(0.063)	(0.013)	(0.038)	(0.033)	(0.014)	(0.011)	(0.026)
IV Quarter	-0.066	0.148**	-0.014	-0.061	-0.052	0.013	-0.009	0.042
	(0.040)	(0.067)	(0.014)	(0.040)	(0.035)	(0.015)	(0.012)	(0.026)
ρ[c]	-0.289***							
	(0.087)							

Notes: Single, double, and triple asterisks indicate significance at the 10%, 5%, and 1% levels respectively. Numbers in parentheses are standard errors.

[a] Slutsky terms calculated at the mean budget shares using model price parameters.

[b] Model expenditure parameters are marginal budget shares.

[c] Autocorrelation coefficient.

Table I-10. **Parameter Estimates from the AIDS Model**

Independent variable	Dependent Variable							
	Palm Oil			Soybean Oil				
	Indo	Malay	ROW	Arg	Brazil	U.S.	ROW	Other Oil
Intercept	0.041	-0.040	0.010	0.001	0.019	-0.008	0.002	-0.026
	(0.031)	(0.030)	(0.010)	(0.020)	(0.023)	(0.009)	(0.007)	(0.017)
Price of[a]:								
IndoPalm	-0.427	0.153	0.021	-0.344**	0.653***	0.055	-0.067**	-0.044
	(0.303)	(0.273)	(0.080)	(0.124)	(0.150)	(0.046)	(0.026)	(0.095)
MalayPalm		-0.131	-0.105	0.440***	-0.426**	-0.007	0.061**	0.015
		(0.309)	(0.078)	(0.127)	(0.150)	(0.041)	(0.024)	(0.095)
ROWPalm			0.038	0.101**	-0.057	0.010	0.005	-0.014
			(0.044)	(0.045)	(0.055)	(0.015)	(0.009)	(0.038)
ArgSoy				-0.416***	0.084	0.027	-0.031*	0.138**
				(0.110)	(0.093)	(0.024)	(0.015)	(0.057)
BrazilSoy					-0.225	-0.022	0.021	-0.029
					(0.141)	(0.031)	(0.018)	(0.076)
U.S.Soy						-0.059***	0.009	-0.014
						(0.014)	(0.007)	(0.023)
ROWSoy							-0.020***	0.022
							(0.006)	(0.013)
Other Oil								-0.075
								(0.072)
Expenditure[b]	0.201**	0.416***	0.010	0.206***	0.046	0.041*	-0.011	0.090**
	(0.072)	(0.071)	(0.023)	(0.046)	(0.052)	(0.022)	(0.016)	(0.038)
I Quarter	0.017	0.003	-0.020	0.033	-0.050	0.008	-0.009	0.017
	(0.050)	(0.048)	(0.016)	(0.032)	(0.036)	(0.015)	(0.011)	(0.027)
III Quarter	-0.035	-0.032	-0.008	0.030	0.013	0.002	0.000	0.030
	(0.046)	(0.045)	(0.015)	(0.030)	(0.033)	(0.014)	(0.010)	(0.024)
IV Quarter	-0.085	0.140**	-0.011	-0.050	-0.049	0.014	-0.008	0.049*
	(0.052)	(0.050)	(0.016)	(0.033)	(0.037)	(0.015)	(0.011)	(0.027)
ρ[c]	-0.230**							
	(0.086)							

Notes: Single, double, and triple asterisks indicate significance at the 10%, 5%, and 1% levels respectively. Numbers in parentheses are standard errors.

[a] Slutsky terms calculated at the mean budget shares using model price parameters.

[b] Marginal budget shares calculated at the mean budget shares using expenditure parameters.

[c] Autocorrelation coefficient.

Table I-11. **Parameter Estimates from the CBS Model**

Independent variable	Dependent Variable							
	Palm Oil			Soybean Oil				
	Indo	Malay	ROW	Arg	Brazil	U.S.	ROW	Other Oil
Intercept	0.040	-0.042	0.010	0.002	0.018	-0.006	0.002	-0.025
	(0.032)	(0.030)	(0.010)	(0.020)	(0.022)	(0.010)	(0.007)	(0.018)
Price of[a]:								
IndoPalm	-0.391	0.161	0.008	-0.355**	0.653***	0.050	-0.071**	-0.055
	(0.309)	(0.280)	(0.081)	(0.125)	(0.150)	(0.047)	(0.026)	(0.097)
MalayPalm		-0.166	-0.097	0.448***	-0.431***	-0.000	0.062**	0.024
		(0.315)	(0.079)	(0.129)	(0.150)	(0.042)	(0.024)	(0.097)
ROWPalm			0.043	0.095*	-0.049	0.011	0.004	-0.016
			(0.044)	(0.046)	(0.055)	(0.016)	(0.009)	(0.040)
ArgSoy				-0.403***	0.086	0.028	-0.033**	0.134**
				(0.098)	(0.093)	(0.025)	(0.015)	(0.060)
BrazilSoy					-0.217	-0.028	0.021	-0.035
					(0.140)	(0.031)	(0.018)	(0.078)
U.S.Soy						-0.056***	0.010	-0.014
						(0.014)	(0.007)	(0.024)
ROWSoy							-0.017**	0.024
							(0.006)	(0.014)
Other Oil								- 0.063
								(0.077)
Expenditure[b]	0.197**	0.419***	0.010	0.206***	0.047	0.043*	-0.012	0.090**
	(0.074)	(0.071)	(0.023)	(0.047)	(0.051)	(0.023)	(0.016)	(0.040)
I Quarter	0.019	0.005	-0.020	0.034	-0.048	0.006	-0.009	0.012
	(0.050)	(0.047)	(0.016)	(0.032)	(0.035)	(0.015)	(0.011)	(0.028)
III Quarter	-0.034	-0.028	-0.008	0.030	0.014	-0.000	0.000	0.026
	(0.046)	(0.044)	(0.015)	(0.030)	(0.032)	(0.015)	(0.010)	(0.026)
IV Quarter	-0.086	0.140**	-0.011	-0.049	-0.048	0.015	-0.009	0.047
	(0.053)	(0.049)	(0.017)	(0.034)	(0.037)	(0.016)	(0.011)	(0.028)
ρ[c]	-0.201**							
	(0.086)							

Notes: Single, double, and triple asterisks indicate significance at the 10%, 5%, and 1% levels respectively. Numbers in parentheses are standard errors.

[a] Model price parameters are slutsky terms.

[b] Marginal budget shares calculated at the mean budget shares using expenditure parameters.

[c] Autocorrelation coefficient.

Table I-12. Marginal Budget Shares of Imported Edible Oils from the General Model, 1999 (I Quarter) through 2006 (III Quarter)

Year	Palm Oil			Soybean Oil				
	Indo	Malay	ROW	Arg	Brazil	U.S.	ROW	Other Oil
1999	0.079	0.569***	0.001	0.142***	0.041	0.052**	0.003	0.113***
Mean	0.224***	0.410***	0.004	0.207***	0.040	0.037*	-0.006	0.084**
2006[a]	0.296***	0.269***	0.004	0.304***	0.031	0.034*	-0.011	0.072**

Note: Single, double, and triple asterisks indicate significance at the 10%, 5%, and 1% levels respectively.
[a] Marginal Budget Shares calculated using the average budget shares of first three quarters.

Table I-13. Marginal Budget Shares and Own-Price Slutsky Terms from all the Models

Model	Palm Oil			Soybean Oil				
	Indo	Malay	ROW	Arg	Brazil	U.S.	ROW	Other Oil
Marginal Shares								
General	0.224***	0.410***	0.004	0.207***	0.040	0.037*	-0.006	0.084**
Rotterdam	0.234***	0.432***	-0.009	0.220***	0.038	0.044*	-0.009	0.051
NBR	0.234***	0.434***	-0.009	0.216***	0.037	0.042*	-0.008	0.053
AIDS	0.201**	0.416***	0.010	0.206***	0.046	0.041*	-0.011	0.090**
CBS	0.197**	0.419***	0.010	0.206***	0.047	0.043*	-0.012	0.090**
Slutsky Terms								
General	-0.591*	-0.313	0.019	-0.437***	-0.246*	-0.061***	-0.028***	-0.088
Rotterdam	-0.726**	-1.109**	0.025	-0.343***	-0.211	-0.053***	-0.016**	0.004
NBR	-0.758**	-1.098**	0.022	-0.361***	-0.216	-0.055***	-0.019***	-0.009
AIDS	-0.427	-0.131	0.038	-0.416***	-0.225	-0.059***	-0.020***	-0.075
CBS	-0.391	-0.166	0.043	-0.403***	-0.217	-0.056***	-0.017**	-0.063

Note: Single, double, and triple asterisks indicate significance at the 10%, 5%, and 1% levels respectively.

Table I-14. Expenditure Elasticities, and Slutsky and Cournot Price Elasticities from the General Model

	Palm Oil			Soybean Oil				
	Indo	Malay	ROW	Arg	Brazil	U.S.	ROW	Other Oil
Expenditure	0.598***	1.480***	0.377	1.191***	0.717	2.590*	-0.525	1.020**
	(0.171)	(0.275)	(2.208)	(0.279)	(0.917)	(1.329)	(1.411)	(0.419)
Slutsky:								
IndoPalm	-1.579*	0.852	-0.017	-0.731**	1.608***	0.135	-0.118*	-0.150
	(0.769)	(0.738)	(0.201)	(0.323)	(0.389)	(0.108)	(0.064)	(0.233)
MalayPalm	1.152	-1.129	-0.214	1.451***	-1.399**	-0.044	0.186*	-0.002
	(0.998)	(1.922)	(0.285)	(0.444)	(0.551)	(0.148)	(0.093)	(0.342)
ROWPalm	-0.669	-6.110	1.973	8.854*	-5.892	1.222	0.320	0.302
	(7.751)	(8.135)	(4.316)	(4.459)	(5.418)	(1.463)	(0.858)	(3.672)
ArgSoy	-1.576**	2.313***	0.495*	-2.517***	0.451	0.154	-0.121	0.801**
	(0.698)	(0.761)	(0.249)	(0.563)	(0.539)	(0.133)	(0.091)	(0.313)
BrazilSoy	10.688***	-6.875**	-1.015	1.390	-4.357*	-0.220	0.388	0.001
	(2.588)	(2.706)	(0.933)	(1.661)	(2.429)	(0.536)	(0.309)	(1.245)
U.S.Soy	3.497	-0.837	0.821	1.850	-0.860	-4.233***	0.365	-0.582
	(2.796)	(2.835)	(0.983)	(1.602)	(2.091)	(0.883)	(0.434)	(1.429)
ROWSoy	-3.705*	4.307*	0.260	-1.750	1.825	0.441	-2.333***	0.956
	(2.003)	(2.144)	(0.696)	(1.314)	(1.453)	(0.523)	(0.538)	(1.063)
Other Oil	1.072	-0.008	0.036	1.690**	0.001	-0.102	0.139	-1.072
	(1.059)	(1.150)	(0.433)	(0.659)	(0.852)	(0.251)	(0.155)	(0.804)
Cournot:								
IndoPalm	-1.803**	0.686	-0.023	-0.835**	1.575***	0.126	-0.126*	-0.199
	(0.772)	(0.739)	(0.201)	(0.325)	(0.390)	(0.108)	(0.064)	(0.233)
MalayPalm	0.597	-1.539	-0.229	1.193**	-1.483**	-0.065	0.169*	-0.124
	(1.003)	(1.923)	(0.285)	(0.480)	(0.551)	(0.148)	(0.093)	(0.343)
ROWPalm	-0.810	-6.214	1.969	8.789*	-5.913	1.216	0.316	0.271
	(7.795)	(8.158)	(4.316)	(4.475)	(5.419)	(1.463)	(0.858)	(3.676)
ArgSoy	-2.022***	1.983**	0.483*	-2.724***	0.384	0.137	-0.135	0.703**
	(0.705)	(0.765)	(0.249)	(0.565)	(0.539)	(0.133)	(0.090)	(0.313)
BrazilSoy	10.419***	-7.073**	-1.022	1.265	-4.397*	-0.231	0.379	-0.058
	(2.611)	(2.718)	(0.933)	(1.669)	(2.430)	(0.536)	(0.309)	(1.247)
U.S.Soy	2.526	-1.554	0.796	1.400	-1.006	-4.270***	0.334	-0.796
	(2.840)	(2.859)	(0.983)	(1.619)	(2.092)	(0.883)	(0.434)	(1.433)
ROWSoy	-3.508	4.453*	0.265	-1.659	1.854	0.448	-2.326***	0.999
	(2.072)	(2.179)	(0.696)	(1.337)	(1.456)	(0.523)	(0.539)	(1.070)
Other Oil	-1.454	-0.290	0.026	1.512**	-0.057	-0.117	0.127	-1.155
	(1.071)	(1.156)	(0.433)	(0.663)	(0.853)	(0.251)	(0.155)	(0.804)

Notes: Single, double, and triple asterisks indicate significance at the 10%, 5%, and 1% levels respectively. Numbers in parentheses are standard errors.

Table I-15. Expenditure Elasticities, and Slutsky and Cournot Price Elasticities from the Rotterdam Model

	Palm Oil			Soybean Oil				
	Indo	Malay	ROW	Arg	Brazil	U.S.	ROW	Other Oil
Expenditure	0.624***	1.562***	-0.911	1.265***	0.669	3.030*	-0.772	0.618
	(0.162)	(0.348)	(2.101)	(0.328)	(0.875)	(1.544)	(1.420)	(0.486)
Slutsky:								
IndoPalm	-1.937**	2.221**	-0.500**	-0.754**	1.517***	0.079	-0.111*	-0.514*
	(0.880)	(0.878)	(0.204)	(0.342)	(0.402)	(0.113)	(0.063)	(0.246)
MalayPalm	3.004**	-4.006**	0.423	1.570**	-1.398**	0.025	0.164	0.217
	(1.187)	(1.473)	(0.315)	(0.607)	(0.617)	(0.184)	(0.112)	(0.408)
ROWPalm	-19.273**	12.073	2.593	3.199	-1.560	1.420	-0.525	2.073
	(7.860)	(8.972)	(3.925)	(4.378)	(5.027)	(1.483)	(0.827)	(3.585)
ArgSoy	-1.629**	2.504**	0.179	-1.973***	0.200	0.163	-0.074	0.628*
	(0.738)	(0.968)	(0.244)	(0.640)	(0.552)	(0.164)	(0.101)	(0.358)
BrazilSoy	10.079***	-6.867**	-0.269	0.616	-3.740	-0.390	0.369	0.201
	(2.668)	(3.030)	(0.866)	(1.700)	(2.280)	(0.545)	(0.302)	(1.316)
U.S.Soy	2.061	0.478	0.954	1.960	-1.521	-3.637***	0.602	-0.899
	(2.935)	(3.530)	(0.997)	(1.966)	(2.125)	(1.128)	(0.500)	(1.717)
ROWSoy	-3.485*	3.801	-0.426	-1.076	1.737	0.727	-1.335**	0.057
	(1.971)	(2.589)	(0.671)	(1.461)	(1.420)	(0.603)	(0.530)	(1.219)
Other Oil	-2.340*	0.730	0.244	1.325*	0.138	-0.158	0.008	0.052
	(1.120)	(1.371)	(0.423)	(0.754)	(0.901)	(0.301)	(0.177)	(0.925)
Cournot:								
IndoPalm	-2.171**	2.048**	-0.506**	-0.863**	1.482***	0.070	-0.119*	-0.566**
	(0.883)	(0.879)	(0.204)	(0.343)	(0.402)	(0.113)	(0.063)	(0.247)
MalayPalm	2.419*	-4.438***	0.408	1.299**	-1.486**	0.002	0.146	0.088
	(1.194)	(1.476)	(0.315)	(0.610)	(0.617)	(0.184)	(0.112)	(0.409)
ROWPalm	-18.932**	12.325	2.602	3.357	-1.508	1.433	-0.514	2.148
	(7.899)	(8.911)	(3.925)	(4.393)	(5.028)	(1.484)	(0.828)	(3.589)
ArgSoy	-2.101**	2.154**	0.167	-2.193***	0.129	0.145	-0.089	0.524
	(0.748)	(0.972)	(0.244)	(0.642)	(0.552)	(0.164)	(0.101)	(0.359)
BrazilSoy	9.829***	-7.052**	-0.275	0.500	-3.778	-0.399	0.361	0.146
	(2.666)	(3.040)	(0.866)	(1.706)	(2.280)	(0.545)	(0.302)	(1.318)
U.S.Soy	0.926	-0.361	0.925	1.434	-1.692	-3.681***	0.566	-1.148
	(2.991)	(3.556)	(0.997)	(1.984)	(2.127)	(1.129)	(0.500)	(1.721)
ROWSoy	-3.195	4.015	-0.418	-0.941	1.781	0.738	-1.326**	0.121
	(2.041)	(2.618)	(0.671)	(1.482)	(1.422)	(0.603)	(0.531)	(1.225)
Other Oil	-2.570**	0.558	0.238	1.218	0.103	-0.167	0.001	0.001
	(1.134)	(1.378)	(0.423)	(0.759)	(0.901)	(0.301)	(0.178)	(0.926)

Notes: Single, double, and triple asterisks indicate significance at the 10%, 5%, and 1% levels respectively. Numbers in parentheses are standard errors.

Table I-16. Expenditure Elasticities, and Slutsky and Cournot Price Elasticities from the NBR Model

	Palm Oil			Soybean Oil				
	Indo	Malay	ROW	Arg	Brazil	U.S.	ROW	Other Oil
Expenditure	0.624***	1.567***	-0.943	1.247***	0.663	2.931*	-0.648	0.647
	(0.156)	(0.345)	(2.060)	(0.325)	(0.878)	(1.461)	(1.428)	(0.460)
Slutsky:								
IndoPalm	-2.023**	2.240**	-0.497**	-0.737**	1.514***	0.085	-0.097*	-0.484*
	(0.842)	(0.841)	(0.197)	(0.333)	(0.394)	(0.109)	(0.061)	(0.236)
MalayPalm	3.030**	-3.966**	0.422	1.569**	-1.393**	0.008	0.161	0.168
	(1.137)	(1.426)	(0.307)	(0.596)	(0.608)	(0.178)	(0.111)	(0.393)
ROWPalm	-19.166**	12.044	2.223	3.441	-1.826	1.382	-0.506	2.410
	(7.612)	(8.756)	(3.883)	(4.337)	(5.027)	(1.452)	(0.818)	(3.502)
ArgSoy	-1.589**	2.503**	0.192	-2.081***	0.193	0.165	-0.065	0.683*
	(0.719)	(0.950)	(0.242)	(0.631)	(0.552)	(0.157)	(0.100)	(0.344)
BrazilSoy	10.059***	-6.841**	-0.314	0.595	-3.837	-0.299	0.374	0.264
	(2.618)	(2.987)	(0.866)	(1.700)	(2.296)	(0.541)	(0.303)	(1.283)
U.S.Soy	2.198	0.146	0.929	1.978	-1.167	-3.790***	0.527	-0.820
	(2.831)	(3.413)	(0.976)	(1.890)	(2.111)	(1.059)	(0.482)	(1.627)
ROWSoy	-3.047	3.732	-0.410	-0.948	1.762	0.636	-1.617***	-0.108
	(1.921)	(2.564)	(0.663)	(1.453)	(1.428)	(0.581)	(0.534)	(1.169)
Other Oil	-2.204*	0.566	0.284	1.440*	0.181	-0.144	-0.016	-0.108
	(1.072)	(1.320)	(0.413)	(0.726)	(0.878)	(0.285)	(0.170)	(0.877)
Cournot:								
IndoPalm	-2.257**	2.067**	-0.503**	-0.845**	1.479***	0.076	-0.105	-0.536**
	(0.844)	(0.842)	(0.197)	(0.334)	(0.394)	(0.109)	(0.061)	(0.236)
MalayPalm	2.443**	-4.340***	0.407	1.297**	-1.481**	-0.015	0.143	0.039
	(1.144)	(1.429)	(0.307)	(0.599)	(0.608)	(0.178)	(0.111)	(0.394)
ROWPalm	-18.813**	12.305	2.232	3.604	-1.772	1.396	-0.495	2.487
	(7.651)	(8.774)	(3.884)	(4.351)	(5.028)	(1.453)	(0.818)	(3.506)
ArgSoy	-2.056**	2.158**	0.180	-2.298***	0.123	0.147	-0.080	0.580
	(0.729)	(0.954)	(0.242)	(0.634)	(0.552)	(0.157)	(0.100)	(0.345)
BrazilSoy	9.811***	-7.025**	-0.321	0.479	-3.874	-0.309	0.366	0.209
	(2.639)	(2.997)	(0.866)	(1.706)	(2.296)	(0.541)	(0.304)	(1.285)
U.S.Soy	1.100	-0.666	0.900	1.469	-1.332	-3.833***	0.492	-1.061
	(2.884)	(3.437)	(0.976)	(1.907)	(2.113)	(1.059)	(0.482)	(1.631)
ROWSoy	-2.804	3.911	-0.404	-0.834	1.798	0.645	-1.609***	-0.055
	(1.994)	(2.594)	(0.663)	(1.474)	(1.430)	(0.582)	(0.534)	(1.175)
Other Oil	-2.446**	0.387	0.278	1.328*	0.144	-0.153	-0.023	-0.161
	(1.086)	(1.326)	(0.413)	(0.731)	(0.878)	(0.285)	(0.170)	(0.878)

Notes: Single, double, and triple asterisks indicate significance at the 10%, 5%, and 1% levels respectively. Numbers in parentheses are standard errors.

Table I-17. Expenditure Elasticities, and Slutsky and Cournot Price Elasticities from the AIDS Model

	Palm Oil			Soybean Oil				
	Indo	Malay	ROW	Arg	Brazil	U.S.	ROW	Other Oil
Expenditure	0.537**	1.503***	1.033	1.188***	0.808	2.834*	-0.896	1.098**
	(0.194)	(0.256)	(2.380)	(0.265)	(0.921)	(1.488)	(1.369)	(0.457)
Slutsky:								
IndoPalm	-1.141	0.408	0.056	-0.918**	1.745***	0.147	-0.179**	-0.118
	(0.808)	(0.728)	(0.213)	(0.330)	(0.400)	(0.122)	(0.068)	(0.253)
MalayPalm	0.552	-0.474	-0.379	1.589***	-1.537**	-0.026	0.221**	0.055
	(0.984)	(1.114)	(0.282)	(0.458)	(0.541)	(0.150)	(0.088)	(0.342)
ROWPalm	2.160	-10.821	3.888	10.447**	-5.835	1.086	0.520	-1.444
	(8.200)	(8.045)	(4.574)	(4.635)	(5.676)	(1.576)	(0.916)	(3.956)
ArgSoy	-1.980**	2.534***	0.584**	-2.397***	0.485	0.157	-0.179*	0.797**
	(0.712)	(0.730)	(0.259)	(0.551)	(0.536)	(0.138)	(0.086)	(0.328)
BrazilSoy	11.592***	-7.552**	-1.005	1.494	-3.998	-0.389	0.378	-0.520
	(2.661)	(2.657)	(0.977)	(1.650)	(2.494)	(0.552)	(0.312)	(1.341)
U.S.Soy	3.800	-0.497	0.730	1.890	-1.519	-4.058***	0.594	- 0.940
	(3.157)	(2.866)	(1.059)	(1.654)	(2.153)	(0.983)	(0.462)	(1.579)
ROWSoy	-5.593**	5.117**	0.422	-2.602*	1.777	0.716	-1.685***	1.849
	(2.138)	(2.038)	(0.742)	(1.244)	(1.470)	(0.557)	(0.494)	(1.111)
Other Oil	-0.534	0.184	-0.170	1.682**	-0.356	-0.165	0.275	-0.908
	(1.149)	(1.149)	(0.466)	(0.692)	(0.918)	(0.277)	(0.162)	(0.877)
Cournot:								
IndoPalm	-1.342	0.259	0.050	-1.011***	1.714***	0.139	-0.185**	-0.162
	(0.811)	(0.730)	(0.213)	(0.332)	(0.401)	(0.122)	(0.068)	(0.253)
MalayPalm	-0.011	-0.891	-0.393	1.328**	-1.622**	-0.048	0.203**	-0.069
	(0.989)	(1.116)	(0.282)	(0.460)	(0.541)	(0.150)	(0.088)	(0.342)
ROWPalm	1.773	-11.107	3.878	10.267**	-5.893	1.070	0.508	-1.529
	(8.248)	(8.072)	(4.574)	(4.654)	(5.677)	(1.576)	(0.916)	(3.960)
ArgSoy	-2.425***	2.205***	0.572**	-2.604***	0.418	0.140	-0.194**	0.700**
	(0.719)	(0.734)	(0.259)	(0.552)	(0.536)	(0.138)	(0.086)	(0.329)
BrazilSoy	11.289***	-7.775**	-1.013	1.354	-4.043	-0.401	0.368	-0.587
	(2.683)	(2.670)	(0.977)	(1.658)	(2.495)	(0.552)	(0.312)	(1.343)
U.S.Soy	2.739	-1.282	0.702	1.398	-1.679	-4.099***	0.560	-1.173
	(3.205)	(2.895)	(1.059)	(1.675)	(2.154)	(0.983)	(0.462)	(1.583)
ROWSoy	-5.257**	5.365**	0.430	-2.447*	1.828	0.729	-1.675***	1.923
	(2.198)	(2.073)	(0.725)	(1.267)	(1.472)	(0.557)	(0.494)	(1.116)
Other Oil	-0.946**	-0.120	-0.181	1.491**	-0.418	-0.181	0.262	-0.999
	(1.161)	(1.156)	(0.466)	(0.697)	(0.918)	(0.277)	(0.162)	(0.878)

Notes: Single, double, and triple asterisks indicate significance at the 10%, 5%, and 1% levels respectively. Numbers in parentheses are standard errors.

Table I-18. Expenditure Elasticities, and Slutsky and Cournot Price Elasticities from the CBS Model

	Palm Oil			Soybean Oil				
	Indo	Malay	ROW	Arg	Brazil	U.S.	ROW	Other Oil
Expenditure	0.526**	1.512***	1.023	1.188***	0.838	2.995*	-1.024	1.092**
	(0.196)	(0.255)	(2.400)	(0.271)	(0.908)	(1.578)	(1.361)	(0.486)
Slutsky:								
IndoPalm	-1.043	0.429	0.022	-0.947**	1.743***	0.132	-0.190**	-0.146
	(0.826)	(0.747)	(0.215)	(0.335)	(0.400)	(0.125)	(0.069)	(0.260)
MalayPalm	0.580	-0.599	-0.351	1.617***	-1.556***	-0.001	0.223**	0.088
	(1.010)	(1.136)	(0.284)	(0.466)	(0.540)	(0.152)	(0.088)	(0.350)
ROWPalm	0.867	-10.016	4.435	9.743*	-5.053	1.172	0.449	-1.599
	(8.292)	(8.097)	(4.563)	(4.708)	(5.666)	(1.607)	(0.922)	(4.069)
ArgSoy	-2.043**	2.578***	0.545**	-2.318***	0.494	0.161	-0.190**	0.773**
	(0.722)	(0.743)	(0.263)	(0.565)	(0.539)	(0.145)	(0.088)	(0.346)
BrazilSoy	11.579***	-7.645***	-0.870	1.523	-3.843	-0.498	0.381	-0.626
	(2.661)	(2.654)	(0.976)	(1.660)	(2.476)	(0.557)	(0.310)	(1.386)
U.S.Soy	3.432	-0.026	0.787	1.938	-1.945	-3.884***	0.672	- 0.973
	(3.240)	(2.914)	(1.080)	(1.744)	(2.174)	(1.059)	(0.482)	(1.689)
ROWSoy	-5.944**	5.162**	0.364	-2.754**	1.793	0.811	-1.403**	1.972
	(2.146)	(2.038)	(0.747)	(1.269)	(1.461)	(0.581)	(0.495)	(1.177)
Other Oil	-0.666	0.297	-0.188	1.631**	-0.429	-0.171	0.287	-0.759
	(1.183)	(1.177)	(0.480)	(0.729)	(0.948)	(0.296)	(0.171)	(0.939)
Cournot:								
IndoPalm	-1.240	0.284	0.017	-1.038***	1.713***	0.125	-0.196**	-0.190
	(0.829)	(0.749)	(0.215)	(0.337)	(0.401)	(0.125)	(0.069)	(0.261)
MalayPalm	0.014	-1.019	-0.366	1.354***	-1.641***	-0.023	0.205**	-0.036
	(1.015)	(1.139)	(0.284)	(0.468)	(0.540)	(0.152)	(0.088)	(0.351)
ROWPalm	0.484	-10.299	4.425	9.566*	-5.110	1.157	0.436	-1.683
	(8.341)	(8.124)	(4.563)	(4.726)	(5.667)	(1.607)	(0.922)	(4.074)
ArgSoy	-2.488***	2.249***	0.533*	-2.525***	0.427	0.144	-0.204**	0.675*
	(0.729)	(0.747)	(0.263)	(0.567)	(0.539)	(0.145)	(0.088)	(0.346)
BrazilSoy	11.265***	-7.877***	-0.878	1.377	-3.890	-0.511	0.371	-0.695
	(2.683)	(2.666)	(0.976)	(1.668)	(2.477)	(0.557)	(0.311)	(1.387)
U.S.Soy	2.310	-0.856	0.758	1.418	-2.114	-3.927***	0.636	-1.220
	(3.293)	(2.947)	(1.080)	(1.766)	(2.175)	(1.059)	(0.482)	(1.694)
ROWSoy	-5.560**	5.445**	0.374	-2.576*	1.851	0.825	-1.391**	2.056
	(2.206)	(2.072)	(0.747)	(1.291)	(1.463)	(0.582)	(0.495)	(1.183)
Other Oil	-1.075**	-0.006	-0.199	1.441*	-0.490	-0.187	0.274	-0.849
	(1.197)	(1.184)	(0.480)	(0.733)	(0.949)	(0.296)	(0.171)	(0.940)

Note: Single, double, and triple asterisks indicate significance at the 10%, 5%, and 1% levels respectively. Numbers in parentheses are standard errors.

Table I-19. Expenditure Elasticities and Own-Price Slutsky and Cournot Elasticities from all the Models

	Palm Oil			Soybean Oil				
Model	Indo	Malay	ROW	Arg	Brazil	U.S.	ROW	Other Oil
Expenditure								
General	0.598***	1.480***	0.377	1.191***	0.717	2.590*	-0.525	1.020**
Rotterdam	0.624***	1.562***	-0.911	1.265***	0.669	3.030*	-0.772	0.618
NBR	0.624***	1.567***	-0.943	1.247***	0.663	2.931*	-0.648	0.647
AIDS	0.537**	1.503***	1.033	1.188***	0.808	2.834*	-0.896	1.098**
CBS	0.526**	1.512***	1.023	1.188***	0.838	2.995*	-1.024	1.092**
Slutsky								
General	-1.579*	-1.129	1.973	-2.517***	-4.357*	-4.233***	-2.333***	-1.072
Rotterdam	-1.937**	-4.006**	2.593	-1.973***	-3.740	-3.637***	-1.335**	0.052
NBR	-2.023**	-3.966**	2.223	-2.081***	-3.837	-3.790***	-1.617***	-0.108
AIDS	-1.141	-0.474	3.888	-2.397***	-3.998	-4.058***	-1.685***	-0.908
CBS	-1.043	-0.599	4.433	-2.318***	-3.843	-3.884***	-1.403**	-0.759
Cournot								
General	-1.803**	-1.539	1.969	-2.724***	-4.397*	-4.270***	-2.326***	-1.155
Rotterdam	-2.171**	-4.438***	2.602	-2.193***	-3.778	-3.681***	-1.326**	0.001
NBR	-2.257**	-4.340***	2.232	-2.298***	-3.874	-3.833***	-1.609***	-0.161
AIDS	-1.342	-0.891	3.878	-2.604***	-4.043	-4.099***	-1.675***	-0.999
CBS	-1.240	-1.019	4.425	-2.525***	-3.890	-3.927***	-1.391**	-0.849

Note: Single, double, and triple asterisks indicate significance at the 10%, 5%, and 1% levels respectively.

APPENDIX I-A

Summary of Model Specifications and Theoretical Restrictions

Model Specifications and Theoretical Restrictions

Model	Restriction: Adding Up	Homogeneity	Symmetry
Rotterdam $w_{ih}\, d\log q_{ih} = \theta_{ih}\, d\log Q + \sum_j \sum_k \pi_{ih\,jk}\, d\log p_{jk}$	$\sum_i \sum_h \theta_{ih} = 1$, $\sum_i \sum_h \pi_{ihjk} = 0$	$\sum_j \sum_k \pi_{ih\,jk} = 0$	$\pi_{ih\,jk} = \pi_{jk\,ih}$
CBS $w_{ih}\,(d\log q_{ih} - d\log Q) = \beta_{ih}\, d\log Q$ $+ \sum_j \sum_k \pi_{ih\,jk}\, d\log p_{jk}$	$\sum_i \sum_h \beta_{ih} = 0$, $\sum_i \sum_h \pi_{ihjk} = 0$	$\sum_j \sum_k \pi_{ih\,jk} = 0$	$\pi_{ih\,jk} = \pi_{jk\,ih}$
AIDS $dw_{ih} = \beta_{ih}\, d\log Q + \sum_j \sum_k \lambda_{ih\,jk}\, d\log p_{jk}$	$\sum_i \sum_h \beta_{ih} = 0$, $\sum_i \sum_h \lambda_{ih\,jk} = 0$	$\sum_j \sum_k \lambda_{ih\,jk} = 0$	$\lambda_{ih\,jk} = \lambda_{jk\,ih}$
NBR $dw_{ih} + w_{ih} d\log Q = \theta_{ih}\, d\log Q$ $+ \sum_j \sum_k \lambda_{ih\,jk}\, d\log p_{jk}$	$\sum_i \sum_h \theta_{ih} = 1$, $\sum_i \sum_h \lambda_{ih\,jk} = 0$	$\sum_j \sum_k \lambda_{ih\,jk} = 0$	$\lambda_{ih\,jk} = \lambda_{jk\,ih}$
General $w_{ih}\, d\log q_{ih} = d_{ih}\, d\log Q + \delta_1\, w_{ih}\, d\log Q$ $+ \sum_j \sum_k e_{ih\,jk}\, d\log p_{jk}$ $+\delta_2\,(d\log p_{ih} - d\log \mathrm{P})$	$\sum_i \sum_h d_{ih} = 1 - \delta_1$, $\sum_i \sum_h e_{ih\,jk} = 0$	$\sum_j \sum_k e_{ih\,jk} = 0$	$e_{ih\,jk} = e_{jk\,ih}$

Notes: Intercepts and seasonal dummy variables are not included.

$\theta_{ih} = w_{ih} + \beta_{ih}$, $\lambda_{ih\,jk} = \pi_{ih\,jk} + w_{ih}\,\delta_{ih\,jk} - w_{ih}w_{jk}$, $d_{ih} = \delta_1 \beta_{ih} + (1 - \delta_1)\,\theta_{ih}$, and

$e_{ih\,jk} = (1 + \delta_2)\,\pi_{ih\,jk} - \delta_2\,\lambda_{ih\,jk}$.

where θ_{ih} is the marginal budget share, and $\pi_{ih\,jk}$ is the compensated price effect (Slutsky term).

CHAPTER 2

CONSUMER DEMAND FOR BEEF VARIETY

Abstract

In the United States, producers of ground beef use attributes like taste, nutritional content, processing techniques, and origin of production to differentiate their products. Some studies in psychology, marketing, and economics suggest that increasing the number of choices in the name of product differentiation might affect consumers' utility in a negative way. Some studies also suggest that the impact of an increase in number of choices on an individual's utility depends on his/her personal characteristics.

This study is intended to determine consumers' willingness to pay for ground beef attributes; including traceability certified by the U.S. Government or a private company, humane production technique, certified natural beef, and fat content. This study is also intended to determine the impact of an increase in the number of ground beef choices on consumers' utility. The impact of personal characteristics on the effect of number of choices on consumers' utility is also considered. A nationwide survey was conducted to elicit consumers' preferences.

Results indicate that consumers are willing to pay more for traceability certified by the U.S. Government than any other ground beef attribute considered in this study. The results also show that an increase in the number of ground beef choices beyond a threshold level has a negative impact on consumers' utility and that impact depends on consumers' individual characteristics.

Keywords: Willingness-to-pay for ground beef attributes, excessive choice effect, maximizers-satisficers.

Introduction

In the United States food producers differentiate their products using various quality attributes like taste, nutritional content, processing techniques, and origin of production (Golan et al. 2004). Although consumers can detect some characteristics like taste, they cannot detect some credence characteristics like processing techniques, impact on environment, and origin of production (Golan et al. 2004). Producers have been using labeling, both mandatory and voluntary, to send signals to consumers regarding these credence attributes.

Product labels allow food retailers to differentiate beef products. To the extent that consumer demand is heterogeneous, this allows retailers to display a variety of products consistent with differences in beef demand. In the case of ground beef, retailers frequently differentiate beef by its fat content, as some consumers prefer the taste a higher fat content adds while others avoid fat due to health concerns. Other beef attributes that are receiving increased attention are natural beef, animal welfare concerns, and traceability.

Traceable beef refers to a beef production and marketing process by which all retail products can be traced back to where the meat was processed, the animal was harvested, and all the farms on which the animal was raised. The outbreak of BSE, also known as Mad Cow Disease, in 2003 has made the development of U.S. beef traceability systems an important issue to both consumers and policy makers. Outbreaks of BSE can easily be prevented by monitoring cattle feed. However, a single producer could possibly reduce their production costs by using unsafe feeding practices, threatening the health of consumers. Food safety is consumers' number one meat issue, outweighing concerns about farm profitability and animal welfare (Norwood, Lusk, and Prickett 2007). Without traceability programs these producers could not be detected and punished. Thus, the likelihood of unsafe made is reduced by purchasing meat that is traceable. A tracing system, of course, would raise costs. However, as long as consumers will pay a premium commensurate with these costs for meat labeled traceable, differentiating beef by traceability could enhance profits.

Animal and meat traceability systems are the two different sets of traceability systems in the livestock/meat industry (Golan et al. 2004). The animal traceability system would allow the animal to be traced back to where it has been during its life. The three important reasons for livestock owners to implement animal traceability systems are to prevent theft or loss, to control or eradicate diseases like BSE, and to increase the value of their animals by maintaining the records of credence attributes like feeding practices, animal welfare, and proper medical care (Golan et al. 2004). A voluntary National Animal Identification System (NAIS) was initiated in 2004 by USDA to help producers and animal health officials to respond to the outbreak of animal disease such as BSE effectively (USDA-APHIS 2007). This program would allow animals to be traced back to where they have been and what other animals have been in contact with them (USDA-APHIS 2007). There has been a debate on whether this system should be made mandatory (Loureiro and Umberger 2007). Some groups representing livestock industry are against making this program mandatory as they are concerned about the increased cost this would impose on the producers and also about the confidentiality of the data. Consumer advocacy groups want to make this program mandatory as they believe this would protect the consumers from animal disease such as BSE and also would help to maintain their confidence in beef.

The meat traceability system, which would allow the tracking of meat from retailers back to the slaughters/processors, was developed to effectively manage supply chain, and to maintain safety and quality (Golan et al. 2004). Almost all the meat is currently traceable to processor/slaughter as they are required to carry the USDA inspection numbers on the labels (Golan et al. 2004). As animal diseases like BSE can cause human health problems, a strong motivation exists to link animal and meat traceability systems (Golan et al. 2004). By linking these two systems meat products can be traced back to the farms where the animals were raised. As consumers consider food safety to be very important, some producers may try to pass on the standard meat products as traceable to sell their products at a premium. Given the fact that traceability is a credence attribute consumers can not determine if the claim on traceability is genuine. For the market to function efficiently, the signals on credence attributes like traceability must be credible. Consumers may trust traceability certified by a public agency more than a private company.

The concept of natural foods is leading to many changes at the grocery store shelf. What constitutes "natural" food is not yet clear, but for consumers it likely refers to the employment of agricultural production practices similar to what would be considered "traditional" practices. For example, allowing animals to breed naturally in a field would be considered natural, whereas cloning of animals is not. Some consumers would consider meat from cattle administered growth hormones and antibiotics to also be unnatural. Mad Cow disease, mentioned above, was the result of feeding sheep parts to cattle, which certainly is not natural. Processing also plays an important role in what is considered natural. Meat taken directly from a carcass with no further processing would be considered natural. Meat cured with nitrates and sanitized by irradiation would not.

As far as meat is concerned, the label “natural” meat usually means that the meat has undergone minimal processing, and has little to do with how the animal itself was raised or treated. There is one exception: natural beef usually implies the animal was fed a strictly vegetarian diet. That is, the natural label provides more information about what happened after the animal was slaughtered then when the animal was alive. Ground beef labeled natural more often than not means simply that the meat was taken from the carcass, ground with beef fat, without any chemicals or preservatives. In some cases it also refers to the absence of growth hormones and (sub therapeutic) antibiotic use.

The issue of animal welfare has been a point of debate between animal welfare activists and livestock industry groups for a long time (Norwood, Lusk, and Prickett 2007). While animal welfare groups argue that modern production practices like the use of gestation crates are unethical and inhumane, industry groups argue that they make sure that animals are treated humanely by following scientifically proven practices (Norwood, Lusk, and Pickett 2007). To cater the needs of consumers who care about animal welfare, industry has started to sell meat products with animal welfare assurance labels (Martin 2006). Although consumers consider “animal welfare” issue to be important, they consider it as less important relative to food safety, food prices, and financial well-being of farmers (Norwood, Lusk, and Prickett 2007). However, they are of the opinion that farms that treat animals humanely would also produce safer meat (Norwood, Lusk, and Prickett 2007).

Sales of organic meat have increases by 140 percent from 2004 to 2006 (Mintel 2006). The number of cows that are raised to produce organic beef has increased by 97.3 percent from 2000 to 2003 (Mintel 2006). Organic beef reflects the three previous attributes; it is traceable; undergoes minimum processing and was fed a vegetarian diet and is therefore natural; and requires the producer to implement practices to ensure high animal welfare standards. Organic beef sells at an average premium of about 50 percent (Beef Retail Marketing 2007).

Given the large premium of organic beef, many retailers may want to provide a beef with only some of the attributes of organic beef. This may be traceable beef, natural beef, guaranteed humane beef, or any combination of these three attributes. To determine what type of premium should be set for this differentiated beef, the value of each three attributes must be estimated. Indeed, one of the objectives of this research is to measure the value consumers place on traceable beef, natural beef, and guaranteed humane beef, relative to traditional ground beef.

In food markets where consumers exhibit remarkably differing tastes, food retailers may consider selling a large number of ground beef varieties. Indeed, most economic models of demand would suggest that increasing product variety can only enhance, and would never detract from, profits. The reason is that these models universally predict that increasing product variety can only increase the probability of a purchase and the number of units purchased. However, prior research in psychology, economics, and marketing suggests that increasing product variety can have an adverse effect on consumer demand (Malhotra 1982; Iyengar and Lepper 2000; Iyengar, Jiang, and Huberman 2004). This adverse effect is termed here as an *excessive-choice effect*.

If consumers are provided with unlimited options, then there is a possibility that they might get confused with all the information and would end up either postponing the decision or not choosing any option at all (Iyengar and Lepper 2000; Schwartz 2000). Thus, product differentiation strategies must design varieties that appeal to different consumer types, without overburdening them with an excessive number of options. Marketing research has devoted a majority of effort on the former while neglecting the latter. Standard theoretical and empirical models do not account for the excessive-choice effect, and therefore may lead to unprofitable marketing strategies.

This study is concerned with consumer demand for traceable, natural, and guaranteed humane beef. Results of the study will help food retailers decide whether increasing the variety of ground beef placed for sale is in their best interest, and if it is, the premium that should be placed on these new varieties. Given that the excessive-choice effect could dampen the profitability of increasing ground beef variety, it is important to understand at what point the excessive-choice effect may be realized and the magnitude of its effect on consumer demand. While it may be that some consumers do prefer beef differentiated according to a particular attribute, and will pay more for that attribute, the demand boost due the introduction of that variety could be offset by the excessive-choice effect. The excessive-choice effect refers to preferences for choice-set size. What is the optimal number of varieties from the consumers' point-of-view, how does increasing variety beyond this point affect overall demand. Measuring preferences for choice set size is the second objective of this study.

The excessive-choice effect is a new phenomenon to economics and marketing. There are really only two things known regarding this effect. The first is that increasing variety can reduce overall demand. The second is that consumers display differences in how they respond to increased product variety, and these differences are best described by the personality characteristics called maximizer and satisfizer. People who always look for the best outcome, referred to as maximizers, tend to get confused more than those who look for the "good enough" outcome, called satisficers. Psychologists have developed a multi-item survey that measures a person's personality in relation to their shopping behavior. Two extremes of personalities are satisficers and maximizers, and this survey provides a numerical score indicating where one resides on the satisficer-maximizer personality spectrum (Schwartz et al. 2002).

In the future, economists and marketing researchers will be interested in how satisficers and maximizers differ, their proportion of the population, and how to create marketing strategies to exploit personality differences. It would be useful if the satisficer-maximizer personality survey could be used in conjunction with standard economic models. This question constitutes the third objective. It is achieved by determining if individuals' score on the psychometric scale can explain differences in preferences for choice set size.

The three aforementioned objectives are achieved using ground beef as a case study. Consumer demand is measured using hypothetical choice experiments and standard discrete choice models. Two different samples of subjects were used. One was recruited via mail surveys, and is representative of the U.S. population but subject to non-response bias. The other is not subject to non-response bias but is biased towards one particular region.

Literature Review

Differentiated Beef

A number of studies have highlighted consumer preferences for certain beef attributes. For example, Dickson and Bailey (2002), using experimental auctions, found that consumers in Utah were willing to pay for meat (beef and pork) attributes like "traceability," "humane production processes," "no growth hormones," and "safety assurances." They found that consumers considered food safety as the most important attribute. Furthermore, the results of their study indicated that it would be profitable to develop traceability, transparency, and extra assurances in the United States.

Loureiro and Umberger (2003), using a survey, found that consumers in Colorado were very concerned about the source of origin and were willing to pay for mandatory COOL program. They also found that consumers were willing to pay for steak and hamburger with label "U.S. Certified beef." In another study the same authors, using a nationwide mail survey, found that U.S. consumers were willing to pay for steak attributes such as traceability, country of origin label (COOL), food safety, and tenderness. They found that consumers valued food safety as the most important attribute. Also, they found that consumers were willing to pay more for COOL than for traceability (Loureiro and Umberger 2007).

Hobbs et al. (2005), using experimental auctions, found that Canadian consumers were willing to pay for beef and pork with assurances on traceability, food safety, and animal welfare. They found that consumers were willing to pay more for the assurance on food safety than for the other attributes. They also found that consumers valued traceability more when it was combined with other attributes such as food safety and animal welfare.

Grannis and Thilmany (2000), using a survey, found that consumers living in intermountain region of Colarado, Utah, and New Mexico perceived “no use of antibiotics” and “hormone free” as important drivers of beef demand. Lusk and Fox (2002), using a nationwide mail survey, found that U.S. consumers were willing to pay for a mandatory labeling program that would inform them whether the beef was from cattle produced using growth hormones or fed genetically modified food. They also found that consumers valued information regarding the beef from cattle produced with growth hormones more than the ones regarding the beef from cattle fed genetically modified corn.

Lusk, Roosen, and Fox (2003), using a mail survey, found that consumers in France, Germany, UK, and U.S. were willing to pay for beef steak from cattle raised without growth hormones, and not fed genetically modified corn. They found that consumers in France were willing to pay more for beef from cattle produced without growth hormones than those in the U.S. However, according to their study, consumers in Germany, and U.K. were willing to pay the same amount for the beef without growth hormones as those in the U.S. They also found that consumers in France, Germany, and U.K. were willing to pay more for beef from cattle not fed genetically modified corn than those in the U.S. Their study showed that consumers in U.S. were willing to pay a lot more for “hormone-free” beef than for “GM-free” beef.

Onyango and Govindasamy (2005), using a nationwide telephone survey, found that U.S. consumers were willing to pay for ground beef produced from cows fed with less antibiotics. Also, they found that consumers expected compensation to purchase ground beef that was the product of a genetic modification involving animal and bacterium genes.

Steiner and Young (2007), using a web-based survey, found that consumers in Alberta and Montana were willing to pay for beef steak that carried labels such as “tested BSE,” “GM-free,” and “hormone-free.” They used a pooled sample of consumers in Alberta and Montana for their study as they determined that the preferences of consumers in those two regions were homogenous. They found that consumers were willing to pay more for beef steak with label “tested BSE” than for the one with label “GM-free,” or “hormone-free.” They also found that consumers were willing to pay more for beef steak with label “hormone-free” than for the one with label “GM-free.”

Norwood, Lusk, and Prickett (2007), using a nationwide telephone survey, found that U.S. consumers valued food safety as the most important attribute. They found that consumers considered animal welfare to be less important than food safety, food prices, and financial well-being of U.S. farmers.

These studies show that consumers value food safety to be very important and they are willing to pay for quality assurances. These studies also demonstrate that product differentiation of beef could increase beef demand. Consumer sects concerned about antibiotic use, hormone use, animal welfare, or other beef production practices may increase their beef consumption if products like natural beef, traceable beef, and certified humane were available. Indeed, the growing prevalence of such products supports this claim.

Natural beef refers to ground beef from cattle fed a strictly vegetarian diet, and produced without the use of antibiotics or growth hormones, and the meat is minimally processed without the use of artificial ingredients. Traceable beef refers to beef that can be traced back to the farm where the animal was raised. Certified humane refers to beef products from cattle that are guaranteed and slaughtered under humane processes.

As several studies demonstrate that consumers consider attributes like traceability, country of origin labeling (COOL), natural beef, and animal welfare to be important, it is imperative to discuss the issues surrounding them. For several years consumer advocacy groups have been asking for legislation that would require the sellers to provide information regarding country-of-origin (COOL) for food products (Krissoff et al. 2004). They believe that mandatory COOL would increase the food safety by helping the consumers to avoid the beef from the region that is affected by animal disease such as BSE. Some producer groups also support this initiative hoping that demand for their products would increase as, according to them, consumers prefer domestic products to imported products (Krissoff et al. 2004). In the 2002 Farm bill, Congress incorporated a COOL provision and the USDA issued guidelines for voluntary labeling in the same year (USDA-AMS 2007). This provision would require country of origin labeling for beef, pork, lamb, fish, perishable agricultural commodities, and peanuts (USDA-AMS 2007). Under this provision if a beef product is to be labeled “Product of USA”, it must be born, raised, and processed in the U.S. (USDA-AMS 2007). The Congress wanted to make it mandatory before September 30, 2004 (USDA-AMS 2007). In the January of 2004, because of the concerns expressed by some producer groups, a public law was passed delaying the implementation of mandatory COOL until September 30, 2006 except for wild and farm-raised fish and shell fish (USDA-AMS 2007). Again in November 2005, a public law was passed delaying the implementation of mandatory COOL until September 30, 2008 (USDA-AMS 2007).

The outbreak of BSE in 2003 has intensified the debate regarding the importance of mandatory COOL. The proponents of this program argue that information regarding country-of-origin would have helped to segregate the meat from the region that was affected by BSE if the COOL system was in place when that incident occurred (Loureiro and Umberger 2007). They also believe that mandatory COOL would increase consumer confidence in beef resulting in increased demand for beef (Krissoff et al. 2004). Opponents argue that consumers are not interested in country-of-origin labeling and the mandatory COOL would impose additional costs on producers. They also believe that international trade agreements might be violated by making COOL provision mandatory (Krissoff et al. 2004).

In 2004, USDA started a National Animal Identification System (NAIS) to tackle the outbreak of animal disease such as BSE effectively (USDA-APHIS 2007). This program is currently voluntary and consists of three components: premises registration, animal identification, and animal tracing (USDA-APHIS 2007). The first component, premises registration, involves registering where the animals are raised, held, or boarded. The second component, animal identification, involves identifying, and linking the animals to the birthplace or premises of origin using a uniform numbering system. The third component, animal tracing, involves tracing the animals back to where they have been and what other animals have been in contact with them (USDA-APHIS 2007). Even though consumer advocacy groups want to make this program mandatory, some producer groups are against this idea as they are concerned about the additional costs this program is expected to impose on the producers. They are also concerned about the confidentiality of the data provided by them. Rosende-Filho and Buhr (2006), using a generalized AIDS model, studied the impact of implementation of NAIS. They found that NAIS might not be profitable in the U.S. market as the costs would outweigh benefits. However, their study did not include the increase in the value of exports that might occur because of the implementation of NAIS (Resende-Filho and Buhr 2006).

Some of the livestock producers that support mandatory COOL do not support mandatory NAIS .They are concerned about the fact that mandatory NAIS would allow the food safety problems to be linked to individual producers and make them vulnerable to liability suits (Golan et al. 2004; Loureiro and Umberger 2007). They argue that National Animal Identification System would not bring any additional benefits to the livestock industry over the COOL provision (Ishmael 2004).

Currently there is a lot of controversy regarding the definition of the term “natural” (Heller 2006). The Food Safety and Inspection Service (FSIS) of USDA allows a meat product to be certified “natural” if it does not contain artificial flavors, colorings, chemical preservations, or other synthetic ingredients, and it is minimally processed (USDA-FSIS 2007). This guidance has been in effect since 1982 (USDA-FSIS 2007).

However, this policy allows for some exceptions if it can be proved that the presence of an ingredient in question would not significantly change the product and make it “not natural”(USDA-FSIS 2007). In 2005, FSIS changed its guidelines and acknowledged that sugar, sodium lactate (from a corn source), and natural flavorings from oleoresins or extractives were acceptable as “natural” (USDA-FSIS 2007).

Consumer advocacy groups and some food producers claim that some food manufacturers try to capture the niche market that is available for natural foods by making false claims about their products. Hormel Foods, a meat producer, has recently expressed concern about the exceptions that are allowed in the FSIS guidance. According to them, some manufacturers would manipulate these exceptions by using ingredients that are not “natural” and have requested FSIS to issue clear guidelines regarding the claim “natural” (USDA-FSIS 2007).

The five freedoms of animal welfare that have been developed from the guidelines given by the Farm Animal Welfare Council of U.K. are: 1) Freedom from thirst, and hunger 2) Freedom from discomfort due to environment 3) Freedom from pain, injury, and disease 4) Freedom to express normal behavior for the species 5) Freedom from fear and distress (Appleby and Hughes 2005). Out of these five freedoms, consumers consider freedom from thirst, and hunger, and freedom from pain, injury, and disease as the most important ones (Norwood, Lusk, and Prickett 2007). Consumers believe that animal welfare is the responsibility of everybody including consumers, food companies, and Government (Norwood, Lusk, and Prickett 2007).

Because of the continued efforts of animal rights activists, changes in public policy and industrial standards are taking place (Norwood, Lusk, and Prickett 2007). Florida passed a legislation imposing a ban on gestation crates (Harper 2002). Backed by groups such as Humane Society of the United States and Farm Sanctuary, voters in Arizona approved for a ban on sow gestation and veal stalls (Arnaut and Gauldin 2006). A bill has been proposed by the House of Representatives which would make the producers of eggs and meat to comply with several animal welfare requirements (HSUS 2007).

In January 2007, Smithfield Foods, the largest pork producer, announced that it would phase out gestation creates (Kaufman 2007). According to the company officials, they took this decision in response to concerns raised by customers such as McDonalds and not because of the pressure from voters or animal right activists (Kaufman 2007). In March 2007, Burger King announced that it would purchase eggs and pork from suppliers that did not confine their animals in cages and crates. They also said that they would prefer chicken from suppliers that use gas rather than electric to make the birds unconscious before slaughter (Martin 2007).

The Excessive Choice Effect

The standard economic model of choice would predict that beef demand increases whenever a new, differentiated product becomes available. That is, conventional economic models predict that increased variety can only increase consumption of beef. An additional choice does not decrease the utility obtained from a choice set, because if the new choice increases utility it will be purchased and if it does not increase utility it will not be purchased. Either way, utility does not fall, and neither does beef demand.

However studies in psychology and marketing have found that proliferation of choices might negatively affect consumers' utility from a choice set. That is, an additional variety in a choice set could decrease the utility obtained from the choice. Iyengar and Lepper (2000), in their study, found that more percentage of consumers purchased gourmet jams or chocolates when offered 6 choices rather than 24 or 30 choices. They also found that students were more likely to complete optional extra-credit assignments when given 6 different essay topics rather than 30 different essay topics.

Using field and laboratory experiments they found that participants were more satisfied with the items and they wrote better papers when the available choices were limited. Iyengar, Jiang, and Huber (2004), using data from 800,000 employees, found that participation rate in 401k plans was higher when the number of choices was limited than when the number of choices was 10 or more. They found that when the number of funds offered was only two, the participation rate was 75 percent, but when the number of funds offered was 59, the participation rate was just 60 percent.

Iyengar and Lepper (2000) attributed two possible factors for this effect. The first factor is that, as the number of options increases, the likelihood of making a non-optimal choice also increases, which in turn would reduce the pleasure one gets from his or her actual choice. This is relevant to those individuals who experience regret from their purchases. Some people frequently ponder whether their choice was indeed optimal. Often the truly optimal choice is never known, and the more options there was to choose from, the higher the probability another option may really have been the best choice. Standard economic models do not account for this regret factor, and thus may miss a salient feature about consumer choices. As choice proliferates, consumers who seek to avoid regret may decide not to make a choice. As choice proliferates, demand falls--the excessive-choice effect.

The second factor that contributes to the dissatisfaction is that, as the number of options increases, it gets harder to gather the information about all the options that is necessary to choose the best option. The costs of gathering the required information necessary to identify the best choice become high. Some consumers may choose to not purchase any item, to avoid the cost of information gathering, instead of risk purchasing a sub-optimal item. This points to an excessive-choice effect, where greater variety can decrease the probability of a purchase. For example, greater beef variety could decrease beef demand.

Further evidence is found in Boatwright and Nunes (2001), who discovered that reducing the number of items of different categories in a supermarket increased the overall sales significantly. They found that customers welcomed the reduction of number of items especially when there were few differences among them at the attribute level. Broniarczyk, Hoyer, and Mc Alister (2001) found that reducing the number of items would not hurt the sales significantly as long as the low preference items were removed. They suggested that optimal selection of items of a particular category would help the stores by reducing the carrying costs significantly without affecting the sales negatively.

As the beef industry continues to explore new ways of processing and packaging beef this excessive-choice effect must be considered. Stores may not be able to increase sales of beef by making more varieties available. Stores must determine the optimal number of varieties and the profit-maximizing varieties within that choice set.

Some marketing studies have delved deeper in the study of consumer behavior under different choice set sizes. Chernev (2003) found that the impact of unlimited options on the preferences depended heavily on the extent to which consumers were already familiar with the products. He found that consumers who had a fairly good idea of what they wanted could derive the highest utility by going through all the available options. On the other hand; consumers who did not have a very good idea of what they wanted could have their preferences weakened by the availability of unlimited options. He concluded that when the available options were fewer, consumers who knew what they wanted were likely to have weaker preferences; compared to those who did not have such a good idea of what they wanted.

As several studies have documented the existence of excessive-choice effect, it is important to discuss the economic theories that can be utilized to explain this concept. In all the studies that have shown the existence of excessive-choice effect, the researcher has exogenously chosen the number of choices (Norwood 2006). However, in the real market, it is the market that determines the number of choices endogenously (Norwood 2006). The optimal variety in a market is determined by the interplay of consumers' preferences for a variety and the economies of scale in production (Lancaster 1990). Lancaster (1990, p. 192) in his paper states, "if there are no economies of scale associated with individual product variants, then it is clearly optimal to custom produce to everyone's chosen specification." Lancaster(1990, p. 192) also states, "if there is no gain from variety and there are scale economies, then it is clearly optimal to produce a single variant if those economies are unlimited, or only such variety as uses scale economies to the limit." Usually, in the markets, a balance is reached between some variety and some scale economies (Lancaster 1990). Based on the assumptions we make, the conclusions on optimal variety could differ (Lancaster 1990).

According to Chamberlin (1933), monopolistic competition would result in a number of varieties that is more than socially optimal. However, according to Dixit and Stiglitz (1977) monopolistic competition could result in fewer varieties than the ones that are socially optimal. According to Lancaster (1975), monopolistic competition would lead to more varieties, and monopolization of the market would result in less varieties. He also observes that it would not be possible to predict in a more complex market structure whether there would be more or less varieties. According to Spence (1976), monopolistic competition would lead to too many varieties if the own and cross price elasticities are high. On the other hand, according to him, low own and cross price elasticities would result in few varieties.

Assuming that monopolistic competition increases product differentiation and results in too many varieties, traditional economic models suggest that this increase in choices is always good for consumers. However these models do not take search cost in to account (Norwood 2006). Norwood (2006), assuming asymmetric monopolistic competition, found that incorporating search cost would result in an excessive-choice effect. This occurs because each time a consumer considers an additional variety, he or she loses some utility (Stivers and Tremblay 2005; Norwood 2006). The increase in number of choices increases the probability of finding a better option, and also decreases the prices. Because of the search cost, consumers go over only a subset of choices and the probability of finding a better choice decreases. If they cannot find the variety they prefer they would not make a purchase (Norwood 2006). The model developed by Norwood (2006) assumes that the additional varieties are preferred by less consumers and market behaves in such a way that the most preferred items are sold first. However, Iyengar and Lepper (2000) in their experiment used the choices that were similar in utility (Norwood 2000). Norwood's (2006) model can be used to explain the excessive choice effect found by Iyengar and Lepper (2000), if it is assumed that consumers develop shopping habits (Norwood 2006). Based on this assumption, if more varieties are offered then consumers would know that the average utility from many varieties would be relatively less than the average utility from few products. They also would know that the average utility would be less than the search cost, and would not consider any of the varieties (Norwood 2006).

Norwood's (2006) model shows that an increase in fixed cost would reduce the number of varieties. His model also supports the concept that monopolistic competition would result in more than socially optimal number of varieties.

Irons and Hepburn (2007) developed a theoretical model incorporating regret factor along with search cost in the consumers' utility function. The model shows that, when the search is non-sequential, increasing the number of options beyond a certain number would affect the consumers who experience regret negatively. The model shows, when the search is sequential with recall (being able to go back to the searched options), excess options would make consumers' who experience regret not to perform any search and to choose none. It shows that, when the search is sequential with no recall (not being able to go back to the searched options), regret at having to stop the search before the best option is chosen increases the amount of search, and regret at skipping the better option decreases the amount of search.

Satisficers Versus Maximizers

Schwartz et al. (2002) consider the fact that the excessive-choice effect may differ according to an individuals' personality. Individuals are classified as either "satisficers" or "maximizers" according to their personality. Through survey research, Schwartz et al. (2002) develop a scale that splits individuals into satisficers and maximizers. This scale is a 13 question survey where the individual's score determines whether they are a satisficer, maximizer, or somewhere between these two extremes. The score can range from 13 to 93. If an individual's score is over 65, then he/she is a maximizer. If an individual's score is below 40, then he/she is a satisficer (Schwartz 2004).

Maximizers are people who always look for the best option. They check out all the alternatives to make sure that they are choosing the best option. Satisficers are people who look for the "good enough" option, and they set standards for what they want. They will stop their search once they find what they are looking for and would not worry if something better is out there (Simon 1955, 1956, 1957).

Schwartz et al. (2002) hypothesized that added options would create problems for maximizers because they would try to choose the best one among all the available options, and the likelihood of choosing the best option decreases as the number of options increases. On the other hand, according to the authors, unlimited options would not create problems for satisficers because they are looking for an option that is "good enough" and they don't care even if they come across a better alternative. Research does indicate that individual's behavior depends on their satisficer - maximizer scale score.

Maximizers are likely to take a longer time than satisficers to make purchasing decisions and are also more likely to indulge in social comparisons than satisficers. Maximizers are also likely to spend a lot of time thinking about the purchases they have made, while satisficers rarely do that. Maximizers experience more regret regarding the choices they make than satisficers. Maximizers are also less happy and more depressed than satisficers (Schwartz et al. 2002). Schwartz et al. (2002) argue that proliferation of choices is the main reason for maximizers to feel depressed. According to the authors, as options proliferate it becomes difficult for maximizers to choose the best options and they blame themselves for not being able to make optimal decisions.

Lusk and Norwood (2007b), using the Becker-DeGroot-Marschak (BDM) mechanism, studied the impact of individuals' personality on their preferences for choice sets. They used the maximizer-satisficer scale developed by Schwartz et al. (2002) for their study. They asked the participants (students at Oklahoma State University) to choose one Jone's soda from a choice set. The size of the choice set ranged from 6 to 24 and it varied across individuals. They found that maximizers preferred less choice, and satisficers preferred more choice.

Iyengar, Wells, and Schwartz (2006), using the maximizer-satisficer scale developed by Schwartz et al. (2002) studied the impact of individuals' personality on their job-search process. They found that although maximizers found better jobs than satisficers they were less satisfied and experienced more negative effects than satisficers throughout their job search. According to the authors, maximizers were less satisfied and experienced more negative effects than satisficers because of their tendency to look for the best job. Although this tendency helped them to find better jobs than satisficers, because of the search cost and an almost limitless number of opportunities they felt regret as they thought that there were better jobs out there than the ones they actually chose (Iyengar, Wells, and Schwartz 2006) .

The excessive-choice effect may be more prevalent in maximizers than in satisficers because of the different strategies they use to choose an option from a choice set. As satisficers stop their search once they find an option that meets the standards they have in mind, added varieties would not be a problem for them. On the other hand, as maximizers try to choose the best option, added varieties would require them to put extra effort to achieve their objectives. To avoid the cognitive burden and regret maximizers may avoid making a purchasing decision resulting in an excessive-choice effect.

In summary, there are three important points from the aforementioned research that motivate the objectives of this research. First, valuation research in agricultural economics indicates that consumers are willing to pay for beef attributes such as traceability and beef processing practices. Providing different beef attributes increases the variety of beef products. Second, marketing studies suggest that increasing product variety alone is not guaranteed to increase beef demand because of the excessive-choice effect. Third, the impact of the excessive-choice effect will likely differ across individuals according to where they lie on the satisficer-maximizer scale.

Conceptual Framework

The subsequent section describes a choice experiment administered to two different samples of consumers. A random utility model is estimated from these experiments. The choice experiments allow consumers to choose among several ground beef products that are differentiated by attributes like "traceability," "certified natural," "certified humane," "fat content,"and "price per pound" at different levels. A no-choice option is also included among the different options.

This approach is based on the assumption that utility for ground beef can be split in to separate utilities for its attributes (Lancaster 1966). It is also based on random utility theory, which assumes that a consumer would choose an option that would maximize his or her utility (McFadden 1974). The utility function of a consumer can be expressed as (Loureiro and Umberger 2003):

(1) $$U = U(\mathbf{X}, m, q)$$

where **X** represents ground beef attributes, m represents income, and q represents quality of ground beef.

The utility derived by consumer i by choosing the ground beef option j can be written as:

(2) $$U_{ij}=V_{ij}+e_{ij}$$

where V_{ij} is the systematic or measurable utility determined by the attributes of ground beef, and e_{ij} is an error term. All options refer to one pound of ground beef. It is assumed that

(3) $$E(e_{ij})=0$$

The utility derived by a consumer from consuming the ground beef of quality q_0 can be expressed as:

(4) $$U_0 = U(\mathbf{X}, m, q_0)$$

The utility derived by consuming the ground beef of improved quality q_1 can be expressed as (Hanemann 1991):

(5) $$U_1 = U(\mathbf{X}, m, q_1)$$

The maximum willingness to pay for a ground beef attribute is the premium set on ground beef with that attribute that makes one indifferent between this product and an otherwise identical product. In other words, it is the amount that makes consumers' indifferent if subtracted from their income to improve the quality of a ground beef product from q_0 to q_1. This can be expressed as:

(6) $$U(\mathbf{X}, m\text{-WTP}, q_1) = U(\mathbf{X}, m, q_0)$$

If the linear approximation is taken around the indifference point, then equation (6) becomes (Lusk and Norwood 2007a):

(7) $$\text{WTP} = [(\partial U/\partial q)(q_1 - q_0)]/(\partial U/\partial m)$$

Equation (7) leads to the expression for willingness to pay for an attribute of ground beef which is the ratio of the marginal utility of that attribute to the marginal utility of money. It can be written as:

$$WTP_{attribute} = MU_{attribute}/MU_{money} \quad (8)$$

where $WTP_{attribute}$ is the willingness to pay for a ground beef attribute of interest, $MU_{attribute}$ is the marginal utility of the ground beef attribute, and MU_{money} is the marginal utility of money.

Equation (2) can be specified as:

$$U_{ij} = f\,(\,TU.S,\ TPr,\ N,\ H,\ FL,\ FM,\ FH,\ P) + e_{ij} \quad (9)$$

where *TU.S* represents traceability certified by the U.S. Government, *TPr* represents traceability certified by a private company, *N* represents certified natural, *H* represents certified humane, *FL, FM, and FH* represents 10, 20, and 30 percent fat content respectively, *P* represents price per pound of ground beef. It can be hypothesized that attributes like certified traceability by U.S. Government or a private company, certified humane, and certified natural would have a positive effect on consumers' utility. The impact of a higher fat content is hypothesized to depend on the current fat content. A higher price, of course, should have a negative effect on consumers' utility.

The willingness to pay for a beef product *j* by the average consumer *i* can be expressed as:

$$WTP_j = V_{ij} + e_{ij} \quad (10)$$

The willingness to pay for a beef product *j* in dollar value is the ratio of the utility derived from the beef product to the marginal utility of money. It can also be written as:

$$WTP_j = U_{ij}/\,MU_{money} \quad (11)$$

Traditional theory assumes that more choices are better and a rational consumer would choose an option that would maximize his or her utility. However, some studies in psychology and marketing suggest that more choices are always not good. The previous section described several reasons why increased choice could actually decrease demand. The proliferation of choices could weaken consumers' preferences affecting the value of a product. If the number of alternatives does affect consumers' utility, then equation (2) can be written as:

(12) $$U_{ij} = V_{ij} + f\,(NCH) + e_{ij}$$

where *f(NCH)* is a function of the variable *NCH*, that represents the number of choices in a choice set. This leads to the second hypothesis that the utility of an average consumer is positively affected by *NCH* at some values of *NCH*, and negatively affected at other values of *NCH*. At some point, it is hypothesized that *NCH* maximizes the value of a good as measured by equation (11).

According to prior research, the personality of an individual also plays an important role in his or her utility maximizing behavior. It suggests that an unlimited number of choices might affect people who always strive to choose the best choice among all the available options, called maximizers, more than those who settle for the choice that matches the criteria they expect, called satisficers (Schwartz et al. 2002). To incorporate personality variables in the utility function, equation (12) can be written as:

(13) $$U_{ij} = V_{ij} + f\,(NCH, MS) + e_{ij}$$

where *MS* is a variable that represents the maximizer-satisficer score of consumer *i*. This leads to the third hypothesis that the proliferation of choices would have different impacts on maximizers and satisficers and it is expected that there would be an inverse relationship between the maximizer-satisficer scores and consumers' utility. Lusk and Norwood (2007b) find that increased choice benefits satisficers but maximizers, at least over a certain range of choice. This study will test whether this result holds true using a different sample of individuals, a different product, in a hypothetical choice experiment setting.

Survey Instrument and Data

To measure consumer preference for ground beef a self-administered paper and pencil survey is used. The survey instrument is an eight-page booklet printed back to back, and has three sections. The first section has four sets of choice questions, the second section has questions on socio-demographic characteristics and ground beef purchasing behavior of consumers, and the third section has maximizer-satisficer scale developed by Schwartz et al (2002).

As one of the objectives of this study is to estimate consumers' willingness to pay for ground beef attributes like "Traceability Certified by the U.S. Government or a Private Company," "Certified Humane," "Certified Natural," and "Fat Content," the choice sets are developed using these attributes and the attribute "Price per Pound" at different levels.

The attribute "Traceability Certified," which indicates if the beef can be traced back to the farm, enters the choice sets with three levels as certification is done either by the U.S. Government or a Private Company or by None. The attribute "Certified Humane," which indicates if the cattle were raised and slaughtered under humane processes, enters the choice sets with two levels as either Yes or No. The attribute "Certified Natural," which indicates if the cattle were produced without any antibiotics or growth hormones, fed a strictly vegetarian diet, and undergoes minimum processing. This attribute enters the choice sets with two levels as either Yes or No.

The attribute "Fat Content," which indicates the level of fat content in ground beef, enters the choice sets with three levels as ether 10%, or 20%, or 30%. The attribute "Price per pound" enters the choice sets with eight levels as either \$2.00, or \$2.50, or \$3.00, or \$3.50, or \$4.00, or \$4.50, or \$5.00, or \$5.50, or \$6.00. The attributes are chosen based on the past literature and the information found on labels of ground beef products available in the local grocery stores. Respondents were given an information sheet describing the meaning of these attributes. That information sheet is provided in Appendix II-A.

An orthogonal fractional factorial design with main-effects only is used to create twenty four ground beef options (Louviere, Hensher, and Swait 2000). These twenty four options are used to create four choice sets with different number of options ranging from four to twenty four. Also, four different combinations of choice sets are designed by shuffling the order of the choice sets based on the number of options. The choice sets are designed with different number of options to determine if the increase in number of choices has any impact on consumers' utility. The options are randomly assigned to the choice sets, and 36 different versions of surveys are developed based on the order in which the options enter the choice sets. A no-choice option is also included in all the choice sets. The responders are asked to choose one option from each of the four choice sets. To help the responders to understand the choice experiment, instructions are provided along with an example of how to answer a choice based question. A sample of the choice experiment can be found in Appendix II-B.

The maximizer-satisficer scale taken directly from Schwartz et al. (2002) has thirteen questions, which are developed to determine whether an individual is a maximizer or a satisficer. These questions ask the respondents to choose on a scale of 1 to 7, the extent to which the statements match their personality. This psychometric scale is provided in Appendix II-C.

A cover letter explaining that the survey is conducted to elicit consumers' preferences for ground beef is attached to the survey booklet. It also explains that the project is conducted by professors in the Department of Agricultural Economics at Oklahoma State University. To increase the response rate, three $50 cash prizes are awarded to those who win the drawing.

After the survey instrument was designed, pre-testing was done by administering the surveys to faculty, and graduate students in the Department of Agricultural Economics at Oklahoma State University, and people who worked in the beef industry. Some of the changes suggested by them were incorporated in the final survey.

The data were collected using a mail survey. A sample of 4,000 U.S. household addresses was purchased from Survey Sampling Inc. These addresses were collected from white-page directories and supplemented with other information sources. Based on the way in which the different choice sets were ordered, four different versions of the survey, 1,000 of each type, were generated. The generated surveys along with the attributes information sheet, cover letter, and a self addressed envelope were mailed in March 2007.

This sample is representative of the U.S. population in that each household in the U.S. has roughly the same probability of receiving a survey. However, individuals with certain personality characteristics are more likely to complete and return the survey than others. For example, individuals truly concerned about food safety and animal welfare are more likely to return a completed survey, simply because they are interested in the topic. There may also be a difference in the rate at which satisficers and maximizers return the surveys. The point is that there is a non-response bias in that certain personality characteristics will be correlated with the rate at which surveys are returned. It is expected that this non-response bias will bias the value of ground beef attributes upward.

A second sample of individuals was taken which is not subject to non-response bias, but is subject to a geographic bias. Mathis Brothers' Furniture is a large retail furniture store in Oklahoma City, Oklahoma. The store employs over 175 diverse salespeople. All salespeople are required to attend business meetings each Saturday. In May of 2007, each salesperson was offered $10 to complete the aforementioned survey. Each salesperson present did indeed complete the survey, resulting in no non-response bias. The number of responses received was 173. Of course, since all respondents work in Oklahoma City, Oklahoma, there is a geographic bias.

All surveys are subject to some sort of bias. This study sought to pursue two different subject recruiting procedures to ensure the entire sample is not dominated by one particular bias. Throughout the study the data are pooled and used to estimate one consumer profile. Pooling is not undertaken because we believe preferences to be the same in both samples. Pooling is undertaken because we are more interested in obtaining descriptive statistics for the entire sample, and are less interested in how the two samples differ.

Empirical Methodology

This section uses data from the choice experiments and the conceptual model from the previous section to obtain empirical estimates that achieve all three aforementioned objectives. The utility person *i* receives from consuming a product *j* is assumed to be the sum of a deterministic component, which is a function of the choice experiment data, and an error term. The error term in equation (2) is assumed to be independently and identically distributed according to the extreme-value distribution. The extreme value Type I distribution can be defined as (Louviere, Hensher, and Swait 2000):

$$F(e_{ij}) = \exp(-\exp(- e_{ij})) \quad (14)$$

If there are *J* possible options in a choice set *B* then the consumer *i* would choose option *j* over all the other options if and only if

$$U_{ij}>U_{ik}\ ;\ k=1,2,\ldots,J \text{ for all } j\neq k \quad (15)$$

The probability that the consumer *i* chooses option *j* from the choice set *B* is given by

$$\text{Prob}_{ij}= \text{Prob}(U_{ij}>U_{ik};\ k=1,2\ldots,J \text{ for all } j\neq k\ ) \quad (16)$$

Equation (16) results in

$$\text{Prob}(e_{ij}-e_{ik}> V_{ik}- V_{ij}\ ;\ k=1,2,\ldots,J \text{ for all } j\neq k\,) \quad (17)$$

where $V_{ij}=\mathbf{X_{ij}\beta}$; $\mathbf{X_{ij}}$ is a vector of independent variables representing the attributes of ground beef, and sometimes demographic or personality variables, and $\boldsymbol{\beta}$ is a vector of parameters. As the residuals are assumed to be identically and independently distributed and follow Type I extreme value distribution, a conditional logit model can be used to represent i^{th} consumer probability of choosing the j^{th} ground beef option (McFadden):

$$\text{Prob}_{ij}= \exp(\mathbf{X_{ij}\beta})/ \textstyle\sum_j \exp(\mathbf{X_{ij}\beta}) \ \text{ for } j=1,\ldots,J \quad (18)$$

The log- likelihood function of the conditional logit model is given as:

(19) $$L = \sum_i \sum_j W_i y_{ij} \ln [\exp(\mathbf{X_{ij}\beta}) / \Sigma_j \exp(\mathbf{X_{ij}\beta})]$$

where y_{ij} is equal to 1 if the option j is chosen, otherwise it is equal to 0. The variable W_i is a weighting variable discussed shortly. The models will be estimated using a weighting procedure. The choice experiment is designed to predict the decisions consumers would make in a grocery store. Some individuals may do a majority of the grocery shopping for the household while others may not. Thus, the responses of some individuals give a better indication of grocery store purchases than others. Responses from individuals who shop more frequently for ground beef should be given greater weight, so that utility function estimates will resemble actual shopping patterns.

A weighting procedure is used that weights the likelihood function for some individuals more than others. Notice the variable W_i in (19) can be given different values across the respondents so that their choices have a larger impact on the log-likelihood function value. Values of W_i are assigned as follows. A survey question asked how frequently the respondent purchases fresh ground beef, with the options being about once a week, about once a month, rarely, and never. The respondents who purchase fresh ground beef once a week will be given a weight of $W_i = 4$, those who purchase once a month will be given a weight of $W_i = 1$, those who purchase rarely will be given a weight of $W_i = 0.2$, and those who never purchase will be given a weight of $W_i = 0$. The weighting decisions $W_i = 4$ and 1 are based off the assumption that those who purchase once a week purchase roughly four times more fresh ground beef than those who say they purchase about once a month. The weight $W_i = 0.2$ was based off intuition.

The empirical model underlying the conditional logit model to estimate equation (2) is specified as:

(20) $$U_{ij} = \boldsymbol{\beta}\, \mathbf{X_{ij}} + e_{ij}$$

$$= \beta_1 TUS_{ij} + \beta_2 TPr_{ij} + \beta_3 N_{ij} + \beta_4 H_{ij} + \beta_5 FL_{ij} + \beta_6 FM_{ij} + \beta_7 FH_{ij}$$

$$+ \beta_8 P_{ij} + e_{ij}$$

where U_{ij} is the latent unobserved utility of consumer i from choosing the ground beef choice j. The term TUS_{ij} is a dummy variable representing the attribute "Certified Traceability." It is equal to 1 if the traceability is certified by the U.S. Government, otherwise it is equal to 0. The term TPr_{ij} is a dummy variable also representing the same attribute. It is equal to 1 if the traceability is certified by the private company, otherwise it is equal to 0. The term N_{ij} is a dummy variable representing the attribute "Certified Natural." It is equal to 1 if it is "Yes," and 0 if it is "No." The term H_{ij} is a dummy variable representing the attribute "Certified Humane." It is equal to 1 if it is "Yes," and 0 if it is "No." The term FL_{ij} is a dummy variable representing the attribute "Fat Content." It is equal to 1 if the fat content is 10%, otherwise it is equal to 0. The term FM_{ij} is the second dummy variable representing "Fat Content." It is equal to 1 if the fat content is 20%, otherwise it is equal to 0. The term FH_{ij} is the third dummy variable representing "Fat Content." It is equal to 1 if the fat content is 30%, otherwise it is equal to 0. The term P_{ij} is a variable representing the attribute "Price per Pound." The βs are the parameters that need to be estimated. Notice that the intercept is dropped from equation (20) because all possible dummy variables for the attribute "Fat Content" is used.

In a conditional logit model the parameters cannot be interpreted directly other than the signs and statistical significance (Burton et al. 2001). However the mean willingness to pay estimates (WTP) of all the attributes can be estimated by calculating the ratios of the parameters of the attributes over the parameter of price (Burton et al. 2001):

(21) $$\text{WTP}= (\beta_{attribute}/(-\beta_8))$$

where $\beta_{attribute}$ is the parameter of an attribute of interest.

The confidence intervals of the mean WTP estimates can be computed using Monte Carlo integration. This is done by generating 10,000 values of the parameter estimates from the joint normal distribution using the variance-covariance matrix of the parameters of the estimated model. Then, 10,000 WTP values are calculated and the calculated WTP values are ranked from the highest to the lowest. To compute the 95 percent confidence interval, the values at the 2.5th percentile and the 97.5th percentile are chosen.

This empirical model can be expanded to determine how the utility of a choice varies with the number of varieties the consumer has to choose from. The empirical model to estimate equation (12) can be written as:

(22) $$U_{ij}= \beta_1 TUS_{ij}+ \beta_2 TPr_{ij} + \beta_3 N_{ij} + \beta_4 H_{ij} + \beta_5 FM_{ij}+ \beta_6 FH_{ij}+ \beta_7 P_{ij} +\gamma_1 NCH5_i + \gamma_2 NCH10_i+ \gamma_3 NCH20_i+ \gamma_4 NCH25_i+ e_{ij}$$

The terms $NCH5_i$, $NCH10_i$, $NCH20_i$, and $NCH25_i$ are dummy variables that represent the number of choices in a choice set faced by consumer i. They are equal to 1 if the choice sets have five, ten, twenty, and twenty five options respectively, otherwise they are equal to 0. The βs, and γs are the parameters that need to be estimated. The dummy variable representing 10% fat content is dropped from equation (22) because all possible dummy variables for the number of choices is used.

The marginal effects due to the increases in the number of choices can be determined using the following set of equations:

$$(\partial U_{ij}/\partial NCH10_i)- (\partial U_{ij}/\partial NCH5_i) = \gamma_2- \gamma_1,$$

(23) $$(\partial U_{ij}/\partial NCH20_i)- (\partial U_{ij}/\partial NCH10_i) = \gamma_3- \gamma_2, \text{ and}$$

$$(\partial U_{ij}/\partial NCH25_i) - (\partial U_{ij}/\partial NCH20_i) = \gamma_3 - \gamma_2 .$$

The confidence intervals of the marginal effects can be calculated using Monte Carlo integration as described previously. If the marginal effect is found to be positive, then an increase in the number of choices has a positive impact on consumers' utility. If it is found to be zero, then an increase in the number of choices has no impact on consumers' utility. Finally, if the marginal effect is found to be negative, then an increase in number of choices has a negative impact on consumers' utility.

Recall that in each choice set there is an opt-out option "none." Individuals check this option if they would not purchase any of the ground beef products. The utility of the none option is set to equal zero, which normalizes the utility function.

A previous section discussed research into personality differences among individuals. When faced with a large choice set, not all people use the same decision-making process. One way to articulate these differences is in the satisficer-maximizer personality scale. Let MAX_i be the score from the satisficer-maximizer psychometric scale discussed previously, where a higher value indicates the individual takes on maximizer personality traits as opposed to satisficer personality traits. The empirical model to estimate equation (13) can be written as:

$$(24) \qquad U_{ij} = \beta_1 TU.S_{ij} + \beta_2 TPr_{ij} + \beta_3 N_{ij} + \beta_4 H_{ij} + \beta_5 FM_{ij} + \beta_6 FH_{ij} + \beta_7 P_{ij} + \gamma_1 NCH5_i + \gamma_2 NCH10_i + \gamma_3 NCH20_i + \gamma_4 NCH25_i + \alpha_1 MAX_i{*}\, NCH + \alpha_2 MAX_i{*}\, NCH10_i + \alpha_3 MAX_i{*}\, NCH20_i + \alpha_4 MAX_i{*}\, NCH25_i + e_{ij}$$

The terms $MAX_i{*}NCH5_i$, $MAX_i{*}NCH10_i$, $MAX_i{*}NCH20_i$, and $MAX_i{*}NCH25_i$ are the variables that represent the interactions between the variable that represents the maximizer-satisficer scores and the variables that represent the number of choices in a choice set. The αs, βs, and γs are the parameters that need to estimated.

The effect of personality (satisficer or maximizer) on the impact of an increase in the number of choices can be determined using the following set of equations:

$$(25)\quad \begin{aligned} &(\partial U_{ij}/\partial NCH10_i) - (\partial U_{ij}/\partial NCH5_i) = (\gamma_2 + \alpha_2 * MAX_i) - (\gamma_1 + \alpha_1 * MAX_i), \\ &(\partial U_{ij}/\partial NCH20_i) - (\partial U_{ij}/\partial NCH10_i) = (\gamma_3 + \alpha_3 * MAX_i) - (\gamma_2 + \alpha_2 * MAX_i), \text{ and} \\ &(\partial U_{ij}/\partial NCH25_i) - (\partial U_{ij}/\partial NCH20_i) = (\gamma_4 + \alpha_4 * MAX_i) - (\gamma_3 + \alpha_3 * MAX_i). \end{aligned}$$

Using the above equations, marginal effects due to the increases in number of choices for both satisficers and maximizers can be calculated by substituting the appropriate values for MAX_i . The value of 28 will be used for satisficers as it is the lowest maximizer-satisficer score, and a value of 82 will be used for satisficers as it is the highest score in the sample. After calculating marginal effects, confidence intervals will be computed using Monte Carlo integration.

If the marginal effect is positive, then the personality of an individual (satisficer or maximizer) has a positive effect on the impact of number of choices on his/her utility. On the other hand, if it is negative, then the personality of an individual has a negative effect. If the marginal effect is zero, then the personality of an individual does not have any effect on the impact of number of choices.

Results

Profile of Survey Respondents

Out of the 4,000 surveys mailed, 222 responses were received (about 5% response rate), and 2 were returned undelivered because of the incorrect addresses. Out of the responses that were received, 209 were found to be usable. A survey was determined to be usable if the respondent was 18 years or over, had answered all the choice questions, and had chosen a single alternative from a choice set. The low response rate could be because of the presence of large choice sets in the surveys. The median age of the respondents was 57 years, and the average household income was from $60,000 to $79,000.The respondents were predominantly white (90 %). About 44 percent of the respondents were females. The median age of the respondents was higher than that of the U.S. population and the percentage of minorities was less than that of the U.S. population. The summary statistics of this sample, called as mail sample, is presented in Table II-1.

Out of these 173 responses received from Mathis Brothers, 140 were found to be usable. The median age of the respondents in this sample was 37 years, and the average house hold income was $40,000 to $59,000. About 74 percent of the respondents were white and about 27 percent of the respondents were females. The summary statistics of this sample, called as captive sample, is presented in Table II-2.

Mailed sample and captive sample are combined and the summary statistics of the pooled sample is presented in Table II-3, and the comparison of the pooled sample with U.S. population is presented in Table II-4. The pooled sample has more people with a bachelor's degree or higher, and has fewer women compared to the U.S. population. It also has fewer households with children below the age of 18 compared to the U.S. population. The sample is comparable to U.S. population in terms of income. It is also loosely comparable to U.S. population in terms of race, and age. About 51 percent of the people in the pooled sample purchase fresh ground beef once a week, and about 33 percent purchase fresh ground beef once a month. About 58 percent eat food products containing fresh ground beef frequently, and about 34 percent eat fresh ground beef products periodically. We do not claim that this sample perfectly represents the U.S. population, but we do believe that it is a good sample with individuals who are diverse.

Exploratory Analysis of Maximizer-Satisficer Scale

A factor analysis using principal factor method and varimax rotation was used to determine the underlying structure of the maximizer -satisficer scale. The number of underlying factors was determined to be four. The results are presented in Table II-5.

The items that represent the difficulty in choosing an option such as difficulty in renting videos, difficulty in finding a gift for a friend, difficulty in finding clothes while shopping, and difficulty in finding the right words while writing loaded on factor one. Items such as having the highest standard for oneself, not settling for the second best, and trying to imagine all the possible alternatives even ones that are not present loaded on to factor two.

The items such as treating relationships like clothing, liking lists that rank lists, always looking out for better options, and fantasizing about living in different ways loaded on to the third factor. The items such as channel surfing while watching T.V, and checking other stations while listening to radio loaded on to the fourth factor. The Cronbach's alpha for the maximizer-satisficer scale is 0.63. The structures of factors one two are same as the results of factor analysis obtained by Schwartz et al. (2002) in their paper. However the items that loaded on to factors three and four in our study loaded on to the same factor component in their study. Also, they obtained a value of 0.71 for Cronbach's alpha.

Consumers' Preferences for Ground Beef Attributes

The estimated results of Equation (20) are given in Table II-6. All the coefficients have expected signs. The null hypothesis that all the coefficients are equal to zero is rejected by likelihood ratio test at the 1 per cent significance level. The coefficients of all the variables except for *Fat 30%* are significant at 1 percent, and the coefficient of *Fat 30%* is significant at 5 percent.

The null hypothesis that the coefficients of the variables *Traceability by U.S. Government* and *Traceability by Private Company* are equal is rejected by likelihood ratio test at the 1 percent significance level. This implies that the impacts of the variables representing traceability certified by the U.S. Government and Private Company on consumers' utility are significantly different. The null hypothesis that the coefficients of the variables *Certified Humane* and *Certified Natural* are equal is rejected by likelihood ratio test at the 1 percent significance level. This implies that the impacts of these two variables on consumers' preferences are different. The null hypothesis that the coefficients of the variables *Fat 10%* and *Fat 20%* are equal is rejected by likelihood ratio test at the 1 percent significance level. This implies that the increase in fat content from 10 to 20 percent affects consumers' utility. The null hypothesis that the coefficients of the variables *Fat 20%* and *Fat 30%* are equal is rejected by likelihood ratio test at the 1 percent significance level. This implies that the increase in fat content from 20 to 30 percent has a significant impact on the consumers' utility.

The variable *Traceability Certified by U.S. Government* has the highest impact on utility. Among the variables that have positive impacts on utility, *Certified Humane* has the lowest impact. The results show that as the percentage of fat content increases, the utility decreases. The variable *price* also has a negative impact on utility.

Willingness to Pay

The mean willingness to pay estimates (WTP) for all the attributes are calculated using the formula given in Equation (21). The confidence intervals of the WTP estimates are calculated using Monte Carlo integration. The WTP estimates and the confidence intervals for all the attributes are given in Table II-7.

All the WTP estimates are different from zero at the 5 percent significance level. The results show that consumers are willing to pay a premium of $3.13 per pound for traceability certified by the U.S. Government, which is the highest premium among the premiums for all the attributes. The consumers are willing to pay a premium of $2.20 per pound for traceability certified by a private company. The estimated premiums for the traceability certified by the U.S. Government or a private company are higher than the values of WTP estimates for traceability estimated in the previous studies by Dickson and Bailey (2002) and Loureiro and Umberger (2007). However, in our study traceability entered the choice set with three levels as either it is certified by the U.S. Government or a Private company or by None, which is different from the previous studies.

The meat products considered in the previous studies were also different. Dickson and Bailey (2002) considered roast beef sandwich, and pork, and Loureiro and Umberger (2007) considered rib eye steak. While Dickson and Bailey (2002) used an experimental auction, Loureiro and Umberger (2007) used a survey for their study. Although the methodology used by Loureiro and Umberger (2007) is comparable to this study, their study included a different set of attributes. Their study had a separate attribute representing food safety, which commanded the highest premium. As we did not include a separate attribute representing food safety in our study, survey responders might have associated the attribute representing traceability with food safety. That could be the reason for the highest premium for traceability certified by the U.S. Government. The studies by Dickson and Bailey (2002), Hobbs et al. (2005), and Steiner and Young (2007) also show that consumers value food safety as the most important attribute.

The consumers are willing to pay $2.15 per pound to be indifferent between the ground beef that carried a label "Certified Natural" and the one without that label. The estimated premium for the attribute "Certified natural" is less than the mean WTP value ($3.33) for beef steak from cattle raised without growth hormones, and is similar to the mean WTP premium ($2.42) for beef raised without any genetically modified organisms estimated by Steiner and Young (2007). However, other than using a different product (steak), they also used a pooled sample of consumers from Alberta in Canada, and Montana in U.S for their study. It is also less than the WTP premium ($8.12) for beef steak from cattle not administered with growth hormones, and less than the WTP premium($3.21) for beef steak from cattle not fed genetically modified corn estimated by Lusk, Roosen, and Fox (2003). Even though the methodology used by them is comparable to this study, the set of attributes used in their study was different. Their study did not include attributes representing traceability or food safety, and the consumers could have associated the attributes representing beef from cattle not administered growth hormones and not fed genetically modified corn with food safety.

The premium for humane treatment of animals is $0.56 per pound, which is the lowest among all the positive premiums. The premium for humane treatment is similar to that of the value obtained by Dickson and Bailey (2002) in their study, which is $0.50 for roast beef sandwich, and $ 0.53 for pork.

As the fat content increases from 10 percent to 20 percent, WTP decreases by $1.17 per pound, and as it increases from 20 percent to 30 percent, WTP decreases by $1.22 per pound. This shows that consumers are concerned about the negative effects of fat on their health, and they are willing to pay more for ground beef products with less fat.

Impact of Number of Choices on Consumers' Utility

The estimated results of Equation (22) are presented in Table II-8. The null hypothesis that all the coefficients are equal to zero is rejected by likelihood ratio test at the one percent significance level. The coefficients of all the variables are statistically significant at the one percent significance level. It can be seen from the results that the inclusion of dummy variables representing number of choices in a choice set did not affect the values of coefficients of choice attributes significantly. The values are almost identical to the ones from the previous model [Equation (20)]. The significance of the coefficients of the dummy variables representing the number of choices in a choice set shows that existence of excessive choice effect for an average consumer. The marginal effects due to the increases in the number of choices are calculated by substituting the estimated parameters in Equation (23).

The confidence intervals at 90 percent and 95 percent are computed using Monte Carlo integration. The calculated marginal effects and confidence intervals are presented in Table II-9. A graph, as shown in Figure II-1, is plotted to show the impact of an increase in the number of choices on the marginal effect. The marginal effect for an increase in the number of choices from 5 to 10 is not different from zero at the 10 percent significance level. This implies that the increase in number of choices from 5 to 10 does not have any impact on an average consumer's utility. The marginal effect for an increase in the number of choices from 10 to 20 is also not statistically different from zero at the 10 percent significance level. This implies that the increase in number of choices from 10 to 20 does not have any significant impact on the purchasing decision of an average consumer. But, the marginal effect for an increase in the number of choices from 20 to 25 is negative and statistically significant at the 10 percent significance level. This implies that the increase in number of choices from 20 to 25 has a negative impact on the preferences of an average consumer. As the negative excessive choice effect occurs when the number of choices is increased beyond 20, it can be interpreted that the optimum number of choices in a choice set for an average consumer is roughly 20. This implies that if the number of choices is increased beyond 20, then the probability of choosing a ground beef item decreases for an average consumer.

The excessive-choice effect is detected, indicating it exists in hypothetical choices as well as real choices. A comparable study by Malhotra (1982) suggests that consumers experience information overload when the number of alternatives is increased from 5 to 10 or more, and the number of attributes is increased from 10 to 15 or more. He used hypothetical profiles of houses to construct his choice sets. As purchasing a house is obviously more complex than purchasing a ground beef item, respondents would have been overwhelmed when the number of alternatives was increased beyond just 5. The results prove the existence of excessive choice effect and the hypothesis that the proliferation of choices has a negative impact on the preferences of an average consumer.

Impact of an Individual's Personality in Dealing with Large Choice Sets

The estimated results of Equation (24) are presented in Table II-10. The null hypothesis that all the coefficients are equal to zero is rejected by the likelihood ratio test at a significance level of one percent. The values of the coefficients of choice attributes are similar to that of the previous two models [Equations (20) and (22)]. The significance of the variables *MAX*NCH5*, *MAX*NCH10,* and *MAX*NCH25* at the significance level of 10 percent shows that the personality of an individual does affect the impact of number of choices on his/her utility. The marginal effects for satisficers and maximizers are calculated using Equation (25). The confidence intervals at 90 percent and 95 percent are computed using Monte Carlo integration. The calculated marginal effects and confidence intervals are presented in Table II-11. A graph, as shown in Figure II-2 is plotted to show the impact of an increase in number of choices on satisficers and maximizers.

For both satisficers and maximizers, the marginal effects as the number of choices increases from 5 to 10 are not significant at the 10 percent significance level. This implies that as the number of choices increases from 5 to 10, the personality of an individual (satisficer or maximizer) does not affect the impact of number of choices. This could be because both satisficers and maximizers perceive no real difference between a choice set with 5 options and a choice set with 10 options. However, as the number of choices increases from 10 to 20, the marginal effect is positive and significant at the 10 percent significance level for satisficers, and it is negative and significant at the 5 percent significance level for maxmizers. This implies that the increase in number of choices from 10 to 20 affects satisficers positively and maximizers negatively. Finally, as the number of choices increases from 20 to 25, the marginal effects are not significant at the

10 percent significance level for both maximizers and satisficers.This implies that the increase in number of choices from 20 to 25 has no impact on the preferences of both satisficers and maximizers. This could be because both maximizers and satisficers do not consider the increase to be significant and they approach a choice set with 25 options in the same way as they do to a choice set with 20 options.

Lusk and Norwood (2007b) have found similar results in their study. They found that if the number of choices is increased from 6 to 24 excessive choice effect is positive for satisficers with score below 40, and negative for maximizers with score above 75. If the scores are between 40 and 75, then according to them the choice effect is not significantly different from zero. The results show that the personality of an individual does affect the impact of number of choices on his/her utility, when the number of choices in a choice set is increase from 10 to 20. This increase has a positive impact on the preferences of people who look for a good enough option (satisficers) and a negative impact on the people who look for the best option (maximizers).

Summary and Implications

In addition to fat content, meat attributes such as traceability, humane production processes, and natural beef have received increased attention. This study, using a choice experiment, estimated consumers' willingness to pay for ground beef attributes such as traceability certified by the U.S. Government or a private company, natural beef, humane production technique, and fat content. The results indicate that consumers trust the U.S. Government more than a private company when it comes to food safety as they are willing to pay more for traceability certified by the U.S. Government than a private company. The results also show that consumers are less concerned about animal welfare than traceability and natural beef as they are willing to pay less for humane production technique than traceability certified by the U.S. Government or a Private Company, and natural beef. The results also show that willingness to pay decreases as the fat content increases.

This study also determined the impact of an increase in number of ground beef varieties on consumers' utility. The results show the existence of negative excessive-choice effect in the ground beef purchasing behavior. The results indicate that an increase in number of choices beyond 20 affects an average consumer's preferences for ground beef in a negative way. This implies that the optimum number of choices in a choice set is roughly 20 for an average consumer.

Moreover, this study determined the effect of an individual's personality on the impact of proliferation of ground beef varieties on his/her preferences. The results show that if the number of choices is increased from 10 to 20, it has a positive impact on consumers who look for a "good enough" option (satisficers), and a negative impact on those who look for the best option (maximizers).

As consumers are willing to pay for attributes such as traceability certified by the U.S. Government or a private company, natural beef, and humane production technique, traditional economic models would suggest that producers could increase their profits by introducing new ground beef varieties with these attributes. However, this study suggests that the optimum number of varieties from an average consumer's perspective is finite. The results show that if the number of varieties offered is more than optimum, then it would affect the profits in a negative way by reducing the probability of purchase.

The negative excessive-choice effect can be avoided if the retailers place optimum number of ground beef varieties for sale as suggested by Norwood (2006). The retailers would want to choose the optimum number of varieties that are most preferred by consumers and place them for sale.

As the results show that increasing the number of varieties has different impacts on satisficers and maximizers, choosing the optimum number of varieties is complicated. If the number of varieties is decreased to reduce the impact of negative excessive-choice effect because of maximizers, this would affect satisficers who actually benefit from the increase in number of varieties. Therefore, future research in this area can try to come up with marketing strategies that would help maximizers to deal with large choice sets.

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Table II-1. **Summary Statistics of Mail Sample**

Variable Name	Description	Mean
Gender	1 if female; 0 if male	0.435
Age	in years	56.950
Degree	1=bachelors degree or higher;0=otherwise	0.492
Income	0=less than $20,000 1=$20,000 to $39,000 2=$40,000 to $59,000 3=$60,000 to $79,000 4=$80,000 to $99,000 5=$100,000 to $119,000 6=$120,000 to $150,000 7=$150,000 to $179,000 8=greater than $180,000	3.095
Under18	1 if a household has children below 18; 0 otherwise	0.230
Race	1 if white; 0 otherwise	0.902
Purchase1	1=purchase fresh ground beef once a week; 0=otherwise	0.449
Purchase2	1=purchase once a month; 0=otherwise	0.354
Purchase3	1=purchase rarely; 0=otherwise	0.129
Purchase4	1=Never; 0= otherwise	0.062
Eat1	1=eat food containing ground beef frequently;0=otherwise	0.483
Eat2	1=eat periodically; 0=otherwise	0.411
Eat3	1=eat rarely; 0=otherwise	0.081
Eat4	1=Never eat ground beef; 0=otherwise	0.023

Note: Number of Responses=209

Table II-2. **Summary Statistics of Captive Sample**

Variable Name	Description	Mean
Gender	1 if female; 0 if male	0.278
Age	in years	39.461
Degree	1=bachelors degree or higher;0=otherwise	0.294
Income	0=less than $20,000 1=$20,000 to $39,000 2=$40,000 to $59,000 3=$60,000 to $79,000 4=$80,000 to $99,000 5=$100,000 to $119,000 6=$120,000 to $150,000 7=$150,000 to $179,000 8=greater than $180,000	2.791
Under18	1 if a household has children below 18; 0 otherwise	0.307
Race	1 if white; 0 otherwise	0.742
Purchase1	1=purchase fresh ground beef once a week; 0=otherwise	0.592
Purchase2	1=purchase once a month; 0=otherwise	0.285
Purchase3	1=purchase rarely; 0=otherwise	0.107
Purchase4	1=Never; 0= otherwise	0.014
Eat1	1=eat food containing ground beef frequently;0=otherwise	0.721
Eat2	1=eat periodically; 0=otherwise	0.221
Eat3	1=eat rarely; 0=otherwise	0.057
Eat4	1=Never eat ground beef; 0=otherwise	0.000

Note: Number of Responses=140

Table II-3. **Summary Statistics of Pooled Sample**

Variable Name	Description	Mean
Gender	1 if female; 0 if male	0.372
Age	in years	49.863
Degree	1=bachelors degree or higher;0=otherwise	0.413
Income	0=less than $20,000 1=$20,000 to $39,000 2=$40,000 to $59,000 3=$60,000 to $79,000 4=$80,000 to $99,000 5=$100,000 to $119,000 6=$120,000 to $150,000 7=$150,000 to $179,000 8=greater than $180,000	2.970
Under18	1 if a household has children below 18; 0 otherwise	0.261
Race	1 if white; 0 otherwise	0.838
Purchase1	1=purchase fresh ground beef once a week; 0=otherwise	0.507
Purchase2	1=purchase once a month; 0=otherwise	0.326
Purchase3	1=purchase rarely; 0=otherwise	0.120
Purchase4	1=Never; 0= otherwise	0.042
Eat1	1=eat food containing ground beef frequently;0=otherwise	0.578
Eat2	1=eat periodically; 0=otherwise	0.335
Eat3	1=eat rarely; 0=otherwise	0.071
Eat4	1=Never eat ground beef; 0=otherwise	0.014

Note: Number of Responses=349

Table II-4. Pooled Sample and U.S. Population

Variable	Pooled Sample	U.S. Population[a]
White	84%	77%
Household with children below 18	26%	36%
Bachelor's degree or higher	41%	24%
Female	37%	51%
Median age	52 years	45 years [b]
Average household income	$40,000 to $ 59,000	$56,604

[a] Source: U.S. Bureau of the Census, Census 2000
[b] Approximate median age of the people who are 18 and above calculated using the age distribution data for the whole U.S. population.

Table II-5. Results of the Factor Analysis of Maximizer-Satisficer Scale

Items	Factor1	Factor2	Factor3	Factor4
Renting videos is really difficult	**0.69**	-0.01	0.14	0.02
Writing is very difficult	**0.65**	0.09	-0.03	0.14
When shopping hard time finding clothes	**0.58**	-0.06	-0.01	-0.06
Difficult to shop for a gift for a friend	**0.57**	0.00	0.21	0.10
I never settle for second best	-0.02	**0.84**	0.08	-0.01
I have the highest standard for myself	-0.02	**0.83**	-0.09	-0.06
I try to imagine all the possibilities even ones that aren't present	0.04	**0.42**	0.19	0.14
I treat relationships like clothing	0.14	0.04	**0.74**	-0.10
I always lookout for better opportunities	-0.25	0.29	**0.59**	0.22
I am a big fan of lists that rank things	0.29	-0.09	**0.56**	0.09
Fantasize about living in different ways than actual life	0.05	0.10	**0.51**	0.26
When I watch TV I channel surf	0.05	-0.04	0.03	**0.85**
When I am in a car listening radio I often check other stations	0.10	0.10	0.20	**0.78**
Cronbach's alpha	0.63			

Notes: Number of responses used=320. The responses of people who never purchase ground beef or who did not respond to the question asking for the frequency at which they purchase ground beef, and those of who did not respond to all the items in the maximizer-satisficer scale are not included in the analysis.

Table II-6. Conditional Logit Estimates for Model with Variables Representing Ground Beef Attributes

Variable Name	Coefficient	Standard Error	p-value
Traceability U.S.	2.061	0.072	0.000
Traceability Private	1.451	0.075	0.000
Humane	0.371	0.080	0.000
Natural	1.415	0.053	0.000
Fat 10%	1.001	0.113	0.000
Fat 20%	0.232	0.100	0.021
Fat 30%	-0.576	0.106	0.000
Price	-0.657	0.024	0.000
LR(Chi square)	2675.229		
Log-likelihood value	-10954.216		
Pseudo R-squared	0.108		

Notes: Number of responses used =333; Number of choice sets=333*4=1332. The responses of people who never purchase ground beef are given a weight of zero, and those of the people who did not answer the question asking for the frequency at which they purchase ground beef are not included.

Table II-7. WTP (Dollars per pound of ground beef) Estimates and Confidence Intervals

Attributes	Mean WTP ($/lb)	95 % Confidence Interval
Traceability U.S.	3.13	[2.91, 3.37]
Traceability Private	2.20	[2.00, 2.42]
Natural	2.15	[2.02, 2.29]
Humane	0.56	[0.32, 0.82]
Fat 10%	1.52	[1.23, 1.79]
Fat 20%	0.35	[0.05, 0.63]
Fat 30%	-0.87	[-1.24, -0.54]

Table II-8. Conditional Logit Estimates for Model with Variables Representing Ground Beef Attributes, and Number of Choices

Variable Name	Coefficient	Standard Error	p-value
NCH5	1.014	0.130	0.000
NCH10	1.080	0.155	0.000
NCH20	1.105	0.199	0.000
NCH25	0.680	0.188	0.000
Traceablity US	2.063	0.072	0.000
Traceability Private	1.453	0.075	0.000
Humane	0.371	0.080	0.000
Natural	1.416	0.053	0.000
Fat 20%	-0.769	0.052	0.000
Fat 30%	-1.578	0.062	0.000
Price	-0.658	0.024	0.000
LR(Chi Square)	2679.557		
Log Likelihood Value	- 10952.052		
Pseudo-R Squared	0.108		

Note: Number of responses used=333; Total number of choice sets=333*4=1332

Table II-9. **Marginal Effects and Confidence Intervals for an Average Consumer**

Change in Number of Choices	Marginal Effects
5 to 10	0.065
	[-0.181, 0.315][a]
	[-0.228, 0.367][b]
10 to 20	0.025
	[-0.333, 0.380][a]
	[-0.406, 0.451][b]
20 to 25	-0.425
	[-0.822, -0.029][a]
	[-0.896, 0.051][b]

[a]Confidence Intervals at 90 percent.
[b]Confidence Intervals at 95 percent.

Table II-10. Conditional Logit Estimates for Model with Variables Representing Ground Beef Attributes, Number of Choices, and Maximizer-Satisficer Scale

Variable Name	Coefficient	Standard Error	p-value
NCH5	0.260	0.497	0.601
NCH10	0.655	0.672	0.329
NCH20	3.002	1.040	0.003
NCH25	2.210	0.950	0.020
*MAX*NCH5*	0.015	0.008	0.093
*MAX*NCH10*	0.007	0.012	0.511
*MAX*NCH20*	-0.033	0.017	0.055
*MAX*NCH25*	-0.027	0.016	0.092
Traceablity US	2.042	0.073	0.000
Traceability Private	1.450	0.076	0.000
Humane	0.379	0.081	0.000
Natural	1.384	0.053	0.000
Fat 20%	-0.774	0.053	0.000
Fat 30%	-1.561	0.063	0.000
Price	-0.657	0.024	0.000
LR(Chi Square)	2559.144		
Log Likelihood Value	- 10678.379		
Pseudo-R Squared	0.107		

Notes: Number of responses used=320; Number of choice sets=320*4=1280.Number of responses used is less than the ones used in the other two models because the responses of people who did not answer all the 13 items in the maximizer-satisficer scale are not included.

Table II-11. Marginal Effects and Confidence Intervals for Satisficers and Maximizers

Change in Number of Choices	Marginal Effects	
	Satisficers	Maximizers
5 to 10	0.195	-0.190
	[-0.491, 0.888] [a]	[-1.005, 0.618] [a]
	[-0.625, 1.026] [b]	[-1.175, 0.761] [b]
10 to 20	1.175	-1.085
	[0.123, 2.253] [a]	[-1.942, -0.233] [a]
	[-0.083, 2.460] [b]	[-2.098, -0.069] [b]
20 to 25	-0.613	-0.270
	[-1.847, 0.584] [a]	[-1.335, 0.795] [a]
	[-2.103, 0.848] [b]	[-1.541, 1.016] [b]

[a] Confidence Intervals at 90 percent.
[b] Confidence Intervals at 95 percent.

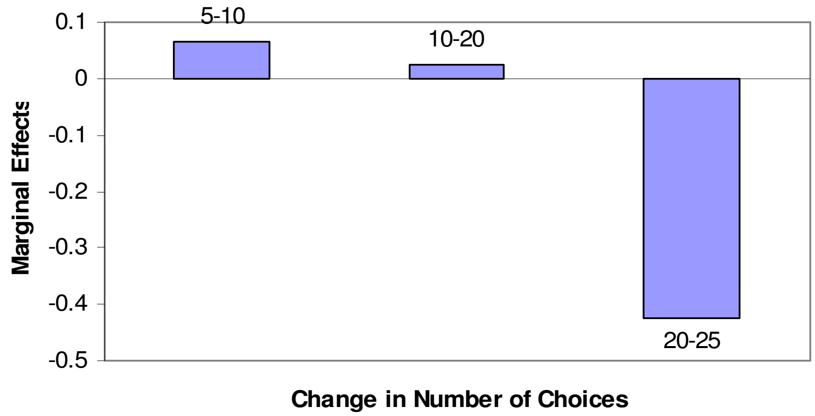

Figure II-1. Marginal effects for an average consumer as the number of choices increases from 5 to 10, 10 to 20, and 20 to 25.

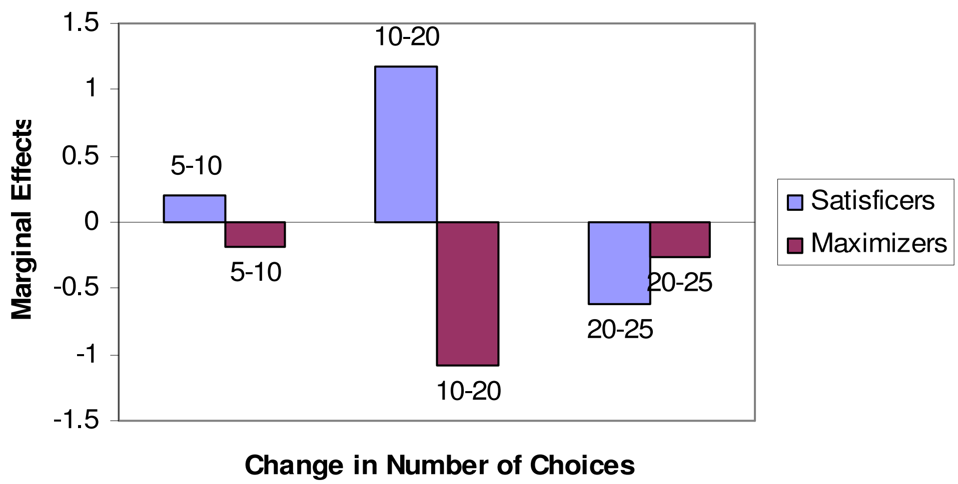

Figure II-2. Marginal effects for satisficers and maximizers as the number of choices increases from 5 to 10, 10 to 20, and 20 to 25.

APPENDIX II-A

Attributes Information Sheet

Survey of Consumer Food Preferences

The purpose of this survey is to ask you about your preferences for ground beef products. In the survey booklet included we will describe various ground beef products and ask you about your preferences for those products. Each ground beef product will be described by its price and the four characteristics described below. Please read the following descriptions carefully, then proceed to the survey booklet.

- ***Price*** *- each item has its own unique price, expressed in dollars per pound.*
- ***Traceability Certified*** *- traceable beef refers to beef that can be traced back to the farm(s) where the animal was raised. Traceability can be assured by either the U.S. government, a private company, or no traceability.*
- ***Certified Humane*** *- refers to ground beef products derived from cattle that are guaranteed to be raised and slaughtered under humane processes.*
- ***Certified Natural*** *- refers to beef products from cattle fed a strictly vegetarian diet, are produced without the use of antibiotics or growth hormones, and the meat is minimally processed without the use of artificial ingredients.*
- ***Fat Content*** *- each ground beef product you will see in the survey has a fat content of 30%, 20%, or 10%.*
- *Note that some beef products may be certified humane and/or certified natural but are not traceable because information on the farm of origin is confidential.*

APPENDIX II-B

Choice Experiment

Oklahoma State University Consumer Preference Survey

In just a moment, we will ask about your grocery shopping patterns. The purpose of this page is to help prepare you for those questions. You will be given questions similar to that in the table below. In the table, there are four ground beef options. In the first option, the meat can be traced back to the farm of origin by a private company, is certified humane, is not certified natural, has a 30% fat content, and has a price of $2.00 per pound. Options 2-4 differ according to these traits, as you can see in the table below.

Imagine you were at your local grocery store on a typical shopping trip, and these four ground beef options were available for purchase. Further, suppose that during this shopping trip you would most likely purchase Option 3. If this is the case, then you would check the third option as illustrated below.

Option	**Meat Traceability Certified by**	**Certified Humane**	**Certified Natural**	**Fat Content**	**Price ($/lb)**	**I Would Purchase (Check ONE):**
Option 1	Private Company	Yes	No	30%	$2.00	☐
Option 2	None	No	Yes	20%	$4.50	☐
Option 3	Private Company	Yes	Yes	10%	$5.00	☑
Option 4	None	Yes	No	10%	$2.50	☐
NONE: I WOULD NOT PURCHASE ANY OF THESE PRODUCTS						☐

If, on the other hand you would most likely choose Option 4, simply check Option 4, and if you would most likely not purchase any of these products simply check **NONE**. However, you may only select ONE OPTION for each table. On the following pages we ask you to make four of these hypothetical shopping decisions, where the number of options is varied across questions. For each question, please make your selection in a manner that best reflects your true preferences.

Imagine you were at your local grocery store on a typical shopping trip. Suppose there were 4 options of ground beef products to choose from, each option is described below, where each product is one pound of ground beef. Of the 4 options, please select the ONE ground beef product you would MOST prefer to purchase. Or, if you would not purchase any of the products, select NONE in the last row.

Option	**Meat Traceability Certified by**	**Certified Humane**	**Certified Natural**	**Fat Content**	**Price ($/lb)**	**I Would Purchase (Check ONE):**
Option 1	None	Yes	No	30%	$2.50	☐
Option 2	None	No	Yes	20%	$4.50	☐
Option 3	None	No	No	30%	$4.00	☐
Option 4	None	Yes	Yes	10%	$3.00	☐
NONE: I WOULD NOT PURCHASE ANY OF THESE PRODUCTS						☐

This question is the same as the previous question, except that now there are 9 items to choose from. Please select the ONE ground beef product you would MOST prefer to purchase. Or, if you would not purchase any, select NONE in the last row.

Option	**Meat Traceability Certified by**	**Certified Humane**	**Certified Natural**	**Fat Content**	**Price ($/lb)**	**I Would Purchase (Check ONE):**
Option 1	U. S. Government	Yes	No	30%	$3.00	☐
Option 2	None	Yes	No	10%	$2.50	☐
Option 3	None	No	No	20%	$2.00	☐
Option 4	None	Yes	Yes	30%	$6.00	☐
Option 5	None	Yes	No	20%	$4.50	☐
Option 6	Private Company	Yes	No	20%	$3.50	☐
Option 7	None	Yes	Yes	20%	$4.50	☐
Option 8	U. S. Government	Yes	Yes	10%	$5.50	☐
Option 9	U. S. Government	Yes	Yes	30%	$5.50	☐
NONE: I WOULD NOT PURCHASE ANY OF THESE PRODUCTS						☐

This question is the same as the previous two questions, except that now there are 19 items to choose from. Please select the ONE ground beef product you would MOST prefer to purchase. Or, if you would not purchase any, select NONE in the last row.

Option	**Meat Traceability Certified by**	**Certified Humane**	**Certified Natural**	**Fat Content**	**Price ($/lb)**	**I Would Purchase (Check ONE):**
Option 1	Private Company	Yes	No	30%	$2.00	☐
Option 2	Private Company	Yes	Yes	20%	$5.00	☐
Option 3	U. S. Government	Yes	No	20%	$2.00	☐
Option 4	Private Company	Yes	Yes	10%	$5.00	☐
Option 5	Private Company	Yes	No	10%	$5.00	☐
Option 6	None	No	Yes	30%	$4.00	☐
Option 7	None	No	No	10%	$2.50	☐
Option 8	None	No	Yes	10%	$3.50	☐
Option 9	U. S. Government	Yes	Yes	20%	$4.00	☐
Option 10	Private Company	Yes	Yes	30%	$3.50	☐
Option 11	U. S. Government	Yes	No	10%	$6.00	☐
Option 12	U. S. Government	Yes	No	30%	$3.00	☐
Option 13	None	Yes	No	10%	$2.50	☐
Option 14	None	No	No	20%	$2.00	☐
Option 15	None	Yes	Yes	30%	$6.00	☐
Option 16	None	Yes	No	20%	$4.50	☐
Option 17	Private Company	Yes	No	20%	$3.50	☐
Option 18	None	Yes	Yes	20%	$4.50	☐
Option 19	U. S. Government	Yes	Yes	10%	$5.50	☐
NONE: I WOULD NOT PURCHASE ANY OF THESE PRODUCTS						☐

This question is the same as the previous three questions, except that now there are 24 items to choose from. Please select the ONE ground beef product you would MOST prefer to purchase. Or, if you would not purchase any, select NONE in the last row.

Option	Meat Traceability Certified by	Certified Humane	Certified Natural	Fat Content	Price ($/lb)	I Would Purchase (Check ONE):
Option 1	None	No	No	10%	$2.50	☐
Option 2	None	No	Yes	10%	$3.50	☐
Option 3	U. S. Government	Yes	Yes	20%	$4.00	☐
Option 4	Private Company	Yes	Yes	30%	$3.50	☐
Option 5	U. S. Government	Yes	No	10%	$6.00	☐
Option 6	U. S. Government	Yes	No	30%	$3.00	☐
Option 7	None	Yes	No	10%	$2.50	☐
Option 8	None	No	No	20%	$2.00	☐
Option 9	None	Yes	Yes	30%	$6.00	☐
Option 10	None	Yes	No	20%	$4.50	☐
Option 11	Private Company	Yes	No	20%	$3.50	☐
Option 12	None	Yes	Yes	20%	$4.50	☐
Option 13	U. S. Government	Yes	Yes	10%	$5.50	☐
Option 14	Private Company	Yes	No	30%	$2.00	☐
Option 15	Private Company	Yes	Yes	20%	$5.00	☐
Option 16	U. S. Government	Yes	No	20%	$2.00	☐
Option 17	Private Company	Yes	Yes	10%	$5.00	☐
Option 18	Private Company	Yes	No	10%	$5.00	☐
Option 19	None	No	Yes	30%	$4.00	☐
Option 20	None	Yes	No	30%	$2.50	☐
Option 21	None	No	Yes	20%	$4.50	☐
Option 22	None	No	No	30%	$4.00	☐
Option 23	None	Yes	Yes	10%	$3.00	☐
Option 24	U. S. Government	Yes	Yes	30%	$5.50	☐
NONE: I WOULD NOT PURCHASE ANY OF THESE PRODUCTS						☐

APPENDIX II-C

Maximizer-Satisficer Scale

This is the last portion of the survey. Please indicate the degree to which the following statements describe you personally. On a scale of 1-7, with 1 being completely disagree and 7 being completely agree, indicate the extent to which you agree with each of the following 13 statements by circling a number.

1. Whenever I'm faced with a choice, I try to imagine what all the other possibilities are, even ones that aren't present at the moment. (*circle one number*)

1 2 3 4 5 6 7

Completely DISagree | Neither agree nor disagree | Completely AGREE

2. No matter how satisfied I am with my job, it's only right for me to be on the lookout for better opportunities.

1 2 3 4 5 6 7

Completely DISagree | Neither agree nor disagree | Completely AGREE

3. When I am in the car listening to the radio, I often check other stations to see if something better is playing, even if I'm relatively satisfied with what I'm listening to.

1 2 3 4 5 6 7

Completely DISagree | Neither agree nor disagree | Completely AGREE

4. When I watch TV, I channel surf, often scanning through the available options even while attempting to watch one program.

1 2 3 4 5 6 7

Completely DISagree | Neither agree nor disagree | Completely AGREE

5. I treat relationships like clothing: I expect to try a lot on before I get the perfect fit.

1 2 3 4 5 6 7

Completely DISagree | Neither agree nor disagree | Completely AGREE

6. I often find it difficult to shop for a gift for a friend.

1	2	3	4	5	6	7
Completely DISagree			Neither agree nor disagree			Completely AGREE

7. Renting videos is really difficult. I'm always struggling to pick the best one.

1	2	3	4	5	6	7
Completely DISagree			Neither agree nor disagree			Completely AGREE

8. When shopping, I have a hard time finding clothing that I really love.

1	2	3	4	5	6	7
Completely DISagree			Neither agree nor disagree			Completely AGREE

9. I'm a big fan of lists that attempt to rank things (the best movies, the best singers, the best athletes, the best novels, etc.).

1	2	3	4	5	6	7
Completely DISagree			Neither agree nor disagree			Completely AGREE

10. I find that writing is very difficult, even if it's just writing a letter to a friend, because it's so hard to word things just right. I often do several drafts of even simple things.

1	2	3	4	5	6	7
Completely DISagree			Neither agree nor disagree			Completely AGREE

11. No matter what I do, I have the highest standards for myself.

1	2	3	4	5	6	7
Completely DISagree			Neither agree nor disagree			Completely AGREE

12. I never settle for second best.

1	2	3	4	5	6	7
Completely DISagree			Neither agree nor disagree			Completely AGREE

13. I often fantasize about living in ways that are quite different from my actual life.

1	2	3	4	5	6	7
Completely DISagree			Neither agree nor disagree			Completely AGREE

APPENDIX II-D

IRB Form

Oklahoma State University Institutional Review Board

Date:	Tuesday, November 21, 2006
IRB Application	AG0648
Proposal Title:	Consumer Demand for Beef Variety
Reviewed and Processed as:	Exempt

Status Recommended by Reviewer(s): Approved **Protocol Expires: 11/20/2007**

Principal Investigator(s):

Shida R. Henneberry	Bharath Arunachalam	F. Bailey Norwood
424 Ag Hall	424 Ag Hall	426 Ag Hall
Stillwater, OK 74078	Stillwater, OK 74078	Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☑ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 219 Cordell North (phone: 405-744-5700, beth.mcternan@okstate.edu).

Sincerely,

Sue C. Jacobs, Chair
Institutional Review Board

VITA

Bharath Arunachalam

Candidate for the Degree of

Doctor of Philosophy

Thesis: IMPORT DEMAND FOR EDIBLE OILS IN INDIA: AN APPLICATION OF SOURCE- DIFFERENTIATED MODELS, AND CONSUMER DEMAND FOR BEEF VARIETY.

Major Field: Agricultural Economics

Biographical:

Education: Received a Bachelor of Engineering degree in Mechanical Engineering from Anna University, Chennai, India in May, 1995; received a Master of Business Administration degree from Oklahoma State University, Stillwater, Oklahoma in December, 2001; completed the requirements for the Doctor of Philosophy in Agricultural Economics at Oklahoma State University, Stillwater, Oklahoma in May, 2008.

Experience: Worked as a Marketing Analyst for Database Marketing consulting firms in India, June 1995 to June 1999; Graduate Teaching Assistant, Spears School of Business, Oklahoma State University, Stillwater, Oklahoma, August 1999 to May 2000; Database Marketing Analyst, Harris, Norfolk, Virginia, May 2002 to August 2002; Graduate Research Assistant, Department of Agricultural Economics, Oklahoma State University, Stillwater, Oklahoma, August 2006 to May 2008.

Name: Bharath Arunachalam Date of Degree: May, 2008

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: IMPORT DEMAND FOR EDIBLE OILS IN INDIA: AN APPLICATION OF SOURCE- DIFFERENTIATED MODELS, AND CONSUMER DEMAND FOR BEEF VARIETY.

Pages in Study: 141 Candidate for the Degree of Doctor of Philosophy

Major Field: Agricultural Economics

Scope and Methods of Study: This study consists of two essays. The purpose of the first essay is to estimate the source differentiated import demand for edible oils in India using different versions of the differential demand model; including the Rotterdam, the almost ideal demand system (AIDS), the Central Bureau of Statistics (CBS), the National Bureau of Research (NBR), and General specifications. The General Model nests all the other models and is estimated to determine the model that best fits the data. The tests for symmetric weak separability and product aggregation are also conducted. The purpose of the second essay is to determine consumers' willingness to pay for ground beef attributes; including traceability certified by the U.S. Government or by a private company, humane production technique, certified natural beef, and fat content. This study is also intended to determine the impact of an increase in the number of ground beef choices on consumers' utility. The impact of personal characteristics on the effect of number of choices on consumers' utility is also considered. A nationwide survey was conducted to elicit consumers' preferences.

Findings and Conclusions: The results from the first study show that the General Model best fits the Indian edible oil import data. The tests for weak separability and product aggregation support the estimation of source differentiated models including all three edible oil types (palm oils, soybean oils, and other oils). The results also indicate that soybean oils have larger own-price (in absolute values) elasticities than palm oils, and Malaysia and the U.S. have the largest expenditure elasticities in the palm and soybean oil import markets, respectively. The results from the second study show that consumers are willing to pay more for traceability certified by the U.S. Government than any other ground beef attribute considered in this study. Furthermore, an increase in the number of ground beef choices beyond a threshold level has a negative impact on consumers' utility and that impact depends on consumers' individual characteristics.

ADVISER'S APPROVAL: Dr. Shida Henneberry