AN IMPACT ANALYSIS ON HOW BIODIESEL DEMAND AFFECTS THE FATS AND OILS MARKET

A Thesis

Presented to

the Faculty of the Graduate School

at the University of Missouri-Columbia

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

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AUGUST 2008

The undersigned, appointed by the dean of the Graduate School, have examined the thesis entitled

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ACKNOWLEDGEMENTS

I wish to express my sincere appreciation to the many people who have assisted me in the completion of this thesis. First, I wish to thank my thesis supervisor, Dr. Wyatt Thompson, for his assistance and advice throughout this project. My thanks to Dr. Seth Meyer and Dr. Doug Miller for their help and suggestions as committee members.

I would like to thank the Food and Agricultural Policy Research Institute (FAPRI). I will always remember the experience I gained at FAPRI and everyone I worked with. A special note of thanks is extended to FAPRI and the Department of Agricultural Economics who funded this research.

I wish to thank my wife, Christina, for her encouragement, friendship, and tolerance throughout this project. I shall always remember it. I would like to thank my son, Harrison, for giving me inspiration and making me feel that all of this work has been meaningful. My sincere thanks to my parents for all of their love and support. For those of you whom I have forgotten to mention, your efforts have been greatly appreciated.

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ABSTRACT

With the signing of the Energy Independence and Security Act of 2007 (EISA), much attention is being given to the biofuel mandates included in the act. Biodiesel use is mandated to increase from 500 million gallons in 2009 to one billion gallons in 2012. This increased use of biodiesel may have a big impact on U.S. agriculture over the next few years. The newly added biodiesel demand could potentially affect the demand for fats and oils and the hierarchy of their prices.

The primary objective of this study is to determine how the fats and oils market is affected by the addition of the newly expanded biodiesel demand. A secondary objective of this study is to estimate some elasticities for the industrial side of the fats and oils market. A third objective, which is also an intermediate stage, is to introduce biodiesel demand, based on the assumption of very elastic demand at a break-even price that takes account of some petroleum-based diesel price and other input costs.

The results show that tax credits and the mandates will play a significant role in biodiesel's future. Without these incentives biodiesel will not be as profitable. The results help us to understand current policies and provisions, as well as a way to look at different scenarios that might affect future policies.

CHAPTER I: INTRODUCTION

With the signing of the Energy Independence and Security Act of 2007 (EISA), much attention is being given to the biofuel mandates included in the act. The EISA will increase the use of alternative fuel sources by setting a mandatory Renewable Fuel Standard (RFS) requiring fuel blenders to use at least 36 billion gallons of biofuel in 2022 (www.whitehouse.gov). This is nearly a four-fold increase over current levels of biofuel use. Ethanol use in 2007 was close to 9 billion gallons and biodiesel use was around 400 million gallons that same year (FAPRI 2008). Biodiesel use is mandated to increase from 500 million gallons in 2009 to one billion gallons in 2012. This increased use of biodiesel may have a big impact on U.S. agriculture over the next few years. The newly added biodiesel demand could potentially affect the demand for fats and oils and the hierarchy of their prices.

Past research of the fats and oils market has generally been focused on the consumer demand of various edible fats and oils. Much of the research is motivated by increased health concerns and beliefs. The studies have generally been done on an annual basis and include many of the main fats and oils consumed in the United States: butter, lard, edible tallow, coconut oil, corn oil, cottonseed oil, soybean oil, palm oil, palm kernel oil and peanut oil. In contrast, few past studies have focused on total demand for oils and even fewer have focused exclusively on industrial uses of oils. Moreover, the recent sudden surge in the quantities of oils purchased for processing into biodiesel defies statistical analysis that might assess the sensitivity of these agents to market prices. Thus, historical studies do not span biodiesel demand for oils, nor do they prepare us to assess how this new category of demand will affect the broader fats and oils complex.

1.1 Objectives

The primary objective of this study is to determine how the fats and oils market is affected by the addition of the newly expanded biodiesel demand. This objective will be accomplished through a structural model of the demands for fats and oils. Fats and oils will be divided into two broad aggregates, edible and inedible uses, and each of these will be further divided into individual fats and oils. Thus, to assess correctly these responses, a secondary objective of this study is to estimate select elasticities for the industrial side of the fats and oils market. A third objective, which is also an intermediate stage, is to introduce biodiesel demand, based on the assumption of very elastic demand at a break-even price that takes account of petroleum-based diesel price and other input costs. The biodiesel use provisions of the EISA can be represented as a minimum quantity.

The output of the model will relate how quantities and prices in the oil complex respond to the introduction and expansion of biodiesel demand for fats and oils. The output will be both narrowly focused, in terms of estimates of the impacts at different prices of petroleum-based diesel, and more broadly indicative of the effects on both the demand scale and shape. In this way, the objective of assessing how expanding biodiesel will affect the fats and oils market will be achieved.

1.2 Context and Guide to the Thesis

In Chapter II, previous literature on the fats and oils complex is discussed and reviewed in chronological order. Chapter III provides an overview of the U.S. fats and oils industry. Chapter IV presents the method used in developing this study, presents the estimation procedure, and describes the data used in this analysis. Chapter V summarizes the estimation results. Chapter VI discusses various scenarios and presents the results of their simulation. Finally, Chapter VII presents the summary and conclusions of this study.

CHAPTER II: LITERATURE REVIEW

This chapter reviews previous research and models of the fats and oils complex. While only a selection of the relevant literature is presented here, an attempt for a review of representative models was made. The journal articles reviewed here are all focused on the consumer demand of various edible fats and oils. The following section reflects chronologically how the relevant literature has evolved.

In 1979, Griffith and Meilke studied the relationships among North American fats and oils prices. Their study attempted to measure the price relationship between nine North American fats and oils. The authors point out that previous attempts were done with annual data, and that they did not take into account cyclical, seasonal, or irregular components within the year. This study used spectral and cross-spectral techniques for analysis.

The data used consisted of 216 monthly observations of U.S. wholesale prices of fourteen fats and oils. The data used were from January 1959 to December 1976. The nine most important fats and oils were: cottonseed oil, peanut oil, rapeseed oil, soybean oil, linseed oil, coconut oil, palm oil, lard, and fish oil.

This study did not produce any elasticities. The results of the study showed that it is probable for substitutability to make up the largest component of the price relationships. The high correlations among many of the oil prices make direct measurement of the elasticities difficult.

In 1989, Goddard and Glance studied the demand for fats and oils in Canada, U.S. and Japan. The study used USDA data for the U.S. analysis on an annual basis from 1962 to1986. The following fats and oils were used: butter, lard, edible tallow, coconut oil, corn oil, cottonseed oil, soybean oil, palm oil, palm kernel oil and peanut oil. The prices were converted to a real basis by dividing by the CPI.

An attempt was made to estimate a complete matrix of price and expenditure elasticities for the selected countries. Aggregate fat and oil expenditure equations were estimated in logarithmic form. It is reasonable to hypothesize that there may have been a structural change in the demand for fats and oils. Diet and health concerns may have affected the demand for fats and oils. Lagged dependent variables and time trends were included in the specifications to account for structural changes in demand and habit formation.

A translog demand system was estimated for the U.S. model over the time period from 1963 to 1986. This model was used to test symmetry in the price parameters. It excludes dynamic responses or a time trend. The exclusion of dynamic responses from the model with symmetry imposed and the exclusion of a time variable were both rejected. Symmetry restrictions were also rejected.

The dynamic model was selected over the model with a time variable. The dynamic model had a higher degree of explanatory power. The largest expenditure elasticities were for fats and oils that have small and declining shares of the total market. In the U.S. this was true for tallow, palm, and peanut oil.

When it comes to answering "what is the demand elasticity" there is no right answer. "Monitoring of any commodity market is an evolutionary process" (Goddard and Glance, 30). The results of the study show that within the edible fats and oils market there is a lot of complementarity. Prior assumptions may have been that oils were more easily substituted than is evidenced by this research. Demand for fats and oils seem to be inelastic both in the aggregate and for each fat and oil. The expenditure elasticities also seem to be inelatic. If production of an individual fat or oil were to increase drastically, then the price would fall more in relative terms. If the individual oil demands are more inelastic than expected this might have implications for exporters. Table 1 shows the results of previous estimates of demand elasticities for fats and oils. Tables 2 and 3 show the U.S. and Canadian price and expenditure elasticities from the study.

Table 2.1: Previous Estimates of Demand Elasticities for Fats and Oils

Reported Demand Elasticities - SOYOIL

Region	Study/Period	Own Price		
USA	Houck (1950-64)	-0.51		
	Vandenborre (1948-63)	-0.45		
	Wescott (1975-81)	-0.09		
	Meilke (1963-77)	-0.13	-0.26	
	Houck (1946-60)	-2.51	-2.59	
	Labys (1955-72)	-1.28		
	Griffith (1963-77)	-0.12	-0.41[a]	
	Houck (1946-67)	-0.28		
	Ghaffar (1971-82)[b]	-0.28		
	Qasmi (1965-80)	-0.26c		
	Suryana (1964-83)	-0.76[d]	-0.79[e]	-0.75[f]
	Woo	-0.11		

a/ Long-run estimate.
b/ Quarterly data.
c/ Evaluated at 1980 prices and quantities.
d/ Unrestricted AIDS model.
e/ AIDS model with homogeneity imposed.
f/ Using correction for autocorrelation among error terms (lag=1).
Source: adapted from Table 1 Goddard and Glance

Reported Demand Elasticities - CORN OIL

Region	Study/Period	Own Price		
USA	Suryana (1964-83)	-0.09[a]	-0.08[b]	-0.09[c]

a/ Unrestricted AIDS model.
b/ Homogeneity imposed.
c/ Corrected for autocorrelation (lag=1).
Source: adapted from Table 1 Goddard and Glance

Reported Demand Elasticities - PALM OIL

Region	Study/Period	Own Price		
USA	Ghaffar (1971-82)[a]	-0.109		
	Senteri (1951-81)	-4.14	-11.67	
	Suryana (1964-83)[b]	-1.46	-1.14	-1.57

a/ Quarterly Data
b/ Estimates for unrestricted AIDS model, homogeneity imposed and correction for autocorrelation, respectively
Source: adapted from Table 1 Goddard and Glance

Reported Demand Elasticities - COTTONSEED OIL

Region	Study/Period	Own Price		
USA	Labys (1955-72)	-.0514	-2.11[a]	
	Suryana (1964-83)	-0.33[b]	-0.64[c]	-0.33[d]

a/ Jacobson, M.A. (1946-64), reported in Labys.
b/ Unrestricted AIDS model.
c/ Homogeneity imposed
d/ Corrected for autocorrelation (lag=1)
Source: adapted from Table 1 Goddard and Glance

Reported Demand Elasticities - COCONUT OIL

Region	Study/Period	Own Price		
USA	Suryana (1964-83)	-0.27[a]	-0.28[b]	-0.27[c]

a/ Unrestricted AIDS model.
b/ Homogeneity imposed
c/ Corrected for autocorrelation (lag=1)
Source: adapted from Table 1 Goddard and Glance

Table 2.2: U.S. Price and Expenditure Elasticities
Translog, Symmetry and Dynamic

1977	Butter	Lard	Edible Tallow	Coconut	Corn	Cotton Seed	Soybean	Palm	Palm Kernal	Peanut
Butter	-0.34	0.01	-0.10	0.04	-0.02	-0.09	-0.44	-0.12	-0.006	-0.04
Lard	0.23	-0.94	0.56	0.16	0.40	-0.39	0.12	-0.73	0.07	0.003
E. Tallow	-0.88	0.81	-0.84	-0.39	-0.86	0.38	-0.99	1.65	-0.21	-0.11
Coconut	0.30	0.13	-0.18	-0.40	-0.07	0.18	-0.33	-0.06	-0.11	-0.07
Corn	-0.09	0.45	-0.63	-0.12	-0.63	-0.22	-0.15	0.47	-0.18	0.10
Cottonseed	-0.75	-0.66	0.42	0.32	-0.31	-1.24	0.29	0.33	0.03	0.54
Soybean	-0.22	-0.008	-0.06	-0.07	-0.01	0.02	-0.54	-0.03	0.003	-0.02
Palm	-1.21	-1.26	1.72	-0.20	0.61	0.29	-0.91	-1.36	0.33	0.04
P. Kernal	0.04	0.31	-0.53	-0.55	-0.61	0.10	0.28	0.90	-0.51	0.06
Peanut	-0.78	-0.04	-0.24	-0.33	0.27	1.09	-0.72	0.10	0.04	-0.86
Expenditure	1.11	0.51	1.43	0.62	1.00	1.04	0.94	1.95	0.50	1.47

1986	Butter	Lard	Edible Tallow	Coconut	Corn	Cotton Seed	Soybean	Palm	Palm Kernal	Peanut
Butter	-0.53	-0.004	-0.07	0.01	-0.02	-0.07	-0.36	-0.08	-0.007	-0.03
Lard	0.52	-0.84	1.20	0.38	0.90	-0.83	0.40	-1.61	0.17	0.003
E. Tallow	-0.63	0.55	-0.89	-0.28	-0.60	0.26	-0.74	1.16	-0.15	-0.08
Coconut	0.48	0.21	-0.29	-0.04	-0.11	0.28	-0.46	-0.11	-0.17	-0.11
Corn	-0.12	0.60	-0.83	-0.15	-0.50	-0.29	-0.16	0.61	-0.23	0.13
Cottonseed	-1.44	-1.27	0.81	0.66	-0.60	-1.47	0.68	0.62	0.07	1.06
Soybean	-0.28	-0.002	-0.08	-0.08	-0.01	0.03	-0.38	-0.05	0.005	-0.02
Palm	-1.86	-1.94	-0.30	-0.30	0.95	0.46	-1.34	-1.57	0.52	0.06
P. Kernal	0.05	0.36	-0.63	-0.63	-0.71	0.11	0.34	1.04	-0.43	0.07
Peanut	-1.65	-0.05	-0.66	-0.66	0.60	2.35	-1.41	0.19	0.09	-0.70
Expenditure	1.16	-0.30	1.39	0.30	0.95	0.88	0.87	2.37	0.41	1.77

Goddard and Glance, 1989

Table 2.3: Canada Price and Expenditure Elasticities
Translog, Symmetry and Dynamic

1977	Butter	Rapeseed	Coconut	Olive	Cottonseed	Soybean	Palm	Palm Kernel	Peanut
Butter	-0.90	-0.29	-0.04	-0.01	-0.02	-0.21	0.01	0.01	0.000
Rapeseed	-0.23	-0.25	-0.01	0.01	0.01	-0.06	0.03	-0.01	-0.02
Coconut	-0.36	-0.07	-0.27	-0.02	-0.03	0.32	-0.56	0.31	0.16
Olive	-0.28	0.08	-0.09	-0.88	0.17	-0.26	-0.51	0.13	0.37
Cottonseed	-1.65	-0.03	-0.11	0.13	-1.31	-0.60	1.43	-0.57	0.73
Soybean	-0.61	-0.17	0.06	-0.01	-0.04	-0.09	0.04	-0.03	0.03
Palm	2.41	0.910	-0.45	-0.12	0.58	0.59	-1.07	-0.08	-0.280
Palm Kernel	2.83	0.34	7.07	0.16	-0.69	-0.09	-0.29	-0.78	-0.26
Peanut	1.79	-0.28	0.78	0.57	1.35	1.04	-1.35	-0.37	-1.67
Expenditure	1.46	0.53	0.51	1.26	1.99	0.82	-2.49	-2.29	-1.87

1986	Butter	Rapeseed	Coconut	Olive	Cottonseed	Soybean	Palm	Palm Kernel	Peanut
Butter	-0.81	-0.150	-0.02	0.00	-0.01	-0.11	0.00	0.01	0.000
Rapeseed	-0.21	-0.46	-0.01	0.01	0.01	-0.05	0.02	-0.01	-0.01
Coconut	-1.31	-0.30	-0.09	-0.04	-0.05	0.27	-0.69	0.40	0.20
Olive	0.23	0.12	-0.03	-0.94	0.08	-0.06	-0.24	0.06	0.17
Cottonseed	-54.97	-6.65	-2.68	1.98	-7.13	-14.97	26.22	-10.11	13.14
Soybean	-1.01	-0.27	0.04	-0.02	-0.04	-0.18	0.05	-0.03	0.03
Palm	2.30	1.000	-0.64	-0.18	0.76	0.64	-1.07	-0.11	-0.370
Palm Kernel	2.09	0.24	0.84	0.13	-0.54	-0.09	-0.23	-0.83	-0.20
Peanut	1.26	-0.23	0.58	0.42	1.01	0.77	-1.01	-0.28	-1.50
Expenditure	1.11	0.72	1.60	0.61	55.17	1.42	-2.38	-1.40	-1.04

Goddard and Glance, 1989

In 1991, Gould, Cox and Perali did a study on the role that demographic variables and government donations played on the demand for food fats and oils. This study estimated a systems model of U.S. food fats and oils demand using quarterly time-series data from 1962-87. The hypothesis of the paper was that U.S. consumption of fats and oils are determined by relative prices along with tastes and preferences, and also reflected by other socioeconomic variables.

Five types of food fats and oils were included: butter, margarine, shortening, salad and cooking oils, and lard. Quarterly data on production and stocks were obtained from the U.S. Dept. of Commerce. Quarterly estimates of prices were obtained from published BLS retail city average price series. Wholesale prices in the study were converted to retail prices using data from the USDA. The demographic variables used in this study were: the median age of the population (AGE), the non-white proportion of the population (NON-WHITE), and the median years of schooling completed by those over twenty-five years of age (SCHOOL). An Almost Ideal Demand System (AIDS) model was used for estimation with data obtained from the Bureau of the Census. All five of the own-price elasticities were statistically significant. Of the cross-price elasticities, fifteen of the twenty were significant. Table 4 shows the price and expenditure elasticities from the study.

Table 2.4: Gould, Brian W., T. L. Cox, and F. Perali.

Price and Expenditure Elasticities

	Price					
Dependent Variable	Butter	Margerine	Short	Cooking	Lard	Expenditure
Butter	-0.622	-0.114	-0.128	-0.150	0.040	1.094
Margerine	-0.130	-0.227	-0.171	-0.379	-0.100	1.006
Shortening	-0.079	-0.107	-0.421	-0.255	-0.030	0.891
Salad Oils	-0.083	-0.204	-0.210	-0.440	-0.045	0.982
Lard	-0.146	-0.285	-0.164	-0.264	-0.277	1.136

In 1992, Yen and Chern estimated a flexible demand system with serially correlated errors of the U.S. fats and oils market. The study used annual time series data from 1950 to 1986. The focus of the study was three animal fats (butter, lard, and tallow) and six vegetable oils (coconut, corn, cottonseed, peanut, palm, and soybean oil). Most of the fats and oils consumed in the U.S. are represented by these nine products. Complete time series data for sunflower seed oil, palm kernel oil, and olive oil were not available, so these minor oils were excluded from this study. The quantity data were collected by crop year beginning October 1, and were obtained from the Bureau of the Census. Price data were obtained from the Economic Research Service of the USDA.

Yen and Chern estimated a flexible demand system that was proposed by Lewbel. This system nests the AIDS and Translog functional forms as two special cases. Within these functional forms, serial correlation is taken into account and corrected for in estimating these systems. The results confirmed the importance of correcting for serial correlation in demand system modeling. Four models were estimated and compared:

Model 1: Full model with serially correlated errors
Model 2: Translog with serially correlated errors
Model 3: AIDS with serially correlated errors
Model 4: Full model with serially independent errors

The results suggest that the full Lewbel model outperformed the Translog and AIDS in accounting for fat and oil demand in the U.S. The results demonstrate the importance of correcting for serial correlation. Table 5 shows elasticities estimated in this study.

Table 2.5: Yen, Steven T., and W. S. Chern

Model I Price and Total Expenditure Elasticities Lewbel Full Model

Commodity	Butter	Coconut Oil	Corn Oil	Cottonseed Oil	Peanut Oil	Palm Oil	Lard	Soybean Oil	Tallow	Total Expenditure
Butter	-0.67	0.01	-0.02	-0.06	0.00	0.02	-0.06	-0.35	-0.06	1.19
Coconut Oil	0.43	-0.40	-0.15	-0.42	0.00	0.16	0.20	-0.54	-0.03	0.74
Corn Oil	-0.11	-0.11	-0.31	-0.02	0.01	0.00	-0.12	-0.23	0.13	0.74
Cottoseed Oil	-1.16	-0.22	-0.09	-1.12	-0.01	-0.11	-0.19	-0.47	0.06	3.30
Peanut Oil	0.34	0.02	0.05	0.07	-1.01	0.61	-0.39	0.28	-0.24	0.26
Palm Oil	2.84	0.50	0.17	-0.23	0.62	-1.52	-1.27	1.44	1.85	-4.40
Lard	0.14	0.08	-0.02	0.03	-0.04	-0.20	-0.86	0.38	0.48	0.02
Soybean Oil	-0.36	-0.05	-0.03	0.09	0.00	-0.02	0.00	-0.55	-0.08	1.01
Tallow	0.13	0.04	0.23	0.59	-0.09	0.72	1.65	0.08	-1.74	-1.61

In 1995, Chern, Loehman, and Yen did a study of information, health risk beliefs, and the demand for fats and oils. Their study dealt with how to identify the demand effects of health risk beliefs and relative price changes. Health information has resulted in increases of consumption for corn, cottonseed, and soybean oils. It has also led to decreased consumption for butter and lard (Chern, Loehman, and Yen). The focus of this paper is on information relevant to food choices, and the linkage between food consumption and health risk.

A Bayesian model was used to explain the process by which beliefs change over time as new health information becomes available. Four models were estimated:

Model 1- with time trend (TIME)
Model 2- with the cholesterol index (CHOL)
Model 3- with Bayes mean (BMEAN)
Model 4- with Bayes mean (BMEAN) and variance (BVAR)

Annual observations were used from 1950-88 and crop years beginning October 1, were used. The authors grouped the fats and oils by end uses, fats used for making margarine and fats used in making salad and cooking oils. The study includes elasticities of information indexes, own price elasticities, and demand elasticities for: butter, corn oil, cottonseed oil, peanut oil, lard, and soybean oil.

The Bayesian model, using mean and variance of beliefs, produced the most reasonable predictions of consumption effects due to health risk beliefs. This model shows how informational inputs can affect behavior. This model depended on surveys carried out by the FDA. Table 6 shows the results of this study. The own price elasticities are reported for all four different models. Own price, cross price, and expenditure elasticities are presented for model four in table 6 as well.

2.1 Summary

The previous literature offers some suggestions in specifying and estimating a demand model for edible fats and oils. As previously stated most of the literature focuses primarily on the edible side of the fats and oils complex. Most of the authors used some of the same primary fats and oils in their studies. Many of the more recent studies are motivated by increased health concerns, as well as tastes and preferences. Having presented the background for modeling the edible fats and oils complex, Chapter III will give a broad overview of the fats and oils industry. Chapter IV, drawing on the literature presented in this chapter, will present the method used in this study.

Table 2.6: Chern, Wen S., E. T. Loehman, and S. T. Yen.

Model 1- with time trend (TIME)
Model 2- with the cholesterol index (CHOL)
Model 3- with Bayes mean (BMEAN)
Model 4- with Bayes mean (BMEAN) and variance (BVAR)

Estimated Own Price Elasticities

Product	Model I	Model II	Model III	Model IV
Butter	-0.76	-0.62	-0.61	-0.82
Corn Oil	-0.27	-0.28	-0.25	-0.24
Cottonseed Oil	-0.82	-0.88	-0.84	-0.65
Peanut Oil	-0.39	-0.45	-0.48	-0.24
Lard	-0.27	-0.44	-0.46	-0.26
Soybean Oil	-0.34	-0.68	-0.67	-0.29

Estimated Demand Elasticities, Model IV

Product	Butter	Corn Oil	Cottonseed Oil	Peanut Oil	Lard	Soybean Oil	Expenditure	Food Away From Home
Butter	-0.82	-0.06	-0.08	-0.01	-0.12	-0.37	1.45	-0.21
Corn Oil	0.15	-0.24	0.06	0.15	-0.10	0.16	-0.19	0.18
Cottonseed Oil	-0.87	-0.03	-0.65	-0.06	-0.10	0.04	1.67	-0.54
Peanut Oil	1.46	0.64	-0.09	-0.24	-0.33	0.53	-1.97	0.29
Lard	-0.84	-0.13	-0.07	-0.08	-0.26	-0.25	1.63	-0.87
Soybean Oil	0.00	0.01	0.10	0.00	0.05	-0.29	0.13	0.73

CHAPTER III: AN OVERVIEW OF THE U.S. FATS AND OILS MARKET

Much of this overview is based on a paper by Alsberg and Taylor. The distinction between a fat and an oil depends upon the environment in which the substance happens to be placed. If the substance is solid at ordinary temperatures, it is called a fat and if it is fluid it is an oil. This distinction is of importance in industrial and in food uses. It also has some importance in nutrition, since fats are somewhat less digestible than oils.

Animal fats and oils are derived both from land and marine animals. Hog lard and beef tallow are used both for food use and for industrial use. The different types of marine fats are used to some extent as food use, but for the most part they are used industrially. Vegetable fats and oils are found in highest concentration in the fruits and seeds. However, fats and oils do occur in the roots, stalks, branches, and the leaves of plants, although they are rarely large enough quantities for commercial purposes. In some seeds and fruits, the fat content is extremely high and these are the commercial sources of vegetable fats. The olive contains a large amount of fat in the pulp surrounding the kernel and only a smaller amount in the kernel itself. In contrast, the oil palm has large concentrations of oil in both the pulp and the kernel. The fat from the pulp may have characteristics quite different from those of the fat in the kernel.

3.1 Edible and Inedible Fats and Oils

A distinction is commonly made between edible and inedible fats and oils. It is generally based either upon external characteristics, such as unattractive color, taste, odor, or considerations such as an unfavorable origin, decomposition, or the possibility of contamination with a poisonous substance or diseased. The distinction between edible and inedible fats and oils is nevertheless a purely practical one. With modern methods nearly all fats can be refined or modified to the point of being edible. The distinction exists only because it is either unprofitable to convert inedible into edible or else because such conversion is not permitted for sanitary reasons.

Sanitary considerations are a more important factor in deterring the transformation of inedible into edible fats in the case of animal fats and oils than in the case of vegetable products. Animal fats may be treated as inedible even if they are not repulsive to the senses, because their origin is unsanitary. This is the case when they are obtained from animals that have died other than by slaughter, as from disease, old age, or accident. Such fats are not permitted by health authorities to be used for food purposes because of the danger of transmitting disease. Because of the danger of disease transmission, fat from animals killed by slaughter is not permitted to be used for food if inspection of the carcass shows that the animals were diseased. In most countries inspections have been established in slaughterhouses to protect the consumer from this danger. The degree and effectiveness of such inspections vary in different areas and in different countries. In the United States, food fats remain subject to the provisions of federal and local food laws after they are shipped out of the inspected slaughterhouse.

The fact that a great proportion of the fat supply, especially vegetable oils, becomes rancid and decomposed if left in unfavorable conditions, creates a need for refining, decolorizing, and deodorizing. Some oils such as cottonseed oil, require refining even when they are not decomposed, because they contain certain impurities and are dark in color. The act of refining is not merely an expense, but in the case of decomposed fats it involves the removal of the fatty acid contaminating the fat or oil. The effect is that the yield of refined oil is less than the crude oil with which the operation started. This disappearance of material is known as refining loss. It may not be profitable to refine a fat or oil even though the refining loss may only be moderate.

3.2 Biodiesel

Biodiesel fuel is a compression ignition fuel made from plant oils or from animal fats. The fuel may be used solely or in blends with petroleum diesel. Before it can be used as a fuel, the vegetable oil is first chemically reacted with alcohol by a process called transesterification. This chemical process produces an ester from the oil and also glycerol. The glycerol is removed before the ester is used as a fuel. The esterified oil can be used by most diesel engines without any modification to the engine. In general, biodiesel fuel is being promoted as a safer, cleaner burning, and biodegradable resource.

Based on this understanding of the fats and oils industry, as well as its use in biodiesel, it is time to introduce the model used in this study. Chapter IV will introduce the method, the estimation process, and describe the data used in this study.

CHAPTER IV: METHOD

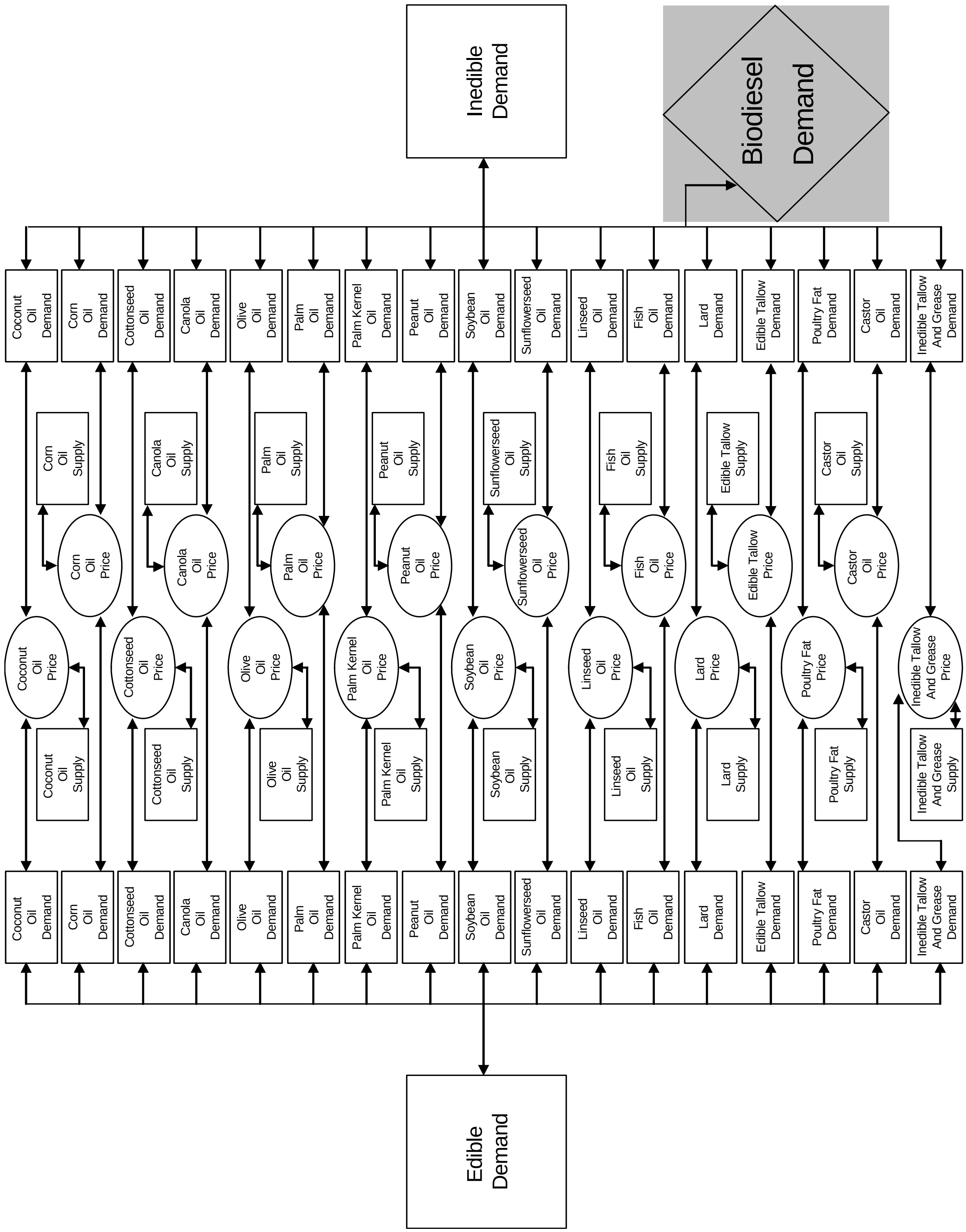
Given the research question, previous studies, and overview of the industry, Chapter IV presents the method used in developing this study and presents the estimation procedure and the data used in this analysis. First the statistical model will be described and then the estimation procedure and the data will be presented.

4.1 The Statistical Model

The model is best represented with a flow chart presented on the following page. As shown in the flow chart, edible demand is made up of seventeen fats and oils. Inedible demand and biodiesel demand are also made up of these same seventeen fats and oils. Linseed oil, fish oil, castor oil, and inedible tallow and grease all have zero edible use. The demand and supply of these fats and oils are balanced through the price of the fats and oils.

The full model is made up of seven parts. These parts include:

1. Edible Demand
2. Inedible Demand
3. Production
4. Net Returns for Biodiesel
5. Biodiesel Demand


Inedible Demand
Biodiesel Demand
Edible Demand
Coconut Oil Demand
Corn Oil Demand
Cottonseed Oil Demand
Canola Oil Demand
Olive Oil Demand
Palm Oil Demand
Palm Kernel Oil Demand
Peanut Oil Demand
Soybean Oil Demand
Sunflowerseed Oil Demand
Linseed Oil Demand
Fish Oil Demand
Lard Demand
Edible Tallow Demand
Poultry Fat Demand
Castor Oil Demand
Inedible Tallow And Grease Demand
Corn Oil Supply
Canola Oil Supply
Palm Oil Supply
Peanut Oil Supply
Sunflowerseed Oil Supply
Fish Oil Supply
Edible Tallow Supply
Castor Oil Supply
Corn Oil Price
Canola Oil Price
Palm Oil Price
Peanut Oil Price
Sunflowerseed Oil Price
Fish Oil Price
Edible Tallow Price
Castor Oil Price
Coconut Oil Price
Cottonseed Oil Price
Olive Oil Price
Palm Kernel Oil Price
Soybean Oil Price
Linseed Oil Price
Lard Price
Poultry Fat Price
Inedible Tallow And Grease Price
Coconut Oil Supply
Cottonseed Oil Supply
Olive Oil Supply
Palm Kernel Oil Supply
Soybean Oil Supply
Linseed Oil Supply
Lard Supply
Poultry Fat Supply
Inedible Tallow And Grease Supply
Coconut Oil Demand
Corn Oil Demand
Cottonseed Oil Demand
Canola Oil Demand
Olive Oil Demand
Palm Oil Demand
Palm Kernel Oil Demand
Peanut Oil Demand
Soybean Oil Demand
Sunflowerseed Oil Demand
Linseed Oil Demand
Fish Oil Demand
Lard Demand
Edible Tallow Demand
Poultry Fat Demand
Castor Oil Demand
Inedible Tallow And Grease Demand

6. Trade

7. Market Clearing

4.1.1 Edible Demand Equations

The edible demand equations are of the form:

```
eq.FAT1 =     + zSODFOD__US_00
          + zSODFOD__US_SO*log(SOPDEC__US/MAGDPD__US)
          + zSODFOD__US_CC*log(CCPROT__W1/MAGDPD__US)
          + zSODFOD__US_CL*log(CLPCHI__US/MAGDPD__US)
          + zSODFOD__US_CO*log(COPPRC__US/MAGDPD__US)
          + zSODFOD__US_VO*log(VOPESP__W1/MAGDPD__US)
          + zSODFOD__US_ML*log(MLPMAL__W1/MAGDPD__US)
          + zSODFOD__US_KO*log(KOPMAL__W1/MAGDPD__US)
          + zSODFOD__US_PO*log(POPSEM__US/MAGDPD__US)
          + zSODFOD__US_RO*log(ROPROT__W1/MAGDPD__US)
          + zSODFOD__US_UO*log(UOPMIN__US/MAGDPD__US)
          + zSODFOD__US_LR*log(LRPRPD__US/MAGDPD__US)
          + zSODFOD__US_TE*log(TEPRPD__US/MAGDPD__US)
          + zSODFOD__US_FO*log(FOPNWE__W1/MAGDPD__US)
          + zSODFOD__US_YY*log(MAGDPR__US/MAPOPT__US)
           - log(SODFOD__US/MAPOPT__US)
                        + zSODFOD__US_RR;
```

Variable definitions are available in the Appendix B. Parameters always begin with an indicator character, *z*, and end with an indication of the cross- or own-effect in question. An exception is the error or calibration term, which is a time-series variable that begins with *z* in all cases and ends with *RR*. Here, and elsewhere, *log* is the natural logarithm operator.

This equation estimates per capita soybean oil food use. Own-price, cross-price, and income elasticity estimates are drawn from previous studies. Specifically, the elasticities from the studies by Goddard and Glance, Yen and Chern, and Chern, Loehman, and Yen. Own-price elasticities were determined by averaging the estimates of the studies. If cross-price elasticities were negative in any of the studies, then the elasticity was assumed to be zero in this study. A table of the elasticities used is found in Appendix C. Each own-price and cross-price elasticity is multiplied by the log of the related price divided by the GDP deflator. The expenditure elasticity is multiplied by the log of real consumer expenditure divided by the total population. Also in the equation is an intercept term and an error term. The other twelve edible oils follow the above format.

4.1.2 Inedible Demand Equations

Now a look at the inedible demand equations. The inedible demand equations are of the form:

```
EQ.FAT204 = zSODIND__US +
     ( 1
     + 1 * (TAGGDINDUS/lag(TAGGDINDUS)-1)
     - 0.4 * ( (SOPDEC__US/lag(SOPDEC__US)-1)
     -     (TAGGPR__US/lag(TAGGPR__US)-1))
     ) * lag(SODIND__US)*zSODIND__RR
        -(SODIND__US);
```

Soybean oil industrial demand is solved for using a CES (Constant Elasticity of Substitution) functional form that is linearized in percent changes.

The CES production function is:

$$y = ((a_1x_1)^e + (a_2x_2)^e + \ldots + (a_nx_n)^e)^{1/e}$$

To attain an estimate for the constant elasticity of substitution two different sample periods were estimated. The first estimation period included the five largest fats and oils used for industrial purposes. The fats and oils used in this regression were coconut oil, palm kernel oil, soybean oil, edible tallow, and inedible tallow. The estimation period was from 1981 to 2005. The parameter estimates, approximate standard errors, and t values are displayed in the following table.

Nonlinear ITSUR Parameter Estimates

Parameter	Estimate	Approx Std Err	t Value	Approx Pr > |t|
E	0.399998	0.0446	8.96	<.0001
zCCDIND__US	1.006812	29.4907	0.03	0.9730
zKODIND__US	3.281119	15.3998	0.21	0.8331
zSODIND__US	-14.4498	19.3447	-0.75	0.4623
zTEDIND__US	-30.2051	22.3953	-1.35	0.1900
zTIDIND__US	16.99773	49.0172	0.35	0.7318

An estimate of 0.4 was given for our constant elasticity in this subset. Ordinary least squares regression was used to give estimates for own-price elasticity, intercept term, income elasticity, and the trend parameter for overall consumer demand for all inedible fats and oils. This equation is in double-logarithmic form. The results are shown below.

Nonlinear OLS Parameter Estimates

Parameter	Estimate	Approx Std Err	t Value	Approx Pr > |t|
zTAGGDINDUS__PP	-0.21326	0.1062	-2.01	0.0576
TAGGDINDUS_00	3.483663	2.3470	1.48	0.1526
zTAGGDINDUS__YY	-0.33902	1.0024	-0.34	0.7386
zTAGGDINDUS__TR	0.00618	0.0188	0.33	0.7460

The second regression was estimated over a shorter time period with more fats and oils. The fats and oils consisted of soybean oil, coconut oil, palm kernel oil, edible tallow, inedible tallow, palm oil, rapeseed oil, and lard. The parameter estimates, approximate standard errors, and t values are displayed in the following table.

Nonlinear OLS Parameter Estimates

Parameter	Estimate	Approx Std Err	t Value	Approx Pr > |t|
E	0.41351	0.0646	6.40	0.0007
zSODIND__US	6.177246	64.3456	0.10	0.9266
zKODIND__US	28.06384	31.5824	0.89	0.4084
zCCDIND__US	-12.0995	54.3510	-0.22	0.8312
zTEDIND__US	-19.055	28.0887	-0.68	0.5228
zTIDIND__US	11.48942	55.4175	0.21	0.8426
zMLDIND__US	21.6795	12.4696	1.74	0.1328
zRODIND__US	4.612496	3.6173	1.28	0.2494
zLRDIND__US	-13.1162	20.3368	-0.64	0.5428

An estimate of 0.41 was given for our constant elasticity in this subset. Again, the double-logarithmic equation representing total demand for fats and oils was also estimated using ordinary least squares regression, generating estimates for own-price elasticity, intercept term, income elasticity, and the trend parameter. The results are shown below.

Nonlinear OLS Parameter Estimates

Parameter	Estimate	Approx Std Err	t Value	Approx Pr > |t|
TAGGDINDUS_00	-48.3653	49.9818	-0.97	0.4046
zTAGGDINDUS__YY	22.00586	21.6002	1.02	0.3833
zTAGGDINDUS__PP	0.216177	0.3789	0.57	0.6083
zTAGGDINDUS__TR	-0.48991	0.4802	-1.02	0.3827

Based on the results of these two regressions an estimate of 0.4 is used for our constant elasticity of substitution. It is quite reassuring that both of the subsets resulted in very close estimates for "E". Parameters are also chosen from these estimation results for the total inedible fat and oil demand equation, which is defined below, but the link is necessarily less precise given the diversity and apparent unreliability of some of the estimated parameters.

The example of the industrial demand equation above is for soybean oil industrial demand. Soybean oil industrial demand is a function of the total aggregate industrial demand divided by the lag of total aggregate industrial demand, minus 0.4 times soybean oil price divided by lag of price, minus the total aggregate price divided by the lag of total aggregate price. This is then multiplied by the lag of soybean oil industrial use with a multiplicative error term. All seventeen oils follow the same form as soybean oil.

The total aggregate demand equation is:

```
eq.FAT202 =
   + TAGGDINDUS_00
   + (0)*log(MAGDPR__US/MAPOPT__US)
   + (-0.2)*log(TAGGPR__US/MAGDPD__US)
   + zTAGGDINDUS__TR*(ztime - 1970)
   - log(TAGGDINDUS / MAPOPT__US)
   + zTAGGDINDUS_RR ;
```

For this equation estimates were used from the subset results reported earlier in this chapter. An estimate of zero is used for the income elasticity because a negative result does not seem plausible. An estimate of -0.2 is used for the own-price elasticity that was a result from the first subset.

The cost equation is:

```
eq.FAT203 =
(1 + (TAGGDINDUS/lag(TAGGDINDUS)-1)+(TAGGPR__US/lag(TAGGPR__US)-1))
 * lag(Cost)
 - Cost;
```

The cost equation is found by taking one plus the total aggregate demand for industrial oils divided by the lag of the total aggregate demand for industrial oils minus one. Total aggregate price is divided by the lag of total aggregate price then subtracting one , and the total is multiplied by the lag of cost.

The total aggregate price equation is:

```
eq.FAT200 =
(
+(SOPDEC__US/lag(SOPDEC__US)-1)*(SOPDEC__US*SODIND__US/Cost)
+(KOPMAL__W1/lag(KOPMAL__W1)-1)*(KOPMAL__W1*KODIND__US/Cost)
+(CCPROT__W1/lag(CCPROT__W1)-1)*(CCPROT__W1*CCDIND__US/Cost)
+(TEPRPD__US/lag(TEPRPD__US)-1)*(TEPRPD__US*TEDIND__US/Cost)
+(TIPRNO__US/lag(TIPRNO__US)-1)*(TIPRNO__US*TIDIND__US/Cost)
+(MLPMAL__W1/lag(MLPMAL__W1)-1)*(MLPMAL__W1*MLDIND__US/Cost)
+(ROPMWT__US/lag(ROPMWT__US)-1)*(ROPMWT__US*RODIND__US/Cost)
+(LRPRPD__US/lag(LRPRPD__US)-1)*(LRPRPD__US*LRDIND__US/Cost)
+(CLPCHI__US/lag(CLPCHI__US)-1)*(CLPCHI__US*CLDIND__US/Cost)
+(COPPRC__US/lag(COPPRC__US)-1)*(COPPRC__US*CODIND__US/Cost)
+(VOPESP__W1/lag(VOPESP__W1)-1)*(VOPESP__W1*VODIND__US/Cost)
+(POPSEM__US/lag(POPSEM__US)-1)*(POPSEM__US*PODIND__US/Cost)
+(UOPMIN__US/lag(UOPMIN__US)-1)*(UOPMIN__US*UODIND__US/Cost)
+(LNPMINJMUS/lag(LNPMINJMUS)-1)*(LNPMINJMUS*LNDINDJMUS/Cost)
+(PFPR____US/lag(PFPR____US)-1)*(PFPR____US*PFDIND__US/Cost)
+(AOPROT__W1/lag(AOPROT__W1)-1)*(AOPROT__W1*AODIND__US/Cost)
+(FOPNWE__W1/lag(FOPNWE__W1)-1)*(FOPNWE__W1*FODIND__US/Cost)
)
-(TAGGPR__US/lag(TAGGPR__US)-1)
+ zTAGGPR__US_RR ;
```

The total aggregate price equation is the summation of all the oil prices divided by the lag of oil price minus one. This term is multiplied by the price of the oil times the industrial demand divided by cost. These equations make up the inedible demand equations. Next are the production equations.

4.1.3 Production Equations

The production equations take the form:

```
eq.FAT508 = + zSOSPRD__US__00
            + 0.5*log(SOPDEC__US/MAGDPD__US)
            + 0.5*log(lag(SOSPRD__US))
            - log(SOSPRD__US)
            + zSOSPRD__US__RR
            ;
```

Soybean production is the log of soybean price divided by the GDP deflator plus the log of the lagged soybean production. The elasticities of 0.5 are assumed for the equations. There is also an intercept term and an error term. All fats and oils except those not produced in the U.S. are included in the production equations.

4.1.4 Net Returns for Biodiesel Equations

The net returns equations for biodiesel are of the form:

```
eq.FAT308 = + zSONRTBD_00
            + BDPPLTM
            - (SOPDEC__US/100)*(7.62/.97)
            - OENGRYCOST
            - ONENGYCOST
            - SONRTBD_US
            + zSONRTBD_RR
            ;
```

For each oil *k*, the net return of using oil *k* to make biodiesel over operating costs is the sum of an intercept term and biodiesel price by marketing year. Then subtracting the price of the oil divided by 100, to get dollars per gallon. The price is then multiplied by a technical conversion factor, namely the number of pounds it takes to get a gallon of biodiesel, and divided by the loss rate. Other energy costs and other non-energy costs are subtracted from the equation, and an error term is added.

The other costs include utility costs and exclude the costs of capital. The other non-energy costs include the costs of methanol, catalyst, ion resin, labor, repairs, and depreciation. These equations are not estimated. They are drawn from the data source that can be found in Appendix A. The intercepts for the net returns equations are assumed. The intercepts were chosen to calibrate the net returns to be positive for soybean oil and inedible tallow for the year 2007, at the appropriate demand levels. The rest of the intercepts were chosen to keep all other fats and oils from having positive net returns for the year 2007. Table 4.1.4 displays the intercepts used in the net returns equations.

Table 4.2 Net Return Intercepts

zCCNRTBD_00	-0.044177
zCLNRTBD_00	0
zCONRTBD_00	0
zVONRTBD_00	0
zMLNRTBD_00	-0.628554
zKONRTBD_00	-0.151075
zPONRTBD_00	0
zRONRTBD_00	0
zSONRTBD_00	1.054709
zUONRTBD_00	0
zLNNRTBD_00	0
zLRNRTBD_00	-0.477805
zTENRTBD_00	-0.840662
zTINRTBD_00	-0.664641
zPFNRTBD_00	-1.161085
zAONRTBD_00	0
zFONRTBD_00	0

4.1.5 Biodiesel Demand Equations

These equations result in the demand for oils that are used to manufacture biodiesel. The demand equations are of the form:

```
eq.FAT408 =   + zSODBIO__00
              +(zSODBIO__US*max(0,SONRTBD_US))**2
              - SODBIO__US
              + zSODBIO__RR;
```

For each oil *k*, the biodiesel demand of oil *k* is the sum of an intercept term, a parameter multiplied by the maximum of zero or the net return of oil *k* squared and an error term. The intercept term is assumed to be zero. The other parameter, *zSODBIO__US*, has been restricted to equal 1. Biodiesel demand for soybean oil has increased steadily since 2005, and the only other fat or oil that biodiesel data was available was for inedible tallow in 2007. Absence of more historical biodiesel demand data for the other fats and oils results in a fairly stylized representation of net returns and biodiesel demand.

4.1.6 Trade Equations

The trade equations are of the form:

```
eq.FAT608 = + zSODEXT__US_00
            - zSODEXT__US_US*log(SOPDEC__US/MAGDPD__US)
            - log(SODEXT__US)
            + zSODEXT__US_RR
            ;
```

For each oil *k*, the trade equations are the sum of an intercept term, minus exports or plus imports (whichever is more significant) multiplied by the log of the price of oil *k* divided by the GDP deflator, and an error term. The assumed elasticities for these equations are negative 1 for exports and positive 1 for imports.

4.1.7 Market Clearing Equations

The market clearing equations are of the form:

```
eq.FAT14 = SOSPRD__US
         + SOSIMP__US
         + SOSTBS__US
         - SODTES__US
         - SODEXT__US
         - SODIND__US
         - SODFOD__US
         - SODBIO__US
```

```
- SOCLEARING;
```

These equations add up the supply of oil and subtract the demand of the oil so that the equation is equal to zero. It is through the market clearing equations that the price of the oils will eventually be solved.

4.2 Estimation

This model does not rely heavily on estimation. The only estimation in this study takes place in the inedible demand equations. As described previously in the chapter, the CES-function is used to estimate a constant elasticity of substitution for the inedible fats and oils (Berck and Sydsaeter, 1991). After solving two subsets of inedible demand equations an estimate of 0.4 was attained for the constant elasticity of substitution. Elasticities of the total inedible fat and oil demand equation are also tied to underlying statistical estimates, but only loosely because only the own-price estimate proved reliable and, even then, only in one of two estimates. For the edible fats and oils equations elasticities were borrowed from previous studies.

For the other sets of equations, a calibration process was used where the intercept term and the error terms were set to zero. Then the equations are solved over a historical time period and predicted for a future time period. The seven different sets of equations are then brought into the full model and solved simultaneously from 2007 to 2017.

4.3 Data

The data used in this study are presented in Appendix A. Marketing year annual data were used for as many years as the data allowed. The data come from a number of different databases. Supply and demand numbers for coconut oil, cottonseed oil, olive oil, palm oil, palm kernel oil, peanut oil, rapeseed oil, soybean oil, and sunflowerseed oil are from the United States Department of Agriculture website for Production, Supply and Distribution (www.usda.gov). Supply and demand numbers for corn oil, linseed oil, lard, and edible tallow are from the Oil Crop Yearbook, also found on the USDA website. Inedible tallow and poultry fat numbers were found on the U.S. Census Bureau website (www.census.gov). Fish oil and castor oil numbers were found in Oil World annual reports. Prices for all the oils are drawn from these same sources, with the exception of poultry fat. Poultry fat numbers are drawn from Vision Track Price Discovery Service. The World Agricultural Supply and Demand Estimates report found on the USDA website was the source for soybean oil used for methyl ester. Inedible tallow used for methyl ester came from the U.S. Census Bureau reports.

CHAPTER V: RESULTS

The fats and oils model is solved for the year 2007 and forecasted through the year 2017 using annual marketing year time series data. The results are presented in Tables 5.1 through 5.7 at the end of the chapter. The tables present the forecasted values for food use, industrial use, trade, production, net returns for biodiesel, demand for use in biodiesel production, and price. The mnemonics are presented in Table 5.8.

5.1 Food Use Results

The food use equation results are presented in Table 5.1. Each food use for the fats and oils grows over the forecast period. Soybean oil is by far the largest of the oils and grows from 16,611 million pounds in 2007 to 20,411 million pounds in 2017. Rapeseed oil's food use is the second largest followed by corn oil in 2007. By 2014, corn oil becomes the second largest moving ahead of rapeseed oil. Both oils are close to 3,000 million pounds in 2017.

5.2 Industrial Use Results

The industrial use equation results are presented in Table 5.2. The total aggregate demand for industrial use increases slightly over the forecast period. The total aggregate price, however, increases steadily. Coconut oil has the most industrial use of any oil in 2007. Coconut oil demand for industrial use decreases every year as more is used for biodiesel. Palm oil, palm kernel oil, rapeseed oil, inedible tallow, and poultry fat all increase over the forecast period. The other fats and oils slowly decrease in industrial use.

5.3 Trade Results

Table 5.3 presents the results for the trade equations. The domestic price of the oils decreases, and is evidenced in these results by the decreases in exports. Imports of oils increase as the world price does not rise as sharply as the domestic price. Palm oil and rapeseed oil are the two largest imports, both increasing steadily over the forecast period.

5.4 Production Results

Table 5.4 presents the results for the production equations. Soybean oil is by far the largest oil of the group and gets larger over time. Inedible tallow increases the most of all the oils from 2007 to 2017. Inedible tallow grows from 6,546 million pounds to 8,584 million pounds. It is interesting to see where the production increase is allocated in the model and how much of the increased production goes toward biodiesel.

5.5 Net Returns for Biodiesel Results

Table 5.5 presents the results for the net returns for biodiesel equations. Since biodiesel demand numbers were only found for soybean oil and inedible tallow, the equations were calibrated so that only soybean oil and inedible tallow have positive net returns in 2007. Soybean oil net returns stay positive and have the largest net returns.

Coconut oil net returns turn positive in 2009 and continue to grow. Inedible tallow net returns become negative in 2008 and then return to positive numbers. Poultry fat, palm kernel oil, palm oil, edible tallow, lard, castor oil, and fish oil all turn positive after a few years of negative returns. For the rest of the oils net returns are never positive.

5.6 Biodiesel Demand Results

Table 5.6 presents the results for the biodiesel processor demands for fats and oils equations. In 2007, the only biodiesel produced is from soybean oil and inedible tallow. Soybean oil demand for biodiesel is the largest in the forecast period for every year. The second largest processor demand comes from inedible tallow, which grows to two-thirds of soybean oil demand. Coconut oil begins to be produced starting in 2009 and steadily climbs throughout the forecast period. Poultry fat starts being produced in 2009 and grows throughout the forecast period. Lard has the fifth largest biodiesel processor demand with over 200 million pounds in 2017. The other oils that have some biodiesel demand are palm kernel oil, palm oil, castor oil, and fish oil.

5.7 Price Results

Table 5.7 presents the results for the price equations. All of the prices trend upward throughout the forecast period. Soybean oil starts at fifty-five cents per pound in 2007 and is up to seventy-six cents per pound in 2017. The lowest priced oil in 2017 is poultry fat and this was evidenced by the amount of poultry fat oil demand by processors for biodiesel. Inedible tallow is one of the cheaper fats and is also evidenced in its growing biodiesel processor demand. As soybean oil price continues to go higher the processor demand for biodiesel drops.

Table 5.1 Edible Food Use

	SODFOD__US	CCDFOD__US	CLDFOD__US	CODFOD__US	VODFOD__US	MLDFOD__US
			(Million Pounds)			
2007	16611.3	198.4	1825.3	654.8	553.4	1455.1
2008	17108.8	202.0	1890.0	647.7	554.1	1489.4
2009	17080.0	204.2	2043.7	688.1	578.2	1592.4
2010	17282.5	207.3	2176.6	733.4	596.0	1657.1
2011	17703.8	211.3	2269.2	770.5	606.3	1687.0
2012	18211.2	215.4	2340.5	798.9	612.5	1685.1
2013	18658.5	219.1	2410.6	823.8	618.1	1688.8
2014	19086.7	222.7	2482.6	848.0	623.8	1695.3
2015	19534.2	226.5	2561.9	874.3	629.9	1708.8
2016	19956.6	230.2	2662.5	908.1	638.3	1748.2
2017	20411.8	234.1	2759.3	942.5	646.2	1777.9

	KODFOD__US	PODFOD__US	RODFOD__US	UODFOD__US	LRDFOD__US	TEDFOD__US
			(Million Pounds)			
2007	242.5	299.8	2017.2	571.0	474.0	1121.1
2008	256.0	316.3	2054.5	580.0	493.6	1187.1
2009	294.5	340.6	2178.7	603.1	524.2	1359.2
2010	324.0	360.0	2289.1	621.2	547.0	1514.9
2011	343.0	373.4	2378.7	631.5	564.8	1606.2
2012	356.5	383.4	2453.7	636.4	576.7	1678.6
2013	368.6	393.1	2522.8	640.0	588.8	1756.5
2014	381.4	403.2	2593.1	643.4	601.4	1838.9
2015	396.2	414.4	2667.8	647.0	616.7	1924.9
2016	417.5	429.0	2753.9	652.4	640.8	2018.8
2017	437.2	442.9	2840.4	657.6	662.3	2114.4

Table 5.2 Industrial Use

	CCDIND__US	CLDIND__US	CODIND__US	VODIND__US	MLDIND__US	KODIND__US	PODIND__US	RODIND__US	SODIND__US	UODIND__US
						(Million Pounds)				
2007	727.5	0.0	0.0	0.0	202.8	416.7	0.0	66.1	487.6	0.0
2008	715.1	0.0	0.0	0.0	241.2	419.9	0.0	75.3	464.8	0.0
2009	687.2	0.0	0.0	0.0	280.9	425.3	0.0	85.1	435.0	0.0
2010	663.3	0.0	0.0	0.0	320.9	427.4	0.0	94.8	406.7	0.0
2011	644.0	0.0	0.0	0.0	361.9	432.7	0.0	104.2	379.4	0.0
2012	627.0	0.0	0.0	0.0	403.4	439.3	0.0	113.5	352.5	0.0
2013	609.8	0.0	0.0	0.0	444.9	443.7	0.0	122.9	325.1	0.0
2014	592.3	0.0	0.0	0.0	486.5	448.0	0.0	132.4	297.3	0.0
2015	574.4	0.0	0.0	0.0	527.9	452.3	0.0	141.9	269.0	0.0
2016	555.4	0.0	0.0	0.0	568.2	456.2	0.0	151.5	240.1	0.0
2017	536.4	0.0	0.0	0.0	609.4	460.2	0.0	161.2	210.8	0.0

	LNDINDJMUS	LRDIND__US	TEDIND__US	TIDIND__US	PFDIND__US	AODIND__US	FODIND__US	TAGGDINDUS	TAGGPR__US	COST
					(Million Pounds)				(Cents/Pound)	(Million Cents)
2007	170.6	272.8	401.4	4805.2	1190.2	26.2	26.0	7670.7	36.9	288354.1
2008	159.7	260.2	378.4	4930.5	1238.1	25.3	25.1	7763.6	37.7	298408.0
2009	158.1	242.1	352.7	4905.5	1237.4	24.9	23.8	7700.2	42.6	334749.6
2010	157.6	225.2	330.0	4930.3	1253.2	24.3	22.5	7692.5	46.5	365169.9
2011	156.4	210.6	309.1	5006.3	1287.7	23.4	21.3	7748.6	48.8	385567.5
2012	154.9	196.8	289.8	5108.3	1331.2	22.5	20.3	7836.4	50.1	400457.7
2013	153.3	182.9	270.3	5212.3	1375.6	21.4	19.2	7922.8	51.5	415858.0
2014	151.7	168.8	250.5	5315.6	1419.9	20.1	18.1	8007.2	53.0	432520.6
2015	150.1	154.5	230.0	5419.0	1464.2	18.8	16.9	8089.5	54.7	450399.8
2016	148.7	139.7	207.7	5512.0	1505.1	17.4	15.8	8156.3	56.9	472617.7
2017	147.2	124.9	186.0	5610.2	1547.9	16.1	14.6	8228.7	59.0	494140.2

Table 5.3 Trade Results

	CCSIMP__US	CLDEXT__US	CODEXT__US	VOSIMP__US	MLSIMP__US	KOSIMP__US	POSIMP__US	ROSIMP__US
					(Million Pounds)			
2007	941.4	740.0	116.8	573.2	1571.9	661.4	138.9	1759.3
2008	932.6	734.6	108.2	574.0	1644.6	678.1	147.7	1807.2
2009	1025.7	733.6	97.9	598.0	1787.3	725.2	160.4	1916.5
2010	1091.2	733.4	92.1	615.7	1900.6	773.3	168.8	2004.0
2011	1116.3	733.4	89.2	626.0	1962.9	792.3	173.5	2070.8
2012	1119.9	733.4	87.4	632.2	2002.5	798.0	176.9	2125.9
2013	1123.7	733.4	85.5	637.7	2047.7	814.4	180.9	2177.6
2014	1128.9	733.4	83.5	643.4	2095.8	831.7	185.3	2231.3
2015	1135.3	733.4	81.3	649.5	2150.7	850.7	190.5	2288.9
2016	1151.7	733.4	78.2	657.8	2230.4	875.9	197.6	2355.6
2017	1164.9	733.4	75.7	665.7	2301.3	899.6	203.8	2421.6

	SODEXT__US	UODEXT__US	LNDEXTJMUS	LRDEXT__US	TEDEXT__US	TIDEXT__US	AOSIMP__US	FODEXT__US
					(Million Pounds)			
2007	1649.1	130.1	75.0	75.0	293.5	1602.7	29.0	85.0
2008	1673.4	132.7	66.3	74.9	283.2	1613.1	28.1	85.6
2009	1553.9	128.0	63.2	67.6	254.8	1432.5	27.7	79.0
2010	1487.2	125.6	62.5	62.9	238.3	1327.5	27.1	74.3
2011	1466.8	125.0	62.7	61.2	230.8	1288.6	26.2	72.6
2012	1468.2	125.1	63.2	60.8	228.9	1279.5	25.3	72.4
2013	1468.9	124.8	63.6	60.5	226.9	1270.4	25.2	72.2
2014	1467.9	124.3	64.0	60.0	224.5	1259.2	25.3	71.9
2015	1465.5	123.8	64.4	59.5	221.0	1246.9	25.5	71.5
2016	1452.8	122.8	64.8	58.5	212.8	1222.4	25.8	70.5
2017	1443.3	122.1	65.2	57.6	206.9	1203.1	26.1	69.7

Table 5.4 Production Results

	CLSPRD__US	COSPRD__US	VOSPRD__US	POSPRD__US	ROSPRD__US	SOSPRD__US
			(Million Pounds)			
2007	2560.0	754.0	2.2	169.8	855.4	20769.7
2008	2554.6	738.3	2.2	177.4	853.9	20760.7
2009	2553.6	768.4	2.3	189.0	878.5	21539.2
2010	2553.4	807.9	2.3	200.0	911.2	22426.5
2011	2553.4	842.1	2.4	208.7	943.4	23042.5
2012	2553.4	868.6	2.4	215.2	972.6	23345.3
2013	2553.4	891.7	2.4	221.1	999.4	23492.9
2014	2553.4	913.9	2.4	226.7	1025.5	23574.9
2015	2553.4	937.9	2.5	232.8	1052.2	23635.2
2016	2553.4	968.7	2.5	240.2	1081.2	23768.9
2017	2553.4	1000.6	2.5	247.9	1111.2	23913.9

	UOSPRD__US	LNSPRDJMUS	LRSPRD__US	TISPRD__US	TESPRD__US	FOSPRD__US
			(Million Pounds)			
2007	659.2	212.0	815.0	6546.5	1817.6	95.0
2008	670.8	192.4	822.0	6525.4	1850.3	94.7
2009	689.1	187.7	869.3	6913.4	1968.3	98.4
2010	705.0	186.5	926.8	7392.0	2098.7	103.4
2011	714.6	185.6	970.2	7758.0	2202.3	107.2
2012	719.5	184.4	995.5	7975.9	2265.6	109.3
2013	722.8	183.3	1011.3	8116.3	2307.9	110.6
2014	725.8	182.1	1023.0	8223.5	2341.6	111.5
2015	728.9	180.9	1033.1	8318.7	2377.5	112.2
2016	733.3	179.9	1047.6	8449.8	2441.0	113.4
2017	737.7	178.8	1062.5	8584.2	2508.9	114.6

Table 5.5 Net Returns for Biodiesel Results

	CCNRTBD_US	CLNRTBD_US	CONRTBD_US	VONRTBD_US	MLNRTBD_US	KONRTBD_US	PONRTBD_US	RONRTBD_US	SONRTBD_US
					(Dollars/Gallon)				
2007	$0.00	-$2.61	-$2.99	-$9.82	$0.00	$0.00	-$4.70	-$2.24	$0.05
2008	-$0.02	-$2.75	-$3.60	-$10.06	-$0.17	-$0.13	-$5.35	-$2.48	$0.05
2009	$0.01	-$2.44	-$4.05	-$10.44	-$0.05	$0.00	-$5.84	-$2.52	$0.06
2010	$0.01	-$2.25	-$4.38	-$10.82	$0.00	$0.00	-$6.21	-$2.61	$0.06
2011	$0.02	-$2.20	-$4.66	-$11.20	-$0.01	$0.00	-$6.54	-$2.80	$0.07
2012	$0.02	-$2.23	-$4.93	-$11.57	-$0.05	-$0.01	-$6.88	-$3.03	$0.06
2013	$0.02	-$2.26	-$5.21	-$11.91	-$0.12	-$0.08	-$7.25	-$3.26	$0.06
2014	$0.02	-$2.28	-$5.52	-$12.27	-$0.18	-$0.15	-$7.66	-$3.50	$0.06
2015	$0.02	-$2.30	-$5.88	-$12.65	-$0.25	-$0.23	-$8.13	-$3.75	$0.06
2016	$0.02	-$2.28	-$6.35	-$13.05	-$0.34	-$0.31	-$8.70	-$4.00	$0.05
2017	$0.02	-$2.26	-$6.79	-$13.45	-$0.43	-$0.40	-$9.24	-$4.28	$0.05

	UONRTBD_US	LNNRTBD_US	LRNRTBD_US	TENRTBD_US	TINRTBD_US	PFNRTBD_US	AONRTBD_US	FONRTBD_US
					(Dollars/Gallon)			
2007	-$4.51	-$2.44	$0.00	$0.00	$0.01	$0.00	-$1.24	-$0.04
2008	-$4.48	-$3.30	-$0.05	-$0.13	-$0.01	-$0.03	-$1.17	-$0.07
2009	-$4.49	-$3.32	$0.01	-$0.05	$0.02	$0.01	-$0.75	$0.00
2010	-$4.49	-$3.22	$0.01	$0.00	$0.03	$0.01	-$0.42	$0.00
2011	-$4.53	-$3.17	$0.01	$0.01	$0.04	$0.02	-$0.20	$0.01
2012	-$4.60	-$3.16	$0.01	$0.01	$0.04	$0.02	-$0.03	$0.01
2013	-$4.70	-$3.16	$0.01	$0.01	$0.04	$0.02	$0.00	$0.01
2014	-$4.80	-$3.15	$0.01	$0.01	$0.04	$0.02	$0.00	$0.01
2015	-$4.91	-$3.13	$0.01	-$0.01	$0.04	$0.02	$0.00	$0.01
2016	-$5.01	-$3.09	$0.01	-$0.08	$0.04	$0.02	$0.00	$0.01
2017	-$5.11	-$3.04	$0.01	-$0.13	$0.04	$0.02	$0.00	$0.01

Table 5.6 Biodiesel Demand Results

	CCDBIO__US	MLDBIO__US	KODBIO__US	SODBIO__US	LRDBIO__US
			(Million Pounds)		
2007	0.0	0.0	0.0	2800.0	0.0
2008	0.0	0.0	0.0	2291.9	0.0
2009	118.9	0.0	3.2	3248.5	42.2
2010	205.2	8.6	19.8	4028.4	98.4
2011	245.5	0.0	14.3	4270.8	140.4
2012	262.1	0.0	0.0	4091.6	167.9
2013	279.3	0.0	0.0	3818.6	185.8
2014	298.4	0.0	0.0	3501.3	199.5
2015	319.0	0.0	0.0	3144.8	209.2
2016	350.7	0.0	0.0	2897.7	215.4
2017	378.9	0.0	0.0	2626.1	224.4

	TEDBIO__US	TIDBIO__US	PFDBIO__US	AODBIO__US	FODBIO__US
			(Million Pounds)		
2007	0.0	156.9	0.0	0.0	0.0
2008	0.0	0.0	0.0	0.0	0.0
2009	0.0	593.8	91.8	0.0	11.6
2010	13.8	1152.4	206.8	0.0	22.7
2011	54.5	1481.3	297.0	0.0	29.3
2012	66.6	1606.3	353.1	0.0	32.7
2013	52.5	1651.9	390.8	1.1	35.2
2014	25.9	1666.9	420.4	2.5	37.5
2015	0.0	1671.1	446.9	3.9	39.8
2016	0.0	1733.6	481.6	5.6	43.2
2017	0.0	1789.2	517.0	7.2	46.3

Table 5.7 Price Results

	CCPROT__W1	CLPCHI__US	COPPRC__US	VOPESP__W1	MLPMAL__W1	KOPMAL__W1	POPSEM__US	ROPMWT__US	SOPDEC__US
					(Cents/Pound)				
2007	41.7	70.0	74.5	156.9	34.2	40.3	96.8	70.0	55.0
2008	42.0	71.8	81.9	159.9	36.5	42.1	104.8	73.2	55.2
2009	47.0	73.1	92.1	169.4	40.3	45.8	115.7	78.9	60.4
2010	51.0	74.5	99.7	177.8	43.7	49.7	124.1	84.1	64.3
2011	53.2	76.0	105.1	184.4	46.0	52.0	130.2	88.7	66.6
2012	54.5	77.6	109.4	190.0	47.9	53.4	135.4	92.9	67.8
2013	55.7	79.0	113.9	195.2	49.9	55.6	141.1	96.9	69.1
2014	57.0	80.5	118.8	200.8	52.1	57.8	147.3	101.2	70.5
2015	58.4	82.1	124.4	206.6	54.5	60.3	154.3	105.9	71.9
2016	60.4	83.7	131.8	213.3	57.6	63.3	163.1	111.0	74.0
2017	62.2	85.2	138.7	219.8	60.5	66.2	171.4	116.3	75.8

	UOPMIN__US	LNPMINJMUS	LRPRPD__US	TEPRPD__US	TIPRNO__US	PFPR____US	AOPROT__W1	FOPNWE__W1
					(Cents/Pound)			
2007	94.5	69.5	31.3	27.3	29.1	23.8	54.4	40.1
2008	94.3	80.0	31.9	28.8	29.5	24.2	53.7	40.6
2009	99.4	85.3	36.0	32.6	33.7	28.4	53.7	44.7
2010	103.2	88.0	39.4	35.5	37.1	31.8	53.5	48.5
2011	105.8	89.5	41.3	37.4	39.0	33.8	53.0	50.6
2012	107.9	90.6	42.4	38.5	40.1	34.8	52.2	51.7
2013	110.2	91.7	43.5	39.5	41.1	35.9	52.9	52.9
2014	112.8	92.8	44.6	40.7	42.3	37.0	54.2	54.1
2015	115.4	94.0	45.9	42.2	43.5	38.3	55.5	55.5
2016	118.6	95.3	47.6	44.6	45.2	40.0	57.4	57.4
2017	121.5	96.5	49.2	46.8	46.8	41.6	59.1	59.1

Table 5.8 Variable Definitions

CC: Coconut Oil
CL: Corn Oil
CO: Cottonseed Oil
VO: Olive Oil
RO: Rapeseed Oil
SO: Soybean Oil
LN: Linseed Oil
PO: Peanut Oil
ML: Palm Oil
KO: Palm Kernel Oil
UO: Sunflowerseed Oil
LR: Lard Oil
TE: Edible Tallow
TI: Inedible Tallow
PF: Poultry Fat
AO: Castor Oil
FO: Fish Oil
LG: Lagged (As in lagged dependent)
RR: Residual/Error
00: Intercept
YY: Income

xxCLEARING: Market Clearing for fat or oil xx.

xxSIMP__US: Imports for fat or oil xx.

xxDEXT__US: Exports for fat or oil xx.

xxSPRD__US: Production for fat or oil xx.

xxNRTBD_US: Net returns for biodiesel for fat or oil xx.

xxDFOD__US: Demand for food use for fat or oil xx.

xxDIND__US: Demand for industrial use for fat or oil xx.

xxDBIO__US: Demand for biodiesel use for fat or oil xx.

xxP_____US: U.S. price of fat or oil xx.

xxP_____US: World price of fat or oil xx.

CHAPTER VI: SIMULATION OF ALTERNATIVE BIODIESEL SCENARIOS

The preceding chapters have developed a fats and oils model for the purpose of evaluating biodiesel impacts on the fats and oils market. In this chapter, the simulation results of two alternative biodiesel scenarios are used to illustrate how different biodiesel prices associated with different U.S. policy regimes affect the fats and oils market. One of the biodiesel policies selected is a recently proposed EISA mandate which requires the production of one billion gallons of biodiesel by 2012. The other takes a look at the effects of letting the biodiesel tax credit expire.

A baseline scenario is also developed for comparison with the other scenarios. Under this scenario, the current blenders credit is extended through 2017. This will provide a basis for comparison with the other scenarios which would change the current biodiesel price. The baseline results were summarized in the preceding chapter. The scenarios are simulated independently of one another over the period of 2007 through 2017.

6.1 Effects of Allowing Biodiesel Tax Credit to Expire

The blender's credit for biodiesel made from pre-consumer fats and oils is currently $1.00 per gallon (FAPRI–MU Report #06–08). This scenario allows this biodiesel tax credit to expire in 2008. It is then compared to the baseline scenario that extends the credit. The model is solved again using FAPRI's estimate of a drop in biodiesel rack price of 5.6%.

With this drop in the biodiesel price, biodiesel net returns and demand for biodiesel fall. Biodiesel blenders have to charge more to consumers and pay less to producers. It is most apparent in soybean oil and inedible tallow. These two fats and oils decline to zero demand in 2015 for soybean oil and 2008 for inedible tallow. Coconut oil demand is reduced but it is not affected as harshly as soybean oil. By 2015, coconut oil has the largest demand and poultry fat has the second largest. Prices of all fats and oils fall in this scenario as the tax credit is removed which meets our *a priori* expectations.

Total aggregate industrial demand for fats and oils rises very slightly in the scenario as compared to the baseline. Food use is lowered across all the oils with the decline in production of all oils. Exports of oils are higher than in the baseline as the domestic prices are down and imports decline. The main effect of allowing the tax credit to expire would be to force consumers of blended diesel fuel to pay for biodiesel use rather than taxpayers (FAPRI–MU Report #06–08).

6.2 Effects of Removing EISA Provisions

The EISA has mandated that by 2012 one billion gallons of biodiesel be produced. To measure the impact of removing these mandates the baseline scenario will be compared to a scenario with FAPRI's estimate of the drop in biodiesel price. FAPRI estimated that this scenario would result in a 29.2% drop in biodiesel rack price.

“If ethanol and biodiesel supplies far exceed the levels of biofuel use required by EISA, the mandates may have little impact on biofuel markets. This is most likely to occur when high petroleum prices and low crop prices make biofuel production profitable” (FAPRI–MU Report #06–08, pg 33). This scenario amplifies what has happened in the tax credit scenario. Prices drop across all oils, as does biodiesel net returns and processor demand for biodiesel. Biodiesel production comes to a halt from 2009 to 2012. Only coconut oil is used to make biodiesel after this time period in this scenario. Coconut oil is profitable from 2013 to 2017.

With the displacement of the previous processor demand for biodiesel, some oils have a growth in food and industrial demand, such as coconut, soybean, and poultry fat. Once again exports increase with a lower domestic price, and imports increase. Production has fallen across all oils as in the other scenario.

Table 6.1 Effects of Letting the Biodiesel Tax Credit Expire on Net Returns for Biodiesel

Year	CCNRTBD_US	CLNRTBD_US	CONRTBD_US	VONRTBD_US	MLNRTBD_US	KONRTBD_US	PONRTBD_US	RONRTBD_US	SONRTBD_US
					(Dollars/Gallon)				
2007	$0.00	-$2.61	-$2.99	-$9.82	$0.00	$0.00	-$4.70	-$2.24	$0.05
2008	-$0.02	-$2.75	-$3.60	-$10.06	-$0.17	-$0.13	-$5.35	-$2.48	$0.05
2009	$0.01	-$2.68	-$3.97	-$10.38	-$0.17	-$0.12	-$5.76	-$2.64	$0.05
2010	$0.01	-$2.50	-$4.36	-$10.76	-$0.12	-$0.07	-$6.20	-$2.75	$0.05
2011	$0.01	-$2.46	-$4.63	-$11.14	-$0.13	-$0.09	-$6.53	-$2.95	$0.05
2012	$0.01	-$2.50	-$4.93	-$11.50	-$0.20	-$0.16	-$6.91	-$3.18	$0.05
2013	$0.01	-$2.53	-$5.23	-$11.85	-$0.27	-$0.24	-$7.30	-$3.41	$0.05
2014	$0.01	-$2.56	-$5.57	-$12.20	-$0.36	-$0.32	-$7.74	-$3.65	$0.04
2015	$0.02	-$2.59	-$5.94	-$12.57	-$0.45	-$0.40	-$8.22	-$3.90	$0.04
2016	$0.02	-$2.57	-$6.38	-$12.97	-$0.53	-$0.48	-$8.76	-$4.16	$0.04
2017	$0.02	-$2.57	-$6.80	-$13.37	-$0.62	-$0.56	-$9.29	-$4.43	$0.03

Percent Change From Baseline

Year	CCNRTBD_US	CLNRTBD_US	CONRTBD_US	VONRTBD_US	MLNRTBD_US	KONRTBD_US	PONRTBD_US	RONRTBD_US	SONRTBD_US
2007	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2008	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2009	-39.3%	9.8%	-1.9%	-0.6%	261.2%	-6828.5%	-1.4%	4.8%	-15.6%
2010	-21.6%	11.4%	-0.4%	-0.5%	-4328.6%	-1604.6%	-0.2%	5.3%	-16.8%
2011	-18.0%	12.1%	-0.6%	-0.5%	2490.4%	-2414.2%	-0.1%	5.3%	-18.1%
2012	-16.9%	12.2%	0.0%	-0.5%	266.5%	1477.4%	0.4%	4.9%	-20.4%
2013	-15.8%	12.3%	0.4%	-0.6%	137.8%	190.6%	0.7%	4.6%	-23.0%
2014	-14.8%	12.4%	0.8%	-0.6%	99.6%	105.3%	1.0%	4.3%	-26.0%
2015	-13.8%	12.6%	1.0%	-0.6%	76.0%	71.6%	1.1%	4.1%	-30.0%
2016	-12.6%	13.1%	0.4%	-0.6%	54.9%	53.0%	0.7%	3.8%	-33.5%
2017	-11.8%	13.5%	0.2%	-0.6%	44.0%	41.6%	0.5%	3.6%	-38.4%

Absolute Change From Baseline

Year	CCNRTBD_US	CLNRTBD_US	CONRTBD_US	VONRTBD_US	MLNRTBD_US	KONRTBD_US	PONRTBD_US	RONRTBD_US	SONRTBD_US
					(Dollars/Gallon)				
2007	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2008	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2009	$0.00	-$0.24	$0.08	$0.06	-$0.12	-$0.12	$0.08	-$0.12	-$0.01
2010	$0.00	-$0.26	$0.02	$0.06	-$0.13	-$0.07	$0.01	-$0.14	-$0.01
2011	$0.00	-$0.27	$0.03	$0.06	-$0.13	-$0.09	$0.01	-$0.15	-$0.01
2012	$0.00	-$0.27	$0.00	$0.06	-$0.14	-$0.15	-$0.03	-$0.15	-$0.01
2013	$0.00	-$0.28	-$0.02	$0.07	-$0.16	-$0.15	-$0.05	-$0.15	-$0.01
2014	$0.00	-$0.28	-$0.05	$0.07	-$0.18	-$0.16	-$0.08	-$0.15	-$0.02
2015	$0.00	-$0.29	-$0.06	$0.07	-$0.19	-$0.17	-$0.09	-$0.15	-$0.02
2016	$0.00	-$0.30	-$0.02	$0.08	-$0.19	-$0.17	-$0.06	-$0.15	-$0.02
2017	$0.00	-$0.31	-$0.01	$0.08	-$0.19	-$0.17	-$0.05	-$0.15	-$0.02

Table 6.1 cont. Effects of Letting the Biodiesel Tax Credit Expire on Net Returns for Biodiesel

Year	UONRTBD_US	LNNRTBD_US	LRNRTBD_US	TENRTBD_US	TINRTBD_US	PFNRTBD_US	AONRTBD_US	FONRTBD_US
				(Dollars/Gallon)				
2007	-$4.51	-$2.44	$0.00	$0.00	$0.01	$0.00	-$1.24	-$0.04
2008	-$4.48	-$3.30	-$0.05	-$0.13	-$0.01	-$0.03	-$1.17	-$0.07
2009	-$4.52	-$3.48	$0.00	-$0.10	$0.01	$0.01	-$0.94	$0.00
2010	-$4.56	-$3.41	$0.01	-$0.07	$0.02	$0.01	-$0.63	$0.00
2011	-$4.62	-$3.37	$0.01	-$0.04	$0.03	$0.01	-$0.41	$0.00
2012	-$4.70	-$3.38	$0.01	-$0.05	$0.03	$0.01	-$0.25	$0.00
2013	-$4.80	-$3.37	$0.01	-$0.08	$0.03	$0.02	-$0.09	$0.00
2014	-$4.91	-$3.37	$0.01	-$0.11	$0.03	$0.02	$0.00	$0.01
2015	-$5.02	-$3.36	$0.01	-$0.16	$0.03	$0.02	$0.00	$0.01
2016	-$5.12	-$3.32	$0.01	-$0.21	$0.03	$0.02	$0.00	$0.01
2017	-$5.23	-$3.28	$0.01	-$0.25	$0.03	$0.02	$0.00	$0.01

Percent Change From Baseline

Year	UONRTBD_US	LNNRTBD_US	LRNRTBD_US	TENRTBD_US	TINRTBD_US	PFNRTBD_US	AONRTBD_US	FONRTBD_US
2007	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2008	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2009	0.8%	4.8%	-50.6%	121.6%	-53.1%	-42.9%	25.4%	-50.9%
2010	1.7%	5.9%	-29.7%	-2041.3%	-30.9%	-27.2%	49.4%	-25.9%
2011	2.1%	6.4%	-22.4%	-633.3%	-26.6%	-22.2%	109.6%	-21.2%
2012	2.2%	6.7%	-21.0%	-692.0%	-26.1%	-20.2%	665.7%	-19.7%
2013	2.2%	6.8%	-20.8%	-1152.1%	-26.2%	-19.0%	-8392.8%	-18.5%
2014	2.2%	7.0%	-21.0%	-2319.6%	-26.5%	-17.9%	-46.1%	-17.4%
2015	2.2%	7.2%	-21.1%	1031.0%	-26.7%	-17.0%	-25.9%	-16.4%
2016	2.2%	7.5%	-19.9%	159.6%	-25.7%	-15.9%	-17.3%	-15.0%
2017	2.3%	7.9%	-18.9%	94.0%	-25.0%	-14.9%	-13.2%	-13.9%

Absolute Change From Baseline

Year	UONRTBD_US	LNNRTBD_US	LRNRTBD_US	TENRTBD_US	TINRTBD_US	PFNRTBD_US	AONRTBD_US	FONRTBD_US
				(Dollars/Gallon)				
2007	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2008	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2009	-$0.04	-$0.16	$0.00	-$0.06	-$0.01	$0.00	-$0.19	$0.00
2010	-$0.08	-$0.19	$0.00	-$0.08	-$0.01	$0.00	-$0.21	$0.00
2011	-$0.09	-$0.20	$0.00	-$0.05	-$0.01	$0.00	-$0.22	$0.00
2012	-$0.10	-$0.21	$0.00	-$0.06	-$0.01	$0.00	-$0.22	$0.00
2013	-$0.10	-$0.22	$0.00	-$0.08	-$0.01	$0.00	-$0.09	$0.00
2014	-$0.11	-$0.22	$0.00	-$0.12	-$0.01	$0.00	$0.00	$0.00
2015	-$0.11	-$0.23	$0.00	-$0.14	-$0.01	$0.00	$0.00	$0.00
2016	-$0.11	-$0.23	$0.00	-$0.13	-$0.01	$0.00	$0.00	$0.00
2017	-$0.12	-$0.24	$0.00	-$0.12	-$0.01	$0.00	$0.00	$0.00

Table 6.2 Effects of Letting the Biodiesel Tax Credit Expire on Demand for Fats and Oils to Produce Biodiesel

Year	CCDBIO__US	CLDBIO__US	CODBIO__US	VODBIO__US	MLDBIO__US	KODBIO__US	PODBIO__US	RODBIO__US	SODBIO__US
					(Million Pounds)				
2007	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2800.0
2008	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2291.9
2009	43.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2316.5
2010	126.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2791.3
2011	165.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2864.8
2012	181.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2590.9
2013	198.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2266.4
2014	216.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1918.4
2015	236.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1543.1
2016	267.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1282.4
2017	295.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	996.8

Absolute Change From Baseline

Year	CCDBIO__US	CLDBIO__US	CODBIO__US	VODBIO__US	MLDBIO__US	KODBIO__US	PODBIO__US	RODBIO__US	SODBIO__US
					(Million Pounds)				
2007	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2008	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2009	-75.1	0.0	0.0	0.0	0.0	-3.2	0.0	0.0	-932.0
2010	-79.0	0.0	0.0	0.0	-8.6	-19.8	0.0	0.0	-1237.0
2011	-80.5	0.0	0.0	0.0	0.0	-14.3	0.0	0.0	-1406.0
2012	-80.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1500.7
2013	-81.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1552.2
2014	-81.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1582.9
2015	-82.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1601.7
2016	-83.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1615.3
2017	-83.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1629.3

Table 6.2 cont. Effects of Letting the Biodiesel Tax Credit Expire on Demand for Fats and Oils to Produce Biodiesel

Year	UODBIO__US	LNDBIOJMUS	LRDBIO__US	TEDBIO__US	TIDBIO__US	PFDBIO__US	AODBIO__US	FODBIO__US
				(Million Pounds)				
2007	0.0	0.0	0.0	0.0	156.9	0.0	0.0	0.0
2008	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2009	0.0	0.0	10.3	0.0	130.6	29.9	0.0	2.8
2010	0.0	0.0	48.7	0.0	550.2	109.7	0.0	12.4
2011	0.0	0.0	84.6	0.0	797.4	179.6	0.0	18.2
2012	0.0	0.0	104.7	0.0	876.5	224.8	0.0	21.1
2013	0.0	0.0	116.5	0.0	898.8	256.7	0.0	23.4
2014	0.0	0.0	124.5	0.0	901.5	283.2	0.7	25.6
2015	0.0	0.0	130.3	0.0	898.8	307.8	2.1	27.8
2016	0.0	0.0	138.3	0.0	956.6	340.8	3.8	31.1
2017	0.0	0.0	147.4	0.0	1007.2	374.7	5.4	34.3

Absolute Change From Baseline

Year	UODBIO__US	LNDBIOJMUS	LRDBIO__US	TEDBIO__US	TIDBIO__US	PFDBIO__US	AODBIO__US	FODBIO__US
				(Million Pounds)				
2007	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2008	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2009	0.0	0.0	-31.9	0.0	-463.2	-61.9	0.0	-8.8
2010	0.0	0.0	-49.7	-13.8	-602.2	-97.1	0.0	-10.2
2011	0.0	0.0	-55.9	-54.5	-683.9	-117.4	0.0	-11.1
2012	0.0	0.0	-63.2	-66.6	-729.8	-128.3	0.0	-11.6
2013	0.0	0.0	-69.3	-52.5	-753.1	-134.1	-1.1	-11.8
2014	0.0	0.0	-75.0	-25.9	-765.4	-137.2	-1.7	-11.9
2015	0.0	0.0	-78.9	0.0	-772.2	-139.0	-1.8	-12.0
2016	0.0	0.0	-77.2	0.0	-777.0	-140.8	-1.8	-12.0
2017	0.0	0.0	-77.0	0.0	-781.9	-142.3	-1.8	-12.0

Table 6.3 Effects of Removing EISA Mandates on Net Returns for Biodiesel

Year	CCNRTBD_US	CLNRTBD_US	CONRTBD_US	VONRTBD_US	MLNRTBD_US	KONRTBD_US	PONRTBD_US	RONRTBD_US	SONRTBD_US
					(Dollars/Gallon)				
2007	$0.00	-$2.61	-$2.99	-$9.82	$0.00	$0.00	-$4.70	-$2.24	$0.05
2008	-$0.02	-$2.75	-$3.60	-$10.06	-$0.17	-$0.13	-$5.35	-$2.48	$0.05
2009	-$0.87	-$3.69	-$4.74	-$10.70	-$1.10	-$1.04	-$6.53	-$3.38	-$0.46
2010	-$0.68	-$3.58	-$5.02	-$11.16	-$1.06	-$1.00	-$6.89	-$3.58	-$0.52
2011	-$0.60	-$3.59	-$5.32	-$11.63	-$1.09	-$1.04	-$7.26	-$3.85	-$0.59
2012	-$0.57	-$3.65	-$5.66	-$12.12	-$1.19	-$1.13	-$7.70	-$4.15	-$0.70
2013	-$0.53	-$3.70	-$5.96	-$12.56	-$1.28	-$1.23	-$8.09	-$4.42	-$0.78
2014	-$0.49	-$3.76	-$6.27	-$13.01	-$1.37	-$1.32	-$8.51	-$4.71	-$0.87
2015	-$0.44	-$3.81	-$6.63	-$13.49	-$1.48	-$1.42	-$8.98	-$5.01	-$0.96
2016	-$0.36	-$3.83	-$6.98	-$13.96	-$1.56	-$1.50	-$9.45	-$5.31	-$1.02
2017	-$0.29	-$3.86	-$7.37	-$14.45	-$1.65	-$1.60	-$9.96	-$5.64	-$1.11

Percent Change From Baseline

Year	CCNRTBD_US	CLNRTBD_US	CONRTBD_US	VONRTBD_US	MLNRTBD_US	KONRTBD_US	PONRTBD_US	RONRTBD_US	SONRTBD_US
2007	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2008	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2009	-8054.2%	51.1%	17.1%	2.5%	2264.8%	-58336.7%	11.8%	34.1%	-898.7%
2010	-4874.8%	59.6%	14.8%	3.1%	-36222.6%	-22504.7%	10.9%	37.1%	-915.4%
2011	-3922.5%	63.2%	14.2%	3.8%	21224.2%	-27455.2%	11.0%	37.3%	-1010.1%
2012	-3605.8%	63.6%	14.9%	4.8%	2104.8%	11115.6%	12.0%	36.6%	-1195.4%
2013	-3279.1%	64.1%	14.3%	5.4%	1005.9%	1406.8%	11.6%	35.6%	-1370.0%
2014	-2930.4%	64.8%	13.6%	6.0%	665.2%	757.0%	11.2%	34.6%	-1566.0%
2015	-2574.1%	65.7%	12.7%	6.7%	479.2%	507.2%	10.5%	33.7%	-1806.5%
2016	-2039.2%	68.4%	9.9%	7.0%	355.5%	382.5%	8.6%	32.7%	-2002.0%
2017	-1596.2%	70.6%	8.5%	7.4%	286.3%	303.6%	7.8%	31.9%	-2256.7%

Absolute Change From Baseline

Year	CCNRTBD_US	CLNRTBD_US	CONRTBD_US	VONRTBD_US	MLNRTBD_US	KONRTBD_US	PONRTBD_US	RONRTBD_US	SONRTBD_US
					(Dollars/Gallon)				
2007	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2008	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2009	-$0.88	-$1.25	-$0.69	-$0.26	-$1.05	-$1.04	-$0.69	-$0.86	-$0.51
2010	-$0.70	-$1.34	-$0.65	-$0.34	-$1.06	-$1.00	-$0.67	-$0.97	-$0.58
2011	-$0.61	-$1.39	-$0.66	-$0.43	-$1.09	-$1.04	-$0.72	-$1.04	-$0.66
2012	-$0.58	-$1.42	-$0.73	-$0.55	-$1.14	-$1.12	-$0.82	-$1.11	-$0.76
2013	-$0.55	-$1.45	-$0.75	-$0.65	-$1.16	-$1.14	-$0.84	-$1.16	-$0.85
2014	-$0.51	-$1.48	-$0.75	-$0.74	-$1.19	-$1.17	-$0.85	-$1.21	-$0.93
2015	-$0.46	-$1.51	-$0.74	-$0.84	-$1.22	-$1.19	-$0.86	-$1.26	-$1.01
2016	-$0.38	-$1.56	-$0.63	-$0.91	-$1.21	-$1.19	-$0.75	-$1.31	-$1.08
2017	-$0.31	-$1.60	-$0.58	-$1.00	-$1.23	-$1.21	-$0.72	-$1.36	-$1.16

Table 6.3 cont. Effects of Removing EISA Mandates on Net Returns for Biodiesel

Year	UONRTBD_US	LNNRTBD_US	LRNRTBD_US	TENRTBD_US	TINRTBD_US	PFNRTBD_US	AONRTBD_US	FONRTBD_US
				(Dollars/Gallon)				
2007	-$4.51	-$2.44	$0.00	$0.00	$0.01	$0.00	-$1.24	-$0.04
2008	-$4.48	-$3.30	-$0.05	-$0.13	-$0.01	-$0.03	-$1.17	-$0.07
2009	-$5.07	-$4.45	-$0.87	-$1.00	-$0.93	-$0.89	-$1.93	-$0.93
2010	-$5.26	-$4.40	-$0.76	-$0.93	-$0.80	-$0.71	-$1.65	-$0.76
2011	-$5.42	-$4.40	-$0.71	-$0.92	-$0.77	-$0.63	-$1.46	-$0.68
2012	-$5.60	-$4.43	-$0.71	-$0.96	-$0.80	-$0.61	-$1.33	-$0.66
2013	-$5.76	-$4.45	-$0.71	-$0.99	-$0.82	-$0.59	-$1.18	-$0.64
2014	-$5.93	-$4.47	-$0.70	-$1.03	-$0.85	-$0.56	-$1.02	-$0.62
2015	-$6.11	-$4.48	-$0.70	-$1.08	-$0.87	-$0.53	-$0.85	-$0.59
2016	-$6.26	-$4.46	-$0.67	-$1.10	-$0.86	-$0.46	-$0.64	-$0.53
2017	-$6.43	-$4.45	-$0.66	-$1.14	-$0.87	-$0.41	-$0.43	-$0.47

Percent Change From Baseline

Year	UONRTBD_US	LNNRTBD_US	LRNRTBD_US	TENRTBD_US	TINRTBD_US	PFNRTBD_US	AONRTBD_US	FONRTBD_US
2007	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2008	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2009	13.0%	34.0%	-13546.7%	2034.5%	-3909.5%	-9416.4%	156.5%	-27467.3%
2010	17.3%	36.7%	-7760.7%	-25254.0%	-2458.7%	-5055.1%	293.7%	-16019.6%
2011	19.8%	38.8%	-6073.1%	-12500.3%	-2100.3%	-3777.7%	644.7%	-12756.5%
2012	21.7%	40.1%	-5593.0%	-11841.9%	-2085.0%	-3351.2%	3912.3%	-11731.3%
2013	22.7%	41.0%	-5282.9%	-13774.2%	-2121.7%	-3073.2%	-114314.8%	-10958.1%
2014	23.5%	42.0%	-5075.4%	-20318.7%	-2170.8%	-2829.2%	-65311.7%	-10202.2%
2015	24.4%	43.0%	-4957.2%	7615.1%	-2222.1%	-2593.6%	-43282.9%	-9432.0%
2016	24.9%	44.7%	-4693.5%	1286.5%	-2168.5%	-2215.1%	-27276.3%	-8130.1%
2017	25.8%	46.4%	-4495.4%	780.7%	-2145.8%	-1902.2%	-16205.2%	-7051.4%

Absolute Change From Baseline

Year	UONRTBD_US	LNNRTBD_US	LRNRTBD_US	TENRTBD_US	TINRTBD_US	PFNRTBD_US	AONRTBD_US	FONRTBD_US
				(Dollars/Gallon)				
2007	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2008	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2009	-$0.59	-$1.13	-$0.88	-$0.96	-$0.95	-$0.90	-$1.18	-$0.94
2010	-$0.78	-$1.18	-$0.77	-$0.94	-$0.83	-$0.73	-$1.23	-$0.76
2011	-$0.89	-$1.23	-$0.72	-$0.92	-$0.81	-$0.65	-$1.27	-$0.69
2012	-$1.00	-$1.27	-$0.72	-$0.97	-$0.84	-$0.63	-$1.29	-$0.67
2013	-$1.07	-$1.29	-$0.72	-$1.00	-$0.86	-$0.61	-$1.18	-$0.65
2014	-$1.13	-$1.32	-$0.72	-$1.03	-$0.89	-$0.58	-$1.02	-$0.63
2015	-$1.20	-$1.35	-$0.72	-$1.06	-$0.91	-$0.55	-$0.85	-$0.60
2016	-$1.25	-$1.38	-$0.69	-$1.02	-$0.90	-$0.49	-$0.65	-$0.53
2017	-$1.32	-$1.41	-$0.67	-$1.01	-$0.91	-$0.43	-$0.44	-$0.48

Table 6.4 Effects of Removing EISA Mandates on Demand for Fats and Oils to Produce Biodiesel

Year	CCDBIO__US	CLDBIO__US	CODBIO__US	VODBIO__US	MLDBIO__US	KODBIO__US	PODBIO__US	RODBIO__US	SODBIO__US
					(Million Pounds)				
2007	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2800.0
2008	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2291.9
2009	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2012	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2013	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2014	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2015	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2017	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Absolute Change From Baseline

Year	CCDBIO__US	CLDBIO__US	CODBIO__US	VODBIO__US	MLDBIO__US	KODBIO__US	PODBIO__US	RODBIO__US	SODBIO__US
					(Million Pounds)				
2007	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2008	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2009	-118.9	0.0	0.0	0.0	0.0	-3.2	0.0	0.0	-3248.5
2010	-205.2	0.0	0.0	0.0	-8.6	-19.8	0.0	0.0	-4028.4
2011	-245.5	0.0	0.0	0.0	0.0	-14.3	0.0	0.0	-4270.8
2012	-262.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-4091.6
2013	-279.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3818.6
2014	-298.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3501.3
2015	-319.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3144.8
2016	-350.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-2897.7
2017	-378.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-2626.1

Table 6.4 cont. Effects of Removing EISA Mandates on Demand for Fats and Oils to Produce Biodiesel

Year	UODBIO__US	LNDBIOJMUS	LRDBIO__US	TEDBIO__US	TIDBIO__US	PFDBIO__US	AODBIO__US	FODBIO__US
				(Million Pounds)				
2007	0.0	0.0	0.0	0.0	156.9	0.0	0.0	0.0
2008	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2009	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2012	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2013	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2014	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2015	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2017	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Absolute Change From Baseline

Year	UODBIO__US	LNDBIOJMUS	LRDBIO__US	TEDBIO__US	TIDBIO__US	PFDBIO__US	AODBIO__US	FODBIO__US
				(Million Pounds)				
2007	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2008	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2009	0.0	0.0	-42.2	0.0	-593.8	-91.8	0.0	-11.6
2010	0.0	0.0	-98.4	-13.8	-1152.4	-206.8	0.0	-22.7
2011	0.0	0.0	-140.4	-54.5	-1481.3	-297.0	0.0	-29.3
2012	0.0	0.0	-167.9	-66.6	-1606.3	-353.1	0.0	-32.7
2013	0.0	0.0	-185.8	-52.5	-1651.9	-390.8	-1.1	-35.2
2014	0.0	0.0	-199.5	-25.9	-1666.9	-420.4	-2.5	-37.5
2015	0.0	0.0	-209.2	0.0	-1671.1	-446.9	-3.9	-39.8
2016	0.0	0.0	-215.4	0.0	-1733.6	-481.6	-5.6	-43.2
2017	0.0	0.0	-224.4	0.0	-1789.2	-517.0	-7.2	-46.3

CHAPTER VII: Summary and Conclusions

In this chapter a brief summary of this study is presented, the conclusions of this research are stated, and recommendations for future research are given. This study represents a first attempt in determining biodiesel demand's effect on the fats and oils market. The primary objective of this study was to determine how the fats and oils market is affected by the addition of the newly expanded biodiesel demand. A structural model was developed for the demands of fats and oils. A secondary objective of this study was to estimate some elasticities for the industrial side of the fats and oils market. A third objective, which was also an intermediate stage, was to introduce biodiesel demand, based on the assumption of very elastic demand at a break-even price that takes account of some petroleum-based diesel price and other input costs.

The study took a look at a scenario where the $1.00 blender's credit was allowed to expire in 2008. Using FAPRI's estimate of an effect of a 5.6% decrease in the biodiesel rack price the model was simulated. The second scenario used FAPRI's estimate of a decrease of 29.2% in biodiesel rack price if the EISA mandates were removed. It was found that if the biodiesel tax credit is allowed to expire or if the EISA mandates are removed that biodiesel net returns drop, as does the demand for biodiesel. Fat and oil prices still rise over the forecast period but at a slower rate than with the tax credit and mandates. Production numbers drop as well with the decline in biodiesel demand and decrease in prices.

There is still a lot to be done in future research. The data obtained for biodiesel in this study were limited to very few observations. Conclusions drawn from this data may suffer from those limitations. There have been many years of inedible uses for fats and oils, yet good data are hard to find relating to these demands. Future research might focus more on the industrial demands and better data will be needed. Also, future research will need to utilize new data over a longer time period that is being collected from biodiesel producers and blenders.

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Appendix A: The Data

Table A.1 Annual Marketing Year Fats and Oils Production

Year	Coconut Oil	Corn Oil	Cottonseed Oil	Canola Oil	Olive Oil	Palm Oil	Palm Kernel Oil	Peanut Oil	Soybean Oil	Sunflower seed Oil	Linseed Oil	Fish Oil	Lard	Edible tallow	Poultry Fat	Castor Oil	Inedible tallow and Grease
							(Million Pounds)										
1980	0	863.5	1194.9	0	2.2	0	0	138.9	11270.0	657.0	251	.	1160.0	1042.7	.	.	6110.0
1981	0	871.5	1549.8	0	2.2	0	0	174.2	10979.0	302.0	237	155.8	1057.0	1130.2	.	0	6042.0
1982	0	982.6	1133.2	0	2.2	0	0	105.8	12041.6	668.0	182	173.8	962.0	1110.0	.	0	6155.5
1983	0	1053.0	776.0	0	2.2	0	0	119.0	10871.0	449.7	265	175.5	959.0	1260.1	.	0	5960.7
1984	0	1193.9	1175.1	0	2.2	0	0	185.2	11468.4	482.8	194	134.6	940.0	1337.8	.	0	5843.4
1985	0	1252.7	1069.2	0	2.2	0	0	257.9	11616.2	584.2	205	150.3	891.0	1610.6	.	0	5659.3
1986	0	1400.1	780.4	0	2.2	0	0	152.1	12782.4	586.4	201	132.6	852.0	1523.4	.	0	5470.2
1987	0	1435.3	1203.7	19.8	2.2	0	0	167.6	12974.2	831.1	217	104.4	916.0	1257.9	.	0	6116.7
1988	0	1414.9	1243.4	61.7	2.2	0	0	249.1	11737.4	518.1	170	101.1	896.7	1296.3	.	0	5887.9
1989	0	1470.3	1038.4	138.9	2.2	0	0	194.0	13002.9	474.0	165	127.3	747.4	1156.8	.	0	5747.2
1990	0	1655.9	1153.0	24.3	2.2	0	0	213.8	13408.5	535.7	172	127.8	759.6	1206.7	.	0	5718.1
1991	0	1821.3	1278.7	30.9	2.2	0	0	357.1	14345.5	910.5	176	84.4	832.0	1251.3	.	0	5807.0
1992	0	1877.7	1137.6	52.9	2.2	0	0	286.6	13778.9	729.7	168	119	829.3	1526.7	.	0.1	6326.4
1993	0	1906.2	1119.9	410.1	2.2	0	0	211.6	13950.8	579.8	169	141.2	740.5	1425.2	.	0.1	6688.8
1994	0	2227.5	1311.8	302.0	2.2	0	0	315.3	15613.1	1164.0	167	109.6	725.0	1557.2	.	0	6828.8
1995	0	2139.0	1228.0	357.1	2.2	0	0	321.9	15240.6	859.8	176	114.4	690.2	1536.3	.	0	6493.2
1996	0	2231.4	1214.7	341.7	2.2	0	0	220.5	15752.0	840.0	195	119.8	670.7	1519.6	.	0	6177.2
1997	0	2334.8	1223.6	451.9	2.2	0	0	176.4	18141.8	959.0	205	101.3	732.3	1416.2	.	0	6543.3
1998	0	2374.4	831.1	551.2	2.2	0	0	145.5	18082.3	1177.3	207	141.6	740.4	1536.8	.	0	6973.6
1999	0	2501.4	939.2	619.5	2.2	0	0	229.3	17824.4	1045.0	224	81.3	723.3	1729.3	.	0	6479.6
2000	0	2403.2	846.6	643.7	2.2	0	0	178.6	18419.6	873.0	234	123.3	715.9	1825.0	.	0	5904.4
2001	0	2461.5	877.4	584.2	2.2	0	0	229.3	18898.0	672.4	195	103.9	743.0	1791.7	.	0	6482.2
2002	0	2453.0	725.3	498.2	2.2	0	0	286.6	18430.6	304.2	205	81.3	744.2	1974.1	678.0	0	6308.6
2003	0	2396.5	873.0	604.1	2.2	0	0	174.2	17081.4	595.2	220	95	775.3	1965.7	991.0	0	6266.4
2004	0	2396.1	956.8	800.3	2.2	0	0	125.7	19361.0	264.6	265	95	775.5	1817.7	1144.0	0	6542.9
2005	0	2482.7	950.2	840.0	2.2	0	0	180.8	20388.3	544.5	320	95	785.5	1817.6	1235.2	0	6546.5
2006	0	2589.9	848.8	881.8	2.2	0	0	165.3	20485.3	623.9	291	95	802.0	1817.6	1235.2	0	6546.5
2007	0	2560.0	754.0	855.4	2.2	0	0	169.8	20769.7	659.2	212	95	815.0	1817.6	1235.2	0	6546.5

Source: USDA/U.S. Census Bureau/Oil World
"." indicates missing data

Table A.2 Annual Marketing Year Fats and Oils Imports

Year	Coconut Oil	Corn Oil	Cottonseed Oil	Canola Oil	Olive Oil	Palm Oil	Palm Kernel Oil	Peanut Oil	Soybean Oil	Sunflower seed Oil	Linseed Oil	Fish Oil	Lard	Edible tallow	Poultry Fat	Castor Oil	Inedible tallow and Grease
							(Million Pounds)										
1980	1122.2	0.0	0.0	13.2	61.7	324.1	169.8	0.0	0.0	0.0	0.0	.	0.0	0.0	.	.	0.0
1981	961.2	0.0	0.0	15.4	63.9	218.3	205.0	0.0	0.0	0.0	0.0	7.6	0.0	0.0	.	35.7	0.0
1982	884.1	0.6	2.2	11.0	72.8	308.6	238.1	4.4	0.0	0.0	0.0	8.3	0.0	5.4	.	29.3	0.0
1983	917.1	0.0	17.6	11.0	90.4	370.4	178.6	0.0	0.0	0.0	0.0	8.4	1.6	7.6	.	39.0	0.0
1984	890.7	0.0	0.0	33.1	97.0	372.6	304.2	0.0	19.8	0.0	0.0	8.9	2.4	8.9	.	36.9	0.0
1985	1217.0	0.0	0.0	92.6	119.0	610.7	361.6	2.2	8.8	0.0	0.0	10.3	1.5	5.3	.	33.4	0.0
1986	1086.9	0.0	11.0	185.2	141.1	474.0	396.8	2.2	15.4	0.0	0.0	14.6	1.2	4.5	.	43.1	0.0
1987	1073.7	2.2	26.5	291.0	165.3	361.6	463.0	33.1	194.0	0.0	0.0	12.1	1.1	3.1	.	27.4	0.0
1988	778.2	0.8	0.0	465.2	187.4	297.6	383.6	2.2	136.7	0.0	0.0	10.4	1.2	0.7	.	36.4	5.2
1989	1038.4	0.0	13.2	421.1	200.6	249.1	370.4	4.4	22.0	4.4	0.0	17.1	1.7	3.5	.	38.9	14.0
1990	945.8	1.8	4.4	604.1	220.5	284.4	306.4	11.0	17.6	33.1	0.0	10.0	3.3	12.1	.	31.6	25.9
1991	837.8	5.1	17.6	824.5	235.9	220.5	341.7	0.0	0.0	8.8	0.0	11.0	2.5	6.5	.	39.4	53.8
1992	1161.8	7.2	37.5	873.0	271.2	266.8	302.0	0.0	11.0	0.0	0.0	11.8	3.1	9.5	.	38.8	44.9
1993	998.7	6.6	26.5	908.3	273.4	368.2	304.2	11.0	68.3	6.6	1.0	19.3	2.7	15.5	.	39.6	36.0
1994	1100.1	10.1	0.0	948.0	282.2	218.3	280.0	4.4	17.6	2.2	3.0	8.5	2.2	17.7	.	49.4	36.4
1995	873.0	11.0	0.0	1095.7	251.3	235.9	262.4	4.4	94.8	2.2	4.0	17.6	1.9	8.5	.	46.1	26.2
1996	1188.3	13.5	0.0	1106.7	326.3	321.9	392.4	13.2	52.9	22.0	6.0	12.6	1.1	4.9	.	34.2	56.5
1997	1439.6	28.1	0.0	1111.1	354.9	282.2	359.4	11.0	59.5	6.6	7.0	11.6	2.1	2.5	.	50.8	68.1
1998	791.5	42.4	48.5	1108.9	374.8	284.4	399.0	72.8	81.6	4.4	12.0	11.2	1.9	2.7	.	44.9	57.3
1999	925.9	17.5	8.8	1177.3	416.7	346.1	392.4	13.2	81.6	4.4	13.0	12.0	2.3	9.6	.	45.5	59.9
2000	1115.5	27.3	0.0	1201.5	467.4	401.2	363.8	79.4	72.8	8.8	12.0	10.1	3.0	32.4	.	48.3	67.5
2001	1093.5	61.4	0.0	1108.9	480.6	474.0	308.6	39.7	46.3	35.3	10.6	12.8	6.4	7.1	.	32.2	58.0
2002	862.0	65.6	19.8	981.1	485.0	383.6	489.4	70.5	46.3	61.7	13.0	17.9	8.9	8.2	.	25.4	32.0
2003	795.9	66.0	0.0	1223.6	540.1	619.5	575.4	125.7	306.4	26.5	14.4	16.0	4.9	0.9	.	29.0	46.0
2004	923.7	49.1	2.2	1133.2	546.7	760.6	520.3	55.1	26.5	75.0	16.0	16.0	4.8	0.7	.	29.0	67.6
2005	1119.9	45.0	2.2	1600.6	544.5	1322.8	520.3	61.7	35.3	57.3	10.0	16.0	6.8	5.1	.	29.0	35.8
2006	903.9	43.1	2.2	1569.7	573.2	1543.2	661.4	105.8	37.5	156.5	8.4	16.0	8.0	6.0	.	29.0	35.8
2007	941.4	45.0	0.0	1759.3	573.2	1571.9	661.4	138.9	37.5	50.7	12.0	16.0	8.0	6.0	.	29.0	35.8

Source: USDA/U.S. Census Bureau/Oil World
"." indicates missing data

Table A.3 Annual Marketing Year Fats and Oils Exports

Year	Coconut Oil	Corn Oil	Cottonseed Oil	Canola Oil	Olive Oil	Palm Oil	Palm Kernel Oil	Peanut Oil	Soybean Oil	Sunflower seed Oil	Linseed Oil	Fish Oil	Lard	Edible tallow	Poultry Fat	Castor Oil	Inedible tallow and Grease
	(Million Pounds)																
1980	24.3	180.5	709.9	0.0	0.0	0.0	0.0	48.5	1631.4	663.6	51.0	.	143.6	88.0	.	.	3109.5
1981	24.3	202.2	846.6	0.0	0.0	0.0	0.0	39.7	2076.8	227.1	54.0	96.7	113.8	142.0	.	0.0	3079.1
1982	19.8	224.4	544.5	0.0	0.0	0.0	0.0	4.4	2023.8	504.9	21.0	174.4	95.1	74.9	.	0.0	2950.0
1983	37.5	310.6	302.0	0.0	0.0	0.0	0.0	6.6	1823.2	414.5	51.0	194.1	78.1	103.8	.	0.0	2896.3
1984	19.8	260.1	432.1	0.0	0.0	0.0	0.0	28.7	1660.1	286.6	15.0	116.7	101.6	53.2	.	0.7	2453.8
1985	22.0	343.9	443.1	0.0	0.0	0.0	0.0	92.6	1256.6	451.9	15.0	88.0	112.3	74.6	.	0.4	2769.6
1986	48.5	267.8	216.1	0.0	0.0	0.0	0.0	6.6	1186.1	343.9	6.0	119.1	102.6	57.5	.	0.4	2503.6
1987	77.2	369.9	407.9	0.0	0.0	0.0	0.0	6.6	1873.9	703.3	8.0	81.3	120.2	64.1	.	1.2	2736.3
1988	55.1	363.9	405.7	8.8	4.4	4.4	4.4	11.0	1662.3	467.4	12.0	68.1	126.9	133.1	.	1.8	2653.1
1989	44.1	413.5	352.7	6.6	8.8	2.2	2.2	19.8	1353.6	350.5	12.0	104.5	73.2	201.8	.	1.3	2207.1
1990	50.7	498.1	231.5	6.6	8.8	4.4	2.2	24.3	806.9	359.4	6.0	111.8	110.3	251.6	.	2.6	1907.3
1991	22.0	566.4	253.5	15.4	19.8	6.6	2.2	154.3	1644.6	526.9	12.0	100.3	130.9	285.2	.	2.4	2182.6
1992	15.4	711.5	176.4	15.4	17.6	6.6	8.8	55.1	1461.7	586.4	8.0	63.9	129.2	332.6	.	2.0	2163.0
1993	19.8	716.6	246.9	77.2	11.0	6.6	4.4	61.7	1532.2	449.7	6.8	120.4	118.8	310.0	.	2.3	2051.2
1994	17.6	865.5	337.3	154.3	22.0	13.2	2.2	97.0	2683.0	978.9	23.9	114.7	140.4	294.7	.	2.2	2762.9
1995	11.0	976.5	220.5	147.7	24.3	19.8	2.2	108.0	992.1	628.3	26.2	79.6	94.3	279.3	.	2.8	2245.7
1996	11.0	987.7	240.3	293.2	22.0	8.8	2.2	19.8	2032.7	709.9	65.8	91.9	103.3	229.2	.	2.5	1616.0
1997	6.6	1118.5	207.2	348.3	22.0	11.0	2.2	13.2	3079.9	815.7	57.9	111.5	121.8	184.9	.	2.9	2196.0
1998	11.0	989.3	110.2	271.2	13.2	11.0	2.2	11.0	2372.2	800.3	63.2	75.2	139.9	246.5	.	3.4	2060.6
1999	13.2	970.1	141.1	284.4	13.2	4.4	2.2	17.6	1375.7	630.5	74.3	78.3	188.6	317.1	.	3.4	1772.9
2000	8.8	950.8	130.1	187.4	8.8	11.0	2.2	13.2	1402.1	544.5	73.0	113.1	92.9	247.6	.	3.0	1398.7
2001	6.6	1172.4	149.9	255.7	11.0	8.8	2.2	8.8	2519.9	451.9	50.5	93.4	89.9	364.5	.	2.6	1643.7
2002	13.2	888.3	110.2	160.9	11.0	11.0	2.2	41.9	2264.1	112.4	70.1	79.4	115.8	511.5	61.1	3.4	1737.6
2003	11.0	766.9	110.2	277.8	15.4	11.0	2.2	28.7	937.0	235.9	76.2	85.0	222.1	419.7	18.1	2.8	1552.9
2004	15.4	789.4	57.3	269.0	24.3	24.3	2.2	11.0	1322.8	125.7	106.9	85.0	165.3	255.4	36.2	2.8	1426.6
2005	15.4	798.9	68.3	471.8	22.0	33.1	2.2	11.0	1153.0	209.4	98.3	85.0	73.6	293.5	28.7	2.8	1602.7
2006	15.4	792.9	136.7	630.5	22.0	24.3	2.2	11.0	1887.2	169.8	75.8	85.0	77.0	293.5	28.7	2.8	1602.7
2007	15.4	740.0	116.8	573.2	22.0	33.1	2.2	6.6	1649.1	130.1	75.0	85.0	75.0	293.5	28.7	2.8	1602.7

Source: USDA/U.S. Census Bureau/Oil World
"." indicates missing data

Table A.4 Annual Marketing Year Fats and Oils Domestic Consumption

Year	Coconut Oil		Corn Oil		Cottonseed Oil		Canola Oil		Olive Oil		Palm Oil		Palm Kernel Oil		Peanut Oil	
	Food Use	Industrial Use	Food Use	Industrial Use	Food Use	Industrial Use	Food Use	Industrial Use	Food Use	Industrial Use	Food Use	Industrial Use	Food Use	Industrial Use	Food Use	Industrial Use
							(Million Pounds)									
1980	337.3	707.7	673.3	0.0	526.9	0.0	13.2	0.0	63.9	0.0	271.2	37.5	0.0	183.0	97.0	0.0
1981	337.3	646.0	692.2	0.0	679.0	0.0	15.4	0.0	66.1	0.0	176.4	52.9	0.0	200.6	114.6	0.0
1982	339.5	537.9	722.1	0.0	604.1	0.0	11.0	0.0	75.0	0.0	249.1	37.5	0.0	244.7	130.1	0.0
1983	299.8	615.1	762.2	0.0	531.3	0.0	11.0	0.0	92.6	0.0	335.1	52.9	0.0	185.2	112.4	0.0
1984	275.6	575.4	930.1	0.0	685.6	0.0	33.1	0.0	99.2	0.0	315.3	55.1	0.0	284.4	172.0	0.0
1985	332.9	683.4	862.1	0.0	648.2	0.0	92.6	0.0	121.3	0.0	513.7	77.2	0.0	332.9	123.5	0.0
1986	319.7	756.2	1143.1	0.0	571.0	0.0	180.8	0.0	143.3	0.0	277.8	229.3	0.0	381.4	160.9	0.0
1987	231.5	703.3	1065.9	0.0	751.8	0.0	282.2	0.0	167.6	0.0	198.4	143.3	119.0	348.3	218.3	0.0
1988	211.6	692.3	1064.4	0.0	851.0	0.0	526.9	0.0	185.2	0.0	205.0	110.2	123.5	251.3	227.1	0.0
1989	216.1	650.4	1111.2	0.0	767.2	0.0	509.3	39.7	194.0	0.0	176.4	79.4	112.4	231.5	194.0	0.0
1990	216.1	681.2	1065.3	0.0	868.6	0.0	573.2	33.1	213.8	0.0	178.6	77.2	125.7	235.9	198.4	0.0
1991	205.0	701.1	1201.9	0.0	1102.3	0.0	780.4	28.7	218.3	0.0	156.5	66.1	116.8	227.1	176.4	0.0
1992	213.8	868.6	1220.1	0.0	994.3	0.0	846.6	68.3	255.7	0.0	187.4	83.8	83.8	169.8	231.5	0.0
1993	233.7	833.3	1227.6	0.0	875.2	0.0	1142.0	30.9	264.6	0.0	321.9	37.5	94.8	220.5	187.4	0.0
1994	240.3	842.2	1249.7	0.0	998.7	0.0	1146.4	33.1	262.4	0.0	187.4	37.5	108.0	187.4	207.2	0.0
1995	224.9	716.5	1298.3	0.0	994.3	0.0	1252.2	30.9	229.3	0.0	160.9	39.7	105.8	187.4	191.8	0.0
1996	273.4	837.8	1244.2	0.0	1003.1	0.0	1135.4	30.9	306.4	0.0	227.1	70.5	136.7	224.9	194.0	0.0
1997	231.5	959.0	1271.3	0.0	1003.1	0.0	1133.2	33.1	335.1	0.0	185.2	97.0	132.3	211.6	218.3	0.0
1998	178.6	842.2	1394.1	0.0	773.8	0.0	1296.3	33.1	363.8	0.0	167.6	94.8	132.3	253.5	209.4	0.0
1999	174.2	754.0	1416.9	0.0	833.3	0.0	1441.8	33.1	405.7	0.0	273.4	57.3	127.9	288.8	233.7	0.0
2000	180.8	802.5	1630.4	0.0	672.4	0.0	1724.0	33.1	460.8	0.0	335.1	50.7	79.4	176.4	244.7	0.0
2001	209.4	910.5	1363.0	0.0	780.4	0.0	1463.9	33.1	471.8	0.0	432.1	41.9	152.1	216.1	260.1	0.0
2002	154.3	705.5	1615.1	0.0	639.3	0.0	1261.0	33.1	476.2	0.0	339.5	37.5	180.8	339.5	269.0	0.0
2003	154.3	716.5	1662.0	0.0	690.0	0.0	1503.6	33.1	526.9	0.0	469.6	46.3	216.1	352.7	249.1	0.0
2004	143.3	718.7	1653.1	0.0	934.8	0.0	1593.9	33.1	524.7	0.0	650.4	59.5	183.0	317.5	209.4	0.0
2005	213.8	842.2	1684.5	0.0	859.8	0.0	1792.4	39.7	524.7	0.0	1177.3	72.8	198.4	324.1	266.8	0.0
2006	198.4	787.1	1858.9	0.0	707.7	0.0	1871.7	50.7	553.4	0.0	1373.5	156.5	242.5	421.1	262.4	0.0
2007	198.4	727.5	1856.1	0.0	654.8	0.0	2017.2	66.1	553.4	0.0	1455.1	202.8	242.5	416.7	299.8	0.0

Source: USDA/U.S. Census Bureau/Oil World
"." indicates missing data

Table A.4 cont. Annual Marketing Year Fats and Oils Domestic Consumption

Year	Soybean Oil		Sunflowerseed Oil		Linseed Oil		Fish Oil		Lard		Edible tallow		Poultry Fat		Castor Oil		Inedible tallow and Grease	
	Food Use	Industrial Use	Food Use	Industrial Use	Food Use	Industrial Use	Food Use	Industrial Use	Food Use	Industrial Use	Food Use	Industrial Use	Food Use	Industrial Use	Food Use	Industrial Use	Food Use	Industrial Use
							(Million Pounds)											
1980	8408.4	502.7	63.9	0.0	0.0	198.0	0.0	.	478.7	545.6	241.0	714.4	0.0	.	.	.	0.0	3008.9
1981	8930.9	401.2	138.9	0.0	0.0	189.0	0.0	17.7	543.4	411.2	223.0	767.2	0.0	.	0.0	36.2	0.0	3027.2
1982	9078.6	575.4	94.8	0.0	0.0	176.0	0.0	20.7	406.8	443.9	312.6	717.6	0.0	.	0.0	29.9	0.0	3168.8
1983	9012.5	343.9	116.8	0.0	0.0	201.0	0.0	23.9	473.1	419.9	501.0	679.0	0.0	.	0.0	38.3	0.0	3173.8
1984	9613.4	302.9	143.3	0.0	0.0	194.0	0.0	23.8	400.6	428.8	418.1	880.7	0.0	.	0.0	32.8	0.0	3167.4
1985	9746.0	307.1	143.3	0.0	0.0	184.0	0.0	22.6	343.3	456.6	475.6	1064.0	0.0	.	0.0	29.6	0.0	3041.2
1986	10504.7	331.0	185.2	0.0	0.0	183.0	0.0	33.6	382.1	361.3	443.4	1035.0	0.0	.	0.0	37.4	0.0	2953.6
1987	10592.3	333.8	83.8	0.0	0.0	219.0	0.0	38.7	372.3	414.4	230.8	961.2	0.0	.	0.0	37.1	0.0	3322.6
1988	10265.3	323.5	125.7	0.0	0.0	151.0	0.0	47.5	313.1	455.3	210.1	946.8	0.0	.	0.0	34.4	0.0	3277.1
1989	11712.2	369.1	172.0	0.0	0.0	164.0	0.0	54.9	166.8	314.9	68.0	897.2	0.0	.	0.0	33.7	0.0	3602.7
1990	11767.8	370.8	200.6	0.0	0.0	163.0	0.0	35.9	393.7	386.3	154.2	808.3	0.0	.	0.0	31.0	0.0	3777.0
1991	11872.5	374.1	339.5	0.0	0.0	164.0	0.0	24.2	286.1	461.1	366.9	608.6	0.0	.	0.0	38.4	0.0	3730.4
1992	12616.3	397.6	187.4	0.0	0.0	146.0	0.0	26.9	256.7	447.5	611.9	593.1	0.0	.	0.0	31.7	0.0	4146.7
1993	12543.6	395.3	127.9	0.0	0.0	154.2	0.0	28.1	298.7	317.4	411.8	715.3	0.0	.	0.0	38.2	0.0	4701.3
1994	12518.0	394.5	169.8	0.0	0.0	164.1	0.0	30.4	141.7	455.3	639.2	636.3	0.0	.	0.0	40.5	0.0	4056.4
1995	13054.5	411.4	167.6	0.0	0.0	148.8	0.0	40.4	137.0	462.4	533.2	735.0	0.0	.	0.0	42.8	0.0	4441.0
1996	13830.3	435.8	207.2	0.0	0.0	150.2	0.0	40.4	187.2	384.1	784.4	521.0	0.0	.	0.0	37.1	0.0	4516.4
1997	14794.2	466.2	183.0	0.0	0.0	147.1	0.0	34.4	183.4	408.8	584.5	638.6	0.0	.	0.0	41.1	0.0	4325.7
1998	15176.8	478.3	319.7	0.0	0.0	149.8	0.0	34.7	199.1	422.8	868.3	432.5	0.0	.	0.0	41.5	0.0	5035.8
1999	15565.7	490.5	383.6	0.0	0.0	161.7	0.0	29.9	200.1	340.1	996.3	428.5	0.0	.	0.0	45.4	0.0	4724.1
2000	15817.9	498.5	357.1	0.0	0.0	179.0	0.0	27.3	313.8	316.1	1125.1	456.2	0.0	.	0.0	36.0	0.0	4690.8
2001	16318.1	514.2	370.4	0.0	0.0	167.0	0.0	26.0	363.7	299.1	868.7	586.1	0.0	.	0.0	35.0	0.0	4878.2
2002	16541.7	539.7	249.1	0.0	0.0	148.8	0.0	25.2	354.7	283.8	973.6	512.8	0.0	616.9	0.0	28.8	0.0	4739.8
2003	16267.6	597.8	372.6	0.0	0.0	168.6	0.0	26.0	284.7	271.4	1107.6	444.7	0.0	972.9	0.0	26.2	0.0	4598.5
2004	16777.0	663.7	231.5	0.0	0.0	148.8	0.0	26.0	374.7	238.9	1163.3	401.3	0.0	1107.9	0.0	26.2	0.0	5250.2
2005	16133.1	270.8	359.4	0.0	0.0	231.8	0.0	26.0	502.1	218.0	1121.1	401.4	0.0	1190.2	0.0	26.2	0.0	4962.1
2006	15499.5	481.2	606.3	0.0	0.0	217.0	0.0	26.0	499.0	236.6	1121.1	401.4	0.0	1190.2	0.0	26.2	0.0	4962.1
2007	16611.3	487.6	571.0	0.0	0.0	170.6	0.0	26.0	474.0	272.8	1121.1	401.4	0.0	1190.2	0.0	26.2	0.0	4805.1

Source: USDA/U.S. Census Bureau/Oil World
"." indicates missing data

Table A.5 Annual Marketing Year Fats and Oils Ending Stocks

Year	Coconut Oil	Corn Oil	Cottonseed Oil	Canola Oil	Olive Oil	Palm Oil	Palm Kernel Oil	Peanut Oil	Soybean Oil	Sunflower seed Oil	Linseed Oil	Fish Oil	Lard	Edible tallow	Poultry Fat	Castor Oil	Inedible tallow and Grease
							(Million Pounds)										
1980	205.0	75.7	79.4	0.0	0.0	57.3	30.9	37.5	1735.0	90.4	56.0	.	35.6	55.9	.	.	422.1
1981	158.7	52.8	103.6	0.0	0.0	46.3	35.3	57.3	1102.3	26.5	50.0	78.0	24.2	53.9	.	3.1	357.7
1982	145.5	89.5	90.4	0.0	0.0	68.3	28.7	33.1	1261.0	94.8	35.0	65.0	40.4	58.8	.	2.5	394.3
1983	110.2	69.7	50.7	0.0	0.0	50.7	22.0	33.1	720.9	13.2	48.0	30.9	29.9	42.5	.	3.2	284.8
1984	130.1	73.5	108.0	0.0	0.0	52.9	41.9	17.6	632.7	66.1	33.0	33.9	41.3	36.2	.	6.6	507.0
1985	308.6	120.2	86.0	0.0	0.0	72.8	70.5	61.7	948.0	55.1	39.0	83.9	21.6	40.5	.	10.0	355.5
1986	271.2	109.4	90.4	4.4	0.0	39.7	86.0	48.5	1724.0	112.4	51.0	78.4	28.8	32.8	.	15.3	368.4
1987	332.9	111.1	160.9	33.1	0.0	59.5	81.6	24.3	2092.2	156.5	41.0	74.9	39.0	39.6	.	4.4	426.2
1988	152.1	98.5	147.7	24.3	0.0	37.5	86.0	37.5	1715.2	81.6	48.0	70.8	41.6	48.3	.	4.6	389.2
1989	280.0	44.1	79.4	28.7	0.0	28.7	110.2	22.0	1305.1	37.5	37.0	55.8	22.9	38.4	.	8.5	340.6
1990	277.8	138.4	136.7	44.1	0.0	52.9	52.9	24.3	1785.7	46.3	40.0	45.9	24.1	37.2	.	6.5	400.2
1991	187.4	196.4	77.2	75.0	0.0	44.1	48.5	50.7	2239.9	99.2	40.0	16.8	27.2	38.7	.	5.1	348.0
1992	251.3	149.7	81.6	70.5	0.0	33.1	88.2	50.7	1554.3	55.1	54.0	56.8	26.2	33.3	.	10.3	409.7
1993	163.1	118.3	105.8	138.9	0.0	35.3	72.8	24.3	1102.3	63.9	63.0	68.8	34.4	33.2	.	9.5	382.0
1994	163.1	240.7	81.6	55.1	0.0	15.4	55.1	39.7	1137.6	81.6	45.0	41.8	24.3	36.3	.	16.2	427.9
1995	83.8	115.8	94.8	77.2	0.0	30.9	22.0	66.1	2015.0	147.7	50.0	53.8	22.7	43.1	.	16.7	260.6
1996	149.9	128.8	66.1	66.1	0.0	46.3	50.7	86.0	1521.2	92.6	35.0	53.9	19.9	33.3	.	11.3	361.9
1997	392.4	101.9	79.4	114.6	0.0	35.3	63.9	41.9	1382.3	59.5	42.0	20.9	40.4	47.4	.	18.1	451.7
1998	152.1	135.4	75.0	174.2	0.0	46.3	75.0	39.7	1519.0	121.3	48.0	63.8	20.8	39.1	.	18.1	386.2
1999	136.7	267.4	48.5	211.6	0.0	57.3	48.5	30.9	1993.0	156.5	49.0	48.9	17.6	33.3	.	14.8	428.7
2000	260.1	116.6	92.6	112.4	0.0	61.7	154.3	30.9	2766.8	136.7	43.0	41.9	13.8	36.7	.	24.1	311.0
2001	227.1	104.1	39.7	52.9	0.0	52.9	92.6	30.9	2358.9	22.0	31.1	39.2	10.5	40.3	.	18.7	329.3
2002	216.1	119.3	35.3	77.2	0.0	48.5	59.5	77.2	1490.3	26.5	30.2	33.8	9.3	25.3	.	11.9	192.5
2003	130.1	152.9	108.0	90.4	0.0	141.1	63.9	99.2	1075.9	39.7	19.8	33.8	11.4	23.6	.	11.9	353.4
2004	176.4	155.5	75.0	127.9	0.0	167.6	81.6	59.5	1699.8	22.0	45.1	33.8	12.8	22.3	.	11.9	287.1
2005	224.9	199.9	99.2	264.6	0.0	207.2	77.2	24.3	3011.5	55.1	45.0	33.8	11.4	24.7	.	11.9	304.7
2006	127.9	181.1	105.8	163.1	0.0	196.2	72.8	22.0	2903.5	59.5	51.6	33.8	8.8	34.6	.	11.9	304.7
2007	127.9	190.0	88.2	121.3	0.0	77.2	72.8	24.3	2162.7	68.3	30.0	33.8	10.0	34.6	.	11.9	304.7

Source: USDA/U.S. Census Bureau/Oil World
"." indicates missing data

Table A.6 Annual Marketing Year Fats and Oils Prices

Year	Coconut Oil	Corn Oil	Cottonseed Oil	Canola Oil	Olive Oil	Palm Oil	Palm Kernel Oil	Peanut Oil	Soybean Oil	Sunflower seed Oil	Linseed Oil	Fish Oil	Lard	Edible tallow	Poultry Fat	Castor Oil	Inedible tallow and Grease
							(Cents/Pound)										
1980	26.4	25.2	25.9	.	.	26.7	27.4	40.5	22.7	27.0	30.0	19.4	20.9	22.2	.	44.2	15.0
1981	22.7	23.4	20.1	.	.	21.7	22.5	27.6	19.0	24.9	30.0	16.5	21.9	28.0	.	42.4	15.4
1982	27.6	23.8	21.8	.	.	19.2	26.8	29.3	20.6	21.4	25.2	15.8	17.7	24.2	.	50.3	13.6
1983	50.9	28.6	32.8	.	.	33.8	47.2	50.1	30.6	32.3	30.1	17.7	25.8	18.4	.	68.0	12.5
1984	33.8	29.1	29.2	.	.	25.4	30.5	39.8	29.5	30.0	32.6	13.6	22.2	26.2	.	39.7	16.6
1985	13.8	18.5	16.9	.	.	12.6	13.1	29.7	18.0	19.1	31.1	11.2	14.2	23.1	.	29.7	16.0
1986	17.8	21.4	17.7	.	.	14.5	18.2	26.1	15.4	16.0	26.3	9.6	14.9	14.1	.	35.8	9.7
1987	24.8	23.3	21.7	.	.	18.2	23.7	33.5	22.7	23.5	24.7	16.2	16.2	15.3	.	47.6	13.2
1988	24.7	21.0	19.7	.	.	16.2	22.6	34.0	21.1	22.7	39.4	10.7	14.3	17.5	.	49.2	16.7
1989	16.8	24.8	23.3	.	.	12.3	16.3	44.6	22.3	24.4	40.2	10.8	13.3	16.3	.	48.2	14.8
1990	16.5	27.5	22.3	.	.	14.4	16.4	42.2	21.0	23.7	38.0	13.9	13.6	20.0	.	35.9	12.8
1991	27.4	25.8	20.1	23.7	.	16.6	26.6	27.3	19.1	21.6	32.0	16.4	13.2	16.1	.	35.4	13.8
1992	20.2	20.9	30.1	22.0	.	17.3	19.9	27.4	21.2	25.4	31.5	17.0	15.2	14.8	.	35.1	13.6
1993	25.6	27.2	30.3	24.0	.	20.2	25.7	43.2	27.0	31.1	31.8	15.1	16.2	16.4	.	39.3	15.3
1994	29.8	26.5	29.2	28.6	.	29.5	30.8	44.3	27.5	28.1	33.7	18.4	20.2	17.3	.	40.5	15.8
1995	33.8	25.2	26.5	29.0	.	23.7	33.1	40.3	24.7	25.4	36.5	20.9	21.7	21.2	.	38.8	19.4
1996	31.4	24.0	25.6	25.7	.	23.9	30.8	43.7	22.5	22.6	36.0	22.8	23.0	21.6	.	37.5	20.0
1997	28.3	28.9	28.8	28.8	.	27.3	29.6	49.0	25.8	27.0	36.3	32.7	19.5	23.0	.	42.9	21.8
1998	33.9	25.3	27.3	22.5	.	22.0	32.1	39.7	19.8	20.1	36.4	18.5	14.7	20.7	.	50.1	19.1
1999	24.4	17.8	21.6	17.1	.	14.0	24.2	35.4	15.6	16.7	35.8	12.2	13.6	15.1	10.8	46.6	13.5
2000	14.7	13.5	16.0	17.6	67.8	10.7	14.2	34.8	14.1	15.9	36.0	17.0	14.6	13.2	9.2	32.9	11.2
2001	17.6	19.1	18.0	23.5	77.5	14.9	17.2	32.5	16.5	23.3	38.1	26.9	13.6	13.4	9.1	31.9	11.4
2002	20.4	28.2	37.8	29.8	101.5	19.1	19.9	46.9	22.0	33.1	39.9	25.4	18.1	13.9	11.0	42.9	12.2
2003	28.6	28.4	32.0	33.8	131.4	21.8	28.1	59.7	30.0	33.4	42.0	29.4	26.1	17.8	14.2	44.6	16.4
2004	28.8	27.9	28.0	30.8	154.8	17.8	28.9	53.1	23.0	43.8	59.5	32.5	21.8	22.4	16.7	47.1	20.1
2005	26.4	25.2	29.5	31.0	199.8	18.9	26.4	44.5	23.4	37.7	54.0	35.9	21.7	18.5	16.6	40.6	17.0
2006	27.5	31.8	35.7	40.6	185.7	20.1	26.4	56.8	31.0	58.0	44.4	35.9	28.4	18.2	15.5	40.6	16.3
2007	41.7	70.0	74.5	70.0	156.9	34.2	40.3	96.8	55.0	94.5	69.5	40.1	31.3	27.3	23.8	54.4	29.1

Source: USDA/U.S. Census Bureau/Oil World
"." indicates missing data

Appendix B: Mnemonics

Table B.1 Variable Definitions

CC: Coconut Oil
CL: Corn Oil
CO: Cottonseed Oil
VO: Olive Oil
RO: Rapeseed Oil
SO: Soybean Oil
LN: Linseed Oil
PO: Peanut Oil
ML: Palm Oil
KO: Palm Kernel Oil
UO: Sunflowerseed Oil
LR: Lard Oil
TE: Edible Tallow
TI: Inedible Tallow
PF: Poultry Fat
AO: Castor Oil
FO: Fish Oil
LG: Lagged (As in lagged dependent)
RR: Residual/Error
00: Intercept
YY: Income

xxCLEARING: Market Clearing for fat or oil xx.

xxSIMP__US: Imports for fat or oil xx.

xxDEXT__US: Exports for fat or oil xx.

xxSPRD__US: Production for fat or oil xx.

xxNRTBD_US: Net returns for biodiesel for fat or oil xx.

xxDFOD__US: Demand for food use for fat or oil xx.

xxDIND__US: Demand for industrial use for fat or oil xx.

xxDBIO__US: Demand for biodiesel use for fat or oil xx.

xxP_____US: U.S. price of fat or oil xx.

xxP_____US: World price of fat or oil xx.

Appendix C: Elasticities

Table C.1 Edible Demand Elasticities

zSODFOD__US_SO	-0.441075	**zCCDFOD__US_CC**	-0.278633	**zCLDFOD__US_CL**	-0.417825	**zCODFOD__US_CO**	-1.118625
zSODFOD__US_CC	0	**zCCDFOD__US_SO**	0	**zCLDFOD__US_SO**	0	**zCODFOD__US_SO**	0.1343
zSODFOD__US_CL	0	**zCCDFOD__US_CL**	0	**zCLDFOD__US_CC**	0	**zCODFOD__US_CL**	0
zSODFOD__US_CO	0.059375	**zCCDFOD__US_CO**	0.013867	**zCLDFOD__US_CO**	0	**zCODFOD__US_CC**	0.2544
zSODFOD__US_VO	0	**zCCDFOD__US_VO**	0	**zCLDFOD__US_VO**	0	**zCODFOD__US_VO**	0
zSODFOD__US_ML	0	**zCCDFOD__US_ML**	0	**zCLDFOD__US_ML**	0.361133	**zCODFOD__US_ML**	0.28
zSODFOD__US_KO	0.004	**zCCDFOD__US_KO**	0	**zCLDFOD__US_KO**	0	**zCODFOD__US_KO**	0.05
zSODFOD__US_PO	0	**zCCDFOD__US_PO**	0	**zCLDFOD__US_PO**	0.0973	**zCODFOD__US_PO**	0.382225
zSODFOD__US_RO	0	**zCCDFOD__US_RO**	0	**zCLDFOD__US_RO**	0	**zCODFOD__US_RO**	0
zSODFOD__US_UO	0	**zCCDFOD__US_UO**	0	**zCLDFOD__US_UO**	0	**zCODFOD__US_UO**	0
zSODFOD__US_LR	0.010575	**zCCDFOD__US_LR**	0.180233	**zCLDFOD__US_LR**	0.20745	**zCODFOD__US_LR**	0
zSODFOD__US_TE	0	**zCCDFOD__US_TE**	0	**zCLDFOD__US_TE**	0	**zCODFOD__US_TE**	0.430833
zSODFOD__US_FO	0	**zCCDFOD__US_FO**	0	**zCLDFOD__US_FO**	0	**zCODFOD__US_FO**	0
zSODFOD__US_YY	0.938467	**zCCDFOD__US_YY**	0.551967	**zCLDFOD__US_YY**	0.626925	**zCODFOD__US_YY**	1.722525
zVODFOD__US_VO	-0.94	**zMLDFOD__US_ML**	-1.482267	**zKODFOD__US_KO**	-0.47	**zPODFOD__US_PO**	-0.704125
zVODFOD__US_SO	0	**zMLDFOD__US_SO**	0	**zKODFOD__US_SO**	0.31	**zPODFOD__US_SO**	0
zVODFOD__US_CL	0	**zMLDFOD__US_CL**	0.5757	**zKODFOD__US_CL**	0	**zPODFOD__US_CL**	0.388575
zVODFOD__US_CO	0	**zMLDFOD__US_CO**	0.173567	**zKODFOD__US_CO**	0.105	**zPODFOD__US_CO**	0.855875
zVODFOD__US_CC	0	**zMLDFOD__US_VO**	0	**zKODFOD__US_VO**	0	**zPODFOD__US_VO**	0
zVODFOD__US_ML	0	**zMLDFOD__US_CC**	0	**zKODFOD__US_ML**	0.97	**zPODFOD__US_ML**	0.301333
zVODFOD__US_KO	0	**zMLDFOD__US_KO**	0.425	**zKODFOD__US_CC**	0	**zPODFOD__US_KO**	0.065
zVODFOD__US_PO	0	**zMLDFOD__US_PO**	0.239167	**zKODFOD__US_PO**	0.065	**zPODFOD__US_CC**	0
zVODFOD__US_RO	0	**zMLDFOD__US_RO**	0	**zKODFOD__US_RO**	0	**zPODFOD__US_RO**	0
zVODFOD__US_UO	0	**zMLDFOD__US_UO**	0	**zKODFOD__US_UO**	0	**zPODFOD__US_UO**	0
zVODFOD__US_LR	0	**zMLDFOD__US_LR**	0	**zKODFOD__US_LR**	0.335	**zPODFOD__US_LR**	0
zVODFOD__US_TE	0	**zMLDFOD__US_TE**	1.091033	**zKODFOD__US_TE**	0	**zPODFOD__US_TE**	0
zVODFOD__US_FO	0	**zMLDFOD__US_FO**	0	**zKODFOD__US_FO**	0	**zPODFOD__US_FO**	0
zVODFOD__US_YY	0.61	**zMLDFOD__US_YY**	-0.026833	**zKODFOD__US_YY**	0.455	**zPODFOD__US_YY**	0.383025

Table C.1 Edible Demand Elasticities cont.

zRODFOD__US_RO	-0.46	**zUODFOD__US_UO**	-1	**zLRDFOD__US_LR**	-0.72625
zRODFOD__US_SO	0	**zUODFOD__US_SO**	0	**zLRDFOD__US_SO**	0.164625
zRODFOD__US_CL	0	**zUODFOD__US_CL**	0	**zLRDFOD__US_CL**	0.288075
zRODFOD__US_CO	0	**zUODFOD__US_CO**	0	**zLRDFOD__US_CO**	0
zRODFOD__US_VO	0	**zUODFOD__US_VO**	0	**zLRDFOD__US_VO**	0
zRODFOD__US_ML	0	**zUODFOD__US_ML**	0	**zLRDFOD__US_ML**	0
zRODFOD__US_KO	0	**zUODFOD__US_KO**	0	**zLRDFOD__US_KO**	0.12
zRODFOD__US_PO	0	**zUODFOD__US_PO**	0	**zLRDFOD__US_PO**	0
zRODFOD__US_CC	0	**zUODFOD__US_RO**	0	**zLRDFOD__US_RO**	0
zRODFOD__US_UO	0	**zUODFOD__US_CC**	0	**zLRDFOD__US_UO**	0
zRODFOD__US_LR	0	**zUODFOD__US_LR**	0	**zLRDFOD__US_CC**	0.2058
zRODFOD__US_TE	0	**zUODFOD__US_TE**	0	**zLRDFOD__US_TE**	0.745233
zRODFOD__US_FO	0	**zUODFOD__US_FO**	0	**zLRDFOD__US_FO**	0
zRODFOD__US_YY	0.72	**zUODFOD__US_YY**	0	**zLRDFOD__US_YY**	0.4649

zTEDFOD__US_TE	-1.156	**zFODFOD__US_FO**	-1.00
zTEDFOD__US_SO	0	**zFODFOD__US_SO**	0.00
zTEDFOD__US_CL	0	**zFODFOD__US_CL**	0.00
zTEDFOD__US_CO	0.411467	**zFODFOD__US_CO**	0.00
zTEDFOD__US_VO	0	**zFODFOD__US_VO**	0.00
zTEDFOD__US_ML	1.1762	**zFODFOD__US_ML**	0.00
zTEDFOD__US_KO	0	**zFODFOD__US_KO**	0.00
zTEDFOD__US_PO	0	**zFODFOD__US_PO**	0.00
zTEDFOD__US_RO	0	**zFODFOD__US_RO**	0.00
zTEDFOD__US_UO	0	**zFODFOD__US_UO**	0.00
zTEDFOD__US_LR	1.003767	**zFODFOD__US_LR**	0.00
zTEDFOD__US_CC	0	**zFODFOD__US_TE**	0.00
zTEDFOD__US_FO	0	**zFODFOD__US_CC**	0.00
zTEDFOD__US_YY	0.401967	**zFODFOD__US_YY**	0.00