U.S. IMPORT DEMAND FOR BEER, WINE, AND SPIRITS BY COUNTRY OF ORIGIN: A DIFFERENTIAL APPROACH

BY

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LIST OF ABBREVIATIONS

AIDS	Almost Ideal Demand System
CBS	The Central Bureau
HS	Harmonized System
LR	Log-likelihood Ratio
NBR	The National Bureau of Research
ROB	Rest of Beverages
ROW	Rest of World

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As few empirical studies that estimate import demand for the U.S. alcoholic beverages exist, this research focuses on providing the latest market trend and specific elasticities for the main commodities under the group of U.S. alcoholic beverages. A differential approach for a general demand model is used to estimate the U.S. import demand for beer, wine and spirits by country of origin from the major exporters to the U.S. alcoholic beverage market. This paper also calculates conditional expenditure elasticities, Slutsky (Cournot) own-price, and cross-price elasticities. The empirical analysis provides policy recommendations for both foreign and domestic alcoholic beverage industries.

CHAPTER 1
INTRODUCTION

The U.S. is the world's second largest consumer of alcoholic beverages (WHO, 2011). Further, the U.S. is the world's largest alcoholic beverages importing country. In 2011, the total import value of alcoholic beverages reach 15.39 billion dollars and make up to 20.8% of the world imports' share (UN Comtrade, 2012). The U.S. has a huge net demand for alcoholic beverages. Net imports are about 12.0 billion dollars in 2011. The large population and an increasing preference for imported alcoholic beverages contribute to the deficit on the commodities of alcohol.

Beer, wine, and spirits are the major groups of alcoholic beverages. Distilled spirits ($5.2 billion), wine ($4.2 billion), and beer ($3.5 billion) lead the alcoholic beverages import in 2010. Figure 1-1 shows the trends of imported beer, wine, and spirits into the U.S. over the last two decades. U.S. beer imports increase over 329% by value; for wine imports, the growth is 366%; for spirits, imports are up 256%. The total value of the alcohol import market is over 15 billion dollars. Beer, wine, and spirits are 14.84% of total U.S. agricultural imports in 2012(USDA-FATUS, 2012). From the perspective of the consumers, alcohol beverages plays an important role in daily life. According to the survey data from the National Center for Health Statistics (NCHS, 2012), 51.5% of adults (18 years of age and over) are current regular drinkers (at least 12 drinks in the past year). From a poll of Gallup (2013), 36% of U.S. regular drinkers consume beer most often, 35% for wine, and 23% for spirits.

Rapid growth in U.S. wine imports has occurred in the last two decades. Total U.S. wine imports increase 366% in terms of value and 350% in terms of quantity. In 2012, the U.S. imports 1.17 billion liters of wines at a value of five billion dollars. France, Italy, Australia, and Chile are the major wine exporters to the U.S. These countries accounted for more than 74% of total U.S. wine imports by value (U.S. Department of Agriculture, 2013).

The U.S. beer imports have also risen impressively from 1992 to 2012. Total U.S. beer imports rise 329% by value and 233% by volume. In 2012, the U.S. imports 3.25 billion liters of beer at a value of 3.7 billion dollars. Mexico and Netherlands are the major beer exporters to the U.S. These two countries account for more than 73% of total U.S. beer imports by value (U.S. Department of Agriculture, 2013).

Tremendous development in U.S. spirits imports has occurred from 1992 to 2012. Total U.S. spirits imports grow 256% in terms of expenditure and 76% in terms of quantity. In 2012, the U.S. imports 685 million liters of spirits at a value of 6.5 billion dollars. Mexico, United Kingdom, France and Sweden are the major exporters to the U.S. These countries account for more than 72% of total U.S. imports of spirits by value (U.S. Department of Agriculture, 2013).

Despite its huge value and importance in daily consumption, few studies or research are found in the literature that focuses on U.S. alcohol trade, and, more specifically, U.S. import demand for beer and spirits. As a result, little is known about demand relationships among these imported products. However, these relationships are extremely important for those exporters and our domestic alcohol industry.

In this thesis, four functional approaches are utilized (i.e., Rotterdam, CBS, AIDS, and NBR) to estimate U.S. import demand elasticities for alcoholic beverages and beer, wine, and spirits by country of origin. In addition, the author estimates a general model that nests these four models to choose the best of the four competing models in terms of data fitting of aggregated beverages and beer, wine, and spirits by country of origin. The usual restrictions implied by demand theory are imposed and tested with log-likelihood-ratio (LR) tests. Conditional expenditure and price parameters are attained for imported alcoholic beverages. Conditional expenditure elasiticities, own-price and cross-price elasticities (both Slutsky and Cournot) are reported and discussed in the empirical results.

This thesis is organized as follow: Chapter 2 provides insight into the literature dealing with several demand models theoretically; prior studies of import demand analysis for alcoholic beverages; and previous work analyzing U.S. import demand for alcoholic beverages. Chapter 3 provides the data sources and descriptive statistics for U.S. import aggregated beverages and U.S. imported beer, wine, and spirits by country of origin. Chapter 4 presents the detailed description of four functional approaches (i.e., Rotterdam, CBS, AIDS, and NBR) and the general demand systems. The multistage budgeting method is discussed as well. Chapter 5 shows U.S. import demand for beer, wine, and spirits from the perspective of testing restrictions, model choice, parameter estimates, conditional expenditure elasticities and two types of price elasticities (Slutsky and Cournot). Chapter 6 shows U.S. import demand for beer, wine and spirits by country of origin. This chapter also presents the empirical results and analysis similar to the chapter 5. Chapter 7 provides the general conclusions and recommendations through the empirical results.

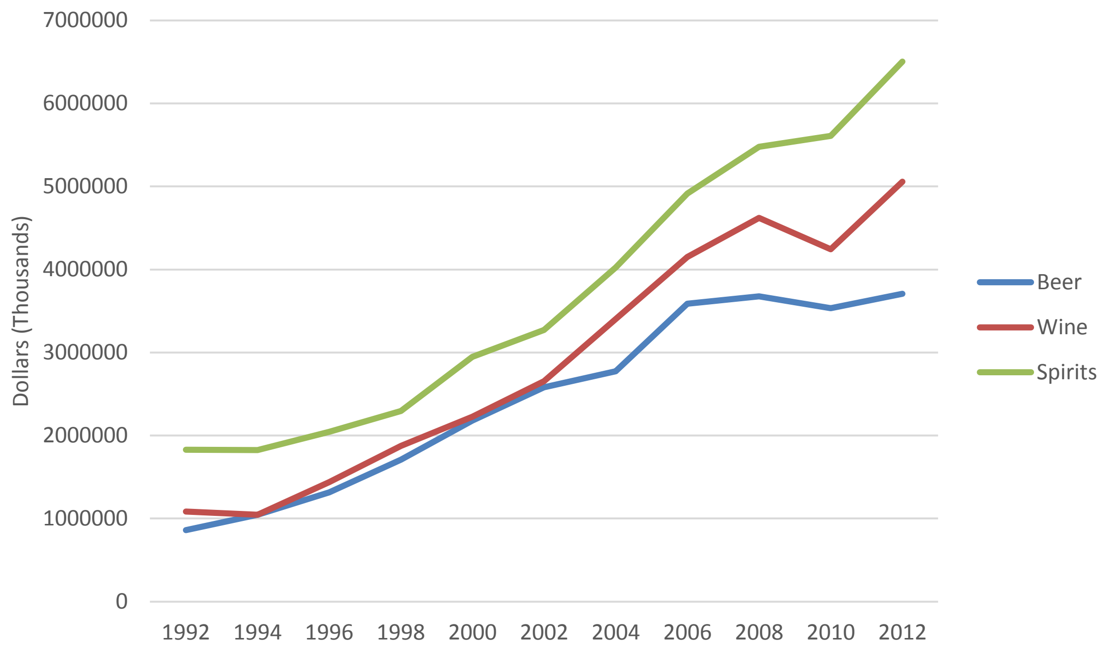

Figure 1-1. U.S. import trends for beer, wine, and spirits by value, 1992-2012.

Source: United States of Department of Agriculture, 2013.

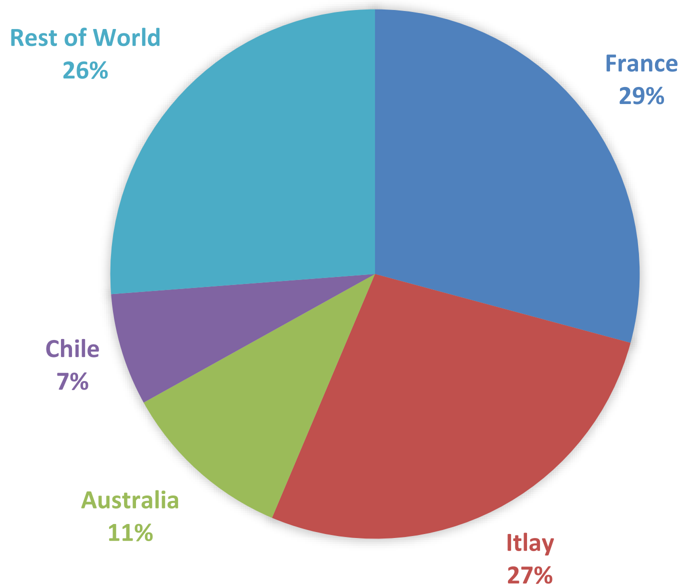

Figure 1-2. U.S. wine import value share by country of origin, 2012.

Source: United States of Department of Agriculture, 2013.

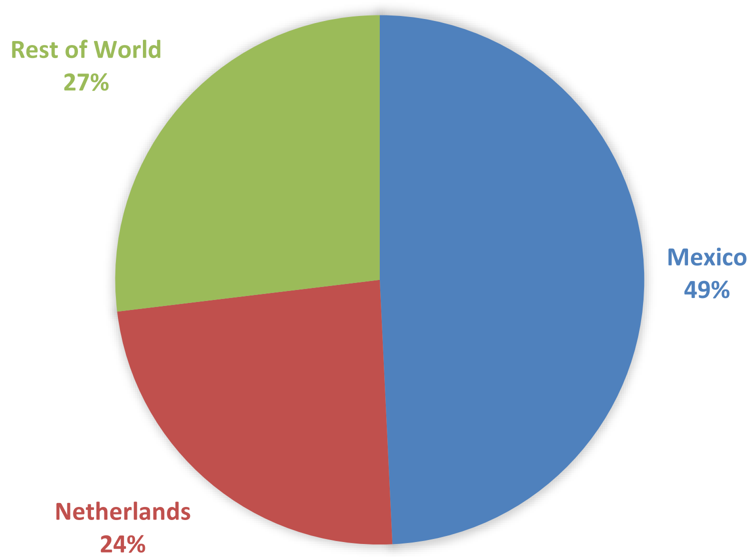

Figure 1-3. U.S. beer import value share by country of origin, 2012.

Source: United States of Department of Agriculture, 2013.

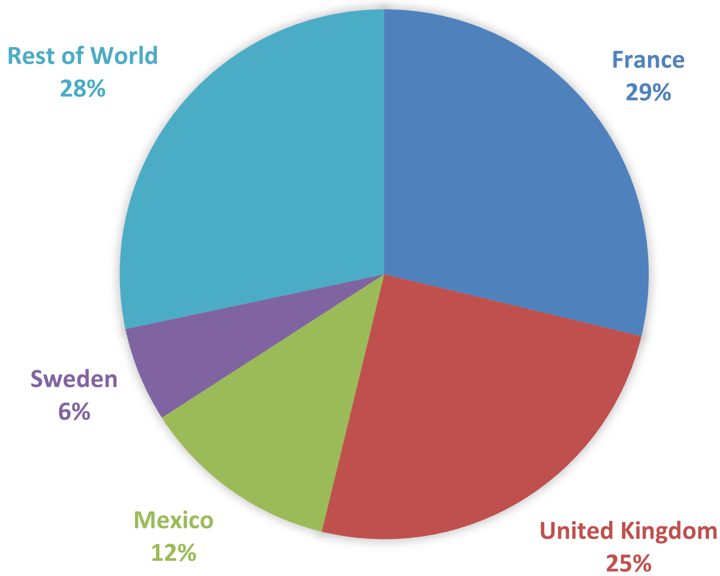

Figure 1-4. U.S. spirits import value share by country of origin, 2012.

Source: United States of Department of Agriculture, 2013.

CHAPTER 2
LITERATURE REVIEW

Few studies estimate the import demand for alcoholic beverages. Andrikopoulos, Brox, and Carvalho (1997) estimate the demand for domestic and imported alcoholic beverages in Ontario, Canada with the Almost Ideal Demand System (AIDS) (Deaton and Muellbauer 1980). They use a dataset from 1958 to 1987 for domestic and imported produced spirits, wine and beer. The results show a strong tendency that the dynamic version of the AIDS better fits the data than its static version, but there is little evidence of strong substitution effects between imported and domestic goods. Likewise, Carew, Florkowski, and He (2005) analyze demand for the imported and domestic table wine market in British Columbia, Canada with the AIDS model. They use retail monthly scanner data of table wine that includes domestic and imported table wine in the province of British Columbia from March 1990 to April 2000. The findings uncover that there are different consumers' preference for foreign produced and locally produced wines. It is shown that the expenditure elasticities for British Columbia produced, European, and rest of world (ROW) white wines are greater than those for red wines. The high expenditure elasticities with British Columbia white wines may represent that these wines are of better quality. Lee, Kennedy, and Hilbun (2008) analyze an import demand system of the South Korean wine market from the source-differentiated AIDS model. With the assumption of partial aggregation and block substitutability, empirical findings indicate that South Korean consumers have a huge preference for French wines with high quality. Also, as a result of the free trade agreement between Chile and South Korea, Chilean wines have increased their market share in South Korea.

Studies for U.S. import demand elasticities by country of origin for alcoholic beverages are limited, especially for the beer and spirits. Seale, Marchant and Basso (2003) analyze the demand for imports versus domestic production for the U.S. red wine market. Results for conditional expenditure elasticities show that the U.S. red wine industry increases earning relative to imports when U.S. consumers' total budgets on red wine increase. Own-price and cross-price elasticities indicate that an increase in the price of U.S. red wine leads to a decline in quantity demanded for U.S. red wine about six times larger than for Italian and French red wines and over 20 times larger than other import partners, thus it is bad for U.S. domestic industry. The findings suggest U.S. red-wine producers may add to their revenue by decreasing prices; however, French and Italian industries may improve total revenues by increasing prices. There are no studies found that focus on the import demand for beer and spirits in the U.S. This is in spite of the fact that U.S. drinkers' preferences and characteristics have been previously estimated (Wang et al. 1996).

Although there are few studies on import demand of alcoholic beverages in the U.S., there are many demand studies on other commodities, both domestic and import demand. In particular, consumer allocation models have been used in research that focus on the demand of commodities both in terms of domestic and import demand. Barten (1993) made a systematic comparison of four versions of differential demand systems. The usual demand systems include the Rotterdam system (Theil 1965), the Almost Ideal Demand system (AIDS) (Deaton and Muellbauer 1980), the Central Bureau of Statistics (CBS) system (Keller and van Driel 1985) and the National Bureau of Research (NBR) system (Neves 1987). Rotterdam and AIDS are most popular in the agricultural economics research (e.g., Eales and Unnevehr 1988; Lee, Seale, and Jierwiriyapant 1990; Sparks, Seale, and Buxton 1992). In general, different systems have various implications and effects of the specific data. For example, marginal expenditure shares and Slutsky terms are assumed constants in the Rotterdam model, while they are assumed functions of budget shares in the AIDS. Besides, CBS and NBR models can be considered as income-response variants of Rotterdam and the AIDS, respectively (Lee, Brown, and Seale 1994).

As the demand systems are more frequently applied in research, the issue of how to choose the model that best fits and represents the data become more important. A synthetic model of Barten (1993) combines the features of the four differential models (i.e. Rotterdam, AIDS, CBS and NBR) and allows nested hypothesis testing among the models to choose which of the four models best fit the data. Specifically, the generalized demand model, a synthetic differential demand model, nests these four demand systems with the addition of two more parameters. A likelihood-ratio test is performed for each of the four models in comparison to the general model. Lee, Brown, and Seale (1994) develop a more general demand formulation of Barten (1993) general model and apply it to Taiwanese consumer behavior and demands for 12 commodity groups from 1970 to 1989.

CHAPTER 3
DATA

The alcoholic beverage dataset is obtained from the Global Agricultural Trade System, supported by the Foreign Agricultural Service, U.S. Department of Agriculture (2013). Specifically, the data sources of beer, wine and spirits are from the U.S. Census Bureau Trade data (2013). The exporters of these commodities to the U.S. chosen for study are the top exporters to the U.S. The import expenditure data contain the volume and price of beer, wine, and spirits. Unit value prices are computed by dividing the import values by the import quantities. The time period ranges from 1992 to 2012 for beer, wine, and spirits. The analyses use HS-4 classification standard to sort the groups of goods. “The beer made from malt” will be equal to beer, “grape wines” will be regarded as wine, and “liqueur, spirits” will be used for spirits, respectively. The data of quantities are adopted with the choice of “FAS converted quantities”. U.S. national population annual data (1992-2012) are adopted from the U.S. Census Bureau (2013) in order to conduct the following analysis on a per capita basis.

Table 3-1 shows the basic descriptive statistics (budget share, unit price, quantity, and value) of the four beverage groups for U.S. imported aggregated beverages in 1992, at the sample mean, and 2012. The largest average expenditure share is spirits (0.351) and the smallest is ROB[1] (0.146). As shown in Table 3-1, the group budget shares are relatively steady over the last two decades for beer and wine. The expenditure share of ROB increases the most from 0.100 to 0.230 and that of spirits drops most from 0.436 to 0.328. However, spirits still keeps the largest import

[1] ROB refers to “rest of beverages”, which includes unsweetened water, non-alcohol water and fermented beverages, etc.

share of the four beverage groups in 2012. In terms of unit price level, all prices increase from 1992 to 2012, but at different rates. The prices of beer and wine just experience a slight increase, while the prices for spirits and ROB almost double. In 2012, the highest import price of the four beverage groups is spirits, which is $9.49 per liter. Quantity and total value are also reported in Table 3-1.

Table 3-2 shows the U.S. import statistics for beer, wine, and spirits by country of origin (Total value, quantity, and value share) from 2008 to 2012. The countries under study for beer imports are Mexico and Netherlands, the top two exporters of beer to the U.S. market at the sample mean from 2008 to 2012. For the wine estimation, Italy, France, Australia and Chile are chosen for analysis. They are the top four largest exporters of wine to the U.S. market at the sample mean from 2008 to 2012. For the spirits estimation, the paper estimate import demand from France, United Kingdom, Mexico and Sweden into the U.S. market. They are also the top four biggest exporters of spirits into the U.S. market from 2008 to 2012.

Due to the lack of import data for values and volumes on the other commodities, it is assumed that alcoholic beverage consumption is weakly separable from other commodities (Barten 1977). Thus, the parameter estimates shown in the following chapters are conditional demand parameters.

Table 3-1. U.S. budget import shares, prices, quantities and values for aggregated beverages, 1992-2012.

Year	Beer	Wine	Spirits	ROB[a]
		Budget share		
1992	0.206	0.259	0.436	0.100
Average	0.235	0.268	0.351	0.146
2012	0.187	0.255	0.328	0.230
		Price (nominal dollars)		
1992	0.883	4.206	4.708	0.416
Average	0.982	4.753	6.957	0.550
2012	1.140	4.333	9.490	0.777
		Quantity (1000 liters)		
1992	976,151	258,016	388,114	1,011,539
Average	2,494,910	615,934	540,973	2,957,780
2012	3,251,923	1,167,454	685,392	5,853,150
		Value (1000 dollars)		
1992	861,859	1,085,217	1,827,372	420,530
Average	2,514,990	2,971,040	3,760,080	1,763,400
2012	3,705,746	5,058,590	6,504,081	4,547,860

Source: Global Agricultural Trade System, U.S. Department of Agriculture, 2013.
[a] ROB represents rest of beverages which includes unsweetened water, non-alcohol water and fermented beverages, etc.

Table 3-2. U.S. average import values, quantities, quantities per capita, and value shares for beer, wine and spirits by country of origin 2008-2012.

Country	Value (1000 dollars)	Quantity (1000 liters)	Quantity, per capita (liter)	Value share (percentage)
			Beer	
Mexico	1,647,396	1,639,889	5.30	46.16%
Netherlands	945,589	662,725	2.14	26.50%
ROW	975,613	907,377	2.94	27.34%
			Wine	
Italy	1,340,814	257,009	0.83	29.51%
France	1,217,391	102,618	0.33	26.79%
Australia	608,855	207,657	0.67	13.40%
Chile	285,036	122,410	0.40	6.27%
ROW	1,091,936	286,472	0.93	24.03%
			Spirits	
France	1,616,796	86,823	0.28	28.01%
United Kingdom	1,388,028	155,496	0.50	24.05%
Mexico	693,602	108,117	0.35	12.02%
Sweden	414,200	142,614	0.46	7.18%
ROW	1,659,025	341,397	1.10	28.74%

Source: Global Agricultural Trade System, U.S. Department of Agriculture, 2013.

CHAPTER 4
METHODOLOGY

Four Basic Demand Systems and the General Model

The Rotterdam model and the AIDS model are popular in current studies. However, there is no special rule or theory for model selection. The scholars often choose these two models or their variants according to their personal needs or inference (Lee, Brown, and Seale 1994). In this paper, we apply the general demand system (Barten 1993) to test which single demand system best fits the U.S. import data of alcoholic beverages.

The Rotterdam model, according to Barten (1964) and Theil (1965), is specified as

$$w_i dlogq_i = \theta_i dlogQ + \sum_j \pi_{ij} dlogp_j + \varepsilon_j \tag{4-1}$$

where $w_i = p_i q_i / \sum_i p_i q_i$ represents the average budget share for commodity i; p_i and q_i are the price and quantity of good i, respectively; $dlogp_i$ and $dlogq_i$ represent $\mathrm{d}p_i/p_i$ and $\mathrm{d}q_i/q_i$, respectively; and dlogQ is the Divisia volume index for the change in real income and may be written as $\mathrm{dlogQ} = \sum_i w_i \, dlogq_i$.

The demand parameters θ_i and π_{ij} are given by

$$\theta_i = p_i(\partial q_i/\partial b),$$

$$\pi_{ij} = (p_i p_j/b) s_{ij},$$

$$s_{ij} = \partial q_i/\,\partial p_i + q_j\,\partial q_i/\,\partial \mathrm{b}, \tag{4-2}$$

where b is total budget or the expenditure, and s_{ij} is the (i, j)th element of the Slutsky substitution matrix. The parameter θ_i is the marginal budget or expenditure share for commodity i, and π_{ij} is a compensated price term. The constraints of demand theory can be directly applied to the Rotterdam parameters. We have

$$\text{Adding-up} \quad \sum_i \theta_i = 1, \sum_i \pi_{ij} = 0$$

$$\text{Homogeneity} \quad \sum_j \pi_{ij} = 0$$

$$\text{Symmetry} \quad \pi_{ij} = \pi_{ji}. \tag{4-3}$$

In the differential demand equation of the Rotterdam model, demand parameters θ_i's and π_{ij}'s are constant. However, there is no rule that indicates θ_i's and π_{ij}'s should be held constant. The following equation is another parameterization based on Working's model (1943), which can be shown as

$$w_i = \alpha_i + \beta_i logb. \tag{4-4}$$

Because the sum of budget shares, w_i, is unity, the above equation implies that $\sum \alpha_i = 1$ and $\sum \beta_i = 0$. In order to derive the marginal shares using Working's model, one multiplies by b and differentiates with respect to b.

$$\partial(p_i q_j)/\partial \mathrm{b} = \alpha_i + \beta_i(1 + logb) = w_i + \beta_i \tag{4-5}$$

With the help of this equation, the ith marginal share differs from the corresponding budget share by β_i. Thus, the budget or expenditure share is not constant with income, and neither is the associated marginal share. The income elasticity based on Equation 4-5 is

$$\eta_i = 1 + \beta_i / w_i. \tag{4-6}$$

The above formula illuminates that a commodity with negative β_i is a necessity. Conversely, a good with positive β_i is a luxury. The good is unitary elastic when β_i is equal to zero and prices hold constant.

By replacing θ_i in Equation 4-1 with Equation 4-5 and rearranging terms, we derive

$$w_i dlogq_i = (w_i + \beta_i) dlogQ + \sum_j \pi_{ij} dlogp_j + \varepsilon_j. \tag{4-7}$$

This model is referred to be the CBS model, following Keller and van Driel (1985). In this equation, β_i and π_{ij} are constant coefficients (Keller and van Driel 1985; Theil and Clements 1987).

The AIDS model, which may be regarded as an expansion or development of Equation 4-4 by including the price effects, can be written as

$$w_i = \alpha_i + \sum_j \gamma_{ij} logp_j + \beta_i \log(b/P) \tag{4-8}$$

where $logp$ is a price index, can be defined by

$$\mathrm{logP} = \alpha_0 + \sum \alpha_k logp_k + 1/2 \sum_k \sum_l logp_k logp_l.$$

The adding-up restrictions for the above equation are

$$\sum_i \alpha_i = 1; \sum_i \beta_i = 0; and \ \sum_i \gamma_{ij} = 0.$$

Homogeneity can be satisfied if

$$\sum_i \gamma_{ij} = 0,$$

and symmetry can be satisfied if

$$\gamma_{ij} = \gamma_{ji}.$$

We can also rearrange the terms and transform the basic equation of the AIDS model to differential form, based on replacing the Divisia price index $\sum_i w_i \, dlogp_i$ for $dlogP$ in Equation 4-8 (Deaton and Muellbauer 1980).

$$\mathrm{d}w_i = \beta_i dlog(b/P) + \sum_j \gamma_{ij} dlogp_j$$

As suggested by Barten (1993), we use the following relations

$$\mathrm{d}w_i = w_i(dlogp_i + dlogq_i - dlogm)$$

$$\mathrm{dlogm} = \mathrm{dlogP} + \mathrm{dlogQ}$$

$$\beta_i = \theta_i - w_i$$

$$\gamma_{ij} = \pi_{ij} + w_i\delta_{ij} - w_i w_j \tag{4-9}$$

where δ_{ij} is the kronecker delta. If i=j, the value is unity; if i≠j, the value is zero. Equation 4-8 can be rewritten as (Lee, Brown and Seale 1994),

$$w_i dlogq_i = (w_i + \beta_i)dlogQ + \sum_j[\gamma_{ij} - w_i(\delta_{ij} - w_j)]dlogp_j + \varepsilon_j. \tag{4-10}$$

Besides the Rotterdam, CBS and AIDS model, we can derive the NBR (Neves 1987) by replacing β_i with $\theta_i - w_i$ in the AIDS model. Thus, the NBR model has the Rotterdam income coefficients but the AIDS price coefficients. More specifically, the NBR model can be shown as:

$$\mathrm{d}w_i + w_i dlogQ = \theta_i dlogQ + \sum_j \gamma_{ij} dlogp_j. \tag{4-11}$$

We can also rewrite the above equation as (Lee, Brown and Seale 1994),

$$w_i dlogq_i = \theta_i dlogQ + \sum_j[\gamma_{ij} - (w_i\delta_{ij} - w_j)]dlogp_j + \varepsilon_j. \tag{4-12}$$

Thus, we obtain the basic expressions of four demand models. In addition, the income and price elasticities are derived and shown in Table 4-1. In the following chapters, these expressions are utilized to calculate and report the income and price elasticities for beer, wine, and spirits. Through the comparison, they have the same left-hand side variable $w_i dlogq_i$ and right-hand side variables $dlogQ$ and $dlogp_j$ with different parameterizations. Four models can be considered as four unique ways to parameterize a general differential demand system; what's more, the Slutsky terms are regarded to be constants in the Rotterdam and CBS but to be variables in the AIDS and NBR; the marginal budget shares are shown to be constant in the Rotterdam and NBR but to be variables in the AIDS and CBS.

The four models analyzed above are single equations for each system, which are not nested. However, a general or synthetic model can be developed which nests all four basic models (Barten 1994). The general demand model of an importing country may be written in conditional form as

$$w_{ict}^{*}dlogq_{ict} = (d_i^{*} + \delta_i w_{ict}^{*})dlogQ_{kct} + \sum_j\left[e_{ij}^{*} - \delta_2 w_{ict}^{*}\left(\delta_{ij} - w_{jct}^{*}\right)\right]dlogp_{jct} + \varepsilon_{jct}\,, j \in S_i \tag{4-13}$$

where $w_{ict}^{*} = w_{ict}/W_{kt}$ is the conditional budget share of imported commodity i from country c in period t, $w_{ict} = p_{ic}q_{ict}/\sum_i p_{ic}q_{ict}$ is the budget share of good i from exporting country c in time period t, $W_{kt} = \sum_i \in S_k$, w_i is the group budget share for group K in time period t,

p_{jct} is the price of imported good j from exporting country c in time period t,

q_{ict} is the quantity of good i imported from exporting country c in time period t,

$dlogq_{ict}$ and $dlogp_{jct}$ equals to dq_{ict}/q_{ict} and dp_{jct}/p_{jct}, respectively,

$dlogQ_{kct}$ represents Divisia volume index for the change in real income,

$dlogQ_{kct} = \sum_i w_{ict}^{*}\, dlogq_{ict}, i \in S_k$, $\theta_{ic}^{*} = \frac{\theta_{ic}}{\Theta_k}$ is the conditional marginal share of good i from country c where

$\theta_{ic} = p_{ict}(\partial q_{ict}/\partial b)$ is the unconditional marginal share of good i from country c, and $\Theta_k = \sum_i \in s_k$, θ_i is the marginal share of group K,

where b is the budget or total outlay.

In the general demand model, $d_i^{*} = \delta_1\beta_i^{*} + (1 - \delta_1)\theta_i^{*}$ and $e_{ij}^{*} = \delta_2\gamma_{ij}^{*} + (1 - \delta_2)\pi_{ij}^{*}$; δ_1 and δ_2 are two additional parameters to be estimated. The demand model will become the conditional Rotterdam model when both δ_1 and δ_2 are restricted to zero, the conditional CBS when δ_1 =1 and δ_2 =0, the conditional AIDS when δ_1 =1 and δ_2 =1, and the conditional NBR when δ_1 =0 and δ_2 =1. The demand restrictions on the general demand model are

$$\text{Adding-up} \quad \sum_i d_i^* = 1 - \delta_1, and \ \sum_j e_{ij}^* = 0,$$

$$\text{Homogeneity} \quad \sum_j e_{ij}^* = 0,$$

$$\text{Symmetry} \quad e_{ij}^* = e_{ji}^*. \tag{4-14}$$

Note that, for an application to discrete data, the specifications are approximated by replacing w_{ict} by $(w_{ict} + w_{ict-1})/2$, $\mathrm{dlog}q_{ict}$ by $\log(q_{ict}/q_{ict-1})$, and $\mathrm{dlog}p_{jct}$ by $\log(p_{jct}/p_{jvt-1})$. Additionally, d_i^* and e_{ij}^* are treated as constant parameters.

The likelihood ratio test (LRT) for model selection can be shown as:

$$\mathrm{LRT} = -2[\mathrm{logL}(\theta^*) - \mathrm{logL}(\theta)] \tag{4-15}$$

where $\theta^*$is the vector of parameter estimates of each of the four restricted demand models; θ is the vector of parameter estimates of the general model; and log L(.) is the log value of the likelihood function (Amemiya 1985). For example, under the null hypothesis that the restricted model best describes the data, test statistic LRT has an asymptotic $\chi^2(q)$ distribution, in which q is the number of restrictions imposed.

The goodness of fit has been tested by the method invoked by Bewley (1986). As the single-equation R^2 statistics are not suitable for measuring the goodness of fit for demand systems, we apply the method and expressions proposed by Bewley, Young, and Coleman (1987),

$$R_L^2 = 1 - 1/\{1 + LR/[T(n-1)]\} \tag{4-16}$$

where LR is twice the difference between the log likelihood of the naive model of four demand systems and the log likelihood of the same dependent variables regressed on the dlogQ term only; T is the number of observations and n is the number of equations in the system.

Two-Stage Budgeting

In this paper, we utilize the multistage budgeting approach, as many studies do (Barten 1977). This method is easily accommodated by the differential approach to utility maximization and is useful when one wants to estimate the demand for disaggregated (imported) goods (Seale, Sparks, and Buxton 1992). First, Countries allocate total income between domestic and imported goods. Then, total import expenditure is allocated among all imported goods including alcoholic beverages. Preferences among these goods are assumed to be blockwise dependent (Theil 1978) or weakly separable (Barten 1977). Based on this structure, imported alcoholic beverages are separable from domestically produced beverages. Finally, we allocate the expenditure on beer, wine and spirits among the different supplying countries.

We need to specify the multistages for estimation of group demand. In this paper, two basic stages are necessary to estimate the import demand of U.S. beer, wine and spirits. To explain the group demand analysis, we use the Rotterdam model in the following parts so we can display our details for the group demand classification easily. The basic equation for the Rotterdam model can be shown as

$$w_i dlogq_i = \theta_i dlogQ + \sum_j \pi_{ij} dlogp_j + \varepsilon_j \qquad (4\text{-}17)$$

when we utilize multistage budgeting, we need to estimate the demand for aggregate groups of goods. In the above formula, $w_i = p_i q_i / \sum_i p_i q_i$ represents the average budget share for commodity i; p_i and q_i are the price and quantity of good i, respectively; $dlogp_i$ and $dlogq_i$ represent $\mathrm{d}p_i/p_i$ and $\mathrm{d}q_i/q_i$, respectively; and dlogQ is the Divisia volume index for the change in real income and may be written as $\mathrm{dlogQ} = \sum_i w_i \, dlogq_i$,

In the first stage, the demand for aggregate groups of goods is

$$W_g dlogQ_g = \Theta_g dlogQ + \sum_h \pi_{gh} dlogp_g + \varepsilon_g \quad (4\text{-}18)$$

where $\mathrm{dlogQ} = \sum_g w_g \, dlogQ_g$ is the Divisia volume index for alcohol, g represents the group containing beer, wine, spirits and ROB (refers to the rest of beverages), and $W_g = p_q q_g / \sum_g p_q q_g$ is the average budget share for commodity group g. With this function, we can estimate three equations for beer, wine, and spirits in a four-equation-system. We drop the ROB to avoid the singularity issue (Barten 1969).

In the second stage, we estimate the import demand for beer, wine and spirits by country of origin, respectively. The functions for the individual commodity import demand can be presented as

$$w_i^* \mathrm{dlog} q_i = \theta_i^* dlogQ_g + \sum_j \pi_{ij}^* \, dlogp_j + \varepsilon_j^*, j \in S_g \quad (4\text{-}19)$$

where $w_i^* = w_i / w_g$ is the average budge share for source country i for commodity in group g, i represents the ith source import country of each of the g (i.e., beer, wine, and spirits) commodities, and $\mathrm{dlog} Q_g = \sum_{j \in Sg} w_i^* \, dlogq_i$ is the Divisia volume index for the change in group g real expenditure. With this function, we can conduct several equations analysis for beer, wine and spirits by country of origin, respectively.

In conclusion, the four basic demand models and the general demand system are utilized in the following chapters for empirical analysis. LR tests and goodness-of-fit tests are applied to the following estimations. With the help of demand elasticity expressions in Table 4-1, marginal shares, conditional expenditure elasticities, own-price and cross-price elasticities are obtained for U.S. import demand of beer, wine, and spirits by country of origin.

Table 4-1. Income and price elasticity expressions for the Rotterdam, CBS, AIDS, and NBR models.

Model	Income elasticity	Price parameter	Slutsky price elasticity	Cournot price elasticity
Rotterdam	θ_i/w_i	π_{ij}	π_{ij}/w_{ij}	$\frac{\pi_{ij}}{w_{ij}} - \frac{\theta_i w_j}{w_i}$
CBS	$1 + \beta_i/w_i$	π_{ij}	π_{ij}/w_{ij}	$\frac{\pi_{ij}}{w_{ij}} - \frac{(\beta_i + w_i)w_j}{w_i}$
AIDS	$1 + \beta_i/w_i$	$\gamma_{ij} - w_i(\delta_{ij} - w_j)$	$\frac{\gamma_{ij}}{w_i} - \delta_{ij} + w_j$	$\frac{\gamma_{ij}}{w_i} - \delta_{ij} + w_j - \frac{(\beta_i + w_i)w_j}{w_i}$
NBR	θ_i/w_i	$\gamma_{ij} - w_i(\delta_{ij} - w_j)$	$\frac{\gamma_{ij}}{w_i} - \delta_{ij} + w_j$	$\frac{\gamma_{ij}}{w_i} - \delta_{ij} + w_j - \frac{\theta_i w_j}{w_i}$

CHAPTER 5
U.S. IMPORT DEMAND FOR BEER, WINE, AND SPIRITS

U.S. import demand for beer, wine and spirits is estimated based on four differential demand system (i.e., Rotterdam, CBS, AIDS, and NBR) and the general demand system. Four-equation-demand systems are estimated from 1992 to 2012 for aggregated beverages (beer, wine, spirits, and ROB) using the five mentioned demand systems. In this part, the AIDS model fits the data best and demonstrated from testing restrictions and LR tests. Conditional parameter estimates, conditional expenditure elasticities, and two types of price elasticities are presented in this chapter.

Testing Restrictions and Model Choice

Firstly, in order to test whether the dataset satisfy homogeneity and symmetry restrictions, the restrictions of homogeneity and symmetry are tested using LR tests. Secondly, LR tests for model selection are applied to choose the best model among the four demand models. The log likelihood values and ratio statistics of the four demand models and the general demand system are reported in Table 5-1 for aggregated beverages. The results in the first three rows are the log-likelihood values; the results in the last three rows are the log-likelihood-ratio test statistics. The test is $-2(L_r - L_u)$ where L_r is the log-likelihood value of the restricted model, and L_u is that of the unrestricted model. The test has an approximately $\chi^2(q)$ distribution. The degree of freedom is the difference between the number of parameters in the unrestricted and restricted model.

On the basis of the results for aggregated beverages, the null hypothesis of homogeneity is not rejected for any model at the 0.05 significance level. Plus, the null hypothesis of symmetry is not rejected for any model at the 0.05 significance level. The model selection results show that only the AIDS model is not rejected at 0.01 significance level. Thus, the results for the AIDS model are displayed and explained further in next section. For the aggregated beverages using the AIDS model with homogeneity and symmetry, the goodness-of-fit measure is R_L^2 = 0.67, which illuminates that the whole system explains 67% of the variation in allocation.

Parameter Estimates

The AIDS parameters are reported in Table 5-2 while marginal shares, conditional expenditure, own-price elasticities and cross-price elasticities are shown in Table 5-3. The own-price parameters are reported along the diagonal of columns (2)-(5) of Table 5-2. The own-price parameters of the four group commodities from beverages are negative and all are less than one absolutely as we expect, ranging from -0.089 (beer) to -0.266 (spirits). Of the four parameters, they are all statistically significant at α=0.05 level.

The cross-price parameters are reported as the non-diagonal numbers of columns (2)-(5) of Table 5-2. These parameters show whether the commodity from other commodities are complements or substitutes, refer to the sign of the parameters. If the parameter is positive, it is a substitute; if negative, it is a complement. All are positive except that of the beer-ROB pairing. Among the conditional cross-price parameters, two are statistically the same as zero. The results show that beer and ROB are complements, and all other pairing are substitutes.

Marginal shares are equivalent to the shares of any additional dollar spent on the group on a whole that will be allocated on each commodity. In the AIDS, the marginal shares equal $\beta_i + w_i$ for aggregated beverages. All marginal shares parameters are calculated at sample mean and are reported in column (2) of Table 5-3. Note that the marginal shares here are functions of budget shares, and they are all significantly different from zero (α=. 01). Both spirits and wine would gain 25 cents each from an additional dollar being allocated to aggregated beverages; 20 cents will be allocated to beer while the rest going to ROB. Among these commodities, the beer industry gains the least if an additional dollar were spent on aggregated beverages.

Conditional Expenditure Elasticities

The conditional expenditure elasticities of the four alcoholic commodities are reported in column (3) of Table 5-3. These elasticities disclose the percentage change in the quantities demanded from each of commodities when U.S. import expenditure increases by 1% on these beverages. The elasticities can be judged by comparing the value with one. If an elasticity is higher than one, it is conditionally elastic, which indicates the budget share for this commodity will raise if U.S. expenditure on beverages increases; if it is lower than one, it is conditionally inelastic which means the budget share for this commodities will decrease if U.S. expenditure on beverage increases. All of these expenditure elasticities are positive and significantly different from zero (α=0. 01). ROB (2.13) has the highest conditional expenditure elasticity among these four beverages. Wine (0.93) has the next highest value of expenditure elasticities among these commodities, but it is inelastic. Beer and spirits are less elastic than wine, 0.83 and 0.70, respectively. These results indicate that if the U.S. increases expenditure on beverages by 1%, the budget share for spirits, wine and beer would decrease slightly, while the quantities demanded of these beverages would increase by 0.93%, 0.83%, and 0.70% for wine, beer, and spirits, respectively. The budget share for ROB would raise and its quantity demanded would increase by 2.13%.

Two Types of Price Elasticities

Slutsky and Cournot elasticities are reported in columns (4)-(7) of Table 5-3. Slutsky own-price elasticities are compensated and account for the substitution effect. The Cournot own-price elasticities are uncompensated, and they have both substitution and income effects. Accordingly, Cournot own-price elasticities are larger absolutely than corresponding Slutsky ones. The results imply all conditional own-price elasticities are negative. For the own-price elasticity results, no matter Slutsky and Cournot, they are all significantly different from zero at α=0.05 level.

For spirits, its Slutsky own-price is inelastic but its Cournot own-price elasticity is unitary. The Slutsky (Cournot) own-price elasticity is -0.76 (-1.00). For wine and beer, both their Slutsky and Cournot own-price elasticities are inelastic. The Slutsky (Cournot) own-price elasticity for wine is -0.67 (-0.92) and for beer is -0.38 (-0.57). Compared with the difference between the conditional Slutsky and Cournot own-price elasticities of each commodity, wine has the biggest change. It indicates wine has the strongest expenditure sensitivity among these commodities in the U.S. import market. These results also point out different effects of price fluctuations on U.S. beverage demand. If the price of imported beer goes up by 1%, the uncompensated quantity demanded of imported beers will go down only 0.38%. However, imported spirits are much more influenced by this kind of own-price fluctuations. More specifically, the uncompensated quantity demanded of imported spirits into the U.S. market would decrease about 0.76%.

Conditional Slutsky cross-price elasticities measure the responsiveness of the demand for a good to a change in the price of a substitute or complement good. Positive (negative) Slutsky cross-price elasticities denote that an increase in the good's price from the ith source country will lead to the quantity demanded of this good to increase (decrease) from jth source country. Thus, their goods would be substitutes (complements). In the 12 conditional Slutsky cross-price elasticities, 10 are positive with two approximately equal to zero. The ROB-spirits (0.80) pairing possesses the largest positive cross-price elasticity. It indicates that a 1% increase in the price of other beverages will increase the quantity demanded (compensated) for spirits by 0.80%.

Among the 12 conditional Cournot cross-price elasticities, seven are negative and others are positive. Spirits-ROB (0.23) has the largest positive cross-price elasticity. ROB-beer has the biggest negative cross-price elasticity. For example, a 1% decrease in the price of ROB will increase by 0.51% the uncompensated quantity demanded for imported beer.

For aggregated beverages, U.S import demand for beer, wine, and spirits are inelastic, as the absolute value of their Slutsky (Cournot) own-price elasticities are less than 1. Spirits and wine are substitutes for all the imported beverages. A compensated price change in spirits and wine has a small positive influence on the quantity demanded for all the other imported beverages. Another interesting fact is that, when we take the income effect plus the substitution effect into account, an increase in the beer price will decrease the demand for all the other beverages. For example, if there is a 1% increase in the price of beers, the demand for ROB will decrease by 0.51%. The decrease also happens for the demand for wine and spirits. Additionally, the largest change between the value of the Slutsky and Cournot cross-price elasticity is for ROB-spirits. The Slutsky value is 0.80 and the Cournot is 0.05. This indicates if the price of ROB increases, the income effects will affect the quantity demanded of spirits in that the quantities demand for spirits will increase only 0.05%, as compared to 0.80% when only the substitution effect is taken into account.

To sum up, all pairings are substitutes except beer and ROB which have no price effect on each other. If the U.S. increases an additional dollar on imported aggregated beverages, both beer and wine would gain 25 cents. Besides, ROB has the highest expenditure elasticity, which means that ROB would have the largest percentage change in the quantities demanded if U.S. import expenditure on these beverages increases by 1%. At last, ROB-spirits possesses the largest positive Slutsky elasticity, and ROB-beer has the biggest negative Cournot elasticity.

Table 5-1. Test results for log-likelihood-ratio tests for different restrictions in the Rotterdam, CBS, AIDS, NBR, and general model for aggregated beverages.

	General	Rotterdam	CBS	AIDS	NBR
			Log-likelihood Value		
Unrestricted	191.28	184.57	185.41	186.50	185.44
Homogeneity	189.103	181.551	182.725	183.97	182.63
Homogeneity and Symmetry	187.98	179.05	180.23	181.83	180.45
			Test Statistics		
Homogeneity	4.35(3)	6.04(3)	5.38(3)	5.06(3)	5.63(3)
Homogeneity and Symmetry	2.25(6)	4.99(6)	5.00(6)	4.27(6)	4.34(6)
Model selection	-	15.10(2)	12.76(2)	10.27(2)	12.96(2)

[a] Table values of χ^2 are 7.81 and 12.59 for 3 and 6 degrees of freedom, respectively, at 0.05 level. Plus, table values of χ^2 is 10.6 for 2 degrees of freedom at 0.01 level.
[b] Numbers in parentheses are degrees of freedom for tests.
[c] Models with homogeneity and symmetry constraints imposed.

Table 5-2. Conditional parameter estimates for U.S. import demand for aggregated beverages.

Aggregated Beverage, 1992-2012, AIDS model					
		Price parameters			Income parameters
Beverage (1)	Spirits (2)	Wine (3)	Beer (4)	ROB (5)	(6)
Spirits	-0.266***	0.093***	0.056***	0.117***	-0.106***
	(0.013)	(0.014)	(0.012)	(0.017)	(0.035)
Wine		-0.179***	0.034	0.052*	-0.020
		(0.028)	(0.023)	(0.027)	(0.041)
Beer			-0.089**	-0.001	-0.040
			(0.040)	(0.028)	(0.030)
ROB				-0.168***	0.165***
				(0.037)	(0.052)

[a] Numbers in parenthesis are standard errors.
[b] *** indicates this number is statistically different from zero at 0.01 level.
[c] ** indicates the number is statistically different from zero at 0.05 level.
[d] * indicates the number is statistically different from zero at 0.1 level.

Table 5-3. Marginal shares, conditional expenditure, Slutsky and Cournot elasticities of U.S. import demand for aggregated beverages at sample mean.

Aggregated Beverage, 1992-2012, AIDS model						
	Marginal shares	Expenditure elasticities	Price elasticities			
Beverage			Spirits	Wine	Beer	ROB
(1)	(2)	(3)	(4)	(5)	(6)	(7)
			Slutsky			
Spirits	0.25***	0.70***	-0.76***	0.27***	0.16***	0.33***
Wine	0.25***	0.93***	0.35***	-0.67***	0.13	0.19*
Beer	0.20***	0.83***	0.24***	0.15	-0.38**	-0.00
ROB	0.31***	2.13***	0.80***	0.35*	-0.00	-1.15***
			Cournot			
Spirits			-1.00***	0.08*	-0.01	0.23***
Wine			0.02	-0.92***	-0.09	0.06
Beer			-0.05	-0.08	-0.57***	-0.12
ROB			0.05	-0.22	-0.51***	-1.46***

[a] *** indicates this number is statistically different from zero at 0.01 level.
[b] ** indicates the number is statistically different from zero at 0.05 level.
[c] * indicates the number is statistically different from zero at 0.1 level.

CHAPTER 6
U.S. IMPORT DEMAND FOR BEER, WINE AND SPIRITS BY COUNTRY OF ORIGIN

The U.S. import demand for beer, wine and spirits by country of origin are estimated using the yearly time-series data with the general demand system from 1992 to 2012. Conditional expenditure, own-price elasticities, and cross-price elasticities are calculated and reported on a per capita basis in various demand systems. The log likelihood and ratio values of four basic demand models and general demand systems are reported in tables as well.

U.S. Import Demand for Beer by Country of Origin

U.S. import demand for beer by country of origin is estimated based on the general demand system. Three-equation-demand systems are estimated from 1992 to 2012 for beer imported into the U.S. from Mexico, Netherlands, and ROW. For beer by country of origin, the best is demonstrated by testing restrictions and LR tests. Accordingly, conditional parameters estimates, conditional expenditure elasticities and two types of price elasticities are presented in this section based on the NBR model.

Testing Restrictions and Model Choice

The log-likelihood and ratio values of the four basic demand models and the general demand system are reported in Table 6-1 for imported beer by country of origin. The null hypothesis of homogeneity is not rejected for any model at the 0.05 significance level, and the null hypothesis of symmetry is not rejected for any model at the 0.05 significance level. The model selection results show that the NBR fits the imported beer by country of origin data best. Thus, the results for the NBR model are presented and discussed further in this section.

Parameter Estimates

NBR parameters and marginal shares are reported in Table 6-2 while conditional expenditure, Slutsky own-price elasticities and cross-price elasticities are shown in Table 6-3. Cournot own-price elasticities and cross-price elasticities are presented in Table 6-4.

The own-price parameters are reported along the diagonal of columns (2)-(4) of Table 6-2. All own-price parameters of the three countries for imported beer are negative and less than one absolutely as expected, ranging from -0.078 (Netherlands) to -0.250 (Mexico).

The cross-price parameters are reported as the non-diagonal numbers of columns (2)-(4) of Table 6-2. Among the conditional cross-price parameters, one is negative and the other two are positive; only one is significantly different from zero (α=. 1). The results show that only the Netherlands-Mexico pairing is complements.

All marginal shares parameters are reported in column (5) of Table 6-2. In the NBR model, the marginal shares equal θ_i for beer and are constant. They are all significantly different from zero (α=. 01). Mexico would gain the most benefit with 48 cents from an additional dollar being allocated to imported beer on a whole. 30 cents and 22 cents from an additional dollar would be spent on beer from Netherlands and ROW, respectively.

Conditional Expenditure Elasticities

The conditional expenditure elasticities of beer by country of origin are reported in column (2) of Table 6-3. As we explained in the former chapter, if the elasticity is higher than one, it is conditionally elastic, which indicates the budget share for this source country will increase if U.S. import expenditure on this commodity increases; if it is lower than one, it should be conditionally inelastic, which means the budget share for this source country will decrease if U.S. import expenditure on this commodity increases; if it is equal to one, it is unitary and suggests that the budget share will not change if U.S. expenditure on this commodity changes.

All of these expenditure elasticities are positive and significantly different from zero (α=0. 01). The country with an elastic conditional expenditure elasticity is Mexico (1.33) for beer. Countries with inelastic conditional expenditure elasticities are Netherlands (0.93) and ROW (0.69). These results indicate that if U.S increases expenditure on imported beer by 1%, the budget share for beer of Mexico would increase while those of the others would decrease. Additionally, quantities demanded of imported beer would increase by 1.33%, 0.93%, and 0.69% for Mexico, Netherlands, and ROW, respectively. Thus, Mexico has the most benefit to gain from an increase in import expenditures for beer.

Two Types of Price Elasticities

Slutsky and Cournot elasticities are reported in columns (3)-(5) of Table 6-3 and columns (2)-(4) of Table 6-4. Conditional Slutsky (Cournot) own-price elasticity for Mexico is -0.68 (-1.53). Netherlands and ROW are less own-price inelastic with conditional Slutsky (Cournot) own-price elasticity of -0.24 (-0.86) and of -0.52 (-1.05), respectively. Compared with the difference between the conditional Slutsky and Cournot own-price elasticities of each source country, Mexico has the biggest difference. This indicates that Mexican beer is most expenditure sensitivity among imports into the U.S. import market. These results also point out different effects of price fluctuations on U.S. beer import demand. If the price of Dutch beer goes up by 1%, the uncompensated quantity demanded for Dutch beers would go down only 0.86%. However, Mexico and

ROW imported beer are much more influenced by this kind of own-price fluctuations. More specifically, the uncompensated quantity demand of Mexico and ROW imported beer into the U.S. market would decrease about 1.53% and 1.05%, respectively.

In terms of conditional cross-price elasticities, the ROW-Mexico (0.54) pairing possesses the largest positive cross-price elasticity, which indicates that a 1% increase in the price of beer from the Mexico will increase the quantity (compensated) demanded for ROW beer by 0.54% in the U.S. import market. What's more, the Slutsky (Cournot) for Netherlands-ROW is negative, but statistically the same as zero sending some evidence that they are complements for the U.S. beer market.

To sum up, imported beer from the Netherlands and Mexico may be complements, but all other pairings are substitutes. If U.S. increases an additional dollar on imported beer, Mexico would gain the most benefit with 48 cents. Besides, Mexico has the highest expenditure elasticity, which means that Mexico has the largest percentage change in the quantities demanded when U.S. import expenditure on beer increases by 1%. At last, ROW-Mexico possesses the largest positive Slutsky elasticity and Mexico has the biggest negative Cournot own-price elasticity (-1.53).

U.S. Import Demand for Wine by Country of Origin

U.S. import demand for wine by country of origin is estimated based on the general demand system. Five-equation-demand systems are estimated from 1992 to 2012 for imported wine into the U.S. market from Italy, France, Australia, Chile, and ROW. In this section, LR tests indicate that the AIDS model fits the data best. Conditional parameters estimates, conditional expenditure elasticities and two types of conditional price elasticities are presented in this section.

Testing Restrictions and Model Choice

The log-likelihood values and ratio values of the four basic demand models and general demand system are reported in Table 6-5 for imported wine. The null hypothesis of homogeneity is not rejected for any model at the 0.05 significance level. When the symmetry restriction is added, the null hypothesis of symmetry is not rejected for any model at the 0.05 significance level. The model selection indicates that Rotterdam and NBR are rejected by the general demand system and that the AIDS is better than the CBS. Also, the estimates of δ_1 and δ_2 are 1.59 and 0.91 with standard errors 0.48 and 0.55, respectively. Therefore, the results for the AIDS model are presented and discussed in this section. For the wine estimation, the goodness-of-fit measure is R_L^2 = 0.45, indicating that the whole system explains 45% of the variation in allocation.

Parameter Estimates

The AIDS parameters for imported wine are reported in Table 6-6 while marginal shares, conditional expenditure, Slutsky own-price elasticities and cross-price elasticities are shown in Table 6-7. Cournot own-price and cross-price elasticities are presented in Table 6-8.

The own-price parameters are reported along the diagonal of columns (2)-(6) of Table 6-6. The own-price parameters of five countries from wine are negative and less than one absolutely, ranging from -0.097 (Chile) to -0.153 (Australia). These five parameters are all statistically significant at α=0.01 level.

The cross-price parameters are reported as the non-diagonal numbers of columns (2)-(6) of Table 6-6. All are positive except that of the France-Chile pairing.

Among the conditional cross-price parameters, only three are significantly different from zero.

All marginal shares parameters are calculated and reported in column (2) of Table 6-7. In the AIDS, the marginal shares equal to $\beta_i + w_i$. They are all significantly different from zero (α=. 01). If the U.S. were to consume an additional dollar of imported wine, 34 cents would go towards purchasing French wines. Italy would also benefit 26 cents. While, 19 cents and 14 cents of the additional dollar would be allocated to ROW and Australia, respectively. Chile would receive only 8 cents of an additional dollar. Thus, the French wine industry would gain the most if an additional dollar were allocated on imported wine.

Conditional Expenditure Elasticities

The conditional expenditure elasticities of wine by country of origin are reported in column (3) of Table 6-7. As shown by the results, Chilean wine (1.43) has the highest expenditure elasticity. Australia (1.10) and ROW (1.07) have conditional elastic expenditure elasticity too. Italy (0.93) and France (0.92) have inelastic ones. With these results, the budget share for Chile, Australia and ROW would rise and others would fall if U.S. import expenditure for wine expands by 1%, while the quantities demanded of wine would increase by 1.43%, 1.10%, 1.07%, 0.93%, and 0.92% for Chile, Australia, ROW, Italy, and France, respectively.

Two Types of Price Elasticities

Slutsky and Cournot elasticities are reported in columns (4)-(8) of Table 6-7 and columns (2)-(6) of Table 6-8. For Chilean wine, no matter whether Slutsky and Cournot, has the most elastic own-price elasticity. Its Slutsky (Cournot) own-price elasticity is -1.81 (-1.88). Italian and French wine are the least own-price inelastic. Conditional

Slutsky (Cournot) own-price elasticity for Italian wine is -0.43 (-0.69) and French wine is -0.41 (-0.75). Australian and ROW wine are more own-price elastic than those of Italy and France, but less than that of Chile. They have conditional Slutsky (Cournot) own-price elasticities -1.20 (-1.34) and -0.75 (-0.93), respectively. Similar to the previous analysis, we contrast with the difference between the conditional Slutsky and Cournot own-price elasticities of each source country. The findings discover that France has the biggest difference. It demonstrates that French imported wine is the most expenditure sensitivity to an own-price change in the U.S. import market. These results also indicate various effects for price changes on U.S. wine import demand. Chilean and Australian wine are mostly influenced if their own-prices increase by 1%. More specifically, the uncompensated quantity demand of wine from Chile and Australia into the U.S. market would decrease 1.88% and 1.34%, respectively.

Through the results for Slutsky and Cournot cross-price elasticities, the U.S. import demand for wine from main source countries is inelastic except that of Chile-Australia, as the absolute value of all other Slutsky (Cournot) cross-price elasticities are less than 1. For Chile, the Slutsky (Cournot) cross-price elasticity with Australia is 1.21 (1.02), which is larger than the cross-price elasticities with other countries. It indicates that the U.S. import demand for Chilean wine is influenced by Australian wine price the most. The same situation is true for Australia-Chile. It shows that they are strong substitutes and Australia holds the price advantage, as the Slutsky (Cournot) cross-price elasticity for Chile-Australia is larger than that of Australia-Chile. Italian and Australian wines are the only ones that are substitutes for all wines. A compensated price change in Italian imported wines has a small positive influence on the quantity demanded for all other wines. In terms of Australia and ROW, a relatively large positive effect would be true for the quantity demanded for all other wines. However, the price changes of the imported wines have more positive effects on the quantity demanded of these source countries. For example, a 1% increase in the price of Chilean wines will increase by 0.51% the compensated quantity demanded for Australian wines. What's more, a 1% increase in the price of French wines will increase by 0.46% the compensated quantity demanded for ROW wines.

To sum up, France and Chile are complements and all other pairings are substitutes. If U.S. increases an additional dollar on imported wine, France would gain the most benefit with 34 cents. Besides, Chile has the highest expenditure elasticity, which means that Chilean wine would have the largest percentage change in the quantities demanded if U.S. import expenditure were to increase by 1%. Comparing the difference between Slutsky and Cournot own-price elasticities, France has the biggest difference. At last, only Chile-Australia has an elastic result in terms of cross-price elasticity.

U.S. Import Demand for Spirits by Country of Origin

U.S. import demand for spirits by country of origin is estimated based on the general demand system. Five-equation-demand systems are estimated from 1992 to 2012 for imported spirits into the U.S. market from France, United Kingdom, Mexico, Sweden, and ROW. In this part, it is found that the NBR model fits the data best through the result from testing restrictions and LR tests. Conditional parameters estimates, conditional expenditure elasticities and two types of price elasticities are presented in this section based on the NBR model.

Testing Restrictions and Model Choice

The log-likelihood and ratio values of the four basic demand models and general demand system are reported in Table 6-9 for spirits. The results for spirits indicate that the null hypothesis of homogeneity and symmetry is not rejected for any model at the 0.05 significance level. The model selection results show that all four demand models are not rejected by the general system while NBR fits the general system best, implying NBR model fits the spirits data better than the other three. Accordingly, results using NBR are reported and analyzed further in this section. For the spirits estimation, the goodness-of-fit measure is R_L^2 = 0.49, indicating that the whole system describes 49% of the variation in allocation.

Parameter Estimates

NBR parameters and marginal shares for spirits are reported in Table 6-10 while conditional expenditure, Slutsky own-price and cross-price elasticities are shown in Table 6-11. Cournot own-price and cross-price elasticities are presented in Table 6-12.

The own-price parameters are reported along the diagonal of columns (2)-(6) of Table 6-10. The own-price parameters of five countries from spirits are negative and less than one absolutely as expected, ranging from -0.013 (Mexico) to -0.197 (France). All parameters are statistically significant at α=0.01 level except that for Mexico.

The cross-price parameters are reported as the non-diagonal numbers of columns (2)-(6) of Table 6-10. All are positive except that of the France-Mexico and United Kingdom-Sweden pairings. Among the conditional cross-price parameters, six are significantly different from zero.

All marginal shares parameters are reported in column (7) of Table 6-10. In the NBR model, the marginal shares equal θ_i for spirits and are constant. They are all significantly different from zero (α=. 01). If an additional dollar were spent on imported spirits, 40 cents of that additional dollar would be allocated to French spirits. ROW would gain 22 cents, while the United Kingdom and Mexico would obtain 19 cents and 11 cents, respectively. Implied by the results, Sweden would be only allocated 8 cents if U.S. increases its expenditure by an additional dollar on spirits imports. Similar to the circumstance of wine, the French industry would be the most beneficial exporter if an additional dollar were spent on imported spirits.

Conditional Expenditure Elasticities

The conditional expenditure elasticities of spirits by country of origin are reported in column (2) of Table 6-11. The budget share of spirits from France would expand the most if U.S. import expenditure on spirits were to go up by 1%. Sweden's and Mexico's import share would also increase slightly. Countries with inelastic expenditure elasticities are ROW (0.71) and the United Kingdom (0.70). If U.S. import expenditure for spirits increases by one percent, the quantities demanded of spirits would increase by 1.68%, 1.05%, 1.03%, 0.71%, and 0.70% from France, Sweden, Mexico, ROW, and the United Kingdom, respectively.

Two Types of Price Elasticities

Slutsky and Cournot elasticities are reported in columns (3)-(7) of Table 6-11 and columns (2)-(6) of Table 6-12. For France, no matter whether the Slutsky and Cournot, its own-price is most elastic, with its Slutsky (Cournot) own-price elasticity being -0.82 (-1.46). Mexican spirits is the least own-price inelastic. The conditional Slutsky (Cournot) own-price elasticity for Mexican spirits is -0.13 (-0.34). ROW spirits has an elastic Cournot own-price elasticity, but not for Slutsky. Its conditional Slutsky (Cournot) own-price elasticity is -0.56 (-1.10). The Slutsky (Cournot) elasticities of the other two sources are inelastic. Through the comparison of the Cournot own-price value with the corresponding Slutsky one, the findings discover that France has the largest difference. It indicates that French imported spirits are the most expenditure sensitivity for the U.S. import market. In addition, results also illustrate that there are various effects for price variations on U.S. spirits import demand. For example, the uncompensated quantity demand of French spirits into the U.S. market would decrease about 1.46% of its own-price increased by one percent. Conversely, the uncompensated quantity demand of Mexican spirits into the U.S. market would just shrink about 0.34% from a 1.0% increase in its own-price.

Through the results for Slutsky and Cournot cross-price elasticities, the U.S. import demand for spirits from main source countries are inelastic as the absolute value of their Slutsky (Cournot) cross-price elasticities are less than 1. For Mexican spirits, the Slutsky (Cournot) cross-price elasticity with French spirits is 1.21 (1.02), which is larger than the cross-price elasticities with other countries. This indicates that the U.S. demand for Mexican imported spirits is influenced by the price of French spirits the most. ROW spirits is the only one that a substitute with all other spirits. A compensated price change in ROW spirits has a small positive influence on the quantity demanded for all other spirits. Besides, the price changes of the imported spirits from these source countries have more positive effects on the quantity demanded of ROW. For example, a 1% increase in the price of French spirits will increase the compensated quantity demanded for ROW spirits by 0.33%. Another interesting fact is that, when we take the income effect plus the substitution effect into account, an increase in the price of spirits produced from France, UK and ROW would decrease the demand for all other spirits.

For example, if there is a 1% increase for the spirits made from the United Kingdom, the demand from ROW will decrease 0.38%. Additionally, increase in the prices of other imported spirits would decrease the uncompensated quantity demanded for France, UK and ROW spirits. For example, a 1% increase in the price of Sweden (Mexico) spirits would decrease the quantity (uncompensated) demanded of UK (France) spirits by approximately 0.8% (0.7%).

To sum up, France-Mexico and United Kingdom-Sweden are complements and all other pairings are substitutes. If U.S. increases an additional dollar on imported spirits, France would gain the most benefit with 40 cents. Besides, France has the highest expenditure elasticity, which indicates that France would have the largest percentage change in the quantities demanded if U.S. import expenditure were to increase by 1%. Comparing the difference between Slutsky and Cournot own-price elasticities, France has the biggest difference. At last, an increase in the price of spirits from France, United Kingdom, and ROW would decrease the uncompensated demand for all other spirits.

Table 6-1. Test results for log-likelihood-ratio tests for different restrictions in the Rotterdam, CBS, AIDS, NBR, and general model for beer.

	General	Rotterdam	CBS	AIDS	NBR
			Log-likelihood value		
Unrestricted	121.31	120.82	120.48	120.76	121.05
Homogeneity	119.62	119.33	118.39	118.69	119.57
Homogeneity and Symmetry	119.47	119.03	118.38	118.67	119.28
			Test statistics		
Homogeneity	3.37(2)	2.99(2)	4.19(2)	4.14(2)	2.96(2)
Homogeneity and Symmetry	0.29(3)	0.60(3)	0.02(3)	0.02(3)	0.59(3)
Model selection	-	0.58(2)	2.46(2)	1.86(2)	0.09(2)

[a] Table values of χ^2 are 5.99 and 7.81 for 2 and 3 degrees of freedom, respectively, at 0.05 level.
[b] Numbers in parentheses are degrees of freedom for tests.
[c] Models with homogeneity and symmetry constraints imposed.

Table 6-2. Conditional parameter estimates for U.S. import demand for beer by country of origin.

Beer, 1992-2012, NBR model				
Country		Price parameters		Marginal shares
(1)	(2)	(3)	(4)	(5)
Mexico	-0.250	0.083	0.167*	0.48***
	(0.152)	(0.108)	(0.093)	(0.047)
Netherlands		-0.078	-0.004	0.30***
		(0.103)	(0.057)	(0.030)
ROW			-0.163*	0.22***
			(0.086)	(0.041)

[a] Numbers in parenthesis are standard errors.
[b] *** indicates this number is statistically different from zero at 0.01 level.
[c] ** indicates the number is statistically different from zero at 0.05 level.
[d] * indicates the number is statistically different from zero at 0.1 level.

Table 6-3. Marginal shares, conditional expenditure and Slutsky (compensated price elasticities) of U.S. import demand for beer by country of origin at sample mean.

Beer, 1992-2012, NBR model				
	Expenditure elasticities	Slutsky price elasticities		
Country		Mexico	Netherlands	ROW
(1)	(2)	(3)	(4)	(5)
Mexico	1.33***	-0.68	0.23	0.46*
Netherlands	0.93***	0.26	-0.24	-0.01
ROW	0.69***	0.54*	-0.01	-0.52*

[a] *** indicates this number is statistically different from zero at 0.01 level.
[b] ** indicates the number is statistically different from zero at 0.05 level.
[c] * indicates the number is statistically different from zero at 0.1 level.

Table 6-4. Cournot (uncompensated price elasticities) of U.S. import demand for beer by country of origin at sample mean.

Beer, 1992-2012, NBR model			
	Cournot price elasticities		
Country	Mexico	Netherlands	ROW
(1)	(2)	(3)	(4)
Mexico	-1.53***	-0.52*	-0.27
Netherlands	-0.45	-0.86***	-0.62***
ROW	-0.08	-0.56***	-1.05**

[a] *** indicates this number is statistically different from zero at 0.01 level.
[b] ** indicates the number is statistically different from zero at 0.05 level.
[c] * indicates the number is statistically different from zero at 0.1 level.

Table 6-5. Test results for log-likelihood-ratio tests for different restrictions in the Rotterdam, CBS, AIDS, NBR, and general model for wine.

	General	Rotterdam	CBS	AIDS	NBR
	Log-likelihood value				
Unrestricted	262.33	258.09	260.89	261.76	258.26
Homogeneity	260.03	254.73	258.35	259.19	254.98
Homogeneity and Symmetry	252.00	248.11	250.76	251.37	248.05
	Test statistics				
Homogeneity	4.60(4)	6.73(4)	5.07(4)	5.14(4)	6.57(4)
Homogeneity and Symmetry	16.06(10)	13.24(10)	15.20(10)	15.65(10)	13.86(10)
Model selection	-	10.60(2)	3.35(2)	1.67(2)	10.10(2)

[a] Table values of χ^2 are 5.99, 9.49 and 18.31 for 2, 4 and 10 degrees of freedom, respectively, at 0.05 level.
[b] Numbers in parentheses are degrees of freedom for tests.
[c] Models with homogeneity and symmetry constraints imposed.

Table 6-6. Conditional parameter estimates for U.S. import demand for wine by country of origin.

Country	Italy	France	Australia	Chile	ROW	Income parameters
	Wine, 1992-2012, AIDS model					
	Price parameters					
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Italy	-0.118***	0.035	0.023	0.036**	0.024	-0.018
	(0.037)	(0.028)	(0.025)	(0.015)	(0.030)	(0.031)
France		-0.152***	0.041	-0.004	0.081***	-0.030
		(0.053)	(0.035)	(0.012)	(0.026)	(0.061)
Australia			-0.153***	0.065***	0.024	0.013
			(0.038)	(0.014)	(0.030)	(0.044)
Chile				-0.097***	0.001	0.023*
				(0.010)	(0.014)	(0.012)
ROW					-0.130***	0.013
					(0.038)	(0.029)

[a] Numbers in parenthesis are standard errors.
[b] *** indicates this number is statistically different from zero at 0.01 level.
[c] ** indicates the number is statistically different from zero at 0.05 level.
[d] * indicates the number is statistically different from zero at 0.1 level.

Table 6-7. Marginal shares, conditional expenditure and Slutsky (compensated price elasticities) of U.S. import demand for wine by country of origin at sample mean.

Country	Marginal shares	Expenditure elasticities	Italy	France	Australia	Chile	ROW
	Wine, 1992-2012, AIDS model						
			Slutsky price elasticities				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Italy	0.26***	0.93***	-0.43***	0.13	0.08	0.13**	0.09
France	0.34***	0.92***	0.09	-0.41***	0.11	-0.01	0.22***
Australia	0.14***	1.10***	0.18	0.32	-1.20***	0.51***	0.19
Chile	0.08***	1.43***	0.67**	-0.08	1.21***	-1.81***	0.01
ROW	0.19***	1.07***	0.14	0.46***	0.14	0.00	-0.75***

[a] *** indicates this number is statistically different from zero at 0.01 level.
[b] ** indicates the number is statistically different from zero at 0.05 level.
[c] * indicates the number is statistically different from zero at 0.1 level.

Table 6-8. Cournot (uncompensated price elasticities) of U.S. import demand for wine by country of origin at sample mean.

	Wine, 1992-2012, AIDS model				
	Cournot price elasticities				
Country	Italy	France	Australia	Chile	ROW
(1)	(2)	(3)	(4)	(5)	(6)
Italy	-0.69***	-0.22**	-0.04	0.08	-0.07
France	-0.16	-0.75***	-0.01	-0.06*	0.06
Australia	-0.12	-0.08	-1.34***	0.45***	-0.00
Chile	0.28	-0.61***	1.02***	-1.88***	-0.24
ROW	-0.15	0.07	0.00	-0.05	-0.93***

[a] *** indicates this number is statistically different from zero at 0.01 level.
[b] ** indicates the number is statistically different from zero at 0.05 level.
[c] * indicates the number is statistically different from zero at 0.1 level.

Table 6-9. Test results for log-likelihood-ratio tests for different restrictions in the Rotterdam, CBS, AIDS, NBR, and general model for spirits.

	General	Rotterdam	CBS	AIDS	NBR
	Log-likelihood value				
Unrestricted	278.47	278.07	277.58	277.22	277.98
Homogeneity	275.79	275.07	274.56	274.83	275.43
Homogeneity and Symmetry	272.27	271.33	271.08	271.54	271.89
	Test statistics				
Homogeneity	5.37(4)	6.06(4)	6.04(4)	4.78(4)	5.09(4)
Homogeneity and Symmetry	7.04(10)	7.45(10)	6.97(10)	6.57(10)	7.09(10)
Model selection		1.47(2)	2.45(2)	1.92(2)	0.71(2)

[a] Table values of χ^2 are 5.99, 9.49 and 18.31 for 2, 4 and 10 degrees of freedom, respectively, at 0.05 level.
[b] Numbers in parentheses are degrees of freedom for tests.
[c] Models with homogeneity and symmetry constraints imposed.

Table 6-10. Conditional parameter estimates for U.S. import demand for spirits by country of origin.

Country	Spirits, 1992-2012, NBR model Price parameter France	United Kingdom	Mexico	Sweden	ROW	Marginal shares
(1)	(2)	(3)	(4)	(5)	(6)	(7)
France	-0.197***	0.088***	-0.023	0.029***	0.103***	0.40***
	(0.037)	(0.021)	(0.018)	(0.010)	(0.030)	(0.054)
United Kingdom		-0.121***	0.009	-0.018	0.042*	0.19***
		(0.026)	(0.013)	(0.012)	(0.025)	(0.037)
Mexico			-0.013	0.017**	0.010	0.11***
			(0.016)	(0.008)	(0.018)	(0.034)
Sweden				-0.049***	0.021*	0.08***
				(0.008)	(0.012)	(0.021)
ROW					-0.l76***	0.22***
					(0.039)	(0.050)

[a] Numbers in parenthesis are standard errors.
[b] *** indicates this number is statistically different from zero at 0.01 level.
[c] ** indicates the number is statistically different from zero at 0.05 level.
[d] * indicates the number is statistically different from zero at 0.1 level.

Table 6-11. Marginal shares, conditional expenditure and Slutsky (compensated price elasticities) of U.S. import demand for spirits by country of origin at sample mean.

Country	Spirits, 1992-2012, NBR model Expenditure elasticities	Slutsky price elasticities France	United Kingdom	Mexico	Sweden	ROW
(1)	(2)	(3)	(4)	(5)	(6)	(7)
France	1.68***	-0.82***	0.37***	-0.09	0.12***	0.43***
United Kingdom	0.70***	0.33***	-0.45***	0.03	-0.07**	0.16*
Mexico	1.03***	-0.22	0.09	-0.13	0.17**	0.10
Sweden	1.05***	0.38***	-0.23	0.22**	-0.65***	0.28*
ROW	0.71***	0.33***	0.13*	0.03	0.07*	-0.56***

[a] *** indicates this number is statistically different from zero at 0.01 level.
[b] ** indicates the number is statistically different from zero at 0.05 level.
[c] * indicates the number is statistically different from zero at 0.1 level.

Table 6-12. Cournot (uncompensated price elasticities) of U.S. import demand for spirits by country of origin at sample mean.

Spirits, 1992-2012, NBR model					
	Cournot price elasticities				
Country (1)	France (2)	United Kingdom (3)	Mexico (4)	Sweden (5)	ROW (6)
France	-1.46***	-0.35***	-0.37***	-0.08**	-0.41***
United Kingdom	-0.08	-0.91***	-0.14**	-0.19***	-0.38***
Mexico	-0.71***	-0.46***	-0.34*	0.01	-0.54***
Sweden	-0.12	-0.78***	0.01	-0.81***	-0.36**
ROW	-0.08	-0.33***	-0.14***	-0.06	-1.10***

[a] *** indicates this number is statistically different from zero at 0.01 level.
[b] ** indicates the number is statistically different from zero at 0.05 level.
[c] * indicates the number is statistically different from zero at 0.1 level.

CHAPTER 7
CONCLUSIONS

U.S. import demand for beer, wine, and spirits are estimated and U.S. import demand for beer, wine, and spirits by country of origin is estimated using the differential approach. Conditional expenditure, own-price, and cross-price elasticities of import demand are calculated from the parameters of the models.

In this paper, we applied the multistage budgeting and demand theory to explore the import demand for the U.S. alcoholic beverage market. The general demand system proved to be an efficient tool to pick the best from the basic demand models-Rotterdam, AIDS and their variants-to fit the specific data. According to the results of LR tests and model selection, we utilize the AIDS model for aggregated beverages in the first stage. NBR (beer and spirits) and the AIDS (wine) model are selected to best fit the data in the second stage. More specifically, the NBR model suggests that Rotterdam-type income and AIDS-type price responses better explain U.S. import demand for beer and spirits than do the other three models; for aggregated beverages and wine, both AIDS-type income and price coefficients are found to best fit the import data for these goods. The functional forms of the Rotterdam and the AIDS models differ (e.g. income and price terms), which lead to the important difference in results. For example, marginal shares are constant in the Rotterdam and NBR models but are variable in the AIDS and CBS models. Price elasticities estimation are also found to be functional-form specific.

An important contribution of this paper is the parameter estimation and elasticity analysis for these beverage commodities. Given the large import budget share for beverages in total U.S. agricultural imports, it is important to have some elasticity estimates that may be used to drive economic models that consider effects of imports, consumer preference and public policy requirements for beer, wine, and spirits. The key findings are obtained from the results.

In the first stage, spirits and wine may keep the budget share while beer may decrease the budget share. Beer, wine, and spirits are substitutes implied by the cross-price parameters. A slight complements effect is found between beer and ROB. Besides, imported wine would gain the most quantity demanded among the imports of beer, wine, and spirits if the U.S. total beverages expenditure were to increase. At last, compared with beer and spirits, imported wine has the strongest expenditure sensitivity in U.S. import market.

In the second stage, several implications obtained from the results are important. First, some countries may gain the most benefit if U.S. import expenditure expands. This is true for Mexico (beer), Chile (wine) and France (spirits). The value of their expenditure elasticities for each commodity are greater than unity. Second, various price strategies may work for different source countries by each commodity. For example, Chile and Australia may increase their revenues by decreasing their price for their wine. Conversely, Netherlands, Italy and Mexico can increase their products' price in order to gain increased revenues. Third, all source countries for wine are substitutes except for France-Chile pairing. Compared with the results of beer and spirits, this relationship is much more competitive between these imported wines. Fourth, when comparing own-price and cross-price elasticities, estimation shows that consumers prefer to choose beer than wine and spirits. More specifically, a unitary reduction in the price of Mexican beer will increase compensated demand by only 0.68%. However, when income effects are considered, a 1% decrease in the price of Mexican beer would contribute to a 1.53% expansion in its quantity demanded.

This paper still has some important issues left unanswered. One is to explore whether the use of quarterly or monthly data may better explain the import demand relationship between these exporters and U.S. and better fit the model chosen by the general demand system. Additionally, if the domestic beverages data were available, the results might be different. Due to the huge demand for domestic beverages, domestic beverages data may swamp the imported ones, which may lead to insignificant results for import demand relationship with those exporters. Finally, import demand estimation for ROB as a group may be highly potential for future research and extension. The U.S. import demand for non-alcoholic water, unsweetened water, and fermented beverages may be estimated by country of origin in the future work.

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BIOGRAPHICAL SKETCH

Bo Gao was a graduate student of the Master of Science program in Food and Resource Economics Department at the University of Florida. Bo was born in Hulunbeier, China in 1990. He attended University of International Relations in China and gained bachelor's degree in international economics and trade from 2008 to 2012. After successfully graduated, he was admitted to the University of Florida, majored in food and resource economics. He graduated in May 2014. His major area is international economics and applied econometrics. After graduation, he may continue his academic work in agricultural economics or go back to China to seek for a work position related to economics.