

Consumer Demand for Alcoholic Beverages in British Columbia
With and Without Free Trade in Wine

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ABSTRACT

An "Almost Ideal Demand System" of consumer demand functions is estimated using monthly data from April 1981 to August 1986 on the sales of various types of alcoholic beverages in British Columbia. The estimation results are used to test the properties of consumer theory and to interpret consumer preferences, both of which are compared to the evidence reported in earlier literature. The demand results are then combined with an analysis of wine production costs to construct a simple industry model. Comparative statics is used to obtain estimates of the direct economic effects of changes in policies assumed to accompany the transition to bilateral or multilateral free trade in wine.

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Chapter 1

INTRODUCTION

Consumers in British Columbia spend between 2 and 3 percent of their budget on alcoholic beverages; this amounted to \$857 million in 1984. A large portion of these expenditures are channelled into provincial government revenues through profits from government liquor stores, sales tax, and permit and licence fees. In 1984, the contribution was \$365 million or 3.8 percent of total provincial government revenues.

Through provincial liquor marketing practices locally produced beer and wine is protected on the British Columbia market. These practices include listing and markup preferences in government liquor stores for beverages produced within the province. Local distilleries do not enjoy the same protection afforded locally produced wine and beer.

The production of alcoholic beverages within British Columbia provides employment for close to 2000 people: 1300 in brewing, 350 in distilling and 350 in wine manufacturing. Additional employment is provided indirectly for inputs and through consumer expenditures. For example, grape growing provides approximately 200 full time and 600 part time jobs. In 1984, the total income (value added) derived from the alcoholic beverage manufacturing in British Columbia was \$174 million: \$27 million in distilling, \$111 million in brewing, and \$36 million wine in manufacturing.

The primary objective of this paper is to describe the nature of demand for various types of alcoholic beverages in British Columbia. The points of departure from earlier studies are the use of a demand system more firmly rooted in consumer theory, and the use of monthly data which allows more finely disaggregated product categories than in previous research. Specifically, the estimation results characterize consumer preferences for B.C. wine, U.S. wine, other import wine, beer and spirits. The results are used to test the properties of consumer theory, to describe the nature of the demand for alcoholic beverages, and to consider some of the economic effects implied by a transition to bilateral or multilateral free trade in wine.

The thesis is organized as follows. Chapter 2 reviews earlier literature on the demand for alcoholic beverages. Chapter 3 outlines the approach taken to model consumer demand in this study. The data, estimation procedures and results are reported in Chapter 4, and the derived policy effects are evaluated and presented in Chapter 5. The conclusions follow in the final chapter.

The literature review reveals an exclusive focus on models of demand (determinants of supply are not considered), a reliance on single equation models, and a dependence on highly aggregated, annual sample data. Most of the models reviewed do not allow for the imposition of all the required theoretical restrictions and impose restrictions beyond those suggested by consumer theory. All the studies reviewed use annual data necessitating either relatively long sample periods, or the pooling of time series and cross section data. This dependence on annual data has motivated the frequent inclusion of independent variables, other than prices and income, in order to control for changes in other determinants of

demand, such as tastes, which may vary over long time periods or between jurisdictions. Finally, few of the studies use product groups that are differentiated beyond the broad categories of spirits, beer and wine; none report further differentiation than domestic and imported categories for wine and beer.

This study continues with the emphasis on models of demand found in the earlier literature, thus prices are assumed to be exogenously determined. This implies that either the B.C. Market is small relative to the total production of each product category, or that production is subject to constant returns to scale.

The demand model used is "An Almost Ideal Demand System (AIDS)" developed by Deaton and Muellbauer (1980a). In this model the estimating equations which comprise the demand system are flexible functional forms which provide a second order approximation to a consumer expenditure function. All the restrictions implied by consumer theory may be imposed and tested, the model does not require the imposition of unnecessary restrictions, and the estimating equations are almost linear and can be approximated by a linear equation. The model also allows for a more rigorous examination of the nature of substitution among alcoholic beverages than that of earlier studies of demand.

The AIDS model is estimated using monthly data for the April 1981 to August 1986 period. Over this relatively short sample period changes in the variables of secondary interest, such as tastes, are unlikely to be a major factor. Attention can be focused on the variables of greatest interest. Also the data allows for a higher degree of product differentiation than earlier studies. The main contribution here stems from consideration of B.C. wine, U.S. wine and other imported wines as three separate product categories.

The results reported in this study were generated by the linear approximation to the AIDS model. The consistency of these results with the properties of consumer theory is first examined and compared with evidence that has been reported in earlier studies using models of demand systems for highly aggregated product groups. Attention next turns to the interpretation of consumer preferences for alcoholic beverages in British Columbia. In this context the results are compared to the earlier studies of the demand for alcoholic beverages which relied on less rigorous models.

The demand results are then combined with an analysis of winery production costs to construct a simple industry model used to estimate the short run, direct economic effects of freer trade in wine. Interest in this question stems from the Canada/U.S. trade negotiations, a preliminary G.A.T.T. Panel decision against provincial liquor marketing practices, and the current round of multilateral trade negotiations under the G.A.T.T.

Chapter 2

REVIEW OF THE LITERATURE

This chapter reviews the related literature on modelling the consumption of alcoholic beverages. The emphasis on models of demand is a reflection of this emphasis in the literature; no studies were found that incorporate supply considerations. The various models of demand found in the literature are first summarized. Discussion then turns to the results of these models. First, evidence regarding the primary determinants of demand according to consumer theory is reviewed. This is followed by evidence regarding the importance of sociological, socio-economic and other variables. Finally, the implications and conclusions of the various studies are reviewed with regard to the public policy objectives of controlling alcohol consumption, raising government revenues and protecting local industry.

2.1 Modelling Approaches

The various modelling approaches found in the literature can readily be categorized into two groups: i) single equation models of demand; and ii) a systems approach to modelling demand. By far the most common approach is the estimation of single demand equations. Two basic specifications are found: linear and log linear demand equations. An alternative approach found in one study is the use of a reduced form equation to represent the market for liquor as a system of

simultaneous equations (Cook and Tauchen, 1982). Only one study was found using a system of demand equations derived directly from utility functions (Anastopoulos et al. 1986).

In all the structural models reviewed, alcoholic beverage prices are taken as exogenous to the model. The implicit assumption is either that the market under consideration is small relative to total production of each good (as in the case of imported wine in Canada), or that the system is recursive rather than simultaneous and, hence, supply prices are exogenous in any given time period (as would be the case under constant returns to scale in production).¹

2.1.1 Linear, Single Equation Models

Linear, single equation demand models are found in numerous studies. Johnson and Oksanen (1974 and 1977) use two variations on a linear model to estimate a model of demand for beer, spirits and wine in Canada which incorporates the influence of sociological variables, such as ethnic origin, religious affiliation and schooling. In another Canadian study, Acheson (1977) uses two linear demand functions for domestic and import wine in order to estimate the cost of protecting the local wine industry in Ontario. Kitchin (1981) uses a linear model to explain consumption of alcohol in the U.K., in terms of socio-economic determinants of demand.

Both of the Johnson and Oksanen articles (1974 and 1977) include economic and sociological variables as determinants of consumption. The authors use pooled cross section, time series data for the ten Canadian provinces over the 1955 to

¹ In addition, markets are assumed to be competitive. In the case where liquor sales are controlled through a central government agent this implies that the agency does not maximize profits.

1971 period to estimate their model. Pooling the data across provinces introduces sufficient variation in the data to study the effects of sociological variables, such as religion, ethnic origin and schooling. Habit persistence is also incorporated into the model through the inclusion of lagged consumption as an explanatory variable.

In their 1974 article, Johnson and Oksanen incorporate seven ethnic, six religious and three educational categories as independent variables. These variables are measured as a percent of the total population. In their subsequent article (1977), the authors reduce each group of sociological variables "through the extraction of principal components" (p.114). Two components replace the seven ethnic variables, two more replace the six religious affiliation variables and one replaces the three schooling variables.

Acheson (1977) uses two linear demand functions to estimate consumption of domestic and import wine as a function prices, number of outlets, lagged income and days on strike for liquor stores. The primary focus of this study is on the trade off between setting liquor store markups at a revenue maximizing level versus imposing lower markups on domestic wines in order to protect the local industry. An estimate of marginal costs is used to calculate revenue maximizing markups for domestic and imported wine, given the estimated coefficients of the model. Estimates of the revenue foregone to protect the domestic wine industry are then constructed.

The focus of Kitchin's paper is on the socio-economic determinants of alcohol consumption in the U.K. It builds on an earlier study by McGuinness (1980) which modelled alcohol consumption as a function of income, own price, advertising and the number of retail outlets. Kitchen's contribution is the addition of unemploy-

ment, deaths and inflation as explanatory variables based on the hypothesis that stress leads to alcohol consumption.

2.1.2 Log Linear, Single Equation Models

A second, single equation specification frequently used for estimating the demand for alcoholic beverages is the log linear or constant elasticity form. Hogerty and Elzinga (1972) use a log linear specification to estimate the demand for beer in the United States. Duffy (1983) and Enemark (1986) use log linear specifications to model the consumption of beer, wine and spirits in the U.K. and B.C., respectively; Duffy also reports results for a linear model. A log linear model is also utilized by Owen in a 1979 study of wine consumption in Australia.

In the study of the "Demand for Wine in Australia", Owen first regresses wine consumption on lagged consumption, income, a time trend, price indices for wine and beer, and advertising expenditures. An insignificant coefficient on the beer price and on the advertising expenditure variable (the latter with a negative sign) results in these variables being dropped from subsequent specifications. In subsequent preferred specifications, the wine and beer price entered as a log of the price ratio. In the second of three regression results reported, Owen suggested that an insignificant income elasticity and a high long run price elasticity implies the presence of multicollinearity. Results of a correlation matrix are provided that support this conclusion. Results of a final regression are presented using ridge regression to address this problem.

2.1.3 A Reduced Form Model

A third, single equation approach was used by Cook and Tauchen (1982). They represent the market for liquor as a system of simultaneous equations, but estimate the parameters of the system's reduced form directly. Two equations are estimated: one with the log of per capita liquor consumption as the independent variable, and the other with the log of the "age-adjusted cirrhosis mortality rate" as the independent variable. In both equations, state excise taxes and income are the independent variables. By estimating the response of liquor consumption in the U.S. to changes in state liquor taxes directly, the authors point out that they avoid the need to access good price data and they eliminate problems of identification.

2.1.4 Systems of Demand Equations

A final class of models found in the demand literature involves estimating a system of demand equations derived directly from a utility function specified by consumer choice theory. This approach was used by Anastasopoulos et al. (1986) to model the demand for alcoholic beverages.

While only one article was found in the literature that used this approach, the treatment was quite comprehensive. Equation systems based on three different specifications of utility functions were utilized: Cobb Douglas, translog, and constant elasticity of substitution utility functions. The Cobb Douglas is a special case of the translog utility function and demand functions based on this specification were estimated as a first step to estimating the more complex translog demand functions.

Empirical estimation was completed with a view to evaluating the regional impacts of sectoral free trade in alcoholic beverages. As in all the other structural models reviewed, prices were assumed to be determined exogenously. The analysis focused on the estimation of demand equations with supply implicitly assumed to be subject to constant returns to scale.

2.2 Empirical Results

The results of the models summarized above are discussed in this section. Of greatest interest are those results concerning the importance of the primary determinants of the demand for alcoholic beverages according to consumer theory. Thus the evidence regarding income, own price and cross price elasticities is first reviewed (Table 1 summarizes these results). The discussion then turns to the importance of sociological, socio-economic and other variables.

2.2.1 Income Elasticities

The reported income elasticities provide a relatively consistent body of evidence. Most studies characterize spirits and, particularly, beer as income inelastic goods. In the case of wine, the evidence suggests that demand is income elastic. Only Acheson reports results for domestic and imported wine as separate categories, however, these results are not reported as elasticities.

The range of income elasticity estimates for spirits runs from a low of 0.15 reported by Johnson and Oksanen (1977) for Canada to a high of 1.67 reported by Duffy (1980) for the United Kingdom. Other Canadian studies range from Ene-mark's (1986) estimate of 0.25 for British Columbia to Anastasopoulos et al.'s (1986) estimate of 0.90 using pooled data for numerous Canadian provinces. For the U.S., Cook and Tauchen (1980) report an income elasticity of 0.43.

The most consistent evidence is provided for beer. Two studies report estimates that are insignificantly different from zero (Johnson and Oksanen, 1974 and 1977). The highest estimate is 1.02 (Anastasopoulos et al., 1986). Three remaining studies report estimates between zero and one. Enemark (1986) reports an estimate of 0.15 for B.C., Hogerty and Elzinga (1972) report 0.43 for the U.S., and Duffy (1983) reports 0.84 for the U.K.

The studies reviewed for wine also provide relatively consistent evidence in this case suggesting that the demand tends to be income elastic across various countries and over numerous time periods. While only three of the six studies reviewed reported income elastic results, two of the remaining studies draw on the same data set.² It is these two studies that provide the low end of the range for the estimates reported; with elasticities close to zero they are also the exception. Only one other study provides an estimate of less than one, Enemark (1986) reports a long run elasticity of 0.82. All three of the "inelastic" studies report positive time trends, as well as two of the others (see Section 1.2.6). A strong correlation between income and time would tend to mask the influence of income on consumption. The remaining three estimates range from 1.23 to 2.50 (Anastasopoulos et al., 1986; Duffy, 1983; and Owen, 1980). Finally, Acheson (1977) reports positive lagged income effects for both domestic and import wine in Ontario that are significant, but the results are not presented as elasticities.

² The two studies by Johnson and Oksanen (1974 and 1977).

2.2.2 Own Price Elasticities

Estimates of own price elasticities are reported for spirits, beer and wine. The estimated own price elasticities of demand cover a fairly broad range for the various time periods and jurisdictions studied, but some consistent patterns are evident. In almost all cases negative and significant own price elasticities are reported. The one noticeable exception to this observation is an estimate for the price elasticity of beer in the U.K. that was positive, but insignificant (Duffy 1983). In general, beer appears to be relatively price inelastic, so this result is not surprising. Neither of the two Canadian studies that differentiate between domestic and imported wine report own price elasticities (Acheson, 1977; and Anastasopoulos et al., 1986)

Estimates of long run, own price elasticities of the demand for spirits range from -0.55 to -1.8. For beer the range is much narrower and the evidence characterizing beer as a price inelastic good is quite consistent. Reported own price elasticities range from insignificantly different from zero to -0.92. The range of estimated own price elasticities of demand for wine is again quite broad; in the studies reviewed the range was zero to -1.78.

With respect to the demand for spirits, earlier Canadian studies generally report higher elasticities than the more recent studies. Johnson and Oksanen (1974 and 1977) report long run elasticities ranging from -1.6 to -1.77 for the 1955 to 1971 period. Two more recent Canadian studies report long run elasticities of -0.74 and -0.55 (Anastasopoulos et al., 1986; and Enemark, 1986). The latter estimate by Enemark was for British Columbia only. The former makes use of data pooled across provinces as do the Johnson and Oksanen articles. U.S. studies

report elasticities at the high end of the range in the order of -1.6 to -1.8 (Cook and Tauchen 1982). Duffy (1983) reports an own price elasticity of -0.77 for the U.K.

The evidence characterizing beer as a price inelastic good is quite strong across all countries considered. In three of the four Canadian articles reviewed, estimates ranged from -0.30 to -0.36 (Johnson and Oksanen, 1974 and 1977; Enemark, 1986). The one exception is Anastasopoulos (1986) where an estimate of -0.92 is reported. Studies of demand in the U.K. provide estimates that are very consistent and low, reflecting the strong tradition of beer drinking in that country. Estimates range from little or no price effect to -0.20 (Duffy, 1983). With regard to the own price elasticity of demand for beer in the U.S., Hogarty and Elzinga report an estimate of -0.9.

The range of estimates of the own price elasticity of wine is the broadest of the three categories. However, while they range from no effect to -1.78, the majority of estimates are clustered around -1.0. Also, a trend towards a lower own price elasticity for wine is evident in the more recent studies. Canadian studies provide the full range of estimates. Anastasopoulos et al. (1986) report an elasticity of -0.03 and attribute this to the strong influence of other more significant determinants, income and tastes (a quadratic time variable). Johnson and Oksanen (1974 and 1977) report elasticities of -1.3 in their earlier article and -1.78 in the later one. Enemark (1986) reports an own price elasticity of demand in British Columbia of -0.96. Estimates available for other countries are -1.00 in the U.K. (Duffy 1983) and -0.62 in Australia (Owen 1979).

2.2.3 Cross Price Elasticities

Evidence regarding the Marshallian substitution effects between spirits, beer and wine is available from most of the studies reviewed (Johnson and Oksanen, 1974 and 1977; Enemark, 1986; Hogerty and Elzinga, 1972; and Owen, 1979) This is the first body of evidence reviewed in this section.³ The latter part of the section reviews evidence from two studies on the degree of substitution between domestic and imported products in Canada (Acheson, 1977; and Anastasopoulos et al., 1986)

The general consensus in the literature is that the cross price effects between spirits, beer and wine are weak. Numerous researchers have concluded that demand studies provide conflicting and inconsistent results concerning the influence of cross price effects on the demand for spirits, beer and wine (Anastasopoulos et al., 1986; and Enemark, 1986) This inconsistency is used as an argument in support of the hypothesis of little substitutability between beer, wine and spirits (Anastasopoulos et al., p.58). Also the view that one would not expect complementarity between alcoholic beverages is frequently advanced (Anastasopoulos et al., 1986; Hogerty and Elzinga, 1972; and Enemark, 1986). In some cases, this view has provided the rationale for dropping cross price variables from the preferred specifications of demand equations, given negative but significant coefficients in earlier experimentation (Hogerty and Elzinga, 1980; and Enemark, 1986).

A detailed review does reveal some patterns that have not been acknowledged in the literature to date, however. The most striking pattern is the frequency of significant, negative cross price effects between beer and other alcoholic beverages. As noted above, these results are often rejected by researchers on the basis

³ None of the studies reviewed report Hicksian substitution effects. Marshallian and Hicksian effects are distinguished from one another in Chapter 3.

of a priori expectations. Johnson and Oksanen (1974 and 1977) report significant and complementary relationships for the effects of changes in the price of spirits on the demand for beer. Enemark (1986) reports estimates of negative, "significant" coefficients for the preferred model using ridge regression for the price of spirits and of wine on the demand for beer. Significance in this case is based on reported pseudo t-statistics.⁴ In results reported by Enemark for an earlier model estimated prior to omitting variables to yield the preferred specification, the only significant cross price term was a negative coefficient relating the price of wine to the demand for beer. The final evidence in support of complementarity between beer and other alcoholic beverages is reported by Hogarty and Elzinga (1972). In a footnote they report on experimentation which produced negative, statistically significant coefficients relating the effect of a change in the price of spirits on the demand for beer in the United States. Although these results were robust even when certain U.S. states were removed from the sample, the authors reject the results on the grounds that beer and spirits are unlikely complements.

Limited evidence of substitution between beer and other alcoholic beverages also appears in the literature. Johnson and Oksanen (1974 and 1977) report positive and significant coefficients measuring the influence of changes in the price of beer on the demand for wine in Canada. Owen (1979) reports relevant results for his preferred specification estimated by ridge regression. The variable of interest is the log of a change in the ratio of the beer to wine price in a demand equation for the wine in Australia. A significant, negative coefficient implies a positive cross price elasticity that is identical in absolute value to the own price elasticity. This is a weakness in the specification, however, since the own price and cross

⁴ T-ratios are not a valid measure of significance for ridge regression.

price terms are restricted in the manner described for no apparent reason. In an earlier regression estimated by OLS, Owen reports a positive, insignificant coefficient.

A second consistent thread in the literature is evident upon examination of the relationship between spirits and wine. In this case, the significant coefficients reported in the literature provide support for characterizing these goods as substitutes. Johnson and Oksanen (1974) report a significant, positive coefficient for the price of wine in the demand for spirits equation. In Enemark's (1986) preferred model (estimated by ridge regression) only one cross price coefficient is reported that is "both significant and carries the expected positive sign", the relative price of wine to spirits in the spirits demand equation (p. 80).

Evidence of substitution between domestic and imported alcoholic beverages is quite strong in the two Canadian studies reviewed (Acheson, 1977; and Anastasopoulos et al. 1986). In both studies, the cross price effects are significant and of expected sign (positive). Neither study reports cross price elasticities, so comparisons of the estimates of the cross price effects between domestic and imported wine reported in the two studies are difficult. Anastasopoulos et al. (1986) also provide estimates of the cross price effects between domestic and imported beer.

Acheson (1977) reports cross price effects of domestic wine consumption with respect to import price changes that are significant and positive, and insignificant and positive for import wine consumption with respect to domestic wine prices. These estimates are used to construct estimates of the cost of protecting the domestic wine industry in Ontario as discussed above in the review of approaches to modelling.

Anastasopoulos et al. (1986) report elasticities of substitution between imports and domestic products for wine and beer of 0.66 and 1.54, respectively. These estimates are based on demand functions derived from a constant elasticity utility function. As the authors point out, the larger value for beer clearly implies that domestic and imported beer are closer substitutes than are domestic and imported wines. Subsequent calculations of the potential effects of free trade between Canada and the U.S. in alcoholic beverages draw on these estimates. This aspect of their study is reviewed below under policy implications.

Table 1: Summary of Results Reviewed

Income Elasticities	Spirits	Beer	Wine
Anastasopoulos et al. (1986)	0.90	1.02	1.32
Cook and Tauchen (1982)	0.43 ¹		
Duffy (1983)	1.67*	0.84*	2.21*
Enemark (1986)	0.25	0.15	0.82
Hogerty and Elzinga (1972)		0.43*	
Johnson and Oksanen (1974)	0.40*	0.06	-0.02
Johnson and Oksanen (1977)	0.15*		
Owen (1979)			1.23*
Own Price Elasticities			
Anastasopoulos et al. (1986)	-0.74	-0.92	-0.03
Cook and Tauchen (1982)	-1.8 ¹		
Duffy (1983)	-0.77*	0.20*	-0.77*
Enemark (1986)	-0.36	-0.55	-0.96
Hogerty and Elzinga (1972)		-0.89	
Johnson and Oksanen (1974)	-1.6*	-0.38*	-1.30*
Johnson and Oksanen (1977)	-1.77*	-0.33*	-1.78*
Owen (1979)			-0.62*
Cross Price Effects	Complements	Substitutes	
Acheson (1977)		imp./Can. wine ^{*2}	
Anastasopoulos et al. (1986)		Can./imp. wine ^{*3}	
Enemark (1986)	beer/spirits*	imp./Can. wine ^{*3}	
Hogerty and Elzinga (1972)	beer/wine*	imp./Can. beer ^{*3}	
Johnson and Oksanen (1974)	beer/spirits*	spirits/wine*	
Johnson and Oksanen (1977)	beer/wine	wine/beer	
Owen (1979)	beer/spirits*	spirits/beer	
		spirits/wine*	
		wine/beer	
		spirits/wine*	
		wine/beer	

1. No measure of statistical significance is available.

2. Imp./Can. wine means effect of a change in the price of Canadian wine on consumption of imported wine.

3. Symmetric.

(*) Significant at 95 percent.

2.2.4 Habit Persistence

Habit persistence is included in four of the single equation models through the inclusion of a lagged consumption variable. Two additional studies represent habit persistence through the use of lagged independent income or price variables.

In the two studies by Johnson and Oksanen (1974 and 1977), a lagged consumption variable is significant in eight out of nine cases. Habit persistence is characterized as being strongest for wine, then spirits, and weakest for beer. Enemark (1986) also includes lagged consumption and reports significant results for spirits, beer and wine demand. The coefficients are similar and relatively small in each case, thus B.C. consumers are seen as reacting quickly to changes in the determinants of demand. Owen (1979) also includes a lagged consumption variable, and again reports a positive and significant coefficient. According to this latter study, Australian wine consumers are relatively slow to react to changes in the prices and incomes.

In the two other studies incorporating lagged independent variables the second period income coefficient is significant and positive (Acheson, 1977; and Cook and Tauchen, 1982). Only Cook and Tauchen (1982) include a lagged price coefficient and they report that most of the influence is picked up in the first period. The evidence that is available, therefore, suggests that consumers react more quickly to price changes than to income changes.

2.2.5 Sociological and Socio-economic Variables

Numerous studies of alcohol consumption have broadened their focus beyond the traditional determinants of demand in consumer theory. Sociological variables such as religious affiliation, level of schooling and ethnic origin have been incorporated into models of demand quite successfully. As well, some studies have included other "socio-economic" variables such as unemployment and inflation levels. The rationale for including these variables has apparently been that higher levels of unemployment and inflation add to stress which in turn encourages alcohol consumption. In one case a variable measuring the frequency of deaths was included as a further test of the stress hypothesis.

The most comprehensive studies of sociological variables are the two articles by Johnson and Oksanen (1974 and 1977). They report results for the influence of ethnic group, religious affiliation and level of schooling. In their 1974 article these influences are picked up through the use of dummy variables. Ethnic group appears as a highly significant determinant of beer and wine consumption, but not significant for spirits. Religious affiliation is highly significant for all beverages except beer. Level of education is highly significant and negative in the spirits equation only. In their 1977 article, the sociological influences are picked up by variables constructed by the method of principal components. Using this method the ethnic effect is nearly always significant and sometimes highly significant, religion is never significant, and schooling is highly significant in the beer equation and insignificant in others.

Two other studies report results for a national origin proxy variable defined as the proportion of residents that were foreign born. Hogerty and Elzinga (1972)

find this variable is positive and significant for beer demand in the United States. Enemark (1986) reports significant, negative coefficients for the "immigrants" variable in beer, spirits and wine demand equations. The variable is defined by the proportion of the British Columbia population that is foreign born.

Kitchin's (1981) contribution to the literature is a test of the hypothesis that stress (proxied by unemployment, mortality and inflation variables) contributes to the consumption of alcohol. This hypothesis is rejected, since the coefficients for unemployment and mortality are significant, but negative. The inflation coefficient was of expected sign (positive), but statistically insignificant.

Enemark (1986) reports a significant and negative estimate of the influence of the male unemployment level in the demand for spirits equation; for the wine and beer equations the effect was insignificant. He argues that this strong result supports the hypothesis that British Columbians associate unemployment with lower perceived future incomes. Enemark also reports a positive and significant inflation coefficient. He notes that this is consistent with the stress hypothesis advanced by Kitchin, but is also consistent with a real income gain argument he advances. Here he argues that expectations of higher future incomes often accompany inflationary periods in British Columbia.

McCornac (1982) reports the opposite result. In this U.S. study of the effect of unemployment on alcohol consumption a positive relationship is reported. The study uses cross sectional data from the early 1970's, a period when unemployment was rising in the U.S.

2.2.6 Other variables

Many other variables have been included in the specifications reported in the literature. The results of two of these are reviewed in this section, the level of advertising expenditures and changes in tastes as approximated by a time variable.

Duffy (1983) reports coefficients measuring the influence of advertising expenditures on consumption of beer, spirits and wine. The variable used is the ratio of per capita advertising expenditures on the dependent variable good to per capita expenditures on all other consumer goods. In all three cases the elasticities are small (between 0.1 and 0.2) and the coefficients are significant only for beer and spirits.

Owen (1979) reports experimentation with an advertising expenditure variable. The coefficient was "of the wrong sign" (negative) and insignificant and, therefore, was dropped from subsequent equations. This result is attributed to the poor quality of data on advertising expenditures although this problem is not apparent in the earlier discussion of sources for constructing this variable. The variable provides a measure of changes in absolute advertising expenditures for wine. Owen suggests that an index "measuring the relative advertising expenditure on wine to other forms of alcoholic beverages" may be more appropriate (p.235).

Four of the studies reviewed report significant time trends as explanatory variables approximating changes in tastes (Johnson and Oksanen, 1974; Enemark, 1986; Owen, 1979; and Anastasopoulos et al., 1986). In all cases positive trends are reported for wine consumption; the evidence is mixed for beer and spirits. Enemark (1986) reports a positive and significant time trend for wine demand over the period from 1952/53 to 1984/85 indicating that changing taste contributed to

an average annual increase in consumption of 2 percent. A time trend variable was not significant for beer or spirits. Owen (1979) also reports a positive and significant time trend variable for wine consumption in Australia from 1955/56 to 1976/77. This result is cited in support of an a priori belief that "the stock of migrants has been a major factor in the increase in the consumption of wine" over the study period (p. 234). A quadratic time trend was included by Anastasopoulos et al. (1986) to account for changes in taste over the period from 1971 to 1983. The independent taste changes indicate a relative movement away from spirits towards wine over the study period. However, the share of income allocated to wine appears to have stabilized since 1982 (p.69). Johnson and Oksanen (1974) report positive and significant time trends for spirits and beer, as well as for wine consumption.

2.3 Policy Implications and Conclusions

Three public policy objectives have been addressed in the literature: controlling alcohol consumption, raising government revenues, and protecting local industry. The first two objectives clearly overlap and are complimentary, although tax policies may differ depending on the relative weights given to the goal of raising revenues versus moderating alcohol consumption. Some studies also provide insights concerning the effectiveness of controls on private sector advertising or public health awareness campaigns in moderating the consumption of alcohol. The third objective gives rise to trade offs of government revenues versus protection. None of the studies reviewed consider the implications of other economic costs of alcohol consumption or the costs of protection in terms of consumer welfare.

2.3.1 Alcohol Consumption and Taxation

Alcoholic beverages are an almost irresistible source of tax revenue for governments in many western countries. There is a clear social rationale for policies to moderate consumption and increasing the relative price of alcoholic beverages through taxation is an effective means to this end. Moreover, alcohol consumption is considered a luxury by many, and a vice by some, and this provides justification for heavier taxes on this class of goods than on necessities, such as food. Another desirable characteristic from the point of view of the government is that the demand for alcoholic beverages appears to be relatively price inelastic. Comparatively high taxes can be levied without commensurate reductions in consumption. A number of studies report the tax policy implications of estimated price and income elasticities with respect to these objectives. The conclusions drawn in the studies reviewed are briefly summarized below.

Johnson and Oksanen (1974) use price elasticities to derive tax policy implications. A simple partial equilibrium model is used to illustrate the impacts of changes in taxes on each alcoholic beverage. Given the own price elasticities of -0.23 for beer, -0.91 for spirits and -0.50 for wine, and a goal of moderating alcohol consumption, the authors suggest taxes should be highest for spirits where they appear to have the greatest moderating influence. However, an alternate goal of revenue maximization would imply large tax increases for beer and wine, but small increases for spirits. A simple model is outlined to illustrate this point.

Hogarty and Elzinga (1972) indicate a preference for lower beer taxes. Given estimated own price elasticity of -0.9 , they suggest that excise taxes could be reduced with only modest losses in tax revenues.

Enemark (1986) notes the tax policy implications of his estimated own price elasticities for alcoholic beverages. With a goal of maximizing tax revenues low own price elasticities are suggested as providing a rationale for increasing mark-ups. The same argument is put forward given a goal of discouraging alcohol consumption. Finally, the observation is made that given both objectives, and the relatively high alcohol content and low own price elasticity of demand for spirits, an increase in the markup on spirits would be justified.

Duffy (1983) concludes that taxation is an effective instrument for restraining consumption, particularly for wine and spirits, and for raising revenue, particularly for beer. Based on the observation that over the period studied (1960's and 70's) only beer taxation has risen with inflation, he concludes that greater weight has been placed on the goal of maximizing revenues. A reluctance to increase taxation on wines is also attributed to pressure from the EEC in light of the frequent excess production of wine.

Cook and Tauchen (1982) make an interesting contribution to the literature. They test the hypothesis that alcohol consumption of heavy drinkers is sensitive to the level of excise taxes as a result of the influence of the income effect, in spite of the addiction that might be expected from chronic drinkers. Using the cirrhosis mortality rate as a proxy for heavy drinking, the 95 percent confidence interval for the effect of a tax change is -5.4 ± 4.3 percent per dollar versus the effect on liquor consumption of -7.2 ± 3.3 percent. The authors conclude that taxation is an effective public policy instrument for reducing alcohol consumption, including that of heavy drinkers.

Several studies comment on the implications of the estimated income elasticities on future tax revenues. Johnson and Oksanen (1974) note that given income elasticities substantially less than unity in all cases, revenues from alcoholic beverages will lag income growth and tax rates will either have to be raised in the future or other sources of revenue will have to be found. Other studies do not support this conclusion, however, except in the the case of beer consumption. As was noted above, most other studies characterize wine as an income elastic good. Also, the majority of studies that include time trend variables report increasing demand for wine since the early 1970's. One might wonder whether the time trends have picked up the variation in consumption that is in fact caused by increasing income.

A question that has not been addressed in the literature to date is the extent to which these changes in consumption patterns involve intergroup substitution between alcoholic beverages and other goods, or within group substitution between product types (wine versus other beverages). Consider alcoholic beverage purchases as a two stage budgeting process where consumers first allocate a portion of their budget to this commodity group and then decide on individual purchases based on relative prices with the group. In this case, the income elasticity can be thought of in terms of the group as a whole. A low income elasticity for beer and spirits, and a high income elasticity for wine, may simply imply substitution of wine for other beverages as incomes increase.

A second point worth considering is the extent to which product aggregation problems may lead to biases in estimation that favour low income and price elasticities. Consider the effect of within product group substitution from low quality

and low priced goods (eg. wines) to higher priced products with no change in the overall quantity consumed. This would be reflected in aggregated data by an increase in price when no change has in fact occurred. The most obvious bias is in favour of a low own price elasticity of demand. A second effect is a bias towards a low income elasticity, since the income increase is falsely reflected in a price increase. As a result, a portion of any change in consumption resulting from the increase in income will be attributed to a price increase which never occurred.

Duffy (1983) outlines two main conclusions related to the effects of changes in taxation in the United Kingdom. Rapid growth in consumption of spirits and wine during the '60's and early '70's is attributed to high income elasticities, as is a fall in consumption levels during the '73 - '74 recession and oil crisis. An implication for the future is suggested that alcohol control policies are likely to face difficulties against an increasingly affluent society.

2.3.2 Alcohol Consumption and Advertising

Additional policies that may be used to moderate alcohol consumption are controls on private sector advertising designed to encourage consumption, or funding of public health campaigns designed to moderate consumption. Given relatively low estimated elasticities of alcohol consumption to advertising levels, Duffy (1983) concludes that either policy would be comparatively ineffective. Other studies report similar conclusions (Owen, 1980; and Enemark, 1986).

2.3.3 Protection versus Free Trade

A final public policy consideration is the effect of protectionist policies on the viability of domestic producers. This aspect was taken up in two of the studies reviewed (Acheson, 1977; and Anastasopoulos et al., 1986). The conclusions of these studies are outlined below.

Acheson (1977) compares estimates of revenue maximizing markups with actual markups and concludes "that the Ontario wine industry is being subsidized in a number of different ways as compared to foreign competitors" (p.261). Domestic wine markups are consistently below the revenue maximizing markups that are calculated, therefore the level of domestic sales is higher than the volume that would accompany revenue maximizing pricing. Domestic wineries also benefit from a transfer of general revenues implicit in a lower government markup for wine sold in local winery stores. Finally, Acheson reports evidence of overpayments by the Ontario Liquor Board for local wine that range from 3 to 24 percent.

Possible reasons are advanced to explain why the Ontario Liquor authorities would both over pay domestic producers and impose low markups that ensure the quantities sold are above revenue maximizing quantities. Acheson suggests that explicit payments beyond some threshold value would be more visible to consumers and that authorities may be motivated by a desire to increase the information costs of determining the extent of subsidy. A second possibility suggested is that the government is concerned about the incidence of protection on grape growers in Ontario. The argument is advanced that grape growers would benefit from overpayments to the wineries only to the extent that they are able to negotiate

higher prices for grapes as a result. However, "by also following markup policies that increase the sale of domestic wine, which must be made from domestic grapes, the demand for grapes increases and the bargaining power of domestic grape growers rises" (p.258).

Anastasopoulos et al. (1986) use their empirical results to estimate the effects of Canada/U.S. free trade on employment and income in Ontario, B.C. and Quebec. The free trade scenario is defined by reducing markups on wine and beer imported from the U.S. to equal markups on domestic products, and removing all tariffs. A range of probable effects is then calculated using the estimated elasticities of substitution for imported versus domestic wine and beer. The actual estimate is taken as the lower bound and the estimate plus three standard errors provides the upper bound. The effects of free trade are calculated in terms of the changes in the share of domestic sales in the three provinces considered. Impact multipliers estimated using the 1974 Canadian input-output tables (from Statistics Canada) are then used to generate the total effects on income and employment for each province.

The estimated direct effect of free trade is presented in terms of the percent loss in income relative to 1982 levels. In the brewing industry, losses of 0.9 percent in Ontario, 0.3 percent in Quebec and 2.1 percent in British Columbia are predicted. In the wine industry, the estimated effects are much greater. Estimated direct income losses are 13 percent for Ontario, 28 percent for Quebec and 22.5 percent for British Columbia. The authors also report total income and employment effects (including indirect effects) of free trade for Ontario, Quebec and British Columbia.

Anastasopoulos et al. point out that their estimates are transitional costs that would occur as resources are reallocated to the most productive uses in a free trade environment (p. 99). The transition to a new equilibrium is predicted to be most severe for the domestic wine industry, particularly in B.C. They also acknowledge that the beer industry would suffer some setbacks. The likelihood of regional plants closing is particularly strong as a result of the economies of scale that could be attained through rationalization with free trade or with the removal of interprovincial trade barriers. With regard to interprovincial trade barriers, they argue that it would be imperative to first remove these "internal distortions before attempting to negotiate a free trade agreement in this sector with the U.S." (p. 98).

In examining the methodology used to generate estimated effects, it is evident that two considerations are not taken into account. While the importance of scale economies is acknowledged and evidence of particularly strong scale economies is provided for beer production, the estimates do not take these considerations into account. Also, the estimates do not incorporate the possibility that free trade may increase Canadian exports to the U.S. market. This is justified on the basis that U.S. barriers to Canadian products are already low. The authors also argue that Canadian wine exports are the least developed and appear to offer the lowest potential from the point of view of developing export markets through achieving premium status; particularly, that portion of the wine industry that "is located in B.C. and Ontario and is based on the Canadian grape" (p.29).

Chapter 3

THE MODEL OF CONSUMER DEMAND

This chapter is devoted to discussion of the approach taken to model the demand for alcoholic beverages. The main properties of consumer theory are first briefly outlined. The second section provides some discussion of the available econometric models of consumer demand along with the rationale for choosing "An Almost Ideal Demand System", hereafter referred to as AIDS (Deaton and Muellbauer, 1980b). The next section provides the estimating equations for the AIDS model, describes how the properties of consumer demand theory are imposed on the model, and outlines additional formulae and statistical tests necessary to interpret the estimated results. Following this, the discussion turns to the interpretation of the calculated descriptive statistics outlined in the previous section: the income, own price and cross price effects. The final section outlines some problems that could arise in estimating the model stemming from the aggregation problem, a simultaneous equation bias or some violations of separability assumptions.

3.1 Consumer Theory

This section outlines the traditional model of the consumer, lists the properties of the Marshallian and Hicksian demand functions, and introduces the Slutsky equation that relates Marshallian to Hicksian demands (see Varian (1978) for a more complete discussion).

Consumer choice theory characterizes the behaviour of individual consumers as that of choosing consumption bundles so as to maximize a utility function subject to a given budget constraint. Formally,

$$(3.01) \quad v(\mathbf{p}, y) = \max u(\mathbf{x})$$

$$\text{s.t. } \mathbf{p} \cdot \mathbf{x} = y$$

where $\mathbf{p} = (p_1, \dots, p_k)$ is the vector of prices of goods $1, \dots, k$; \mathbf{x} is a bundle of goods (and services); $u(\mathbf{x})$ is a utility function; y is consumer income; and $v(\mathbf{p}, y)$ is the indirect utility function. The Marshallian demand function, denoted $x(\mathbf{p}, y)$, is then the function that relates \mathbf{p} and y to \mathbf{x}^* (where \mathbf{x}^* is the utility maximizing bundle of goods).

It can be shown that utility maximization for a given level of income can be equivalently represented by expenditure minimization to achieve a given level of utility:

$$(3.02) \quad e(\mathbf{p}, u^*) = \min \mathbf{p} \cdot \mathbf{x}$$

$$\text{s.t. } u(\mathbf{x}) = u^*$$

where $e(\mathbf{p}, u^*)$ is the expenditure function. Hicksian or income compensated demand functions, denoted $h(\mathbf{p}, u)$, are constructed by varying prices and income, while consumer utility is held constant.

While the Hicksian substitution effects are not directly observable, in a model with sufficient theoretical content the substitution effects can be derived from the Marshallian effects using the Slutsky equation:

$$(3.03) \quad (\partial h_j(\mathbf{p}, u) / \partial p_i) = (\partial x_j(\mathbf{p}, y) / \partial p_i) + (\partial x_j(\mathbf{p}, y) / \partial y) \cdot x_i$$

where: $(\partial h_j(\mathbf{p}, u) / \partial p_i)$ is the Hicksian substitution effect;

$(\partial x_j(\mathbf{p}, y) / \partial p_i)$ is the Marshallian substitution effect;

$(\partial x_j(\mathbf{p}, y) / \partial y) \cdot x_i$ is the income effect; and

i, j are goods indices.

The main properties of consumer theory can now be stated as follows.

Property 1: Adding up. The total value of both Hicksian and Marshallian demands sums to total income or expenditure.

Property 2: Homogeneity. Marshallian demands are homogeneous of degree zero in prices and income; Hicksian demands are homogeneous of degree zero in prices.

Property 3: Symmetry. The matrix of Hicksian substitution terms, $\partial h_i(\mathbf{p}, u) / \partial p_j$, is symmetric.

Property 4: Negativity. The matrix of Hicksian substitution terms is negative semi-definite; this implies, among other things, that the compensated own price effect is non-positive.

Marshallian demands are directly observable and, therefore, at least in principle, they can be estimated empirically. It can be shown that a utility function representing consumer preferences can be derived from any system of demand equations that satisfy the above properties (Deaton, 1986, p.1774).

3.2 Choice of Model

The appropriate choice of econometric model is shaped by a number of issues. If the objective is forecasting or policy evaluation, strict conformity with theoretical models may not be important. Reduced form models will suffice as long as they convey information about the parameters of interest.⁵

If the objective is to test the theory and to provide a better understanding of consumer demand preferences, as in the present study, then structural models are most appropriate.⁶ In this case, an ideal model would allow for the imposition of all necessary theoretical restrictions, but impose only minimal restrictions beyond that suggested by the theory. An additional consideration of importance is the ease of estimation. These considerations are the focus of discussion in this section.

Within the class of structural models there is a fairly broad range of functional forms that may be used. Early studies of consumer demand relied extensively on the use of single equation methodology focusing on the measurement of elasticities, little attention was paid to the theory (Deaton and Muellbauer, 1980a, p. 61). More recent advances, particularly in the use of flexible functional forms, have allowed the estimation of empirical models that satisfy all the properties of consumer theory (Deaton, 1986; Deaton and Muellbauer, 1980a; and Theil, 1980). A brief discussion of the relative merits of the different approaches and of particular functional forms follows below.

⁵ Of course, structural models can also be used to achieve these objectives.

⁶ Not only would a reduced form model provide less information such a model would be ineffective with the data set used for this study, since there was little or no variation in the policy variables of interest (taxation) over the study period.

Two common specifications of single demand equations are the linear model and the multiplicative or log linear model. Most of the studies reviewed in the previous chapter used one or both of these models. In the linear model, elasticities are not constrained to one particular value, whereas they are in the log linear model. Thus, the linear model is better suited to some applications, for example, the case where revenue maximizing prices are calculated by Acheson (1977). On the other hand, the log linear form may be a more realistic approximation to a demand function as a result of the interdependence among exogenous variables that is imposed by the multiplicative form. The model imposes a larger absolute price effect at high income levels than at low income levels. However, both specifications suffer from the imposition of a restriction not required by economic theory. There is no a priori reason to believe demand functions are either linear or non-linear with constant elasticities.

An additional problem shared by both specifications is that they are relatively empty with respect to the propositions of consumer theory. Only the hypothesis of homogeneity can be tested and most studies using these forms appear to take homogeneity as a maintained hypothesis.⁷ While the Hicksian own price negativity property could also be tested in a single equation model, neither the linear nor the log linear form allow for the derivation of the net substitution (Hicksian) terms. This may not be a serious problem in many studies, however, since one would expect Marshallian terms to be close to Hicksian terms for individual commodities that account for only a small portion of a consumer's budget.

⁷ Only one of the studies reviewed reported results with and without homogeneity imposed and in this case no test of homogeneity was reported.

Other forms of estimating equations for demand models are derived from explicit specifications of utility functions. This class of models includes systems of demand equations derived from the Cobb-Douglas utility function and from the Constant Elasticity of Substitution (CES) utility function.⁸ While both models facilitate a closer relation between preferences and empirical models of demand, both impose excessive restrictions. The restrictions imposed by the demand functions in the Cobb Douglas case are the most extreme, since they impose strong (additive) separability; demands are assumed to be independent of the prices of other goods. In the CES case, there is no a priori reason to suppose that elasticities of substitution are constant nor that they are the same for any two goods.

Deaton and Muellbauer (1980a) review two studies by Stone (1954a and 1954b) which they regard as the first attempts to model consumer demand more rigorously. The first of these studies (1954a) uses a model derived from the log linear demand function that enables Hicksian price effects to be calculated, but does not allow symmetry to be imposed. Also, this specification still suffers from the imposition of unnecessary restrictions (constant elasticities) on the form of the demand functions. The second study utilized the linear expenditure system, a system of demand equations derived by imposing the theoretical restrictions of adding up, homogeneity and symmetry on a general linear formulation of demand. Stone's primary objective in formulating this model was to reduce the number of parameters to be estimated by imposing the theoretical restrictions. Deaton and Muellbauer (1980a) point out that this model also imposes two unnecessary restrictions. If concavity of the associated expenditure function holds, then all goods must be substitutes and the model does not allow for inferior goods. Moreover,

⁸ Anastasopoulos et al. (1986) report empirical results using both models.

the model imposes the theoretical restrictions by construction, so there is no way to test the restrictions statistically.

The use of flexible functional forms to model demand has addressed many of the problems apparent in the earlier models outlined above. The basic idea behind flexible functional forms is that finite approximations, such as the Taylor series expansion, are used to approximate the relationships of interest. Benefits of this technique are derived from the capability "to allow at least one free parameter for the measurement of each effect of interest" (Deaton, 1986). This capability permits estimating equations to be specified that conform to consumer theory, but do not impose additional restrictions. As well, the properties of consumer theory can be tested statistically, since these functional forms can be estimated with and without the restrictions imposed.

As in the case of the earlier models discussed, flexible functional forms can be applied either directly to demand functions or to preferences. In the former case, a local, first order approximation is necessary to model the effects of changes in income and prices on demands. An example of this approach is the Rotterdam model. In the latter case, the use of flexible functional forms requires a second order approximation to move from preferences to demands. Here three points of departure are possible. One can approximate the direct utility function, the indirect utility function, or the expenditure function. Examples of each respective approach include the direct translog model, the indirect translog model and "An Almost Ideal Demand System (AIDS)" (Deaton, 1986). All four of these models, the Rotterdam system, the direct and indirect translog models and the AIDS, are discussed by Deaton (1986) and by Deaton and Muellbauer (1980a). Giv-

en that the underlying assumptions regarding preferences are satisfied, all of the models except the Rotterdam system⁹ are able to satisfy the properties of consumer theory and none require that additional restrictions be imposed. On the basis of theoretical criteria, there appear to be no a priori reasons to prefer either one of the translog models or the AIDS model, but all three appear preferable to the Rotterdam system.

A second important consideration in the choice of model is the ease of estimation and in this respect some differences are also apparent that favour the translog and AIDS models. While the Rotterdam system is linear in parameters¹⁰ and, therefore, relatively simple to estimate, "severe problems" may be encountered in testing this model for symmetry (Deaton, 1986, p.1794). Alternate statistical tests have been shown to consistently yield divergent results. On the other hand, while the other three models are non-linear in parameters, symmetry is easily tested provided sufficient degrees of freedom are available to estimate the unrestricted form.

Problems in applying the indirect and direct translog forms are also noted in the literature (Theil, 1980; Deaton, 1986; and Deaton and Muellbauer, 1980a). The direct translog is criticized for the "practically nonsensical assumption" implied by the estimating equation that "prices are determined by quantities rather than the other way around" (Deaton and Muellbauer, 1980a, p.75). In discussing the

⁹ The Rotterdam system is an approximation to a log linear specification (in first differences), so earlier criticisms of this functional form also apply here; "log linear models cannot satisfy the theory exactly" (Deaton and Muellbauer, 1980a, p.72).

¹⁰ Theil derives two versions of the Rotterdam system, the "absolute price version" is linear in parameters and the "relative price version" is non-linear (1980, p. 161).

indirect translog model, Theil (1980, p.154) and Deaton and Muellbauer (1980a, p. 74) point to empirical results¹¹ that reject the restrictions implied by consumer theory. They argue that the results do not necessarily imply a rejection of demand theory, but could instead be a consequence of the poor quality of this approximation. According to Theil (1980, p.156), the translog approximations have been the subject of several experiments that have indicated a high sensitivity of the quality of the approximation to the values of some exogenous variables.¹² Theil (1980, p. 154) also points out that, since the translog approach is not self dual, either the direct or the indirect translog model must be an incorrect specification.

Regarding questions of the ease of estimation, Deaton and Muellbauer (1980a, p.74) express the view that the demand functions derived from the indirect translog model "are complicated and clumsy to estimate". As an alternative they suggest the AIDS model¹³ which they argue is "as general as the translog, ... much simpler to use" and has great advantages concerning aggregation over consumers. The AIDS model starts with a second order approximation of the expenditure function (Deaton, 1986, p. 1790). Simplicity in use results from the fact that the demand functions derived from this model "are very close to being linear" (Deaton and Muellbauer, 1980a, p.76). In fact, Deaton and Muellbauer (1980b) derive an

¹¹ Christenson, Jorgenson and Lau (1975) report disappointing results and conclude that they can "unambiguously reject the theory of demand" (Theil, 1980).

¹² Among other things, Theil states that the approximation appears satisfactory for values of price to expenditure ratios close to one, but quite bad for other values.

¹³ This model was developed by Deaton and Muellbauer (1980b), so it is hardly surprising that it is their preferred model.

approximation to the model that is linear in parameters which can be used in many situations where prices are closely collinear.

3.3 An Almost Ideal Demand System

For reasons outlined in the previous section the AIDS model was chosen for use in the present study. This section first states the two estimating equations for Marshallian demand functions that are derived from the model: the original specification and the linear approximation.¹⁴ The restrictions necessary to satisfy the properties of Marshallian demand functions for a single consumer are then outlined as they apply to these two estimating equations. Following this, the formula for calculating the Hicksian price effects is provided and the procedures for testing the restrictions imposed on the model are outlined. Finally, additional formulae which facilitate the descriptive characterization of consumer preferences are introduced, such as Marshallian and Hicksian price elasticities, and income elasticities. The Marshallian demand functions in budget share form are:

$$(3.04) \quad w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log (y / P)$$

where P is the price index defined by

$$(3.05) \quad \log P = \alpha_0 + \sum_k \alpha_k \log p_k + 1/2 \sum_j \sum_k \gamma_{kj} \log p_k \log p_j$$

Substituting equation (5) into (4) yields the estimating equation

$$(3.06) \quad w_i = (\alpha_i - \beta_i \alpha_0) + \sum_j \gamma_{ij} \log p_j + \beta_i (\log y - \sum_k \alpha_k \log p_k - 1/2 \sum_k \sum_j \gamma_{kj} \log p_k \log p_j)$$

This system of non-linear equations can be estimated by maximum likelihood estimation.

¹⁴ These equations are derived in Deaton and Muellbauer (1980b).

The alternate specification suggested as an approximation for equation (3.05) involves substituting some known price index to approximate P . Equation (3.06) then becomes linear in parameters α , γ , and β and can be estimated using OLS equation by equation or by a linear system estimation technique, such as 3SLS. To approximate P , Stone's (1953) index $\log P^* = \sum_k w_k \log p_k$ is suggested. Then, given $P \approx \varnothing P^*$, equation (3.06) can then be approximated by:

$$(3.07) \quad w_i = \alpha_i^* + \sum_j \gamma_{ij} \log p_j + \beta_i \log (y / P^*)$$

where $\alpha_i^* = \alpha_i - \beta_i \log \varnothing$ and \varnothing is a proportionality constant. The restrictions implied by the properties of consumer theory listed in section 3.1 may now be stated as follows:

$$(3.08) \quad \sum_i \alpha_i = 1; \sum_i \gamma_{ij} = 0; \sum_i \beta_i = 0$$

$$(3.09) \quad \sum_j \gamma_{ij} = 0$$

$$(3.10) \quad \gamma_{ij} = \gamma_{ji}$$

Adding up, property one, is satisfied by (3.08); these restrictions are automatically satisfied, since the data add up by construction. Homogeneity of the demand functions, property two, is satisfied by (3.09) which can be tested equation by equation. Slutsky symmetry, property 3, is satisfied by equation (3.10) which can be tested for the system as a whole. Both homogeneity and symmetry are tested statistically through comparisons of test statistics for the model estimated with and without the restrictions imposed. Property four, negativity, requires no restrictions on the system of estimating equations and is checked through examination of the eigenvalues of the matrix of Hicksian terms. Details regarding the procedures and formulas are outlined below.

Homogeneity may be checked equation by equation using an F test or for the system as a whole using the likelihood ratio test. The test statistic for an F-test involving more than one parameter is

$$(3.11) \quad [(ESS_r - ESS_{ur}) / q] / [ESS_{ur} / (N - k)]$$

where ESS_r and ESS_{ur} are the regression error sums of squares for the restricted and the unrestricted models, respectively; q is the number of parameter restrictions imposed by the null hypothesis; and $N - k$ is the number of observations minus the number estimated coefficients. If the null hypothesis is true, then equation (3.11) will have an F distribution with q degrees of freedom in the numerator and $N - k$ in the denominator (Pindyck and Rubinfeld, 1981).

The likelihood ratio test may be used to test the hypotheses of homogeneity, of symmetry given homogeneity, or of homogeneity and symmetry jointly.¹⁵ The likelihood ratio test statistic is

$$(3.12) \quad 2 \cdot (LL_{ur} - LL_r)$$

where LL_{ur} and LL_r are the logs of the likelihood values for the unrestricted and restricted models, respectively. If the null hypothesis is true, then equation (3.12) is distributed as a chi square with q degrees of freedom where q is the number of restrictions imposed on the restricted model.

Negativity may be checked from the matrix of Hicksian substitution terms (the hessian of the expenditure function). The Hicksian substitution effects are calculated using the Slutsky equation (see equation 3.03). The matrix is constructed with the own price effects as the diagonal terms, from equation 3.14, and the cross price effects as the off diagonal terms, from equation 3.13. If negativity is

¹⁵ The AIDS model does not allow symmetry to be tested without homogeneity imposed, since the symmetry restrictions (3.10) combined with the adding up restrictions (3.08) force the imposition of the homogeneity restrictions (3.09).

satisfied all the diagonal terms and the eigenvalues of the matrix will be non-positive (Chiang, 1974, p.345). This property follows from the concavity of the expenditure function (Varian, 1978, p. 99).

Hicksian Cross Price Effects:

$$(3.13) \quad (y/p_i p_j) \cdot (\gamma_{ij} + \beta_i \beta_j \log(y/P) + w_i w_j) = \partial h_i(\mathbf{p}, y) / \partial p_j \quad i \neq j$$

Hicksian Own Price Effects:

$$(3.14) \quad (y/p_i^2) \cdot (\gamma_{ii} + \beta_i^2 \log(y/P) + w_i^2 - w_i) = \partial h_i(\mathbf{p}, y) / \partial p_i$$

Additional formulae are necessary to facilitate the descriptive characterization of consumer preferences from the estimation results of the model. For this purpose formulae are provided to calculate the Marshallian and Hicksian price elasticities, the income elasticities and Marshallian price effects. The elasticity terms form the basis for the discussion in Section 4.2.2 and are used to calculate the results presented in Tables 4 to 9. The Marshallian price effects are used in Chapter 5 to calculate the effects of changes in the markup differentials between B.C. wine and imports that are assumed to result from free trade (see equation 5.01 and Table 18).

Marshallian Cross Price Effects:

$$(3.15) \quad (y/p_i p_j) \cdot (\gamma_{ij} - \beta_i w_j + \beta_i \beta_j \log(y/P)) = \partial x_i(\mathbf{p}, y) / \partial p_j \quad i \neq j$$

Marshallian Own Price Effects:

$$(3.16) \quad (y/p_i^2) \cdot (\gamma_i - \beta_i w_i + \beta_i^2 \log(y/P) - w_i) = \partial x_i(\mathbf{p}, y) / \partial p_i$$

Marshallian Cross Price Elasticity:

$$(3.17) \quad (1/w_i) \cdot (\gamma_{ij} - \beta_i w_j + \beta_i \beta_j \log(y/P)) = \\ (\partial x_i(\mathbf{p}, y) / \partial p_j) \cdot (p_j / x_i(\mathbf{p}, y)) \quad i \neq j$$

Marshallian Own Price Elasticity:

$$(3.18) \quad -1 + (1/w_i) \cdot (\gamma_{ii} - \beta_i w_i + \beta_i^2 \log(y/P)) =$$

$$(\partial x_i(\mathbf{p}, y) / \partial p_i) \cdot (p_i / x_i(\mathbf{p}, y))$$

Income Elasticity:

$$(3.19) \quad 1 + \beta_i / w_i = (\partial x_i(\mathbf{p}, y) / \partial y) \cdot (y / x_i(\mathbf{p}, y))$$

Hicksian Cross Price Elasticity:

$$(3.20) \quad (1/w_i) \cdot (\gamma_{ij} + w_i w_j + \beta_i \beta_j \log(y/P)) = \\ (\partial h_i(\mathbf{p}, y) / \partial p_j) \cdot (p_j / h_i(\mathbf{p}, y)) \quad i \neq j$$

Hicksian Own Price Elasticity:

$$(3.21) \quad -1 + (1/w_i) \cdot (\gamma_{ii} + w_i^2 + \beta_i^2 \log(y/P)) = (\partial h_i(\mathbf{p}, y) / \partial p_i) \cdot (p_i / h_i(\mathbf{p}, y))$$

3.4 Interpretation of Results

The previous section outlined some descriptive statistics that may be calculated from the estimated coefficients in the AIDS model. This section describes how these statistics can be interpreted as characterizing individual consumer preferences. Implications of different results within the range of expected values are first discussed for income and own price elasticities. The concept of two stage budgeting and separability between commodity groups is then introduced to facilitate the subsequent discussion of cross price effects of changes in relative prices on demands.

With respect to income elasticities goods are often classified by values that are within the bounds of three different ranges of interest. Income elasticities greater than one are generally used to classify goods as luxuries. Income elasticities which are positive but less than one classify a good as a necessity. As a consumer's income grows consumption increases for both luxuries and necessities, but luxury goods account for an increasing share of the budget while the reverse is

true for necessities. Both luxuries and necessities are referred to as superior goods defined by the characteristic that more income implies more consumption (Varian, 1978, p.87). Goods with a negative income elasticity are defined as inferior goods, since as income grows the consumer actually wants to consume less of the good.

Marshallian demand functions may also have positive or negative own price elasticities while still conforming to the properties of consumer theory. Positive elasticities can be explained for inferior goods by an income effect that overpowers the negative Hicksian own price effect (such goods are referred to as Giffen goods). Goods with negative Marshallian own price effects are defined as normal goods. All superior goods (those with positive income effects) must be normal goods as well, given the negative Hicksian own price effects implied by consumer theory (Intriligator, 1978, p.216).

According to consumer theory, Hicksian demand functions must have non-positive own price elasticities (see property four, Section 3.1). No further theoretical requirements are imposed on the own price elasticities, but estimated values do provide additional information regarding consumer perceptions of particular goods. Specifically, one would expect goods with few close substitutes to be price inelastic and goods with many substitutes to be price elastic.

The predictions concerning Hicksian cross price effects require only that the matrix of substitution terms is negative semi-definite and that, as a consequence of homogeneity, the price weighted sum of the own and cross price effects add to zero. In a two good model, this last point implies that the negative own price term must be matched by a positive cross price term. However, in models of three or more goods, it is entirely possible that goods may be net complements.

Contrary to the prevailing view expressed by others (see Section 2.2.2 above) it is not at all surprising that alcoholic beverages are net or gross complements for each other. This point can be illustrated if one thinks of consumers making decisions in two stages. Accordingly, consumers may be thought of as first allocating expenditures between alcoholic beverages and all other goods, and then among alcoholic beverages.¹⁶ Even with net within group substitution, alcoholic beverages may be net complements for one another as a result of the effect of a price change on group expenditures.

To see why, consider the effect of an increase in the price of one beverage on the other in terms of two parts. First, its effect on net substitution between alcoholic beverages as a group and other goods as a group. Second, its effect on net substitution among the beverages. The first effect working through group expenditures will be negative; it will result in a reduction in the demand for alcoholic beverages as a group. A priori, this effect will be larger the greater the proportion of income spent on the beverage whose price has increased and the degree of substitutability between other goods and alcoholic beverages as a group. The second effect depends on the degree of intragroup net substitutability between the beverages. Even if the second effect is positive, the combined effect may be negative since it will depend on the relative magnitude of the two effects. In other words, if the degree of intragroup substitutability is less than the degree of inter-

¹⁶ See Deaton and Muellbauer (1980a, pp. 120-137) for a detailed discussion of two stage budgeting where consumers are assumed to allocate expenditures, first, among broad commodity groups and, second, among individual commodities within groups. In the first stage, demands for commodity groups are taken to be a function of total expenditures and group price indices; in the second stage, individual commodity demands are a function of group expenditures and prices of the commodities within the group only. Weak separability between commodities in different groups is a necessary and sufficient condition for the second stage.

group substitutability then the former effect will dominate and the beverages will, overall, be net complements.¹⁷

3.5 Potential Estimation Problems

There are a number of additional considerations that should be taken into account in specifying, estimating and interpreting the results of models of consumer demand. Problems may be encountered estimating models of aggregate demand as a result of divergent tastes among individuals. Estimation results may be biased if simultaneity is ignored and endogenous variables are treated as exogenous. Additional sources of bias or specification error include violations of separability assumptions, or omitted variables.

One of the most serious problems, the aggregation problem, arises from the obvious fact that preferences vary from person to person. As Varian (1978, p.134) points out, the symmetry restrictions imposed by the model of individual consumer behaviour are not carried over to aggregate demand functions. The credibility of these restrictions applied to models of aggregate demand requires that "aggregate consumer behaviour can be regarded as if it were the outcome of a single maximizing consumer" (Deaton and Muellbauer, 1980a, p.148). Deaton and Muellbauer outline the necessary conditions for this requirement, "exact aggregation", to be satisfied under various circumstances.

¹⁷ Within group and between group cross price effects cannot be separated using the model specification adopted in this study. To do so would require the formulation of a estimating equation where expenditure on the alcoholic beverage group is a function of commodity group price indices and total expenditures; and expenditure on individual commodities is a function of within group prices and group expenditure.

Problems of simultaneous equation bias are caused by the misrepresentation of an endogenous variable as exogenous. The most obvious and frequently cited case is caused by the equilibrium nature of aggregate equations in a model of supply and demand. Unless equilibrium prices are determined exogenously, as when observed consumer behaviour is a small part of a larger system, then failure to correctly specify a supply as well as a demand equation will lead to econometric problems of identification and simultaneous equation bias (Varian, 1978, p. 129).

Deaton and Muellbauer (1980a, pp. 124-25) provide four examples where separability assumptions may be particularly important. They are separability between: time periods, leisuers and goods, commodity groups, and rationed (supply constrained) goods and other goods. Two of these are relevant to the current study.

The first, intertemporal separability, denies any interaction between demands for commodities consumed in different time periods. A static, one period model estimated with time series data is an example of an application of this assumption. This assumption can be dropped through the use of lagged variables, as in some of the studies reviewed in the previous chapter where lagged consumption entered as an independent variable.

The second relevant example is the separability between individual commodities or commodity groups which is assumed in any partial equilibrium model of demand. All of the studies reviewed in the previous section adopt this assumption. For example, Anastasopoulos et al. (1986) assume separability between the demand for alcoholic beverages and other goods. If the assumption holds, then "detailed commodity expenditure can be related to group outlay and prices alone"

(Deaton, 1980a, p. 125). The more general problem of omitted variables is simply a violation of this assumption.

Chapter 4

DATA, ESTIMATION AND RESULTS

This chapter describes the data and estimation, and reports the results of the AIDS model of demand outlined in Chapter 3. Data used to estimate the model and the various aggregations of these data are first briefly described. The specifications that were estimated leading to the choice of preferred specification are then outlined. Subsequent discussion focuses on tests of consistency of these results with the properties of consumer theory outlined in the previous chapter. Finally, the coefficients and descriptive statistics are presented and discussed with a view of interpreting consumer preferences.

4.1 Data and Estimation

The AIDS model was estimated using monthly observations of the prices and quantities of alcoholic beverages sold through the British Columbia Liquor Distribution Branch (LDB) over the period April 1981 to August 1986. Regression results discussed in this chapter are based on two different product groupings of these data, hereafter referred to as models I and II. Model I is aggregated into 5 product groupings: B. C. wine; imported wine; beer (includes cider and wine coolers); spirits (includes all other alcoholic beverages); and all other goods. Model II separates import wines (in model I) into U.S. wines and other imports, yielding six product categories.

In the other goods category, price is taken to be the CPI for Vancouver. The expenditure share on other goods is calculated using the residual income not spent on alcoholic beverages. This avoids any need for a measure of the quantity of "other goods" consumed and imposes the adding up property required by the budget constraint (Property 1 in Chapter 3). All quantities and income measures are expressed in per capita terms, using the 15+ age group population.

In all the systems estimated, the other goods equation was dropped to avoid problems in estimation that would arise from a singular variance-covariance matrix, caused by the adding up restriction on expenditure shares. (Deaton, 1986, p. 1781). Coefficient estimates have been shown to be invariant to the particular equation that is omitted and the other goods equation was of least interest in this study.

Model I data were first used to estimate equation 3.06 by maximum likelihood, with eleven monthly dummy variables included to control for seasonal variation. A final variable included was the number of business days per month. The number of coefficients estimated was kept to a minimum by imposing homogeneity and symmetry on the model.

Problems were encountered in obtaining convergence of this non-linear model and different initial values produced very different coefficients, but similar likelihood values (suggesting a flat likelihood surface with multiple extrema). As a consequence of these difficulties this version of the model was abandoned and the linear approximation, equation 3.07, was used instead. The results of the non-linear estimation suggest that the estimates generated by the linear model should be interpreted with some caution, since the informational content in the data was insufficient to generate reliable results using the non-linear model.

Three versions of the linear system were estimated by 3SLS: unrestricted, homogeneity imposed, and both homogeneity and symmetry imposed. As in the case of the non-linear model, eleven monthly dummy variables and a business day variable were added to equation 3.07.

Estimation results using Model I data proved to be the most satisfactory from the point of view of statistical tests of the properties of consumer theory. However, further disaggregation through separating U.S. wines from other imports added substitution results of particular interest. As a consequence Model II became the preferred model despite moderate costs in terms of slightly stronger rejections of the hypotheses of consumer theory. Of the various specifications, the most basic specification produced the most satisfactory results. The addition of variables such as time trends, lagged consumption and shift and price dummy variables resulted in stronger rejections and more frequent violations of the theoretical properties of the model.¹⁸

4.2 Results

The first portion of this section is devoted to the presentation of the results of tests of Properties 2 to 4, homogeneity, symmetry and negativity, for the "basic specification of Model II", hereafter referred to as just "Model II". The discussion centres on the consistency of these results with consumer theory. Estimated coefficients and descriptive statistics are then presented and discussed in the latter half of the section. Results of other model aggregations and specifica-

¹⁸ The observation that wine coolers were first introduced in the 37th time period motivated some experimentation with dummy variables and with wine coolers as a separate category. Estimation of the system with wine coolers as a separate category was tried, but later abandoned, since the price of wine coolers and beer had a simple correlation of 0.97.

tions are introduced where they provide additional evidence or insights of interest, but only the Model II results are presented in detail. The estimation results for the unrestricted, homogeneous, and homogeneous and symmetric versions of the model are presented in Tables 11, 12 and 13, respectively.

4.2.1 Consistency with consumer theory

The properties for consumer theory are considered. Property one, adding up, is imposed by construction.¹⁹ Properties two and three, homogeneity and symmetry, are checked through estimation restrictions and statistical tests that were outlined in Chapter 3. Negativity is checked through examination of the matrix of Hicksian substitution effects (the hessian of the AIDS cost function).

4.2.1.1 Homogeneity

Homogeneity requires that restriction 3.09 is satisfied. This is checked through an F-test for the individual regression equations and a likelihood ratio test for the system of equations.

The results of the F-tests are reported in Table 2. These test statistics allow acceptance of the null hypothesis of homogeneity of degree zero in prices and income for all but the beer equation, at a 5 percent significance level.²⁰

The likelihood ratio test for the system of demand equations leads to rejection of the null hypothesis of homogeneity at a 95 percent level (see Table 3). However, Deaton (1986) suggests that homogeneity should always be tested using

¹⁹ It can be shown that if the left hand (dependent) variables sum to one and each equation uses the same set of right hand (explanatory) variables, the estimated coefficients will satisfy the adding up property.

²⁰ Using the Model I data aggregation homogeneity was accepted for beer, but only at a 99 percent significance level.

Table 2: F-tests of Homogeneity

	B.C. Wine	Import Wine	U.S. Wine	Beer	Spirits
R^2_{ur}	0.7863	0.8220	0.8992	0.9152	0.7983
R^2_r	0.7786	0.8190	0.8992	0.8971	0.7976
F Test Stat.	2.34	1.09	0.03	13.91	0.24
$F_{1,45}$					
@95%	4.06	4.06	4.06	4.06	4.06
@99%	7.25	7.25	7.25	7.25	7.25
Null Hypoth.	accept	accept	accept	reject	accept
	(@95%)	(@95%)	(@95%)	(@95%)	(@95%)

exact statistics such as F-statistics and never using asymptotic test statistics such as likelihood ratios, since with exact tests "no problems of asymptotic approximation arise" (p.1794).

The F-test results compare favourably to those of earlier demand studies. Deaton (1986) reports that in the literature to date the "rejection of homogeneity tends to be confirmed using exact tests" (p.1794). For example, Deaton and Muellbauer (1980b) report that homogeneity is rejected in four of the eight equations estimated in their demand system.

They advance a number of reasons homogeneity could be rejected in spite of a true null hypothesis. The proposition they emphasize is that the rejection may be caused by an inappropriate specification. Other explanations include mistaken expectations about the prices of individual commodities and inappropriate assumptions underlying aggregation or intertemporal separability.

They argue that the most probable cause of specification error is that "expenditures may be inflexible in the short run" (p.320). This explanation is based on the observation that in the four cases where they rejected homogeneity, positive

serial correlation was introduced by the imposition of homogeneity. This suggests that "time trends and possibly lagged dependent variables are omitted variables in the static model and that the price coefficients are biased by their omission" (Deaton and Muellbauer, 1980a, p.77).

A similar pattern emerges in the results reported here, except serial correlation is evident with and without homogeneity imposed and the D.W. statistic increases rather than falls when homogeneity is imposed.²¹ However, experimentation with lagged expenditure share variables in Model I did not significantly alter the results for the beer equation. Homogeneity was still rejected at the 95% level, positive serial correlation remained and the lagged expenditure share coefficient was insignificant.

This suggests other sources of misspecification. One plausible explanation is tied to the strong seasonal pattern evident in beer consumption. If the highly significant monthly dummy variables are taken as proxies for average temperatures, then it could be argued that the monthly dummy variables do not pick up all the seasonal variation in temperature. This in turn could account for the serial correlation, if unusually warm months are clustered, and therefore cause the incorrect rejection of homogeneity.

²¹ With homogeneity imposed the D.W. statistic is in the indeterminate range, since $D.W. (Table\ 12) = 1.74$ and $d_1 = 1.44 < 1.74 < 1.77 = d_u$.

4.2.1.2 Symmetry

The requirement of cross equation restrictions for testing symmetry necessitates the use of asymptotic tests, such as likelihood ratio tests, and precludes the use of exact tests. Consequent problems in testing symmetry arise from difficulties in obtaining reliable estimates of the variance-covariance matrix of disturbances (Ω), as a result of the poor small sample properties of the estimator of Ω . As well, Deaton (1986) reports on experiments with the Wald, likelihood ratio and Lagrange multiplier tests that have found that, when the null hypothesis of symmetry is true, the tests tend to grossly over-reject. Deaton concludes that, since no alternative testing procedures are available, "it is probably best to suspend judgement on existing tests of symmetry (positive or negative) and to await theoretical or empirical developments in the relevant test statistics" (1986, p.1796).

Table 3: Likelihood Ratio Tests

Using likelihood values taken from Tables 11 to 13.

	Homogeneity	Symmetry given Homogeneity	Joint homogeneity and Symmetry
LL _{ur}	2433.18	2422.91	2433.18
LL _r	2422.91	2403.80	2403.80
2*(LL _{ur} -LL _r)	20.54	38.22	58.76
Number of Restrictions	5	10	15
Critical χ^2			
@95%	11.07	18.31	25.00
@99%	15.09	23.21	30.58
Null Hypothesis	reject	reject	reject

A likelihood ratio test was used to test the symmetry restrictions imposed on Model II. The results outlined in Table 3 indicate that both the null hypothesis of

symmetry given homogeneity, and of joint homogeneity and symmetry, should be rejected. However, the above discussion from Deaton (1986) suggests some caution in interpreting these results.²²

The literature indicates that the rejection of symmetry tends to be the rule rather than the exception. Deaton and Muellbauer (1980b) report a much stronger rejection of symmetry, with and without homogeneity as a maintained hypothesis.²³ They also note that their result is consistent with earlier studies, although most other studies report joint tests of homogeneity and symmetry.

They argue, however, that without some explanation for their rejection of homogeneity it is difficult to interpret the rejection of symmetry. As an example, they point out that it would be possible to introduce habits into their demand functions such that symmetry would hold when they are included, but not when they are omitted.

4.2.1.3 Negativity

The final property used to check the consistency of the estimation results with consumer theory is negativity. As outlined in the previous chapter, negativity may be checked using the hessian of the AIDS expenditure function in Table 4. The diagonal terms of the hessian are calculated using equation 3.14 and the off diagonal terms are calculated using equation 3.13; in both cases the coefficients

²² The reason for caution was more clearly illustrated by the Model I results where homogeneity was rejected using a likelihood ratio test, but accepted using an F-test at a 99% level. Moreover, the rejection of symmetry for Model I provided much less margin for error with a critical chi square value of 16.81 at 99%, versus a test statistic of 19.96.

²³ However, their model included eight commodities. Estimation of more highly disaggregated models of the demand for alcoholic beverages also led to stronger rejections of the symmetry restrictions

for the homogeneous and symmetric model are used (reported in Table 13). Negativity requires that the diagonal terms are all non-positive and that the hessian is negative semi-definite.

Table 4: Hessian for the Homogeneous and Symmetric Model

	B.C. Wine	Import Wine	U.S. Wine	Beer	Spirits	Other Goods
B.C. Wine	-113.40	8.22	2.95	-83.28	-10.11	6.02
Import Wine	8.22	-39.38	5.86	-135.98	41.48	-2.01
U.S. Wine	2.95	5.86	-0.20	-19.76	3.02	-0.55
Beer	-83.28	-135.98	-19.76	19.62	-312.86	56.28
Spirits	-10.11	41.48	3.02	-312.86	-21.47	5.61
Other Goods	6.02	-2.01	-0.55	56.28	5.61	0.56

As can readily be seen all the own price terms are negative, with the exception of the beer and the other goods terms. However, these two violations are minor, since the values are very close to zero in relative terms. This is most effectively illustrated in terms of the Hicksian own price elasticities of 0.005 and 0.006 (see Table 6).²⁴

A further check of the hessian reveals that the matrix is not negative semi-definite, since not all the eigenvalues are non-positive. The eigenvalues are -0.5, 2.2, -65, -104, -352 and 366. Again, the results are inconsistent with the theoretical prediction and the violation of theory centres on the beer equation.²⁵

²⁴ These values along with all those reported in Tables 5 to 10 were calculated using mean values of the estimated coefficients.

²⁵ Experimentation with a dummy variable in the beer equation in Model I to account for the introduction of wine coolers produced a negative definite hessian.

4.2.2 Interpretation of Consumer Preferences

The estimation results were outlined and discussed above within the context of tests of consumer theory. The discussion now turns to the characterization of consumer preferences implied by the estimation results. Income elasticities are first presented and discussed, followed by the own price and cross price elasticities. The discussion focuses on the results of the full theoretical model with homogeneity and symmetry imposed (see Tables 5, 6 and 13).²⁶

4.2.2.1 Income elasticities

The implications of particular values of income elasticities were discussed in Section 3.4. From this discussion, the calculated income elasticities outlined in Table 5 classify imported wines, U.S. wines, spirits and beer as superior goods, while B.C. wines are characterized as inferior goods. Within the group of superior goods, import wines and spirits appear as luxuries, U.S. wines as "modest" luxuries and beer as a necessity. Thus, a given increase in income would be expected to lead to a relatively large increase in the consumption of spirits and import wine, an equivalent increase in the consumption of U.S. wine, a relatively small increase in the consumption of beer and an actual decline in the consumption of B.C. wine.²⁷

²⁶ The results pertaining to the unrestricted and homogeneous model are presented in Tables 7 to 12. Each column heading in Tables 5 to 13 represents a dependent variable.

²⁷ These results are only dependent on the restrictions adopted in the case of B.C. wine and of beer. B.C. wine appears as a necessity in the unrestricted model and beer appears as a luxury.

The body of evidence reviewed in Section 2.1.3 allows for some comparisons with respect to the income elasticities of spirits, beer and wine. For beer and wine the income elasticities reported above are consistent with the earlier studies reviewed. Five out of the six studies reviewed reported an income elasticity for beer that was between zero and one. In the case of wine, three out of six studies reported an income elasticity greater than one. However, all but one of these studies reported positive and significant time trends. It may be that the inclusion of the time trend masked the influence of income on wine consumption. For spirits the range reported in the literature reviewed was fairly broad, but the estimate reported above exceeds the high end of the range (1.67 reported by Duffy).

Table 5: Marshallian Elasticities - Homogeneity and Symmetry

	B.C. Wine	Import Wine	U.S. Wine	Beer	Spirits	Other Goods
B.C. Wine	-0.727	0.084	0.587	-0.051	-0.054	-0.0004
Import Wine	0.092	-0.754	2.006	-0.142	0.345	-0.003
U.S. Wine	0.037	0.124	-0.076	-0.023	0.028	-0.0005
Beer	-0.234	-0.706	-1.777	0.0005	-0.711	0.00002
Spirits	-0.254	1.798	2.401	-0.762	-0.447	-0.002
Other Goods	1.608	-3.831	4.225	0.498	-1.432	-0.958
Income	-0.523	3.285	1.138	0.480	2.273	0.989

Table 6: Hicksian Elasticities - Homogeneity and Symmetry

	B.C. Wine	Import Wine	U.S. Wine	Beer	Spirits	Other Goods
B.C. Wine	-0.728	0.091	0.590	-0.050	-0.049	0.00003
Import Wine	0.091	-0.748	2.008	-0.141	0.350	-0.003
U.S. Wine	0.036	0.124	-0.077	-0.023	0.030	-0.0004
Beer	-0.240	-0.673	-1.766	0.005	-0.688	0.010
Spirits	-0.260	1.834	2.414	-0.757	-0.422	0.002
Other Goods	1.098	-0.629	-3.116	0.966	-0.783	0.006

4.2.2.2 Own price elasticities

A priori expectations with respect to Marshallian own price elasticities were briefly discussed in the previous chapter (Section 3.4). The discussion noted that inferior goods may have positive Marshallian own price elasticities, but for superior goods they must be negative, according to consumer theory.

With respect to a priori expectations the following observations apply. The one inferior good, B.C. wine, appears to be a normal good rather than a Giffen good, since the negative substitution effect is stronger than the negative income effect. The remaining superior goods all have negative coefficients with the exception of beer and other goods, hence, they conform with theoretical expectations. Moreover, as was argued in the above discussion of the Hicksian price effects, the beer and other goods coefficients are not "sufficiently positive" to be considered a violation of the theory.

In all cases the demand for alcoholic beverages is characterized as price inelastic. Beer and U.S. wine both appear completely insensitive to changes in their own price. Spirits are somewhat more elastic, while B.C. wine and import wine are the most price elastic.

A comparison of these results with the earlier literature reviewed indicates a fair degree of consistency in the results. This is particularly true of the own price elasticity for beer which appeared as a price inelastic good in the literature. The evidence reviewed for spirits was less consistent, but results reported in the two most recent Canadian studies are in accord with the results reported here.²⁸ Finally, in the case of wine, the broadest range of estimates was reported in the

²⁸ Recall that Anastasopoulos et al. (1986) and Enemark (1986) report elasticities of -0.74 and -0.55, respectively.

literature. The elasticity reported by Enemark (-0.96) is in accord with the results reported here, but other studies report widely divergent results.

The results of this study allow comparison of the Marshallian elasticities (Table 5) with the Hicksian elasticities (Table 6). Differences in the elasticities reveal the importance of the income effect of price changes of particular goods. This is best illustrated by comparison of the other goods elasticities. For the five alcoholic beverages the Marshallian and Hicksian results are similar, since the budget shares the income effects are relatively small.

4.2.2.3 Cross price elasticities

The final results of interest are the Hicksian and Marshallian cross price elasticities. The Hicksian elasticities provide the most accurate picture of cross price substitution, since they are a measure of substitution effects net of the income effects induced by a change in the price of a good. As noted in chapter 3, this consideration is unlikely to be of importance empirically unless the particular good accounts for a large portion of the budget. The Marshallian elasticities allow comparison with earlier literature where only gross substitution effects were reported.

The restrictions imposed by the properties of consumer theory on net substitution effects were discussed in chapter 3. Recall that no restrictions are imposed on the individual substitution terms other than the negativity requirement for the hessian.²⁹ Individual substitution effects may be positive if goods are substitutes or negative if goods are complements.

²⁹ We have seen already that this condition was not satisfied.

The Hicksian cross price elasticities yield a number of immediate observations (Table 6). Most striking is the characterization of beer as a net complement with other alcoholic beverages and a net substitute with other goods. Import wine, U.S. wine and spirits exhibit strong net substitution; however, import wine and U.S. wine appear as weak substitutes for B.C. wine.³⁰

A comparison of the Hicksian substitution effects with elasticities (Tables 3 and 6) illustrates the proper interpretation of the symmetry restriction. While the restriction imposes symmetric absolute cross price effects, asymmetric elasticities remain due to differences in budget shares. This seemingly obvious point is best illustrated through a comparison of the cross price elasticity of U.S. wine with respect to a change in the import wine price ($\epsilon_{US,I}$) with the reverse ($\epsilon_{I,US}$).

The budget share devoted to each commodity group also works through the income effect to influence the gross or Marshallian substitution elasticities. As with the own price elasticities previously discussed, the only notable change in moving from the Hicksian to the Marshallian elasticities involves the cross price elasticities of the various alcoholic beverages with respect to changes in the price of other goods. This is, of course, a result of the large budget share of other goods.

The evidence on the Marshallian cross price elasticities is in accord with the literature reviewed in Section 1.2.2. Two consistent threads of evidence were identified in the literature reviewed: complementarity between beer and other alcoholic beverages, and substitution between wine and spirits. Neither had been

³⁰ The most robust elasticities were calculated for the U.S. wine equation, as well as for substitution between B.C. wine, import wine and spirits. The results most sensitive to the imposition of restrictions were generated by the beer equation.

acknowledged by earlier researchers, but both are supported by the evidence presented here. The finding of substitution between domestic and import wine was also consistent with the evidence reviewed.

4.2.2.4 Discussion

Examination of the results from an overall perspective paints an interesting picture of consumer behaviour related to alcoholic beverages. If one views alcoholic beverages as a composite commodity group, the results could be interpreted through the two stage budgeting model briefly outlined in section 3.4. Using this model, the results characterize beer as the central commodity in that group. In other words, one plausible explanation of the complementarity between beer and other alcoholic beverages is that once consumers allocate expenditures to alcoholic beverages as a group, then a fixed proportion of those expenditures is allocated to beer consumption regardless of relative price changes within the group. Thus, the complementarity between beer and other alcoholic beverages can be interpreted as working through the influence of a change in the price of beer on the price of the alcoholic beverage composite good.

This interpretation of consumer behaviour is supported by the estimated income elasticity for beer which suggests that consumers view beer as a necessity. Moreover, the insensitivity of demand with respect to own price changes supports the view that few substitutes are available.

On the contrary, there is considerable evidence that import wine, U.S wine and spirits are perceived as similar goods and as acceptable substitutes for one another. All three have income elasticities greater than one which suggests they are perceived as luxury goods. As well, the cross price elasticities suggest strong substitution.

The one result that is difficult to explain is the inelastic own price elasticity for U.S. wine. Recall the argument outlined in section 3.4 that one would expect goods with few substitutes to be price inelastic. This inelastic own price result is unexpected given the apparent availability of strong substitutes and the higher own price elasticity for import wine which is characterized as a similar good and a strong substitute.

A final element of the picture is the perception of B.C. wine as an inferior good and a weak substitute for other alcoholic beverages, notably import wine and U.S. wine. The negative income elasticity lends support to this view, as do the estimated cross price elasticities.

A closer look at these results adds further credibility to this interpretation. Taking the income elasticities as an indication of differences in perceived quality suggests less difference between B.C. wine and U.S. wine, than between B.C. wine and import wine. This interpretation is supported by the estimated cross price elasticities which suggest stronger substitution between B.C. and other import wine. Stronger substitution is particularly evident when one considers that the average budget share for U.S. wine was only 0.00013, versus 0.0021 for both B.C. wine and other import wine. Moreover, the results for the unrestricted model provide even stronger evidence in support of this interpretation.

The implications of these results are discussed further in the following chapter which examines the potential impacts of free trade in wine. The differentiated wine product categories allow consideration of both bilateral free trade with the U.S. and multilateral free trade.

Table 7: Hicksian Elasticities - Unrestricted model

Coefficient	B.C. Wine	Import Wine	U.S. Wine	Beer	Spirits
B.C. Wine	-0.370	0.195	0.764	0.532	0.551
Import Wine	0.266	-0.315	2.077	-0.400	0.414
U.S. Wine	0.572	-0.286	-0.254	1.500	0.327
Beer	-1.610	-0.620	-1.923	-1.594	-1.053
Spirits	0.458	1.838	2.849	1.002	0.715
Other Goods	1.498	1.074	-3.641	1.975	0.347

Table 8: Marshallian Elasticities - Unrestricted Model

Coefficient	B.C. Wine	Import Wine	U.S. Wine	Beer	Spirits
B.C. Wine	-0.371	0.188	0.762	0.525	0.545
Import Wine	0.265	-0.322	2.075	-0.407	0.409
U.S. Wine	0.572	-0.286	-0.254	1.499	0.327
Beer	-1.613	-0.654	-1.933	-1.628	-1.081
Spirits	0.454	1.800	2.838	0.965	0.684
Other Goods	1.173	-2.220	-4.570	-1.241	-2.399
Income	0.333	3.381	0.954	3.300	2.818

Table 9: Hicksian Elasticities - Homogeneous Model

Coefficient	B.C. Wine	Import Wine	U.S. Wine	Beer	Spirits
B.C. Wine	-0.299	0.202	0.764	0.582	0.553
Import Wine	0.021	-0.508	2.077	-0.836	0.287
U.S. Wine	0.267	-0.524	-0.231	0.930	0.182
Beer	-0.801	-0.300	-1.986	-0.495	-0.907
Spirits	0.473	1.743	2.785	0.891	0.711
Other Goods	-0.026	-0.073	-3.487	-0.726	2.429

Table 10: Marshallian Elasticities - Homogenous Model

Coefficient	B.C. Wine	Import Wine	U.S. Wine	Beer	Spirits
B.C. Wine	-0.298	0.195	0.761	0.577	0.549
Import Wine	0.021	-0.514	2.078	-0.868	0.282
U.S. Wine	0.267	-0.524	-0.231	0.930	0.182
Beer	-0.798	-0.329	-1.997	-0.517	-0.933
Spirits	0.476	1.711	2.773	0.867	0.683
Other Goods	0.253	-2.904	-4.489	-2.869	-0.052
Income	-0.286	2.905	1.028	2.200	2.545

Table 11: Estimated Coefficient - Unrestricted

Coefficient	B.C. Wine	Import Wine	U.S. Wine	Beer	Spirits
YiBC	0.0013 (1.46)	0.0005 (0.46)	0.0001 (1.81)	0.0056 (1.77)	0.0063 (0.96)
YiI	0.0006 (0.91)	0.0012 (1.64)	0.00027 (6.55)	-0.0051 (-2.13)	0.0036 (0.73)
YiUS	0.001 (1.11)	-0.0006 (-0.49)	0.0001 (1.46)	0.015 (3.93)	0.0036 (0.45)
YiB	-0.0031 (-2.41)	-0.0024 (-1.67)	-0.00025 (-3.23)	-0.011 (-2.40)	-0.016 (-1.75)
YiS	0.0012 (0.82)	0.0029 (1.73)	0.00037 (4.03)	0.0056 (1.06)	0.015 (1.39)
YiCPI	0.0011 (0.41)	0.00021 (0.07)	-0.0006 (-3.64)	0.01 (1.09)	-0.0069 (-0.35)
β _i	-0.0013 (-0.81)	0.005 (2.65)	-0.000006 (-0.056)	0.023 (3.90)	0.020 (1.61)
D _{Apr}	0.0002 (1.33)	-0.00008 (-0.53)	0.00001 (1.51)	0.0016 (3.56)	-0.0002 (-0.25)
D _{May}	0.00008 (0.71)	-0.0001 (-1.09)	-0.000006 (-0.86)	0.0010 (2.49)	-0.0011 (-1.28)
D _{Jun}	0.0001 (1.14)	-0.0003 (-1.97)	-0.000003 (-0.71)	0.0021 (4.88)	-0.0012 (-1.38)
D _{Jul}	0.0005 (3.55)	0.000005 (0.017)	0.00003 (3.55)	0.0055 (11.87)	0.0014 (1.46)
D _{Aug}	0.0002 (1.52)	0.00005 (0.39)	0.000007 (0.88)	0.0035 (7.98)	0.0010 (1.12)
D _{Sep}	-0.0002 (-1.17)	-0.0003 (-2.34)	-0.00002 (-2.88)	-0.0007 (-1.60)	-0.0017 (-1.86)
D _{Oct}	0.0001 (0.85)	-0.0002 (-1.55)	-0.000005 (-0.58)	-0.0005 (-0.99)	-0.0004 (-0.38)
D _{Nov}	-0.0003 (-2.68)	-0.0004 (-3.21)	-0.00003 (-4.79)	-0.001 (-2.62)	-0.0020 (-2.44)
D _{Dec}	0.0007 (5.56)	0.0009 (6.48)	0.000008 (1.00)	0.0008 (1.81)	0.0067 (7.14)
D _{Jan}	-0.0002 (-1.72)	-0.0002 (-1.21)	-0.00002 (-2.66)	-0.0008 (-1.91)	-0.0005 (-0.60)
D _{Feb}	-0.0002 (-1.86)	0.0002 (-1.38)	-0.00002 (-2.15)	-0.0004 (-0.89)	-0.0011 (-1.29)
#DAYS	0.00007 (5.20)	0.00008 (5.45)	0.000003 (3.75)	0.0001 (2.92)	0.0003 (3.42)
Constant	0.0004 (0.018)	-0.056 (-2.18)	0.0012 (0.88)	-0.30 (-3.70)	-0.20 (-1.22)
RSQ	0.7863	0.8220	0.8992	0.9152	0.7983
DW	2.47	2.36	2.17	1.69	2.48

log of likelihood function = 2433.18

Table 12: Estimated Coefficients - Homogeneity

Coefficient	B.C. Wine	Import Wine	U.S. Wine	Beer	Spirits
YiBC	0.0014 (1.49)	0.0005 (0.50)	0.0001 (1.80)	0.0061 (1.74)	0.0065 (0.98)
YiI	0.00014 (0.23)	0.0009 (1.30)	0.0003 (7.46)	-0.0091 (-3.92)	0.0025 (0.57)
YiUS	0.00056 (0.54)	-0.0011 (-0.98)	0.0001 (1.67)	0.0093 (2.43)	0.0020 (0.28)
YiB	-0.0014 (-2.12)	-0.0011 (-1.52)	-0.0003 (-6.72)	0.0036 (1.48)	-0.012 (-2.63)
YiS	0.0014 (0.90)	0.0030 (1.78)	0.0004 (4.02)	0.0068 (1.18)	0.016 (1.43)
YiCPI	-0.0021 (-1.15)	-0.0022 (-1.12)	-0.0006 (-5.42)	-0.017 (-2.47)	-0.014 (-1.12)
Bi	-0.0027 (-1.82)	0.0040 (2.45)	0.000004 (0.04)	0.012 (2.11)	0.017 (1.57)
DApr	0.00013 (0.98)	-0.0001 (-0.80)	0.00001 (1.60)	0.0012 (2.49)	-0.0004 (-0.38)
DMay	0.00009 (0.74)	-0.0001 (-1.05)	-0.000006 (-0.86)	0.0011 (2.35)	-0.0011 (-1.26)
DJun	0.00015 (1.19)	-0.0003 (-1.91)	-0.000005 (-0.72)	0.0021 (4.58)	-0.0012 (-1.36)
DJul	0.00042 (3.22)	-0.00003 (-0.24)	0.00003 (3.71)	0.0050 (10.26)	0.0013 (1.38)
DAug	0.00013 (1.04)	0.000004 (0.03)	0.000007 (1.00)	0.0029 (6.47)	0.0009 (1.01)
DSep	-0.00014 (-1.06)	-0.0003 (-2.25)	-0.00002 (-2.90)	-0.0006 (-1.23)	-0.0017 (-1.83)
DOct	0.00011 (0.72)	-0.0003 (-1.63)	-0.000005 (-0.57)	-0.0006 (-1.18)	-0.0004 (-0.42)
DNov	-0.00032 (-2.72)	-0.0004 (-3.24)	-0.00003 (-4.79)	-0.0011 (-2.56)	-0.002 (-2.47)
DDec	0.00073 (5.49)	0.0009 (6.45)	0.000008 (0.99)	0.0008 (1.70)	0.0067 (7.14)
DJan	-0.00024 (-2.09)	-0.0002 (-1.47)	-0.00002 (-2.69)	-0.0011 (-2.56)	-0.0006 (-0.72)
DFeb	-0.00026 (-2.16)	-0.0002 (-1.60)	-0.00002 (-2.16)	0.0007 (-1.51)	-0.0012 (-1.41)
#Days	0.00007 (5.36)	0.00008 (5.59)	0.000003 (3.76)	0.0002 (3.14)	0.0003 (3.51)
Constant	0.029 (2.05)	-0.035 (-2.24)	0.001 (1.24)	-0.056 (-1.06)	-0.14 (-1.39)
RSQ	0.7786	0.8190	0.8992	0.8971	0.7976
DW	2.42	2.35	2.18	1.74	2.48

log of likelihood function = 2422.91.

Table 13: Estimated Coefficients - Homogeneity and Symmetry

Coefficient	B.C. Wine	Import Wine	U.S. Wine	Beer	Spirits
YiBC	0.00047 (0.97)	0.00033 (1.12)	0.00008 (0.67)	-0.0007 (-1.29)	-0.0001 (-0.11)
YiI	0.00033 (1.12)	0.0003 (0.62)	0.00026 (3.32)	-0.0012 (-1.80)	0.0032 (1.99)
YiUS	0.00008 (0.67)	0.0003 (3.32)	0.00012 (0.98)	-0.0002 (-2.68)	0.0003 (1.50)
YiB	-0.00067 (-1.29)	-0.0012 (-1.80)	-0.00023 (-2.68)	0.0097 (5.74)	-0.007 (-2.12)
YiS	-0.00014 (-0.11)	0.0032 (1.99)	0.00031 (1.50)	-0.007 (-2.12)	0.0044 (0.53)
YiCPI	-0.00005 (-0.04)	-0.0029 (-1.75)	-0.00053 (-2.30)	-0.0006 (-0.18)	-0.0007 (-0.09)
Bi	-0.0032 (-2.78)	0.0048 (3.16)	0.00002 (0.094)	-0.0052 (-1.22)	0.014 (1.86)
DApr	0.0001 (0.95)	-0.00009 (-0.55)	0.00001 (0.71)	0.0011 (2.02)	-0.0003 (-0.36)
DMay	0.0001 (1.06)	-0.0002 (-1.11)	-0.000006 (-0.36)	0.0016 (3.20)	-0.0008 (-1.03)
DJun	0.0002 (1.46)	-0.0003 (-1.71)	-0.000005 (-0.28)	0.0027 (5.33)	-0.0009 (-1.12)
DJul	0.0004 (3.17)	-0.00002 (-0.13)	0.000029 (1.60)	0.0051 (9.35)	0.0013 (1.43)
DAug	0.0001 (0.93)	0.00006 (0.40)	0.000008 (0.48)	0.0024 (4.99)	0.0008 (0.99)
DSep	-0.00007 (-0.54)	-0.0003 (-2.10)	-0.00002 (-1.17)	0.0001 (0.24)	-0.0012 (-1.38)
DOct	0.0002 (1.14)	-0.0003 (-1.45)	-0.000003 (-0.17)	0.00008 (0.13)	-0.00001 (-0.01)
DNov	-0.0003 (-2.30)	-0.0004 (-2.74)	-0.00003 (-1.96)	-0.0008 (-1.77)	-0.0017 (-2.10)
DDec	0.0008 (6.33)	0.001 (5.92)	0.00001 (0.63)	0.0013 (2.86)	0.0073 (8.43)
DJan	-0.0002 (-2.05)	-0.0001 (-1.01)	-0.00002 (-1.06)	-0.0014 (-3.07)	-0.0005 (-0.62)
DFeb	-0.0003 (-2.23)	-0.0002 (-1.13)	-0.00001 (-0.86)	0.0010 (-2.21)	-0.0011 (-1.43)
#Days	0.00007 (5.33)	0.00008 (5.70)	0.000003 (1.60)	0.0002 (3.24)	0.0003 (3.57)
Constant	0.03 (2.66)	-0.041 (-2.68)	0.0008 (0.44)	0.74 (1.84)	-0.14 (-1.95)
RSQ	0.7714	0.8142	0.8979	0.8627	0.7908
DW	2.50	2.34	2.15	1.74	2.54

log of likelihood function = 2403.80.

Chapter 5

POLICY ANALYSIS

The primary purpose of this chapter is to estimate the direct economic effects of changes in British Columbia policies affecting the local wine industry that would result from freer trade in wine. Interest in this question stems from the Canada - U.S. trade negotiations, a G.A.T.T. Panel investigating provincial marketing practices, and the current round of multilateral trade negotiations under the G.A.T.T.

The policies of greatest interest are a markup differential between domestic (B.C.) and import wine, and an import restriction on grapes.³¹ All British Columbia wines sold within the province benefit from a substantial markup preference relative to import wines. However, to obtain a winery licence, wineries must adhere to restrictions on importing grapes. The effects of changes in these policies are considered both within the context of bilateral free trade between Canada and the United States, and of multilateral free trade.

The structure of this chapter is as follows. The first section briefly describes the input market for grapes and provides production cost information to allow for consideration of the effect of removing the grape import restriction. This is followed by an analysis of the effects of changes in the markups and tariffs assumed

³¹ Only commercial wineries, as opposed to estate wineries, are considered in this analysis. Commercial wineries account for the bulk of British Columbia wine production.

to accompany bilateral and multilateral free trade; the effect of each markup scenario is considered with and without removing the import restriction on grapes. The chapter closes with a brief discussion of the strengths and limitations of the policy analysis.

5.1 Input Market for Grapes

The input market for grapes can be characterized as a bilateral monopoly. By virtue of an import restriction local growers have a captive market for their production. They negotiate prices with the wineries through the B.C. Grape Marketing Board whose bargaining power is largely derived from the import restriction.³² At the same time, wineries are the dominant buyers of local wine grapes.³³ They are represented in price negotiations by the B.C. Wine Council whose bargaining power stems from their dominant market share.

The restriction on grape imports affects wine production in two ways. By restricting access to imported grapes the quality of B. C. wine is affected. Not only are the wineries' choices of grape variety and quality constrained over the short term, but incentives for B. C. growers to compete on the basis of new varieties and improved quality are limited. This quality effect is difficult to evaluate in any analytical way.

³² Winery licensing policy restricts the use of imported grapes or "grape equivalent quantities" of juice, must or wine to a maximum of 20 percent of total grape input requirements. In years where domestic grape supplies are insufficient to meet 80 percent of the requirements, additional "grapes" may be imported provided local wineries secure contracts for future grape production to satisfy 80 percent of their needs (B.C. Ministry of Agriculture and Fisheries).

³³ In 1984, they purchased 94 percent of the total British Columbia grape crop (Agriculture Canada, 1986).

A second consideration is the effect of the restriction on grape prices and, hence, on winery production costs. Wine grapes produced in British Columbia are considerably more expensive than comparable varieties produced in the United States, particularly, California (see Table 14). However, without the import restriction on grapes this would no longer be the case, since the Grape Marketing Board would lose the ability to restrict the supply of grapes to the wineries. The effect of removing the grape import restriction can therefore be approximated by reducing the grape input price to the level of average California prices. As shown in Table 14, the decline in price implied by comparative California and B. C. prices is 50 percent.

Table 14: Comparative Grape Prices

	Average ¹ California Prices (\$U.S.)	Exchange ² Rate Sept. 30 (Spot)	Landed ³ Cost in B.C. (\$Can.)	Average ⁴ B.C. Price \$Can.	Percent ⁵ Difference in Price
1981	266	1.2068	353	584	40
1982	218	1.2363	296	538	45
1983	209	1.2323	283	631	55
1984	180	1.3180	261	616	58
Average			298	592	50

1. Source: Wines and Wines Magazine.
2. Source: I.M.F. International Financial Statistics.
3. California Price x Exchange Rate + 10 percent for transportation.
4. Average Price paid by B. C. wineries. Statistics Canada, Census of Manufacturers Microdata Extractions. British Columbia Central Statistics Bureau.
5. The change in price implied by removing the grape import restriction calculated as the B. C. - California price differential divided by B.C. price expressed as a percentage.

5.2 Evaluation of the Effects of Free Trade

The effects of three "free trade" markup policies are evaluated in this section, with and without removing the import restriction on grapes. In the first, bilateral free trade, the markup preference between B.C. and U.S. wine is eliminated through reducing the markup on U.S. wine from 110 to 50 percent and the tariff on U.S. wine is removed. In the multilateral free trade case, two alternatives are considered. The markup preference is eliminated through reducing the markup on all imports from 110 to 50 percent, and through increasing the markup on B. C. wine from 50 to 110 percent. In both cases all tariffs on import wines are removed. The underlying assumptions and evaluation methods are outlined below.

If one assumes that wine production is characterized by a fixed input share technology, then the effect of a change in the grape input price on the winery producer price (equal to average cost) can be derived from data on factor input shares (Table 15).

Table 15: B. C. Winery Production Input Shares

	1981	1982	1983	1984	Average
Elect. & Fuel	0.01	0.01	0.01	0.01	0.01
Grapes	0.16	0.18	0.19	0.19	0.18
Matured Wines	0.13	0.12	0.07	0.05	0.09
Glass & Pck'g	0.37	0.35	0.39	0.36	0.37
Other Materials	0.12	0.11	0.10	0.13	0.12
Value Added	0.22	0.22	0.24	0.25	0.23

Statistics Canada, Census of Manufacturers Microdata Extractions. British Columbia Central Statistics Bureau.

An x percent decline in the grape input price (g) will reduce average cost by x percent of the grape input factor share.³⁴ With the additional assumption of constant returns to scale, any change in average cost, or tax, leads to an equivalent change in the market clearing retail price.

Thus, the data on comparative grape prices and relative factor input shares indicate that dropping the import restriction on grapes would lead to a 50 percent reduction in the grape price and a 9 percent reduction in average cost. This reduces the average producer price from \$1.86 to \$1.69 per liter. A new retail price may then be calculated by adding taxes and the markup. Table 17 presents the results of these derivations using markups of a 50 percent and 110 percent for B.C. wine, with and without removing the import restriction. Changes in the U.S. and import wine markups are evaluated in a similar fashion in Table 18. The effects of these price changes on consumption are derived using the Marshallian price effects for the unrestricted and full models reported in Table 19.

The following six policy scenarios may then be evaluated using equation 5.1 to calculate the quantity of B.C. wine demanded in each case. Table 16 provides the results of these calculations for each of the six scenarios.

$$(5.1) \quad \partial x_{bc} / \partial p_{bc} \cdot \Delta p_{bc} + \partial x_{bc} / \partial p_{us} \cdot \Delta p_{us} + \partial x_{bc} / \partial p_i \cdot \Delta p_i$$

Bilateral free trade

1. Reduce the U.S. markup from 110 to 50 percent and remove the U.S. wine tariff with no change in the grape import restriction.

³⁴ The status quo producer price (before any changes in policy) is first calculated by netting out markups and taxes, from the status quo retail price.

2. Reduce the U.S. markup from 110 to 50 percent, and remove the U.S. wine tariff and the grape import restriction.

Multilateral free trade

3. Reduce the U.S. and other import wine markups from 110 to 50 percent and remove the import wine tariffs with no change in the grape import restriction.
4. Reduce the U.S. and other import wine markups from 110 to 50 percent, and remove import wine tariffs and the grape import restriction.
5. Increase the B.C. wine markup from 50 to 110 percent and remove the import tariffs with no change in grape import restriction.
6. Increase the B.C. wine markup from 50 to 110 percent, and remove the import wine tariffs and the grape import restriction.

Table 16: Equilibrium Prices and Quantities for Six Policy Scenarios

Prices are expressed as \$/liter and Quantities are expressed as liters/month per capita.

	P_{bc}	P_{us}	P_i	X_{full}^1	X_{unr}^2
Status Quo	4.14	7.94	7.10	0.6312	0.6312
Scenario 1	4.14	5.60	7.10	0.6243	0.5229
Scenario 2	3.83	5.60	7.10	0.6594	0.5408
Scenario 3	4.14	5.60	5.01	0.6069	0.4726
Scenario 4	3.83	5.60	5.01	0.6420	0.4905
Scenario 5	5.79	7.84	7.01	0.4433	0.5292
Scenario 6	5.36	7.84	7.01	0.4920	0.5540

1. Equilibrium quantities demanded using the full model with homogeneity and symmetry imposed.
2. Equilibrium quantities demanded using the unrestricted model.

Table 17: Effects of Markups and the Grape Import Restriction on the B.C. Wine Price

%Δ in grape price Markup	0 50%	-50 50%	0 110%	-50 110%
Producer Price	1.86	1.69	1.86	1.69
Fed. Excise Tax	0.42	0.42	0.42	0.42
Price incl. Ex. Tax	2.28	2.11	2.28	2.11
Fed. Sales Tax (13%)	0.30	0.27	0.30	0.27
Price incl. Sales Tax	2.58	2.39	2.58	2.39
B.C. Wine Markup	1.29	1.19	2.83	2.63
Price incl. Markup	3.86	3.58	5.41	5.01
Prov. Sales Tax (7%)	0.27	0.25	0.38	0.35
B.C. Retail Price (P _{bc})	4.14	3.83	5.79	5.36

Source: Anastasopoulos et al. (1986) for 1984 federal and provincial tax rates and markups.

Table 18: Effects of Tariffs and Markups on Imported Wine Prices

Markup	U.S. Wine			Import Wine		
	110%	110%	50%	110%	110%	50%
C.I.F. Price	3.49	3.49	3.49	3.12	3.12	3.12
Tariff	0.04	0	0	0.04	0	0
Price incl. Tariff	3.53	3.49	3.49	3.16	3.12	3.12
Markup	3.89	3.84	1.75	3.48	3.43	1.56
Price incl. Markup	7.42	7.33	5.24	6.64	6.55	4.68
Prov. Sales Tax (7%)	0.52	0.51	0.37	0.46	0.46	0.33
Retail Price (P _r)	7.94	7.84	5.60	7.10	7.01	5.01

Source: Anastasopoulos et al. (1986) for 1984 tariff rate.

Table 19: Marshallian Price Effects

Unrestricted model	B.C. Wine	Import Wine	U.S. Wine
B.C. Wine	-57.72	16.99	3.82
Import Wine	24.04	-16.97	6.05
U.S. Wine	46.28	-13.48	-0.66
Full Model ¹	B.C. Wine	Import Wine	U.S. Wine
B.C. Wine	-113.23	7.60	2.95
Import Wine	8.32	-39.74	5.85
U.S. Wine	2.96	8.84	-0.20

1. With homogeneity and symmetry imposed.

5.3 Bilateral and Multilateral Free Trade in Wine

In general, the estimated effects of freer trade on the value added earned in local wine production are relatively modest.³⁵ The worst case scenarios under bilateral and multilateral free trade predict losses of 17 percent and 30 percent, respectively, when the import restriction remains in force. The most optimistic scenarios predict slight increases when the restriction on importing grapes is removed.

Using the full model, the predicted effects of eliminating the markup differential either by reducing the markup on U.S. wine only or on both U.S. and other imported wines are inconsequential. Moreover, if the import restriction on grapes is removed consumption of B.C. wine actually increases slightly. The worst case scenario under the full model arises when the markup preference is eliminated

³⁵ The estimates outlined in Table 20 can interpreted either as the effect of changes in the markups and the grape import restriction on the quantity of local wine demanded in the British Columbia market, or in terms of the effect on value added earned in wine production. This latter interpretation follows from the assumption of constant returns to scale.

through increasing the price of B.C. wine. In this case value added declines by 30 percent with the import restriction in force and by 22 percent if it is removed.

Using the unrestricted model, the method of eliminating the markup preference is less important and the effects are more consistent. Bilateral free trade results in an 17 percent decline in demand which can be reduced to 14 percent if the grape import restriction is dropped. Under multilateral free trade, equalizing the markups leads to a decline of between 16 and 25 percent; with the import restriction removed the range is 12 to 22 percent.

The estimated effects allow comparison with one earlier study reviewed in Chapter 2. Recall that Anastasopoulos et al. (1986) reported the effects of bilateral free trade within British Columbia.³⁶ Their estimates ranged from a minimum fall in sales of 20 percent to a maximum of 41 percent. Expressed as total retail sales, the results of the current study are consistent with these earlier results; for bilateral free trade, they predict a change in total B.C. wine sales ranging from -1 to -17 percent (Table 20).

When multilateral free trade is considered the range in predicted sales revenues is +17 to -28 percent. The 17 percent increase in sales results from the inelastic own price term when the markup for B.C. wine is increased. This result illustrates the potential for a divergence of effects on industry income and government revenues. Given a government revenue objective, the results clearly point to a higher markup on B.C. wine as the appropriate response to multilateral free trade. From an industry perspective the effects of either option are roughly equivalent.

³⁶ No change in the grape import restriction was considered in their analysis.

Table 20: Summary of the Effect of Policy ChangesB.C. Wine Industry Value Added (% Δ)

		With Import Restriction	Without Import Restriction
Bilateral Free Trade			
Reduce U.S. Markup:	Unrestricted	-17	-14
	Full Model	-1	+4
Multilateral Free Trade			
Reduce Import Markups: (U.S. and Import Wine)	Unrestricted	-25	-22
	Full Model	-4	+2
Increase B.C. Markup:	Unrestricted	-16	-12
	Full Model	-30	-22

Total B.C. Wine Sales Revenue (% Δ).

		With Import Restriction	Without Import Restriction
Bilateral Free Trade			
Reduce U.S. Markup:	Unrestricted	-17	-21
	Full Model	-1	-3
Multilateral Free Trade			
Reduce Import Markups: (U.S. and Import Wine)	Unrestricted	-25	-28
	Full Model	-3	-5
Increase B.C. Markup:	Unrestricted	+17	+14
	Full Model	-1	+1

Some final comments are in order regarding the reliability of the estimated effects of policy changes. One remarkably consistent aspect of the results is the extent of substitution between the various categories of wine in absolute terms. The results suggest that, given current price differentials and historic ranges of

price variation, consumers perceive all wines as substitutes. However, as discussed in more detail in the previous chapter, substitution between B.C. and imported wine appears somewhat weaker than between either U.S. and B.C. wine, or U.S. and other imported wine. This characterization is supported by the income elasticities which suggest that U.S. wine and particularly other imported wine are perceived as superior to B.C. wine, hence, the limited substitution. That spirits and imported wine both appear as income elastic and as close substitutes adds further credibility to this argument.

Extending these results to predict the consequences of free trade involves a further leap of faith. The magnitude of the change in relative prices that would accompany freer trade is much greater than the variation that has occurred over the study period. Consequently, there is no a priori reason to expect the estimated price effects to apply to changes of the magnitude implied by free trade. In fact, a strong argument can be made that the rate of substitution in favour of the superior good (eg. from B.C. wine to imported wine) will increase as the price of that good declines. This argument suggests that the high end of the range of the estimated effects of policy changes should be interpreted as a minimum estimate of the effect of introducing free trade in wine within the British Columbia market.

One omission in the analysis points to a bias in the opposite direction. The analysis has not considered the benefits free trade would offer in terms of improved access to export markets. However, the evidence that B.C. wine is perceived as inferior to imports suggests that this effect may be less significant.

A final observation relates to the fact that the estimated policy effects were derived from a static model of demand. As a consequence, the policy predictions implicitly assume that no change in the characteristics of B.C. wine will accompany the transition to free trade. While this may be true in the short term, more intense competition would probably lead to changes in product characteristics over the long term. The most obvious source of such changes would follow from freer access to U.S. grapes for B.C. wineries, and more intense competition for local growers of wine grapes. To the extent that these changes would lead to enhanced quality, one would expect an improvement in export opportunities. This is a double edged sword, however, since it suggests the transition to free trade will be most difficult for local grape growers.

Chapter 6

CONCLUSIONS

This study has estimated a model of consumer demand using recent data on sales of alcoholic beverages in British Columbia. The estimation results were used to test the properties of consumer theory and to interpret consumer preferences, both of which were compared to the evidence reported in earlier literature. The demand results were then combined with an analysis of wine production costs to construct a simple industry model. Comparative statics yielded estimates of the direct economic effects of policy changes assumed to accompany a transition to bilateral and multilateral free trade in wine.

"An Almost Ideal Demand System (AIDS)" developed by Deaton and Muellbauer (1980a) was chosen as the model of consumer demand. The estimating equations which comprise the demand system are flexible functional forms providing a second order approximation to a consumer expenditure function. Advantages of the model are that it allows all the restrictions implied by consumer theory to be imposed and tested, does not require the imposition of unnecessary restrictions, and the estimating equations are almost linear and can be approximated by a linear equation. The results reported in this study were generated by the linear estimating equation.

The consistency of the estimation results with the properties of consumer theory compares favourably with earlier studies. Homogeneity is accepted in four

of the five demand equations at a 95 percent level using an F-test. Symmetry is rejected using a likelihood ratio test, but the rejection is not as strong as in most earlier studies. Moreover, asymptotic tests such as the log likelihood test have been shown to over reject when the null hypothesis is true. In the full theoretical model with homogeneity and symmetry imposed four of the six Hicksian own price effects are negative; measured as elasticities the two positive terms are very close to zero. Finally, the requirement of a concave expenditure function is not satisfied, since not all of the eigenvalues of the hessian are non-positive.

With regard to the characterization of consumer behaviour, the results are largely in accord with the literature reviewed. All alcoholic beverages are cast as price inelastic goods. Beer appears as an income inelastic good and as a complement with all other alcoholic beverages. Spirits, U.S. wine and other imported wine all appear as strong substitutes and as luxury goods. B.C. wine is characterized as an inferior good and as relatively weak substitute for other wines.

If one views the purchase of alcoholic beverages as a two stage budgeting process where expenditures are first allocated to alcoholic beverages as a composite commodity group, and then to the individual beverages within the group on the basis of relative prices, then the widespread complementarity between beer and other beverages can be interpreted as follows. Beer is perceived as the central commodity in the group in the sense that a fixed proportion of group expenditures is allocated to beer regardless of relative price changes within the group. Given this lack of substitution, the complementarity between beer and other alcoholic beverages can be interpreted as working through the influence of the price of beer on the alcoholic beverage group price and, hence, the substitution between alco-

holic beverages and other goods. Complementarity results when between group substitution exceeds within group substitution.

The effects of removing protection from the B.C. wine industry were estimated by comparative statics using a simple industry model. The demand results were used to evaluate the effects of eliminating markup differentials between B.C. and imported wine. Winery production cost and comparative B.C. - California grape price data were used to estimate the effects of removing a restriction on importing grapes. Six policy scenarios were considered in addition to the status quo: two within the context of bilateral free trade, and four within the context of multilateral free trade.

The worst case scenarios predict declines in B.C. winery value added of 17 percent with bilateral free trade in wine, and 30 percent with multilateral free trade, if the protection for local grape growers remains in force. With the import restriction on grapes removed, the worst case scenarios are moderated to 14 and 22 percent, respectively.

The characterization of U.S. and other import wines as superior goods and B.C. wine as an inferior good suggests that the results may under predict the consequences of free trade in wine. The price shocks that would accompany free trade exceed the range of price variation experienced over the study period, so there is no a priori reason to expect the estimated effects to apply over this broader range. As well, one would expect that rate of substitution in favour of the superior good to increase as the price of that good approaches the price of the inferior good.

Two additional consequences of free trade not considered in the analysis are the potential benefits of improved access to export markets and the probable effects on product characteristics. To the extent that free trade would lead to enhanced quality in wine production over the long term, one would expect the export performance of the industry to improve.

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With and Without Free trade in Wine

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