AN ANALYSIS OF THE DEMAND FOR LIQUOR IN MICHIGAN

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ABSTRACT

AN ANALYSIS OF THE DEMAND
FOR LIQUOR IN MICHIGAN

by Leo J. Navin

In view of the lack of information about liquor demand parameters in Michigan, the answers to policy questions which affect and are affected by demand variables have had to rely on "best guesses." Reliable revenue estimates of the yield of liquor excise taxes and profits from the State's liquor enterprise (ten per cent of State General Fund revenues in 1966) have been very difficult to make. These factors coupled with the excellent body of available data for a demand study were instrumental in promoting an analysis of the demand for liquor in Michigan.

Through the use of quarterly time series data (1955-1966) and multiple linear regression techniques, this study primarily identified price and income elasticity coefficients for "liquor," "distilled spirits" and "component" demand functions. Several variations of a basic demand model which included case sales, final price (a Laspeyres chain linked index), Michigan disposable income and dummy variables for seasonal adjustments were tested. Liquor, which included beverages having an alcoholic content of sixteen per cent or more, was found to be slightly price and income inelastic with respect to physical

volume sales. The price elasticity was not, however, significantly different from one. When actual total liquor expenditures (including taxes) were examined, a significant inverse price-total expenditures relationship emerged. A comparison of total expenditure, price and income elasticity coefficients arrived at through the direct regression of actual expenditures on the demand variables and the expenditure elasticities which would normally be inferred from the demand parameters revealed a significant discrepancy in the price elasticity coefficients. This was explained in terms of intra-basket substitution. A major portion of this substitution was accounted for when the analysis of demand for spirits over 22 per cent alcohol content was examined. A significant cross price elasticity of demand was revealed between fortified wines and the other liquors. An analysis of the demand for ten categories of liquor was performed. The resulting price and income elasticities were aggregated and compared with the composite liquor demand results as well as receiving brief individual treatment.

The financial structure of the Michigan liquor operation is subsequently analyzed with a view to the identification of the impact changes in tax, mark-up and wholesale cost parameters would have on the price parameter and ultimately State excise and monopoly revenue. A monopoly profit model is presented along with an excise model.

AN ANALYSIS OF THE DEMAND FOR LIQUOR IN MICHIGAN

By

Leo J. Navin

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INTRODUCTION

When fiscal "crises" threaten to disrupt state budgetary processes, the executive and legislative bodies of state government usually turn their attention to the revenue side of the budget. While various measures are taken to assure the electorate that economy and efficiency are the overriding considerations with respect to state expenditures, it is usually assumed that the pressures which have been exerted to provide the various goods and services of state government reflect "the public's demand" or "needs." Whether or not this is a correct assumption and whether or not the public values the level and allocation of governmental programs to such a degree that it is willing to assume consciously full financial responsibility for all such programs is uncertain.

For the most part, the budgetary activities of governments are not clearly understood by the electorate. These activities do not seem to be of major concern to many except where there is a considerable degree of personal involvement. On the revenue side of government finance, a lack of conscious involvement is, at times, a product of the type of tax legislation which is proposed or enacted. The lack of broad public reaction to certain tax legislation may be due to ignorance of the complicated provisions of a law and its full implications or to the selective character of the tax. A group of taxes which fall into the latter classification are the sumptuary taxes.

Sumptuary taxes are purportedly levied to reduce or curtail the consumption of various goods and services on the grounds that some form of social control is necessary for moral or social reasons. Taxation is supposed to provide the economic vehicle for achieving the espoused objective by increasing the price and discouraging consumption. Under the disguise of control, the primary purpose of the tax may be to provide a new source of revenue for the government. If the sumptuary objective were to be successfully achieved, the revenue objective of the selective tax may be seriously frustrated. Thus it becomes quite relevant to attempt to identify the market behavior of a commodity which is likely to become subject to sumptuary taxation.

Alcoholic beverages have historically been a favorite category of goods subject to selective taxation. In 1791 a specific excise was levied by the United States Government on distilled spirits. From that time on alcoholic beverages have been singled out as fair game for federal and state government tax policy makers. Following the ratification of the Twenty-first Amendment (repeal of Prohibition) in 1933, this group of commodities became even more vulnerable to selective taxation. When Prohibition was lifted, taxation of alcoholic beverages was particularly appealing. Here was a new source of state revenue at a time when state finances throughout the country were in a precarious condition. Taxation assumed such forms as state liquor monopoly profits--where the states actually went into the business of wholesaling and retailing beverages--and various license fees. Presently every state in the nation derives revenue from the taxation of alcoholic beverages. The growth in the popularity of these taxes is illustrated by the fact that between 1934 and 1964 state and local government revenue from alcoholic beverages rose from a level of $177 million to $1.8 billion.[1]

In Michigan, alcoholic beverage revenues have become an integral part of the state's financial structure. Since 1933 various fees, taxes, and changes in monopoly profit margins have been employed to help alleviate periodic financial crises while functioning to "control" the consumption and distribution of alcoholic beverages. Excise taxes on distilled spirits, wine and beer, as well as

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[1]Licensed Beverage Industries, Inc., The Alcoholic Beverage Industry and the National Economy, A State by Analysis (New York: Licensed Beverages Industries, Inc., 1955).

profits from the state liquor enterprise, constitute the sources for the bulk of Michigan alcoholic beverage revenue today. Various licenses and other fees and fines make up the remaining alcoholic beverage revenue. Local units of government receive the greatest portion of the latter types of revenue.

In fiscal 1966 the State of Michigan had $97.9 million in revenue transferred to the State's General Fund from liquor excise collections, state liquor monopoly profits, and beer and wine excise taxes. This was in the neighborhood of eleven per cent of all General Fund revenue that year. An additional $9.6 million in liquor excise collections were deposited in the "special purpose" State School Aid Fund.[2]

In spite of the millions of dollars contributed to Michigan State Government by the various alcoholic beverage taxes, a number of gaps exist in the identification of basic economic behavioral parameters which are important in understanding the behavior of liquor revenue. It is the purpose of this study to attempt to identify some of the relevant parameters and to indicate through the construction of a simple revenue model how this information can contribute to better informed policy decisions. Since

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[2]State of Michigan, The Executive Budget (Lansing, Michigan: State of Michigan Bureau of the Budget, 1967), pp. 6, 7, 13.

TABLE 1.--General fund alcoholic beverage revenue State of Michigan 1946-1966 (in thousands).

Fiscal Year	Liquor Purchase Revolving Fund	Liquor Excise	Beer-Wine Excise	Misc. Alcoholic Beverage Revenue	Total
1966	$50,220	$9,575	$38,098	$1,160	$99,053
1965	43,932	8,615	37,702	1,181	91,430
1964	24,607	7,805	36,052	1,161	69,625
1963	39,431	7,357	34,005	1,210	82,003
1962	39,293	143	6,829	1,422	47,687
1961	36,906	6,703	13,601	1,389	58,599
1960	39,045	3,678	11,349	1,404	55,476
1959	36,576	-	6,986	1,333	44,895
1958	55,579	-	7,094	1,280	63,953
1957	44,463	-	7,367	1,337	53,167
1956	33,798	-	7,747	1,347	42,892
1955	36,556	-	7,369	1,346	45,271
1954	37,988	-	7,385	1,316	46,689
1953	35,044	-	7,392	1,315	43,751
1952	35,561	-	6,861	1,203	43,625
1951	28,322	-	6,975	988	36,285
1950	30,279	-	6,832	990	38,101
1949	34,863	-	6,909	1,072	42,844
1948	33,988	-	6,980	561	41,529
1947	13,005	-	6,787	490	20,282
1946	23,790	-	6,686	408	30,884

Source: State of Michigan, The Executive Budget for selected years.

liquor monopoly profits and excise taxes are the major source of alcoholic beverage revenue, specific attention is devoted to the demand for liquor. The restriction of the inquiry to liquor, herein defined to mean distilled spirits of at least 22 per cent alcohol and "fortified" wines, is due to its importance as a revenue source and to the limitations on reliable data for beer and wines not handled by the state enterprise.

The basic format found in the following chapters is as follows. (a) A brief survey of various liquor demand studies appears in Chapter I. These studies are of foreign markets as well as United States markets. The significance of these inquiries lies in the scope of their analysis, the statistical techniques employed, and the character of the parameters identified. (b) Chapter II presents the major results of our statistical investigation. Models are constructed on three levels of aggregation to identify significant parameters. These are principally the income and price elasticities. The analysis of a composite demand function for liquor is presented. This function aggregates total liquor case sales in Michigan and regresses them on seasonal, price and income variables. The price-quantity relationship is found to be slightly inelastic. However, price elastic demand behavior is "identified" according to the movements of total expenditures; that is, when actual dollar sales data are regressed on the demand parameters a significant inverse relationship emerges. The subsequent level of analysis, which concentrates on an aggregated demand function for distilled spirits reveals that the price elasticity of the composite demand function can be partially explained by the strong substitution of fortified wines for distilled spirits. This intra-basket substitution is confirmed by a strong positive cross price elasticity between fortified wines and distilled spirits. The price elasticity of distilled spirits case sales can be closely reconciled with the behavior of actual dollar sales on distilled spirits during the sample period. Finally there is presented a discussion of ten demand functions which are "components" of the composite function. These component functions are aggregated and compared with the foregoing results. A brief discussion of each component follows.

[The basic statistical tool used throughout the analysis of the demand for liquor was the direct least squares multiple regression technique. The equations were estimated with the use of basic data that were obtained as part of this inquiry.] (c) Chapter III develops a sketch of Michigan's state liquor revenue structure. Through the use of a model for computing profits from the state liquor monopoly and a simple excise tax model, the information obtained from the preceding chapter is shown to be useful in assessing the revenue implications of variations in such factors as excise tax rates, profit margins and increased liquor costs from the manufacturers. The models presented are very meaningful for revenue estimating. The liquor demand variables would play the primary role in the determination of such estimates.

Following the conclusion of Chapter III, three appendices appear. The first contains a number of selected regression equations and demand elasticities which are the product of Chapter II's inquiry. Selected data are presented in the following appendix. The last appendix presents a simulation of the revenue models developed in Chapter III to estimate liquor revenues for fiscal 1967. These results are compared with reported 1967 returns.

CHAPTER I

EMPIRICAL STUDIES

In 1948 Sten Malmquist, a Swedish economist, undertook a statistical demand analysis for liquor in Sweden.[1] Malmquist approached the analysis by using a log linear model of the demand equation. He utilized annual time series data which ran from 1923 through 1940. The basic equation employed the three basic economic variables: quantity (Q), price (P) and income (Y). A fourth variable, the average ration during the year (Z), was also employed as an explicit explanatory variable. The constraint imposed by rationing was of central concern to the author.

Malmquist constructed three separate price statistics. One was the average price per liter of liquor (distilled and fermented spirits); another was the average price per liter of distilled 40% (80 proof) spirits; and the last was an "average price per litre of liquor calculated from the distribution of purchases among the main types of liquor in 1930."[2] These statistics are identified as P', P''', P'' respectively.

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[1]Sten Malmquist, _A Statistical Analysis of the Demand for Liquor in Sweden_ (Uppsala, Sweden: University of Uppsala, 1948).

[2]_Ibid._, p. 18f.

Seventeen regressions were performed using various combinations of the variables mentioned plus a consumer price index for forming a relative price statistic as well as "real" income data. The results are found in Table 2.

The price and income elasticities are very low in the above regressions. Overall, "(t)hese results would appear to show that the demand for liquor is decidedly under-elastic (inelastic)."[3] This however is due to the rationed characteristic of the commodities under consideration.

How should a rationed commodity affect elasticity estimates? Malmquist indicates that the price elasticity is not the elasticity which can properly be associated with a "normal" demand function. The function under study involves the elasticity for only a select group of consumers. In the case of a price hike those who had a "normal" consumption level less than or equal to the rationed quantity at the original market price, curtail consumption as would be expected. Others who at the original price level would have consumed a much larger quantity of the produce than they were able to purchase, do not respond in a normal fashion. They do not react by reducing their consumption of the commodity and hence

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[3] Ibid., p. 9.

TABLE 2.--Regression coefficients, demand for liquor in Sweden 1923-1940.[1]

log Q = a +	log P'_n	log Z	log Y_n	log C	R	
1.	-0.423	-	-	-	0.881	
2.	-0.336	0.457	-	-	0.926	
3.	-0.467	-	0.173	-	0.906	
4.	-0.353	-	-	0.711	0.977	
5.	-0.372	0.705	0.316	-	0.992	
6.	-0.373	0.868	0.374	0.173	0,993	
	log P'_r	log P''_r	log P'''_r	log Z	log Y_r	R
7.	-0.406	-	-	-	-	0.959
8.	-0.369	-	-	0.174	-	0.964
9.	-0.369	-	-	0.651	0.300	0.992
10.	-	-0.376	-	-	-	0.949
11.	-	-0.320	-	0.782	0.368	0.995
12.	-	-	-0.282	-	-	0.964
13.	-	-	-0.274	0.531	0.304	0.993
14.	-0.456	-	-	-	-	0.969*
15.	-	-	-0.326	-	-	0.961*
16.	-0.443	-	-	0.538	0.286	0.982*
17.	-	-	-0.340	0.338	0.271	0.973*

[1]Regressions 1-13 used data to 1939 and 14-17 used data through 1940 (*); subscripts n, r signify nominal and deflated data respectively.

Source: Sten Malmquist, A Statistical Analysis of the Demand for Liquor in Sweden (Uppsala, Sweden: University of Appsala, 1948), Chapter I, Tables I, II, III, IV.

the elasticity coefficient understates "normal" behavior. An analogous explanation can be made for the low income elasticity.[4]

Malmquist's study drew upon the basic causal relationships established by economic theory. In formulating the relationship in a log linear form using multiple regression techniques, he attempted to discover the elasticity coefficients in accordance with popular econometric methods. Malmquist's principal concern, however, was directed toward the behavior of a rationed commodity.

The year after Malmquist published his analysis, A. R. Prest wrote on "Some Experiments in Demand Analysis."[5] While investigating general consumer expenditure patterns in the United Kingdom (1870-1938), he performed an analysis of the demand for spirits. Prest followed a pattern quite similar to Malmquist in utilizing a logarithmic form of the demand function. He added two variables to the three basic variables of quantity, real (national) income and prices. These were population and a variable identifying the given time period (year). The latter variable was intended to explicitly identify a given state of tastes and consequently a change in tastes over time. His basic equation was of

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[4] _Ibid._, Chapter II.

[5] A. R. Prest, "Some Experiments in Demand Analysis," _The Review of Economics and Statistics_, XXI (February, 1949).

the following form: $Q/O = A(Y/O)^{b_1}(P/C)^{b_2} e^{b_3 T}$

Q = quantity demanded (proof gallon)
O = population
Y = "real" (deflated by C) income
P = price of commodity
C = index of all other prices
e = base of the natural logarithm
T = given time period (a given state of tastes)

The price elasticity (b_2) equaled -.8365 and the income elasticity (b_1) was 1.0996. While various alternative formulations were also tested, the above results represent the basic findings of the inquiry.

In 1954 Richard Stone published the results of an extensive study of consumer expenditures and behavior in the United Kingdom.[6]

In the course of this inquiry he performed an analysis of demand for distilled spirits. This analysis used annual time series data (1920-1938). This statistical model for spirits deviated from his general time series regression model for demand functions. The modifications consisted of eliminating *per capita* income and quantity variables, the exclusion of prices of related variables and the introduction of a trend variable. The regressions were run in first differences in a log-linear form. The results are as follows:

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[6]Richard Stone, *The Measurement of Consumers' Expenditure and Behavior in the United Kingdom, 1920-1938* (Cambridge, England: University Press, 1954).

TABLE 3.--Demand analysis for distilled spirits--United Kingdom 1920-1938.

log (dQ) = a + $b_1$log (dY) + $b_2$lob [d(P/C)] + b_3(dT)*

Income Elasticity	Elasticity	Residual Trend	R^2	d
0.80 (0.21)		-0.053 (0.010)	47	1.22
-	-	-0.020 (0.009)	55	2.58
0.60 (0.14)	-0.57 (0.12)	-0.033 (0.006)	79	2.48

*Notation is essentially the same as that used for Prest, c.f. p. 9.

Source: Richard Stone, The Measurement of Consumers' Expenditure and Behavior in the United Kingdom, 1920-1938 (Cambridge, England: University Press, 1954), Table 110, p. 390.

These results are reasonably consistent with the work of Prest as far as the relatively inelastic price behavior is concerned.

U. S. Studies

While in the process of analyzing the whiskey industry in the United States, Harold Wattel discussed the demand characteristics of the Pennsylvania market during the period extending from 1936 to 1951.[7] He formulated a series

[7]Harold L. Wattel, The Whiskey Industry: An Economic Analysis (New York: New School for Social Research, 1953), p. 296 ff.

of point elasticities of demand for each year using a demand function derived from "multiple correlation" techniques. He employed the simple linear hypothesis with consumption, price and income data. Price was related to the consumer price index for the nation as a whole. Unfortunately the results of the analysis did not report enough statistical information to evaluate the coefficients or the overall performance of the equation. Wattel's "basic formulae" were:

$$Q = 2.0169 - 0.2494\,P + 0.0001048\,Y$$

$$e^t = P^t/Q^t\,(-0.2494035)$$

Q = consumption
P = relative price
Y = income
e^t = elasticity in year t

The resulting point elasticities ranged in value from -1.24 to -.69 with the mean value being approximately -9.1.

Wattel did not have considerable interest in the demand characteristics *per se*. He seemed to accept these results and alluded in selected references to various opinions and at what can probably best be described as "guesstimates" of the demand characteristics of distilled spirits.[8]

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[8] *Ibid.*, p. 290ff.

In January, 1960 William A. Niskanen published a monograph entitled Taxation and the Demand for Alcoholic Beverages.[9] This publication was directed toward describing an aggregate demand function for alcoholic beverages in the United States. The model used the total national market for alcoholic beverages. It essentially broke this into three markets for the aggregated commodities of distilled spirits, beer and wine. Niskanen utilized annual time series data from the years 1934-1954. He formulated a system of demand and supply equations. Least squares estimates of the reduce-form coefficients were transformed to yield the estimates of the structural parameters of his demand functions. He obtained the following elasticity coefficients as the product of the ratio of the arithmetic means of the "explained" and "unexplained" variables and the relevant demand coefficient.

price elasticities:

distilled spirits	-1.74
wine	-2.27
beer	- .49

Interestingly, rather than using income as an exogenous variable in the system, "real monetary assets" (demand deposits adjusted plus currency outside banks) was used as a measure of general purchasing power. This produced a "purchasing power" elasticity of 1.99 for spirits, .57 for beer and .78 for wine.

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[9] William A. Niskanen, Taxation and the Demand for Alcoholic Beverages (Santa Monica, California: The Rand Corporation, 1960).

In 1962 Niskanen published his doctoral dissertation in which he altered somewhat the form of his earlier work as well as updated his data.[10] He included the 1955-1960 period and excluded the 1942-1946 period. He added the income variable. He used the direct least squares and the two-stage techniques to estimate the relevant parameters. Niskanen also employed the two-stage estimators with a transformation of price data (basically producers' price data) to reflect a hypothesized constant absolute distributors' profit margin. His results are found in Table 4.

In 1966 Julian Simon published a paper in Econometrica which was devoted to the development of a method of determining the price elasticity of liquor in the United States.[11] Simon's "quasi-experimental method" was essentially an effort "to examine the 'before' and 'after' sales of a given state, sandwiched around a price change and standardized with the sales figures of states that did not have a price change . . . then pool the results of as many quasi-experimental 'trial' events as are available."[12]

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[10] William Arthur Niskanen, Jr., The Demand for Alcoholic Beverages (Chicago, Illinois: The University of Chicago, 1962).

[11] Julian L. Simon, "The Price Elasticity of Liquor in the U. S. and a Simple Method of Determination," Econometrica, XXXIV (January, 1966).

[12] Ibid., p. 196.

TABLE 4.--Alcoholic beverage demand elasticities for the U. S. 1934-1960.

Technique		Elasticities: price	income	monetary assets	$\bar{R}^2$
(a) Direct least squares	spirits:	-1.420 (.235)	.214 (.153)	.565 (.147)	.929
	beer:	- .626 (.169)	-.332 (.134)	.441 (.073	.961
	wine:	- .563 (.227)	.687 (.172)	-.048 (1.40)	.943
(b) Two stage least squares	spirits:	-1.401 (.240)	.327 (.80)	.457 (.173)	.944
	beer:	- .696 (.236)	-.380 (.180)	.422 (.090)	.954
	wine:	- .681 (.229)	.606 (.192)	-.102 (.155)	.942
(c) Two stage constant distributor margin hypothesis	spirits:	-2.135 (.367)	.327 (.180)	.457 (1.73)	
	beer:	- .696 (.326)	.380 (.180)	.422 (.090)	
	wine:	- .981 (.329)	.606 (.192)	-.103 (.155)	

Source: William A. Niskanen, Jr., The Demand for Alcoholic Beverages (Chicago, Illinois: The University of Chicago, 1962), Table 8, Table 9, Table 10, pp. 56-58.

Simon's analysis obtains one "trial" over a horizon of thirty-one months. He assumed one brand (Segrams Seven Crown) as being representative of all spirits.[13] Simon computed the "price elasticities" for a number of states at various times for given price changes. The results of some of these computations are found in the following table. The states selected are those for which he reported two or more "trials." The "trials" are arranged in chronological order.

TABLE 5.--Price elasticities via the quasi-experimental method.

State	Trial		
	#1	#2	#3
Idaho	0.85	-0.84	
Ohio	0.83	-1.32	
Washington	0.25	-0.02	
Oregon	0.06	-0.03	-1.00
Maine	-0.12	-0.84	
Montana	-0.15	-3.73	
Iowa	-1.03	-1.90	
Virginia	-1.40	-2.25	

Source: Julian L. Simon, "The Price Elasticity of Liquor in the U. S. and a Simple Method of Determination," Econometrica, XXXIV (January, 1966).

[13]In our own inquiry using a logarithmic form of the function and including seasonal and income variables, these price elasticities differed considerably with Seagrams Seven Crown having a price elasticity of -2.27 (std. error .276) and the overall demand price elasticity of -.925 (std. error .231).

Concluding Comments

Each set of circumstances surrounding the various liquor demand studies have, of course, led to results peculiar to those circumstances. The identification of behavioral parameters in each instance can only be relied upon for dependable information about the relationships directly measured. Inference to different circumstances or to different behavioral patterns not directly identified may lead to misinformation. With these thoughts in mind, we will now proceed to analyze the demand for liquor in Michigan and attempt to identify the parameters which are relevant for a clear understanding of that market.

CHAPTER II

MICHIGAN LIQUOR DEMAND

The basic postulates of economic theory set out a general functional relationship between the quantity of a good purchased and a vector of determining factors. A select few of these factors or variables have attained special importance in economic analysis. The price of the commodity under consideration and the overall level of income of the consumer are singled out as principal economic determinants of demand. Prices of complementary and substitute goods, the state of tastes, and a host of variables which can be related to the commodity round out the list of determining factors. The definition of the period of time during which the flow of demand is to be considered plays an important role in determining whether a seasonal variable needs to be explicitly identified in the demand function, and in influencing the characteristics assumed by the other behavioral parameters. The general demand function for a commodity assumes the following form:

$$Q_x = F\ (P_x, Y, P_c, P_s T, Z, S) \tag{2.0}$$

where:

Q_x = the quantity of good x demanded

P_x = the price of good x

Y = the income level of the consumer(s)

P_c = vector of prices of complementary goods

P_s = vector of prices of substitute goods

T = a state of tastes

Z = vector of all other factors not elsewhere identified

S = seasonal variable (when required)

Such a general function, while logically complete, is not empirically implementable. However, the identification of economically relevant variables establishes the point of departure for productive analysis. Similarly the identification of the nature of the influence of the determining variables on quantity demanded provides a logical framework within which to examine empirical demand results. For example, we would normally expect an inverse relationship between the price and the quantity demanded of a good.

The empirical problems associated with the general demand function are not due to the lack of recognition of relevant variables, but rather to its all-encompassing nature. It is impossible to empirically identify, let alone quantify in a meaningful fashion, all of the variables which in any way influence the quantity demanded of a good. Consequently market demand studies must rely on the distillates theory offers, namely, the variables which rank high among the determinants of demand. Likewise such investigations can only record results within the limits of the data and the caveats surrounding the statistical techniques used.

The Models

The market defined.--The first task of our inquiry is to delineate the perimeter within which we will operate. The market under consideration has been defined by the policy orientation of this study. The Michigan liquor market is the subject of our analysis. Liquor as employed in this study connotes the entire range of distilled alcoholic beverages with an alcohol content of 22 per cent or more, plus the whole range of "fortified" wines having an alcohol content of 16 per cent or more. This assortment of alcoholic beverages constitutes the merchandise which is wholesaled solely through the facilities of the Michigan Liquor Control Commission. The market for liquor is confined to legal sales and does not attempt to incorporate an analysis of illegal liquor traffic.[1]

Within the general confines of the market as used in this study we have dealt primarily with wholesale sales of liquor to licensed retail outlets. These include "specially designated distributors," taverns, hotels, and selected organizations such as social clubs, etc. By far the largest retailers of liquor are the "specially designated distributors" or "S.D.D."s. They account for almost three-quarters of the state's liquor sales. S.D.D.s sell packaged liquor for consumption off premises. The Liquor

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[1]The attempt to measure illegal traffic must rely on rough proxy variables for measurement. Such variables are dependent upon a number of factors other than the amount of illegal traffic. The most significant is enforcement effort.

Control Commission also operates packaged retail outlets which handle from two to three per cent of gross sales in the state.[2] Bars and hotel sales make up the bulk of the remaining sales. In this study it is assumed that wholesale sales are final sales. The problem of stocks of inventories in the retail outlets as well as the consumers' stocks are ignored.

The basic liquor distribution system encompasses the central warehousing, wholesale, and some retail operations. Chart I provides an overview of the physical structure of the distribution system. It also indicates the magnitude of the flow of traffic between districts. As can be seen, the system operates through three major warehouses and approximately ninety state operated "stores." The latter are for the most part combination stores which supply the various retail licensees with liquor as well as maintain a very limited retail trade. Close to eight hundred persons were involved in this system's operations in fiscal 1966 not counting the non-state contractural help. Common carriers and railway transportation provided the basic means for shipments from point to point throughout the system. The heaviest concentration of activity was in the metropolitan Detroit area which accounted for close to seventy per cent of total annual sales.

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[2]Michigan Liquor Control Commission, Financial Report, selected years.

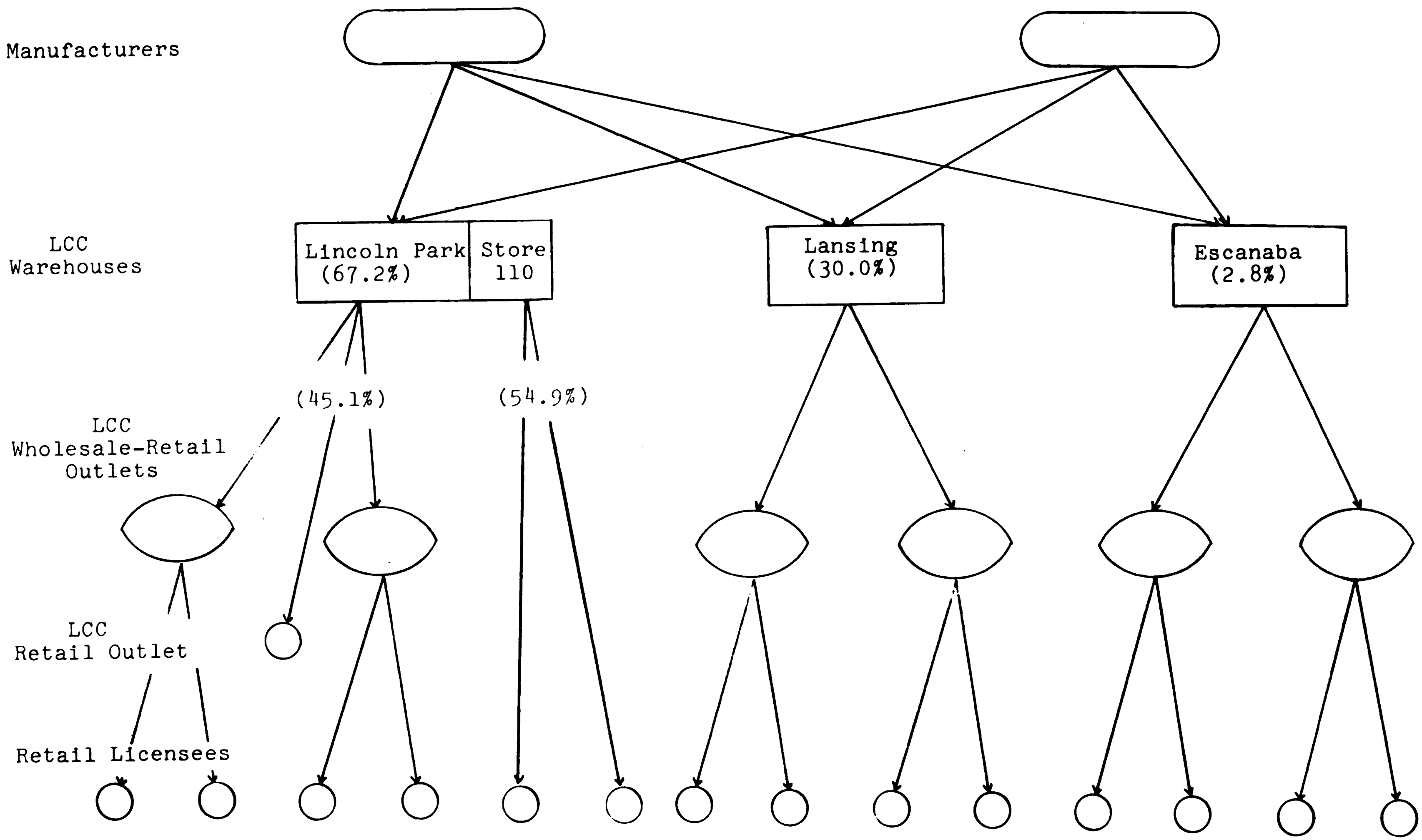

Chart I.--State of Michigan Liquor Distribution System.

In defining the market it is important to identify the time span under consideration as well as the unit of time in which the data are formed. The market for liquor was examined over an eleven-year period beginning in July of 1955 and ending in June of 1966. This time span was chosen due to data limitations as well as considerations for reasonably consistent population parameter determination for current policy decisions. The unit of time considered during this period was the quarter. This was considered as optimal both for maximizing the number of observations obtainable for time series analysis, and for aiding in identifying points in time when significant variables changed. It likewise is a useful form for obtaining information for budgetary purposes.

Within the framework of the above market description we have found it informative to attempt three different approaches to the liquor market due to each's contribution to the identification of significant behavioral statistics and due to their interest to economic analysis. At one level the market is studied in its completely aggregated form. This entails the attempt to identify the parameters for a composite demand function for liquor. A second approach singles out distilled spirits. It attempts to identify behavior in this market both for analytical and policy purposes. Finally the market is subdivided into ten categories or "components" to reveal the reactions of each subgroup to the independent demand variables as well as to compare the composite demand parameters with weighted parameters of the subfunctions.

The market for liquor is thus delineated by its geographical, legal, distributional and temporal characteristics for analysis on three distinct planes.

The General Function

The general functional relationship between variables draws upon the prominent economic factors identified in the general demand function previously discussed. It assumes the form:

(2.1) $Q = f(P, Y, S)$

where: Q = quarterly case sales
P = price expressed in index form
Y = quarterly estimates of "Michigan Disposable Income"
S = seasonal factor identified by three dummy variables

Variations of this function were tested in the composite, distilled spirits and component markets.

Composite Demand.--The composite function assumed the following form:

(2.2) $Q_g = F(P_g Y, S)$

In this demand function liquor was treated as a composite commodity leaving no room for distinction of type, brand or price category. It basically assumed a homogeneity of the commodity and demonstrated the behavior of the total quarterly volume of case sales of liquor responding to the determining variables--price, income and the seasonal factor.

In identifying the price of liquor, a Laspeyres chain linked price index was used.[3] It employed seventy individual brand prices and quantities as a representative sample of the commodity, liquor. Seven brands from each of ten categories of liquor were chosen.[4] They were selected from the most popular low, medium and high priced brands within each category. The formula used to form each link of the index was:

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[3]The chain linked index is conceptually similar to that used in Niskanen's study. It differs principally in so far as it does not use average prices of liquors in the various categories but a Laspeyres type index to determine these also. Furthermore, the time span per observation is shorter. This type of index satisfies the proportionality criterion, i.e. as all prices within the components vary by some proportion k, the index will also vary by k. This property is important when comparing the composite and aggregated component results later in this chapter.

[4]These categories--blends, bourbon, Canadian, scotch, gin, vodka, rum, cordials and liqueurs, brandy and wines--are discussed below in the section on component demand functions.

$$I^t = \frac{\sum_{j=1}^{10} \left(\frac{\sum_{i=1}^{7} P_i^t \cdot Q_i^{t-1}}{\sum_{i=1}^{7} P_i^{t-1} \cdot Q_i^{t-1}} \right)_j^t \cdot Q_j^{t-1}}{\sum_{j=1}^{10} \left(\frac{\sum_{i=1}^{7} P_i^t \cdot Q_i^{t-1}}{\sum_{i=1}^{7} P_i^{t-1} \cdot Q_i^{t-1}} \right)_j^{t-1} \cdot Q_j^{t-1}}$$

where:

Q_i^t (j) = quarterly seasonally adjusted volume of case sales for the i (j)th brand (category) in time period t.

P_i^t = the final price to the consumer of the i-th brand in period t.[5]

The income statistic was computed by reducing quarterly estimates of Michigan Personal Income by the amount of federal personal income taxes paid by Michigan residents. The adjustment was deemed expedient in light of the passage of the Revenue Act of 1964 which changed significantly the federal income tax rates for 1964 and 1965. Thus the income statistic more closely reflected Disposable Income behavior.

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[5]In its composite form the price statistic included all excise taxes. When the tax component was not included the resulting price index did not perform well in statistical analysis. The standard errors of the price coefficients in the equations tested were too high to be statistically significant.

The use of quarterly unadjusted quantity data required that a seasonal variable be introduced into the equation. This was accomplished by the use of dummy variables.[6]

Variation of the basic model used selected additional variables. These included population (O), consumer price index (C), the price of beer (B) and a trend factor (T) as a proxy for a state of tastes. Annual estimates of population twenty-one years of age and over were employed to attempt to identify if possible the impact of the number of eligible consumers. The Detroit Consumer Price Index was introduced into the equations as an explicit variable. It was also used in the formation of relative price and "real" income statistics. Beer was assumed to be a substitute commodity and its price was used in some of the variations of the equations tested. Due to the lack of reliable beer price data specifically for the Michigan market, the beer price index provided by the Bureau of Labor Statistics for the U. S. was employed as a proxy.[7]

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[6]The employment of dummy variables was intended to avoid the possibility of introducing spurious behavior into the quantity data through deseasonalization. The introduction of the dummy variables involves three such variables with the remaining quarter being identified in the constant term of a linear regression. For the first calendar quarter, the variables D(1), D(2), D(3) assumed the values 0; in the second quarter 1,0,0 respectively; in the third quarter 0,1,0; and in the fourth quarter 0,0,1. See the brief discussion in Lawrence R. Klein, An Introduction to Econometrics (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1962), p. 35.

[7]Tables of all the statistics discussed in this section are found in Appendix B.

The five basic variables (three dummy seasonal variables, the composite price index and income) were employed in various equations alone and in combination with the remaining four variables. A linear equation and exponential form using natural logarithms were used. Under these hypotheses the multiple linear regression technique was employed to identify price and income elasticity coefficients as well as to help evaluate the explanatory value of the other variables. This technique was expected to provide the best linear unbiased estimates of the demand parameters. The disturbance terms in the linear regression were assumed to reflect specification errors in the basic equations since the basic data which were used were considered reliable. The regression equations took the basic forms:

$$(2.2a) \quad Q = a + b_1D(1) + b_2D(2) + b_3D(3) + b_4P + b_5Y + \ldots + E$$

$$(2.2b) \quad \ln Q = a + b_1D(1) + b_2D(2) + b_3D(3) + b_4\ln P + b_5\ln Y + \ldots + E$$

where:

Q = total case sales of liquor

$D(i)$ = seasonal dummy variables ($i = k,2,3$)

P = composite price index

Y = income

E = disturbance term assumed $N(0,1)$

The above equations assume that the statistics being used in their formulation identify the demand for liquor. This critical premise is based on the definition of the relevant market, the character of the variation in and specification of the demand and supply functions and the causal relationship established within the body of economic theory. Since Michigan constitutes a relatively small percentage of the national market for liquor and since the consumers may obtain any quantity of liquor they wish at the given price, the assumption is made that within the unit of time specified the supply function for liquor was perfectly price elastic. Thus variations in the quantity of liquor purchased were determined by the demand variables. Variations in price due to the vertical shifting of the supply function aided in the identification of the "price-quantity demanded" relationship. While income was considered an explicit variable in the demand function, there was no reason to believe that it had any direct explanatory value in the assumed supply function. Thus the income coefficient could be expected to identify the relationship between income and quantity demanded.[8] The

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[8]The price variations during the sample period can for the most part be directly attributed to supply-price changes associated with alterations in the excise tax rate. Thus the demand function can be statistically "identified," that is, var $(E_t) < k$ var (U_t) where $0 < k < 1$ and U_t is the supply function disturbance. The absence of income in the supply function indicates its independence within the

line of causality between the dependent and independent variables was based on the postulates of demand theory as presented at the beginning of this chapter. Selected results of the regressions performed are reported in Table 6.

All of the equations presented in Table 6 exhibited high values of the F statistic. The simplest linear form of the demand equation performed statistically as well if not better than all of the other equations tested. This equation was also the frontrunner when additional variables were added to the equation under both the linear and logarithmic hypotheses.[9] The introduction of population, beer prices and the trend variables proved to be of little explanatory value. This is clearly demonstrated by the actual decreases in the R-bar square statistic as these variables were added.[10] This may partly be explained

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assumed system of equations and thus its coefficient in the demand equation statistically identifies its relationship to the quantity of liquor sold. See Klein, pp. 13-19.

[9]The statistical results of the variations tested are found in Appendix A, Tables 18-24. Also found in the Appendix is a more detailed description of the equations presented in Table 6 above.

[10]The R-bar square statistic is the coefficient of multiple determination adjusted for the degrees of freedom. It is formed according to the following formula: $\bar{R}^2 = 1 - \frac{N - 1}{N - K - 1}(1-R^2)$ where N is the number of observations, K is the number of independent variables and R^2 is the coefficient of multiple determination.

TABLE 6.--Composite liquor demand equations.[1]

Linear hypothesis:							$\bar{R}^2$	Durbin-Watson
Q =	a +	b_1 D(1) +	b_2 D(2) +	b_3 D(3) +	b_4 P +	b_5 Y		
A	940.611	81.518	59.298	399.042	-778.951	0.192	0.966	2.112
B[2]	0.2098	0.0177	0.0128	0.0866	-0.1715	0.1889	0.963	2.096
C[3]	970.365	81.850	49.027	398.665	-841.979 (339.32)	0.202	0.966	2.116
D[2,3]	0.1966	0.0178	0.0128	0.0866	-0.1663 (0.0716)	0.1979	0.964	2.124
log-linear hypothesis								
lnQ =	a +	b_1 D(1) +	b_2 D(2) +	b_3 D(3) +	b_4 lnP +	b_5 lnY		
E	0.0483	0.0846	0.0564	0.3531	-0.9251	0.8196	0.963	2.536
F[2]	-1.4746	0.0845	0.0567	0.3534	-0.9205	0.8061	0.960	2.505
G[3]	0.2160	0.0843	0.0563	0.3534	-0.8713	0.7991	0.962	2.531
H[2,3]	-1.4843	0.0844	0.0568	0.3538	-0.7940 (0.320)	0.7872	0.959	2.513

[1]All coefficients are significant at the .995 level or above unless the standard error is indicated.

[2]Per-capita quantity and income statistics used.

[3]Relative price and "real" income statistics used.

by the crude character of most of these additional variables.

One of the major problems associated with the composite demand function is whether the function is measuring basketwide responses to the movement of the independent variables specified. Liquor is not a homogeneous commodity. This fact alone could serve as a deterrent to the formulation of such a function if it were not for the fact that some broad public policy decisions are made for the commodity liquor without distinctions being made about the particular type under consideration. Can the foregoing models and their statistical results provide meaningful decision parameters for liquor policies? If the determining statistics do represent factors which have a broad influence on the bundle of goods, and this influene is exerted at essentially the same time, the parameters derived from the composite functions should be meaningful. The concordant character of the demand variables' movements enables us to treat such a group as a single commodity. This property is referred to by Wold and Jureen as the "Leontief-Hicks' theorem."[11]

During the sample period definite points in time were identifiable when pervasive movements in the major

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[11]Herman Wold and Lars Jureen, Demand Analysis (New York: John Wiley & Sons, Inc., 1953), pp. 108-109.

variables occurred. Liquor prices throughout most of the bundle experienced wide variations due for the most part to fluctuations in the ad valorem liquor excise taxes. During this period at least seven distinct commodity-wide price shifts can be identified varying in magnitude from one to four per cent.[12] The concordant character of these price movements is manifested in the very high simple correlation coefficients for the prices of the ten categories of liquor as shown in Table 7. Wine appears as the most significant exception.

The seasonal and income variables exerted significant influence throughout the bundle of goods as the statistical results reveal. This pervasive influence is further illustrated by their performance in the component demand models presented later in this chapter.

Overall, the statistical results reported above indicate that the tested composite demand hypothesis did not seriously violate the assumptions required to approximate the parameters which identify price-quantity, income-quantity and seasonal-quantity relationships.

Elasticities: The price and income elasticities derived from the above equations are found in Table 8. These are the (constant-elasticity) regression coefficients

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[12]C.f. Table 45, Appendix B.

TABLE 7.--Price correlation coefficients between liquor categories indexes.

	comp	blds	bour	cand	scth	gin	vdka	brdy	cord	rum	wine
composite	1000										
blends	998	1000									
bourbons	991	995	1000								
Canadian	996	996	997	1000							
Scotch	968	966	965	970	1000						
gin	949	948	950	951	958	1000					
vodka	992	989	986	991	961	922	1000				
brandy	984	981	976	979	960	936	986	1000			
cordials	994	991	986	993	964	926	992	978	1000		
rum	957	949	952	957	945	892	972	971	969	1000	
wine	853	836	798	825	738	699	843	814	862	807	1000

for the logarithmic form of the function and the point elasticities using the mean price, income and quantity data for the linear equations. The standard errors are found below each coefficient. These results indicate that the composite demand for liquor displayed a somewhat price inelastic coefficient though not significantly different from one. They also reveal a slightly income inelastic coefficient which was significantly different from one. The price elasticities ranged from -0.7599 to -0.9251 while the income elasticities had a range of +0.7590 to +0.8196.

Given these results, the question arises concerning the value of these statistics for policy decisions. If the policy issue centers around the impact of changes in the determinants of demand on the physical volume of liquor handled, these statistics are very useful. Such might be the case where physical volume is a prime determinant of costs. After establishing the cost function, changes in costs can be estimated when the demand parameters change. If a revenue decision is to be made on a unit tax, these statistics are meaningful in determining the yield of such a tax by projecting the tax base which is adjusted by the tax increase. These are but a few examples of the usefulness of this information. Further uses of these and subsequent results are discussed in Chapter III.

TABLE 8.--Composite liquor demand price and income elasticities.

Equation	Price Elasticities		Income Elasticities	
	linear	logarithmic	linear	logarithmic
A	-0.7714 (0.226)	-0.9251 (0.231)	+0.7725 (0.045)	+0.8196 (0.049)
B[1]	-0.7837 (0.230)	-0.9205 (0.235)	+0.7590 (0.025)	+0.8061 (0.054)
C[2]	-0.8210 (0.331)	-0.8713 (0.324)	+0.7946 (0.021)	+0.7991 (0.046)
D[1,2]	-0.7599 (0.322)	-0.7940 (0.320)	+0.7801 (0.024)	+0.7872 (0.050)

[1]per-capita income and quantity statistics.

[2]relative price and "real" income statistics.

Turning our attention to the price elasticity, a probable question to be raised is whether information concerning total expenditures on liquor can be inferred from the value of this parameter. Given certain assumptions, the answer to this inquiry is yes. In general, theory tells us that if the relevant segment of the demand function is price elastic, inelastic, or of unitary elasticity, total expenditures on a commodity will vary inversely, directly or will remain constant when price changes. The exact relationship between the price elasticity and total expenditures behavior can be seen from the mathematical relationship between the elasticity (η) of the quantity demanded (Q) with respect to price (P) and the elasticity (Z) of total expenditures (S) with respect to price.[13]

$$Z = 1 + \eta$$

Using the above mathematical relationship and the statistical results reported in Table 8, the inference might be drawn that total expenditures on liquor vary directly to a small degree with prices. For example, if prices were to increase by one per cent, total expenditures on liquor would be expected to increase by about .23 per cent with a price elasticity of -0.77. This relationship will hold if the commodity under consideration is homogeneous and uniformly priced. Such was <u>not</u> the case in the study for liquor nor is it usually the case in most markets. Shifting <u>within</u> the bundle of goods which are aggregated could take place when prices change and such a movement would not be reflected in price elasticity which is based on an

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[13] This relationship can be derived in the following manner: price elasticity of demand

$$\eta = \frac{dQ}{dP} \cdot \frac{P}{Q}$$

price elasticity of total expenditures $Z = \frac{dS}{dP} \cdot \frac{P}{S}$

$$S = P \cdot Q \qquad \frac{dS}{dP} = Q + \frac{dQ}{dP}P \qquad \frac{P}{S} = \frac{P}{PQ} = \frac{1}{Q}$$

$$Z = \frac{Q}{Q} + \frac{dQ}{dP}\frac{P}{Q} = 1 + \eta \ .$$

investigation of the behavior of quantity qua quantity. While physical volume, in our study cases of liquor, may not be "responsive" to price changes, expenditures may be, due to intra-basket substitutability.

To examine the use of the elasticity coefficients directly obtained from the composite demand function, to infer expenditures behavior, and to obtain reliable parameters for decisions requiring gross expenditure information, actual quarterly gross dollar sales figures for liquor (sales inclusive of excise tax collections) were regressed on price, income and the seasonal variables. The price coefficients under both the linear and log-linear hypotheses were negative in sign. This inverse relationship indicated that the demand price elasticities previously obtained would not only differ in magnitude from those needed to make decisions on total expenditures but also reverse the direction in which total expenditures would move.[14] Below in Table 9 is a comparison of the elasticity of total expenditures with respect to price obtained from the composite demand function, and the value this elasticity would have to assume to provide a more reliable basis for

[14]The equations obtained from these regressions are found in Table 25 of Appendix A. All of the coefficients are significant at the .995 level or above and have high coefficients of multiple determination.

TABLE 9.--A comparison of total expenditure price elasticities directly and indirectly computed.

Hypothesis	Total Expenditure Elasticities		Demand Elasticity
	direct	indirect	
linear[1]	-0.9194 (0.2585)	+0.2286	-0.7714 (0.226)
logarithmic	-1.0863 (0.2598)	+0.0749	-0.9251 (0.231)

[1]Computed using mean values for variables.

decisions requiring total expenditure behavioral parameters. The former is determined by adding one to the price elasticity coefficient derived from the composite demand function.[15]

If we direct our attention to the behavior of the income elasticity coefficients and the behavior of total expenditures, we again find a difference, though somewhat less crucial, in the expectations of total expenditures from the results obtained in the demand equations and the total expenditure functions. The precise mathematical relationship between the elasticity (E) of quantity with respect

[15]This procedure works from the mathematical relationship developed above, i.e. $\eta + 1 = Z$. c.f. footnote 13.

to income (Y) and the elasticity (V) of total expenditures (S) with respect to income is:[16]

$$V = \frac{dP}{dY}\frac{Y}{P} + E$$

If price and income are independent of each other, the elasticity of total expenditures with respect to income and the elasticity of quantity demanded with respect to income should be equal. This relationship assumes, as did the theoretical relationship between price and total expenditures, that the commodity under consideration is of a homogeneous quality and uniformly priced. If there is a discrepancy between the income elasticities with the demand elasticity being less than the total expenditures elasticity, it may well be explained by intra-basket substitution between lower and higher priced liquors. Such movements would be reflected in the behavior of average price. When logarithmic linear regressions of average price (both inclusive and exclusive of excise taxes) were

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[16]This relationship can be derived in the following manner:

income elasticity of demand $E = \frac{dQ}{dY} \cdot \frac{Y}{Q}$

income elasticity of total expenditures $V = \frac{dS}{dY}\frac{Y}{S}$

$S = P\,Q \qquad \frac{dS}{dY} = \frac{dP}{dY}Q + \frac{dQ}{dY}P \qquad \frac{Y}{S} = \frac{Y}{P\,Q}$

$V = \frac{dP}{dY}\frac{Y}{P} + E$.

performed on income, a significant positive income coefficient emerged having the value +0.1187 (0.032).[17] Thus the discrepancy between the total expenditure's income elasticity which appears in Table 10, can be explained by the substitution within the commodity liquor. This substitution is directly related to income movements.

TABLE 10.--A comparison of income elasticities of the composite demand and the total expenditure functions.

Hypothesis	Composite Demand	Total Expenditure
linear[1]	0.7725 (0.045)	0.8839 (0.051)
logarithmic	0.8196 (0.049)	0.9303 (0.055)

[1]Computed using mean values of variables.

In evaluating these empirical results, it is clear that the demand for liquor is somewhat price inelastic with respect to quantity behavior (though not significantly different from unitary elasticity) but fairly price elastic as far as the total expenditures on liquor are concerned. Similarly the income elasticity of quantity is somewhat less than the income elasticity of total expenditures. Both of

[17]The statistical results were identical in both regressions.

these phenomena can be explained by substitution which takes place within the bundle of goods. On the basis of these findings it is easy to see that when dealing with an aggregated demand function, misinformation may be elicited when conclusions concerning total expenditures are imputed from the identified demand parameters without due consideration being given to the crucial assumptions underlying the "pure" model. The demand function is primarily meaningful as an aid in identifying the parameters which relate the specified independent and dependent variables.

Distilled Spirits Demand.--One of the weakest elements of the analysis of the composite demand function was the behavior of the wine component. This component is quite different from the other categories of liquor in so far as it is not taxed in the same manner as the other categories of liquor. Wine is taxed on the basis of physical volume rather than *ad valorem*. Wine likewise is not a distilled spirit which again singles it out from virtually all of the remaining liquors. Because of the unique character of wine both in terms of its special treatment and the performance of the price of wine in terms of correlation with other liquor prices, a second aggregated demand function was tested. This time distilled spirits were aggregated--excluding the fortified wines. This formulation was structurally identical to the composite demand function. It basically included the quantity of cases of distilled spirits sold, a Laspeyres chain-linked price index for distilled spirits (including excise taxes), income and seasonal variables. Some of the equations tested under the linear and log-linear hypotheses can be found in Table 26 of Appendix A. The price elasticity for the distilled spirits equations increased in absolute value and proved to be definitely elastic. The income elasticities also increased. Table 11 presents these results.

TABLE 11.--Distilled spirits demand price and income elasticities.

Hypothesis	Price Elasticity	Income Elasticity
linear[1]	-1.8500 (0.486)	1.1186 (0.104)
logarithmic	-1.9054 (0.429)	1.1161 (0.099)

[1]Computed using mean values of variables.

Once more a cross check was run on the price and income elasticities of the demand equations against those obtained from the regressions of actual gross dollar sales of distilled spirits (including excise taxes) on the demand variables. The price elasticity from the demand equation more closely approximated the value it would have to assume to be consistent with the directly computed price elasticity of total expenditures. This is reported in Table 12. This would indicate that there is less substitution among the distilled spirits when prices change than there is within the total liquor basket. This further indicates that there is a fairly high cross-elasticity of substitution between fortified wines and distilled spirits. To verify this hypothesis the quantity of wine sold was regressed on the distilled spirits price index. This resulted in a significant high positive price coefficient. The cross price elasticity coefficient was 3.0176 (0.413) under the linear hypothesis and 3.1970 (0.439) when using logs.

TABLE 12.--A comparison of distilled spirits total expenditure price elasticities directly and indirectly computed.

Hypothesis	Total Expenditure Elasticities		Demand Elasticity
	direct	indirect	
linear[1]	-0.9261 (0.263)	-0.8500	-1.8500 (0.486)
logarithmic	-1.0731 (0.263)	-0.9054	-1.9054 (0.429)

[1]Computed using mean values of variables.

When the income elasticities obtained from the demand equation and the total expenditures function are compared, the demand coefficient somewhat exceeds that of the total expenditures coefficient. See Table 13. This reverses the direction detected in the behavior of the composite liquor functions. This indicated that when considering increases in income, there is for liquor as a whole a shift from wines and other beverages to distilled spirits. This shift into distilled spirits, however, is strongly in favor of less expensive types. This may partially explain the strong income elasticities in such categories of liquor as gin, vodka and rum.

TABLE 13.--Income elasticities of the distilled spirits demand and the total expenditure functions.

Hypothesis	D. S. Demand	D. S. Total Expenditures
linear[1]	1.1186 (0.104)	0.8957 (0.056)
logarithmic	1.1161 (0.099)	0.9386 (0.061)

[1]Computed using mean values of variables.

One small difference between the demand and gross sales functions for distilled spirits is that there does not appear to be any significant seasonal difference in quantity sales during the first three quarters of the calendar year but these quarters are significantly different with respect to the dollar expenditures.

The distilled spirits function has led to some interesting results in terms of identifying the type of substitution that is taking place within the liquor market in Michigan.

Component Demand.--One further step was taken in the analysis of the demand for liquor in Michigan. It consisted in the testing of equations for ten sub-categories or components of the commodity liquor. These were: blended whiskey, bourbon whiskey, Canadian whisky, Scotch whisky, gin, vodka, brandy, cordials and liqueurs, rum and wines. Each of these categories was tested under twenty different hypotheses.

Ten consisted of the simple linear regression equations using the categories' own price index, income and seasonal dummies. To these the Detroit Consumer Price Index, population, trend and beer price index were added in various combinations. Ten similar equations were logarithmic formulations of these same basic linear equations.[18]

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[18]The basic equations were:

$$Q_i^* = f_1(P_i^*, Y^*, S)$$

$$Q_i^* = f_i(P_i^*, Y^*, S, T)$$

$$Q_i^* = f_i[(P_i/C)^*, (Y/C)^*, S$$

Tables 29 through 42 in Appendix A present the more significant logarithmic results obtained for each category.

Aggregation: While the investigation of the component demand equations was partially intended to reveal some specific difference with respect to the behavioral parameters within the group, it was also intended to provide components to be aggregated into overall price and income elasticities. These aggregated statistics could then be compared with the results of the composite and distilled spirits functions. Aggregation of elasticities was accomplished by taking the quantity weighted average of the income and price elasticities of the ten component

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$$Q_i^* = f_i[(P_i/C)^*, (Y/C)^*, S, T]$$

$$Q_i^* = f_i[(P_i/C)^*, (Y/C)^*, S, (B/C)^*, O^*]$$

$$Q_i^* = f_i[(P_i/C)^*, (Y/C)^*, S, (B/C)^*, O^*, T]$$

$$(Q_i/O)^* = f_i[P_i^*, (Y/O)^*, S]$$

$$(Q_i/O)^* = f_i[P_i^*, (Y/O)^*, S, T]$$

$$(Q_i/O)^* = f_i[(P_i/C)^*, (Y/C/O)^*, S]$$

$$(Q_i/O)^* = f_i[(P_i/C)^*, (Y/C/O)^*, S, T]$$

*signifies variables tested using their natural logarithms as well as linear form.

functions. The quantity weights were the mean quantities of each of the sub-categories.[19] The elasticity coefficients from each of the components were selected under three criteria: most significant value for the coefficient, coefficient from the best fitted equation and coefficients from identically structured equations.[20] The results are reported in Table 14.

While the aggregate elasticity coefficients were close to each other when the first two criteria were used, there were considerable differences between these results and the parameters arrived at by aggregating the elasticities of the equations which were from the identically structured equations, $Q_i = f_i(P_i, Y, S)$. The major deviant was the perennial trouble maker--fortified wines. The price and income coefficients in the wine category were influenced to a high degree by the introduction of a trend variable to the simple equation. Both the price and income elasticities became <u>negative</u> and increased in significance

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$$\eta = \sum_{i-1}^{10} \eta i \; W_i$$

where $$W_i = \frac{Q_i}{\sum_{i-1}^{10} Q_i} \quad \text{and} \quad \sum_{i-1}^{10} W_i = 1$$

This technique is similar to that in Wold and Jureen, pp. 112-114.

20 The component elasticities are found in Table 28 in Appendix A.

TABLE 14.--Aggregated liquor demand price and income elasticities.

Criterion	Price Elasticity		Income Elasticity	
	linear	log	linear	log
identically structured equation	-0.2091 (0.499)	-0.1224 (0.639)	0.7818 (0.084)	0.8147 (0.102)
most significant coefficient	-2.7903 (0.582)	-2.7055 (0.644)	0.5828 (0.085)	0.5619 (0.106)
best fitted equation	-2.7328 (0.584)	-2.6075 (0.633)	same as above	

with its introduction. The Durbin-Watson statistic for the wine equations increased significantly to an acceptable level as did the coefficient of multiple determination. Thus the wine component was the major cause for the drastic shift in the aggregated elasticity coefficients under the various criteria tested. This influence is due to the relatively large physical volume of this component and its large elasticity values. Wine constituted 16 per cent of the physical volume and had price elasticities ranging from 7.1922 to -8.5311. The high cross elasticity factor referred to in the discussion of the composite function as well as weakly correlated and non-proportional price movements within the wine category itself resulted in a price coefficient which cannot be considered reliable for the above type of statistical aggregation.

In spite of the poor performance of the aggregated price elasticities, income behavior was consistent throughout the sub-categories. The aggregation of the income elasticities could therefore be expected to provide reasonably good results. When the weighted average income elasticity for like structured equations is compared with the composite demand functions income elasticity coefficients, the results are very similar. See Table 15.

TABLE 15.--Liquor demand income elasticities composite and aggregated compared.

Hypothesis	Composite Demand	Aggregated Demand	
		identically structured	most significant coefficient
linear	0.7725 (0.045)	0.7818 (0.084)	0.5828 (0.085)
logarithmic	0.8196 (0.049)	0.8147 (0.102)	0.5619 (0.106)

When the coefficients from the best fitted equation of the sub-categories as well as the most significant regression coefficients were compared, they proved to be the same coefficients as those in the identically structured equation [$Q = f(P_i, Y, S)$] except for the wine coefficient. As mentioned above, the wine income elasticity coefficient reversed its sign (became negative) and improved in significance when the trend variable was added. The presence of the trend variable in the composite function, however, did not produce results which had any significant effect on the composite income elasticity (nor price for that matter) though a slight change in income (and price) elasticities could be noted. These changes influenced the elasticities in the direction of the aggregated results--though not significantly.[21]

Next in our analysis, aggregation of the sub-categories' price and income elasticities was undertaken with the exclusion of wine. These aggregated results were distilled spirits parameters. These are presented in Table 16.

These statistics were fairly compatible with the results obtained from the distilled spirits demand function discussed above. The absolute values of the coefficients were somewhat less than were obtained from the direct distilled spirits demand regressions. A strong positive vodka price elasticity appears as a likely candidate which might account for a large proportion of the difference.[22]

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[21]See equation B, Table 33 in Appendix A.

[22]When vodka price and income were divided by the Detroit Consumer Price Index and a trend variable added, a fairly large significant price elasticity was obtained. See Table 38 in Appendix A.

TABLE 16.--Aggregated distilled spirits demand price and income elasticities

Criterion	Price Elasticity		Income Elasticity	
	linear	log	linear	log
identically structured equation[1]	-1.6150 (0.406)	-1.5580 (0.335)	0.8696 (0.077)	0.9289 (0.093)
most significant equation	-1.6837 (0.423)	-1.6751 (0.394)	same as above	

[1]These were also the best fitting equations in which the same form of the price and income statistics were used, viz., Q = f(P, Y, S).

It should be recalled that while price movements between the various categories are highly correlated, they are not perfectly correlated. Small price changes experienced within the categories which might not evoke a strong response may well attenuate the overall measure of responsiveness or "price elasticity" for the category. The design of the sample of seven brands making up the price index may also not be large enough and may introduce a downward bias on the elasticity coefficient by overstating the pervasive character of price movements within a given category.

One interesting observation is that while the income elasticity coefficient resulting from the sub-categories being aggregated is smaller than the income elasticity directly computed in the distilled spirits demand equation, it is almost identical with the income elasticity of total expenditures on distilled spirits.

Overall, the aggregation of the component functions to form demand parameters for liquor does not appear to be productive. The increased sensitivity of the disaggregated functions may well be a liability rather than an asset when broad based parameters need to be identified.

Component demands: The component demand functions reveal some interesting differences in the behavior of the sub-categories of liquor.

The most popular type of liquor sold in the Michigan market was blended whiskey. This group of whiskeys accounts for almost 41 per cent of the liquor sold and close to 49 per cent of distilled spirits sales. Blended whiskey on the whole is the least expensive of the whiskey group. It is widely used in popular mixed drinks.

The demand parameters which were identified in the regression performed on "blends" showed the commodity to be fairly price elastic and income inelastic. The dominant explanatory variable in terms of the quarterly case sales was the fourth quarter seasonal factor. This is reflected in the very high beta weight associated with the dummy variable D (3). The introduction of the trend variable into the equations as well as the forming of relative price and "real" income statistics increased the income elasticity and had a depressing effect on the price coefficient. The high price elasticity may indicate the possibility of a fairly high substitutability between blends and the more neutral spirits such as gin or vodka.

Bourbon whiskey which was another category including bonded bourbon, displayed an inelastic price elasticity and an income elasticity of approximately unity. Bourbon, which is predominantly a corn distillate, has a more distinct character than blended whiskey. If the distinct physical characteristics do indeed reduce the suitability of cheaper substitutes, this might explain the elasticities which were obtained.

Canadian whiskey is for the most part more expensive than bourbon though it is usally a bourbon type liquor. Its fairly high price elasticity may reflect the consumers' willingness to substitute the somewhat less expensive bourbon. The high income elasticity would tend to confirm the "superior" character of the commodity and help reinforce the expectation of a higher price elasticity.

Scotch whiskey has a rather special character that would tend to isolate its market from other whiskeys. In spite of this factor, Scotch appeared to be slightly price elastic. This might suggest that given price changes some Scotch drinkers may--at least in the short run--prefer to switch to higher quality liquor among the other categories than switch to cheaper grades of Scotch.

Gin, which is predominantly a neutral spirit, was one of the lowest priced types of liquor. For this reason, it would be one of the distilled spirits which would be a substitute good for other less expensive types of alcoholic beverages. This would contribute to an elastic price coefficient. On the other hand, it would also be substituted for more expensive distilled spirits when their prices increased. This aspect would dampen, completely offset or more than offset the elastic property less expensive types of beverages would tend to create. Our investigation indicates that overall gin was price elastic (in the neighborhood of -2.0). The heavy seasonal character of gin sales was reflected in the highly significant summer dummy variable [D (2)] and the high beta weight for this variable during the sample period. The elastic income coefficient for gin indicated both its "superior" character with respect to alcoholically weaker and less expensive competitors as well as more affluent alcoholic consumption patterns associated with a rising standard of living.

Vodka, like gin, is a relatively inexpensive distilled spirit which is predominantly "neutral" in character. The statistical behavior of vodka was dominated by its increased popularity. Most of the equations tested indicated some autocorrelation in residuals. One of the better equations which minimizes the problem appeared when "real" income, relative prices, beer prices, population and the trend variable were included. The trend variable would presumably account for some of the changes in tastes directed in favor of vodka. This should be expected to reduce autocorrelation in disturbances. The price variable was dwarfed in terms of its explanatory value by trend, seasonal, population and income variables. Under this formulation the price elasticity which was not statistically too significant, was more elastic than gin in a similarly structured equation.[23] Vodka's income elasticity was negative under this hypothesis indicating that while there was a movement which favors vodka, it is--technically speaking--an inferior good.

Brandy is a rather select type of liquor which is popular during the winter holidays. It was somewhat price elastic. Its income elasticity hovered near unity.

Cordials and liqueurs form a rather heterogeneous type of liquor. They are more or less specialty items and are quite seasonal in character. They displayed a slightly price elastic behavior. Their reputation of being luxury goods was confirmed by their elastic income parameter.

Rum is a type of liquor which is popular both in the summer and during the winter holiday season. It is a very inexpensive liquor and a likely candidate for substitutions

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[23]See Table 37, equation B and Table 38, equation C in Appendix A.

with cheaper alcoholic beverages as well as higher priced distilled spirits. It had a fairly strong income elasticity--in the neighborhood of two. It may as well qualify as a "luxury" good more for specialty drinks in which it is used than as a ready substitute for other alcoholic beverages as suggested above. Price does not perform well statistically and the price elasticity seems to be imprecisely estimated.

Fortified wines have been one of the most elusive types of liquor studied. The trend variable had the most significant "explanatory" statistical value. If this was a true measure of changing tastes or habits, this variable had some analytical explanatory value. Income ranked second in importance in terms of explaining wine consumption. Interestingly enough, the income elasticity coefficient for wine was <u>negative</u> in sign and greater than one in absolute value. This definitely indicated that fortified wine was technically speaking, economically "inferior." As consumers' incomes rose, less and less fortified wines were purchased due to this rise. The significant wine price elasticity coefficients were negative and fairly high in absolute value. The high degree of substitutability between fortified wines and non-fortified wines is the first line of explanation. It is possible to purchase the same physical volume of wine at a somewhat lower price but with a loss in alcoholic content. Other alcoholic and even non-alcoholic beverages may serve as other fairly close substitutes.

Overall, our investigation of the liquor market in Michigan revealed the following. Because of non-proportional and imperfectly correlated price changes for the commodity "liquor" and intra-basket substitutions during the period, a slightly inelastic price parameter was derived from the composite liquor demand equations. This inelasticity was restricted to the price-quantity relationship. An examination of the behavior of total expenditures on liquor revealed a definite inverse relationship between the prices and total expenditures. The subsequent distilled spirits demand analysis led to the identification of a significant cause of the conflict between the composite demand and total expenditure results by separating fortified wines from the other spirits. A high cross price elasticity between distilled spirits and fortified wines was then revealed. The aggregation of component demand functions revealed that using the most significant parameters for the demand equations and aggregating them, provided an overall price elastic demand for liquor. Income elasticities were fairly consistent between the composite, the distilled spirits and the aggregated component functions. A brief look into the component demands revealed certain other interesting points about the behavior of each. The higher component price elasticities simply pointed out the fact that for any given type of liquor there are generally more substitutes than for liquor as a whole.

CHAPTER III

MICHIGAN LIQUOR REVENUE

In view of the material discussed above, it is now possible to discuss Michigan's liquor revenues and to better understand the impact the major economic determinants have on them. Furthermore, we can explore the implications that changes in selected parameters will have on revenue as well as provide a basic framework for productive revenue estimation.

Michigan's liquor revenue flows from two basic sources--profits from the state liquor enterprise and excise tax collections. Currently excise taxes are channeled into both the General Fund and the School Aid Fund of the State of Michigan. Each fund received close to ten million dollars in excise revenues in fiscal 1966. In that same year, the amount of revenue transferred to the General Fund from state liquor monopoly earnings was two and one-half times that amount or approxaimtely fifty million dollars. The transferred earnings were from the state's Liquor Purchases Revolving Fund. The LPRF is the operating fund of the state liquor monopoly.

Michigan's State Liquor Enterprise

There are three basic sources of receipts for the liquor monopoly. Ths most significant is the total dollar sales of liquor.[1] Two minor sources of revenue are the return from the sale of liquor tax stamps to manufacturers and the "mark-up" received when liquor is brought into the State of Michigan by consumers.[2] The two latter sources are relatively insignificant in size and can be ignored.

The total retail dollar sales of liquor do not constitute the receipts of the state enterprise since this amount includes the discounts allowed the various licensees.[3] These discounts are aggregated into a total discount figure which is the weighted average of the

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[1]Excise taxes do not constitute part of the receipts of the monopoly. They are merely collected by the monopoly and are deposited with the State Treasurer in the General Fund. These are discussed later in this chapter.

[2]The fact that certain out-of-state purchases of liquor are subject to the payment of the "mark-up" substantiates the contention that the liquor operations are involved in indirect taxation. The exceptions to the mark-up payment are found in Section 436.3 and Section 436.4 of the Liquor Control Act.

[3]The discount on the retail price is different for different categories of licensees. From 1955-1966 it was 10%, 12½% and 22% for S.D.D.s, class "C" licensees, and the military and hospitals respectively.

separate discounts. The weights in this instance are primarily the value of the sales made to the separate categories of licensees, that is:

$$D = \sum_{i=1}^{3} d_i \; S_i$$

where:

D = total discount

d_i = discount rate allowed the i-th category of licensees

S_i = retail value of sales to the i-th category of licensees

If both D and S_i were divided by total retail sales, the resulting expression would be the overall average discount rate. Interestingly, when the overall actual average discount rate was computed for the period 1955-1966 on an annual basis, it was found to be fairly stable and just slightly above the discount rate for S.D.D.s, the dominant retailer of liquor. (See Table 17.)

TABLE 17.--Discounts as a per cent of total dollar retail sales fiscal 1955-1966.

1955--10.18	1959--10.25	1963--10.34
1956--10.22	1960--10.28	1964--10.37
1957--10.23	1961--10.29	1965--10.37
1958--10.21	1962--10.31	1066--10.39

Source: Computed from Michigan Liquor Control Commission, Financial Report for years indicated.

The total retail dollar sales, as we have seen in the previous chapter, depend in part upon price. The retail price of liquor is determined in a fairly uniform fashion. Most liquor is marked up forty-six per cent of its delivered cost to the state warehouses.[4] Basically retail price is determined according to the following formula:

$$P = C(1 + M)$$

where:

P = retail price of liquor
C = delivered cost of liquor
M = "mark-up"

Although the foregoing formula describes how the retail price is determined, it ignores the _ad valorem_ excise taxes on spirits. These were included in the price index used in the analysis in the previous chapter. It can be included in the preceding formulation quite easily along with a weighting factor. The latter is necessary since these excise taxes do not apply to spirits with less than twenty-two per cent alcohol. Thus we have:

$$P_T = C(1 + M)(1 + tw)$$

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[4]Special order items which are not found on the published "Price List" are charged a forty-eight per cent mark-up. These orders constitute a very small proportion of sales and need not be separated from the regular codes on the revenue side.

where: P_T = total price of liquor

t = excise tax rate

w = ratio of taxable liquor sales to total dollar liquor sales. $w < 1$.

This formula now gives us the basic pricing structure in the Michigan market as well as a tool for approximating price responses to parametric changes.[5] Consequently the impact of such changes can be traced through the price elasticity coefficients developed in the previous chapter and provide a measure of the response on total dollar retail sales. For example, if the question arose concerning the impact an increase in the mark-up from forty-six to fifty per cent might have on net liquor receipts, we could procede as follows. Total price would respond by increasing approximately 3.24 per cent (using the arc formula above) and consequently total retail dollar sales (excluding excise

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[5]The elasticity of total price of liquor with respect to the variables C, M or t is obtained from the following formulas if we treat w as a constant:

	point elasticity	arc elasticity
$E(P_T\ C) =$	1	1
$E(P_T\ M) =$	$\frac{M}{1 + M}$	$\frac{(M + M')/2}{1 + (M + M')/2}$
$E(P_T\ t) =$	$\frac{t\,w}{1 + tw}$	$\frac{[(t + t')/2]w}{1 + [(t + t')/2]w}$

An additional bit of information revealed by these formulae is that as long as $M > tw$, we know $E(P_T\ C) > E(P_T\ M) > E(P_T\ t)$.

taxes) would be depressed by approximately 6.29 per cent.[6] If it is assumed that there was little or no effect on the distributional parameters between the retail licensees, the net receipts of the state enterprise would be attenuated proportionately--note, actual sales need not fall since they may still increase if other factors such as increases in income offset the depressing price effect. Also note that this depressing effect does not mean that the state will necessarily lose money since it will now be getting a larger slice of a smaller pie.

We find two general determinants of the monopoly operation's receipts, namely, total retail dollar sales of liquor and the total amount of dollar discounts allowed against these sales. The former is determined by the major economic variables income and price. The price is anatomically determined by delivered cost of liquor, mark-up rates, and excise taxes. Discounts amount to the weighted average of three basic discount rates. This figure has been fairly stable with a very slight movement upward.

The costs incurred in the distribution of liquor are basically outlined in Chart II. In view of the retail pricing structure discussed above, the costs incurred in

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[6]The value of the sales elasticity with respect to price (-1.9409) is taken from equation B, Table 26 in Appendix A.

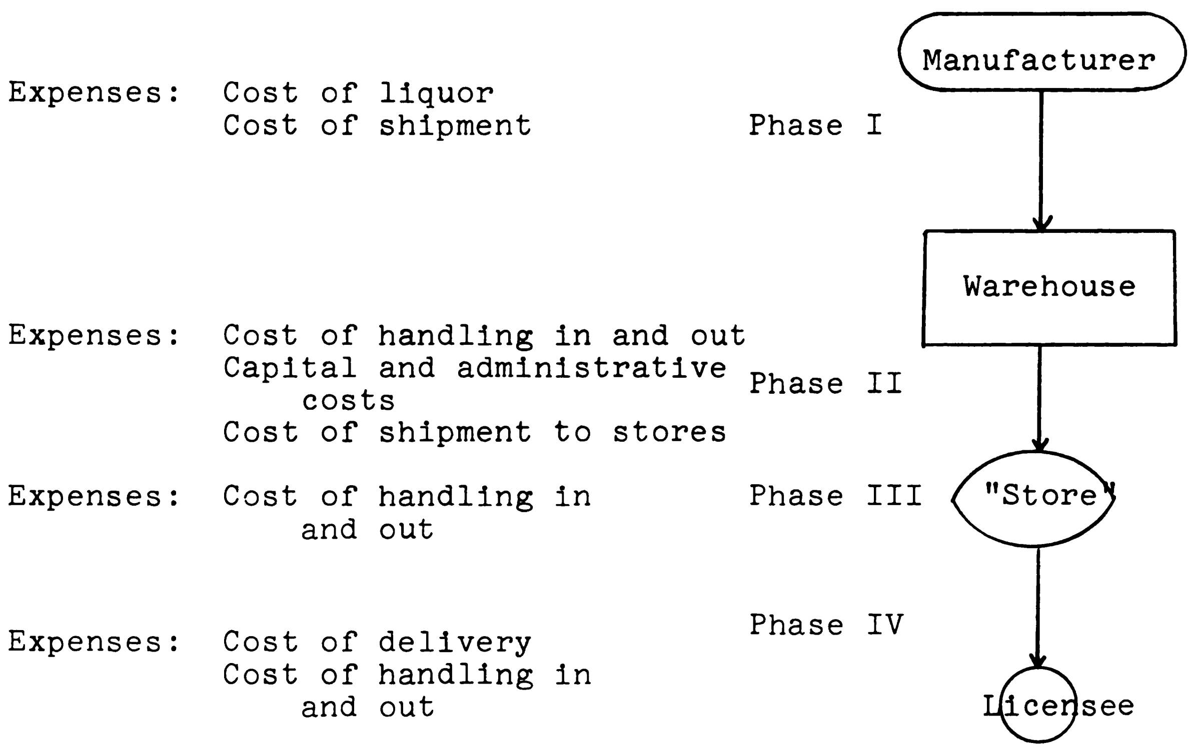

Chart II.--Flow Chart of Costs in Michigan Liquor Distribution System.

Phase I on the flow chart can be expected to bear a direct proportional relationship to total dollar retail sales. If all items were marked up forty-six per cent, the cost of liquor sold would be 68.493% of total sales. The actual mark-up during the 1955-1966 period was approximately 46.3187% or 68.344% of retail dollar sales. The slight discrepancy is attributable to the special order items mentioned above. In so far as Phase I costs form the base for price determination, they affect the absolute value of the mark-up on a particular item when they change. An increase in delivered costs, for example, increases the gross profit margin on a particular code. However, since such variations in the base cause a decrease in the value of total retail sales through the price variable, increased delivered costs would have an adverse impact on revenue. Therefore it is in the interests of the Michigan Liquor Control Commission to resist price increases from the manufacturers of liquor and attempt to keep transportation costs experienced in delivery to the warehouses at a minimum.

Costs incurred in Phases II and III of the liquor operation are relatively small in magnitude, ranging from $3.8 million in 1956 to $4.3 million in 1966. These costs are predominantly "variable" in character, that is, they are related to the physical volume of liquor sales rather than the dollar value of sales. This factor would tend to reduce the variation of such costs more than Phase I costs when price changes occur. This follows from the relatively inelastic character of the liquor price-quantity relationship identified in the foregoing chapter. These costs, which are predominantly handling costs, are strongly influenced by labor costs and the overall efficiency of the distribution system. Labor costs reflect changes in wage rates, fringe benefits, and productivity emerging from more efficient handling techniques and equipment. The overall efficiency of the system is influenced by all of the foregoing factors being integrated into an optimal combination of capital facilities and flow patterns. This optimal system must operate within the constraints and objectives set forth in the Liquor Control Act. When considering projections of these costs, changes in quantity sales, labor costs, equipment mix and any major changes in the system structure must be considered.

Merchandizing costs incurred in Phase IV are not incurred by the state except in its very limited retail operations. They are presented primarily to round out the picture of the total distributional system.

Costs of the state liquor enterprise can be broken into two major categories--the cost of the merchandise and total handling costs. The former classification is directly related to the retail dollar sales and the latter is geared to physical sales volume and input productivity and factor market conditions.

So far we have outlined the basic factors which must be considered to identify the revenue which accrues to the State of Michigan from the Liquor Purchase Revolving Fund. One key factor, however, needs to be identified before our model is complete. This is the increase in the State's equity in the liquor monopoly. This primarily consists of the net changes in the value of liquor inventories over the fiscal year. The amount of such changes directly affects the size of the transfer from the LPRF to the General Fund. While our major concern is with the market parameters and their impact on revenue through sales, the inventory variable cannot be completely ignored. Since there is not at this time a systematic inventory control policy which can be relied upon for estimating purposes, an estimate of the timing of the demand parameters in the second calendar quarter may help somewhat in estimating inventory behavior.

Gathering together the major elements of the receipt and cost factors involved in the State liquor monopoly operation in Michigan, we form the following simple LPRF transfer model:

$$LPRF_t = S - D - C_1 - C_2 - i$$

where: S = total retail value of liquor sales

D = total discounts

C_1 = cost of liquor sold

C_2 = handling costs

i = change in the value of inventories

Sales can be determined on the basis of the demand parameters with due consideration being given to any changes in cost of liquor, tax rates or mark-up policies. Discounts can be considered a function of sales unless the discount rates are altered. Cost of liquor sold can be expected to vary proportionately with sales. Cost of handling must be estimated in terms of projected quantity growth, labor costs, etc. Change in inventories may be partially projected on the basis of estimated fourth quarter timing of variation in demand parameters. This model in its simplicity performed quite well when tested against actual historical data. The major problem area, the inventory behavior, notwithstanding.[7]

Liquor Excise Taxes

Liquor excise taxes are levied on both distilled spirits and fortified wines. The former, however, are taxed on an *ad valorem* basis whereas the latter are taxed at varying rates on a physical volume base.[8] Since fortified wines constitute less than a third of the volume of wine consumed in Michigan, the amount of excise revenue

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[7]See Appendix C for a simulation of this model.

[8]Wines are taxed on a discriminatory basis. Wine made with Michigan-grown grapes receives favorable treatment vis-a-vis "imported wines."

which they bring in is relatively small, less than a half million dollars in 1966. Their revenue growth is directly proportional to their sales behavior. Thus it can be identified from the demand parameters for wine.

Currently distilled spirits are taxed at a rate of eight per cent. Half of the revenue is deposited in the State General Fund and the other half in the State School Aid Fund. Since the taxes are levied on the retail sale price of distilled spirits, their yield is determined by the rate of taxation (t) and the base, namely, total dollar retail sales of distilled spirits (S).

$$\text{Excise taxes} = tS$$

A change in the rate would directly affect the yield of the taxes and would affect it indirectly through its impact on price and ultimately retail dollar sales.

Since liquor excise is a function of retail dollar sales, it is also affected by any variation in the non-tax price parameters as well as Michigan Disposable Income--a major determinant of sales. It should be noted that due to the price elastic character of distilled spirits sales, excise tax yields would, *ceteris paribus*, be adversely affected by increases in the non-tax parameters. Excise yields would be the same proportion of a *reduced* base.[9] It

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[9]See Table 26 in Appendix A for regressions of demand parameters on retail dollar sales of distilled spirits.

is possible that the behavior of sales due to the income elasticity may outweigh and thus "hide" the loss incurred. This basic model performed very satisfactorily when tested against excise returns.[10]

From the foregoing material it is clear that liquor revenue is very intimately bound up with the movements of liquor demand. Both Michigan's liquor monopoly profits and excise yields are directly determined by the liquor demand parameters. The information generated by the demand analysis throws some light on the implications changes in policy parameters and the demand variables have on state revenue as well as statewide alcoholic beverage consumption patterns. While there is room for more extensive study of some of the areas of the alcoholic beverage market, at least some of the guesswork associated with liquor demand and liquor revenue has been removed.

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[10]See Appendix C for a simulation of this model.

APPENDIX A

Selected Regression Equations and Elasticities

TABLE 18.--Liquor demand equations linear composite.

Q"	Equation A	Equation B	Equation C	Equation D
a +	940.6116*	1023.7034	1222.8383	823.4495
b_1 D(1) +	81.5176*	81.5063*	81.6317*	81.8226*
b_2 D(2) +	59.1982*	59.3614*	59.3088*	58.8039*
b_3 D(3) +	399.0421*	399.0184*	397.2113*	395.8405*
b_4 P +	-788.9509*	-848.2443 (448.96)	-1088.8320*	-806.6426 (463.27)
b_5 Y +	0.1922*	0.1880*	0.1891*	0.2197*
b_6 O +			-0.1400 (0.1612	-0.2611 (0.2027)
b_7 C +				
b_8 B +			694.4514 (703.93)	1278.1402 (919.92)
b_9 T		0.3941 (2.1881)		-3.0929
$\bar{R}^2$	0.9658	0.9649	0.9653	0.9652
D.W.	2.1117	2.0995	2.1386	2.2659
F. Sig (overall Regression)	0.000	0.0005	0.0005	0.0005

*Coefficient significant at the .995 level or above.

TABLE 19.--Liquor demand equations linear composite using relative price and real income.

Q =	Equation A	B	C	D
a	970.3651	833.8587	284.7213	284.2710
+ b_1 D(1)	81.8500*	82.3432*	83.8862*	83.8841*
+ b_2 D(2)	59.0273*	59.1962*	61.3029*	61.3076*
+ b_3 D(3)	309.6646*	309.5708*	397.5920*	397.5914*
+ b_4 P/C	-841.9787 (339.32)	-750.8514 (302.71)	-943.8154 (413.03)	-945.4149 (477.79)
+ b_5 Y/C	0.2015*	0.2140*	0.2079*	0.2078*
+ b_6 O			-0.0015 (0.20)	-0.0013 (0.21)
+ b_7 B/C			769.1917 (745.19)	771.3802 (818.57)
+ b_8 T		-0.5395 (1.13)		0.0087 (1.25)
$\bar{R}^2$	0.9669	0.9653	0.9655	0.9645
D.W.	2.1162	2.1543	2.1919	2.1915
F Sig (overall regression)	0.000	0.0005	0.0005	0.0005

*Coefficient significant at the .995 level or above.

TABLE 20.--Liquor demand equations linear per-capita composite.

Q =	Equation A	Equation B	Equation C[1]	Equation D[1]
a	0.2098*	0.2256	0.1966	0.1621
+ b_1 D(1)	0.0177*	0.0177*	0.0178*	0.0179*
+ b_2 D(2)	0.0128*	0.0128*	0.0128*	0.0128*
+ b_3 D(3)	0.0866*	0.0866*	0.0866*	0.0865*
+ b_4P	-0.1715*	-0.1842 (0.0992)	-0.1663 (0.0716)	-0.1458 (0.0782)
+ b_5 Y/O	0.1889*	0.1847*	0.1979*	0.2159*
+ b_6 T		0.0001		-0.0002
$\bar{R}^2$	0.9632	0.9622	0.9635	0.9630
D.W.	2.0963	2.0853	2.1237	2.1796
F Sig. (Overall regression)	0.000	0.0005	0.000	0.0005

*Coefficient significant at the .995 level or above.

[1]Relative price and "real" income statistics used.

TABLE 21.--Liquor demand equations log-linear composite.

ln Q	Equation A	Equation B	Equation C	Equation D
a	0.0483*	0.1762	4.8208	7.6959
+ b_1 D(1)	0.0846*	0.0846*	0.0846*	0.0849*
+ b_2 D(2)	0.0564*	0.0564*	0.0567*	0.0561*
+ b_3 D(3)	0.3531*	0.3532*	0.3514*	0.3499*
+ b_4 ln P	-0.9251* (0.2311)	-0.9746 (0.4380)	-1.2687* (0.3509)	-0.9807 (0.4472)
+ b_5 ln Y	0.8196*	0.8039*	0.7817*	0.9362*
+ b_6 ln B			-0.5272 (0.6530)	-1.0160 (0.8049)
+ b_7 ln O			0.8065 (0.6614)	1.3232 (0.8276)
+ b_8 T		0.0003 (0.0022)		-0.0032 (0.0030)
$\bar{R}^2$	0.9627	0.9617	0.9624	0.9625
D.W.	2.5363	2.5217	2.5459	2.7281
F Sig. (overall regression)	0.0005	0.0005	0.0005	0.0005

*Coefficient significant at the .995 level or above.

TABLE 22.--Liquor demand equations log-linear composite using relative price and real income.

ln Q	Equation A	Equation B	Equation C	Equation D
a +	0.2160	-0.1389	-0.5433	-0.3992
b_1 D(1) +	0.0843*	0.0847*	0.0867*	0.0866*
b_2 D(2) +	0.0563*	0.0564*	0.0590*	0.0592*
b_3 D(3) +	0.3534*	0.3532*	0.3522*	0.3522*
b_4 ln P/C +	-0.8713 (0.3242)	-0.8075 (0.3665)	-0.9881 (0.3966)	-1.0549 (0.4562)
b_5 ln Y/C +	0.7991*	0.8423*	0.8245*	0.7880*
b_6 ln O +			0.0651 (0.8390)	0.0834 (0.8518)
b_7 ln B/C +			0.8850 (0.6866)	0.9860 (0.8794)
b_8 T		-0.0004 (0.0011)		0.0004 (0.0012)
$\bar{R}^2$	0.9624	0.9616	0.9626	0.9616
D.W.	2,5307	2.5679	2.6301	2.6092
F Sig. (overall regression)	0.000	0.0005	0.000	0.0005

*Coefficient significant at the .995 level or above.

TABLE 23.--Liquor demand equations log-linear per-capita composite.

ln Q/O	Equation A	Equation B	Equation C[1]	Equation D[1]
a	-1.4746*	1.4784*	1.4843*	-1.4680*
+ b_1 D(1)	0.0845*	0.0844*	0.0844*	0.0849*
+ b_2 D(2)	0.0567	0.0568*	0.0568*	0.0568*
+ b_3 D(3)	0.3534*	0.3534*	0.3538*	0.3535*
+ b_4 ln P	-0.9205* (0.2353)	-0.9570 (0.4509)	-0.7940 (0.3201)	-0.7251 (0.3438)
+ b_5 ln Y/O	0.8061*	0.7928*	0.7872*	0.8536*
b_6 T		0.0002 (0.0024)		-0.0006 (0.0010)
$\bar{R}^2$	0.9595	0.9584	0.9591	0.9584
D.W.	2.5047	2.4933	2.5133	2.5712
F Sig.	0.0005	0.0005	0.0005	0.0005

*Coefficient significant at the .995 level or above.

[1]Relative price and "real" income statistics used.

TABLE 24.--Liquor demand equations linear composite using average price.[1]

Q "	Equation A	Equation B	Equation C	Equation D
a	392.1310	507.5150	1276.6269	714.4820
+ b_1 D(1)	84.1163*	88.3219*	85.4874*	91.3784*
+ b_2 D(2)	61.5341*	64.4310*	61.5359*	65.4610*
+ b_3 D(3)	412.4062*	430.1795*	418.6920*	436.8782*
+ b_4 AP	-4.0255	-11.1737	-6.1664	-15.4019
	(7.4209)	(7.0750)	(7.3693)	(7.0886)
+ b_5 Y	0.1707*	0.2416*	0.2065*	0.2996*
+ b_6 O			0.0109	-0.4174
				(0.1989)
+ b_7 B			-970.8817	1756.0345
			(510.78)	(935.39)
b_8 T		-3.7670		-8.6058
$\bar{R}^2$	0.9556	0.9639	0.9575	0.9667
D.W.	1.6767	1 1.9627	0.8398	2.2157
F Sig. (overall regression)	0.0005	0.0005	0.0005	0.0005

*Coefficient significant at the .995 level or above.

[1]Average price is used here to mean the average final price inclusive of all excise taxes.

TABLE 25.--Gross dollar sales regressed on demand parameters of liquor and distilled spirits.[1]

Equation: S =	Liquor A	Liquor B[2]	Distilled spirits A	Distilled spirits B[2]
a +	46010.852*	7.5845*	43840.488*	7.4769*
b_1 D(1) +	4479.616*	0.0976*	4561.472*	0.1030*
b_2 D(2) +	3290.920*	0.0675*	3236.668*	0.0697*
b_3 D(3) +	22399.138*	0.4104(	22181.462*	0.4217*
b_4 P +	-44589.810*	-1.0863*	-43047.932*	-1.0731*
	(12537.28)	(0.260)	(12227.154)	(0.263)
b_5 Y	10.559*	0.9303*	10.308*	0.9386*
	(0.61)	(0.055)	(0.647)	(0.061)
$\bar{R}^2$	0.9667	0.9642	0.9600	0.9566
F Sig. (overall regression)	0.000	0.0005	0.0005	0.0005

*Coefficient significant at the .995 level or above.

[1]Gross dollar sales include all excise taxes.

[2]Logarithmic form of the equation:

$$\ln S = a + b_1 D(1) + b_2 D(2) + b_3 D(3) + b_4 \ln P + b_5 \ln Y.$$

TABLE 26.--Retail dollar sales regressed on demand parameters of liquor and distilled spirits.[1]

Equation:	Liquor		Distilled Spirits	
S =	A	B[2]	A	B_2
a +	84243.137*	2.9828*	78742.859*	7.4738*
b_1 D(1) +	4316.475*	0.0987*	4382.835*	0.1042*
b_2 D(2) +	3086.109*	0.0676*	3141.417*	0.0721*
b_3 D(3) +	21291.359*	0.4099*	21071.151*	0.4217*
b_4 P +	-79619.659*	-1.9404*	-74843.282*	-1.8815
	(11424.81)	(0.250)	(11293.81)	(0.259)
b_5 Y	9.854*	0.9306*	9.617*	0.9395*
	(0.56)	(0.053)	(0.70)	(0.060)
$\bar{R}^2$	0.9670	0.9643	0.9594	0.9553
F Sig. (overall regression)	0.0005	0.0005	0.0005	0.0005

*Coefficient significant at the .995 level or above.

[1]Total dollar sales excluding ad valorem excise taxes.

[2]Logarithmic form of the equation:

$$\ln S = a + b_1 D(1) + b_2 D(2) + b_3 D(3) + b_4 \ln P + b_5 \ln Y.$$

TABLE 27.--Distilled spirits demand equations.

Q "	Equation A	Equation B	Equation C[1]	Equation D[1]
a	14845.477*	2388.631	4.3922*	-5.6836
+		(17247.63)		(11.312)
b_1 D(1)	244.249	238.147	0.0506	0.0499
+	(316.032)	(322.04)	(0.030)	(0.031)
b_2 D(2)	221.258	224.498	0.0395	0.0401
+	(316.348)	(322.83)	(0.030)	(0.031)
b_3 D(3)	3416.985*	3411.424*	0.3663*	0.3658*
+				
b_4 P	-15658.368*	-18174.728	-1.9054*	-2.1985*
+	(4112.18)	(6373.42)	(0.429)	(0.635)
b_5 Y	2.344*	1.988*	1.1161*	0.9236*
+				
b_6 O		1.520		0.7511
+		(3.16)		(1.313)
b_7 B		95.089		1.1614
		(155.32)		(1.534)
$\bar{R}^2$	0.8881	0.8609	0.8881	0.8850
F Sig. (overall regression)	0.0005	0.0005	0.0005	0.0005

*Coefficient significant at the .995 level or above.

[1]Logarithmic form of the equation:

$$\ln Q = a + b_1\, D(1) = b_2\, D(2) + b_3\, D(3) +$$

$$b_4 \ln P + b_5 \ln Y + b_6 \ln O + b_7 \ln B.$$

TABLE 28.--Component price and income elasticity coefficients.

Category	Price linear	Price logarithmic	Income linear	Income logarithmic
		same equation[1]		
Blends	-2.3147 (0.317)	-2.3478 (0.351)	0.3894 (0.072)	0.4495 (0.086)
Bourbon	-0.7751 (0.272)	-0.9265 (0.304)	0.9591 (0.051)	1.0184 (0.061)
Canadian	-2.6708 (0.477)	-2.8447 (0.411)	1.4543 (0.093)	1.4671 (0.087)
Scotch	-0.7116 (0.362)	-0.6048 (0.405)	2.0933 (0.066)	2.0673 (0.080)
Gin	-1.8863 (0.362)	-2.0838 (0.306)	1.0236 (0.070)	1.1007 (0.066)
Vodka	+2.4252 (0.734)	+4.4548 (1.237)	1.6328 (0.142)	1.4038 (0.277)
Brandy	-0.3655 (0.231)	-0.3730 (0.275)	1.3384 (0.058)	1.3716 (0.075)
Cordials	-1.2576 (0.396)	-1.4576 (0.414)	1.4171 (0.085)	1.4800 (0.096)
Rum	+0.1101 (0.549)	+0.1520 (0.535)	1.7604 (0.104)	1.7669 (0.109)
Wine	+6.9709 (1.649)	+7.1922 (1.863)	0.1900 (0.123)	0.2273 (0.147)
		coefficient of best fit equation[2]		
Wine	-8.5311 (1.661)	-8.0723 (1.824)	-1.0324 (0.129)	-1.3252 (0.174)
		most significant coefficient[2]		
Scotch	-1.2447 (0.524)	-1.6809 (0. 534)		
Brandy	-1.1591 (0.353)	-1.3553 (0.400)		
Rum	-0.7687 (0.747)	-1.0518 (0.654)		
Wine	-8.5311 (1.661)	-8.0723 (1.824)	-1.0324 (0.129)	-1.3252 (0.174)

[1]Basic equation(s) being: $(\ln Q = a + b_1\ D(1) + b_2\ D(2) + b_3\ D(3) + b_4\ (\ln)P + b_5\ (\ln)Y$.

[2]Coefficients exactly the same as those in "same equation" category except for coefficients indicated.

TABLE 29.--Liquor demand equations for sub-categories linear hypothesis.

Equation: Q =	Blends	Bourbons	Canadian	Scotch	Gin
a	1190744.6003*	61104.7692	161685.9959*	-36237.1898	144828.2528*
+ b_1 D(1)	37589.5000*	4393.9974	10129.2027*	7711.6129*	24120.5665*
+ b_2 D(2)	7882.6794	2509.2574	5085.0036	7584.4437*	45411.0464*
+ b_3 D(3)	173176.5061*	39745.6174*	55100.0430*	31756.9066*	26611.2971*
+ b_4 P	-915666.7181*	-65259.1771 (22906.2)	-202805.8579*	-43036.4611 (21872.09)	-159625.5849*
+ b_5 Y	38.2902*	19.7554*	27.1704*	31.0081*	21.4287*
$\bar{R}^2$	0.9067	0.9693	0.9543	0.9818	0.9279
D.W.	1.4570	1.7025	1.4346	1.9124	1.4213
F. Sig. (overall regression)	0.000	0.0005	0.000	0.0005	0.000

*Coefficient significant at the .995 level or above.

TABLE 30.--Liquor demand equations for sub-categories linear hypothesis.

Equation: Q =	Vodka	Brandy	Cordials Liqueurs	Rum	Wines
a +	-173429.2246*	-944.6761	11195.8668	-11957.5360	-1049705.1339*
b_1 D(1) +	7564.3203*	-833.2373	-3528.5395*	973.7036*	8582.4787
b_2 D(2) +	10435.4792*	-2025.7805*	-4796.6970*	2356.4026*	-3553.6210
b_3 D(3) +	16253.8838*	8816.8475*	19600.9298*	5927.3127*	12383.1669
b_4 P	122768.6708*	-6785.8949 (4286.8)	-31219.1278 (18745.4)	1159.5410 (5779.4)	1156717.5144*
b_5 Y	20.3220*	6.2213*	13.1097*	4.5043*	7.4477 (4.7749)
$\overline{R}^2$	0.9067	0.9808	0.9679	0.9676	0.6227
D.W.	0.8963	1.6060	1.9024	1.9617	0.6254
F Sig. (overall regression)	0.000	0.0005	0.0005	0.0005	0.0005

*Coefficient significant at the .995 level or above.

TABLE 31.--Liquor demand equations for sub-categories log-linear hypothesis

Equations: lnQ =	Blends	Bourbons	Canadian	Scotch	Gin
a +	9.2298*	2.7857*	-1.0505	-6.4445*	2.0351*
b_1 D(1) +	0.1007*	0.0567	0.1518*	0.1507*	0.3102*
b_2 D(2) +	0.0254	0.0255	0.0726	0.1437*	0.5214*
b_3 D(3) +	0.3869*	0.4166*	0.6296*	0.4980*	0.3354*
b_4 lnP +	-2.3478*	-0.9265*	-2.8447*	-0.6048 (0.405)	-2.0838*
b_5 lnY	0.4495*	1.0184*	0.4671*	2.0673*	1.1007*
$\bar{R}^2$	0.8806	0.9595	0.9695	0.9754	0.9488
D.W.	1.5467	2.0274	1.0499	0.6919	1.3286
F. Sig.	0.0005	0.0005	0.0005	0.0005	0.000

Coefficient significant at the .995 level or above.

TABLE 32.--Liquor demand equations for sub-categories log-linear hypothesis.

Equations: lnQ "	Vodka	Brandy	Cordials Liqueurs	Rum	Wines
a +	-1.3606	-1.6265	-1.8653	-5.7394*	9.9474*
b_1 D(1) +	0.1721	-0.0421	-0.1024*	0.0994*	0.0488
b_2 D(2) +	0.2002	-0.1284*	-0.1612*	0.2275*	-0.0289
b_3 D(3) +	0.3033*	0.3946*	0.4654*	0.5253*	0.0734
b_4 lnP +	4.4548*	-0.3730 (0.275)	-1.4576*	0.1520 (0.535)	7.1922* (1.863)
b_5 lnY	1.4038*	1.3716*	1.4800*	1.7669*	0.2273 (0.147)
$\bar{R}^2$	0.7934	0.9710	0.9609	0.9689	0.6212
D.W.	0.4960	2.0072	2.0033	1.7479	0.6000
F. Sig. (overall regression)	0.0005	0.0005	0.000	0.0005	0.0005

*Coefficient significant at the .955 level or above.

TABLE 33.--Component demand equations blended whiskey log-linear hypothesis.

Equation: lnQ	A	B[2]	C[1]	D[1,2]
a	0.6081*	7.6302	1.5167	4.7692*
+ b_1 D(1)	0.1011*	0.1082*	0.1003*	0.1034*
+ b_2 D(2)	0.0235	0.0306	0.0267	0.0240
+ b_3 D(3)	0.3853*	0.3825*	0.3873*	0.3853*
+ b_4 ln P	-1.2312 (0.618)	-1.1495 (0.607)	-2.2757*	-0.5039 (0.512)
+ b_5 ln Y	0.8949*	0.9997*	0.3624*	1.1683*
+ b_6 ln B		2.4830 (1.224)		
+ b_7 ln O		-0.3447 (1.337)		
+ b_8 T	-0.0082 (0.004)	-0.0085*		-0.0113*
$\bar{R}^2$	0.8910	0.9048	0.8745	0.8932
D.W.	1.7703	2.0843	1.4805	1.8999
F. Sig. (overall regression)	0.0005	0.0005	0.0005	0.0005

*Coefficient significant at the .955 level or above.

[1]Per capita income and quantity variables.

[2]Relative price and "real" income variables.

TABLE 34.--Component demand equations bourbon whiskey log-linear hypothesis.

Equation: lnQ	A	B_2	C^1	$D^{1,2}$
a +	3.3882	-4.6113	-2.9508*	2.9358*
b_1 D(1) +	0.0565	0.0645*	0.0563	0.0583*
b_2 D(2) +	0.0257	0.0363	0.0268	0.0274
b_3 D(3) +	0.4167*	0.4155*	0.4179*	0.4171*
b_4 ln P +	-1.1196 (0.483)	-0.9606 (0.453)	-0.8575 (0.9342)	-0.6589 (0.397)
b_5 ln Y +	0.9442*	0.8978*	0.9342*	1.0760*
b_6 ln B +		2.8880*		
b_7 ln O +		0.9899 (0.973)		
b_8 T	0.0013 (0.002)	0.0019 (0.001)		
$\bar{R}^2$	0.9587	0.9675	0.9523	0.9581
D.W.	2.0128	2.4102	0.8200	2.1096
F. Sig. (overall regression)	0.0005	0.0005	0.0005	0.000

*Coefficient significant at the .995 level or above.

[1]Per capita income and quantity variables.

[2]Relative price and "real" income variables.

TABLE 35.--Component demand equations Canadian whiskey log-linear hypothesis.

Equation: ln Q "	A^2	B^2	C^1	$D^{1,2}$
a +	-4.9296*	-22.0876	-14.0361*	3.0452*
b_1 D(1) +	0.1521*	0.1546*	0.1514*	0.1513*
b_2 D(2) +	0.0716*	0.0782*	0.0721*	0.0696
b_3 D(3) +	0.6285*	0.6312*	0.6307*	0.6269*
b_4 ln P +	-1.9053*	-1.4775 (0.609)	-0.9977 (0.544)	-2.2990*
b_5 ln Y +	1.9454*	1.7843*	2.0287*	1.9176*
b_6 ln B +		0.9509 (1.151)		
b_7 ln O +		2.1892 (1.235)		
b_8 T	-0.0079*	-0.0075*	-0.0117*	-0.0071*
$\bar{R}^2$	0.9712	0.9721	0.9733	0.9671
D.W.	1.5824	1.7107	0.9518	0.4116
F. Sig. (overall regression)	0.0005	0.0005	0.0005	0.0005

*Coefficient significant at the .995 level or above.

[1]Per capita income and quantity variables.

[2]Relative price and "real" income variables.

TABLE 36.--Component demand equations Scotch whiskey log-linear hypothesis.

Equation: ln Q =	A	B^2	C^1	$D^{1,2}$
a +	-3.0909	-4.7771*	-10.2283*	2.4564*
b_1 D(1) +	0.1478*	0.1538*	0.1469*	0.1537*
b_2 D(2) +	0.1427*	0.1471*	0.1439*	0.1451*
b_3 D(3) +	0.4981*	0.4999*	0.4993*	0.4981*
b_4 ln P +	-1.6809*	-0.7209 (0.496)	-1.8533*	1.9586*
b_5 ln Y +	1.6544*	1.8546*	1.4965*	0.9586*
b_6 T	0.0072 (0.003)	0.0059	0.0086*	0.0056*
$\bar{R}^2$	0.9792	0.0911	0.9747	0.9819
D.W.	1.8386	2.1833	0.5741	2.3793
F. Sig. (overall regression)	0.0005	0.0005	0.0005	0.0005

*Coefficient significant at the .995 level or above.

[1]Per capita income and quantity variables.

[2]Relative price and "real" income variables.

TABLE 37.--Component demand equations gin log-linear hypothesis.

Equation: ln Q =	A	B^2	C^1	$D^{1,2}$
a +	1.0951	28.6107*	-5.7602*	3.0016*
b_1 D(1) +	0.3103*	0.3123*	0.3097*	0.3137*
b_2 D(2) +	0.5210*	0.3123*	0.3097*	0.3138*
b_3 D(3) +	0.3351*	0.3312*	0.3364*	0.3351*
b_4 ln P +	-1.8716*	-1.2587*	-2.0752*	-0.7853 (0.428)
b_5 ln Y +	1.2163*	1.8601*	1.0247*	1.6974*
b_6 ln B +		-0.7166 (0.979)		
b_7 ln O +		-3.8915*		
b_8 T	-0.0018 (0.003)	0.0062*		-0.0066*
$\bar{R}^2$	0.9481	0.9649	0.9375	0.9522
D.W.	1.3642	2.1536	1.1681	1.7693
F. Sig. (overall regression)	0.0005	0.0005	-0.000	0.0005

*Coefficient significant at the .995 level or above.

[1]Per capita income and quantity variables.

[2]Relative price and "real" income variables.

TABLE 38.--Component demand equations vodka log-linear hypothesis

Equation: ln Q "	A	B^2	C^2	$D^{1,2}$
a	8.6759	17.8476*	-112.6384*	1.4705*
+ b_1 D(1)	0.1703	0.1518	0.1816*	0.1511
+ b_2 D(2)	0.2069	0.2003*	0.2624*	0.2033*
+ b_3 D(3)	0.3038*	0.2974*	0.3131*	0.3118*
+ b_4 ln P	0.6208 (1.947)	-4.4019 (1.523)	-1.9251 (1.164)	-4.0091 (1.373)
+ b_5 ln Y	0.1666 (0.568)	-0.9311 (0.498)	-2.3959*	-1.2924 (0.494)
+ b_6 ln B			11.5757*	
+ b_7 ln O			16.8807*	
+ b_8 T	0.0242 (0.010)	0.0353*	0.0410*	0.0367*
$\bar{R}^2$	0.8175	0.8520	0.9371	0.8613
D.W.	0.3433	0.3917	1.0189	0.4423
F. Sig. (overall regression)	0.0005	0.0005	0.0005	0.0005

*Coefficient significant at the .995 level or above.

[1]Per capital income and quantity variables.

[2]Relative price and "real" income variables.

TABLE 39.--Component demand equations brandy log-linear hypothesis.

Equation: $\ln Q$ =	A	B^2	C^2	$D^{1,2}$
a +	1.6415	1.1665	-0.4909	1.4074*
b_1 D(1) +	-0.0444*	-0.0442*	-0.0387	-0.0040
b_2 D(2) +	-0.1291*	-0.1290*	-0.1208*	-0.1289*
b_3 D(3) +	0.3957*	0.3956*	0.3948*	0.3955*
b_4 ln P +	-1.3553*	-1.1276 (0.410)	-1.2038*	-1.1081
b_5 ln Y +	0.9693*	1.0280*	0.9167*	1.0518*
b_6 ln B +			2.2779 (0.927)	
b_7 ln O +			0.8959 (0.956)	
b_8 T	0.0077*	0.0062*	0.0075*	0.0060* (0.397)
$\bar{R}^2$	0.9765	0.9761	0.9787	0.9749
D.W.	2.2837	2.2829	2.4840	2.2926
F. Sig. (overall regression)	0.0005	0.0005	0.0005	0.0005

*Coefficient significant at the .995 level or above.

[1]Per capita income and quantity variables.

[2]Relative price and "real" income variables.

TABLE 40.--Component demand equations cordials and liqueurs log-linear hypothesis.

Equation: ln Q =	A	B^2	$C^{1,2}$	$D^{1,2}$
a +	-1.2035	1.7345	2.1593*	2.2965*
b_1 D(1) +	-0.1025*	-0.0935*	-0.0998*	-0.0983*
b_2 D(2) +	-0.1599*	-0.1524*	-0.1596*	-0.1593
b_3 D(3) +	0.4655*	0.4624*	0.4663*	0.0654*
b_4 ln P +	-1.7095 (0.756)	-1.2912 (0.600)	-0.8640 (1.521)	-0.6751 (0.555)
b_5 ln Y +	1.3986*	1.6669*	1.5781*	1.7688*
b_6 ln B +		2.4650 (1.151)		
b_7 +		-0.6139 (1.367)		
b_8 T	0.0016 (0.004)			-0.0018 (0.002)
$\bar{R}^2$	0.9600	0.9678	0.9628	0.9628
D.W.	1.9962	2.5621	2.2197	2.3256
F. Sig. (overall regression)	0.0005	0.0005	0.0005	0.0005

*Coefficient significant at the .995 level or above.

[1]Per capita income and quantity variables.

[2]Relative price and "real" income variables.

TABLE 41.--Component demand equations rum log-linear hypothesis.

Equation: ln Q "	A	B^2	$C^{1,2}$	$D^{1,2}$
a	-2.9265	24.8609	0.8452*	0.6095*
+ b_1 D(1)	0.0940*	0.0928*	0.1003*	0.0996*
+ b_2 D(2)	0.2261*	0.2125*	0.2255*	0.2287*
+ b_3 D(3)	0.5251*	0.5184*	0.5253*	
+ b_4 ln P	-1.0518 (0.654)	-1.0808 (0.700)	-0.8534 (0.628)	-0.5624 (0.501)
+ b_5 ln Y	1.4187*	2.4510*	2.3104*	1.5950*
b_6 ln B		-2.6225		
+	(1.242)			
b_7 ln O	-4.2938*			
+ b_8 T	0.0071 (0.003)			0.0071*
$\bar{R}^2$	0.9737	0.9675	0.9621	0.9763
D.W.	1.8641	0.7124	1.4136	2.2359
F. Sig. (overall regression)	0.0005	0.0005	-0.000	0.0005

*Coefficient significant at the .995 level or above.

[1]Per capita income and quantity variables.

[2]Relative price and "real" income variables.

TABLE 42.--Component demand equations wine log-linear hypothesis.

Equation: ln Q "	A	B^2	C^1	$D^{1,2}$
a	22.5389*	9.9509	14.8903*	3.0250*
+ b_1 D(1)	0.0748*	0.0619	0.0730*	0.0581
+ b_2 D(2)	-0.0160	-0.0172	-0.0150	-0.0193
+ b_3 D(3)	0.0820*	0.0794	0.0833*	0.0825*
+ b_4 ln P	-8.0723*	-0.4386 (2.105)	-7.3294*	1.0288 (0.686)
+ b_5 ln Y	-1.3252*	-1.0245*	-1.4204*	-1.0668*
+ b_6 ln B		1.7947 (2.034)		
+ b_7 ln O		1.2082		
+ b_8 T	0.0318*	0.0180*	0.0315*	0.0194*
$\bar{R}^2$	0.8940	0.8324	0.8845	0.8329
D.W.	1.6545	0.9946	1.6304	1.0360
F. Sig. (overall regression)	0.0005	0.0005	0.0005	0.0005

*Coefficient significant at the .995 level or above.

[1]Per capita income and quantity variables.

[2]Relative price and "real" income variables.

APPENDIX B

Selected Time Series Data

TABLE 43.--Total case sales of liquor in Michigan 1955-1966.

Year	Quarter			
	I	II	III	IV
1955			883,786	1,296,228
1956	864,155	924,440	932,176	1,287,689
1957	901,642	1,022,389	829,412	1,221,741
1958	818,798	915,073	883,291	1,173,887
1959	866,059	953,285	892,379	1,246,693
1960	905,734	1,047,623	950,093	1,288,134
1061	867,950	906,437	988,333	1,304,749
1962	902,387	1,003,855	979,110	1,349,146
1963	937,106	1,044,483	1,052,688	1,398,224
1964	1,027,277	1,073,845	1,183,855	1516,229
1965	1,110,514	1,190,193	1,269,967	1,672,612
1966	1,187,639	1,298,549		

Source: Michigan Liquor Control Commission, *Financial Report*, 1955-1966.

TABLE 44.--Gross dollar sales of liquor in Michigan 1955-1966.

Year	Quarter			
	I	II	III	IV
1955			41,644,466	63,964,689
1956	40,353,647	43,314,895	44,010,852	63,347,308
1957	42,302,584	48,847,318	38,543,202	59,379,094
1958	36,658,220	40,436,881	39,310,550	54,840,899
1959	38,394,078	42,498,478	40,451,977	59,101,265
1960	40,891,479	46,648,973	42,352,978	59,567,685
1961	36,687,551	38,954,270	43,755,890	60,546,508
1962	39,373,982	45,693,536	42,723,471	61,731,971
1963	40,465,294	45,381,908	46,000,919	64,384,371
1964	44,616,159	50,917,996	52,389,234	70,724,141
1965	49,361,819	53,422,096	57,202,808	79,555,124
1966	53,793,191	59,324,178		

Source: Michigan Liquor Control Commission, <u>Financial Report</u>, 1955-1966.

TABLE 45.--Composite liquor price index in Michigan 1955-1966. (100=1955)

Year	Quarter			
	I	II	III	IV
1955			100.000	100.008
1956	100.008	100.360	100.360	100.469
1957	100.469	101.874	105.391	105.564
1958	105.564	105.454	105.454	105.022
1959	105.022	105.284	105.284	105.326
1960	108.754	108.714	108.714	108.651
1961	109.738	109.694	106,376	106.322
1962	106.322	106,372	109.704	109.640
1963	109.640	109.629	109.629	109.904
1964	109.904	109.802	109.802	109.666
1965	109.666	109.679	109.679	109.606
1066	109.606	109.837		

Sources: Michigan Liquor Control Commission, Financial Report, 1955-1966; Michigan Liquor Control Commission, Retail Price List, 1955-1966.

TABLE 46.--Total case sales of distilled spirits in Michigan 1955-1966.

Year	Quarter			
	I	II	III	IV
1955			773,844	1,156,667
1956	734,002	792,824	808,021	1,146,602
1957	769,772	883,805	698,860	1,064,242
1958	663,661	732,580	717,295	995,871
1959	701,938	778,604	747,842	1,072,297
1960	748,015	857,061	786,486	1,115,593
1961	712,381	734,677	817,125	1,119,061
1962	732,296	851,349	797,411	1,141,689
1963	752,971	847,607	862,405	1,194,181
1964	830,103	852,599	1,000,180	1,315,165
1965	920,463	1,003,699	1,079,497	1,484,754
1966	1,005,213	1,115,942		

Source: Michigan Liquor Control Commission, Financial Report, 1955-1966.

TABLE 47.--Gross dollar sales of distilled spirits in Michigan 1955-1966.

Year	Quarter			
	I	II	III	IV
1955			40,360,060	62,347,980
1956	38,891,910	41,840,740	42,743,180	61,689,570
1957	40,758,820	47,283,480	37,077,120	57,528,040
1958	34,929,810	38,412,980	37,469,070	52,725,890
1959	36,555,320	40,557,950	38,831,830	57,026,490
1960	39,060,600	46,433,050	40,479,260	57,517,860
1961	34,892,300	37,032,690	41,889,080	58,391,880
1962	37,462,090	43,562,050	40,702,260	59,451,390
1963	38,425,600	43,214,580	43,900,160	62,037,670
1964	42,432,160	48,584,000	50,211,990	68,417,600
1965	47,240,580	51,341,520	55,253,120	77,379,190
1066	51,663,250	57,484,200		

Source: Michigan Liquor Control Commission, Financial Report, 1955 - 1966.

TABLE 48.--Distilled spirits price index for Michigan 1955-1966 (100 = 1955).

Year	Quarter			
	I	II	III	IV
1955			100.000	100.009
1956	100.009	100.281	100.281	100.385
1957	100.385	102.012	106.092	106.297
1958	106.297	106.280	106.280	105.745
1959	105.745	105.579	105.579	105.629
1960	109.691	109.643	109.643	109.567
1961	110.582	110.527	106.408	106.342
1962	106.342	106.404	110.496	110.418
1063	110.418	110.404	110.404	110.741
1064	110.741	110.614	110.614	110.452
1965	110.452	110.468	110.468	110.382
1966	110.382	110.535.		

Sources: Michigan Liquor Control Commission, Financial Report, 1955-1966; Michigan Liquor Control Commission, Retail Price List, 1955-1966.

TABLE 49.--Michigan Disposable Income[1] 1955-1966. (Millions of dollars.)

Year	Quarter I	Quarter II	Quarter III	Quarter IV
1955			3593.9	3668.4
1956	3603.6	3616.6	3669.3	3800.1
1957	3788.1	3743.6	3752.6	3739.7
1958	3690.2	3633.7	3786.0	3760.1
1959	3805.6	3952.0	3949.9	3954.1
1960	4097.7	4089.6	4084.5	4023.3
1961	3941.0	4037.1	4067.2	4194.1
1962	4180.7	4277.9	4321.4	4433.1
1963	4488.5	4547.0	4626.1	4811.0
1964	4920.8	5027.7	5133.0	5183.0
1965	5422.8	5578.1	5659.0	4920.1
1966	5899.8	6012.0		

[1]Michigan Disposable Income figure is arrived by by deducting Michigan Personal Income Taxes from Michigan Personal Income.

Sources: Direct correspondence, Regional Economics Division, Office of Business Economics, U.S. Department of Commerce, June 20, 1967; U. S. treasury Department, Internal Revenue Service, Individual Income Tax Returns, selected years

TABLE 50.--Consumer Price Index Detroit 1955-1966 (100 = 1957-1959).

Year	Quarter			
	I	II	III	IV
1955			94.7	94.6
1956	94.5	95.7	97.2	96.5
1957	98.0	98.9	99.7	99.9
1958	100.4	100.8	100.5	100.0
1959	100.0	100.1	100.8	100.8
1960	100.4	101.0	101.9	101.9
1961	102.3	101.9	101.7	101.4
1962	101.7	102.0	102.3	102.6
1963	102.6	102.7	103.9	103.6
1964	103.5	103.5	104.4	104.8
1965	104.8	106.2	106.9	107.7
1966	108.9	110.7		

Source: U. S. Department of Labor, Bureau of Labor Statistics, Consumer Price Index, Bulletin No. 1351.1953-1962.

TABLE 51.--Michigan population 21 years and over 1955-1966 (quarterly estimates in thousands).

Year	Quarter			
	I	II	III	IV
1955			4,471	4,502
1956	4,533	4,563	4,594	4,596
1957	4,598	4,600	4,602	4,607
1958	4,613	4,618	4,623	4,617
1959	4,611	4,605	4,599	4,593
1960	4,586	4,580	4,578	4,575
1961	4,573	4,570	4,567	4,563
1962	4,558	4,554	4,550	4,561
1963	4,573	4,584	4,596	4,613
1964	4,630	4,647	4,665	4,687
1965	4,709	4,731	4,752	4,758
1966	4,764	4,770		

Source: U. S. Department of Commerce, Population Estimates, Series P-25, No. 151, 172, 194, 214, 254.

TABLE 52.--Beer Price Index U. S. 19-5-1966 (100 = 1957-1959).

Year	Quarter			
	I	II	III	IV
1955			96.4	96.6
1956	96.8	97.5	98.8	99.7
1957	100.1	99.8	99.9	99.9
1958	99.8	99.7	99.5	99.7
1959	99.7	99.9	101.3	101.4
1960	101.5	101.9	102.6	102.3
1961	101.9	102.0	102.4	102.5
1962	102.3	102.8	102.8	103.2
1963	103.2	103.5	103.8	104.2
1964	104.2*	104.2	104.5*	104.8
1965	104.9*	105.0	105.6*	106.2
1966	106.9	107.5		

*Interpolated by Straight Line Method.

Source: U. S. Department of Labor, Bureau of Labor Statistics, Consumer Price Index, Price Indexes for Selected Items and Groups, selected years.

TABLE 53.--Total beer purchased in Michigan 1955-1966 (full barrels of 31 gallons)

Year	Quarter			
	I	II	III	IV
1955			1,617,947	1,238,873
1956	1,179,971	1,483,380	1,458,378	1,262,964
1957	1,100,974	1,468,947	1,471,390	1,178,042
1958	1,061,993	1,389,367	1,399,900	1,160,697
1959	1,040,324	1,432,567	1,547,074	940,367
1960	1,264,225	1,461,311	1,482,302	1,183,758
1961	1,127,473	1,416,944	1,545,066	1,150,741
1962	1,134,301	1,529,717	1,407,028	1,147,527
1963	1,124,318	1,152,400	1,466,049	1,216,981
1964	1,194,126	1,485,554	1,540,897	1,250,754
1965	1,211,214	1,538,158	1,523,482	1,248,537
1966	1,278,753	1,553,684		

Source: Michigan Liquor Control Commission, Financial Report, 1955-1966.

APPENDIX C

Revenue Estimate Simulations

Liquor Purchase Revolving Fund

The simple revenue model developed in Chapter III states:

$$LPRF_t = S - D - C_1 - C_2 - i$$

To help evaluate this model the following simulation was run based on recent data which described the behavior of economic parameters identified in Chapter II. The results are compared with actual revenue yields.

Sales for the folowing fiscal year are estimated according to the following procedure:

$$S_t\ (1+r_1a)^{*} = S_1$$

$$S_t\ (1+r_1a)(1+r_2a) = S_2$$

$$S_t\ (1+r_1a)(1+r_2a)(1+r_3a) = S_3$$

$$S_t\ (1+r_1a)(1+r_2a)(1+r_3a)(1+r_4a) = S_4$$

$$S_{t+1} = \frac{\sum_{i=1}^{4} S_1}{4}$$

where: $S_{t(+1)}$ = total retail liquor sales in year t(+1)

r_i = rate of growth of disposable income in quarter 1

a = the income elasticity of sales

*If measurable price changes are to take place, the bracketed term for that quarter is modified as follows: $(1+r_i a+n_i z)$ where: n_i is the percentage change in price in the ith quarter and z is the price ealsticity of sales.

Actual quarterly growth rates of Michigan Personal Income as reported in the <u>Survey of Current Business</u> (October, 1967) were used as proxies for disposable income growth during fiscal 1967. The two liquor income elasticities derived from equations A and B in Table 26, Appendix A and the approximate retail liquor sales figure for fiscal 1966 ($250 million) were also employed to compute the estimates of 1967 sales.

$r_1 = 3.860 \quad r_2 = 0.952 \quad r_3 = -1.055 \quad r_4 = 2.395$

$a = \text{(linear) } 0.8675 \qquad a' = \text{(log) } 0.9306$

It should be noted that the total dollar sales of the preceding year are used and not the last quarter's sales. This approach avoids the need for seasonal adjustments.

<u>Discounts</u> would be estimated on the basis of the model presented in Chapter III and relies on the foregoing sales estimate.

$$D = \sum_{i=1}^{3} d_i S_i$$

During fiscal 1967 the discount allowed Specially Designated Distributors was changed from 10% to 11.5% effective February 26, 1967 (enrolled House Bill No. 3236). Thus to estimate discounts, 1966 sales distribution weights were assigned the discount rates for the respective categories of customers and the resulting overall discount rate proportioned to the sales estimated to be made during the respective periods of time.

d_1 = 10.0% (11.5%) w_1 = .744

d_2 = 12.5% w_2 = .229

d_3 = 22.0% w_3 = .004*

The weighted average discount rate prior to February would be 10.39% and after the change approximately 11.51%. Assuming approximately 2/3 sales would take place prior to the change and 1/3 after, the overall weighted average rate would be approxaimtely 10.75% of sales.

Cost of liquor sold (C_1) would be expected to approximate the same proportion of sales as 1966 costs since there was not reason to anticipate changes in the percentage mark-up, i.e.

C_1 = 0.68344 x Sales.

Costs of distribution (C_2) would be contingent upon expectations of growth in physical volume and any extra-ordinary expenses which might be tied to the efficienty of the distribution system. Since it is not the purpose of the demand analysis to account for the latter cost factors,

*These do not total 1.000 due to retail sales by the Michigan Liquor Control Commission.

we will use the actual costs incurred to arrive at the model's estimate.

Increase in inventories (i) would have to be estimated outside the framework of the demand model. We will simply use the actual figures for this component.

Our results are presented in Table 54.

TABLE 54.--Simulations of liquor purchase revolving fund transfer model for fiscal 1967 (in millions of dollars).

Hypothesis	Linear Income Elasticity	Logarithmic Income Elasticity	Actual Reported Figures[1]
Sales	$260.12	260.86	260.13
Discounts	-27.96	-28.04	-27.95
Cost (1)	-177.78	-178.28	-177.39
Cost (2)	-1.67	-1.67	-1.67
Inventory Adjustment	-2.79	-2.79	-2.79
	49.92	50.08	50.33
$LPRF_t$			
(actual less estimates)	0.41	0.25	——

[1]Source: Michigan Liquor Control Commission, Financial Report (June, 1967).

<u>Liquor Excise Taxes</u>: The simple revenue model developed in Chapter III for excise taxes states:

$$T = tS$$

Sales of liquor subject to the excise tax during the fiscal year are estimated according to the following procedure:

$$S_t \ (1+r_1b)^{*} = S_1$$

$$S_t \ (1+r_1b)(1+r_2b) = S_2$$

$$S_t \ (1+r_1b)(1+r_2b)(1+r_3b) = S_3$$

$$S_t \ (1+r_1b)(1+r_2b)(1+r_3b)(1+r_4b) = S4$$

$$S_{t+1} = \frac{\sum_{i=1}^{4} S_i}{4}$$

where: $S_{t(+1)}$ = total retail distilled spirits sales in year t(+1)

r_i = rate of growth of disposable income in quarter i

b = the income elasticity of sales

Actual quarterly growth rates used in the $LPRF_t$ model were employed with the two distilled spirits income elasticities derived from equations A and B in Table 9, Appendix A, and the approximate retail sales figure for fiscal 1966 ($241.8 million) to compute 1967 sales estimates.

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*If measurable price changes are to take place the bracketed term for that quarter is modified as follows: $(1+r_ib+m_ix)$ where: m_i is the percentage change in price in the i-th quarter and x is the price elasticity of sales.

b = (linear) 0.8801   b' = (log) 0.9306

When the four per cent tax rate was applied to the sales figures the following results were obtained:

b = $10.07 million   b' = $10.10 million

actual: $10 million

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