THE OWN-PRICE ELASTICITY OF ALCOHOL: A META-ANALYSIS[1]

by

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ABSTRACT

Interpreting the own-price elasticity of demand for alcohol literature is difficult. While numerous studies have been conducted, the point estimates reported vary dramatically. Some studies suggest the demand for alcohol is price inelastic, others suggest it is price elastic. This paper presents an empirical synthesis of own-price elasticity of demand for alcohol estimates using the technique of meta-regression analysis. 150 point estimates, drawn from studies covering 18 different countries are considered. The results of the empirical work reported in this paper suggest: the year of the study, the length of study, the per capita level of alcohol consumption, and the relative ethanol share of a beverage are important factors when explaining variations in estimates of the own-price elasticity of demand for alcohol. Interestingly, the study also suggests country specific and beverage specific effects are not statistically significant.

1. INTRODUCTION

"Alcohol, the cause of and solution to all the world's problems." H.J. Simpson

Throughout history alcohol consumption has generated debate, controversy, and a diversity of government responses. Government policy prescriptions have varied greatly, and have included: alcohol specific taxes; restrictions on, and prohibition of, the sale of alcohol; regulation of product labels; and limits on advertising. That excessive alcohol consumption presents society with significant economic costs is undeniable. That on health grounds a case can be made for limiting access to alcohol there is no doubt. Yet to formulate sound public policy with respect to alcohol, it is necessary to know more than these two facts; it is necessary to understand the nature of the demand for alcohol.

Cook and Moore (2000) present an excellent summary of the contribution economics has made to understanding the market for alcohol. The only topic in their comprehensive review not fully explored, is the own-price elasticity of demand for alcohol. Cook and Moore's approach is understandable, as Edwards et al. (1994) presents summary information on an extensive number of alcohol elasticity studies.

While Edwards et al. (1994) presents a comprehensive review of alcohol issues from a public health point of view, they make little comment on the elasticity estimates themselves. In fact, the main conclusion the authors' draw with respect to the relationship between price and quantity is: "Other things being equal, a population's consumption of alcohol will in lessor of greater but usually significant degree, be influenced by price" (Edwards et al. 1994, p. 121). This same point is repeated by Cook and Moore: "Estimated elasticities for beer, wine, and spirits differ widely over time, place, data set, and estimation method, but one conclusion stands out: In almost every case the own-price elasticities are negative" (Cook and Moore 2000, p. 1639).

This paper, by presenting a meta-analysis of known alcohol own-price elasticity information, fills a noticeable gap in the literature. In doing so it makes a valuable contribution to our knowledge of the demand for alcohol. It shows a range of empirical regularities, and highlights several interesting relationships.

2. Data Overview

The primary source of information on the own-price elasticity of alcoholic beverages was Edwards et al. (1994). However, on several occasions the results reported were ambiguous, or economically improbable; amendments and additions have therefore been made. The details of these amendments, and the process employed to corroborate the reported elasticities, are described in Appendix I.

A summary of the own price elasticity, η_{qp}, information -- reported in absolute value form -- is presented in Table 2.1. Estimates are reported for 18 countries, and there are 46 beer own-price elasticity estimates, η_{bb}, 54 wine own price elasticity estimates, η_{ww}, and 50 spirits own-price elasticity estimates, η_{ss}. The η_{bb} estimates ranged from highly inelastic (0.09) to elastic (1.20), with a mean $\overline{\eta}_{bb}$ of 0.38. For the η_{ww} the range of estimated values was slightly greater; (0.05) to (1.80), $\overline{\eta}_{ww}$ = 0.77. While the η_{ss} estimates showed the greatest variation, ranging from; (0.10) to (2.00), $\overline{\eta}_{ss}$ = 0.70. The $\overline{\eta}_{ww}$ estimate and the $\overline{\eta}_{ss}$ estimate appear quite similar, and statistical tests -- details of which are given in Appendix II -- indicate the $\overline{\eta}_{ww}$ and the $\overline{\eta}_{ss}$ are not statistically different. Using the same approach, it is possible to conclude the $\overline{\eta}_{bb}$ is statistically different to both the $\overline{\eta}_{ww}$ and the $\overline{\eta}_{ss}$.

Frequency distributions for the η_{bb}, the η_{ww}, and the η_{ss} are presented in Figures 2.1, 2.2, and 2.3 and the plots clearly show the majority of estimates to be less than one. In particular, 93 percent of the η_{bb} estimates, 69 percent of the η_{ww} estimates, and 80 percent of the η_{ss} estimates are less than one. Based on this result, it might seem reasonable to generalise and conclude: The demand for all alcoholic beverages is inelastic, and beer is the most inelastic beverage category.

The above summary of the elasticity estimate information is not the only way a macro representation of the data can be developed. An alternative is to consider price elasticity ratios. Where possible, the elasticity ratios: $\frac{\eta_{ww}}{\eta_{bb}}$, $\frac{\eta_{ss}}{\eta_{bb}}$, $\frac{\eta_{ss}}{\eta_{ww}}$, and denoted ρ_{wb}, ρ_{sb}, ρ_{sw} have been calculated. The results are reported in Table 2.2.

TABLE 2.1
PRICE ELASTICITY FOR BEER WINE AND SPIRITS: SUMMARY INFORMATION

Author	Country	Period	η_{bb}	η_{ww}	η_{ss}
1. Johnson and Oksanen (1974)	Canada 1 (S)	1955-1971	.22	.50	.91
2. __________________(1974)	Canada 2	1955-1971	.38	1.30	1.60
3. Johnson and Oksanen (1977)	Canada 3 (S)	1955-1971	.27	.67	1.14
4. __________________(1977)	Canada 4	1955-1971	.33	1.78	1.77
5. Quek (1988)	Canada 5	1953-1982	.28	.58	.30
6. Johnson et al. (1992)	Canada 6 (S)	1956-1983	.28	.79	.64
7. ___________ (1992)	Canada 7	1956-1983	.19	1.2	-
8. Selvanathan (1991)	Canada 8	1953-1982	.26	.16	.10
9. Niskanen (1962)	USA 1	1934-1960	.70	1.00	2.00
10. Hogarty and Elzinga (1972)	USA 2	1956-1959	.89	-	-
11. Simon (1966)	USA 3	1955-1961	-	-	.79
12. Comanor and Wilson (1974)	USA 4 (S)	1947-1964	.56	.68	.25
13. _________________ (1974)	USA 5	1947-1964	.39	.84	.30
14. Norman (1975)	USA 6	1946-1970	.87	-	-
15. Smith (1976)	USA 7	1970	-	-	1.95
16. Labys (1976)	USA 8	1954-1971	-	1.04	-
17. Clements and Selvanathan (1987)	USA 9	1949-1982	.09	.22	.11
18. Selvanathan (1991)	USA 10	1949-1982	.11	.05	.10
19. Eecen (1985)	Netherlands 1	1960-1983	-	.50	-
20. Labys (1976) / EEC (1972)	Belgium 1	1954-1971	-	1.14	-
21. Labys (1976)	France 1	1954-1971	-	.06	-
22. ______(1976)	Italy 1	1954-1971	-	1.00	-
23. ______(1976)	Portugal 1	1954-1971	-	.68	-
24. ______(1976)	Spain 1	1954-1971	-	.37	-
25. ______(1976)	W. Germany 1	1954-1971	-	.38	-
26. Walsh and Walsh (1970)	Ireland 1	1953-1967	.17	-	.64
27. Prest (1949)	UK 1	1870-1938	.66	-	.57
28. Wong (1988)	UK 2	1920-1938	.25	.99	.51
29. Stone (1945)	UK 3	1920-1938	.73	-	.72
30. Stone (1951)	UK 4	1920-1948	.69	1.17	.57
31. Walsh (1982)	UK 5	1955-1975	.13	.28	.47
32. Clements and Selvanathan (1987)	UK 6	1955-1975	.19	.23	.24
33. McGuinness (1983)	UK 7	1956-1979	.30	.17	.38
34. Duffy (1983)	UK 8	1963-1978	-	1.00	.77
35. Godfrey (1988)	UK 9	1956-1980	-	.67	.72
36. ________(1988)	UK 10	1956-1980	-	.95	1.49
37. Treasury (1980)	UK 11	1980	.20	1.10	1.60
38. Duffy (1987)	UK 12	1963-1983	.29	.77	.51
39. Selvanathan (1988)	UK 13	1955-1985	.13	.37	.32
40. Jones (1989)	UK 14	1964-1983	.27	.77	.95
41. ______(1989)	UK 15	1964-1983	.40	.94	.79
42. Selvanathan (1991)	UK 16	1955-1985	.13	.40	.31
43. Baker and Mckay (1990)	UK 17	1970-1986	.88	1.37	.94
44. Duffy (1991)	UK 18	1963-1983	.09	.75	.86
45. Salo (1990)	Finland 1	1969-1986	.60	1.30	1.00
46. Selvanathan (1991)	Finland 2	1969-1983	.54	.86	.73
47. Horverak (1979)	Norway 1	1960-1974	-	1.50	1.20
48. Selvanathan (1991)	Norway 2	1960-1986	.14	.07	.18
49. Malmquist (1948)	Sweden 1	1923-1939	-	.90	.30
50. Bryding and Rosen (1969)	Sweden 2	1920-1951	1.20	1.60	.50
51. Sundstrom-Ekstrom (1962)	Sweden 3	1931-1954	-	1.60	.30
52. Huitfeldt and Jorner (1972)	Sweden 4	1956-1968	-	.70	1.20
53. Selvanathan (1991)	Sweden 5	1960-1986	.35	.87	.22
54. Miller and Roberts (1972)	Australia 1	1957-1971	-	1.80	-
55. Clements and Selvanathan (1987)	Australia 2	1956-1977	.12	.34	.52
56. Clements and Jonhson (1983)	Australia 3	1956-1977	.11	.40	.53
57. Selvanathan (1991)	Australia 4	1955-1985	.15	.60	.61
58. Clements and Selvanathan (1991)	Australia 5	1956-1986	.15	.32	.61
59. Pearce (1986)	New Zealand 1	1966-1982	.15	.35	.32
60. Selvanathan (1991)	New Zealand 2	1965-1986	.12	.42	.52
61. Wette et al. (1993)	New Zealand 3	1983-1991	1.10	1.10	.50
62. Partanen (1991)	Kenya 1	1963-1985	.33	-	-
63. ________ (1991)	Kenya 2	1963-1985	1.00	-	-
64. Selvanathan (1991)	Japan 1	1964-1983	.25	-	.68

Summary Statistical Information	η_{bb}	η_{ww}	η_{ss}
Mean	.38	.77	.70
Mode	.13	1.00	.30
Median	.28	.76	.59
Mean Standard Error	.04	.06	.07
Standard Deviation	.297	.45	.48
Maximum	1.20	1.80	2.00
Minimum	.09	.05	.10
Number of Elasticity Esimates	46	54	50

Source: Edwards et al. (1994, pp. 112-14) provided most estimates. See Appendix I for further details.
(S) = Short-Run elasticity estimate

Figure 2.1
Beer Own-Price Elasticity Frequency Distribution

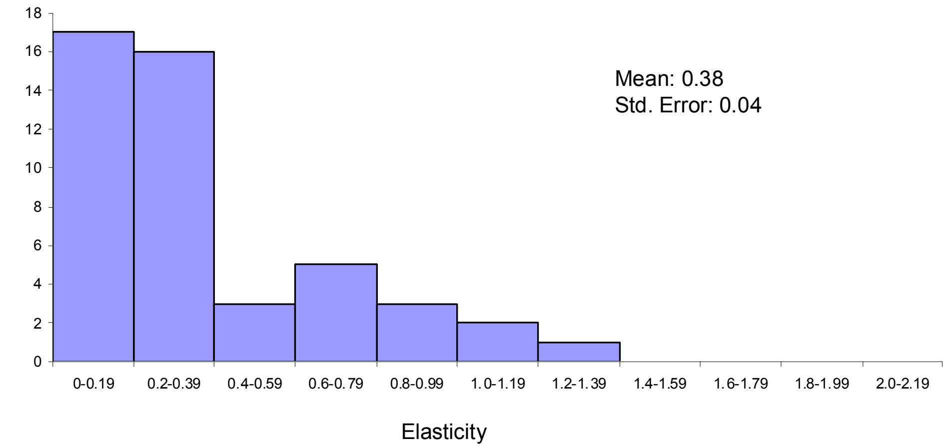


Figure 2.2
Wine Own-Price Elasticity Frequency Distribution

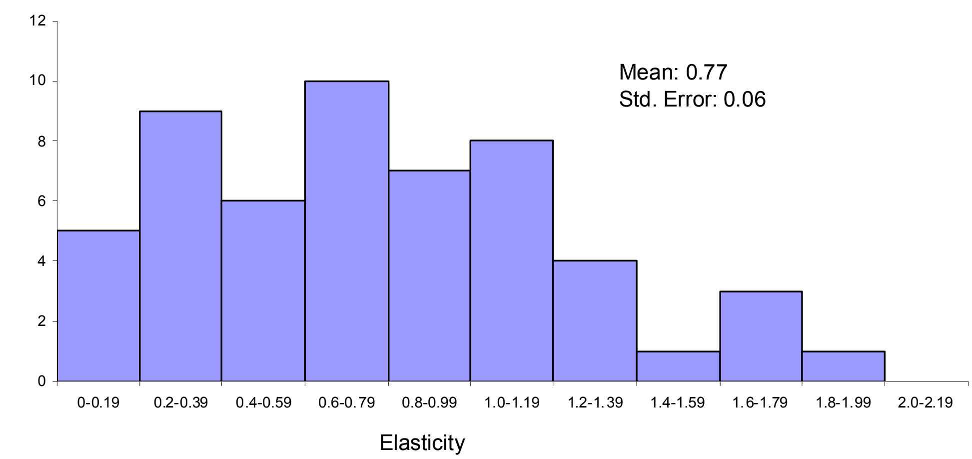


Figure 2.3
Spirits Own-Price Elasticity Frequency Distribution

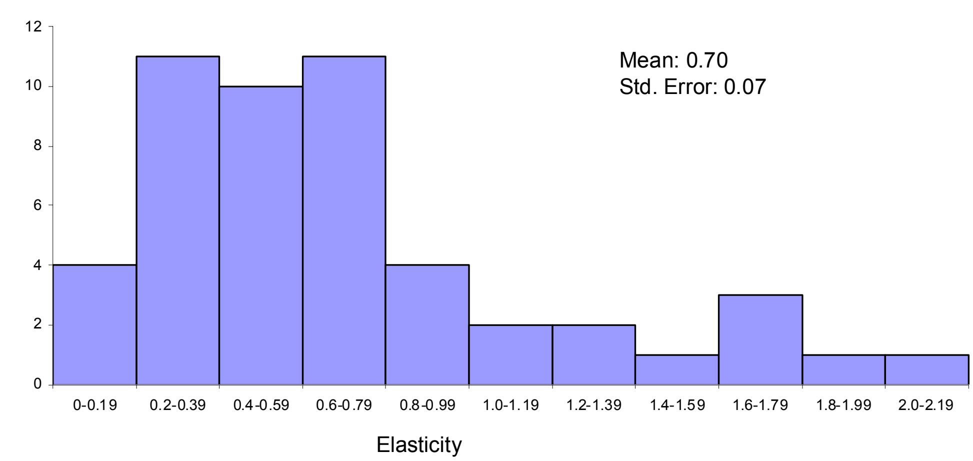


TABLE 2.2
PRICE ELASTICITY RATIOS FOR BEER WINE AND SPIRITS: SUMMARY INFORMATION

Author	Country	Period	ρ_{wb}	ρ_{sb}	ρ_{sw}
1. Johnson and Oksanen (1974)	Canada 1 (S)	1955-1971	2.27	4.14	1.82
2. __________________(1974)	Canada 2	1955-1971	3.42	4.21	1.23
3. Johnson and Oksanen (1977)	Canada 3 (S)	1955-1971	2.48	4.22	1.70
4. __________________(1977)	Canada 4	1955-1971	5.39	5.36	.99
5. Quek (1988)	Canada 5	1953-1982	2.07	1.07	.52
6. Johnson et al. (1992)	Canada 6 (S)	1956-1983	2.82	2.29	.81
7. ___________ (1992)	Canada 7	1956-1983	6.32	-	-
8. Selvanathan (1991)	Canada 8	1953-1982	.62	.38	.63
9. Niskanen (1962)	USA 1	1934-1960	1.43	2.86	2.00
10. Hogarty and Elzinga (1972)	USA 2	1956-1959	-	-	-
11. Simon (1966)	USA 3	1955-1961	-	-	-
12. Comanor and Wilson (1974)	USA 4 (S)	1947-1964	1.21	.45	.37
13. __________________ (1974)	USA 5	1947-1964	2.15	.77	.36
14. Norman (1975)	USA 6	1946-1970	-	-	-
15. Smith (1976)	USA 7	1970	-	-	-
16. Labys (1976)	USA 8	1954-1971	-	-	-
17. Clements and Selvanathan (1987)	USA 9	1949-1982	2.44	1.22	.50
18. Selvanathan (1991)	USA 10	1949-1982	.45	.91	2.00
19. Eecen (1985)	Netherlands 1	1960-1983	-	-	-
20. Labys (1976) / EEC (1972)	Belgium 1	1954-1971	-	-	-
21. Labys (1976)	France 1	1954-1971	-	-	-
22. ______(1976)	Italy 1	1954-1971	-	-	-
23. ______(1976)	Portugal 1	1954-1971	-	-	-
24. ______(1976)	Spain 1	1954-1971	-	-	-
25. ______(1976)	Germany (FR) 1	1954-1971	-	-	-
26. Walsh and Walsh (1970)	Ireland 1	1953-1967	-	3.76	-
27. Prest (1949)	UK 1	1870-1938	-	.86	-
28. Wong (1988)	UK 2	1920-1938	3.96	2.04	.52
29. Stone (1945)	UK 3	1920-1938	-	.99	-
30. Stone (1951)	UK 4	1920-1948	1.70	.83	.49
31. Walsh (1982)	UK 5	1955-1975	2.15	3.62	1.68
32. Clements and Selvanathan (1987)	UK 6	1955-1975	1.21	1.26	1.04
33. McGuinness (1983)	UK 7	1956-1979	.57	1.27	2.24
34. Duffy (1983)	UK 8	1963-1978	-	-	.77
35. Godfrey (1988)	UK 9	1956-1980	-	-	1.07
36. ________(1988)	UK 10	1956-1980	-	-	1.57
37. Treasury (1980)	UK 11	1980	5.50	8.00	1.45

Author	Country	Period	ρ_{wb}	ρ_{sb}	ρ_{sw}
38. Duffy (1987)	UK 12	1963-1983	2.66	1.76	.66
39. Selvanathan (1988)	UK 13	1955-1985	2.85	2.46	.86
40. Jones (1989)	UK 14	1964-1983	2.85	3.52	1.23
41. ______(1989)	UK 15	1964-1983	2.35	1.98	.84
42. Selvanathan (1991)	UK 16	1955-1985	3.08	2.38	.78
43. Baker and Mckay (1990)	UK 17	1970-1986	1.56	1.07	.69
44. Duffy (1991)	UK 18	1963-1983	8.33	9.56	1.15
45. Salo (1990)	Finland 1	1969-1986	2.17	1.67	.77
46. Selvanathan (1991)	Finland 2	1969-1983	1.59	1.35	.85
47. Horverak (1979)	Norway 1	1960-1974	-	-	.80
48. Selvanathan (1991)	Norway 2	1960-1986	.50	1.29	2.57
49. Malmquist (1948)	Sweden 1	1923-1939	-	-	.33
50. Bryding and Rosen (1969)	Sweden 2	1920-1951	1.33	.42	.31
51. Sundstrom-Ekstrom (1962)	Sweden 3	1931-1954	-	-	.19
52. Huitfeldt and Jorner (1972)	Sweden 4	1956-1968	-	-	1.71
53. Selvanathan (1991)	Sweden 5	1960-1986	2.49	.63	.25
54. Miller and Roberts (1972)	Australia 1	1957-1971	-	-	-
55. Clements and Selvanathan (1987)	Australia 2	1956-1977	2.83	4.33	1.53
56. Clements and Jonhson (1983)	Australia 3	1956-1977	3.64	4.82	1.33
57. Selvanathan (1991)	Australia 4	1955-1985	4.00	4.07	1.02
58. Clements and Selvanathan (1991)	Australia 5	1956-1986	2.13	4.07	1.91
59. Pearce (1986)	New Zealand 1	1966-1982	2.33	2.13	.91
60. Selvanathan (1991)	New Zealand 2	1965-1986	3.50	4.33	1.24
61. Wette et al. (1993)	New Zealand 3	1983-1991	1.00	.45	.45
62. Partanen (1991)	Kenya 1	1963-1985	-	-	-
63. ________ (1991)	Kenya 2	1963-1985	-	-	-
64. Selvanathan (1991)	Japan 1	1964-1983	-	2.72	-

Summary Statistical Information	ρ_{wb}	ρ_{sb}	ρ_{sw}
Mean	2.61	2.57	1.05
Mode	n.a.	4.33	2.00
Median	2.34	2.04	.89
Mean Standard Error	.27	.32	.09
Standard Deviation	1.65	2.03	.59
Maximum	8.33	9.56	2.57
Minimum	.46	.36	.19
Number of Ratios	38	41	44

Source: Based on entries in Table 2.1.
(S) = Ratio based on short-run elasticity estimates.

Figure 2.4
Elasticity Ratio Frequency Distribution : ρ_{wb}

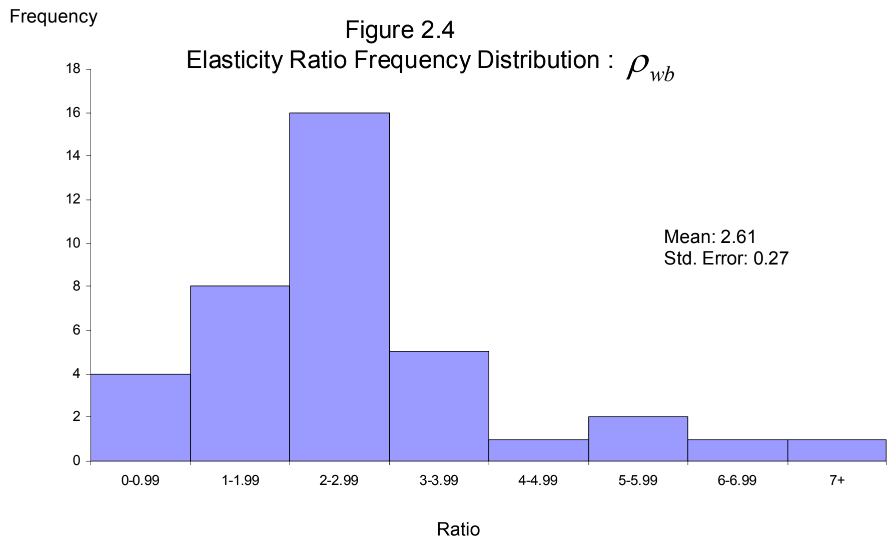


Figure 2.5
Elasticity Ratio Frequency Distribution : ρ_{sb}

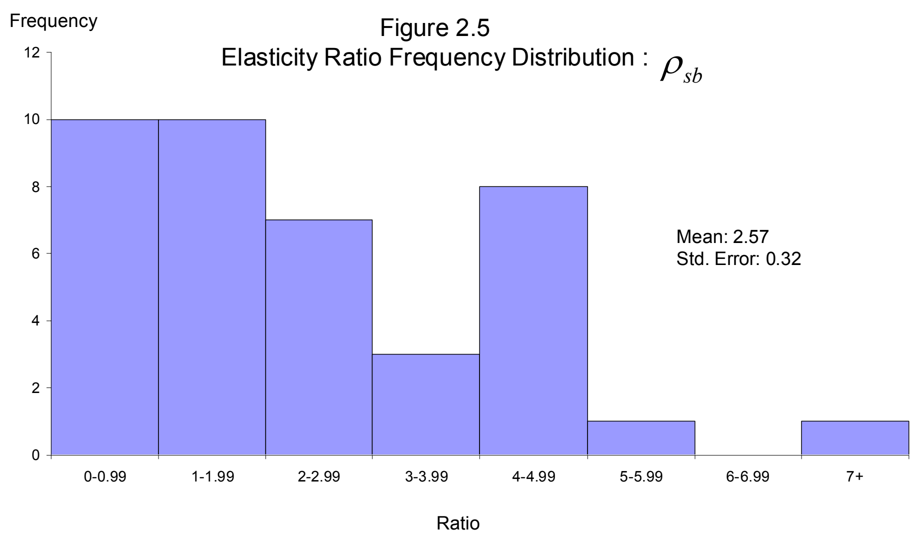
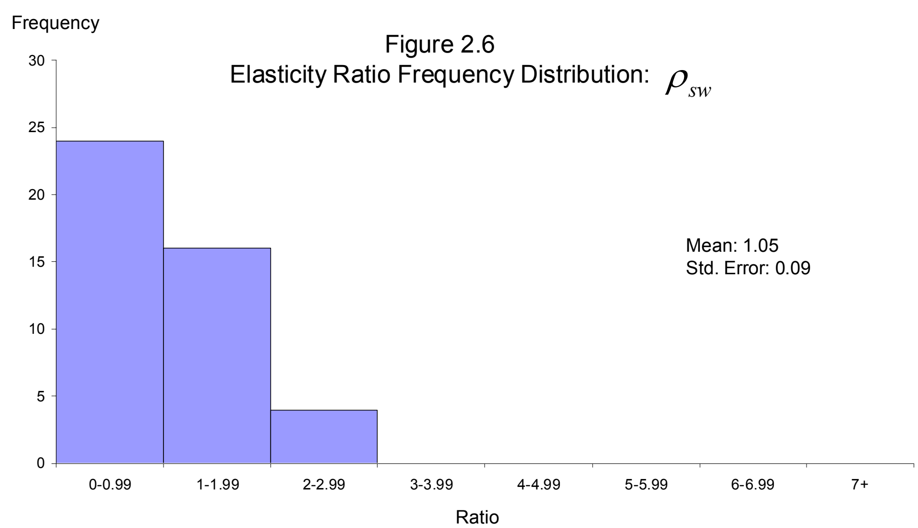


Figure 2.6
Elasticity Ratio Frequency Distribution: ρ_{sw}



The values for ρ_{wb} ranged from (0.45) to (8.33), with mean, $\overline{\rho}_{wb}$ = 2.61; for ρ_{sb} values ranged from (0.38) to (9.56), $\overline{\rho}_{sb}$ = 2.57; and for ρ_{sw} values ranged from (0.19) to (2.57), $\overline{\rho}_{sw}$ = 1.05. To aid exposition, frequency distributions are shown in Figures 2.4, 2.5 and 2.6. The correct framework for interpreting ρ_{ij} is ambiguous. The Stigler and Sherwin approach to defining the size of a market may however provide some insight. Stigler and Sherwin suggest when two goods *i* and *j* are part of the same market, the ratio of prices, P_i/P_j should be relatively constant over time (Stigler and Sherwin 1985, p. 557).

If ρ_{ij}, is relatively constant, it tells us elasticity estimates for the two goods move together. In this situation, if study *k* were to find a low η_{ii}, it would also find a low η_{jj}, and vice versa. We already know the $\overline{\eta}_{ss}$ and the $\overline{\eta}_{ww}$ estimates are not statistically different. So, if most ρ_{sw} values are around unity, it tells us, as we move from study to study, estimates of the η_{ss} and the η_{ww} move together. 52 percent of the ρ_{sw} values fall within the range 0.55 - 1.55, i.e., $\bar{\rho}_{sw}$ ± 0.5, implying at least some co-movement between the η_{ss} and the η_{ww}. 42 percent of the ρ_{wb} values fall within the range, $\bar{\rho}_{wb}$ ± 0.5, again suggesting at least some co-movement between the η_{ww} and the η_{bb} across studies. However, only 15 percent of the ρ_{sb} values fall within the range, $\bar{\rho}_{sb}$ ± 0.5, suggesting studies finding a high η_{ss} did not usually find a correspondingly high η_{bb}. Figure 2.5 clearly demonstrates this failure to find parallel movement in η_{bb} and η_{ss} estimates.

The findings of this introductory review of own-price elasticity information can be summarised as follows:

- The demand for alcohol is price inelastic;
- The own-price elasticity of wine and spirits are similar;
- Beer is the most inelastic category, and the elasticity of beer is different to wine and spirits;
- Elasticity estimates for wine and spirits, while varying between studies, broadly move together;
- Wine and beer estimates and wine and spirit estimates, while varying between studies, broadly move together, and;
- Beer and spirit estimates vary from study to study and do not broadly move together.

To draw further conclusions with respect to alcohol elasticity estimates, and to more fully understand the implications of price changes on alcohol consumption, we need a more comprehensive analysis. Separating the data into country specific sub-samples is the first step in developing a more complete understanding of alcohol own-price elasticity.

3. COUNTRY-BY-COUNTRY ANALYSIS

While reviewing the data yielded interesting information, examining the $\overline{\eta}_{ii}$ estimates for individual countries provides further insights. Columns 1 - 9 of Table 3.1 present the data separated and summarised at the country level. Such a representation allows us to elaborate on the general conclusions reached from the overview presented in Section 2. Consider columns 7, 8, and 9 of Table 3.1. Although the $\overline{\eta}_{bb}$<1 and the $\overline{\eta}_{ss}$<1 for all countries, this is not true for the $\overline{\eta}_{ww}$. The $\overline{\eta}_{ww}$<1 in ten countries, $\overline{\eta}_{ww}$>1 in four (indicated by an oval in Table 3.1) and the $\overline{\eta}_{ww}$= 1 in Italy. Further, the general conclusion about beer -- that it is the most inelastic alcohol category -- holds for all countries except Sweden. Immediately this raises two questions: (i) are there any factors common to those countries where the $\overline{\eta}_{ww}$>1? and (ii) is there anything different about Sweden?

Columns 7, 8, and 9 of Table 3.1 highlight another interesting feature. Australia, New Zealand, Norway, Ireland, and Japan appear to have, in general, below average alcohol elasticity estimates. The UK, USA, Canada, Sweden, and Finland appear to have, on balance, above average alcohol elasticity estimates. The picture for the remaining countries being unclear. An obvious question to ask is: are there any factors common to those countries where the demand for alcohol is in general more inelastic? and its twin; are there any factors common to those countries where the demand for alcohol is in general less inelastic? In answering such questions there are untold possibilities to investigate. However, factors likely to be influential include: the per capita level of alcohol consumption in the country; the relative market share of beer, wine, and spirits in each country; and, the tax rate on each beverage in each country. Each of these factors will now be considered.

Columns 10 - 13 of Table 3.1 show the level of per capita alcohol consumption in each country. Consider the four countries -- U.K., Sweden, Finland and Belgium -- where the $\overline{\eta}_{ww}$>1; in each country the per capita level of wine consumption is below average, i.e., Q_w< $\overline{Q}_w$. It is possible this finding indicates a more general relationship between alcohol

TABLE 3.1
SUMMARY INFORMATION ON ALCOHOL CONSUMPTION: BY COUNTRY

	Country	No. of Elasticity Studies	Sample Period of Studies	No. of Elasticity Estimates			Mean Elasticity			Level of Consumption* (litres)				Relative Ethanol Share* (percent)		
				Beer	Wine	Spirits	Beer	Wine	Spirits	Beer	Wine	Spirits^	Alcohol	Beer	Wine	Spirits
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1.	U.K.	18	1870-1983	15	16	18	0.57	1.08	0.87	114.3	6.7	3.8	6.58	64.3	12.3	23.4
2.	U.S.A.	10	1934-1982	7	6	7	0.52	0.64	0.79	79.8	6.1	8.0	7.82	46.9	11.8	41.3
3.	Canada	8	1949-1982	8	8	7	0.28	0.87	0.92	85.5	5.7	7.8	8.25	51.8	11.6	36.6
4.	Australia	5	1956-1986	4	5	4	0.13	0.69	0.57	144.7	11.3	3.3	10.03	72.2	14.6	13.2
5.	Sweden	5	1920-1986	2	5	5	0.78	1.13	0.50	58.6	7.7	7.3	6.18	36.0	16.3	47.6
6.	New Zealand	3	1966-1991	3	3	3	0.33	0.58	0.50	126.8	9.2	4.3	7.49	64.3	13.4	22.3
7.	Finland	2	1969-1983	2	2	2	0.57	1.08	0.87	56.2	9.2	7.3	6.57	36.6	16.3	44.1
8.	Kenya	2	1966-1985	2	-	-	0.67	-	-	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
9.	Norway	2	1960-1986	1	2	2	0.14	0.79	0.69	43.9	3.2	4.5	4.23	46.8	10.2	43.0
10.	Belgium	1	1954-1971	-	1	-	-	1.14	-	132.6	15.8	4.8	9.77	61.1	19.4	19.4
11.	France	1	1954-1971	-	1	-	-	0.06	-	44.2	103.0	6.0	16.90	12.7	73.1	14.2
12.	W. Germany	1	1954-1971	-	1	-	-	0.38	-	147.0	20.2	6.8	11.69	56.4	20.5	23.1
13.	Ireland	1	1953-1967	1	-	1	0.17	-	0.64	86.7	3.6	4.8	6.66	65.1	6.4	28.5
14.	Italy	1	1954-1971	-	1	-	-	1.00	-	14.4	110.5	5.0	14.21	5.1	80.9	14.1
15.	Japan	1	1964-1983	1	-	1	0.25	-	0.68	33.0	15.5	3.8	5.91	27.9	46.7	25.4
16.	Netherlands	1	1960-1983	-	1	-	-	0.50	-	75.7	10.4	7.0	7.78	48.6	16.1	35.4
17.	Portugal	1	1954-1971	-	1	-	-	0.68	-	27.0	80.0	2.5	15.15	8.9	84.6	6.5
18.	Spain	1	1954-1971	-	1	-	-	0.37	-	42.0	75.0	7.5	13.65	15.4	62.6	22.0
	Total/Mean	65	1870-1991	46	54	50	0.38#	0.77#	0.70#	77.2	29.0	5.5	9.4	41.9	30.4	27.0

* Values are for 1974 and based on Brown (1976).
\# Mean of entire sample
^ based on a conversion rate of 40 percent alcohol by volume for pure alcohol intake.

consumption and alcohol elasticity. Perhaps countries with more elastic own price elasticity estimates for alcohol are countries consuming low volumes of alcohol.

Consider, for a moment, the country specific elasticity estimate information presented columns 7, 8, and 9 of Table 3.1 as being only either above average, or below average. If the consumption data presented in columns 10 - 13 of Table 3.1 is thought of in the same manner, it is possible to detect certain patterns. For example, Australia has both below average own-price elasticity estimates, and above average levels of per capita alcohol consumption. By considering the data this way, a series of Venn diagrams can be constructed to represent the relationship between own-price elasticity and the level of per capita alcohol consumption.

First, consider Figures 3.1 and 3.2. Countries with, on balance, below average alcohol elasticity estimates are listed in the oval of Figure 3.1; countries with, on balance, above average alcohol elasticity estimates are listed in the oval of Figure 3.2[2]. Next, consider the alcohol consumption data. Countries with above average alcohol consumption are listed within the oval of Figure 3.3; while countries with below average alcohol consumption are listed in the oval of Figure 3.4. If the two sets of Figures, 3.1 and 3.3 are combined -- as they are in Figure 3.5 -- it becomes clear five countries have both below average alcohol elasticity estimates and above average alcohol consumption. Following a similar process, and combining Figure 3.2 with 3.4 -- as has been done in Figure 3.6 -- indicates a further five countries have below average alcohol consumption and above average alcohol elasticity estimates. In Figures 3.7, 3.9, 3.11, and 3.13 grey shading is used highlight countries where, $Q_i > \overline{Q}_i$ and the $\overline{\eta}_{ii} < \eta_{ii}$. In Figures 3.8, 3.10, 3.12, and 3.14 grey shading is used highlight countries where, $Q_i < \overline{Q}_i$ and the $\overline{\eta}_{ii} < \eta_{ii}$.

These visual representations provide interesting insights. The existence of an inverse relationship between alcohol consumption generally, and own-price elasticity appears to be supported by the data. This also appears to be the case for wine. Beer looks like a case of independence. While spirits most closely resembles a situation where above average consumption is associated with above average elasticity.

Such visual representations can be useful; however, a more formal approach can be followed. A formal approach would start by posing the question: If I have information about

[2] In the Venn diagrams an asterisk denotes countries for which there are elasticity estimates for only one beverage category.

the level of consumption of beverage *i* do I also have information about the own-price elasticity of beverage *i*? Or, is the own price elasticity of beverage *i* independent of the per capita level of consumption of beverage *i*? Such propositions regarding the independence of events can be tested through the use of a contingency table. Table 3.2 is a contingency table and the observed values are shown first, with expected values under independence in parenthesis. For the general category alcohol and elasticity, the null of independence can not be rejected. The same is true for both beer, and wine. Only for spirits, and only at the 10 percent certainty level, can the proposition of independence be rejected. This result is a clear demonstration of need to augment visual representations with the formal testing of propositions.

FIGURE 3.1:
Countries with below average elasticity estimates

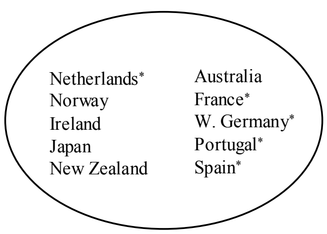


FIGURE 3.2:
Countries with above average elasticity estimates

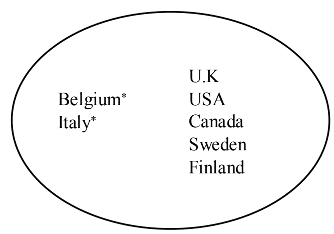


FIGURE 3.3:
Countries with above average alcohol consumption

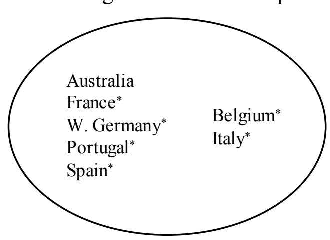


FIGURE 3.4:
Countries with below average alcohol consumption

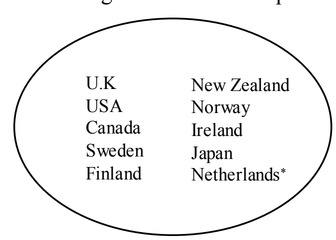


FIGURE 3.5:
Figure 3.1 and Figure 3.3 combined

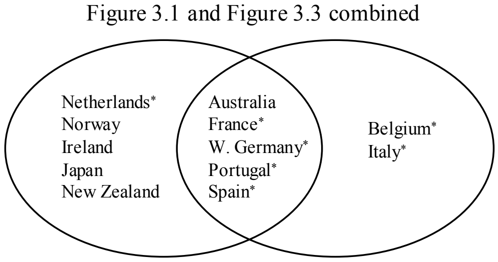


FIGURE 3.6:
Figure 3.2 and Figure 3.4 combined

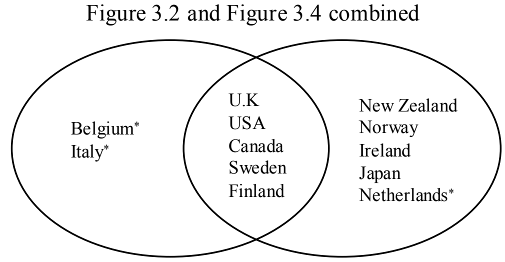


FIGURE 3.7: ALCOHOL
Overlap shows countries with above average consumption and below average elasticity estimates

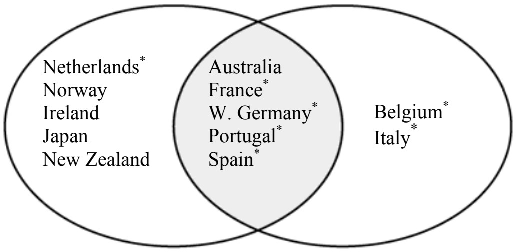


FIGURE 3.8: ALCOHOL
Overlap: Countries with below average consumption and above average elasticity estimates

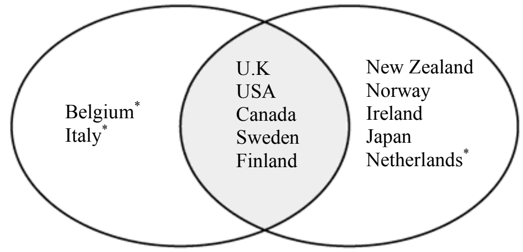


FIGURE 3.9: BEER
Overlap: Countries with above average consumption and below average elasticity estimates

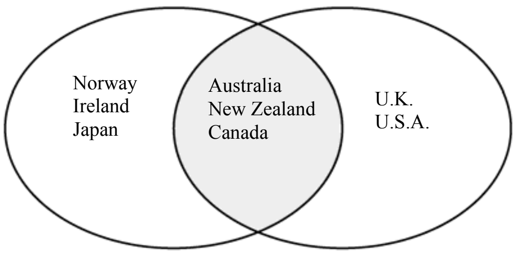


FIGURE 3.10: BEER
Overlap: Countries with below average consumption and above average elasticity estimates

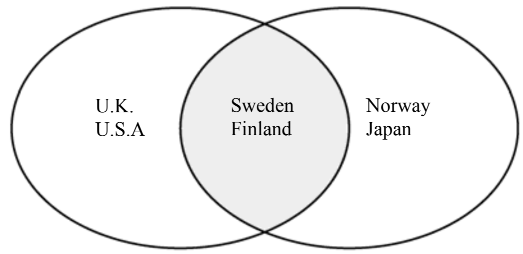


FIGURE 3.11: WINE
Overlap: Countries with above average consumption and below average elasticity estimates

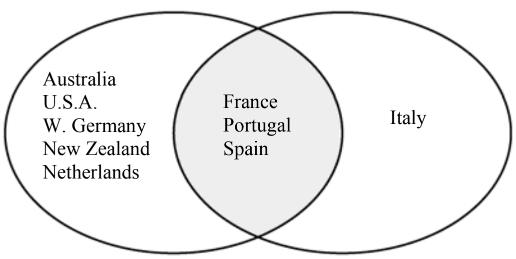


FIGURE 3.12: WINE
Overlap: Countries with below average consumption and above average elasticity estimates

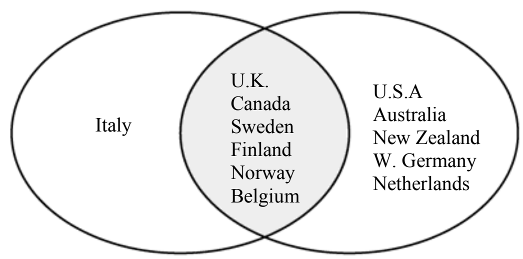


FIGURE 3.13: SPIRITS
Overlap: Countries with above average consumption and below average elasticity estimates

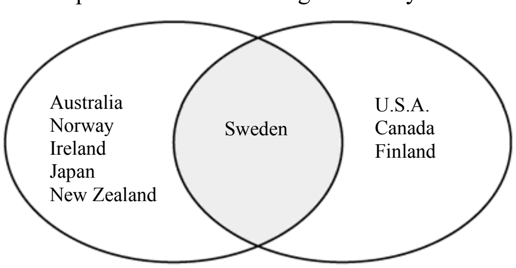


FIGURE 3.14: SPIRITS
Overlap: Countries with below average consumption and above average elasticity estimates

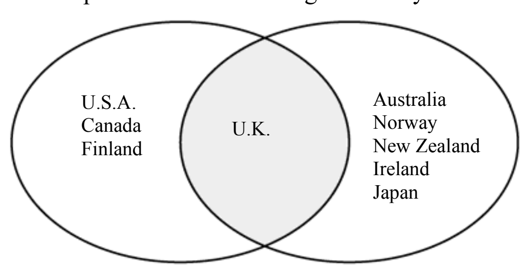


TABLE 3.2
CONTINGENCY TABLE TEST OF INDEPENDENCE

Alcohol Consumption and Elasticity

$\bar{\eta}_{aa}$ \ Q_a	$Q_a > \bar{Q}_a$	$Q_a < \bar{Q}_a$	Total
$\bar{\eta}_{aa} > \eta_{aa}$	2 [2.88]	5 [4.12]	7
$\bar{\eta}_{aa} < \eta_{aa}$	5 [4.12]	5 [5.88]	10
Total	7	10	17

$\chi^2 = 0.78$

Beer Consumption and Elasticity

$\bar{\eta}_{bb}$ \ Q_b	$Q_b > \bar{Q}_b$	$Q_b < \bar{Q}_b$	Total
$\bar{\eta}_{bb} > \eta_{bb}$	2 [2.22]	2 [1.78]	4
$\bar{\eta}_{bb} < \eta_{bb}$	3 [2.78]	2 [2.22]	5
Total	5	4	9

$\chi^2 = 0.09$

Wine Consumption and Elasticity

$\bar{\eta}_{ww}$ \ Q_w	$Q_w > \bar{Q}_w$	$Q_w < \bar{Q}_w$	Total
$\bar{\eta}_{ww} > \eta_{ww}$	1 [2.88]	6 [4.12]	7
$\bar{\eta}_{ww} < \eta_{ww}$	3 [4.12]	5 [5.88]	8
Total	4	11	15

$\chi^2 = 1.0$

Spirits Consumption and Elasticity

$\bar{\eta}_{ss}$ \ Q_s	$Q_s > \bar{Q}_s$	$Q_s < \bar{Q}_s$	Total
$\bar{\eta}_{ss} > \eta_{ss}$	3 [2.22]	1 [1.78]	4
$\bar{\eta}_{ss} < \eta_{ss}$	1 [2.78]	5 [2.22]	6
Total	5	4	10

$\chi^2 = 3.4$

The level of alcohol consumption is one consideration; the relative importance of each beverage to the consumer is another. It is possible to imagine a country where: $Q_b < \bar{Q}_b$, $Q_w < \bar{Q}_w$, and $Q_s < \bar{Q}_s$, yet such a country would still have a most preferred alcoholic beverage. The most satisfactory measure of the relative importance of beer, wine, and spirits in each country would be the conditional market shares, where the market share, w_i of beverage *i* is given by $\left(p_{it}q_{it}/M_t\right)$, where p_{it} is the price of beverage *i* at time *t*, q_{it} is the quantity of beverage *i* consumed at time *t*, $M_t = \sum_{i=1}^{3} p_{it}q_{it}$ and $\sum_{i=1}^{3} w_i = 1$. Unfortunately, it was not possible to calculate such a measure for each country, and so an alternative was sought.

Data on the per capita ethanol share of each beverage was available, and is a good proxy for conditional market share information. This relative ethanol share information is shown in columns 14, 15, and 16 of Table 3.1. s_i, the relative ethanol share of beverage *i* is given by $(a_{it} q_{it} / E_t)$ where, a_{it} is the level of alcohol by volume of beverage *i* at time *t*, q_{it} is the quantity of beverage *i* consumed at time *t*, $E_t = \sum_{i=1}^{3} a_{it} q_{it}$ and $\sum_{i=1}^{3} s_i = 1$.

As the per capita ethanol intake data concerns only three beverages, this information can be represented within an equilateral triangle. Consider Figure 3.15; each axis represents a beverage category, and runs from zero to 100 percent. Points in the bottom left triangle represent points of consumption where more than 50 percent of the total per capita ethanol intake is from beer. Similarly, points in the top and bottom right triangles represent points where wine and spirits are the dominate beverages. The centre triangle represents an area where no single beverage accounts for more than 50 percent of the consumer's ethanol intake.

For any given consumption combination of beer, wine, and spirits there is a unique point within the triangle associated with that combination. Consider the point E in Figure 3.16. To work out the percent of ethanol ingested from beer associated with this point, draw a line parallel to the wine axis from E to the beer axis. The value s_b^* is the percent of total ethanol consumed attributable to beer. To find wine's share, draw a line parallel to the spirit axis, from E, to the wine axis. The value s_w^* is the percent of total ethanol consumed attributable to wine. Finally, a line drawn parallel to the beer axis, from E, to the spirit axis, will give the relative share for spirits, s_s^*. By construction $s_b^* + s_w^* + s_s^* = 100$. Figure 3.17 plots the data for most countries under consideration, and details of how the plot was developed are given in Appendix III.

Roughly speaking, Figure 3.16 shows the sample of countries being considered can be divided into three groups: wine drinkers (24 percent of countries), beer drinkers (41 percent), and neutrals (35 percent). Note, a small shift in relative weights would place the Netherlands and the US in the beer drinking triangle, and Finland, Sweden, and Norway in the spirit triangle. This would leave Japan as the only neutral country in the sample, an intriguing finding.

FIGURE 3.15
The Alcohol Consumption Triangle

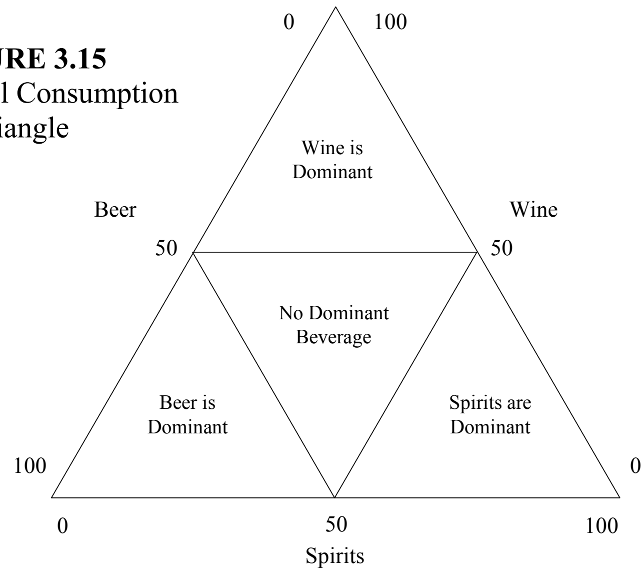


FIGURE 3.16
Alcohol Consumption Geometry

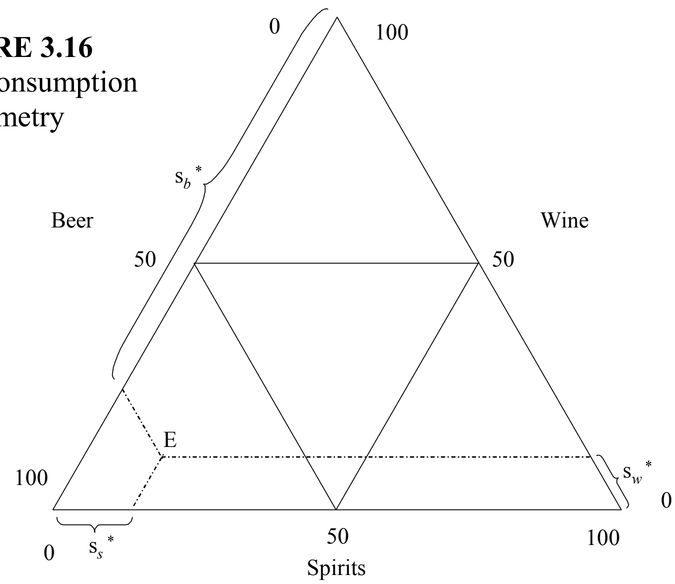
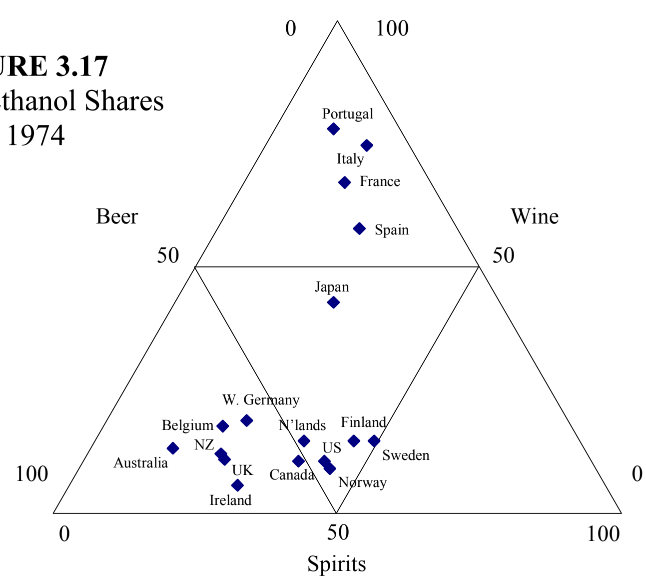


FIGURE 3.17
Relative Ethanol Shares in 1974



If the mean elasticity estimates in columns 7, 8, and 9 -- for countries with elasticity estimates for all three alcoholic beverage categories -- are compared with the relative ethanol information, columns 14, 15, and 16, a relationship becomes apparent. Within a country the beverage with the largest market share is the beverage with the most inelastic demand. This relationship holds for every country except Finland, a country where the most preferred beverage is spirits, and the most inelastic beverage is beer. However, given the small difference in the market share of beer and spirits -- 37 percent versus 44 percent -- and the relative closeness of the mean elasticity estimates -- (0.57) versus (0.87) -- this finding is not overly worrying.

The opposite also appears to be true. The alcoholic beverage least preferred in a nation is the one with the most elastic demand. This result holds for all countries -- with elasticity estimates for all three alcoholic beverage categories -- except the U.S.A. and Canada. In both countries the least consumed alcoholic beverage is wine, and the alcoholic beverage with the highest elasticity value is spirits. However, a close inspection of elasticity values in both countries reveals the difference between spirit and wine elasticity estimates, (0.92) and (0.87) for Canada and (0.79) and (0.64) for USA, is marginal. t-tests, details of which are given in Appendix II, indicate the mean own-price elasticity estimates for wine and spirits in both countries are not statistically different.

Such findings suggest an inverse relationship between the market share of a beverage, as measured by per capita ethanol intake, and own-price elasticity. Alcoholic beverages with a large market share tend to have a more inelastic demand than alcoholic beverages with a small market share. This relationship can be investigated by regressing the mean elasticity estimate for each beverage on the relative ethanol share. Let $\overline{\eta}_{bc}$ be the mean elasticity estimate in absolute value for beverage b (b = 1,2,3) in country c (c = 1,…,8) and S_{bc} be the ethanol measure of market share for beverage b in country c. Then, using the 3 × 8 = 24 observations, and OLS, we obtain the following estimated equation:

$$(1) \qquad \overline{\eta}_{bc} = \underset{(.090)}{.959} - \underset{(.002)}{.009}S_{bc} \quad R^2 = 0.39,$$

where standard errors are in parentheses. Equation (1) says, as market share increases, demand becomes more inelastic. The absolute own-price elasticity decreasing at a rate of .009 for every 1 percentage point increase in market share. Equation (1) was estimated using microfit for windows 4.1 and passed Heteroscedasticity, Functional Form, and Normality tests.

Taxation is another factor likely to be relevant when considering own-price elasticity estimates. If Ramsey taxation principles are used in setting commodity taxes then: "In taxing commodities which are rivals for demand, like wine, beer and spirits, or complementary like tea and sugar, the rule to be observed is that the taxes should be such as to leave unaltered the proportions in which they are consumed" (Ramsey 1927, p. 59). Such policy requires commodity taxes to vary inversely with the absolute value of the commodity's own-price elasticity; the government's revenue raising requirements determining the exact proportionality of the relationship. While it is likely governments focus on political consideration more than economic efficiency when setting tax rates, a relationship between alcohol tax rates and the own-price elasticity of alcohol is plausible.

The ideal measure for quantifying the relative tax levels of beer, wine, and spirits would be tax as a percentage of pre-tax price. Obtaining such information for so diverse a range of countries presented substantial problems, and so an alternative measure was sought. As production costs vary greatly between beer, wine, and spirits a simple measure of tax per unit of product is not appropriate. The most appropriate approximation available for each country was the level of tax per unit of pure alcohol expressed in a common currency.

Let t_{bc} be the tax in Canadian dollars per litre of absolute alcohol applicable to beverage *b* (*b* = 1,2,3) in country *c* (*c* = 1,…18). The arithmetic mean of the three taxes in country *c* is then $T_c = \frac{1}{3}\sum_{i=1}^{3}(t_{bc})$, and the deviations from the average sum across beverages to zero, $\sum_{i=1}^{3}(t_{bc} - T_c) = 0$. Table 3.3 presents information on the taxation levels in each country, and the relative over/under taxation of beer, wine, and spirits. Given the elasticity data, 1974 appeared an appropriate year to use for tax information.

Interestingly, it appears when weighted by alcohol content, the level of tax on spirits is above average in every country. Beer appears to be lightly taxed everywhere except Australia, and wine is taxed at a level greater than the unweighted arithmetic mean level of alcohol tax only in the U.S.A. and Ireland. No visual representation of the taxation data and its relationship to the own-price elasticity estimates is immediately apparent. As such none is presented.

TABLE 3.3
SUMMARY INFORMATION ON ALCOHOL TAXES IN 1974

	Country	Taxation Levels				Under/Over Taxation		
		t_{bc}	t_{wc}	t_{sc}	T_c	$(t_{bc} - T_c)$	$(t_{wc} - T_c)$	$(t_{sc} - T_c)$
1	U.K.	34.37	71.86	91.92	66.05	-31.68	5.81	25.87
2	U.S.A.	14.48	9.38	42.57	22.14	-7.66	-12.76	20.43
3	Canada	36.80	58.25	87.97	61.01	-24.21	-2.76	26.96
4	Australia	51.60	2.66	77.47	43.91	7.69	-41.25	33.56
5	Sweden	65.89	55.86	159.36	93.70	-27.81	-37.84	65.66
6	New Zealand	18.19	15.72	31.64	21.85	-3.66	-6.13	9.79
7	Finland	47.54	47.57	80.60	58.57	-11.03	-11.00	22.03
8	Kenya	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
9	Norway	67.10	66.36	168.72	100.73	-33.63	-34.37	67.99
10	Belgium	13.78	17.56	42.16	24.50	-10.72	-6.94	17.66
11	France	10.79	7.55	49.37	22.57	-11.78	-15.02	26.8
12	W. Germany	10.59	4.39	30.66	15.21	-4.62	-10.82	15.45
13	Ireland*	13.33	17.33	19.32	16.66	-3.33	0.67	2.66
14	Italy	14.13	8.00	32.93	18.35	-4.22	-10.35	14.58
15	Japan	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
16	Netherlands	16.38	12.9	35.59	21.62	-5.24	-8.72	13.97
17	Portugal*	2.05	0.00	45.14	15.73	-13.68	-15.73	29.41
18	Spain*	1.02	0.00	38.29	13.10	-12.08	-13.10	25.19
	mean	26.13	24.71	64.61	38.48	-12.35	-13.77	26.13

Source: Brown (1976) * Smith (1999) and relates to duty rates in 1999.

4. A META-ANALYSIS

An increasingly popular way of reviewing areas subject to numerous studies is the technique of meta-regression analysis:

> In particular, meta-regression analysis is a form of meta-analysis especially designed to investigate empirical research in economics (Stanley and Jarrell, 1989: Jarrell and Stanley, 1990). In a meta-regression analysis, the dependent variable is a summary statistic, perhaps a regression parameter, drawn from each study, while the independent variables may include characteristics of the method, design and data used in these studies. Thus meta-regression analysis can identify the extent to which the particular choice of methods, design and data affect reported results. Meta regression analysis can help to explain the wide study-to-study variation found among research findings and offer specific reasons, based on the studies

themselves, why the evidence on a certain question may appear contradictory or overly varied (Stanley, p. 131-132, 2001).

Within the context of reviewing elasticity estimates the meta-regression approach appears particularly appropriate. The process of selecting explanatory variables was influenced by the availability of details on each study, and the relationships suggested in Section 3. Table 4.1 provides summary details of the variables considered, while Table 4.2 reports the regression results for equation (2).

(2) $$\log \eta_{ic} = \sum_{k=1}^{K} \beta_k X_{kic} + \varepsilon_{ic}$$

Where, $\log \eta_{ic}$ is the natural logarithm of the absolute value of the own-price elasticity of demand for beverage *i*, in country *c*; β_k represents the estimated response coefficient *k*; X_{kic} are the factors thought to influence the reported elasticity estimate, and discussed in Table 4.1; and ε_{ic} are iid error terms with zero mean and constant variance.

Column 1 of Table 4.2 gives the meta-regression results; standard errors are reported in parentheses. As taxation details were unavailable for Japan, the first variables examined for influence upon reported elasticity estimates were the taxation variables. Individually, the tax variables are statistically insignificant, and an F-Test indicates an extremely high probability they jointly have no explanatory power. Ramsey, in 1927, wondered whether tax rates on alcohol reflected the principles of taxation he espoused, but did not know the answer (Ramsey 1927, p. 59). That there is no discernable relationship between alcohol tax rates and the own-price elasticity of alcoholic beverages answers his question. Alcohol taxes do not reflect Ramsey commodity taxation principles. Establishing exactly what does determine alcohol tax rates is an interesting question, but beyond the scope of this study. As taxation data add no value to the regression, equation (2) was re-estimated excluding taxation variables, and including the observations for Japan. These results are reported in column 2 of Table 4.2

The initial data summary presented in Table 2.1 suggested the $\overline{\eta}_{ss}$ and the $\overline{\eta}_{ww}$ were not statistically different, but both were statistically different to the $\overline{\eta}_{bb}$. To test this within the meta-regression framework dummy variables allowing for differences between the three beverage categories were considered. Surprisingly, once other factors are controlled for, these dummies are unnecessary. Both the spirit and wine dummy variables are individually not statistically different from zero -- beer is in the base --and an F-test indicates they are not jointly significant. This finding demonstrates the advantage of a meta-regression approach over a simple summary of the data. When we take other factors into consideration, as is done with the meta-regression, it is possible to consider beer, wine, and spirit elasticity information jointly.

Many non-economists would assume heterogeneous tastes across countries. A view perhaps supported by the large differences in country specific mean elasticity estimates reported in Table 3.1. The alternate view, articulately put forward by Stigler and Becker (1977, p.76) contends "tastes neither change capriciously nor differ importantly between people." With these alternate views in mind the meta-regression was specified with country specific dummy variables. An F-test on the country dummy variables suggests they are not required. This is quite an interesting finding, which again shows the value of the meta-regression approach. The pooling of cross-country elasticity measures is something we may have considered unwise based on the summary information presented in Table 3.1. Yet the meta-regression approach shows once we control for the particulars of the study, and consumption details, it is possible to pool own-price elasticity information over a wide variety of countries.

An interesting question to ask at this point concerns the overlap between the information provided by the consumption data, and the country dummies. If the meta-regression is estimated with country dummies, but excluding consumption information, the regression fails the Ramsey RESET functional form test. Further, even when consumption data is excluded, based on the F-statistic, it is not possible to reject the hypothesis the coefficients on the country dummy variables are jointly zero. It therefore appears reasonable to conclude the country dummies do not provide similar information to that provided by the consumption data. Including consumption information, and excluding country dummy variables therefore appears appropriate.

While the coefficient attached to the dummy variable for short run elasticity estimates takes the expected sign, the standard error indicates the variable adds little to explaining the variability observed in elasticity estimates. This dummy variable has therefore been excluded from the final meta-regression results reported in column 5 of Table 4.2.

There was some concern about the impact of countries with only one or two observation. As an additional check of robustness the final meta-regression was re-estimated excluding countries with only one or two observations. The resulting point estimates were compared to those reported for the full sample. In all cases the point estimates fall with the 95 percent confidence band of the results reported in column 5 of Table 4.2. Further details regarding the point estimates computed are given in Appendix II.

TABLE 4.1
SUMMARY DESCRIPTORS

Variable	Description	Details			
		Mean.	St. dev.	Max.	Min.
Log η_{ic}	Natural logarithm of η_{ic}. Observations: beer (44), wine (54) or spirits (50).	0.63	0.45	2.00	0.05
Year	Mid-point of study data range.	1964	14.47	1987	1904
Range	Study length in years.	22.14	8.92	69	1
Volume	Per capita level of ethanol consumed for beverage *i* in country *c*.	35.42	46.77	147	1.3
Relative	Relative per capita ethanol share of beverage *i* in country *c*.	33.72	20.55	84.6	10.2
TaxB	The difference between the mean tax level and the tax on beer (t_{bc} - T_c) in country *c*.	-12.35	11.46	7.69	-33.63
TaxW	The difference between the mean tax level and the tax on wine (t_{wc} - T_c) in country *c*.	-13.77	13.26	5.81	-41.25
Short	Dummy variable indicating if the estimate is a short-run elasticity. 1 if short run estimate, 0 otherwise.				
All	Dummy variable indicating whether the study reports estimates for more than one beverage category. 1 if study reports results for at least two beverage categories, 0 otherwise.				
Multi	Dummy variable indicating whether or not the study looked at more than one country. 1 if study looked at more than one country, 0 otherwise.				
Country	Dummy variable allowing for country specific effects. 1 if country *i* (i = 1,…,12), 0 otherwise				
Wine	Dummy variable for wine estimates. 1 if wine elasticity, 0 otherwise.				
Spirit	Dummy variable for spirits estimates.1 if spirit elasticity, 0 otherwise.				
$Year^2$	The year variable squared.				
Base Variables	The base elasticity estimate category is beer, the base country is Canada and the base taxation level is that applicable to spirits.				

TABLE 4.2

META - REGRESSION RESULTS: DEPENDENT VARIABLE LOG η_{ic}

(standard errors on parentheses)

Variable	(1)		(2)		(3)		(4)		(5)	
Intercept	1711	(873)	1739	(863)	1726	(856)	1749	(650)	1778	(633)
Year	-1.74	(.895)	-1.77	(.885)	-1.76	(.877)	-1.78	(.666)	-1. 81	(.649)
$Year^2$	.0004	(.0002)	.0005	(.0002)	.0004	(.0002)	.0005	(.0002)	.0005	(.0002)
Range	-.026	(.009)	-.026	(.008)	-.026	(.008)	-.026	(.007)	-.026	(.007)
Multi	-.629	(.152)	-.634	(.150)	-.630	(.148)	-.595	(.134)	-.590	(.131)
All	-.799	(.348)	-.802	(.346)	-.802	(.343)	-.629	(.206)	-.632	(.204)
Volume	-.004	(.007)	-.002	(.006)	-.003	(.002)	-.004	(.002)	-.004	(.002)
Relative	-.012	(.010)	-.014	(.009)	-.012	(.005)	-.011	(.004)	-.011	(.004)
Short	-.114	(.228)	-.115	(.226)	-.114	(.225)	-.042	(.194)	-	-
TaxB	-.8e-5	(.009)	-	-	-	-	-	-	-	-
TaxW	-.002	(.007)	-	-	-	-	-	-	-	-
Wine	-.108	(.510)	.035	(.385)	-	-	-	-	-	-
Spirit	-.054	(.574)	.107	(.449)	-	-	-	-	-	-
Country										
U.S.A.	-.319	(.233)	-.307	(.220)	-.313	(.217)	-	-	-	-
U.K.	-.201	(.209)	-.225	(.201)	-.208	(.191)	-	-	-	-
Australia	-.090	(.296)	-.101	(.264)	-.069	(.236)	-	-	-	-
Sweden	.057	(.284)	.088	(.261)	.071	(.253)	-	-	-	-
New Zealand	-.379	(.336)	-.408	(.329)	-.380	(.313)	-	-	-	-
Finland	.374	(.348)	.391	(.337)	.381	(.333)	-	-	-	-
Ireland	-.546	(.493)	-.533	(.477)	-.540	(.473)	-	-	-	-
Norway	-.360	(.352)	-.324	(.335)	-.342	(.328)	-	-	-	-
Europe 1*	-.287	(.903)	-.490	(.851)	-.322	(.572)	-	-	-	-
Europe 2*	-.191	(.709)	-.160	(.692)	-.280	(.533)	-	-	-	-
Japan	-	-	.046	(.510)	.044	(.490)	-	-	-	-
$\bar{R}^2$	.434		.439		.447		.445		.449	
F-statistic	6.06		6.47		7.25		15.75		18.95	
Functional Form	2.01	[.156]	1.76	[.185]	1.94	[.164]	1.83	[.176]	1.80	[.178]
Normality	1.66	[.476]	1.83	[.401]	1.74	[.420]	2.83	[.243]	2.71	[.257]
Hetroscedasticity	.082	[.775]	.070	[.791]	.079	[.772]	.159	[.690]	.157	[.691]
Observations	146		148		148		148		148	
Variables	22		21		19		8		7	

* Europe 1 beer drinking: Netherlands, Belgium, W. Germany. Europe 2 wine drinking: France, Italy, Portugal, Spain.

Notes: Functional Form Test: Ramsey's RESET test using the square of the fitted values.
Normality Test: Based on a test of skewness and kutosis of residuals.
Hetroscedasticity Test: Based on the regression of the squared residuals on squared fitted values.

<u>Year:</u> The mid-point of the study period entered the meta-regression as a quadratic. The turning point is 1969 and this represents a minimum. Other meta-analysis tend to include year of publication as the time variable, not mid-point of the study. Other meta-studies therefore often note improvements in estimation technique as the driver of the variation attributable to the time coefficient. Such an interpretation is not applicable here as the study period may differ substantially from the date of publication.

One possible explanation for the pattern of increasing inelasticity as we move toward 1969, and decreasing inelasticity post 1969 could be based around the influence of substitute products. Recreational drugs, having broadly the same intoxicating or mind altering properties as alcohol, are thought to be substitute products for beer, wine, and spirits (Clements et al., 2003, p.1). If, since 1969, substitute products such as marijuana, ecstasy and other drugs have become more readily available, and/or cheaper, then we would expect to see an increase in the absolute value of the own price elasticity of alcoholic beverages on the basis of greater availability of substitute products. Similarly, if, as we moved through the first 69 years of the 20th century, recreational drugs became more expensive, and less readily available, it is reasonable to expect the own-price elasticity of alcoholic beverages to show increasing inelasticity.

Certainly there is evidence suggesting non-alcoholic mind altering drugs became increasingly more difficult to obtain as we progressed through the early 20th century. During the later half of the 19th century, when little was known about the addictive properties of cocaine and opiates, there was little drug regulation. However, as the 20th century progressed, most developed nation began to restrict access to cocaine and opiates. With the US leading the way, most nations ultimately signed up to the *Single Convention on Narcotic Drugs* in 1961. The convention covers opiates, cocaine, and cannabis and Article 36(1)(a) of the convention states:

> Subject to its constitutional limitations, each Party shall adopt such measures as will ensure that cultivation, production, manufacture, extraction, preparation, possession, offering, offering for sale, distribution, purchase, sale, delivery on any terms whatsoever, brokerage, dispatch, dispatch in transit, transport, importation and exportation of drugs contrary to the provisions of this Convention, and any other action which in the opinion of such Party may be contrary to the provisions of this Convention, shall be punishable offences when committed intentionally, and that serious offences shall be liable to adequate punishment particularly by imprisonment or other penalties of deprivation of liberty.

As we have moved forward from the 1961 convention it has become clear prohibition is not an effective policy, and alternative drug control strategies have been followed. In particular there has been a relaxation in prohibition enforcement. It could therefore be argued, the 1960's represent the peak of the prohibition drive on illicit drugs; substitute products for alcohol.

Changes in the level of prohibition enforcement can be interpreted as a changes in price. If, as is illustrated in Daryal (1999), we treat the full price of a drug (P_d) as comprising two parts: (i) the money price of the drug (P_d') and (ii) the illicit activity costs associated with using the drug (X). Then the full money price can be found as $P_d = P_d' + X$, and any reduction in prohibition enforcement will result in a fall in the value of X, and so, a fall in the full money price. The effect of a reduction in the full money price of drugs is illustrated in Figure 4.1(a), while the impact of an increase in prohibition enforcement is shown in Figure 4.1(b).

Figure 4.1(a)
Decrease in Enforcement

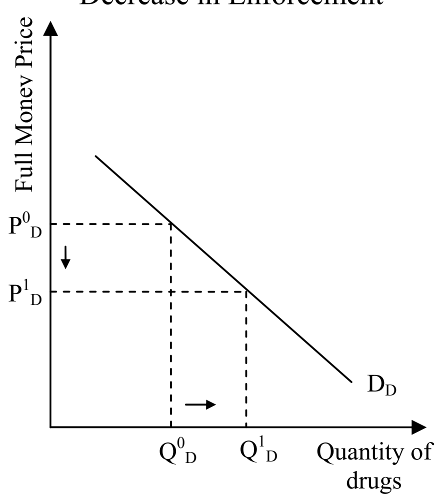
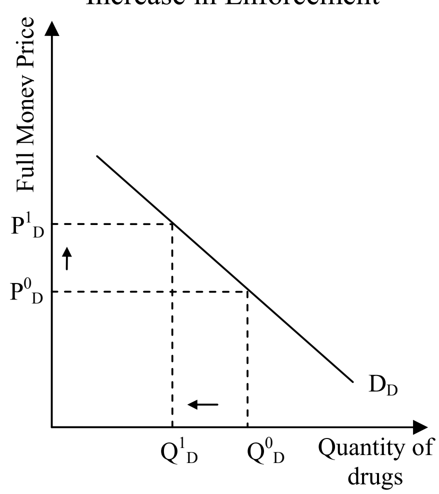


Figure 4.1(b)
Increase in Enforcement



Prohibition enforcement is of course not the only issue when considering the attractiveness of illicit substitutes for alcohol. There is the explicit money price component, and in the case of drugs, the purity of the goods to consider. In an excellent review of the US illicit drugs market, Basov et al. (2001, p.16) point out:

> The real purity-adjusted prices of cocaine and heroin have dropped markedly since the mid or late 1970s. Cocaine has fallen from roughly \$700 dollars per pure gram in the late 1970s to about \$60

during the 1990s. Heroin has fallen from almost $6000 per pure gram at its peak in the late 1970s to roughly $300 in recent years.

This pattern of real prices falling is replicated regardless of whether the purchase quantity is large or small and is repeated throughout the world. See BBC (2002a) and Clements (2002) for details of non-US drug prices. We also know, at least in the UK and Australia, marijuana consumption has grown substantially since the 1960's Neligan (2002); Clements and Daryal (1999).

Since the end of the 1960's the full money price of illicit drugs, clear substitutes for alcohol, have fallen significantly. Consumption levels of these substances have either remained relatively constant, or, as in the case of marijuana increased substantially. Changes in the full money price of illicit drugs have increased their attractiveness as substitutes for alcohol. These changes provide a plausible explanation as to why the time coefficients indicate increasing inelasticity up to 1969, and decreasing inelasticity after 1969.

Range: The coefficient attached to the range variable was somewhat of a surprise. Economic theory suggests the greater the length of time a consumer has to respond, the more elastic the good becomes. The results of the meta-regression suggest the longer the sample period the more inelastic the estimate. This is an intriguing finding and something worthy of further investigation.

Multi: There were no a priori expectations as to the sign of this dummy variable, and it could possibly be interpreted as a researcher effect. There are 40 observations (out of a total of 148) from multi-country studies, of which, 35 have Selvanathan as either author or co-author. As such, this dummy variable is likely to reflect characteristics specific to this researcher's work.

All: Studies estimating an elasticity value for a single beverage category generate significantly higher elasticity values than studies estimating elasticities for multiple alcohol categories. This finding is perhaps best described as an interesting empirical regularity rather than a finding requiring deeper investigation.

Volume: The meta-regression suggests, the greater the consumption level, the more inelastic the demand. Consider a country where the consumption of beer is very high. High per capita beer consumption could be the result of: cheap beer, high incomes, or relatively plentiful opportunities to consume beer. All three options suggest illicit drugs would be a less attractive to consumer. If substitutes are less attractive we would expect to find more inelastic demand. It is also worth noting, if we suppose a CES utility function, it can be shown the absolute value of the own price elasticity of demand of commodity *i* decreases as the budget share of commodity *i* increases (Selvanathan and Clements 1995, p. 42). The alcohol consumption data used in the study approximates budget share information, and it is pleasing the results conform to this known relationship.

Relative: The relative variable reflects the relative importance of each beverage, a measure slightly different to volume. The suggested explanation for why higher relative market shares are associated with more inelastic demand, is, however, similar. Consider certain European countries, countries where traditionally the main meal of the day is accompanied by wine. In such countries, when ordering a meal, substitute products such as beer and spirits are unlikely to be available. With reduced relative availability of substitute products we would expect to see more inelastic demand. A similar case can be developed for countries where life centres on local pubs or hotels. In such countries beer is readily available, wine and spirits less so.

5. CONCLUSION

By conducting a systematic analysis of a substantial number of published own-price elasticity estimates, this study has brought some order to an apparently disparate and conflicting literature. This study started by summarising the available data, and ended with a meta-regression analysis. One of the most interesting findings of this study concerns country specific effects. It appears once consumption data is considered there is no country specific effect. Further, it appears possible to infer something about the own-price elasticity of a beverage when you know per-capita consumption details. A finding which became clear, only once the meta-regression concept was introduced.

The meta-regression suggests the demand for alcohol will become increasingly less inelastic as we proceed through the 21st Century. Is this likely? Before a definitive answer can be reached, the relationship between the price and availability of illicit drugs, and alcohol needs further investigation. Is the increasing elasticity of alcoholic beverages being driven by the falling price of substitutes, or is it a function of some as yet unidentified factor? Perhaps Australia, a country where drug laws differ from state to state, would be an ideal society in which to further pursue this question.

Finally the meta-regression suggests two relationships very relevant for those in the business of supplying alcohol. Higher levels of per capita consumption and higher relative market shares are associated with more inelastic demand. As consumption patterns change, producers need to be aware of the impact these changes will have on the own-price elasticity of demand and adjust pricing policies accordingly.

APPENDIX I

THE DATA

Edwards et al. (1994), Alcohol Policy and the Public Good, provided the base reference for the information reported in Table 2.1. On several occasions the own-price elasticity estimates reported in Edwards et al. (1994) required clarification; the following amendments, alterations, and additions were made in compiling Table 2.1.

Niskanen (1962): Two elasticity values are reported for beer, wine and spirits and there is no footnote in Edwards et al. (1994) explaining why. The PhD thesis Niskanen (1962a) The Demand for Alcoholic Beverages, states: "The own price elasticity of spirits is around -2.0; of beer, around -0.7; and of wine, around -1.0." (Niskanen 1962a, p. 61). The values reported in Table 2.1 are these values.

Eecen (1985): The elasticity estimate for beer in the Netherlands is reported as (0.0). This observation has been excluded from the study.

Nyberg (1967): The short run elasticity estimate reported for beer in Finland is (0.00), and the long run elasticity (0.01). The results from this study have been omitted.

Labys (1976): An elasticity value is reported for domestic wine (-0.44), and for imported wine (-1.65). The value in Table 2.1 is the arithmetic mean of these two estimates.

Lidman (1976): The elasticity estimate for spirits in California is (0.02). This observation has been omitted from the study.

Godfrey (1988): Two sets of elasticity values are reported and there is no footnote in Edwards et al. (1994) explaining why. Reviewing this paper revealed the values relate to two different models. The first has expenditure as the dependent variable, the second volume. A range of functional forms: linear - linear, linear - log, log - linear and log - log are estimated for each model. The values in Table 2.1 represent the arithmetic mean of estimates from valid functional forms. For the model with expenditure as the dependent variable: the spirit elasticity is (-0.72), (actuals: -0.61, -0.84, -0.62, -0.67, -0.99, -0.56); and the wine elasticity is (-0.67), (actuals: -0.26, -0.88, -0.63, -0.91). For the model with volume as the dependent variable: the spirit elasticity is (-1.49), (actuals: -1.07, -3.03, -0.88, -0.98); and the wine elasticity is (-1.95), (actuals: -2.67, -1.14, -2.05). As Godfrey expresses concern about the accuracy of the beer estimates they have been excluded.

Godfrey (1988) is also the source of a further series of elasticity estimates. The paper notes UK Treasury estimates for the year 1980 as: beer (-0.2), wine (-1.1) and spirits (-1.6). These estimates have been added to Table 2.1, and are the entries associated with the heading Treasury (1980).

Johnson et al. (1992): For beer, wine, and spirits a range of elasticity estimates are reported. The values in Table 2.1 represent the arithmetic mean of estimates from valid functional forms. Beer short run: (-0.28), (actuals: -0.31, -0.27, -0.30, -0.26), beer long run: (-0.19), (actuals: -0.28, -0.14, -0.14); wine short-run: (-0.79), (actuals: -0.70, -0.86, -0.72, -0.88), wine long-run: (-1.20), (actuals: -1.26, -1.17, -1.17): spirits short-run: (-0.64) (actuals: -0.67, -0.45, -0.82, -0.63). The models estimated generate positive values for the elasticity of spirits in the long run. Long run spirit elasticity estimates were therefore excluded.

Jones (1989): Two sets of results are reported. As the paper notes: "In terms of the habit and non-habit versions of the model, the diagnostic tests presented in the appendix suggest that there is no clear case for preferring one version against the other."(Jones 1989, p. 95). Both sets of results are included in Table 2.1.

Huitfeldt and Jorner (1972): The beer estimate reported is for 'strong beer'. Due to uncertainty as to the exact meaning of 'strong beer', and the very high elasticity estimate reported (-3.0), this observation has been excluded.

Lau (1975): The elasticity estimates reported are: beer (-0.03), wine (-1.65), and spirits (-1.45). The problem with this set of estimates becomes clear once elasticity ratios are considered. The three elasticity ratios are: ρ_{wb} = 55.00, ρ_{sb} = 48.33 and ρ_{sw} = 0.88. As illustrated in Table A1, these ratios distort the average elasticity ratios for Canada, and the results for the entire sample. The Lau (1975) estimates have therefore been excluded from the study.

TABLE A1
THE IMPACT OF LAU (1975) ON MEAN ELASTICITY RATIOS
(number of observation in parentheses)

Description	$\bar{\rho}_{wb}$	n	$\bar{\rho}_{sb}$	n	$\bar{\rho}_{sw}$	n
Results for Canada Including Lau (1975).	8.93	(9)	8.75	(8)	1.07	(8)
Results for Canada Excluding Lau (1975).	3.17	(8)	3.10	(7)	1.10	(7)
Overall Result Including Lau (1975).	3.96	(39)	3.66	(42)	1.04	(45)
Overall Results Excluding Lau (1975).	2.61	(38)	2.57	(41)	1.05	(44)

The University of Western Australia, Department of Economics, Discussion Paper Series, contained several articles, or extended versions of papers referred to in Edwards et al. (1994). This resource was used to spot-check the accuracy of the estimates reported in Edwards et al. (1994).

Clements and Johnson (1983) was checked and no discrepancies were found.

Clements and Selvanathan (1991) was checked and no discrepancies were found. Clements and Selvanathan (1991) also included a table with elasticity estimates for: Clements and Selvanathan (1987), Pearce (1986), Quek (1988), Selvanathan (1988) and Wong (1988). These elasticity estimates were checked against those in Edwards et al. (1994) and no discrepancies were found.

Selvanathan (1991) was checked and no discrepancies were found. This paper also recorded the elasticity estimates for the studies: Clements and Selvanathan (1983), Clements and Selvanathan (1987), Duffy (1987), Jones (1989) and McGuiness (1983). For McGuinness (1983) a transcription error was made in Edwards et al. (1994). The correct elasticities are: beer (-0.18), wine (-0.30), spirits (-0.38); not: beer (-0.30), wine (-0.17), spirits (-0.38).

Selvanathan (1991) included 6 elasticity estimates not reported in Edwards et al.(1994). These estimates were for: Canada, Finland, Japan, New Zealand, Norway and Sweden, and they have been included in Table 2.1. The own-price elasticity of wine for Japan reported in Selvanathan (1991) is positive, and so was omitted.

APPENDIX II

STATISTICAL TESTS

Table A2 presents a comparison between the final regression results reported in Table 4.2, and the result when countries with only one or two observations are excluded. Column 1 of Table A2 contains the point estimates and standard errors reported in Table 4.2. Column 2 of Table A2 contains the point estimates and standard errors when countries with only one or two observations were excluded from the study.

Table A3 presents univariate test calculation supporting statements made throughout the text. Tests A1 - A4 present the calculations for concluding the $\overline{\eta}_{ww}$ and the $\overline{\eta}_{ss}$ are statistically different from the $\overline{\eta}_{bb}$ and that the $\overline{\eta}_{ww}$ and the $\overline{\eta}_{ss}$ are not statistically different. Calculations for concluding the elasticity ratios $\overline{\rho}_{wb}$ and $\overline{\rho}_{sb}$ are not statistically different, while $\overline{\rho}_{wb}$ and $\overline{\rho}_{sb}$ are statistically different from $\overline{\rho}_{sw}$ are given in Tests A5 - A8. Test B1 and B2 compare the $\overline{\eta}_{ss}$ and $\overline{\eta}_{ww}$ for the USA and the $\overline{\eta}_{ss}$ and $\overline{\eta}_{ww}$ for Canada.

TABLE A2
POINT ESTIMATE COMPARISON

Variable	Estimates (1)		Estimates (2)	
Intercept	1778	(633)	1825	(626)
Year	-1. 81	(.649)	-1. 86	(.641)
$Year^2$	.0005	(.0002)	.0005	(.0002)
Range	-.026	(.007)	-.025	(.007)
Multi	-.590	(.131)	-.654	(.136)
All	-.632	(.204)	-.649	(.287)
Volume	-.004	(.002)	-.004	(.002)
Relative	-.011	(.004)	-.011	(.005)
Observations	n = 148		n = 137	

TABLE A3
SUMMARY STATISTICAL TESTS

Test*	Hypotheses	Calculations	Conclusion
A1	H$_0$: $\overline{\eta}_{ww} = \overline{\eta}_{ss} = 0.70$ H$_1$: $\overline{\eta}_{ww} \neq \overline{\eta}_{ss} \neq 0.70$	$t = \frac{\sqrt{54}(0.77-0.70)}{0.45} = 1.14$	∴ Accept Null
A2	H$_0$: $\overline{\eta}_{ss} = \overline{\eta}_{ww} = 0.77$ H$_1$: $\overline{\eta}_{ss} \neq \overline{\eta}_{ww} \neq 0.77$	$t = \frac{\sqrt{50}(0.70-0.77)}{0.48} = 1.03$	∴ Accept Null
A3	H$_0$: $\overline{\eta}_{bb} = \overline{\eta}_{ss} = 0.70$ H$_1$: $\overline{\eta}_{bb} \neq \overline{\eta}_{ss} \neq 0.70$	$t = \frac{\sqrt{46}(0.38-0.70)}{0.30} = 7.23$	∴ Reject Null
A4	H$_0$: $\overline{\eta}_{bb} = 0.77 = \overline{\eta}_{ww}$ H$_1$: $\overline{\eta}_{bb} \neq 0.77 \neq \overline{\eta}_{ww}$	$t = \frac{\sqrt{46}(0.38-0.77)}{0.30} = 8.82$	∴ Reject Null
A5	H$_0$: $\overline{\rho}_{wb} = \overline{\rho}_{sb} = 2.57$ H$_1$: $\overline{\rho}_{wb} \neq \overline{\rho}_{sb} \neq 2.57$	$t = \frac{\sqrt{38}(2.61-2.57)}{1.65} = 0.15$	∴ Accept Null
A6	H$_0$: $\overline{\rho}_{sb} = \overline{\rho}_{wb} = 2.57$ H$_1$: $\overline{\rho}_{sb} \neq \overline{\rho}_{wb} \neq 2.57$	$t = \frac{\sqrt{41}(2.57-2.61)}{2.03} = 0.13$	∴ Accept Null
A7	H$_0$: $\overline{\rho}_{sw} = \overline{\rho}_{sb} = 2.57$ H$_1$: $\overline{\rho}_{sw} \neq \overline{\rho}_{sb} \neq 2.57$	$\frac{\sqrt{44}(1.05-2.57)}{0.59} = 17.09$	∴ Reject Null
A8	H$_0$: $\overline{\rho}_{sw} = \overline{\rho}_{wb} = 2.61$ H$_1$: $\overline{\rho}_{sw} \neq \overline{\rho}_{wb} \neq 2.61$	$\frac{\sqrt{44}(1.05-2.61)}{0.59} = 17.54$	∴ Reject Null
B1	H$_0$: USA: $\overline{\eta}_{ss} = \overline{\eta}_{ww} = 0.79$ H$_1$: USA: $\overline{\eta}_{ss} \neq \overline{\eta}_{ww} \neq 0.79$	$t = \frac{\sqrt{7}(0.79-0.64)}{0.84} = 0.47$	∴ Accept Null
B2	H$_0$: Canada: $\overline{\eta}_{ss} = \overline{\eta}_{ww} = 0.92$ H$_1$: Canada: $\overline{\eta}_{ss} \neq \overline{\eta}_{ww} \neq 0.92$	$t = \frac{\sqrt{7}(0.92-0.87)}{0.63} = 0.21$	∴ Accept Null

*Test: $t = \left|\frac{\sqrt{n}(y-\mu)}{S}\right|$ where: n = number of observations,
y = sample mean,
μ = hypothesis mean, and
S = standard deviation of y.

APPENDIX III

THE GEOMETRY OF DRINKING

When considering any three products with market shares that sum to 100 percent, it is possible to express the information within an equilateral triangle. Clements and Lan (2000), drawing on the properties of the 90º, 60º, and 30º triangle, show how this can be done. Consider Figure A1, and the triangle FGH with angles of 90º, 60º and 30º. Such a triangle has properties such that if FH = a, GH = $\frac{1}{2}a$ and FG = $\frac{1}{2}\sqrt{3a}$. Given this property, it is possible to convert the ethanol intake information for beer, wine, and spirits -- $s_b^{`} + s_w^{`} + s_s^{`} = 1$ -- shown in Table 3.1 into (x,y) co-ordinates. In Figure A2, as the angle of AB is the same as FH, FH = $s_w^{`}$ which implies GH = $\frac{1}{2}s_w^{`}$ and FG, the Y co-ordinate, is $\frac{1}{2}\sqrt{3s_w^{`}}$. The X co-ordinate is equal to $s_s^{`}$ plus GH i.e. $s_s^{`} + \frac{1}{2}s_w^{`}$. So for each country there exists a single consumption point in (x,y) space representing the relative ethanol intake of beer, wine, and spirits.

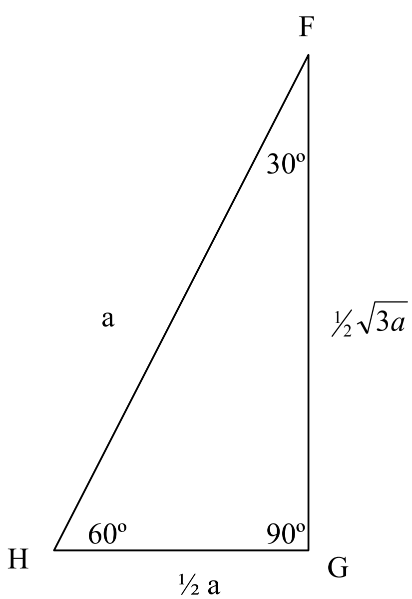


FIGURE A1
The Properties of the 30° 60° 90° triangle

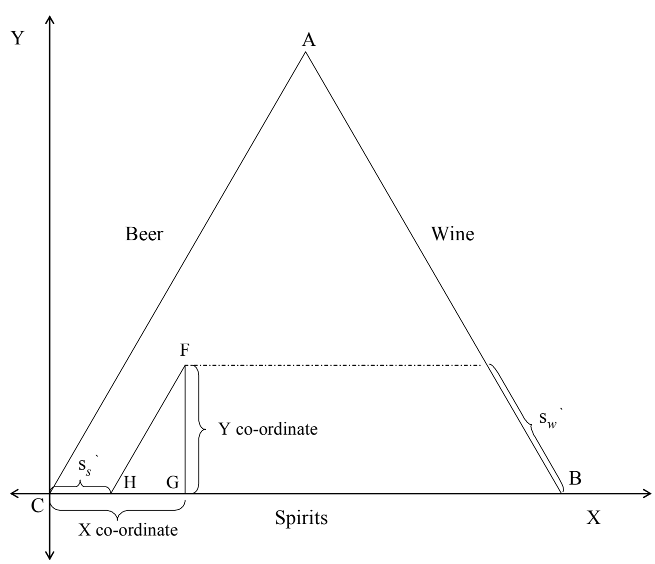


FIGURE A2
Ethanol shares in (x,y) space

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