A CROSS-COUNTRY ALCOHOL CONSUMPTION COMPARISON: AN APPLICATION OF THE ROTTERDAM DEMAND SYSTEM

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Abstract:

This paper analyses the consumption patterns of the three beverages beer, wine and spirits in nine countries, Australia, Canada, Finland, Japan, New Zealand, Norway, Sweden, the UK and the US, using the Rotterdam demand system. A cross-country comparison of the results shows that in most countries (i) wine consumption has grown at a faster rate than beer and spirits; (ii) the proportion of consumers' expenditure on alcohol is declining; (iii) beer is a necessity and spirits is a luxury; (iv) the demand for the three beverages is price inelastic; and (iv) all three beverages are pair-wise substitutes. We also investigated the hypothesis of identical parameters for all countries by pooling the data across countries and found that the data do not support the hypothesis.

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annual data for the period 1963-1983 whereas Selvanathan (1989) uses annual data for the period 1955-1975. Selvanathan (1988) estimates Working's model using the UK alcohol data for the years 1955-1985. We shall compare the results of some of the above studies with the current study later in the paper.

Several other published studies on the analysis of demand for alcohol are also available. For example, Clements and Selvanathan, 1988; Johnson, 1985; Johnson and Oksanen, 1974, 1977; Johnson, Oksanen, Veall and Fretz, 1990; McGuiness, 1980; Ornstein and Levy, 1983; Walsh, 1982; Walsh and Walsh, 1970; and Duffy, 1982, 1983, which we do not discuss here. Most of the alcohol studies available are mainly for Australia, the UK and the US. Very little research has been done on the analysis of the demand for alcohol in most other countries at the disaggregated level of alcohol (that is, beer, wine and spirits). This study attempts to fill at least a part of that vacuum by analysing the demand for beer, wine and spirits in nine countries, namely, Australia, Canada, Finland, Japan, New Zealand, Norway, Sweden, the UK and the US. To our knowledge this is the first study which compares the demand for alcoholic beverages beer, wine and spirits at a cross country level using the system-wide approach.

Statistics show that, on average, three fourths of the world adult population consume alcohol. Many studies found that the price of alcohol is one of the important factors which influence the level of alcohol consumption. The price of an alcoholic beverage is heavily dependent on the level of alcohol taxes. Taxes on alcoholic beverages are imposed for different reasons. In some countries they are used for revenue collection or for economic considerations and in some others as instruments to control alcohol misuse (either to reduce the consumption of all alcoholic beverages or to shift the consumption from one beverage to another) while in some others alcohol taxes are used as a combination of the two. The level of taxation on alcoholic beverages differs from beverage to beverage and also from country to country. For example, based on 1984 statistics, 5.4 percent of all government revenues for the UK were raised from alcohol taxes. To obtain the appropriate level of taxation to be placed on each beverage, the income and price elasticities are being used as key inputs. Consequently, the findings of this paper are of crucial importance as this study yields reliable

econometric estimates for the income and price elasticities for the three beverages in the nine countries. Such information will also be very useful to the alcohol industry in the nine countries as well as in other countries in marketing their products and to governments in those countries for policy-making (e.g., alcohol tax policy to increase government revenue, control policies to reduce alcohol misuse and so on).

The paper is organised as follows. In Section 2 we present a preliminary data analysis. Section 3 presents the estimation results, the implied income and price elasticities and compare our results with the results of a number of selected studies. In Section 4 we investigate the possibility of pooling the data across countries. Finally, in Section 5 we give our concluding comments.

2. Alcohol Data

The annual time-series consumption data for beer, wine and spirits in the nine countries are collected from various issues of government publications and the sources are reported in the data appendix of the paper. The sample period used in the analysis of the nine countries are Australia, 1955-1985, Canada, 1953-1982, Finland, 1969-1983, Japan, 1964-1983, New Zealand, 1965-1982, Norway, 1960-1986, Sweden, 1960-1986, the UK, 1955-1985 and the USA, 1949-1982. For all countries, except Japan, we consider three beverages beer, wine and spirits and for Japan we consider a fourth beverage 'sake' but do not report the results for sake in this paper.

Table 1 presents the volume consumed of beer, wine and spirits for the four periods 1970, 1975, 1980 and 1985. The quantities are expressed in terms of liters per capita and are comparable across countries. As can be seen, Australians are big drinkers of beer and wine while New Zealanders and the British are competing for the second and third places. However, there is a decreasing trend in beer consumption during the late 70's and continued during the early 80's in these countries. In general, beer consumption has declined in all countries except in Finland and Japan, in the recent years. The Japanese consume the least amount of beer. Wine consumption has increased in all countries. The Canadians, Finns,

Swedes and Americans are heavy spirits drinkers. Spirits consumption remained more or less a constant in most countries during the late 70's except in Japan. The mean consumption for the nine countries shows a fall in beer consumption and a steady increase in wine consumption.

In Table 2, we give the quantities consumed (q_{it}'s) of beer (i=1), wine (i=2) and spirits (i=3) and the corresponding prices (p_{it}'s) in log-change form, $Dq_{it} = \ln q_{it} - \ln q_{i,t-1}$ and $Dp_{it} = \ln p_{it} - \ln p_{i,t-1}$, at sample means (all are multiplied by 100). These mean values are the annual average growth rates of consumption and prices of the three beverages. Looking at columns 3-5 of the table, it can be seen that, on average, per capita consumption of beer, wine and spirits have increased in all countries except spirits consumption in Sweden, where the average consumption growth rate for spirits is negative. Columns 6-8 of the table show that the prices of the three beverages in all countries have increased. As can be seen from the last row of the table, on average, the consumption of beer, wine and spirits in the nine countries have increased by 1.5, 5.2 and 2.4 percent per annum, respectively, while prices have risen by 7.3, 6.5 and 6.2 percent per annum. In most countries, wine consumption and beer price have the fastest growth.

The conditional budget shares (the proportions of total alcohol expenditure devoted to each beverage) of beer, wine and spirits calculated as $w_{it}' = p_{it}q_{it}/\Sigma_{i=1}^{3} p_{it}q_{it}$ and budget share of total alcohol $W_{gt} = \Sigma_{i=1}^{3} p_{it}q_{it}/M_t$, where M_t is the per capita total consumption expenditure, for the periods 1970, 1975 and 1980 as well as at the sample means are presented in Table 3. For example, columns 14-17 in row 1 of the table show that, on average, Australians spend around 6 percent of their income on alcohol; 69 percent of this expenditure is devoted to beer, 15 percent to wine and the remaining 16 percent to spirits. During the 70's, the beer market share in the alcohol market has fallen in most countries with the exception of Finland, Japan and the U.S.; most of this fall has been captured by the wine market. The spirits share remains more or less a constant in all countries except Japan (where there is a significant increase) and the U.S. (where there is a significant fall). The overall alcohol market share in an average consumer's budget fell over the period 1970-80 in most countries. This could be due to the awareness campaign by the health profession

TABLE 1

Alcohol Consumption (Litres per Capita)

	Beer				Wine				Spirits			
ountry/Year	1970	1975	1980	1985	1970	1975	1980	1985	1970	1975	1980	1985
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Australia	125.8	137.9	129.3	114.5	8.7	13.0	18.2	21.3	2.6	2.9	2.8	3.0
Canada	70.5	85.5	86.4	82.2	3.7	5.9	8.4	10.2	5.1	7.8	8.0	6.6
Finland	43.5	51.2	54.6	61.7	4.2	8.9	8.2	8.7	4.6	7.5	7.3	7.0
Japan	28.1	33.7	37.5	40.6	.3	.5	.6	.8	3.4	3.8	5.1	6.0
New Zealand	116.8	125.7	120.5	114.8	5.6	9.1	13.8	14.4	2.6	4.2	4.6	4.3
Norway	36.6	45.3	48.0	47.5	2.3	3.3	4.4	5.1	3.6	4.3	4.5	3.5
Sweden	57.2	60.0	47.8	46.8	6.3	8.2	9.5	11.7	6.6	7.5	7.0	5.2
United Kingdom	101.6	117.6	116.3	108.6	6.5	9.4	12.1	16.0	2.3	3.7	4.4	4.3
United States	70.0	80.8	91.8	89.7	4.7	6.3	7.9	9.0	6.9	7.4	7.5	6.8
Mean	72.2	82.0	81.4	78.5	4.7	7.2	9.2	10.8	4.2	5.5	5.7	5.2

TABLE 2

Alcohol Quantity and Price Log-Changes
(At Sample Means)

		Quantities			Prices		
Country	Sample Period	Beer	Wine	Spirits	Beer	Wine	Spirits
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. Australia	1955-1985	.29	4.60	1.57	6.68	6.30	6.17
2. Canada	1953-1982	1.11	5.92	4.39	4.00	3.05	2.91
3. Finland	1969-1983	1.26	5.77	4.30	11.38	9.02	9.05
4. Japan	1964-1983	4.19	2.91	3.12	4.92	6.60	7.15
5. New Zealand	1965-1982	.86	9.26	3.07	10.96	10.82	8.33
6. Norway	1960-1986	2.81	5.51	.27	7.55	5.15	7.04
7. Sweden	1968-1986	1.09	4.98	-.21	9.24	6.43	6.77
8. United Kingdom	1955-1985	1.00	5.32	3.56	7.86	6.72	5.70
9. United States	1949-1982	1.07	2.84	1.55	3.49	4.03	2.42
Mean		1.52	5.23	2.40	7.34	6.46	6.17

against excessive alcohol drinking, the ban on alcohol advertising in the media and the introduction of new legislative laws regarding drinking and driving in most countries.

Now we summarize all the price and quantity data in the form of Divisia volume index $DQ_{gt} = \sum_{i=1}^{3} \bar{w}_{it}^{i} Dq_{it}$, Divisia price index $DP_{gt} = \sum_{i=1}^{3} \bar{w}_{it}^{i} Dp_{it}$ and Divisia price-quantity correlation coefficient $\rho_{gt} = \Gamma_{gt}/[K_{gt}\Pi_{gt}]^{\frac{1}{2}}$, where $\Gamma_{gt} = \sum_{i=1}^{3} \bar{w}_{it}^{i} Dp_{it}^{*} Dq_{it}^{*}$ is the Divisia price-quantity covariance; and $K_{gt} = \sum_{i=1}^{3} \bar{w}_{it}^{i} Dq_{it}^{*2}$ and $\Pi_{gt} = \sum_{i=1}^{3} \bar{w}_{it}^{i} Dp_{it}^{*2}$ are the Divisia quantity and price variances; $Dp_{it}^{*} = Dp_{it} - DP_{gt}$ and $Dq_{it}^{*} = Dq_{it} - DQ_{gt}$ are the relative price and consumption of beverage i and $\bar{w}_{it}^{i} = \frac{1}{2}(w_{it}^{i} + w_{i,t-1}^{i})$. Table 4 presents these measures. Looking at columns 2-3 we see that, on average, per capita alcohol consumption has increased by 1 to 3 percent per annum in all countries with an average of 2 percent, where Sweden has the lowest annual growth and Finland has the highest; the price of alcohol has increased by 3 to 10 percent with an average alcohol price increase of 7 percent per annum, where the lowest price increase was in the US and the highest in New Zealand. The price-quantity correlation presented in column 4 of the table is negative in most countries with an average of -.3. This reflects the tendency of the drinkers to move away from those beverages having above average price increases.

Columns 5-7 and 8-10 of the table present the relative growth in consumption and prices of the three beverages. As can be seen, within the alcohol market, in most countries the growth in consumption of beer is negative while that of wine is positive; and the growth in price of beer is positive while that of wine is negative. This could be due to higher beer taxes and lower wine taxes.

3. The Estimation Results

In this section we estimate the well-known Rotterdam demand system for the three beverages. Under block independence the conditional version of the Rotterdam demand equation for beverage i in absolute prices can be written as (Theil, 1975/76)

$$\bar{w}_{it} Dq_{it} = \alpha_i + \theta_i' W_{gt} DQ_{gt} + \sum_{j=1}^{3} \pi_{ij}^{g} Dp_{jt} + \varepsilon_{it}, \qquad (1)$$

TABLE 3

Conditional Budget Shares of Beer, Wine and Spirits and Budget Share of Total Alcohol

	1970				1975				1980				At Sample Means			
itry	Beer (2)	Wine (3)	Spirits (4)	Alcohol (5)	Beer (6)	Wine (7)	Spirits (8)	Alcohol (9)	Beer (10)	Wine (11)	Spirits (12)	Alcohol (13)	Beer (14)	Wine (15)	Spirit (16)	Alcohol (17)
stralia	68.9	15.7	15.3	6.16	66.2	18.3	15.5	6.06	62.6	21.7	15.7	5.56	68.6	15.4	16.0	5.82
nada	42.9	9.1	48.0	3.53	39.4	11.8	48.8	3.43	39.2	16.2	44.6	3.00	44.8	9.2	46.0	3.57
land	39.5	11.2	49.4	6.38	33.8	14.9	51.3	7.10	37.5	13.7	48.8	6.34	37.1	13.2	49.7	6.63
an	36.2	.8	23.0	.51	34.7	1.5	26.4	.36	38.0	1.8	30.8	.32	37.6	1.4	24.7	.41
w Zealand	67.8	8.4	23.8	6.61	61.4	13.0	25.6	5.96	57.2	19.3	23.5	7.25	62.5	12.4	25.1	6.36
way	44.9	11.7	43.4	4.97	44.6	12.2	43.2	5.25	42.8	14.4	42.8	4.76	44.6	13.4	42.0	4.71
eden	32.6	11.7	55.7	5.35	32.1	13.8	54.1	5.33	26.8	18.8	54.4	4.52	27.4	15.6	57.0	4.86
ited Kingdom	58.9	14.5	26.6	7.20	55.1	17.2	27.7	7.42	53.4	19.2	27.3	7.25	57.2	15.6	27.3	6.82
ited States	43.4	8.0	48.6	3.77	47.3	9.7	43.0	3.44	51.5	11.9	36.6	3.16	47.1	7.3	45.6	3.87
an	48.3	10.1	37.1	5.05	46.1	12.5	37.3	5.08	45.4	15.2	36.1	4.75	47.6	11.5	37.0	4.96

TABLE 4

Divisia Indexes and Relative Consumption and Price Log-Changes of Alcohol (At Sample Means)

Country	Divisia Volume Index	Divisia Price Index	Divisia Price-Quantity Correlation	Relative Consumption $Dq_i - DQ_g$			Relative Prices $Dp_i - DP_g$		
	DQ_g	DP_g	ρ_g	Beer	Wine	Spirits	Beer	Wine	Spirits
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1. Australia	1.25	6.43	-.35	-.96	3.35	.32	.25	-.13	-.26
2. Canada	2.49	3.49	-.88	-1.38	2.11	-.92	.51	-.44	-.58
3. Finland	3.30	9.94	-.42	-2.04	2.47	1.00	1.44	-.92	-.90
4. Japan	2.59	5.54	.00	1.60	.32	.53	-.62	1.02	1.61
5. New Zealand	2.22	10.41	-.25	-1.36	7.04	.85	.55	.41	-2.08
6. Norway	2.16	7.09	-.42	.65	3.36	-1.89	.46	-1.94	-.05
7. Sweden	.98	7.45	-.30	.10	4.00	-1.19	1.79	-1.01	-.68
8. United Kingdom	2.42	7.04	-.35	-1.42	2.90	1.14	.82	-.31	-1.33
9. United States	1.46	3.07	.03	-.39	1.38	.09	.42	.96	-.65
Mean	2.10	6.72	-.33	-.58	2.99	-.01	.62	-.26	-.55

where $\overline{w}_{it} = \overline{w}_{it}' W_{gt}$; α_i is a constant term; θ_i' is the conditional marginal share of i; and π_{ij}^g is the $(i,j)^{th}$ conditional Slutsky coefficients. The parameters of the system satisfy the adding-up restrictions:

$$\sum_{i=1}^{3} \alpha_i = 0, \qquad \sum_{i=1}^{3} \theta_i' = 1, \qquad \sum_{i=1}^{3} \pi_{ij}^g = 0. \tag{2}$$

The Slutsky coefficients satisfy demand homogeneity and symmetry

$$\sum_{j=1}^{3} \pi_{ij}^g = 0, \qquad \pi_{ik}^g = \pi_{ki}^g, \qquad i \neq k = 1,2,3. \tag{3}$$

Dividing both sides of (1) by $\overline{w}_{it}$ we obtain the income and price elasticities:

$$\eta_i = \frac{\theta_i'}{\overline{w}_{it}'} \qquad \eta_{ij} = \frac{\pi_{ij}^g}{\overline{w}_{it}}. \tag{4}$$

We specify the coefficients α_i, θ_i' and π_{ij}^g in (1) as constants. The constant terms are included in (1) to take account of autonomous trends in consumption due to variables such as advertising, demographic structure of the population, drink-driving laws, social factors etc. The zero-mean error terms ε_i's on the the right-hand side of (1) are independent and multivariate normal with a constant covariance matrix. We take total alcohol consumption and prices to be predetermined and use maximum likelihood for estimation. We used the likelihood ratio test to test the homogeneity and symmetry hypotheses (3).

Table 5 presents the homogeneity and symmetry constrained estimates of marginal shares and the upper triangular elements of the Slutsky matrix. Columns 12-13 of the table present the chi-squared values of the likelihood ratio test statistic for homogeneity and symmetry and the corresponding critical values. The estimation results of the constant terms (not presented in Table 5 but available on request from the author) show that in all countries the constant for wine is positive and for spirits is negative (except α_3 for Japan) indicating an

autonomous trend out of the latter into the former. Looking at columns 3-5 of the table, we see that all marginal shares are positive and most of them are significant. All diagonal elements of the Slutsky matrix (π^{g}_{BB}, π^{g}_{WW} and π^{g}_{SS}) are negative as they should be (except for WW of Japan). Comparing column 12 with 13 we conclude that the homogeneity and symmetry hypotheses are acceptable for 6 out of the 9 countries at the 5 percent level of significance and acceptable for all countries at the 1 percent level. We shall come back to the last row and column of the table in the next section.

We present the income and price elasticities implied by Table 5 estimates (at sample means) in Table 6. As can be seen, the income elasticity of beer is less than one in all countries (except Japan) indicating that beer is a necessity. Wine is a luxury in Finland, New Zealand, Norway and the U.K., and spirits is a luxury in all countries (except Japan). All the own-price elasticities (see BB, WW and SS columns of the table) are less than one in absolute value indicating that the demand for all three beverages are price inelastic. Majority of the cross-price elasticities are positive showing that in most countries the three beverages are pair-wise substitutes. We shall come back to the last row of Table 6 in the next section.

Table 7 presents the results of the current study and other (mainly system-wide) studies for Australia, the UK and the US referred to in Section 1 of the paper, as such studies are available only for these three countries among the nine countries considered in this paper. Our study differs from these studies mainly either on the functional forms employed for estimation or on the sample periods used. For Australia we compare our results with Clements and Johnson (1983) and Clements and Selvanathan (1987); for the UK we use Clements and Selvanathan (1987), Duffy (1987), Jones (1989) and McGuiness (1983); and for the US with Clements and Selvanathan (1987). As can be seen, our income and price elasticities are broadly similar to the results reported in other studies. This gives some confidence on our estimates and the selection of the functional form (that is, the Rotterdam Demand System).

TABLE 5

Estimates of Conditional Marginal Shares and Slutsky Coefficients
(Standard errors are in parentheses)

Country	Sample Period	Marginal Shares			Slutsky Coefficients x100						Test Statistic	5% Critical Value	Log-Likelihood Value for Pooling
		θ^{I}_{B}	θ^{I}_{W}	θ^{I}_{S}	π^{g}_{BB}	π^{g}_{BW}	π^{g}_{BS}	π^{g}_{WW}	π^{g}_{WS}	π^{g}_{SS}			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1. Australia	1955-1985	.576 (.046)	.112 (.040)	.311 (.045)	-.599 (.184)	.283 (.134)	.316 (.110)	-.536 (.128)	.253 (.084)	-.568 (.112)	10.676	7.815	119.52
2. Canada	1953-1982	.318 (.071)	.089 (.023)	.593 (.067)	-.414 (.271)	.222 (.084)	.192 (.251)	-.053 (.116)	-.170 (.123)	-.022 (.270)	8.846	7.815	140.36
3. Finland	1969-1983	.148 (.068)	.209 (.043)	.643 (.049)	-1.333 (1.190)	-.163 (.654)	1.496 (.819)	-.754 (.517)	.917 (.399)	-2.413 (.708)	1.036	7.815	173.15
4. Japan	1964-1983	.538 (.117)	.004 (.005)	.117 (.098)	-0.188 (.335)	.031 (.016)	.039 (.213)	.022 (.009)	-.017 (.013)	-.329 (.202)	4.728	12.590	-
5. New Zealand	1965-1982	.562 (.114)	.140 (.075)	.297 (.128)	-.482 (.410)	-.010 (.197)	.492 (.402)	-.335 (.182)	.345 (.227)	-.837 (.480)	7.086	7.815	46.07
6. Norway	1960-1986	.151 (.055)	.193 (.026)	.656 (.041)	-.299 (.528)	-.010 (.228)	.309 (.383)	-.041 (.147)	.051 (.160)	-.360 (.323)	1.230	7.815	96.64
7. Sweden	1960-1986	.061 (.049)	.075 (.029)	.864 (.062)	-.465 (.132)	.254 (.082)	.212 (.147)	-.660 (.117)	.406 (.103)	-.618 (.196)	4.370	7.815	92.39
8. United Kingdom	1955-1985	.297 (.044)	.204 (.032)	.499 (.037)	-.516 (.225)	.187 (.143)	.329 (.160)	-.427 (.138)	.240 (.109)	-.569) (.159)	3.417	7.815	101.81
9. United States	1949-1982	.333 (.055)	.046 (.020)	.620 (.058)	-.195 (.172)	.005 (.056)	.191 (.181)	-.014 (.040)	.010 (.070)	-.201 (.210)	11.185	7.815	175.80
	Pooling	.317 (.028)	.154 (.016)	.529 (.026)	-.441 (.115)	.116 (.061)	.325 (.096)	-.300 (.056)	.184 (.051)	-.509 (.109)	-	-	689.13

TABLE 6

Estimates of Conditional Income and Price Elasticities
(Standard errors are in parentheses)

Country	Income Elasticity $\frac{\theta^{I}_{i}}{w_{it}}$			Price Elasticity $\frac{\pi^{g}_{ij}}{w_{it}}$								
	B	W	S	BB	BW	BS	WB	WW	WS	SB	SW	SS
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1. Australia	.84 (.07)	.73 (.26)	1.94 (.28)	-.15 (.04)	.07 (.03)	.08 (.03)	.32 (.15)	-.60 (.14)	.28 (.09)	.34 (.12)	.27 (.09)	-.61 (.12)
2. Canada	.71 (.16)	.97 (.25)	1.29 (.15)	-.26 (.17)	.14 (.05)	.12 (.16)	.68 (.26)	-.16 (.35)	-.52 (.37)	.12 (.15)	-.10 (.07)	-.01 (.16)
3. Finland	.40 (.18)	1.58 (.33)	1.29 (.09)	-.54 (.48)	-.07 (.27)	.61 (.33)	-.19 (.75)	-.86 (.59)	1.05 (.46)	.45 (.25)	.28 (.12)	-.73 (.21)
4. Japan	1.43 (.31)	.29 (.36)	.47 (.40)	-.25 (.45)	.04 (.02)	.05 (.29)	1.12 (.58)	.80 (.33)	-.62 (.47)	.08 (.44)	-.04 (.03)	-.68 (.42)
5. New Zealand	.90 (.18)	1.13 (.60)	1.18 (.51)	-.12 (.10)	-.00 (.05)	.12 (.10)	-.01 (.25)	-.42 (.23)	.44 (.29)	.31 (.25)	.22 (.14)	-.52 (.30)
6. Norway	.34 (.12)	1.44 (.19)	1.56 (.10)	-.14 (.25)	-.48 (.11)	.15 (.18)	-.16 (.36)	-.07 (.23)	.08 (.25)	.16 (.19)	.03 (.08)	-.18 (.16)
7. Sweden	.22 (.18)	.48 (.19)	1.52 (.11)	-.35 (.10)	.19 (.06)	.16 (.11)	.34 (.11)	-.87 (.15)	.54 (.14)	.08 (.05)	.15 (.04)	-.22 (.07)
8. United Kingdom	.52 (.08)	1.31 (.21)	1.83 (.14)	-.13 (.06)	.05 (.04)	.08 (.04)	.18 (.13)	-.40 (.13)	.23 (.10)	.18 (.09)	.13 (.06)	-.31 (.09)
9. United States	.71 (.12)	.63 (.27)	1.36 (.13)	-.11 (.09)	.00 (.03)	.10 (.10)	.02 (.20)	-.05 (.14)	.04 (.25)	.11 (.10)	.01 (.04)	-.11 (.12)
	Pooling	.67	1.34	1.43	-.19	.05	.14	.20	-.53	.32	.18	.10	-.28

TABLE 7

A Comparison of Demand Elasticities for Beer, Wine and Spirits of the Current Study with Other Studies

Study	Model & Period	Income Elasticities			Own Price Elasticities		
		Beer	Wine	Spirits	Beer	Wine	Spirits
			AUSTRALIA				
Clements & Johnson (1983)	Rotterdam Model 1956-1977	.75	.75	2.32	-.11	-.40	-.53
Clements & Selvanathan (1987)	Working's Model 1956-1977	.73	.62	2.50	-.12	-.34	-.52
Selvanathan (1991)	Rotterdam Model 1955-1985	.84	.73	1.94	-.15	-.60	-.61
			UNITED KINGDOM				
Clements & Selvanathan (1987)	Working's Model 1955-1975	.41	1.91	1.81	-.19	-.23	-.24
Duffy (1987)	Rotterdam Model 1963-1983	.60	1.70	1.42	-.29	-.77	-.51
Jones (1989)	AIDS Model 1964-1983 (Quarterly)	.31	1.15	1.14	-.27	-.77	-.95
McGuiness (1983)	Linear Model 1956-1979	.13	1.11	1.54	-.18	-.38	-.30
Selvanathan (1991)	Rotterdam Model 1955-1985	.52	1.31	1.83	-.13	-.40	-.31
			UNITED STATES				
Clements & Selvanathan (1987)	Working's Model 1949-1982	.75	.46	1.34	-.09	-.22	-.10
Selvanathan (1991)	Rotterdam Model 1949-1982	.71	.63	1.36	-.11	-.05	-.11

4. Testing Pooling

In this section we answer the question, should the data be pooled across countries or should the demand system be estimated for each country separately? The advantage of pooling is that it increases both the sample size and the range of variation of relative prices and income. Consequently, estimation of the demand system with pooled data results in more precise estimates of the demand system parameters and better predictions of behaviour than could be obtained by analysing the data from individual countries. In this study, we exclude Japan from pooling as the number of commodities for Japan is four in contrast to three for all other countries.

The estimation results with the data pooled are presented in the last row of Table 5. As can be seen, there is significant improvement in terms of the precision of the estimates.

All marginal shares and price coefficients are estimated more precisely. The implied income and price elasticities are presented in the last row of Table 6. The points worth noting are that beer is a necessity and wine and spirits are luxuries, the demand elasticities are price inelastic and the three beverages are pair-wise substitutes.

When the demand system (1) is estimated for each country separately, we adjust two trend terms α_i for each country (one α_3 is constrained by $\alpha_1 + \alpha_2 + \alpha_3 = 0$). As there are eight countries, there is a total of $8 \times 2 = 16$ independent α_i's when the data are not pooled. Under pooling each α_i takes the same value in each country, so that we adjust only two trend terms. Consequently, pooling involves $16 - 2 = 14$ restrictions in terms of the trend terms. Similarly pooling involves $8 \times 2 - 2 = 14$ restrictions on the marginal shares. When the model is estimated for each country separately by imposing homogeneity and symmetry restrictions we adjust three independent Slutsky price coefficients π_{11}, π_{12} and π_{22} for each country (π_{13} is constrained by $\pi_{13} = - \pi_{11} - \pi_{12}$, π_{21} is constrained by $\pi_{21} = \pi_{12}$ and π_{23} is constrained by $\pi_{23} = - \pi_{21} - \pi_{22}$). For the eight countries, there is a total of $8 \times 3 = 24$ independent π_{ij}'s when the data are not pooled. Under pooling each π_{11}, π_{12} and π_{22} takes the same value in each country, so that we adjust only three Slutsky coefficients. Consequently, pooling involves $24 - 3 = 21$ restrictions on the Slutsky coefficients. Relative to the eight individual country models, pooling therefore involves a total of $14+14+21 = 49$ restrictions.

We shall test these restrictions by means of a likelihood ratio test. Under the null hypothesis of pooling, the statistic $-2(L_r - L_u)$ has an asymptotic $\chi^2(49)$ distribution, where L_r is the log-likelihood value with the restrictions and L_u is the unrestricted log-likelihood value. Under the assumption that the observations are independent across countries, the unrestricted log-likelihood value is the sum of the values for the eight countries individually, given in the last column of Table 5; thus $L_u = 119.52 + 140.36 + 173.15 + 46.07 + 96.64 + 92.39 + 101.81 + 175.80 = 945.74$. As the restricted log-likelihood value (the log-likelihood value under pooled restrictions) is 689.13, the value of the test statistic for pooling is $-2(689.13 - 945.74) = 513.22$. As this value is too high for $\chi^2(49)$ at the 5 percent level of significance, we must reject the pooled model and use the individual country models.

5. Concluding Comments

In this paper we analysed the consumption patterns of the three alcoholic beverages beer, wine and spirits in the nine countries Australia, Canada, Finland, Japan, New Zealand, Norway, Sweden, the UK and the US using the system-wide approach. The results show that in most countries wine consumption has increased at a faster rate than the other two beverages. The implied income and price elasticities reveal that in most countries beer is a necessity and spirits is a luxury; and the demand for all three beverages is price inelastic as expected. The results also show that the three beverages are pair wise substitutes. We also investigated the possibility of pooling the data across countries and found that the hypothesis of identical parameters of the demand system for all countries was rejected by the data.

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