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THE DEMAND FOR TRANSPORT AND COMMUNICATION IN THE UNITED KINGDOM AND AUSTRALIA

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The Demand for Transport and Communication in the United Kingdom and Australia

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Abstract:

This paper presents an empirical analysis of the demand for transport and communication in the United Kingdom and Australia, 1960-1986. We use the system-wide approach to obtain income and price elasticities for private transport, public transport and communication. The results show that the consumption patterns for these goods are broadly similar in the two countries. Taken as a group, transport and communication is a luxury. We also find that, within the transport and communication group, in both countries, private transport is a luxury and public transport and communications are necessities. Furthermore, private transport is a substitute for public transport as well as for communication.

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1. Introduction

The literature of transport and communication shows that very little empirical analysis has been done in the past (e.g., see Salomon 1985, 1986; Clark and Unwin, 1981). The aim of this paper is to present an empirical analysis of the demand for transport and communication. We use the popular system-wide approach to consumption economics (e.g., see Theil and Clements, 1987; Clements and Selvanathan, 1988; and Selvanathan, 1988) to present an econometric analysis of the demand for these goods in two countries, the United Kingdom and Australia. This analysis will produce income and price elasticities of private transport, public transport and communication which are the heart of economic policy decisions. In addition, our analysis will also shed some light on the question whether consumer behaviour is the same in the two countries.

The organisation of the paper is as follows: Section 2 presents the data sources and a preliminary data analysis. In Section 3, we analyse the demand for all goods by considering four goods, private transport, public transport, communication and all other goods. The next section presents a conditional analysis of the first three goods within the transport and communication group. Finally, in Section 5 we give our concluding comments.

2. The Basic Data

The basic data, consisting of annual consumption expenditures (in current and constant prices) and population for the United Kingdom and Australia are from various issues of Annual Abstract of Statistics,

Australian National Accounts, National Income and Expenditure and International Financial Statistics Year Books; see the appendix (available on request from the author) for details. Let p_{it} be the price and q_{it} the per capita quantity consumed of good i during year t. The transport and communication group (say, group g) is classified into 3 goods, namely, private transport (i=1), public transport (i=2) and communication (i=3).

Table 1 presents the quantity and price data for the UK and Australia in log-changes, $Dq_{it} = \ln q_{it} - \ln q_{i,t-1}$ and $Dp_{it} = \ln p_{it} - \ln p_{i,t-1}$, i = 1,2,3. For each country, in the first three columns we give the quantity log-changes and in the last three columns the price log-changes. Looking at the last row of the table it can be seen that the per capita consumption of private transport, public transport and communication in the UK (Australia) increased by 5.0 (2.6) percent, .9 (1.0) percent and 5.2 (5.4) percent per annum, respectively. The corresponding average annual price increases for the UK (Australia) are 7.2 (6.3), 8.5 (7.0) and 7.5 (5.9) percent. In both countries public tansport has the largest growth in prices and the lowest growth in consumption.

Table 2 presents the unconditional ($\bar{w}_{it}$), group ($\bar{W}_{gt}$) and conditional ($\bar{w}^{!}_{it}$) budget shares in arithmetic average form, $\bar{w}_{it} = {}^{1}/_{2}(w_{it} + w_{i,t-1})$, $\bar{W}_{gt} = {}^{1}/_{2}(W_{gt} + W_{g,t-1})$, and $\bar{w}^{!}_{it} = {}^{1}/_{2}(w^{!}_{it} + w^{!}_{i,t-1})$, where $w_{it} = p_{it}q_{it}/M_t$ with M_t the total consumption expenditure; $W_{gt} = \Sigma_{i=1}^{3} p_{it}q_{it}/M_t$; and $w^{!}_{it} = p_{it}q_{it}/\Sigma_{i=1}^{3} p_{it}q_{it}$, i = 1,2,3. Clearly, $W_{gt} = \Sigma_{i=1}^{3} w_{it}$ and $w^{!}_{it} = w_{it}/W_{gt}$. Columns 2-5 and 9-12 of the table give the unconditional budget shares of private transport, public transport and communication as well as their total (group budget share) for the UK and Australia. These are the proportions of total consumption expenditure devoted to each good. Columns 6-8 and 13-15 of the table give the conditional budget shares,

Table 1

Quantity and Price Log-changes for Transport and Communication:

The United Kingdom and Australia, 1960-1986

Year	United Kingdom						Australia					
	Quantities			Prices			Quantities			Prices		
	Private transport	Public transport	Communi-cation	Private transport	Public transport	Communi-cation	Private transport	Public transport	Communi-cation	Private transport	Public transport	Communi-cation
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1960	11.92	-1.48	5.56	-.84	5.90	-.10	1.69	-1.96	-4.87	.13	4.26	5.61
1961	-.47	-1.49	2.92	-.02	6.05	1.08	.79	-2.75	9.45	-2.35	.43	-.51
1962	10.71	-.87	-.87	.01	4.69	6.58	20.69	-.65	1.69	-.42	2.26	.27
1963	16.71	1.01	4.34	-3.98	3.11	2.52	11.23	2.62	2.61	-2.16	1.24	-.86
1964	12.65	2.10	5.17	1.45	3.46	2.21	5.25	2.00	10.57	1.24	4.53	7.11
1965	3.27	-1.64	8.50	3.95	6.01	3.69	-1.49	.51	7.25	1.57	3.83	1.88
1966	5.59	.44	1.29	1.81	5.63	4.19	4.70	-.06	5.75	2.35	7.34	-.89
1967	8.08	-1.06	5.58	3.25	3.86	3.77	10.49	1.44	2.44	2.38	4.33	10.41
1968	7.65	-1.69	3.32	5.12	7.51	-.55	7.00	.09	7.19	2.74	5.86	2.98
1969	-2.77	2.72	6.09	6.39	4.49	6.87	5.93	5.78	8.59	3.94	4.72	3.52
1970	7.14	1.20	10.86	4.42	6.49	6.05	2.34	-1.34	9.16	5.86	8.36	6.66
1971	13.16	-.03	.50	7.20	12.73	13.57	1.43	-6.43	5.72	5.86	10.81	13.72
1972	11.22	5.86	11.38	4.72	4.61	3.55	2.21	5.98	8.72	4.45	3.75	3.72
1973	1.01	5.20	10.56	11.42	7.47	7.62	1.00	2.13	14.64	10.58	4.95	.33
1974	-11.68	-2.91	3.55	21.23	13.64	12.90	.64	-3.28	5.01	18.70	14.95	17.63
1975	1.81	-1.83	-.48	25.02	25.13	35.71	-1.66	1.36	-5.74	15.93	17.12	37.12
1976	5.21	-3.70	6.27	12.71	20.92	21.38	2.90	1.86	4.64	8.94	7.67	8.38
1977	-2.93	.30	6.02	16.23	13.06	-4.16	-2.36	1.67	8.00	7.98	7.50	.96
1978	10.47	1.61	9.90	10.86	12.21	6.81	3.63	6.31	8.03	9.31	4.14	2.95
1979	5.86	5.46	11.65	19.27	11.98	2.10	3.67	1.82	7.99	12.62	11.03	1.47
1980	-1.31	1.71	4.24	13.40	20.04	24.24	-.08	-5.84	11.36	8.23	16.28	.74
1981	.70	-.57	.66	8.87	8.33	20.35	.54	.34	5.31	8.41	10.56	6.77
1982	2.69	-2.57	.32	7.10	8.11	10.19	-.75	3.04	-6.52	11.58	6.53	9.78
1983	8.67	2.81	3.12	4.19	6.90	-.61	-2.82	-1.30	4.49	7.85	9.52	7.74
1984	-1.23	5.24	7.16	4.91	.35	2.94	.67	9.26	5.50	9.86	4.86	4.31
1985	4.17	3.95	5.51	5.40	2.92	5.33	-1.30	-.04	5.38	7.90	6.68	4.74
1986	6.85	5.55	6.23	-.41	3.34	5.31	-7.29	2.58	3.40	7.70	4.69	3.67
Mean	5.01	.94	5.16	7.17	8.48	7.54	2.56	.95	5.40	6.34	6.97	5.93

All entries are to be divided by 100.

Table 2

Arithmetic Averages of Unconditional and Conditional Budget Shares for Transport and Communication:

The United Kingdom and Australia, 1960-1986

(Percentages)

Year	United Kingdom							Australia						
	Unconditional				Conditional			Unconditional				Conditional		
	Private	Public	Communi-cation	Total	Private	Public	Communi-cation	Private	Public	Communi-cation	Total	Private	Public	Communi-cation
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1960	5.84	3.38	.82	10.05	58.17	33.64	8.19	8.99	3.66	.75	13.39	67.12	27.31	5.57
1961	5.89	3.38	.83	10.10	58.34	33.48	8.17	8.79	3.57	.77	13.13	66.96	27.21	5.83
1962	5.92	3.37	.83	10.12	58.54	33.28	8.18	9.38	3.45	.78	13.61	68.91	25.34	5.75
1963	6.32	3.32	.84	10.48	60.30	31.72	7.98	10.25	3.35	.75	14.36	71.39	23.36	5.25
1964	6.82	3.29	.85	10.96	62.23	30.04	7.73	10.45	3.33	.79	14.57	71.74	22.87	5.39
1965	7.15	3.26	.88	11.29	63.31	28.89	7.80	10.28	3.35	.85	14.48	70.98	23.12	5.89
1966	7.28	3.25	.91	11.45	63.61	28.43	7.96	10.11	3.37	.87	14.35	70.47	23.48	6.05
1967	7.63	3.24	.94	11.80	64.61	27.47	7.92	10.45	3.36	.89	14.71	71.09	22.88	6.04
1968	8.12	3.20	.94	12.25	66.26	26.08	7.66	10.90	3.32	.93	15.15	71.94	21.93	6.12
1969	8.26	3.20	.95	12.41	66.56	25.77	7.67	11.16	3.36	.96	15.48	72.13	21.65	6.22
1970	8.32	3.22	1.03	12.57	66.20	25.59	8.21	11.34	3.39	1.03	15.76	71.94	21.53	6.53
1971	8.89	3.24	1.10	13.22	67.21	24.51	8.28	11.35	3.33	1.14	15.82	71.76	21.04	7.19
1972	9.51	3.25	1.13	13.89	68.46	23.40	8.14	11.13	3.26	1.22	15.61	71.29	20.91	7.80
1973	9.65	3.21	1.18	14.05	68.74	22.89	8.37	10.73	3.13	1.23	15.09	71.12	20.73	8.15
1974	9.37	3.14	1.22	13.73	68.26	22.89	8.85	10.60	2.91	1.26	14.76	71.80	19.69	8.51
1975	9.44	3.13	1.32	13.90	67.95	22.51	9.54	10.56	2.85	1.39	14.80	71.38	19.23	9.39
1976	9.87	3.20	1.52	14.59	67.66	21.95	10.39	10.46	2.85	1.50	14.81	70.63	19.22	10.15
1977	10.00	3.23	1.52	14.75	67.76	21.92	10.32	10.27	2.81	1.51	14.59	70.39	19.26	10.35
1978	10.36	3.23	1.45	15.03	68.89	21.45	9.66	10.18	2.81	1.51	14.49	70.23	19.37	10.40
1979	11.19	3.23	1.45	15.87	70.52	20.35	9.13	10.59	2.84	1.50	14.94	70.92	19.03	10.04
1980	11.50	3.36	1.53	16.39	70.18	20.48	9.34	10.76	2.87	1.50	15.14	71.10	18.98	9.93
1981	11.32	3.43	1.73	16.48	68.67	20.84	10.49	10.49	2.86	1.52	14.87	70.56	19.23	10.21
1982	11.33	3.34	1.84	16.50	68.65	20.21	11.13	10.33	2.83	1.46	14.62	70.66	19.33	10.01
1983	11.61	3.29	1.79	16.69	69.53	19.72	10.75	10.10	2.79	1.43	14.32	70.55	19.48	9.96
1984	11.67	3.29	1.77	16.73	69.76	19.67	10.57	10.02	2.86	1.46	14.35	69.85	19.96	10.19
1985	11.57	3.25	1.82	16.64	69.53	19.52	10.95	9.99	2.91	1.48	14.38	69.51	20.21	10.28
1986	11.49	3.22	1.87	16.58	69.30	19.43	11.27	9.52	2.86	1.48	13.87	68.67	20.65	10.68
Mean	9.12	3.27	1.26	13.65	66.27	24.67	9.06	10.34	3.12	1.18	14.65	70.56	21.37	8.07

which are the proportions of expenditure on transport and communication devoted to each category within that group.

At sample means, the British (Australians) spend 9.1 (10.3) percent of their income on consumption of private transport, 3.3 (3.1) percent on public transport, 1.3 (1.2) percent on communication. On average, transport and communication as a whole absorbs about 14 (15) percent of the consumers' income in the UK (Australia). As can be seen, in both countries, the share of communication in the total consumption expenditure almost doubled during the sample period (see columns 4 and 11 of Table 2). On the other hand, the share of private transport steadily increases in the UK, whereas in Australia it initially rises and then steadily decreases; the share of public transport is more or less constant in the UK, but decreases in Australia. The share of transport and communication in total consumption expenditure increases steadily for the UK while it fluctuates around the mean value for Australia (see columns 5 and 12 of Table 2). Looking at the columns for conditional budget shares we see that within transport and communication the share for communication increases while that of public transport decreases in both countries; the share for private transport initially increases, but then declines during recent years in both countries. At sample means, the British (Australians) allocate 66 (71) percent of their expenditure on transport and communication to private transport, 25 (21) percent to public transport and the remaining 9 (8) percent to communication.

Now we summarize the above information in the form of Divisia indexes. The Divisia volume and price indexes are defined as

$$DQ_{gt} = \sum_{i=1}^{3} \bar{w}^{!}_{it} Dq_{it} \qquad \text{and} \qquad DP_{gt} = \sum_{i=1}^{3} \bar{w}^{!}_{it} Dp_{it}.$$

These are budget-share weighted averages of quantities and prices. The corresponding second-order moments are the Divisia quantity variance, price variances and price-quantity covariances defined as

$$K_{gt} = \sum_{i=1}^{3} \bar{w}^{!}_{it}(Dq_{it} - DQ_{gt})^2, \qquad \Pi_{gt} = \sum_{i=1}^{3} \bar{w}^{!}_{it}(Dp_{it} - DP_{gt})^2$$

and

$$\Gamma_{gt} = \sum_{i=1}^{3} \bar{w}^{!}_{it}(Dq_{it} - DQ_{gt})(Dp_{it} - DP_{gt}).$$

We also define the Divisia price-quantity correlation,

$$\rho_{gt} = \frac{\Gamma_{gt}}{\sqrt{K_{gt}\Pi_{gt}}},$$

which measures the co-movement of consumption and prices. Table 3 presents the Divisia price and volume indexes as well as the price-quantity correlation for both countries. Columns 2-3 and 5-6 of the table show the Divisia price and volume indexes for the two countries. Looking at the last row of the table we see that, on average, the price of transport and communication as a whole increases by 7.6 (6.4) percent per annum in the UK (Australia) and consumption increases by 3.9 (2.4) percent per annum. The price-quantity correlation is negative in 24 (23) out of the 27 cases, and for both countries has an average of -.6. This negative value reflects the tendency of consumers to move away from those categories of transport and communication having above average price increases.

The relative quantity changes ($Dq_i - DQ_g$) and price changes ($Dp_i - DP_g$) within the transport and communication group (at sample means) are:

Table 3

Divisia Indexes of Transport and Communication:

The United Kingdom and Australia, 1960-1986

Year	United Kingdom			Australia		
	Price index DP_g	Quantity index DQ_g	Price-quantity correlation ρ_g	Price index DP_g	Quantity index DQ_g	Price-quantity correlation ρ_g
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1960	1.49	6.89	-.98	1.56	.33	-.99
1961	2.11	-.53	-.51	-1.48	.33	-.40
1962	2.10	5.91	-.98	.30	14.17	-.95
1963	-1.21	10.74	-1.00	-1.29	8.77	-.95
1964	2.12	8.90	-.98	2.30	4.79	-.08
1965	4.52	2.26	-.91	2.11	-.51	.34
1966	3.08	3.78	-.99	3.33	3.65	-.98
1967	3.46	5.37	-.94	3.31	7.93	-.70
1968	5.31	4.88	-.43	3.44	5.50	-1.00
1969	5.94	-.68	-.54	4.09	6.06	-.49
1970	5.09	5.93	-.67	6.45	1.99	-.58
1971	9.09	8.87	-1.00	7.47	.09	-.38
1972	4.60	9.98	-.03	4.25	3.51	-.96
1973	10.20	2.77	-.88	8.58	2.34	-.81
1974	18.76	-8.33	-.96	17.87	.24	.69
1975	26.06	.77	-.28	18.15	-1.46	-.71
1976	15.41	3.36	-.69	8.64	2.88	.41
1977	13.43	-1.30	-.96	7.16	-.51	-.92
1978	10.76	8.51	-.50	7.65	4.71	-1.00
1979	16.22	6.30	-.79	11.20	3.75	-.79
1980	15.77	-.17	1.00	9.02	-.04	-.95
1981	9.96	.43	.21	8.65	.99	-.65
1982	7.65	1.36	-.56	10.43	-.59	-.51
1983	4.21	6.92	-.05	8.16	-1.80	.06
1984	3.81	.93	-.86	8.30	2.88	-.94
1985	4.91	4.27	.34	7.31	-.36	-.96
1986	.96	6.53	-.82	6.65	-4.11	-.99
Mean	7.62	3.88	-.58	6.43	2.43	-.60

All entries in columns 2-3 and 5-6 are to be divided by 100.

Good i	United Kingdom		Australia	
	$Dq_i - DQ_g$	$Dp_i - Dp_g$	$Dq_i - DQ_g$	$Dp_i - DP_g$
Private transport	1.13	-.45	.13	-.09
Public transport	-2.94	.86	-1.48	.54
Communication	1.28	-.08	2.97	-.50

As can be seen, for both countries, private transport and communication have positive relative consumption growth and negative relative price growth; and public transport has a negative consumption growth and positive growth in price. This shows that, in general, positive price growth reduces the growth in consumption. In conclusion, the analysis of this section points in the direction of similar consumption patterns of transport and communication across the two countries.

3. Demand for Transport and Communication: An Unconditional Analysis

In this section we consider all consumer goods and analyse the demand for transport and communication given the consumer's total consumption expenditure (unconditional demand analysis). In the following section, we present a within group demand analysis for transport and communication given the total consumption expenditure on the group (conditional demand analysis).

Now we estimate the unconditional demand equations for the four goods public transport (i=1), private transport (i=2), communication (i=3) and all other goods (i=4). These demand equations explain the demand for each good in terms of the total consumption expenditure (or income) and prices of all four goods. The unconditional Rotterdam demand equation for good i

(e.g., see Theil and Clements, 1987) is

$$(1) \qquad \bar{w}_{it} Dq_{it} = \theta_i DQ_t + \sum_{j=1}^{4} \pi_{ij} Dp_{jt} + \epsilon_{it}, \qquad i=1,\ldots,4,$$

where the θ_i's (i=1,...,4) are the unconditional marginal shares which satisfy $\Sigma_{i=1}^{4} \theta_i = 1$; $DQ_t = \Sigma_{i=1}^{4} \bar{w}_{it} Dq_{it}$ is the Divisia volume index of the change in the consumer's real income; the π_{ij}'s are the unconditional Slutsky coefficients; and the ϵ_{it}'s are serially independent and normally distributed error terms with zero means and a constant contemporaneous covariance matrix.

The marginal share θ_i answers the question, "if income increases by \$1, how much of that will be spent on i?". The Slutsky coefficient π_{ij} measures the effect of a change in the price of good j on the demand for i under the condition that income remains constant. These coefficients satisfy demand homogeneity and Slutsky symmetry,

$$(2) \qquad \sum_{j=1}^{4} \pi_{ij} = 0, \quad i=1,..,4, \qquad \pi_{ij} = \pi_{ji}, \quad i,j=1,\ldots,4,$$

and the 4 × 4 matrix $[\pi_{ij}]$ is negative semidefinite with rank 3. Demand homogeneity means that a proportionate change in all prices, total consumption expenditure remaining unchanged, does not effect the demand for any good. Slutsky symmetry means that when real income is held constant, the effect of an increase in the price of commodity j on the demand for i is equal to the effect of a price increase of i on the demand for j.

Dividing both sides of equation (1) by $\bar{w}_{it}$, we find the unconditional income and price elasticities are

$$(3) \qquad \eta_i = \frac{\theta_i}{\bar{w}_{it}} \qquad \text{and} \qquad \eta_{ij} = \frac{\pi_{ij}}{\bar{w}_{it}} .$$

We estimate (1) with a constant term α_i added subject to homogeneity and symmetry (2). Table 4 presents the estimates for the two countries. As can be seen, the estimates for the marginal shares are broadly similar in the two countries and are highly significant (communication in Australia being the only exception). The estimates for the UK (Australia) are .19 (.23) for private transport, .03 (.03) for public transport, .02 (.01) for communication and .76 (.73) for all other goods. These values indicate that when income increases by one pound (one dollar), expenditure on private transport increases by 19 pence (23 cents), on public transport by 3 pence (3 cents), on communication by 2 pence (1 cent) and on all other goods by 76 pence (73 cents); altogether 24 pence (27 cents) on transport and communication. For both countries all the diagonal elements of the Slutsky matrix $[\pi_{ij}]$ are negative as they should be and most of them are highly significant. All the off diagonal elements, except π_{34} for the UK, are positive indicating that all four goods are pairwise substitutes. The characteristic roots of $[\pi_{ij}]$ are UK: -7.86, -1.92, -.01, 0 and Australia: -8.90, -3.15, -.95, 0 (all ×100), which verifies that the matrix is negative semidefinite. A likelihood ratio test of homogeneity and symmetry yields a χ^2-value of 11.10 (for the UK) and 9.80 (for Australia), which are below the critical value of $\chi^2_6(.05) = 12.59$. Thus demand homogeneity and symmetry hypotheses are acceptable.

In Table 5 we present the income and price elasticities, implied by Table 4 estimates. These elasticities are calculated using (3) with $\bar{w}_{it}$ replaced by the mean value of $\bar{w}_{it}$ given in the last row of Table 2. Looking at columns 2 and 7 of Table 5 we see that the unconditional income elasticities for private transport, public transport, communication and other goods for the UK are 2.11, .98, 1.19 and .88 and for Australia are 2.27, .80, .50 and .86. These numbers show that in both countries

Table 4

Unconditional Demand Equations for Transport and Communication:

The United Kingdom and Australia, 1960-1986

$$\bar{w}_{it} Dq_{it} = \alpha_i + \theta_i DQ_t + \sum_{j=1}^{4} \pi_{ij} Dp_{jt} + \epsilon_{it}$$

(Asymptotic standard errors are in parentheses)

Good i	United Kingdom						Australia					
	Constant α_i ×1000	Marginal share θ_i	Slutsky coefficients (×100)				Constant α_i ×1000	Marginal share θ_i	Slutsky coefficients (×100)			
			π_{i1}	π_{i2}	π_{i3}	π_{i4}			π_{i1}	π_{i2}	π_{i3}	π_{i4}
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Private transport	-.010 (.836)	.192 (.030)	-4.854 (1.895)	.623 (.344)	.716 (.223)	3.515 (1.813)	-2.391 (1.070)	.235 (.041)	-5.644 (3.338)	1.544 (.709)	.374 (.405)	3.726 (3.240)
Public transport	-.203 (.155)	.032 (.006)		-1.347 (.337)	.112 (.135)	.612 (.527)	-.109 (.241)	.025 (.009)		-2.275 (.485)	.213 (.186)	.518 (.775)
Communi-cation	.362 (.101)	.015 (.004)			-.146 (.098)	-.682 (.296)	.475 (.138)	.006 (.005)			-.717 (.133)	.130 (.408)
Other	-.148 (.784)	.761 (.028)				-3.444 (1.957)	2.024 (1.054)	.734 (.041)				-4.374 (3.323)

Table 5

Unconditional Income and Price Elasticities for Transport and Communication: The United Kingdom and Australia, 1960-1986

Good i	United Kingdom					Australia				
	Income elasticity	Price elasticities				Income elasticity	Price elasticities			
	η_i	η_{i1}	η_{i2}	η_{i3}	η_{i4}	η_i	η_{i1}	η_{i2}	η_{i3}	η_{i4}
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Private transport	2.11	-.53	.07	.08	.39	2.27	-.55	.15	.04	.36
Public transport	.98	.19	-.41	.03	.19	.80	.49	-.73	.07	.17
Communi-cation	1.19	.57	.09	-.12	-.54	.50	.31	.18	-.60	.11
Other	.88	.04	.01	-.01	-.04	.86	.04	.01	.00	-.05

private transport is a luxury ($\eta_i > 1$) and public transport is a necessity ($\eta_i < 1$). Communication is a luxury in the UK while it is a necessity in Australia. The reason for this dissimilarity could be that the distances between the Australian cities are much larger than those in the UK. All price elasticities are less than one in absolute value for both countries. The own-price elasticities of private transport, public transport and communication are -.5, -.4 and -.1 for the UK, and -.6, -.7 and -.6 for Australia.

4. The Demand for Transport and Communication: A Conditional Analysis

The analysis we presented in the last section dealt with the demand for all goods (private transport, public transport, communication and all other goods). In this section we divide all goods into two groups. One, the transport and communication group formed by private transport (i=1), public transport (i=2) and communication (i=3) and the other, the group formed by all other goods (i=4). Previous empirical studies have shown that transport and communication as a group is separable from all other goods in the consumer's utility function (e.g., see S. Selvanathan, 1987). Therefore, such a partition is possible.

Under block independent preferences the conditional demand equation for good i (e.g., see Theil and Clements, 1987) is

$$(4) \qquad \bar{w}_{it} Dq_{it} = \theta_i^! \bar{w}_{gt} DQ_{gt} + \sum_{j=1}^{3} \pi_{ij}^{g} Dp_{jt} + \epsilon_{it}^{g}, \qquad i=1,2,3,$$

where $\theta_i^! = \theta_i/\Theta_g$ is the conditional marginal share of good i; $\Theta_g = \Sigma_{i=1}^{3} \theta_i$ is the group marginal share; $DQ_{gt} = \Sigma_{i=1}^{3} \bar{w}_{it}^{!} Dq_{it}$ is the Divisia volume

index for the transport and communication group; and π^g_{ij} is the conditional Slutsky coefficient.

The conditional demand equations explain the allocation of total expenditure on the transport and communication group in terms of the variable pertaining to that group. Comparing equation (1) with (4) we see that now the demand for good i in the transport and communication group is expressed in terms of the demand for the group as a whole ($\overline{W}_{gt}DQ_{gt}$) and the prices of the only three goods in that group.

The conditional marginal shares sum to one, $\Sigma_{i=1}^{3}\ \theta^!_i = 1$, and the conditional Slutsky coefficients satisfy demand homogeneity, $\Sigma_{j=1}^{3}\ \pi^g_{ij} = 0$, i=1,2,3, and Slutsky symmetry, $\pi^g_{ij} = \pi^g_{ji}$, i,j=1,2,3. The 3 × 3 conditional Slutsky matrix $[\pi^g_{ij}]$ is negative semidefinite with rank 2. The conditional marginal share $\theta^!_i$ answers the question, "if income increases by \$1, resulting in a certain additional amount spent on the group, what proportion of this additional amount will be devoted to good i?". Demand homogeneity for the group means that a proportionate change in prices of all goods in the group does not effect the demand for any good in the group, total consumption of the group remaining unchanged.

Now we estimate (4) using maximum likelihood with homogeneity and symmetry restrictions imposed. The estimates for the UK and Australia are presented in Table 6. The conditional marginal shares for all three goods in each country are highly significant, except that for communication in Australia. The estimates for the UK are .87, .10 and .03 for private transport, public transport and communication respectively. These figures indicate that due to an increase in income, if the expenditure on the transport and communication group in the UK increases by one pound, expenditure on private transport would increase by 87 pence, public transport by 10 pence and communication by 3 pence. For both countries all the diagonal elements of the Slutsky matrix are negative, as they should

Table 6

Conditional Demand Equations for Transport and Communication, The United Kingdom and Australia, 1960-1986

$$\bar{w}_{it}Dq_{it} = \alpha_i^g + \theta_i^! \bar{w}_{gt} DQ_{gt} + \sum_{j=1}^{3} \pi_{ij}^g Dp_{jt} + \epsilon_{it}^g$$

(Asymptotic standard errors are in parentheses)

Good i	United Kingdom					Australia				
	Constant	Conditional marginal share	Conditional Slutsky coefficients (×100)			Constant	Conditional marginal share	Conditional Slutsky coefficients (×100)		
	α_i^g ×1000	$\theta_i^!$	π_{i1}^g	π_{i2}^g	π_{i3}^g	α_i^g ×1000	$\theta_i^!$	π_{i1}^g	π_{i2}^g	π_{i3}^g
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Private transport	-.448 (.240)	.868 (.033)	-1.609 (.390)	1.148 (.300)	.461 (.153)	-.742 (.204)	.923 (.032)	-2.400 (.484)	1.951 (.421)	.450 (.196)
Public transport	-.067 (.171)	.100 (.024)		-1.024 (.293)	-.124 (.134)	.150 (.174)	.076 (.027)		-2.196 (.434)	.245 (.179)
Communication	.515 (.100)	.032 (.014)			-.337 (.090)	.592 (.102)	.001 (.016)			-.694 (.137)

Table 7

Conditional Demand Elasticities for Transport and Communication: The United Kingdom and Australia, 1960-1986

Good i	United Kingdom				Australia			
	Conditional income elasticity	Conditional price elasticities			Conditional income elasticity	Conditional price elasticities		
	$\eta_i^!$	$\eta_{i1}^!$	$\eta_{i2}^!$	$\eta_{i3}^!$	$\eta_i^!$	$\eta_{i1}^!$	$\eta_{i2}^!$	$\eta_{i3}^!$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Private transport	1.31	-.18	.13	.05	1.31	-.23	.19	.04
Public transport	.41	.35	-.31	-.04	.36	.63	-.70	.08
Communication	.35	.37	-.10	-.27	.01	.38	.20	-.58

be, and are highly significant. All the off-diagonal elements of the conditional Slutsky matrices, except π_{23}, in both countries are highly positively significant. This means that, in both countries, private transport and public transport, and private transport and communication are pairwise substitutes. According to the sign of π_{23}, public transport and communication are pairwise complements in the UK, and pairwise substitutes in Australia. The characteristic roots of the conditional Slutsky matrices are all nonpositive, which verifies that for each country this matrix is negative semidefinite. As before we use a likelihood ratio test to test homogeneity and symmetry. This gives a χ^2-value of 7.17 (for the UK) and 4.0 (for Australia), which are below the critical value of $\chi^2_3(.05) = 7.82$. Thus demand homogeneity and symmetry hypotheses within the group are also acceptable.

Dividing both sides of (4) by $\bar{w}_{it}$, we obtain the conditional income and price elasticities.

$$(5) \qquad \eta_i^! = \frac{\theta_i^!}{\bar{w}_{it}^!} \quad \text{and} \quad \eta_{ij}^! = \frac{\pi_{ij}^g}{\bar{w}_{it}}, \qquad i,j=1,2,3.$$

Table 7 presents the conditional demand elasticities (5) implied by the Table 6 estimates and the mean conditional budget shares presented in the last row of Table 2. Looking at columns 2 and 6 of the table we see that in both countries private transport is a conditional luxury ($\eta_i^! > 1$) and public transport and communication are conditional necessities ($\eta_i^! < 1$). All the conditional price elasticities are less than one in absolute value for both countries. The conditional income elasticities for the UK (Australia) are 1.3 (1.3), .4 (.4) and .4 (.01) for private transport, public transport and communication, respectively. The own-price elasticities for the UK are -.2, -.3 and -.3. The corresponding figures for Australia are -.2, -.7 and -.6.

5. Concluding Comments

In this paper we presented an analysis of the demand for transport and communication for the two countries, the United Kingdom and Australia. The analysis was carried out by considering the demand for all goods (unconditional) as well as the demand for goods within the transport and communication group (conditional). We applied the system-wide approach to consumption economics to obtain income and price elasticities for private transport, public transport and communication.

Table 8 presents a summary of results for the two countries. Rows 1 and 2 of the table give the average growth rate in consumption and prices, rows 3-6 present the unconditional and conditional budget shares and the marginal shares for the 3 goods as well as for the group, and rows 7-10 present the unconditional and conditional demand elasticities. A comparison of the figures in the first 6 rows for the UK with the corresponding figures for Australia reveals that they are broadly similar. In both countries, on average, the annual growth in consumption of transport and communication increased by 2 to 4 percent, while prices increased by 6 to 8 percent (see rows 1 and 2 of columns 5 and 9). It can also be seen that, consumers in both countries allocate approximately 14 to 15 percent of their income to transport and communication (see row 3 of columns 5 and 9). A one pound (dollar) increase in income will increase the expenditure on transport and communication by 24 pence (27 cents) in the UK (Australia) (see row 5 of columns 5 and 9). The estimates for the income elasticity of transport and communication as a whole for each of the UK and Australia presented in the table (see row 7 of columns 5 and 9) are well in agreement with the previous findings reported in the OECD cross-country consumption study of S. Selvanathan (1987). In both countries transport and communication as a group is a luxury. Looking at row 8 it can be seen that, the own-price elasticity of transport and

Table 8

Summary Results for Transport and Communication:

The United Kingdom and Australia, 1960-1986

Statistic	United Kingdom				Australia			
	Private transport	Public transport	Communi-cation	Group	Private transport	Public transport	Communi-cation	Group
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. Annual growth in consumption	5.0	.9	5.2	3.9	2.6	1.0	5.4	2.4
2. Annual growth in prices	7.2	8.5	7.5	7.6	6.3	7.0	5.9	6.4
3. Unconditional budget shares	9.1	3.3	1.3	13.7	10.3	3.1	1.2	14.7
4. Conditional budget shares	66.3	24.7	9.1	-	70.6	21.4	8.1	-
5. Unconditional marginal shares	19.2	3.2	1.5	23.9	23.5	2.5	.6	26.6
6. Conditional marginal shares	86.8	10.0	3.2	-	92.3	7.6	.1	-
7. Unconditional income elasticities	2.1	1.0	1.2	1.8	2.3	.8	.5	1.8
8. Unconditional own-price elasticities	-.5	-.4	-.1	-.7	-.6	-.7	-.6	-.8
9. Conditional income elasticities	1.3	.4	.4	-	1.3	.4	.0	-
10. Conditional own-price elasticities	-.2	-.3	-.3	-	-.2	-.7	-.6	-

All entries in rows 1-6 are annual averages and are to be divided by 100. The group marginal shares presented in row 5 of columns 5 and 9 for the two countries are obtained by summing the three unconditional marginal shares presented in columns 2-4 and 6-8, respectively, of the same row. The income elasticity for the group given in row 7 is the ratio of the group marginal share to the group budget share; 23.9/13.7 = 1.74 for the UK and 26.6/14.7 = 1.81 for Australia. The own-price elasticity for the group presented in row 8 is obtained by multiplying the income elasticity of the group by the income flexibility of that country; -.40 × 1.75 = -.70 for the UK and -.46 × 1.82 = -.84 for Australia; source of the income flexibility (-.40 for the UK and -.46 for Australia) is S. Selvanathan (1987).

communication is -.8 for the UK and -.7 for Australia. Within the group (see row 9), private transport is a conditional luxury and public transport and communication are conditional necessities for both countries. All own-price elasticities (conditional and unconditional) are less than one in absolute value indicating that the demand for the three goods are price inelastic. We also find that, in both countries, transport and communication are pairwise substitutes.

The immediate use of the results of this study is for policy analysis

about private transport, public transport and communication. In addition, the results can also be used to forecast the demand for transport and communication at a future time in a system-wide manner. Furthermore, the analysis can be extended to analyse the demand for goods within public transport (e.g., bus and train services) and communication (e.g., telephone and postal services).

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