THE UNIVERSITY OF
WESTERN AUSTRALIA

Business School

COMPARING INTERNATIONAL CONSUMPTION PATTERNS*

by

Kenneth W Clements

Yanrui Wu

Jing Zhang

Economics Program
The University of Western Australia
35 Stirling Highway, Crawley WA 6009
Tel: 08 9380 3964
Fax: 08 9380 1016

*This research was supported in part by a grant from ACIAR. For excellent research assistance, we would like to acknowledge the help of Yihui Lan and Clare Yu; and for his support, stimulus and comments, we would like to acknowledge the help of Ray Trewin.

COMPARING INTERNATIONAL CONSUMPTION PATTERNS

Abstract When attempting to identify empirical regularities in consumption patterns, their tremendous diversity across countries represents both a major opportunity and challenge. For example, consumers in rich countries devote less than 20 percent of their budget to food, while this rises to more than 50 percent in the poorest countries. This paper uses a major new database released in Selvanathan and Selvanathan (2003) to explore several related issues, including the extent to which the consumption basket is diversified and how this changes with income, whether a simple utility-maximising model is capable of explaining the diversity of consumption patterns internationally, the measurement of the extent to which tastes differ across countries, and how the world can be partitioned into groups of countries with minimal within-group heterogeneity of tastes on the basis of the revealed preference of consumers.

Key Words: cross country comparison, consumption patterns, income and price elasticity.

JEL Codes: D12, C20

COMPARING INTERNATIONAL CONSUMPTION PATTERNS

1. Introduction

Why do consumers in the poorest countries in the world devote more than one-half of their budgets to expenditure on food, while in the rich countries food absorbs only 20 percent or less? This behaviour is usually explained in terms of Engel's law, whereby the income elasticity of demand for food is less than unity. As this law has been confirmed time and time again (Houthakker, 1987) and is one of the most pervasive and useful in all of economics, having a status similar to, say, the quantity theory of money, it might be profitable to investigate whether there are other patterns in consumption that may have a similar validity and be equally useful. With this idea in mind, in this paper we use a major, new body of international consumption data recently published in a book by Selvanathan and Selvanathan (2003) to analyse cross-country patterns and empirical regularities in consumption.¹ We also investigate the extent to which a simple utility-maximising model is capable of explaining the tremendous diversity of cross-country consumption patterns, the extent to which tastes can be said to differ internationally, and explore possible ways of grouping countries on the basis of the "similarity" of consumption.

Whenever cross-country comparisons of economic data are made, almost inevitably there is the troublesome problem of how to convert from one currency unit to another. For example, a direct comparison of incomes in the USA and India requires that incomes in both countries be expressed in terms of a common currency. There are several approaches to this problem, all of which have their own weaknesses. The problem associated with using prevailing exchange rates is the Balassa (1964)-Samuelson (1964) productivity bias hypothesis, which has the effect of making rich countries look even richer and the poor poorer. This occurs because international productivity differences in the production of traded goods cause nontraded goods to be relatively more expensive in rich countries and cheaper in poor

¹ Apart from Selvanathan and Selvanathan (2003), other studies on international comparisons of consumption patterns include Clarke (1940, 1957), Chen (1999), Clements and Chen (1996), Clements and Ye (2003), Clements and S. Selvanathan (1994), Houthakker (1957), Kravis et al. (1982, Chap. 9), Lluch and Powell (1975), Lluch et al. (1977), S. Selvanathan (1993), E. A. Selvanathan and S. Selvanathan (2003), Theil (1987, 1996), Theil et al. (1989) and Theil and Suhm (1981).

countries. As nontraded goods prices are not fully reflected in prevailing exchange rates, the result is an artificial amplification of world income inequality. A second approach is to use purchasing power parities (PPP).² While PPP values have much more appeal than prevailing exchange rates, they still do not enjoy universal acceptance due to problems associated with the choice of the base period, disagreement regarding the length of time needed for PPP to hold, what price indexes should be used in calculating the parities, disputation about the direction of causality, and so on. Paraphrasing Friedman (1956) and Laidler (1991), it could therefore be said that “PPP is always and everywhere controversial”. A distinguishing feature of this paper is the emphasis on dimensionless concepts such as budget shares and changes in the logarithms of prices and quantities, which are independent of currency units. The approach we employ, which has been previously used by Clements and Chen (1996) and Chen (1999), has the major benefit of avoiding many of the problems associated with exchange-rate conversions of incomes, expenditures and consumption.

The plan of the paper is as follows. In the next section we provide an overview of the data from the Selvanathan and Selvanathan (2003), as well as a summary of the data in the form of price and volume indexes. The theory and measurement of the diversity of the consumption basket is dealt with in Section 3. Then, in Section 4, we discuss issues related to the income and price sensitivity of consumption. We use in Section 5 cross-country demand equations to explain consumption patterns in 45 countries, and provide an analysis of the quality of these predictions. Section 6 deals with issues of disparities of tastes internationally, and how optimal groups of countries can be constructed on this basis. Section 7 contains concluding comments.

² PPP rates are either produced by the International Comparisons Project (see, e.g., Summers and Heston, 1991) or by some other body such as the famous Big Mac Index published by The Economist magazine (see Ong, 2003). A related approach is to use a measure of the “equilibrium exchange rate”, computed from either econometrically-estimated trade/current account equations, or a computable general equilibrium model (see, e.g., Clarke and MacDonald, 1998, Driver and Westaway, 2001, MacDonald, 2000, Montiel and Hinkle, 1999, Williamson, 1994, and Wren-Lewis and Driver, 1998). A recent innovation in this area is by Lan (2003) who relates the equilibrium exchange rate to the steady-state value associated with a simple time-series model of the deviations from PPP. More recently, Chua (2003) presented a study comparing cross-country income on the basis of food consumption patterns.

2. Consumption in 45 Countries

Selvanathan and Selvanathan (2003) present detailed consumption data for a large number of countries, both developed and developing. They use these data to compute indexes of price and quantities, estimate income and price elasticities of demand for the broad aggregates such as food, clothing, housing, etc., carry out extensive hypotheses testing, as well as much other interesting analysis. In this section and the next, we draw extensively on the Selvanathans' work to present a summary of their data and their elasticities. Unless otherwise noted, the source for all the subsequent data and estimates is Selvanathan and Selvanathan (2003); see the Appendix for detailed information regarding our use of the Selvanathans' data and results.

Table 1 presents in columns 1 – 4 the names of the 45 countries to be subsequently used, the underlying sample period and per capita income. Countries are listed in terms of decreasing per capita GDP and as can be seen, the USA is the richest and Zimbabwe is the poorest with an income of about 6 percent that of the USA. We will return to columns 5 and 6 of the table.

Let p_i and q_i be the price and per capita quantity consumed of good i , so that $p_i q_i$ is expenditure on that good. If there are n goods, then $M = \sum_{i=1}^n p_i q_i$ is total expenditure, and $w_i = p_i q_i / M$ is the proportion of this total expenditure devoted to good i . This w_i is known as the budget share of good i . Table 2 presents the budget shares in the 45 countries for $n = 8$ goods. These w_i are averages over each year included in the relevant sample period indicated in column 2 of Table 1. Several interesting features emerge from Table 2. First, food is the dominant good as it has the largest single budget share in all countries except three. The three exceptions to this rule are the USA, Canada and New Zealand, where the budget share of housing exceeds that of food. Averaging over all countries, the food budget share is 32 percent, and in some of the poorest countries food absorbs more than one-half of the consumer's budget. Second, there is a distinct tendency for the food budget share to rise

TABLE 1
INCOME, PRICES AND CONSUMPTION IN 45 COUNTRIES

Country	Sample period	Per capita GDP in 1992		Divisia price and volume indexes ($\times 100$)	
		International dollars	With US = 100	Price index	Volume index
(1)	(2)	(3)	(4)	(5)	(6)
1. USA	1961-1996	23,220	100	4.49	2.25
2. Switzerland	1961-1994	21,631	93	4.09	1.40
3. Luxembourg	1970-1991	21,144	91	5.62	2.84
4. Hong Kong	1970-1995	21,034	91	7.92	5.16
5. Canada	1960-1997	20,970	90	4.67	2.24
6. Germany	1961-1994	20,197	87	3.37	2.62
7. Japan	1970-1997	19,920	86	4.09	2.96
8. Denmark	1966-1995	18,730	81	6.41	1.71
9. Australia	1960-1996	18,500	80	6.04	2.25
10. Sweden	1963-1996	18,387	79	6.71	1.21
11. France	1964-1996	18,232	79	5.79	2.54
12. Belgium	1960-1995	18,091	78	4.40	2.44
13. Netherlands	1952-1996	17,373	75	3.89	2.82
14. Norway	1964-1996	17,094	74	6.05	2.38
15. Austria	1964-1996	16,989	73	4.23	2.36
16. Singapore	1963-1995	16,736	72	2.95	4.30
17. Italy	1964-1996	16,724	72	9.27	2.63
18. Iceland	1977-1996	16,324	70	22.77	1.55
19. UK	1961-1996	16,302	70	6.89	2.05
20. Finland	1960-1996	15,619	67	6.35	2.74
21. New Zealand	1983-1995	15,502	67	6.29	1.56
22. Spain	1964-1996	12,986	56	9.27	2.77
23. Israel	1970-1995	12,783	55	42.07	3.24
24. Ireland	1973-1996	12,259	53	8.94	1.67
25. Cyprus	1980-1994	11,742	51	4.95	5.29
26. Taiwan	1962-1997	9,850	42	5.08	6.32
27. Korea	1974-1996	9,358	40	9.50	5.88
28. Portugal	1986-1995	9,005	39	8.77	3.82
29. Greece	1961-1995	8,658	37	11.21	3.31
30. Venezuela	1984-1995	8,449	36	30.96	-.13
31. Mexico	1970-1998	7,867	34	28.57	1.14
32. Malta	1974-1993	7,625	33	3.79	4.69
33. Puerto Rico	1963-1994	7,120	31	4.20	2.71
34. Hungary	1983-1994	5,780	25	15.43	.09
35. Fiji	1977-1991	5,288	23	7.36	-.11
36. Thailand	1976-1995	5,018	22	5.68	4.83
37. Colombia	1972-1992	4,254	18	22.00	1.67
38. Iran	1983-1995	4,161	18	19.45	.27
39. South Africa	1960-1995	3,885	17	9.23	.76
40. Ecuador	1973-1993	3,420	15	26.61	1.47
41. Jamaica	1974-1988	2,978	13	14.57	-.14
42. Sri Lanka	1974-1995	2,783	12	11.35	1.88
43. Honduras	1970-1982	1,792	8	7.65	.89
44. India	1980-1995	1,633	7	8.13	2.08
45. Zimbabwe	1975-1987	1,479	6	11.61	-4.35
46. Mean					
Countries 1-25	-	17,244	76	7.90	2.60
Countries 26-45	-	5,520	24	13.06	1.85
Countries 1-45	-	12,198	53	10.32	2.27

TABLE 2
BUDGET SHARES OF 8 COMMODITIES FOR 45 COUNTRIES

Country	Food	Clothing	Housing	Durables	Medical	Transport	Recreation	Other
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. USA	15.80	7.17	19.12	6.72	12.18	15.38	6.86	16.77
2. Switzerland	30.43	5.85	18.85	6.74	7.90	11.32	9.66	9.24
3. Luxembourg	23.85	7.49	19.07	9.81	6.75	15.34	3.82	13.88
4. Hong Kong	25.54	18.40	14.56	11.17	5.75	8.21	7.14	9.24
5. Canada	19.95	7.23	20.80	9.23	4.09	14.90	6.93	16.88
6. Germany	27.00	9.57	18.24	10.57	3.02	14.31	9.25	8.05
7. Japan	23.23	7.05	18.47	6.09	9.68	10.17	10.43	14.86
8. Denmark	25.42	6.33	23.65	7.90	2.03	15.68	8.07	10.92
9. Australia	25.47	7.79	17.71	7.62	6.43	14.59	6.57	13.81
10. Sweden	25.52	7.65	24.78	6.78	2.82	15.10	9.28	8.07
11. France	22.93	7.39	16.66	9.22	10.06	13.95	6.39	13.40
12. Belgium	25.65	7.54	16.76	12.60	8.49	11.48	5.02	12.47
13. Netherlands	26.04	10.94	14.33	10.09	9.29	9.33	8.09	11.89
14. Norway	27.27	8.71	18.32	7.96	3.09	14.63	8.27	11.76
15. Austria	25.05	10.53	14.55	8.40	3.88	14.30	6.28	17.00
16. Singapore	26.24	8.23	10.33	8.43	3.13	13.41	11.94	18.29
17. Italy	30.14	9.57	13.94	7.81	4.84	11.31	7.40	15.00
18. Iceland	25.19	8.83	18.00	10.26	1.67	15.98	8.58	11.48
19. UK	24.43	7.69	18.30	7.28	1.13	14.69	8.42	18.05
20. Finland	29.85	6.72	18.65	6.85	3.30	15.11	8.18	11.43
21. New Zealand	18.42	5.25	18.49	11.32	6.04	15.80	8.73	15.94
22. Spain	29.87	9.40	13.86	7.64	4.36	12.27	6.55	16.04
23. Israel	27.32	6.54	21.93	11.56	5.10	11.41	4.00	12.14
24. Ireland	38.93	6.98	13.09	6.87	2.94	12.92	7.25	11.02
25. Cyprus	27.19	10.01	7.88	11.03	2.86	16.81	6.50	17.72
26. Taiwan	42.32	5.09	16.85	4.69	5.19	7.21	11.46	7.18
27. Korea	39.77	6.38	10.62	5.97	5.13	10.52	10.27	11.34
28. Portugal	29.90	9.20	9.35	8.07	4.79	15.58	6.78	16.32
29. Greece	41.18	9.86	12.86	8.15	3.47	11.06	3.97	9.44
30. Venezuela	37.87	8.61	10.93	4.06	2.47	7.22	2.78	26.05
31. Mexico	35.05	8.54	10.73	11.46	3.83	10.81	5.50	14.07
32. Malta	34.66	8.36	6.30	10.07	3.69	14.84	6.60	15.48
33. Puerto Rico	29.00	9.33	14.60	8.38	5.70	14.46	6.36	12.17
34. Hungary	43.41	8.42	12.04	8.67	1.18	12.02	6.81	7.45
35. Fiji	37.81	7.60	15.78	9.81	2.23	14.40	4.84	7.53
36. Thailand	39.02	10.71	9.31	7.93	5.76	11.49	4.49	11.28
37. Colombia	37.75	6.77	11.90	5.80	5.82	14.06	3.99	13.92
38. Iran	41.95	10.79	25.85	6.29	4.23	5.78	1.88	3.22
39. South Africa	33.93	8.73	11.31	12.31	3.90	15.17	5.67	8.99
40. Ecuador	38.34	10.40	8.28	7.07	4.01	11.16	4.19	16.56
41. Jamaica	41.87	3.70	11.92	5.86	2.18	12.87	3.25	18.34
42. Sri Lanka	61.69	6.84	5.08	4.41	1.62	12.94	3.74	3.67
43. Honduras	46.25	10.22	20.58	7.90	6.93	3.10	2.47	2.56
44. India	54.53	10.90	11.18	4.32	2.68	9.10	1.44	5.86
45. Zimbabwe	33.99	12.18	15.24	10.29	4.78	2.20	4.86	16.45
46. Mean								
Countries 1-25	25.87	8.35	17.21	8.80	5.23	13.54	7.58	13.41
Countries 26-45	40.01	8.63	12.54	7.58	3.98	10.80	5.07	11.39
Countries 1-45	32.16	8.48	15.13	8.25	4.68	12.32	6.47	12.52

Note: All entries are to be divided by 100.

as we go down column 2 of Table 2, i.e., as GDP per capita falls. This tendency is in agreement with Engel's law. The feature is also illustrated in Figure 1, where the food share is plotted against GDP per capita. The figure shows that as the budget shares for Sri Lanka and Zimbabwe are a considerable distance away from the regression line, these shares are much different to those expected on the basis of income. Third, on average for this group of countries, housing has the second largest budget share, although there is considerable variability in this share. Fourth, the housing share tends to fall with GDP per capita. This can be clearly seen from the third last and second last entries in column 4 of Table 2 where the 45 countries are divided into two groups, (i) countries 1-25, whose per capita incomes are at least 50 percent of that of the USA (which we shall refer to as the "rich countries"); and (ii) countries 26-45, whose per capita incomes are below 50 percent that of the USA (the "poor" countries). For the first group, the average housing share is 17.2 percent, while it is 12.5 percent for the second.

Let $Dp_{it} = \log p_{it} - \log p_{i,t-1}$ and $Dq_{it} = \log q_{it} - \log q_{i,t-1}$ be the log-change in the i^{th} price and quantity consumed of good i from year $t-1$ to t ; when multiplied by 100, these log-changes are approximately annual percentage changes. If we write Dp_i and Dq_i for the averages of these log-changes, one way to summarise the change in the price of the consumption basket as a whole and its associated volume is via Divisia indexes:

$$DP = \sum_{i=1}^8 w_i Dp_i, \quad DQ = \sum_{i=1}^8 w_i Dq_i. \quad (2.1)$$

In words, the Divisia price index DP is a budget-share weighted average of the eight individual price log-changes; and similarly for the corresponding volume index DQ . These indexes are independent of currency units, expressed in terms of percent p.a. (when multiplied by 100) and directly comparable across countries. These indexes are given in columns 5 and 6 of Table 1, from which we see that the high-inflation countries tend to be among the poorer. That is, mean inflation for the rich countries is about 7.9 percent p.a., while for the poor countries it is 13.1 percent p.a.. For the 45 countries as a whole, the

FIGURE 1 FOOD BUDGET SHARE AND PER CAPITA GDP

average rate of inflation over the period considered is about 10.3 percent p.a. Regarding the value of the volume index, the country with the highest growth in per capita consumption is Taiwan (6.3 percent p.a.), followed by Korea (5.9 percent); the slowest growth occurred in Zimbabwe where the volume of per capita consumption fell by 4.4 percent p.a.. As a group, the Asian NICs distinguish themselves as rapid growers.

3. Diversity of the Consumption Basket

In this section we use information theoretic concepts to measure the extent to which consumption patterns are diversified over goods, and how this changes with income. This material is mainly based on Theil (1967, Chap. 4) and Theil and Finke (1983).

A very poor consumer will devote much of the budget to necessities and little to luxuries. But as income increases, the budget shares of necessities fall while those of luxuries rise, so that there is more diversity, or less specialisation, in the consumption basket. A natural measure of the diversity of consumption patterns is the entropy of the n budget shares $w_1, \dots, w_n$:

$$H = \sum_{i=1}^n w_i \log \frac{1}{w_i}. \quad (3.1)$$

This H takes a minimum of 0 when consumption is specialised in one good, so that $w_i = 1$ for some i and all other shares vanish. When each w_i equals $1/n$, then H takes its maximum value of $\log n$. When the budget shares are more equal, total expenditure is more widely spread over goods, so there is more diversity in the consumption basket. In this sense then, there is no contradiction in identifying more equality in the budget shares with greater diversity.

As indicted by the old saying “variety is the spice of life”, diversity is something that valued by most consumers.³ Thus as the entropy (3.1) is increasing in diversity, we would expect H to rise with GDP per capita. We pursue this matter by applying equation (3.1) to the $n = 8$ budget shares of Table 2, and the results are contained in column 2 of Table 3. As can be seen, there is a tendency for the entropy to decline as we go down the column, that is, as GDP per capita falls: For the USA, $H = 2.01$ which is only slightly below the maximum of $\log 8 \approx 2.08$. The lowest value of the entropy is for Sri Lanka, where $H = 1.33$. Recall that Figure 1 seems to suggest that Zimbabwe and Sri Lanka could be outlying countries with respect to food consumption. This is also reflected in their entropy values of column 2 of Table 3 -- the value of H for Zimbabwe is higher than those of its near neighbours, as its food budget share is lower, while H for Sri Lanka is lower for the opposite reason.

Next, we divide the n goods into $G < n$ groups, to be denoted by $S_1, \dots, S_G$, such that each good belongs to only one group. Let the budget share for group g be $W_g = \sum_{i \in S_g} w_i$. We can then express the entropy (3.1) as

³ Another way of making the same point is in the two-good case where $q_i^* = M/p_i$ is the maximum quantity the consumer can purchase of i ($i = 1, 2$) with income M . Suppose the consumer is indifferent between the two specialised baskets $(q_1^*, 0)$ and $(0, q_2^*)$, so that $u(q_1^*, 0) = u(0, q_2^*)$, where $u(\cdot, \cdot)$ is the utility function. For any positive fraction λ , we can define the diversified basket $(\lambda q_1^*, (1-\lambda)q_2^*)$, which is feasible as $p_1 \lambda q_1^* + p_2 (1-\lambda)q_2^* = M$. Convexity of indifference curves implies that the diversified basket is always preferred to specialisation, that is, $u(\lambda q_1^*, (1-\lambda)q_2^*) > u(q_1^*, 0) = u(0, q_2^*)$. See Dixit and Stiglitz (1977).

TABLE 3
ENTROPY OF THE CONSUMPTION BASKET IN 45 COUNTRIES

Country	Total	Between food and nonfood	Within nonfood	Column 3 as a percentage of column 2
(1)	(2)	(3)	(4)	(5)
1. USA	2.01	.44	1.57	21.75
2. Switzerland	1.92	.61	1.30	32.05
3. Luxembourg	1.95	.55	1.40	28.20
4. Hong Kong	1.96	.57	1.40	28.94
5. Canada	1.96	.50	1.46	25.53
6. Germany	1.93	.58	1.35	30.18
7. Japan	1.99	.54	1.44	27.29
8. Denmark	1.88	.57	1.31	30.17
9. Australia	1.96	.57	1.39	28.96
10. Sweden	1.88	.57	1.32	30.16
11. France	2.00	.54	1.46	26.93
12. Belgium	1.97	.57	1.40	28.87
13. Netherlands	2.00	.57	1.43	28.66
14. Norway	1.93	.59	1.34	30.43
15. Austria	1.95	.56	1.39	28.84
16. Singapore	1.94	.58	1.37	29.64
17. Italy	1.93	.61	1.32	31.71
18. Iceland	1.92	.56	1.36	29.33
19. UK	1.89	.56	1.34	29.37
20. Finland	1.89	.61	1.28	32.26
21. New Zealand	1.99	.48	1.51	23.98
22. Spain	1.92	.61	1.31	31.76
23. Israel	1.90	.59	1.31	30.88
24. Ireland	1.80	.67	1.14	37.04
25. Cyprus	1.91	.59	1.33	30.58
26. Taiwan	1.74	.68	1.06	39.16
27. Korea	1.79	.67	1.12	37.59
28. Portugal	1.85	.61	1.24	33.00
29. Greece	1.74	.68	1.06	38.95
30. Venezuela	1.68	.66	1.02	39.44
31. Mexico	1.83	.65	1.18	35.38
32. Malta	1.79	.65	1.15	36.01
33. Puerto Rico	1.88	.60	1.28	32.06
34. Hungary	1.68	.68	1.00	40.66
35. Fiji	1.73	.66	1.07	38.27
36. Thailand	1.79	.67	1.12	37.38
37. Colombia	1.76	.66	1.10	37.68
38. Iran	1.63	.68	.95	41.74
39. South Africa	1.81	.64	1.17	35.34
40. Ecuador	1.76	.67	1.10	37.72
41. Jamaica	1.63	.68	.95	41.65
42. Sri Lanka	1.33	.67	.66	50.19
43. Honduras	1.65	.69	.96	41.84
44. India	1.48	.69	.79	46.50
45. Zimbabwe	1.90	.64	1.26	33.70
Mean				
Countries 1-25	1.94	.57	1.37	29.34
Countries 26-45	1.72	.66	1.06	38.71
Countries 1-45	1.84	.61	1.23	33.51

$$H = \sum_{g=1}^G W_g \log \frac{1}{W_g} + \sum_{g=1}^G W_g H_g, \quad (3.2)$$

where

$$H_g = \sum_{i \in S_g} \frac{w_i}{W_g} \log \frac{1}{w_i / W_g}. \quad (3.3)$$

Equation (3.3) is the within-group entropy, which deals with the conditional, or within group, budget shares w_i/W_g . As the conditional share $w_i / W_g = p_i q_i / \sum_{j \in S_g} p_j q_j$, it measures expenditure on good i as a fraction of total expenditure on the group to which the good belongs. The measure H_g increases as the conditional shares become more equal, that is, with greater diversity of the within-group basket. The first term on the right-hand side of equation (3.2) is the between-group entropy. Accordingly, equation (3.2) states that the entropy of the entire basket can be decomposed into the sum of the between-group entropy and a weighted average of the G within-group entropies, the weights being the relevant group budget shares.

Given the dominance of food in the consumer's basket, it is natural to consider $G = 2$ groups of goods, food and nonfood. The food group contains just one more elementary good, viz., food, while the remaining seven elementary goods comprise the group nonfood. Thus, as w_1 is the budget share for elementary food, and $1 - w_1$ is the budget share for the remaining seven goods, we have in the notation of the previous paragraph $W_1 = w_1$ and $W_2 = 1 - w_1$. The first term on the right-hand side of decomposition (3.2) then becomes

$$\sum_{g=1}^G W_g \log \frac{1}{W_g} = w_1 \log \frac{1}{w_1} + (1 - w_1) \log \frac{1}{1 - w_1},$$

while the second term becomes

$$\begin{aligned}
\sum_{g=1}^G W_g H_g &= \sum_{g=1}^G W_g \left[\sum_{i \in S_g} \frac{w_i}{W_g} \log \frac{1}{w_i / W_g} \right] \\
&= w_1 \frac{w_1}{w_1} \log \frac{1}{w_1 / w_1} + (1 - w_1) \sum_{i=2}^8 \frac{w_i}{1 - w_1} \log \frac{1}{w_i / (1 - w_1)} \\
&= (1 - w_1) \sum_{i=2}^8 \frac{w_i}{1 - w_1} \log \frac{1}{w_i / (1 - w_1)} .
\end{aligned}$$

In words, the entropy within the food group is zero as this group contains only one elementary good. Collecting terms, application of equation (3.2) to the $G = 2$ case yields

$$\begin{aligned}
H &= w_1 \log \frac{1}{w_1} + (1 - w_1) \log \frac{1}{1 - w_1} \\
&\quad + (1 - w_1) \sum_{i=2}^8 \frac{w_i}{1 - w_1} \log \frac{1}{w_i / (1 - w_1)} .
\end{aligned} \tag{3.4}$$

The first two terms on the right-hand side of equation (3.4) represents the between-group entropy for the food/nonfood partitioning of the budget. Column 3 of Table 3 contains this measure and as can be seen, this tends to increase as we go down the column and hit poorer and poorer countries. For rich countries, the food budget share w_1 is modest, so that the share for nonfood, $1 - w_1$, is large. At this two-group level, it could be said that the budget for the rich is concentrated in nonfood and that there not much diversity in the basket. As income falls, w_1 rises and $1 - w_1$ declines, making for more diversity. This explains why the between-group entropy increases as income falls. Column 4 of Table 3 gives the weighted-average within-group entropy for nonfood, the last term on the right of equation (3.4). This tends to decline with income, implying that the nonfood part of the basket is more diversified for the rich and less diversified for the poor. Finally, column 5 of Table 3 gives the percentage share of the total accounted for by the between-group entropy. At high incomes this term accounts for something of the order of 30 percent of the total; but as income falls,

total entropy falls, while the between-group term rises, causing its percentage share to increase substantially.⁴

4. The Income and Price Responsiveness of Consumption

In this section we present the values of income and price elasticities that will be used in the next section to analyse the extent to which the evolution of consumption patterns can be explained.

A Slutsky demand equation explains the quantity consumed of good i (q_i) in terms of real income (Q) and the prices of the n goods, $p_1, \dots, p_n$, $q_i = q_i(Q, p_1, \dots, p_n)$. We express this for our $n = 8$ goods in terms of logarithmic changes: $Dq_i = \eta_i DQ + \sum_{j=1}^8 \eta_{ij} Dp_j$, where D is the log-change operator (as before); η_i is the income elasticity of demand for good i ; and η_{ij} is the (i, j) th Slutsky (or compensated) price elasticity. We consider a modest extension of this framework by allowing for trend-like change in tastes by adding an intercept term (α_i):

$$Dq_i = \alpha_i + \eta_i DQ + \sum_{j=1}^8 \eta_{ij} Dp_j. \quad (4.1)$$

As $Dq_i = \alpha_i$ when income and prices are all constant, this coefficient is interpreted as the exponential trend rate of growth of consumption of good i on account of factors other than income and prices; for short, we shall refer to α_i as the “autonomous trend” in consumption of good i . It follows from the consumer’s budget constraint that the coefficients of equation (4.1) for $i=1, \dots, 8$ satisfy

$$\sum_{i=1}^8 w_i \alpha_i = 0, \quad \sum_{i=1}^8 w_i \eta_i = 1, \quad \sum_{i=1}^8 w_i \eta_{ij} = 0, \quad j = 1, \dots, 8. \quad (4.2)$$

⁴ The previously-mentioned “problems” associated with food consumption in Zimbabwe and Sri Lanka are also manifest in columns 4 and 5 of Table 3. As the food budget share, w_1 , for Zimbabwe is lower than that expected on the basis of its GDP, $(1-w_1) = W_2$ is higher, causing $W_2 H_2$ to also be higher, as indicated by the last entry of column 4 of Table 3. This in turn leads to the corresponding entry of column 5 to be lower. A similar argument, but in reverse, applies to Sri Lanka.

Selvanathan and Selvanathan (2003) use time-series data to estimate a demand system for each of the 45 countries and in what follows we draw on their estimates. See the Appendix for details. Table 4 gives estimates of the trend terms. From the last row of this table, we see that on average there is a trend out of food, clothing and durables, into the other goods. Table 5 presents the income elasticities. As expected, in all case the food income elasticity is not greater than unity, which supports Engel's law. The housing income elasticities tend to be surprisingly low, but these values have to be considered in conjunction with the positive trend terms for this good; that is, the low income elasticities tend to be offset by the high positive trend terms. A similar argument also applies to medical care.

Regarding the value of the price elasticities η_{ij} , we face a problem of dimensionality. When $n = 8$, there are 64 of these elasticities for each of the 45 countries. The homogeneity and symmetry constraints mean that the number of unconstrained elasticities is less than 64, but there still remains a large number of unknowns. To solve this problem, we follow the Selvanathans and make the simplifying assumption that tastes can be characterised by a utility function of the preference independent form, $u(q_1, \dots, q_n) = \sum_{i=1}^n u_i(q_i)$, where $u_i(\bullet)$ is a sub-utility function involving the consumption of good i only. Preference independence (PI) means that the marginal utility of each good is independent of the consumption of all others. The implications of PI are that all income elasticities are positive, so that inferior foods are ruled out, and all pairs of goods are Slutsky substitutes. The hypothesis of PI has been recently tested with alcohol data -- beer, wine, and spirits -- for seven countries by Clements et al. (1997) and, using a variety of approaches, they find that the hypothesis cannot be rejected. It is usually argued that PI is possibly acceptable when applied to the broad aggregates such as food, clothing, housing, etc. on the basis that there is likely to be only limited substitution possibilities between these sorts of goods. As beer, wine and spirits are quite narrowly defined goods, the finding that they exhibit PI can be interpreted as saying that it is likely that there is even stronger support for the hypothesis when applied to the

TABLE 4
AUTONOMOUS TREND TERMS FOR 8 COMMODITIES IN 45 COUNTRIES

Country	Food	Clothing	Housing	Durables	Medical	Transport	Recreation	Other
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. USA	-.46	-1.07	.93	-1.66	2.78	-2.68	1.87	.18
2. Switzerland	-.64	-3.45	1.40	-3.37	2.63	.03	.26	1.35
3. Luxembourg	-.26	-2.51	.46	-.91	-1.51	1.87	4.24	-.68
4. Hong Kong	-.29	-6.36	4.92	2.43	2.27	-.95	2.57	.23
5. Canada	-.99	-2.38	2.09	-.40	-2.04	-.55	1.36	.26
6. Germany	-.32	-1.95	2.42	-1.61	1.49	-.99	2.24	-1.35
7. Japan	-1.59	-3.96	3.27	-1.95	1.74	-.89	2.13	-.92
8. Denmark	-.01	-2.70	1.72	-2.77	1.89	-1.36	1.28	.54
9. Australia	-.12	-2.68	2.45	-4.74	.27	-.01	.07	1.04
10. Sweden	-.51	-1.56	1.09	-1.58	2.91	-.13	.68	-.48
11. France	-.18	-1.80	2.18	-3.49	5.00	-1.12	-.69	-1.26
12. Belgium	-.01	-.96	1.22	-1.57	1.73	.03	1.85	-1.39
13. Netherlands	.25	-3.32	1.10	-2.06	1.54	-.04	1.30	.88
14. Norway	-.43	-2.39	2.58	-1.67	-2.03	-1.54	1.18	1.50
15. Austria	-.61	-1.91	2.05	-.34	2.32	-.55	1.35	-.07
16. Singapore	-1.23	-2.54	3.25	.38	2.81	.26	1.21	-.57
17. Italy	-.41	-2.79	1.20	-1.33	2.08	-.12	1.22	.99
18. Iceland	.58	-1.76	1.38	-2.78	2.08	-1.67	1.85	1.06
19. UK	-.85	.55	.97	-1.54	1.76	-.05	2.15	-.52
20. Finland	-.32	-3.14	3.35	-1.66	2.03	-2.44	.97	.17
21. New Zealand	-1.05	-2.45	1.85	-2.04	1.29	-1.13	.40	1.74
22. Spain	-2.16	-1.13	.61	-1.22	2.41	.85	.53	3.22
23. Israel	.45	-3.14	1.93	-3.84	2.89	-.92	-.47	.66
24. Ireland	.28	-2.92	1.29	-1.99	-.15	-.54	.75	.73
25. Cyprus	-1.21	4.24	5.48	-.89	8.65	-3.96	1.25	-.52
26. Taiwan	-.56	-.43	4.27	.60	1.54	-4.56	1.05	-5.01
27. Korea	-1.93	-4.59	2.06	-2.19	4.00	2.45	2.71	2.03
28. Portugal	-.31	-2.14	3.30	-1.92	1.36	-.49	1.36	.32
29. Greece	.53	-5.12	2.06	-.94	-.96	1.33	-.31	-.03
30. Venezuela	.55	-2.11	.02	-2.49	3.13	.66	2.85	-.51
31. Mexico	.30	-2.67	1.58	-.44	1.15	-.12	-1.07	.22
32. Malta	.63	-2.13	-2.79	-1.18	1.73	-.67	1.09	1.42
33. Puerto Rico	-1.97	-1.83	1.16	-1.89	3.74	.11	.63	3.79
34. Hungary	-1.91	-3.70	2.32	-1.18	2.51	.39	1.14	10.90
35. Fiji	-.59	.77	-.61	-1.00	1.63	1.71	1.67	-.07
36. Thailand	-2.70	2.26	2.38	1.31	5.36	-2.39	.51	3.79
37. Colombia	-.19	-3.28	1.54	-1.09	-2.07	1.20	-.36	1.00
38. Iran	-1.01	-1.25	.77	-1.62	1.96	.83	4.22	7.80
39. South Africa	.04	-.52	.17	-1.09	1.56	.71	.35	-.47
40. Ecuador	-1.26	-.59	1.20	-2.00	.62	2.56	1.83	1.20
41. Jamaica	-.64	1.13	.73	-1.69	3.37	.48	2.48	.12
42. Sri Lanka	-1.00	1.23	1.93	.57	-.43	2.64	2.51	-.60
43. Honduras	-.89	-3.79	3.47	-1.29	.03	1.58	3.21	2.28
44. India	-1.09	.89	.72	-1.92	4.06	.95	-1.68	5.66
45. Zimbabwe	-1.00	-.61	2.67	-1.00	4.72	2.24	1.62	-1.46
46. Mean								
Countries 1-25	-.48	-2.16	2.05	-1.70	1.87	-.74	1.26	.27
Countries 26-45	-.75	-1.42	1.45	-1.12	1.95	.58	1.29	1.62
Countries 1-45	-.60	-1.83	1.78	-1.45	1.91	-.16	1.27	.87

Note: All entries are to be divided by 100.

TABLE 5

INCOME ELASTICITIES FOR 8 COMMODITIES IN 45 COUNTRIES

Country	Food	Clothing	Housing	Durables	Medical	Transport	Recreation	Other
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. USA	.37	1.33	.52	1.59	.33	2.34	1.16	.96
2. Switzerland	.96	1.41	.40	1.44	.79	1.54	1.23	1.06
3. Luxembourg	.43	1.11	.92	1.63	2.03	1.26	-.08	1.08
4. Hong Kong	.48	2.39	.18	1.13	.75	1.16	.68	1.06
5. Canada	.72	1.48	.43	1.23	1.28	1.45	1.36	1.10
6. Germany	.67	1.45	.25	1.50	.63	1.97	.27	1.87
7. Japan	.79	1.81	.30	1.28	.81	1.83	.77	1.42
8. Denmark	.45	1.61	.36	1.50	.27	2.47	.97	1.01
9. Australia	.43	1.27	.34	2.57	1.11	1.20	2.04	1.12
10. Sweden	.74	1.65	.36	1.73	.18	1.95	1.42	.57
11. France	.42	.83	.64	1.85	.15	1.82	1.55	1.48
12. Belgium	.43	1.20	.54	1.75	.81	1.32	.77	1.83
13. Netherlands	.47	1.86	.55	1.90	.69	1.65	1.01	.89
14. Norway	.57	1.22	.46	1.36	1.53	2.20	1.08	.72
15. Austria	.65	1.54	.49	1.31	.40	1.90	.99	.85
16. Singapore	.70	1.32	.45	.72	.64	1.23	1.35	1.40
17. Italy	.70	1.77	.49	1.60	1.01	1.58	.85	.92
18. Iceland	.31	1.15	.47	1.84	.56	2.02	.87	1.23
19. UK	.61	1.01	.30	1.67	.80	1.69	.87	1.47
20. Finland	.56	1.36	.47	1.50	.47	2.08	1.00	1.21
21. New Zealand	.38	1.36	.93	1.55	.71	1.45	.88	1.03
22. Spain	.84	.78	.69	.92	1.71	1.78	1.16	.87
23. Israel	.52	1.87	.25	2.32	.51	2.07	1.81	.66
24. Ireland	.44	2.04	.42	1.72	.83	1.58	1.74	1.43
25. Cyprus	.91	.92	.76	.88	.57	1.65	.45	1.03
26. Taiwan	.75	1.29	.43	1.16	1.08	2.37	1.14	1.84
27. Korea	.91	1.29	.50	1.68	1.04	1.25	.91	1.10
28. Portugal	.27	.26	2.22	.90	.69	2.28	.76	1.07
29. Greece	.52	2.23	.56	1.20	1.89	1.31	1.75	1.23
30. Venezuela	.54	1.39	.99	2.61	.35	1.81	.19	1.21
31. Mexico	.64	1.73	.26	1.26	.75	1.81	1.64	1.01
32. Malta	.62	.97	1.31	1.00	.47	1.26	.79	1.70
33. Puerto Rico	.95	.90	.88	.96	1.22	1.29	1.20	.81
34. Hungary	.77	1.21	1.12	1.49	.91	.75	1.88	.96
35. Fiji	.92	.62	1.04	.48	2.66	1.63	.97	.71
36. Thailand	.63	1.09	.54	1.61	1.22	1.84	1.12	1.14
37. Colombia	.88	1.58	.13	1.55	2.37	1.12	1.07	.83
38. Iran	.59	1.13	1.15	1.42	1.50	1.30	1.61	2.26
39. South Africa	.74	1.40	.32	1.27	.73	1.52	1.11	1.26
40. Ecuador	.88	1.55	.47	1.87	.55	.91	1.00	1.00
41. Jamaica	.71	1.32	.79	1.72	.98	.90	.73	1.63
42. Sri Lanka	.93	1.10	.11	1.81	.85	1.38	.58	1.37
43. Honduras	.95	.31	1.45	1.17	.92	.94	.64	1.08
44. India	.98	1.33	.67	1.49	2.20	.10	2.71	1.22
45. Zimbabwe	1.00	1.08	1.09	.72	.50	2.00	.73	1.13
46. Mean								
Countries 1-25	.58	1.43	.48	1.54	.78	1.73	1.05	1.13
Countries 26-45	.76	1.19	.80	1.37	1.14	1.39	1.13	1.23
Countries 1-45	.66	1.32	.62	1.46	.94	1.58	1.08	1.17

broad aggregates.⁵

Under PI price elasticities are linked to income elasticities according to

$$\eta_{ij} = \varphi \eta_i (\delta_{ij} - w_j \eta_j), \quad (4.3)$$

where φ is reciprocal of the income elasticity of the marginal utility of income (the “income flexibility” for short); and δ_{ij} is the Kronecker delta ($\delta_{ij} = 1$ if $i = j$, 0 otherwise). For the derivation of equation (4.3) and more details, see, e.g., Clements et al. (1995). To implement equation (4.3), we use the income elasticities and budget shares from Tables 5 and 2, respectively. Regarding the specification of φ , we shall use the same value for all 45 countries. Selvanathan and Selvanathan (2003) provided an estimate of φ for each country, but they conclude that these values are unrelated to income. While this finding contradicts Frisch’s (1959) famous conjecture, it is consistent with much of the previous literature.⁶ The finding that the income flexibility is independent of income is not surprising given that this elasticity involves a third-order derivative of the utility function; economic data are usually silent regarding the value of such high-order effects (Clements and Theil, 1996). For φ we use the value -0.41 , which is the mean of the 45 estimates reported by Selvanathan and Selvanathan (2003). The left-hand side of Table 6 presents three sets of price elasticities so obtained by averaging over all 45 countries (panel I), the rich countries (panel II) and the poor countries (panel III). These are compensated price elasticities η_{ij} , which hold constant real income. We obtain the corresponding uncompensated elasticities, which hold nominal income constant, by adding back to η_{ij} the income effects of the price changes, $\eta'_{ij} = \eta_{ij} - w_j \eta_i$. These η'_{ij} are given in the right-hand side of Table 6. A comparison of the elasticities for the rich and the poor reveals that there tends to be more substantial differences between the uncompensated elasticities, highlighting the role of income effects of price changes.

⁵ Earlier studies tended to reject PI (see Barten, 1977, for a survey), but it is now understood that the source of many of these rejections was the use of asymptotic tests, which are biased against the null (S. Selvanathan, 1987, 1993).

⁶ For a survey, see Clements and S. Selvanathan (1994, Sec. 9).

TABLE 6

PRICE ELASTICITIES FOR THREE GROUPS OF COUNTRIES

Commodity	Compensated price elasticities								Uncompensated price elasticities							
	Food	Clothing	Housing	Durables	Medical	Transport	Recreation	Other	Food	Clothing	Housing	Durables	Medical	Transport	Recreation	Other
I. <u>World</u> (countries 1-45)																
1. Food	-.20	.03	.03	.03	.01	.05	.02	.04	-.41	-.02	-.07	-.02	-.02	-.03	-.02	-.04
2. Clothing	.12	-.47	.05	.07	.02	.11	.04	.08	-.30	-.59	-.16	-.04	-.04	-.06	-.05	-.09
3. Housing	.05	.03	-.22	.03	.01	.05	.02	.04	-.14	-.03	-.31	-.02	-.02	-.03	-.02	-.04
4. Durable	.13	.07	.06	-.52	.03	.12	.04	.09	-.34	-.05	-.18	-.65	-.05	-.06	-.05	-.10
5. Medical	.08	.04	.04	.05	-.36	.08	.03	.06	-.22	-.04	-.10	-.03	-.40	-.04	-.03	-.06
6. Transport	.14	.07	.06	.08	.03	-.51	.05	.10	-.36	-.06	-.19	-.05	-.05	-.72	-.06	-.11
7. Recreation	.10	.05	.04	.05	.02	.09	-.41	.07	-.24	-.04	-.13	-.03	-.03	-.04	-.47	-.07
8. Other	.10	.05	.05	.06	.02	.09	.03	-.41	-.28	-.04	-.13	-.04	-.04	-.05	-.04	-.55
II. <u>Rich countries</u> (countries 1-25)																
1. Food	-.20	.03	.02	.03	.01	.06	.02	.04	-.35	-.02	-.08	-.02	-.02	-.02	-.03	-.04
2. Clothing	.09	-.51	.05	.08	.02	.14	.05	.09	-.28	-.63	-.20	-.05	-.05	-.05	-.06	-.10
3. Housing	.03	.02	-.18	.03	.01	.05	.02	.03	-.09	-.02	-.26	-.02	-.02	-.02	-.02	-.04
4. Durable	.10	.08	.05	-.54	.03	.15	.05	.10	-.31	-.05	-.22	-.68	-.06	-.06	-.06	-.11
5. Medical	.05	.04	.03	.04	-.30	.08	.03	.05	-.15	-.03	-.11	-.03	-.34	-.03	-.03	-.06
6. Transport	.11	.09	.06	.10	.03	-.53	.06	.11	-.34	-.06	-.25	-.05	-.06	-.77	-.08	-.13
7. Recreation	.07	.05	.04	.06	.02	.10	-.39	.07	-.21	-.03	-.15	-.03	-.04	-.04	-.47	-.08
8. Other	.07	.06	.04	.06	.02	.11	.04	-.39	-.22	-.04	-.16	-.04	-.04	-.04	-.05	-.54
III. <u>Poor countries</u> (countries 26-45)																
1. Food	-.21	.03	.03	.03	.01	.05	.02	.04	-.50	-.03	-.06	-.03	-.02	-.04	-.02	-.04
2. Clothing	.15	-.43	.05	.05	.02	.07	.03	.07	-.33	-.53	-.10	-.04	-.02	-.06	-.03	-.07
3. Housing	.10	.03	-.28	.03	.01	.05	.02	.05	-.22	-.04	-.38	-.03	-.02	-.03	-.02	-.05
4. Durable	.17	.06	.06	-.51	.03	.08	.03	.08	-.39	-.06	-.11	-.61	-.03	-.07	-.04	-.09
5. Medical	.14	.05	.05	.05	-.44	.07	.03	.07	-.30	-.05	-.10	-.04	-.48	-.05	-.03	-.06
6. Transport	.17	.06	.06	.06	.03	-.47	.03	.08	-.39	-.06	-.12	-.05	-.03	-.64	-.04	-.08
7. Recreation	.14	.05	.05	.05	.02	.07	-.43	.06	-.29	-.04	-.09	-.04	-.02	-.05	-.46	-.06
8. Other	.15	.05	.05	.05	.02	.08	.03	-.43	-.35	-.05	-.10	-.04	-.03	-.06	-.04	-.57

5. Predicting Consumption

Equation (4.1) explains consumption of good i in terms of an autonomous trend, the change in real income and changes in the prices. To what extent does this provide an acceptable explanation of consumption?

To address this question, we use the right-hand side of equation (4.1) to provide predicted consumption, which we then compare to the corresponding actual value. To evaluate (4.1) we use the trend term from Table 4, the income elasticity from Table 5 and obtain the price elasticities from equation (4.3). Regarding the variables on the right of (4.1), the Divisia volume index is from column 6 of Table 1 and the price log-changes are from Selvanathan and Selvanathan (2003), as discussed in the Appendix. This yields a predicted value for the log-change in the consumption of good i , $\hat{D}q_i$. As discussed in the Appendix, the actual log-change Dq_i is available in Selvanathan and Selvanathan (2003). Denote the prediction error by $e_i = Dq_i - \hat{D}q_i$. Table 7 contains these errors for all goods and all countries. Several countries tend to have large errors for the majority of commodities; New Zealand, Cyprus, Thailand and India would seem to be included in this group. Going back to Figure 1, recall that for Sri Lanka and Zimbabwe the budget shares of food were some distances away from the regression line which controlled for GDP per capita. Interestingly, the prediction error for food in Sri Lanka in Table 7 is of a not unreasonable magnitude (-.13 percent p.a.), which points to the importance of controlling for the influence of relative prices, as well as total consumption (rather than GDP). For Zimbabwe, the food error is larger (-1.26 percent), but not as large (in absolute value) as those for four other goods in that country.

The right-hand side of equation (4.1) defines predicted consumption $\hat{D}q_i$. If we multiply this right-hand side by the corresponding budget share w_i , sum over $i = 1, \dots, 8$ and then use constraints (4.2), we obtain $\sum_{i=1}^8 w_i \hat{D}q_i = DQ$. If we write this as $\sum_{i=1}^8 w_i (Dq_i - e_i) = DQ$, where e_i is the prediction error, it then follows from the second member of equation (2.1) that $\sum_{i=1}^8 w_i e_i = 0$. In words, a budget-share weighted-average of the errors is zero, which

TABLE 7
PREDICTION ERRORS OF QUANTITY LOG-CHANGES

Country	Food	Clothing	Housing	Durables	Medical	Transport	Recreation	Other
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. USA	-.04	-.10	-.01	-.18	.22	-.05	-.19	.12
2. Switzerland	.12	.80	-.28	.89	-.43	-.03	-.14	-.40
3. Luxembourg	-.08	.00	-.03	.04	.01	.16	-.01	-.04
4. Hong Kong	-.17	.33	.02	-.53	-.06	-.02	-.09	.56
5. Canada	-.16	.16	-.11	-.03	-.03	-.01	.24	.19
6. Germany	-.03	-.10	.03	-.11	-.06	.19	.04	-.06
7. Japan	-.03	-.04	-.03	.11	.10	.09	-.10	.01
8. Denmark	-.04	.22	.13	-.14	-.07	-.39	.04	.33
9. Australia	-.02	-.09	.01	.49	-.25	-.02	-.21	.05
10. Sweden	-.04	-.42	.05	-.05	.20	.19	-.07	.07
11. France	.04	-.06	.05	-.13	.02	.08	-.05	-.09
12. Belgium	-.12	-.08	.01	-.79	.51	.15	-.06	.63
13. Netherlands	-.06	-.96	.17	-.89	.80	.58	.05	.45
14. Norway	.11	.35	-.84	.36	1.22	-.03	.44	-.03
15. Austria	-.06	-.37	.20	-.23	.04	.18	-.05	.11
16. Singapore	-.18	-.19	.16	.09	.02	.19	-.06	.11
17. Italy	-.39	.27	.16	.40	.31	.01	-.22	.25
18. Iceland	.00	.15	-.68	-.07	.17	.20	.06	.66
19. UK	.15	-.52	.22	-.14	.10	.42	-.49	-.26
20. Finland	-.01	.11	-1.13	.00	.38	.70	.25	.60
21. New Zealand	.93	-1.18	-.98	1.63	1.34	.39	.60	-1.92
22. Spain	.75	.52	-.36	.41	-1.87	-.29	-.24	-.77
23. Israel	-.01	.15	-.05	-.02	.19	-.06	-.27	.11
24. Ireland	-.21	-.27	.14	-.26	.38	.21	-.31	.77
25. Cyprus	.58	-4.11	-3.77	1.95	-1.59	-2.02	2.91	3.00
26. Taiwan	-.22	-.76	-.07	.26	-.52	1.55	.54	-.23
27. Korea	-.17	-.47	.62	.08	.32	-.33	.44	.01
28. Portugal	1.49	2.55	-2.85	1.61	-.57	-3.48	3.11	-1.14
29. Greece	.05	-.34	-.08	-.04	.06	.11	-.05	.15
30. Venezuela	.23	-2.19	-1.70	5.33	-.14	.51	-1.28	.27
31. Mexico	-.36	-1.60	.06	-.63	.15	1.39	.78	.91
32. Malta	-.10	.73	.66	.34	-.32	-.38	.06	-.25
33. Puerto Rico	-.33	2.33	-.43	1.88	-2.01	.00	.26	-.97
34. Hungary	.30	-.65	1.63	-.28	-.09	3.41	.07	-8.84
35. Fiji	.01	-.57	-.12	1.31	.04	.08	-2.59	.59
36. Thailand	1.84	-1.44	-1.72	-.99	-3.60	1.38	-.53	-2.24
37. Colombia	-.11	-.50	-.10	-.21	.05	.42	-.19	.31
38. Iran	-.22	.78	1.37	.76	.07	-1.75	.42	-9.39
39. South Africa	-.03	.22	.02	.04	-.31	-.01	-.02	-.03
40. Ecuador	.31	-.30	-.39	.14	.16	.09	-1.23	-.18
41. Jamaica	-.51	-.62	.64	1.36	.05	.26	-1.61	.54
42. Sri Lanka	-.13	.12	-.14	-.51	-.66	.85	.16	-.14
43. Honduras	.13	.49	-.83	2.65	-.19	-2.82	-2.40	.57
44. India	.19	-1.36	-1.20	3.12	-8.57	5.61	-.81	-3.89
45. Zimbabwe	-1.26	-.65	-.83	2.74	-2.79	-6.02	1.73	3.24
46. Mean								
Countries 1-25	.04	-.22	-.28	.11	.07	.03	.08	.18
Countries 26-45	.06	-.21	-.27	.95	-.94	.04	-.16	-1.04
Countries 1-45	.03	-.12	-.29	.47	-.21	.02	-.04	-.38

Note: All entries are to be divided by 100.

reflects that the system comprising equation (4.1) for $i = 1, \dots, 8$ is an allocation model. Given that the weighted first-order moment of the prediction errors is zero, it is natural to measure their dispersion by the corresponding weighted second-order moment, $\sum_{i=1}^8 w_i e_i^2$. This weighted mean-squared error (MSE) is a measure of the quality of predictions, with higher values indicating poorer performance. A commodity decomposition of the MSE is $w_i e_i^2 / \sum_j w_j e_j^2$, $i = 1, \dots, 8$, and these shares are given in percentage form in columns 2 - 9 of Table 8, together with the square root of the MSE (RMSE) in column 10. Averaging over all countries, we find that transport represents the largest contributor to the MSE, which is then followed by other. Regarding the RMSEs given in column 10 of Table 8, it can be seen the predictions for the rich countries tend to be considerably better than those for the poor. On average, the RMSE for the poor countries is more than double that of the rich. Note also that the countries that seem to have poor predictions are Cyrus, Hungary and India, a similar group to that discussed above.

The RMSEs in Table 8 tell us about the quality of the predictions from the demand equations (4.1) for $i = 1, \dots, 8$. These demand equations are implemented with country-specific coefficients for the trend terms α_i , income elasticities η_i and price elasticities η_{ij} . To analyse the importance of these determinants, we start by setting all the coefficients in equation (4.1) equal to zero, i.e., $\alpha_i = \eta_i = \eta_{ij} = 0$ for $i, j = 1, \dots, 8$, and then compute the associated MSE. In this case, the MSE equals $\sum_{i=1}^8 w_i Dq_i^2$, where Dq_i is the actual log-change, so that the MSE is equivalent to a (weighted average of the) total sum of squares. The square root for this measure for all 45 countries is given in column 2 of Table 9. Column 3 of this table gives the RMSEs when the eight income elasticities are specified as unity and the other coefficients zero. Column 4 reveals that in all cases the RMSEs fall when setting $\eta_i = 1$, although in a handful of countries the fall is minimal (Venezuela, Hungary, Fiji, Iran and Jamaica). Averaging over the 45 countries, the RMSE falls from 2.99 to 1.47 percent when consumption is allowed to be proportional to income. Next, column 5 gives the RMSEs corresponding to all the coefficients taking their previous country-specific values, so that this column coincides with column 10 of Table 8. We give in column 6 of

TABLE 8
THE QUALITY OF THE FIRST SET OF PREDICTIONS AND COMMODITY DECOMPOSITIONS

Country	Percentage share of mean-squared error								Root-mean-squared-error
	Food	Clothing	Housing	Durables	Medical	Transport	Recreation	Other	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1. USA	1.88	4.84	.12	15.37	40.91	2.63	17.52	16.73	.12
2. Switzerland	2.62	26.27	11.17	37.03	10.36	.08	1.53	10.94	.38
3. Luxembourg	18.43	.11	1.36	3.26	.19	74.32	.00	2.33	.08
4. Hong Kong	9.07	21.71	.08	36.18	.25	.03	.73	31.95	.30
5. Canada	28.74	8.37	14.66	.90	.25	.34	18.42	28.32	.14
6. Germany	4.13	12.29	1.24	15.71	1.58	59.40	1.23	4.40	.09
7. Japan	8.00	3.68	5.45	15.28	21.21	19.66	26.35	.36	.06
8. Denmark	.96	6.30	7.59	3.56	.26	55.87	.21	25.24	.21
9. Australia	.36	2.23	.10	70.44	14.85	.18	10.35	1.50	.16
10. Sweden	1.99	60.74	2.92	.93	5.02	24.65	2.20	1.56	.15
11. France	5.96	6.72	8.50	34.27	1.07	18.53	3.04	21.92	.07
12. Belgium	2.36	.31	.03	49.80	14.29	1.68	.11	31.42	.40
13. Netherlands	.31	33.78	1.42	26.67	19.74	10.19	.06	7.83	.55
14. Norway	1.54	5.06	59.07	4.92	21.56	.06	7.75	.05	.46
15. Austria	2.88	45.99	16.98	13.88	.18	14.05	.63	5.42	.18
16. Singapore	40.78	12.93	11.31	2.79	.06	21.02	2.37	8.76	.15
17. Italy	54.40	7.71	3.97	14.39	5.10	.00	4.33	10.11	.29
18. Iceland	.00	1.46	58.27	.32	.33	4.36	.23	35.02	.38
19. UK	5.77	22.07	9.41	1.44	.13	27.94	21.04	12.19	.31
20. Finland	.02	.23	65.75	.00	1.31	20.19	1.35	11.16	.60
21. New Zealand	10.63	5.10	12.29	20.33	7.34	1.59	2.07	40.64	1.21
22. Spain	35.18	5.41	3.51	2.71	31.28	2.07	.75	19.10	.70
23. Israel	1.41	15.27	7.93	1.14	18.47	5.71	34.63	15.44	.09
24. Ireland	14.40	4.47	2.56	3.99	3.98	5.22	6.08	59.29	.33
25. Cyprus	1.43	27.27	18.07	6.67	1.17	11.15	8.77	25.47	2.49
26. Taiwan	7.28	10.61	.28	1.12	5.06	62.38	11.93	1.36	.53
27. Korea	11.38	13.38	39.95	.36	5.25	10.68	19.00	.02	.32
28. Portugal	13.32	12.02	15.15	4.22	.31	37.64	13.14	4.19	2.23
29. Greece	5.28	67.93	5.81	1.10	.64	7.24	.68	11.31	.13
30. Venezuela	1.00	20.85	15.90	58.02	.03	.95	2.30	.95	1.41
31. Mexico	6.75	32.79	.05	6.86	.12	31.09	4.95	17.40	.82
32. Malta	2.29	37.34	22.77	10.06	2.91	17.03	.26	7.34	.35
33. Puerto Rico	2.65	41.74	2.25	24.42	19.06	.00	.36	9.52	1.10
34. Hungary	.51	.46	4.19	.09	.00	18.36	.00	76.38	2.76
35. Fiji	.01	4.53	.40	30.90	.01	.17	59.14	4.83	.74
36. Thailand	38.33	6.48	8.01	2.28	21.71	6.30	.37	16.53	1.86
37. Colombia	6.05	24.83	1.41	3.46	.27	39.99	2.09	21.91	.26
38. Iran	.57	1.84	13.33	1.01	.01	4.85	.09	78.31	1.90
39. South Africa	3.18	48.77	.20	1.85	44.17	.21	.27	1.36	.09
40. Ecuador	27.48	7.23	9.67	1.00	.79	.58	48.95	4.29	.36
41. Jamaica	25.07	3.26	11.71	25.55	.02	2.03	19.82	12.56	.65
42. Sri Lanka	7.55	.78	.73	8.98	5.56	75.08	.76	.56	.35
43. Honduras	.69	2.22	12.54	49.26	.22	21.77	12.57	.74	1.06
44. India	.31	3.11	2.46	6.42	30.12	43.88	.15	13.55	2.56
45. Zimbabwe	11.93	1.15	2.36	17.15	8.27	17.68	3.23	38.23	2.12
46. Mean									
Countries 1-25	10.13	13.61	12.95	15.28	8.84	15.24	6.87	17.09	.40
Countries 26-45	8.58	17.07	8.46	12.70	7.23	19.89	10.00	16.07	1.15
Countries 1-45	9.44	15.15	10.95	14.14	8.12	17.31	8.26	16.63	.70

Note: All entries in column 10 are to be divided by 100.

Table 9 the changes in the RMSEs in going from column 2, where all coefficients are zero, to column 5, where the country-specific coefficients are used. Several comments can be made regarding the results of column 6. First, the RMSEs fall in all cases except two -- Venezuela and Hungary. This could possibly be taken as evidence against the assumption of preference independence for these countries, or it could be related to data problems. Whatever the cause, it seems sensible to treat these countries as outliers and disregard them in the subsequent analysis. Accordingly, the means given in the last two entries in columns 5 and 6 exclude these two countries.

A second point to make about the results of column 6 of Table 9 is that in addition to the above two cases, for four countries the RMSEs increase when moving from column 3, where $\eta_i = 1$, to column 5. These countries are Cyprus, Portugal, Mexico and India. While a case can be made that these countries should also be treated as outliers, in what follows we shall leave them in as their “problems” are not nearly as severe as those of the previous group of countries. Third, averaging over all countries, the RMSE falls from 2.99 to 0.64 percent, or by almost 80 percent, when using the demand model, as can be seen from the last entries of columns 2 and 5 of Table 9. For the rich and poor groups of countries, the model accounts for 86 and 69 percent of the total variation, respectively. Fourth, the last row of the Table 9 provides the basis for the rough rule of thumb that for all countries, allowing consumption to be proportional to income accounts for about one-half of the total variation in consumption patterns, while using the coefficients of the demand model explains a further one-half of the remaining one-half. This rule of thumb thus involves an explanation of about $1/2 + 1/2 \times 1/2 = 3/4$ of the total variation in consumption. As discussed above, the actual reduction in the average RMSE is almost 80 percent (from 2.99 to 0.64), which shows that the rule of thumb is not too inaccurate. Taken as a whole, these findings seem to indicate that a substantial part of international consumption patterns can be explained by a simple demand model.

TABLE 9
THE QUALITY OF THREE SETS OF PREDICTIONS

Countries	All coefficients zero $\alpha_i=0, \eta_i=0, \eta_{ij}=0$	Unitary income elasticities $\alpha_i=0, \eta_i=1, \eta_{ij}=0$		All coefficients non-zero $\alpha_i \neq 0, \eta_i \neq 0, \eta_{ij} \neq 0$	
	RMSE	RMSE	Δ RMSE	RMSE	Δ RMSE
(1)	(2)	(3)	(4)	(5)	(6)
1. USA	2.52	1.13	-1.39	.12	-2.40
2. Switzerland	1.61	.80	-.81	.38	-1.23
3. Luxembourg	3.32	1.72	-1.60	.08	-3.25
4. Hong Kong	5.55	2.06	-3.49	.30	-5.25
5. Canada	2.57	1.28	-1.30	.14	-2.43
6. Germany	2.74	.81	-1.93	.09	-2.65
7. Japan	3.34	1.55	-1.79	.06	-3.28
8. Denmark	1.95	.95	-1.00	.21	-1.74
9. Australia	2.55	1.19	-1.36	.16	-2.38
10. Sweden	1.46	.81	-.64	.15	-1.31
11. France	2.96	1.52	-1.44	.07	-2.89
12. Belgium	2.61	.93	-1.68	.40	-2.22
13. Netherlands	3.01	1.04	-1.97	.55	-2.46
14. Norway	2.65	1.16	-1.49	.46	-2.18
15. Austria	2.58	1.06	-1.53	.18	-2.40
16. Singapore	4.75	2.00	-2.74	.15	-4.59
17. Italy	2.85	1.10	-1.75	.29	-2.56
18. Iceland	1.81	.94	-.88	.38	-1.44
19. UK	2.36	1.17	-1.19	.31	-2.06
20. Finland	2.95	1.12	-1.84	.60	-2.35
21. New Zealand	2.05	1.34	-.72	1.21	-.84
22. Spain	3.24	1.69	-1.56	.70	-2.55
23. Israel	3.57	1.51	-2.06	.09	-3.48
24. Ireland	1.90	.90	-1.00	.33	-1.56
25. Cyprus	5.55	1.67	-3.88	2.49	-3.05
26. Taiwan	6.74	2.35	-4.39	.53	-6.22
27. Korea	6.50	2.76	-3.74	.32	-6.18
28. Portugal	4.30	1.97	-2.33	2.23	-2.06
29. Greece	3.60	1.42	-2.18	.13	-3.46
30. Venezuela	1.00	1.00	-.01	1.41	.40
31. Mexico	1.37	.76	-.61	.82	-.55
32. Malta	4.95	1.59	-3.37	.35	-4.60
33. Puerto Rico	3.35	1.97	-1.38	1.10	-2.24
34. Hungary	2.24	2.24	.00	2.76	.52
35. Fiji	1.30	1.30	.00	.74	-.56
36. Thailand	5.32	2.23	-3.09	1.86	-3.46
37. Colombia	1.81	.69	-1.12	.26	-1.55
38. Iran	2.20	2.18	-.02	1.90	-.29
39. South Africa	.92	.53	-.40	.09	-.83
40. Ecuador	2.02	1.38	-.63	.36	-1.65
41. Jamaica	1.39	1.39	-.01	.65	-.74
42. Sri Lanka	2.86	2.16	-.70	.35	-2.50
43. Honduras	2.14	1.94	-.20	1.06	-1.07
44. India	2.83	1.93	-.91	2.56	-.28
45. Zimbabwe	5.39	3.18	-2.21	2.12	-3.27
46. Mean					
Countries 1-25	2.90	1.26	-1.64	.40	-2.50
Countries 26-45	3.11	1.75	-1.36	.97	-2.14
Countries 1-45	2.99	1.47	-1.52	.64	-2.36

Notes: 1. Column (4) = (3)-(2); and column (6)=(5)-(2). 2. For columns 5 and 6, the means exclude Venezuela and Hungary. See text. 3. All entries are to be divided by 100.

6. Disparities in Tastes and Groups of Countries

In the previous section we used country-specific coefficients in the demand equations so that, in this sense, tastes were allowed to differ across countries. In making comparisons of consumption patterns between countries as different as the USA and Zimbabwe, where GDP per capita differs by a factor of almost 20, this may seem a natural way of proceeding. But on the other hand, if we were to use a strict model of *Homo economicus*, we would probably argue that the only determinants of cross-country disparities in consumption patterns are observable differences in real incomes and relative prices -- not tastes. According to this view, ascribing differences in behaviour to differing tastes is a “fudge factor” as it is vacuous with no behaviour -- no matter how unconventional -- ruled out. A somewhat less stringent attitude is to regard models as only approximations to reality (at best), and accept the inevitability of omitted factors and that the world is likely to be more complex than any simple model.

Even if we agreed that allowing for cross-country differences in tastes is the appropriate way to proceed, identical tastes are still of interest as the base case in the analysis of the extent to which tastes are different. That is, a comparison of the RMSEs associated with identical and different tastes is a way to quantify the role of tastes in explaining cross-country consumption. To implement identical tastes, we average over the 43 countries the autonomous tends, income and price elasticities, and then renormalise so that the coefficients satisfy the aggregation constraints (4.2).⁷ We then use these coefficients for each country to compute the RMSEs and column 3 of Table 10 contains the results. For comparison, column 2 of this table reproduces column 5 of Table 9, the RMSEs associated with different tastes, as measured by the country-specific coefficients. The last entry of column 4 of Table 10 shows that the hypothesis of identical tastes increases the RMSE by about 0.35 percentage points

⁷ Here and subsequently, when we refer to prices elasticities averaged over countries, it is understood to mean the elasticities obtained from equation (4.3) for $i, j = 1, \dots, 8$ evaluated with $\phi = -.41$ and the relevant cross-country averages of the income elasticities and budget shares. Note that the averages over the 45 countries of the trends, income elasticities and price elasticities are given in the last row of Table 4, the last row of Table 5 and the left-hand part of panel I of Table 6, respectively. These values do not necessarily satisfy constraints (4.2), however. The averages of the budget shares are given in the last row of Table 2.

on average for all countries; and surprisingly in 11 countries the RMSE decreases with identical tastes.⁸ While this 0.35 percentage-point increase in the average RMSE may seem modest, it still involves a rise from 0.64 percent to 0.97 percent, an increase of more than one half.

Rather than postulating identical tastes in all countries, it would seem natural to consider groups of countries with the same tastes. We consider the rich and poor countries as two groups and apply the same approach as before.⁹ Columns 5 and 6 of Table 10 contain the results. As can be seen from the last entry of column 6, the average increase in the RMSE is now 0.31 percentage points, whereas when all countries belong to the same group the rise was 0.35 percentage points, as discussed in the previous paragraph.

The division of the 43 countries into rich and poor groups is based on a comparison of their per capita GDP with that of the USA. A country whose per capita GDP is at least 50 percent that of the USA is declared to be “rich”, while all other countries are “poor”. As the basis for dividing up the world in this manner is admittedly arbitrary, it is useful to explore alternatives which have firmer analytical foundations. Even if we confine our attention to the problem of classifying the 43 countries into just two groups, there is a total of $43 \times 42 / 2 = 903$ possibilities. Obviously, putting some additional structure on the problem is desirable in the interests of manageability. To do this, we shall keep countries ranked by income and consider the following 42 alternative groupings:

<u>Grouping</u>	<u>Frist group</u>	<u>Second group</u>
1	Richest country	Remaining 42 countries
2	Top 2 richest countries	Remaining 41 countries
⋮	⋮	⋮
42	Top 42 richest countries	Remaining 1 country

⁸ It should be noted that six of these countries have previously distinguished themselves as troublemakers (New Zealand, Cyprus, Portugal, Thailand, Iran and India).

⁹ We follow the previous approach of defining countries 1-25 as “rich” and the remaining 18 as “poor”.

TABLE 10
IMPACT OF IDENTICAL TASTES AND GROUPING COUNTRIES

Countries	Country-specific coefficients	Rich/poor grouping						Linear combination of rich and poor groups' parameters	
	RMSE	Identical tastes		Arbitrary		Optimal		RMSE	ΔRMSE
		RMSE	ΔRMSE	RMSE	ΔRMSE	RMSE	ΔRMSE		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1. USA	.12	.73	.61	.63	.51	.66	.54	.77	.65
2. Switzerland	.38	.67	.29	.72	.34	.68	.30	.64	.26
3. Luxembourg	.08	1.00	.93	.91	.83	.82	.74	1.00	.92
4. Hong Kong	.30	1.24	.94	1.19	.89	1.29	.99	1.30	1.00
5. Canada	.14	.84	.70	.75	.61	.73	.59	.87	.73
6. Germany	.09	.39	.30	.38	.29	.37	.28	.39	.30
7. Japan	.06	.63	.57	.53	.46	.55	.49	.66	.60
8. Denmark	.21	.44	.23	.46	.25	.44	.23	.42	.21
9. Australia	.16	.63	.47	.58	.42	.55	.39	.65	.49
10. Sweden	.15	.67	.52	.73	.58	.69	.54	.66	.51
11. France	.07	.70	.64	.65	.58	.68	.61	.75	.68
12. Belgium	.40	.34	-.06	.37	-.03	.39	-.01	.34	-.06
13. Netherlands	.55	.45	-.10	.52	-.03	.44	-.11	.39	-.16
14. Norway	.46	.25	-.21	.28	-.18	.23	-.23	.27	-.19
15. Austria	.18	.59	.41	.46	.28	.44	.26	.65	.47
16. Singapore	.15	.84	.69	.89	.74	.93	.78	.87	.72
17. Italy	.29	.48	.18	.54	.24	.55	.26	.48	.19
18. Iceland	.38	.81	.43	.87	.49	.86	.48	.78	.40
19. UK	.31	.69	.38	.70	.39	.66	.35	.69	.38
20. Finland	.60	.33	-.27	.38	-.23	.37	-.23	.33	-.27
21. New Zealand	1.21	.91	-.30	.85	-.36	.84	-.37	.94	-.27
22. Spain	.70	.92	.23	1.05	.36	1.01	.31	.83	.13
23. Israel	.09	.72	.63	.62	.53	.60	.51	.76	.67
24. Ireland	.33	.53	.20	.64	.31	.49	.16	.51	.18
25. Cyprus	2.49	2.47	-.03	2.70	.20	2.14	-.35	2.51	.02
26. Taiwan	.53	1.02	.49	1.15	.63	1.15	.62	1.04	.51
27. Korea	.32	1.22	.90	1.02	.70	1.11	.79	1.20	.88
28. Portugal	2.23	1.73	-.50	1.87	-.37	1.81	-.42	1.78	-.45
29. Greece	.13	.60	.47	.60	.47	.67	.54	.61	.48
30. Venezuela	1.41	--	--	--	--	--	--	--	--
31. Mexico	.82	.87	.05	.82	.00	.89	.07	.82	.00
32. Malta	.35	1.73	1.38	1.54	1.19	1.54	1.19	1.71	1.36
33. Puerto Rico	1.10	.78	-.32	.71	-.39	.70	-.40	.76	-.34
34. Hungary	2.76	--	--	--	--	--	--	--	--
35. Fiji	.74	1.65	.91	1.34	.61	1.42	.68	1.60	.86
36. Thailand	1.86	1.11	-.75	1.30	-.56	1.29	-.57	1.11	-.75
37. Colombia	.26	1.08	.82	1.06	.80	1.14	.88	1.03	.77
38. Iran	1.90	.98	-.93	1.06	-.84	.95	-.95	1.01	-.89
39. South Africa	.09	1.02	.92	.99	.90	1.00	.91	1.01	.92
40. Ecuador	.36	.94	.58	.86	.49	.90	.54	.90	.54
41. Jamaica	.65	.84	.19	.64	-.02	.60	-.05	.81	.16
42. Sri Lanka	.35	1.43	1.07	1.35	1.00	1.41	1.06	1.39	1.04
43. Honduras	1.06	1.43	.36	1.53	.47	1.56	.50	1.45	.39
44. India	2.56	1.85	-.70	1.75	-.81	1.83	-.73	1.81	-.75
45. Zimbabwe	2.12	3.13	1.01	2.75	.62	2.75	.63	3.11	.99
46. Mean									
Countries 1-25	.40	.73	.33	.74	.34	.70	.30	.74	.34
Countries 26-45	.97	1.30	.37	1.24	.27	1.26	.29	1.29	.32
Countries 1-45	.64	.97	.35	.95	.31	.93	.30	.97	.33

Notes: 1. Column (4) = (3) - (2); column (6) = (5) - (2); and column (8) = (7) - (2). 2. All the means exclude Venezuela and Hungary. See text. 3. All entries are to be divided by 100.

In essence, this approach lists the 43 countries in order of decreasing per capita GDP and uses a “dividing line” between the two groups that starts at the top of the list and then successively moves downward.

For all countries in a given group, we use the same set of trends and demand elasticities, and then evaluate the RMSE for each member of the group, as before. Accordingly, tastes are specified to be identical across countries within the same group, but they differ for countries in different groups. Finally, we judge the “quality” of a given grouping by averaging over the 43 countries the RMSEs so obtained. For the trends and demand elasticities for a group we use the averages over its members of the country-specific coefficients and then renormalise. Figure 2 plots the average RMSEs for each of the 42 possible groups and as can be seen, this criterion is minimised when the first 23 countries are included in one group, and the remaining 20 countries are in the other. As this grouping of countries minimises the heterogeneity of tastes within each of the two groups, in this sense it is the “optimal way” to divide up the world. The interesting result is that this optimal grouping is very close to the previous arbitrary grouping, whereby countries 1-25 were in the first group and the remaining 18 in the second. This result can be seen from column 7 of Table 10 which contains the individual country RMSEs associated with the optimal grouping. In the vast majority of cases, these RMSEs are close to the corresponding entries in column 5, the RMSEs associated with the previous arbitrary grouping.

A final way of grouping countries is as follows. For country c , let $\mathbf{Dq}^c$ be a vector of log-change of quantities consumed; $\mathbf{x}^c$ be a vector of income and price changes; and $\boldsymbol{\theta}^c$ be a vector of parameters comprising autonomous trends, income and price elasticities. We can then write the system of demand equations as $\mathbf{Dq}^c = \mathbf{f}(\mathbf{x}^c, \boldsymbol{\theta}^c)$. When $\boldsymbol{\theta}^c$ is country-specific, tastes differ internationally; when $\boldsymbol{\theta}^c = \boldsymbol{\theta}$, a vector of constants, tastes are identical; and when $\boldsymbol{\theta}^c = \boldsymbol{\theta}^g$, $g = r$ for $c \in \mathbf{S}_r$, the group of rich countries, and $g = p$ for $c \in \mathbf{S}_p$, the poor, then the world is divided into two groups of countries. These three cases have been considered above. An alternative approach, which is a mixture of the second and third cases,

FIGURE 2 RMSEs FOR 42 GROUPING METHODS

is when the parameter vector θ takes the same value for all countries, and is defined as a weighted average of that for the rich, θ^r , and the poor, θ^p :

$$\theta^* = \lambda \theta^r + (1 - \lambda) \theta^p, \quad (6.1)$$

where the scalar λ is the weight accorded to the rich, with $0 \leq \lambda \leq 1$. Note that equation (6.1) treats all commodities symmetrically as the weight λ is neither commodity nor elasticity specific. For a related approach, see Clements and Ye (2003).

For a fixed value of the weight λ , we can define θ^* from equation (6.1), use it in the demand system for each country, compute the RMSE (weighted by commodity, as before), and then average over all countries. This procedure can be repeated for various values of λ to determine which one minimizes the average RMSE.¹⁰ This yields $\lambda = .55$, a value that has democratic attractions as rich and poor countries are treated approximately equally. The associated RMSEs for the individual countries are given in column 9 of Table 10. The values in this column are quite close to those of column 3, where

¹⁰ This problem has a unique minimum as the average RMSE is quadratic in λ with positive second derivative.

tastes are specified as being identical. The reason for this result is as follows. The parameter vector associated with identical tastes is an average over the 43 countries of the individual-country vectors, $\bar{\theta} = (1/43) \sum_{c=1}^{43} \theta^c$, while those for the rich and the poor are also the corresponding averages, $\theta^r = (1/n_r) \sum_{c \in S_r} \theta^c$, $\theta^p = (1/n_p) \sum_{c \in S_p} \theta^c$, where n_g is the number of countries contained in group g ($g = r, p$). It then follows that

$$\bar{\theta} = \gamma \theta^r + (1 - \gamma) \theta^p, \quad (6.2)$$

where $\gamma = n_r / (n_r + n_p)$ is the share of the rich in the total number of countries. In our application, $n_r = 25$, $n_p = 18$, and $n_r + n_p = 43$, so that $\gamma = 25 / 43 \approx .58$, which is quite close to the optimal value of λ , viz. $.55$. As equation (6.2) has the same form as (6.1) and as $\gamma \approx \lambda$, it follows that $\bar{\theta} \approx \theta^*$, so that identical tastes approximate the linear combination of the rich and the poor.¹¹

7. Concluding Comments

This paper has analysed similarities and differences in consumption patterns across countries. Using a large international database recently published by Selavanathan and Selvanathan (2003), we showed that consumption baskets have a distinct tendency to become more diversified as income rises, indicating a positive income elasticity of the demand for variety. But when we confine attention to just food and nonfood, the reverse happens as due to the operation of Engel's law, consumers in rich countries have a distinct concentration on nonfood items, so that at this level the basket becomes more specialised. Using income and price elasticities basically from the Selvanathans, we demonstrated that a surprisingly large

¹¹ It is worth mentioning that Theil and Moss (2003) consider the related problem of how a country qualifies for admission to the Group of Seven. This does not seem to be on the basis of population nor GDP per capita alone; e.g., the world's most populous country, China, is not a member, while some rich countries, in GDP per capita terms, such as Norway, Switzerland and Australia, are also excluded. Accordingly, Theil and Moss postulate that eligibility for membership (E) is "produced" with inputs population (P) and GDP per capita (G) with constant returns to scale Cobb-Donglas technology, $E = P^\delta G^{1-\delta}$, where δ is a parameter lying between zero and one. Theil and Moss seem to favour the value $\delta \approx .2$ and note that $\delta = .5$, whereby population and GDP are equally weighted, is too high as this amounts to eligibility being $E = \sqrt{P \times G}$, which is increasing in total GDP, $P \times G$.

share of the overall variability of international consumption patterns can be explained by simple demand equations without having to resort to the old favorite “special case” arguments that have only *post hoc* justifications. In light of the large variability of cross-country consumption patterns, whereby food, for example, occupies more than one half of the overall budget in the poorest countries and only about 15 percent in the richest, this is quite a spectacular result.

Other key findings of the paper include:

- Consumption in rich countries can be explained considerably better than that in poor. Conceivably, this could be due to inferior quality data produced by poor countries, although we cannot rule out other explanations such for some reason or other, our modeling of the utility-maximising consumer simply is deficient for those countries. These alternatives could be usefully explored further in subsequent research.
- As a rough rule of thumb, allowing consumption to be proportional to income explains about one-half of the total variation in consumption patterns, while using a conventional demand model explains a further one half of the remaining one-half. Accordingly, a respectable $\frac{1}{2} + \frac{1}{2} \times \frac{1}{2} = \frac{3}{4}$ of the total is accounted for.
- The assumption that tastes are identical across countries seems to be too rigid, even for the broad aggregates such as food, clothing, housing, etc. Such an assumption substantially increases the degree to which consumption is unexplained and should be relaxed in future work on cross-country demand systems.
- Dividing countries up into two groups, “the rich”, which have per capita GDPs of at least 50 percent that of the USA, and “the poor”, comprising all other countries, has some attractions. This partitioning of the world closely approximates an “optimal” structure, which minimizes the heterogeneity of tastes between countries belonging to the same group.

Appendix : The Data and Coefficients of the Demand Equations

The appendix describes the source of the data for the budget shares, prices and quantities consumed, as well as the coefficients of the demand equations.

Budget Shares, Prices and Quantities

Columns 1-4 of Table 1 are from Selvanathan and Selvanathan (2003, Table 1.2), henceforth S & S (2003), with the Philippines omitted due to missing data for medical care, recreation and education.

The starting point for Table 2 is S & S (2003, Tables 3.3 and 4.3). It should be noted that the goods recreation and other are both a bit heterogeneous across countries. Recreation includes education in a number of countries in S & S's data (S & S, 2003, Tables 3.2 and 4.2). For those countries in which education is separately identified by S & S, we combine that good with the S & S good "miscellaneous" to form "other". The budget shares in Table 2 are renormalised such that $\sum_{i=1}^8 w_i = 1$. Table A1 provides more details of the transition from S & S's data to ours.

The mean price log-changes are from S & S (2003, Tables 3.5 and 4.5). Where commodities are combined, we take a weighted average of the two price log-changes, the weight being the share of the good in total expenditure on the combination. A similar approach is used for the mean quantity log-changes, from S & S (2003, Tables 3.4 and 4.4). For recreation in Ecuador, Dp_i is estimated by the Divisia index for that country calculated on the basis of the other goods; and Dq_i is estimated by an average of that in South Africa and Jamaica, Ecuador's closest neighbours on the income scale.

TABLE A1

RECONCILIATION OF NUMBER OF COMMODITIES SEPARATELY IDENTIFIED

Countries	Number of commodities				Comments
	Budget shares		Estimates by S & S		
	S & S	Current study	DLDE	PI	
(1)	(2)	(3)	(4)	(5)	(6)
Australia, Austria, Canada, Colombia, Denmark, France, Greece, Hong Kong, Iceland, Ireland, Italy, Israel, Norway, Sweden, USA	9	8	9	9	Data are complete in all stages. “Education” and “Miscellaneous” from S & S are combined in the current study into “Other”.
Belgium, Finland, Germany, Japan, Korea, Luxembourg, Malta, Mexico Netherlands Puerto Rico Singapore, South Africa, Spain, Sri Lanka, Switzerland, Taiwan, Thailand, UK	8	8	8	8	In S & S, “Education” is included in “Miscellaneous”. So “Other” in current study is the same as “Miscellaneous” in S & S for these countries.
India	9	8	9	7	Commodities are aggregated to achieve non-singularity of covariance matrix in PI model.
Cyprus, Jamaica	9	8	9	6	
Fiji	8	8	8	6	
Honduras, Hungary, Iran, New Zealand, Venezuela, Zimbabwe	8	8	8	5	
Portugal	8	8	8	-	Sample size is too small to estimate PI model
Ecuador	7	8	7	7	Budget share for “Recreation” in the current study is predicted using the estimated equation $w = -.13+.02 \log \text{GDP}$. This figure is then subtracted from the budget share of “Other”.
Philippines	6	-	5	5	Not included in the current study because the number of commodities in S&S is only 6.

Note: S & S denotes Selvanathan and Selvanathan (2003); DLDE = double-log demand equations; and PI = preference independence demand model.

Coefficients of the Demand Equations

Equation (4.1) for $i = 1, \dots, 8$ is a system of demand equations that contains three sets of coefficients, (i) the autonomous trend terms α_i ; (ii) the income elasticities η_i ; and (iii) the price elasticities η_{ij} . We shall discuss the sources for each set of coefficients.

S & S (2003, Chap. 9) estimate the CBS preference independence model (Keller and van Driel, 1985). The i^{th} equation of this model takes the form

$$\bar{w}_{it}(Dq_{it} - DQ_t) = \alpha_i^* + \beta_i DQ_t + \phi(\beta_i + \bar{w}_{it})(Dp_{it} - DP'_t), \quad (A1)$$

where $\bar{w}_i = (w_{it} + w_{i,t-1})/2$ is the arithmetic average of the i^{th} budget share over the years t and $t-1$; $Dq_{it} = \log q_{it} - \log q_{i,t-1}$ is the log-change in the quantity demanded of good i ; $DQ_t = \sum_{i=1}^n \bar{w}_{it} Dq_{it}$ is the Divisia volume index, with n the number of goods; $Dp_{it} = \log p_{it} - \log p_{i,t-1}$ is the log-change in the price of good i ; $DP'_t = \sum_{i=1}^n (\bar{w}_{it} + \beta_i) Dp_{it}$ is the Frisch price index; and α_i^* , β_i and ϕ are parameters. By rearranging equation (A1) we obtain

$$Dq_{it} = \frac{\alpha_i^*}{\bar{w}_{it}} + \left(1 + \frac{\beta_i}{\bar{w}_{it}}\right) DQ_t + \phi \left(1 + \frac{\beta_i}{\bar{w}_{it}}\right) (Dp_{it} - DP'_t),$$

or

$$Dq_{it} = \alpha_i + \eta_i DQ_t + \sum_{j=1}^n \eta_{ij} Dp_{jt}, \quad (A2)$$

where $\alpha_i = \alpha_i^* / \bar{w}_{it}$, $\eta_i = 1 + \beta_i / \bar{w}_{it}$ and $\eta_{ij} = \phi \eta_i (\delta_{ij} - \bar{w}_{jt} \eta_i)$, with δ_{ij} the Kronecker delta. Clearly equations (A2) and (4.1) have the same form.

S & S (2003, Tables 9.1 and 9.2) present estimates of the intercept α_i^* for each good and country. As there are some missing values, we estimate these by the means of the other OECD countries or the less developed countries, as the case may be; see S & S (2003, Table 1.1) for details of these two groups of countries. As the estimate of α_i^* for durables in Korea

seemed to be an outlier, we replace with the mean over the LDCs. When goods are combined, we take a budget-share weighted average of the two intercepts, as before. To obtain the corresponding values of the autonomous trends, defined as $\alpha_i = \alpha_i^* / w_i$, we divide the intercepts α_i^* by the budget shares w_i given in Table 2. As the trends for clothing and medical care in New Zealand seemed to be outliers, we replace them with the means over the remaining 44 countries. Finally, we renormalised so that $\sum_{i=1}^8 w_i \alpha_i = 0$.

The income elasticities implied by the estimates of model (A1) are given in S & S (2003, Tables 9.8 and 9.9). Missing values are replaced with income elasticities estimated from double-log demand equations (S & S, 2003, Tables 3.8 and 4.17). When goods are combined, we use a budget-share weighted average of the two income elasticities, as before. Finally, we renormalise so that $\sum_{i=1}^8 w_i \eta_i = 1$.

The parameter ϕ in equation (A1) is the income flexibility, the reciprocal of the income elasticities of the marginal utility of income. S & S (2003, Tables 9.2 and 9.4) present estimates of ϕ for each country. All estimates are negative except those for Cyprus and India; the average of the negative values is -.41. As S & S (2003, Secs. 3.6 and 4.6) find ϕ to be unrelated to per capita income, we use $\phi = -.41$ for all countries. We then use this value, the budget shares from Table 2 and the income elasticities from Table 5 in equation (4.3) to compute the own- and cross-price elasticities η_{ij} . By construction, these elasticities satisfy $\sum_{i=1}^8 w_i \eta_{ij} = 0, j = 1, \dots, 8$.

References

- Balassa, B. (1964). "The Purchasing-Power Parity Doctrine: A Reappraisal." Journal of Political Economy 72: 584-96.
- Barten, A. P. (1977). "The Systems of Consumer Demand Functions Approach: A Review." Econometrica 45; 23-51.
- Chen, D. -L. (1999). World Consumption Economics. Singapore: World Scientific.
- Chua, G. (2003), "Food and Cross-Country Income Comparisons", Economics Discussion Papers 03-14, University of Western Australia, Perth.
- Clark, C. (1940), Third Edition (1957). The Conditions of Economic Progress. London: Macmillan.
- Clark, P. B. and R. MacDonald (1998). "Exchange Rates and Economic Fundamentals: A Methodological Comparison of BEERs and FEERs." IMF Working Paper 98/67. Washington DC: International Monetary Fund.
- Clements, K. W. and D. -L. Chen (1996). "Fundamental Similarities in Consumer Behaviour." Applied Economics 28: 747-57.
- _____ and Q. Ye (2003). "The Economics of Global Consumption Patterns." Journal of Agricultural and Applied Economics, Supplement, 35: 21-37.
- _____ and H. Theil (1996). "A Cross-Country Analysis of Consumption Patterns." In H. Theil Studies in Global Economics. Dordrecht: Kluwer. Pp. 95-108.
- _____ and S. Selvanathan (1994). "Understanding Consumption Patterns." Empirical Economics 19: 69-110.
- _____, W. Yang and S. W. Zheng (1997). "Is Utility Additive? The Case of Alcoholic Beverages." Applied Economics 29: 1163-67.
- Dixit, A. K. and J. E. Stiglitz (1977). "Monopolistic Competition and Optimum Product Diversity" American Economic Review 67: 297-308.
- Driver, R. and P. F. Westaway (2001). "Concepts of Equilibrium Exchange Rates." Mimeo, Bank of England.
- Friedman, M. (1956). "The Quantity Theory of Money -- A Restatement." Chapter 1 in M. Friedman (ed) Studies in the Quantity Theory of Money. Chicago: The University of Chicago Press. Pp. 3-21.
- Frisch, R. (1959). "A Complete Scheme for Computing All Direct and Cross Demand Elasticities in a Model with Many Sections." Econometrica 27: 177-96.

- Houthakker, H. S. (1957). "An International Comparison of Household Expenditure Patterns, Commemorating the Centenary of Engel's Law." Econometrica 25: 532-51.
- Houthakker, H. S. (1987). "Engel's Law." In J. Eatwell, M. Milgate and P. Newman (eds) The New Palgrave Dictionary of Economics. London: Macmillan. Volume 2. Pp. 143-44.
- Keller, W. J. and J. van Driel (1985). "Differential Consumer Demand Systems." European Economic Review 27: 375-90.
- Kravis, I. B., A. W. Heston and R. Summers (1982). World Product and Income: International Comparisons of Real Gross Product. Baltimore: Johns Hopkins University Press.
- Laidler, D. (1991). "The Quantity Theory is Always and Everywhere Controversial: Why?" Economic Record 77: 199-225.
- Lan, Y. (2003). The Long-Run Behaviour of Exchange Rates. Unpublished PhD thesis. Economic Research Centre, Department of Economics, The University of Western Australia.
- Lluch, C. and A. A. Powell (1975). "International Comparison of Expenditure Patterns." European Economic Review 5: 275-303.
- _____ and A. A. Powell and R. A. Williams (1977). Patterns in Household Demand and Saving. Oxford: Oxford University Press.
- MacDonald, R. (2000). "Concepts to Calculate Equilibrium Exchange Rates: An Overview." Discussion Paper 3/00. Economic Research Group, the Deutsche Bundesbank.
- Montiel, P. J. and L. E. Hinkle (1999). "Exchange Rate Misalignment: An Overview." Chapter 1 in L. E. Hinkle and P. J. Montiel (eds) Exchange Rate Misalignment: Concepts and Measurement for Developing Countries. New York: The World Bank, Pp. 1-40.
- Ong, L. L. (2003). The Big Mac Index: Applications of Purchasing Power Parity. London: Macmillan.
- Samuelson, P. A. (1964). "Theoretical Notes on Trade Problems." Review of Economics and Statistics 46:145-54.
- Selvanathan, E. A. and S. Selvanathan (2003). International Consumption Comparisons: OECD versus LDC. Singapore: World Scientific.

- Selvanathan, S. (1993). A System-Wide Analysis of International Consumption Patterns. Boston, Dordrecht and London: Kluwer.
- Summers, R. and A. Heston (1991). "The Penn World Table (Mark 5): An Expanded Set of International Comparisons." Quarterly Journal of Economics 106: 327-68.
- Theil, H. (1967), Economics and Information Theory. Amsterdam: North-Holland.
- _____ (1987). "Evidence from International Consumption Comparison." Chapter 2 in H. Theil and K. W. Clements Applied Demand Analysis: Results from System-Wide Approaches. Cambridge, Mass.: Ballinger. Pp. 37-100.
- _____ (1996). Studies in Global Economics. Dordrecht: Kluwer.
- _____ and R. Finke (1983). "The Consumer's Demand For Diversity." European Economic Review 23: 395-400.
- _____, C. -F. Chung and J. L. Seale Jr. (1989). International Evidence on Consumption Patterns. Greenwich and London: JAI Press.
- _____ and C. B. Moss (2003). "Les Maitres du Monde: The G-7's Path to Prominence, 1885-1994." Journal of Agricultural and Applied Economics, Supplement 35: 155-60.
- _____ and F. E. Suhm (1981). International Consumption Comparisons: A System-Wide Approach. Amsterdam: North Holland.
- Williamson, J. (ed) (1994). Estimating Equilibrium Exchange Rates. Washington DC: Institute for International Economics.
- Wren-Lewis, S. and R. L. Driver (1998). Real Exchange Rates for the Year 2000. Washington DC: Institute for International Economics.