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# The Economics of Global Consumption Patterns

**Kenneth W. Clements and Ye Qiang**

Henri Theil devoted a good deal of the last two decades of his professional activities to the analysis of international consumption patterns. This paper commences with a review of Theil's path-breaking research on cross-country demand, and then investigates in some detail two important issues: (i) the extent to which differences in incomes and prices explain international consumption patterns; and (ii) new empirical evidence regarding the extent to which tastes are similar internationally. The paper also contains an evaluation of another important building block of Theil's work in this area, that of the assumption of preference independence, whereby there are no interactions between goods in the utility function.

*Key Words:* cross-country demand, preference independence, system-wide approach

Henri Theil was one of the pioneers of the system-wide approach to demand analysis in which the consumption of all $n$ goods in the budget is explained jointly. This work was characterized by much creativity and an appealing blend of theory and measurement. His early work in this area analyzed issues associated with the quality of consumption and ways of measuring substitutability/complimentary relations with cross-sectional data (Theil 1952; Theil and Neudecker). But it was Theil's work in later decades that became even more influential and has had a lasting effect. This later work included the introduction of the famous Rotterdam model, which Theil developed in conjunction with Barten (Barten 1964; Theil 1965). For the first time, this model allowed rigorous testing of the major hypotheses of consumer demand theory. The major reference for this work is the two-volume book, *Theory and Measurement of Consumer Demand* (Theil 1975/1976), which includes an in-depth treatment of the economic theory of the consumer, index numbers, aggregation over individuals, the econometrics of demand systems, conditional demand models, summary measures of the consumer's basket, extensive empirical applications, and much more. A rereading of that book is highly rewarding because it reveals amazing insights, originality, and attention to data, and it serves as a reminder of just how high were Theil's scholarly standards.

A further major contribution of Theil was cross-country demand analysis, whereby systems of demand equations were estimated with data from different countries. The availability of the Kravis, Heston, and Summers data was an important stimulus to this strand of research. The assumption of this work was that tastes were the same in different countries, at least as a working hypothesis. The assumption that tastes are always constant is a major tenant of Chicago economics and has been long championed by leading lights such as Becker, Friedman, and Stigler (Freidman; Stigler and Becker). Given that Theil was at The Univer-

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sity of Chicago when he initiated his cross-country research, it is interesting to speculate about the influence that this institution played in shaping his research. For someone with the strongest of personalities and someone who did not always identify overtly with the Chicago School, was the force of Chicago economics sufficiently strong to influence, perhaps only subconsciously, Theil's thinking about tastes in different countries?

This paper commences with a review of Theil's pathbreaking research on cross-country demand analysis and then investigates in some detail two important issues. First, we analyze the extent to which differences in incomes and prices explain international consumption patterns; second, we provide new empirical evidence regarding the extent to which tastes are similar internationally. We also discuss another important building block of Theil's work in this area—the assumption of preference independence whereby there are no interactions between goods in the consumer utility function. The structure of the paper is as follows. First, we provide an account of Theil's work on the Rotterdam model and its cross-country extensions. The next two sections then contrast consumption patterns in rich and poor countries and analyze the extent to which these differences can be explained. We then introduce the concept of an "international consumer" who is an appropriately weighted average of cousins in rich and poor countries. The last section contains concluding comments.

## Henri Theil's Brand of Demand Analysis

In this section, we present some of the highlights of Theil's work in demand analysis, starting with the Rotterdam model.

### *The Rotterdam Model*

In the early 1960s there were probably only two system-wide models of consumer demand: Houthakker's addilog model (see also Leser and Somermeijer 1956, 1962) and Stone's linear expenditure system. Both models were based on restrictive forms of preferences (an additive indirect or direct utility function) and were not designed to test the basic hypotheses of consumer theory of demand homogeneity and Slutsky symmetry. In the mid 1960s, Barten (1964) and Theil (1965) opened up new possibilities with the introduction of the Rotterdam model.

The Rotterdam model has as its starting point a double-log demand equation for good $i$ in terms of differentials over time:

$$(1) \qquad d(\log q_i) = \eta_i d(\log Q) + \sum_{j=1}^{n} \gamma_{ij} d(\log p_j),$$

where $q_i$ is the quantity demanded of good $i$, $d(\log Q)$ is the change in real income, $p_j$ is the price of good $j$, $\eta_i$ is the income elasticity of demand for $i$, $\gamma_{ij}$ is the $(i, j)$th compensated price elasticity, and $n$ is the number of goods in the consumer basket. To deal with the demand for each of the $n$ goods simultaneously, there is one demand equation for each good so that the demand system consists of Equation (1) for $i = 1, \ldots, n$.

The elasticities in the above system are subject to three constraints: adding up, homogeneity, and symmetry. Adding up requires that the system satisfies the consumer's budget constraint, $\Sigma_{i=1}^{n} p_i q_i = M$, where $M$ is total expenditure, or "income" for short. This implies that (1) a budget share weighted average of the income elasticities is unity and (2) a budget share weighted average of the price elasticities is zero:

$$(2) \qquad \sum_{i=1}^{n} w_i \eta_i = 1, \qquad \sum_{i=1}^{n} w_i \gamma_{ij} = 0, \qquad j = 1, \ldots, n,$$

where $w_i = p_i q_i / M$ is the budget share of good $i$. Homogeneity, or the absence of money illusion, implies that an equiproportional change in all prices has no effect on the consumption of any good, under the condition that real income remains unchanged. This amounts to the row sums of the $n \times n$ matrix of price elasticities $[\gamma_{ij}]$ being zero:

$$(3) \qquad \sum_{j=1}^{n} \gamma_{ij} = 0, \qquad i = 1, \ldots, n.$$

Finally, symmetry relates to the $n \times n$ matrix of compensated price slopes of the demand functions $[\partial q_i/\partial p_j]$. This matrix must be symmetric, which in terms of the price elasticities of Equation (1) implies

$$(4) \qquad w_i\gamma_{ij} = w_j\gamma_{ji}, \qquad i, j = 1, \ldots, n.$$

In Equation (1), the income and price elasticities are taken to be constants. Although this is a natural way of proceeding, it does present problems for the adding up and symmetry constraints of Equations (2) and (4) because these contain the budget shares $w_i$, which in general are not constants. Theil (1965) solved this problem by means of an ingenious reparameterization. If we multiply both sides of Equation (1) by $w_i$, we obtain

$$(5) \qquad w_i d(\log q_i) = \theta_i d(\log Q) + \sum_{j=1}^{n} \pi_{ij} d(\log p_j),$$

where $\theta_i = w_i\eta_i = \partial(p_iq_i)/\partial M$ is the marginal share of good $i$ and $\pi_{ij} = w_i\gamma_{ij}$ is the $(i, j)$th Slutsky coefficient. The marginal share, $\theta_i$, answers the question: If income increases by \$1, what fraction of this is spent on good $i$? In terms of the coefficients of Equation (5), adding up, homogeneity, and symmetry now imply

$$(6) \qquad \sum_{i=1}^{n} \theta_i = 1, \qquad \sum_{i=1}^{n} \pi_{ij} = 0, \qquad j = 1, \ldots, n,$$

$$(7) \qquad \sum_{j=1}^{n} \pi_{ij} = 0, \qquad i = 1, \ldots, n,$$

$$(8) \qquad \pi_{ij} = \pi_{ji}, \qquad i, j = 1, \ldots, n.$$

Comparing the conditions in Equations (2)–(4) with (6)–(8), it can be seen that the attractive feature of the latter set of constraints is that it involves only the coefficients of Equation (5) and not the budget shares. Accordingly, Theil suggested treating the coefficients of Equation (5) as constants, and this equation for $i = 1, \ldots, n$ became known as the "Rotterdam demand model." The implementation of the model with discrete data involves two adjustments. First, $w_i$ is replaced with $\bar{w}_{it} = (w_{it} + w_{i,t-1})/2$, the arithmetic average of the budget share in years $t$ and $t - 1$. Second, for any variable $x$, $d(\log x)$ is replaced with its log-change from $t - 1$ to $t$, $\log x_t - \log x_{t-1}$.

The Rotterdam model has a number of attractive properties. First, it is consistent with the behavior of individual consumers in that it can be obtained by consistently aggregating micro demand functions under weak conditions (Barnett; E. A. Selvanathan 1991). Second, its coefficients, $\theta_i$ and $\pi_{ij}$, have clear economic interpretations. Third, the model and constraints of Equations (6)–(8) are all linear in the unknown coefficients, which facilitates testing and estimation. Forth, it is a "flexible function form" in that it provides a second-order approximation to the underlying utility function (Mountain). Finally, the model provides a straightforward way to test hypotheses regarding the structure of preferences. These features account for the long-standing popularity of the Rotterdam model. For an extensive treatment of the model, see Theil (1975/1976).

An important special case of the structure of preferences is when the consumer's utility function is additive in the $n$ goods, $u(q_1, \ldots, q_n) = \sum_{i=1}^{n} u_i(q_i)$, where the subutility function $u_i(\cdot)$ is a function of the consumption of good $i$ only. Here, there are no utility interactions between goods, so the marginal utility of good $i$ depends only on its own consumption, $\partial u/\partial q_i = du_i/dq_i$. Because the Hessian matrix of the utility function is diagonal, Theil refers to this case as "preference independence" (PI). Under PI, the $(i, j)$th Slutsky coefficient takes the form $\pi_{ij} = \phi\theta_i(\delta_{ij} - \theta_j)$, where $\phi < 0$ is the income flexibility (the reciprocal of the income elasticity of the marginal utility of income) and $\delta_{ij}$ is the Kronecker delta ($\delta_{ij} = 1$ if $i = j$, 0 otherwise). If we define the Frisch (or marginal) price index as $d(\log P') = \sum_{i=1}^{n} \theta_i \, d(\log p_i)$, the $i$th demand equation of the Rotterdam model under PI is then

$$(9) \qquad w_i d(\log q_i) = \theta_i d(\log Q) + \phi\theta_i[d(\log p_i) - d(\log P')].$$

A comparison of Equation (9) with (5) reveals that the assumption of PI greatly simplifies the demand equation. Because the term in square brackets on the right-hand side of Equation (9) is interpreted as the change in the relative price of good *i*, we see that PI implies that only the own-relative price appears in the demand equation, which means that all cross-price elasticities are zero.[1] Furthermore, the *i*th own-price elasticity is $\phi\theta_i/w_i$, which is proportional to the corresponding income elasticity $\theta_i/w_i$. As the factor of proportionality $\phi < 0$, for the own-price elasticity to be negative, the income elasticity must be positive, which serves to rule out inferior goods. These implications of PI are obviously restrictive.

In his earlier work, Theil was sceptical about the validity of PI. After describing the simplifications that PI leads to in terms of the reduced number of unknown coefficients, Theil (1975/1976, Volume 1, p. 21) writes:

> The price to be paid for this simplification is the restrictive character of the assumption of preference independence. It is sometimes argued that this assumption is acceptable when the commodities used are broad aggregates, such as food, clothing, and shelter, because the competition between such aggregates is largely limited to the general competition for the consumer's dollar. Whether this is so remains to be seen. One of the objectives of this book is to verify empirically whether preference independence is an acceptable hypothesis.

Later in his book, Theil finds evidence from both Dutch and British data against the hypothesis of PI. This evidence is in the form of (1) significant cross-price elasticities and (2) a substantial deterioration in the goodness-of-fit of the models when PI is imposed. We shall have more to say about the assumption of PI in the last subsection of this section.

In subsequent work, Theil (1980) developed a more general framework for demand analysis in which the "coefficients" of Equation (5) are not necessarily constants. He called this the "differential approach," and in the next subsection we consider an example.

*Cross-Country Applications*

Theil's initial applications of the Rotterdam model involved the use of time series data; this work culminated with Theil (1975/1976). In the late 1970s, Theil modified the approach so it could be applied to the cross-country data complied by Kravis and associates as part of the International Comparisons Project at the University of Pennsylvania (Kravis, Heston, and Summers). Thus, rather than comparing consumption in one year with that in the previous year, now one country is compared with another on the assumption that all countries involved share the same tastes. This turned into a highly productive line of research that led to a series of influential publications (Clements and Theil; Theil 1996; Theil, Chung, and Seale; Theil and Clements; Theil and Suhm). In this subsection we discuss some features of that work.

The countries included in the Kravis data range from the poorest to the richest in the world, and Theil emphasized that the substantial variability in income and prices represented an attractive opportunity and challenge for the estimation of a demand system. One important dimension of income differences is the behavior of the budget share of food, which ranges from more than 50% for the poorest countries to around 10% for the richest. This is illustrated in Figure 1, which plots this share against total real per capita consumption (which plays the role of income) for 30 countries in 1975. With the exception of the three indicated African countries (for which there are substantial data problems), the points in the figure are scattered reasonably closely around a downward sloping straight line. In view of the diversity of countries involved, this is an impressive empirical regularity.

Given that income is measured on the horizontal axis of Figure 1 on a geometric scale, the food budget share ($w_i$) seems to evolve with income ($Q$) according to

$$(10) \quad w_i = \alpha_i + \beta_i \log Q,$$

[1] Strictly speaking, the price elasticities discussed here and below in this paragraph hold constant the marginal utility of income and are known as "Frisch price elasticities."

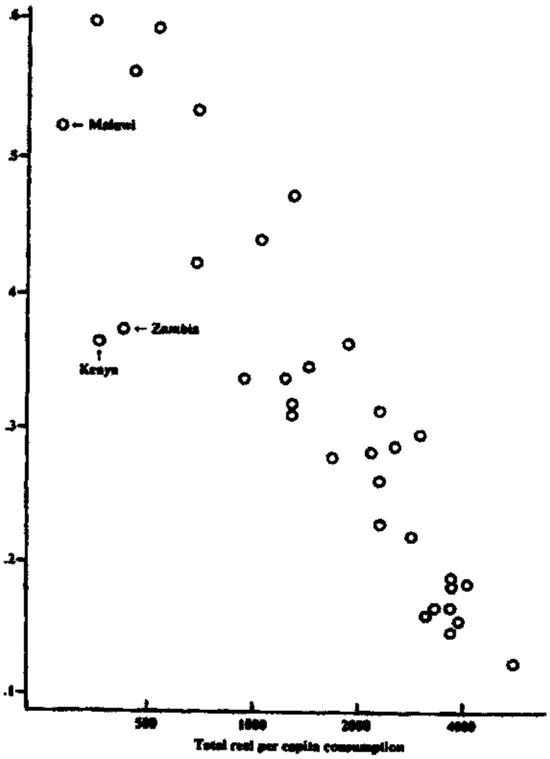


**Figure 1.** Working's Model for Food; ICP Data, Phase III, 1975

where $\alpha_i$ and $\beta_i$ are coefficients and $i$ is food. This equation is known as "Working's model" after Working. Equation (10) is a partial specification of a demand function because it deals only with the role of income, not prices; in the next paragraph, we indicate how Theil extended it by including prices. After allowing for cross-country differences in prices and using the Kravis, Heston, and Summers data, Theil, Chung, and Seale obtained an estimate of the food $\beta_i$ in the vicinity of $-0.15$, a value in broad agreement with estimates of this parameter from a number of other studies.[2]

To interpret this value, consider moving from one country with income $Q^*$ to another that is twice as rich, so that its income is $2Q^*$. Accordingly, $\Delta \log Q = \log 2 \approx 0.69$, and from Equation (10), the associated change in the food budget share is

$$\Delta w_i = \beta_i \Delta \log Q = -0.15 \times 0.69 \approx -0.10.$$

Thus, when income doubles, the food budget share declines by 10 percentage points, a result that Theil, Chung, and Seale refer to as *the strong version of Engel's law.* Engel's law in its conventional form states that the food share declines as income rises (or equivalently, the income elasticity of food is less than unity). The strong version of the law is a specific numerical statement of the nature of the decline in the food share.[3]

To analyze the effects of cross-country differences in income and prices simultaneously, Theil and his co-workers used the differential approach with Working's model. This yields a demand equation for good $i$ in country $c$ of the form

$$\text{(11)} \quad w_{ic} = \alpha_i + \beta_i \log Q_c + \sum_{j=1}^{n} \pi_{ij} \log \frac{p_{jc}}{\bar{p}_j} + w_{ic}\left(\log \frac{p_{ic}}{\bar{p}_i} - \sum_{j=1}^{n} w_{jc} \log \frac{p_{jc}}{\bar{p}_j}\right),$$

where $\bar{p}_j$ is the cross-country geometric mean of the price of good $j$. The first two terms on the right-hand side of Equation (11) are just Working's model; the second is the substitution term with $\pi_{ij}$ the $(i, j)$th Slutsky coefficient (as before); the last term relates to the dependence of $w_i$ on relative prices even when the quantity demanded remains unchanged (Theil 1987a). To reduce the number of coefficients to be estimated, the Slutsky coefficients are restricted by the assumption of preference independence. The demand Equation (11) is from Theil and Suhm; for earlier and later versions of this model, see Clements and Theil and Theil, Chung, and Seale, respectively.

The model in Equation (11) for $i = 1, \ldots, n$ goods and $c = 1, \ldots, C$ countries specifies that the coefficients take the same values in all countries. In other words, tastes are assumed

[2] For surveys, see Chen, and Chung and Lopez. For estimates of $\beta_i$ for food for 24 countries, see Yuen.

[3] The strong version of Engel's law also has implications for the own-price elasticity of demand for food. If the Slutsky price elasticity for this commodity is approximately constant, then under preference independence, a doubling of income leads to the Cournot price elasticity falling in absolute value by about 0.10. For details of this extension, see Clements and Chen (1996).

to be the same internationally. Interestingly, in earlier work, Theil seemed to argue that it was perfectly acceptable for tastes to be different in different countries: When describing the results from two independent applications of the Rotterdam model for $n = 4$ goods to Dutch and British time series data, Theil (1975/1976, Volume 1, p. 208) writes:

> The income elasticities of food agree with each other and they are of the order of magnitude which one would expect them to be, but the elasticities of the three other commodity groups show larger differences. There is no reason to be apologetic about this result, since different nations may have different preferences.

Theil avoided a jump in logic by using a pragmatic type of argument that advocated the use of broad commodity groups to minimize the differences in tastes across countries. Kravis, Heston, and Summers used their international data to estimate log-linear demand equations for each of 103 narrowly defined goods. The estimated income elasticities of bread and rice were 1.3 and −0.8, respectively, which Theil (1983) regarded as implausible—the bread elasticity is too high, whereas that of rice is too low. He argued that these values in part reflect variations in tastes as consumers in rich countries tend to eat bread and those in poorer countries eat rice (Theil 1987a, p. 47). When introducing their cross-country demand model for $n = 8$ goods, Theil and Suhm (pp. 1–2) state:

> The underlying assumption is that "all countries are the same" in the sense that their per capita consumption of goods and services can be viewed as being generated by essentially the same consumer preferences. If this assumption is acceptable, the only (but major!) differences between countries result from their differences in income and prices, apart possibly from random effects. But this assumption immediately raises the objection that different nations have different cultures. We should expect that Indians spend little on meat and, indeed, the data produced by Kravis et al. confirm that this is so. The appropriate answer is that a cross-country demand system should be constructed, not for a very large number of detailed consumption categories, but only for a modest number of much broader categories. Accordingly, meat is part of a "good" called Food . . .

It is of interest to note the parallels between this justification and that of the assumption of preference independence to which we now return.[4]

### *The Assumption of Preference Independence*[5]

There are two distinct justifications for the assumption of preference independence (PI) (Clements): (1) The economic justification in terms of PI being plausible when the commodities in question are broad aggregates and (2) the statistical justification that the assumption reduces the number of unknown coefficient to be estimated from the order of $n^2$ (where $n$ is the number of commodities), to something much less. These twin justifications are embodied in the following quotation from Theil (1987b, p. 148):

> The assumption of preference independence should be viewed as a convenient simplification when broad groups of goods are considered. Allowing such goods to be specific substitutes or complements will in many cases yield estimates that are even less precise.

Preference independence is the *simplest* possible specification of tastes. This simplicity and transparency of the assumption is clear from the form of the utility function, $\sum_{i=1}^{n} u_i(q_i)$, as well as from the associated demand Equation (9), which focuses exclusively on the role of income and the own–relative price. As a general principle, simplicity is to be preferred to complexity in the sense that if the world can be understood with a simple explanation, then there is no point in pursuing more complex alternatives. This is merely a matter of scientific efficiency. However, whether it is truly legitimate to invoke the as-

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[4] S. Selvanathan (1993) uses data from OECO countries and the six Australian states to directly test the hypothesis of identical tastes. In the main, her evidence points to a common set of tastes.

[5] This subsection draws in part on Clements and Selvanathan.

sumption of PI is largely an empirical question.

As discussed above, in earlier work, Theil was sceptical of the validity of the preference independence assumption. Although he never tested this assumption, others did, and in early work, it was rejected more often than not (see Barten 1977 for a survey of this research). A particularly influential paper on this topic is Deaton (1974).

He claims "... that *the assumption of* [preference independence] *is almost certain to be invalid in practice and the use of demand models based on such an assumption will lead to severe distortion of measurement*" (Deaton 1974, p. 346, his emphasis).

Deaton's (1974) investigation of PI was based on an indirect approach. As discussed following Equation (9), PI implies that own-price elasticities are proportional to income elasticities, with $\phi$ the (negative) factor of proportionality. In other words, luxuries are more price elastic than necessities. This proportionality relationship might, at first, seem counterintuitive. The income elasticity reflects the luxuriousness of the good, whereas the size of the price elasticity is an indication of the availability of substitutes. Because these are different dimensions of the good, one might be tempted to argue that there should be no a priori relationship between the elasticities. On the other hand, it is common practice to identify as necessities those goods that consumers cannot easily do without (e.g., food), whereas luxuries involve a discretionary expenditure for which there are many competing uses and thus can be easily foregone or postponed (e.g., durables). This use of language points in the direction of a relationship between the two types of elasticities (Deaton 1987).

Deaton's (1974) rejection of PI was based on examining the proportionality of income and price elasticities. But this result is contradicted by S. Selvanathan (1993), who found evidence in favor of the proportionality relationship for 18 OECD countries. Moreover, the studies reviewed by Barten (1977) employed tests of PI that had only an asymptotic justification, and these tests perform poorly with the sample sizes typically available.[6] S. Selvanathan (1987) developed a Monte Carlo test of PI that does not rely on asymptotic theory. Her application of this test to 18 OECD countries reveals substantial support for the PI hypothesis.[7] In summary, more recent research has shown that the case against PI is not nearly as strong as was once thought.

## Consumption Patterns in Rich and Poor Countries

In this section, we provide a contrast between the consumption patterns in rich countries with those in poor countries. There are 18 rich countries, all members of the OECD, and 13 poor ones. The data are from Clements and Chen (1996), and in the Appendix we provide a brief summary.

Let $p_{it}^c$ and $q_{it}^c$ be the price and per capita quantity consumed of good $i$ in year $t$ and country $c$. If there are $n$ goods, then $M_t^c = \Sigma_{i=1}^n p_{it}^c q_{it}^c$ is total expenditure ("income" for short) and $w_{it}^c = p_{it}^c q_{it}^c / M_t^c$ is the budget share of good $i$. Let $Dp_{it}^c = \log p_{it}^c - \log p_{i,t-1}^c$ be the log-change in the $i$th price, $Dq_{it}^c = \log q_{it}^c - \log q_{i,t-1}^c$ be the corresponding quantity log-change, and $\bar{w}_{it}^c = (w_{it}^c + w_{i,t-1}^c)/2$ be the arithmetic average of the budget share of good $i$ over the years $t$ and $t-1$. If $T^c$ is the sample size for country $c$, we can then eliminate the time dimension by averaging to define $Dp_i^c = (1/T^c)\ \Sigma_{t=1}^{T^c} Dp_{it}^c$, $Dq_i^c = (1/T^c)\ \Sigma_{t=1}^{T^c} Dq_{it}^c$, and $\bar{w}_i^c = (1/T^c)\ \Sigma_{t=1}^{T^c} \bar{w}_{it}^c$. Column 2 of Table 1 presents the budget shares $\bar{w}_i^c$ for $i = 1, \ldots, 8$ goods, averaged over the 18 rich countries. Column 3 contains the same budget shares averaged over the 13 poor countries. These budget shares reveal the following differences in the structure of consumption patterns for the two groups of countries ([rich − poor] × 100).

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[6] The failure of asymptotic tests of homogeneity and symmetry has been clearly demonstrated by the Monte Carlo studies carried out by Laitinen and Meisner, who were both students of Theil.

[7] It is also relevant to note that Clements, Yang, and Zheng test preference independence with respect to the consumption of beer, wine, and spirits. Using data for seven countries, they are unable to reject PI, which indicates that the assumption can also be applied to goods that are fairly narrowly defined.

**Table 1.** Consumption Data for Rich and Poor Countries

| Commodity | Budget Shares | | Log-Changes in Relative Prices | | Log-Changes in Per Capita Quantities | |
|---|---|---|---|---|---|---|
| | Rich | Poor | Rich | Poor | Rich | Poor |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| 1. Food | 29.59 | 40.44 | −0.28 | 0.31 | 1.67 | 1.69 |
| 2. Clothing | 9.17 | 9.29 | −1.02 | −1.36 | 2.38 | 3.45 |
| 3. Housing | 16.35 | 11.41 | 0.64 | −0.60 | 3.30 | 3.74 |
| 4. Durables | 9.04 | 8.43 | −0.77 | −0.63 | 3.26 | 4.01 |
| 5. Medicine | 5.06 | 3.77 | 0.88 | −0.12 | 4.09 | 4.54 |
| 6. Transport | 12.37 | 9.72 | 0.03 | 0.58 | 4.89 | 5.29 |
| 7. Recreation | 7.49 | 5.93 | −0.21 | −0.43 | 4.34 | 4.87 |
| 8. Other | 10.94 | 11.02 | 0.93 | 0.58 | 3.17 | 4.25 |
| 9. Divisia index | | | 7.05 | 13.97 | 3.05 | 3.23 |

Note: All entries to be divided by 100.

| | | | |
|---|---|---|---|
| 1. Food | −10.85 | 5. Medicine | 1.29 |
| 2. Clothing | −0.12 | 6. Transport | 2.65 |
| 3. Housing | 4.94 | 7. Recreation | 1.56 |
| 4. Durables | 0.61 | 8. Other | −0.08 |

Thus, the major difference is that food is relatively less important in the OECD, which is a reflection of Engel's law. Housing and transport, in particular, absorb most of the "savings" on food. Other than this, the other budget shares are not too different.

The Divisia price and volume indexes are defined as

$$(12)\quad DP_t^c = \sum_{i=1}^{8} \bar{w}_{it}^c Dp_{it}^c, \qquad DQ_t^c = \sum_{i=1}^{8} \bar{w}_{it}^c Dq_{it}^c,$$

which measure the overall growth in prices and quantities. Row 9 of Table 1 contains Equations (12) averaged over time and countries. The relative prices given in columns 4 and 5 are defined as the changes in the nominal prices deflated by the Divisia index, $DP_{it}^c - DP_t^c$, again averaged over time and countries. As can be seen, the relative prices of clothing and durables have declined in both groups of countries, whereas the prices of medicine and other have risen in the rich countries. The quantities given in columns 6 and 7 are $Dq_t^c$ averaged over time and countries. The evolution of the quantities consumed is quite similar in the rich and the poor countries, with food increasing the slowest and transport the fastest.

## Explaining the Differences

Consider a double-log demand equation for good $i$ in country $c$:

$$(13)\quad Dq_{it}^c = \alpha_i^c + \eta_i^c DQ_t^c + \gamma_i^c (Dp_{it}^c - DP_t^c) + \varepsilon_{it}^c,$$

where $\alpha_i^c$ is the autonomous trend in consumption of $i$, $\eta_i^c$ is the $i$th income elasticity, $\gamma_i^c$ is the (own) price elasticity of demand for $i$, and $\varepsilon_{it}^c$ is a disturbance term. S. Selvanathan (1993) estimates by least squares in Equation (13) for $i = 1, \ldots, 8$ for each of the rich countries, and Chen estimates the same model for the poor countries. Clements and Chen (1996, Table 2) estimates are averaged over countries. The major cross-country differences in the estimates are: (1) the trend terms for clothing and transport are much lower for the rich, (2) transport has a lower income elasticity for the poor, and (3) both clothing and transport are more price elastic for the rich. For a further analysis of the differences in the elasticities, see Clements and Chen (1996).[8]

If we average both sides of demand Equation (13) over $t = 1, \ldots, T^c$ observations, we obtain

[8] Clements and Chen (1994) investigate the sensitivity of the elasticities with respect to the classification of countries as rich or poor. They find the results to be fairly robust.

**Table 2.** Demand Elasticities for Rich and Poor Countries

| Commodity | Autonomous Trends (×100) | | Income Elasticities | | Price Elasticities | |
|---|---|---|---|---|---|---|
| | Rich | Poor | Rich | Poor | Rich | Poor |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| 1. Food | −0.24 | −0.57 | 0.59 | 0.71 | −0.37 | −0.34 |
| 2. Clothing | −2.86 | −1.87 | 1.46 | 1.33 | −0.67 | −0.36 |
| 3. Housing | 2.58 | 2.30 | 0.31 | 0.36 | −0.13 | −0.15 |
| 4. Durables | −2.39 | −1.63 | 1.74 | 1.77 | −0.62 | −0.51 |
| 5. Medicine | 2.61 | 1.93 | 0.66 | 0.81 | −0.17 | −0.31 |
| 6. Transport | −1.22 | 0.28 | 2.00 | 1.55 | −0.74 | −0.28 |
| 7. Recreation | 0.64 | 0.69 | 1.19 | 1.13 | −0.74 | −0.42 |
| 8. Other | 0.24 | 0.51 | 1.05 | 1.19 | −0.37 | −0.32 |

$$(14)\quad Dq_i^c = \alpha_i^c + \eta_i^c DQ^c + \gamma_i^c(Dp_i^c - DP^c) + \varepsilon_i^c,$$

where the variables are now averages over time. We shall apply Equation (14) to the two groups of countries to decompose observed consumption into components of incomes, prices, and tastes. First, we use the data in Table 1 and the estimates of Table 2 to compute $\hat{\varepsilon}_i^c$, the residual from Equation (14). Columns 11–13 of row 9 of Table 3 give the sums of squared residuals for the two country groups, $SS^c = \Sigma_{i=1}^{8} (\hat{\varepsilon}_i^c)^2$ for $c = 1$ (the rich), 2 (the poor), and the world as a whole (defined as the 31 rich and poor countries), $SS = \Sigma_{c=1}^{2} SS^c$. As can be seen, for the rich countries, $SS^c = 0.22\ (\times 10^4)$ is about one third that for the poor ($SS^c = 0.64 \times 10^4$). Thus, the rich account for $0.22/(0.22 + 0.64) \approx 25\%$ of the lack of fit of the demand model for the whole world, and the poor account for the remaining 75%, as indicated in row 10 of columns 11 and 12 in Table 3. The entries in rows 1–8 of column 11 give the percent contribution of each commodity to the residual sums of squares for the rich, $100(\hat{\varepsilon}_i^c)^2/SS^c$, and the same rows of columns 12 and 13 give the percentages for the poor and the world. Thus, the medicine demand equation fits the worst for the rich, with this commodity accounting for 71% of the residual sum of squares, and clothing is the worst for the poor (44%).

Next, we recompute the above measures with the trend terms, income and prices ignored by setting $\alpha_i^c = \eta_i^c = \gamma_i^c = 0$ ($i = 1, \ldots, 8$; $c = 1, 2$), and columns 2–4 of Table 3 contain the results. Similarly, columns 5–7 present the sums of squared residuals when all income elasticities are unity ($\alpha_i^c = 0$, $\eta_i^c = 1$, $\gamma_i^c = 0$), and columns 8–10 are based on unitary income elasticities and price elasticities all minus one ($\alpha_i^c = 0$, $\eta_i^c = 1$, $\gamma_i^c = -1$). Table 4 facilitates the comparison of the various columns of Table 3. Row 1 of Table 4 reproduces from Table 3 the total sums of squares, whereas in row 3, these are expressed as a percentage of the SS when all the coefficients are set equal to zero. Thus, if we ignore the negative signs, these percentage changes in the sums of squares are interpreted as the share of the total variability explained by the elasticities, incomes, and prices. Accordingly, row 3 of columns 11–13 shows that the demand equations with the estimated coefficients explain more than 99% of the total variability of consumption. In other words, *the observed variation in tastes* (i.e., the different elasticities), *incomes, and prices account for more than 99% of the observed variation in international consumption patterns.* This is obviously a spectacular result.

The effect of assuming unitary income elasticities is to reduce the total SS by about 90% (see row 3, columns 5–7 of Table 4). However, the joint assumption of unitary income elasticities and price elasticities (−1) reduces the fall to between 84 and 89% (row 3, columns 8–10). It could be argued that those commodities that absorb a larger proportion of expenditure should be more heavily weighted.

**Table 3.** Squared Residuals from Demand Equations

| Commodity | All Coefficients Zero | | | Income Elasticities Unitary | | | Income Elasticities Unitary and Price Elasticities Minus Unitary | | | Estimated Coefficients for Individual Country Groups | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rich | Poor | Rich + Poor | Rich | Poor | Rich + Poor | Rich | Poor | Rich + Poor | Rich | Poor | Rich + Poor |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) |
| Percentage of Total | | | | | | | | | | | | |
| 1. Food | 2.80 | 2.11 | 2.41 | 22.13 | 18.27 | 19.81 | 17.24 | 9.92 | 13.67 | 0.02 | 0.81 | 0.61 |
| 2. Clothing | 5.69 | 8.80 | 7.48 | 5.22 | 0.37 | 2.30 | 17.87 | 8.52 | 13.31 | 4.97 | 44.44 | 34.51 |
| 3. Housing | 10.95 | 10.35 | 10.60 | 0.73 | 2.00 | 1.49 | 4.96 | 0.05 | 2.56 | 9.37 | 5.45 | 6.44 |
| 4. Durables | 10.68 | 11.89 | 11.38 | 0.51 | 4.69 | 3.02 | 1.96 | 0.15 | 1.08 | 8.36 | 24.69 | 20.85 |
| 5. Medicine | 16.81 | 15.25 | 15.91 | 12.57 | 13.22 | 12.96 | 21.88 | 9.28 | 15.73 | 71.09 | 0.29 | 18.10 |
| 6. Transport | 24.03 | 20.70 | 22.11 | 39.34 | 32.70 | 35.35 | 21.88 | 45.69 | 33.51 | 0.48 | 4.28 | 3.32 |
| 7. Recreation | 18.93 | 17.54 | 18.13 | 19.34 | 20.72 | 20.17 | 7.30 | 9.60 | 8.42 | 3.34 | 19.00 | 15.06 |
| 8. Other | 10.10 | 13.36 | 11.98 | 0.17 | 8.02 | 4.89 | 6.90 | 16.78 | 11.73 | 2.37 | 1.04 | 1.38 |
| 9. Total $\times 10^4$ | 99.496 | 135.201 | 234.697 | 8.606 | 12.978 | 21.584 | 15.980 | 15.253 | 31.233 | 0.216 | 0.643 | 0.859 |
| 10. Percentage of total | 42.39 | 57.61 | 100.00 | 39.87 | 60.13 | 100.00 | 51.16 | 48.84 | 100.00 | 25.15 | 74.85 | 100.00 |

**Table 4.** Sums of Squared Residuals from Demand Equations

| Type of Residual | All Coefficients Zero | | | Income Elasticities Unitary | | | Income Elasticities Unitary and Price Elasticities Minus Unitary | | | Estimated Coefficients for Individual Country Groups | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rich | Poor | Rich + Poor | Rich | Poor | Rich + Poor | Rich | Poor | Rich + Poor | Rich | Poor | Rich + Poor |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) |
| Total × $10^4$ | | | | | | | | | | | | |
| 1. Unweighted | 99.496 | 135.201 | 234.697 | 8.606 | 12.978 | 21.584 | 15.980 | 15.253 | 31.233 | .216 | .643 | .859 |
| 2. Weighted | 10.400 | 12.106 | 22.506 | 1.219 | 1.796 | 3.014 | 2.053 | 1.835 | 3.888 | .015 | .057 | .072 |
| Percent Change | | | | | | | | | | | | |
| 3. Unweighted | 0.00 | 0.00 | 0.00 | −91.35 | −90.40 | −90.80 | −83.94 | −88.72 | −88.69 | −99.78 | −99.52 | −99.63 |
| 4. Weighted | 0.00 | 0.00 | 0.00 | −88.28 | −85.17 | −86.61 | −80.26 | −84.84 | −82.73 | −99.86 | −99.53 | −99.68 |

Note: The weights used in rows 2 and 4 are budget shares.

Accordingly, we redo the above computations using as weights the budget shares given in Table 1. A comparison of rows 3 and 4 of Table 4 shows that none of the qualitative results change by weighting.[9]

**Table 5.** Sums of Squared Residuals with Same Coefficients for Both Country Groups

| Weight (λ) Given to Rich (1) | Sums of Squared Residuals × $10^4$ Rich (2) | Poor (3) | Rich + Poor (4) |
|---|---|---|---|
| Unweighted | | | |
| 1. 0 | 1.322 | .643 | 1.965 |
| 2. .1 | 1.084 | .612 | 1.696 |
| 3. .2 | .875 | .610 | 1.485 |
| 4. .3 | .694 | .636 | 1.330 |
| 5. .4 | .541 | .691 | 1.231 |
| 6. .5 | .416 | .774 | 1.190 |
| 7. .6 | .319 | .886 | 1.206 |
| 8. .7 | .251 | 1.027 | 1.278 |
| 9. .8 | .211 | 1.197 | 1.408 |
| 10. .9 | .200 | 1.395 | 1.594 |
| 11. 1 | .216 | 1.621 | 1.838 |
| 12. Mean | .558 | .917 | 1.475 |
| Weighted | | | |
| 13. 0 | .128 | .057 | .185 |
| 14. .1 | .105 | .055 | .160 |
| 15. .2 | .084 | .057 | .141 |
| 16. .3 | .066 | .061 | .127 |
| 17. .4 | .050 | .068 | .118 |
| 18. .5 | .038 | .077 | .115 |
| 19. .6 | .028 | .090 | .117 |
| 20. .7 | .021 | .105 | .125 |
| 21. .8 | .016 | .122 | .138 |
| 22. .9 | .014 | .143 | .157 |
| 23. 1 | .015 | .166 | .181 |
| 24. Mean | .051 | .091 | .142 |

## Identifying International Consumers

In the preceding analysis, the two groups of consumers each had their own sets of demand elasticities. In this sense, the behavior of consumers in the rich countries is different from that in the poor, so that consumers could be described as idiosyncratic. In this section, we proceed in the direction of globalism by defining "international consumers" by taking weighted averages of consumers in the different countries. The idea that consumers are in some basic sense the same the world over is a bold one, but one which is forcefully advocated by Stigler and Becker.[10]

Consider the following demand equation for good $i$ in country $c$.

$$(15)\quad Dq_i^c = \alpha_i + \eta_i DQ^c + \gamma_i(Dp_i^c - DP^c) + \varepsilon_i^c.$$

This demand equation pertains to both groups of countries simultaneously (i.e., for $c = 1, 2$) because the coefficients do not have country superscripts. A simple way of proceeding is to specify the coefficients as weighted averages of their country group counterparts:

$$(16)\quad \alpha_i = \lambda\alpha_i^1 + (1 - \lambda)\alpha_i^2,$$
$$\eta_i = \lambda\eta_i^1 + (1 - \lambda)\eta_i^2,$$
$$\gamma_i = \lambda\gamma_i^1 + (1 - \lambda)\gamma_i^2,$$

where $0 \le \lambda \le 1$ is the weight given to the rich. Note that (16) treats all commodities symmetrically in that the weight λ is neither commodity nor elasticity specific.

We now evaluate the sums of squared residuals from Equation (15) by specifying various values of λ in Equation (16); Table 5 contains the results. The unweighted SS given in the upper part of the table are plotted against λ in Figure 2. It can be seen from the upper panel in this figure that the sum of squares for the rich declines more or less monotonically as the weight given to that country group rises. Similarly, reading the middle panel of the figure from right to left, the SS for the poor also decreases as their weight $(1 - \lambda)$ rises. Finally, the lower panel shows that the sum of squares for the world as a whole (rich + poor) has a minimum in the vicinity of $\lambda = .5$. Because this value of λ involves giving equal weight to both groups of countries, this optimal weighting defines "international consumers" as being located midway between the rich and the poor, which has appealing democratic fea-

[9] For some further explorations, see the Appendix.

[10] For related work, which analyzes the extent to which tastes differ internationally, see Clements and Chen (1996) and Selvanathan (1993).

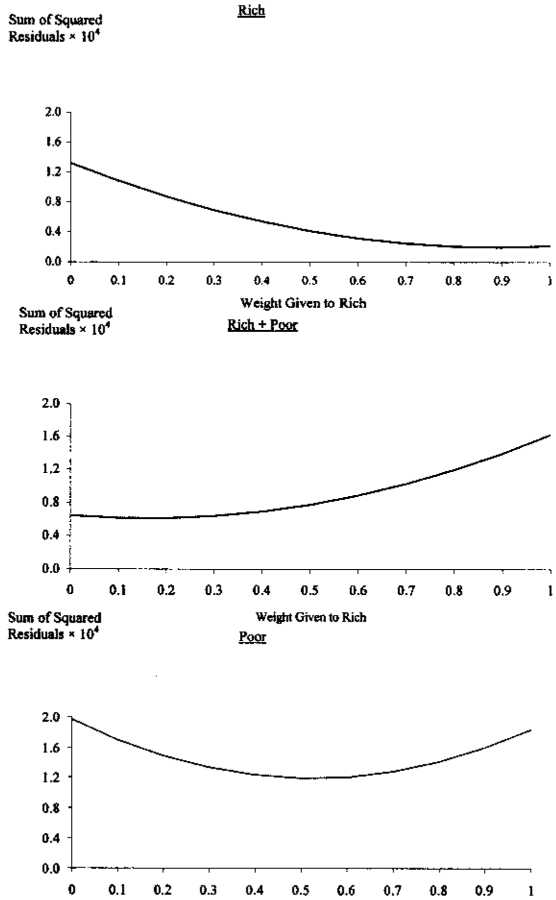


**Figure 2.** Unweighted Sums of Squared Residuals

tures. The lower part of Table 5 shows that weighting (by budget shares) does not substantially change the conclusion.

Another way of obtaining the optimal value of the weight $\lambda$ is from the regression $y_i^c = \lambda x_i^c + \varepsilon_i^c$ $(i = 1, \ldots, 8;\ c = 1, 2)$, where $y_i^c = Dq_i^c - \alpha_i^2 - \eta_i^2 DQ^c - \gamma_i^2(Dp_i^c - DP^c)$ and $x_i^c = (\alpha_i^1 - \alpha_i^2) + (\eta_i^1 - \eta_i^2)DQ^c + (\gamma_i^1 - \gamma_i^2)(Dp_i^c - DP^c)$. The least squares estimate of $\lambda$ yields the same value as before, $\hat{\lambda} = .5$, but now we also obtain the standard error of the optimal value of the weight (.16). Accordingly, we see that it is possible to reject the hypothesis that $\lambda$ takes the extreme values of 0 or 1. However, it has to be admitted that the two-standard-error band for $\lambda$ is fairly wide viz. [.18, .82]; this reflects the flatness of the SS function in the bottom panel of Figure 2.

Table 6 presents the implied demand elasticities for these international consumers. In a situation where nothing at all is known about consumer behavior, we recommend using these elasticities. Defining international consumers (ICs) in terms of a weighted average of rich and poor consumers means that ICs lie somewhere "between" the consumers in the two groups of countries. It is thus natural to inquire how different ICs are from their rich and poor cousins. One measure of this difference is the increase in the sum of squared residuals when the individual coefficients in the demand equations are replaced with common values, the weighted averages. This is pursued in Table 7, which shows (in row 1, columns 5–10) that the SSs for the rich increase from 0.216 to 0.416 (both $\times 10^4$), or by 93%. The increase in the sum of squares for the poor is 20% (from 0.643 to 0.774, $\times 10^4$) and 39% (0.859 to 1.190, $\times 10^4$) for the two groups of countries combined. Although these increases are substantial and point to differences in tastes, it can be seen for columns 8–10 of row 3 of Table 7 that the demand equations with common coefficients still explain in excess of 99% of the variation in consumption patterns; it is to be noted that this is true for the rich and the poor individually, the combined group as a whole, and the weighted and unweighted consumption patterns.[11]

**Table 6.** Demand Elasticities for International Consumers

| Commodity (1) | Autonomous Trend (×100) (2) | Income Elasticity (3) | Price Elasticity (4) |
|---|---|---|---|
| 1. Food | −0.41 | 0.65 | −0.36 |
| 2. Clothing | −2.37 | 1.40 | −0.52 |
| 3. Housing | 2.44 | 0.34 | −0.14 |
| 4. Durables | −2.01 | 1.76 | −0.57 |
| 5. Medicine | 2.27 | 0.74 | −0.24 |
| 6. Transport | −0.47 | 1.78 | −0.51 |
| 7. Recreation | 0.67 | 1.16 | −0.58 |
| 8. Other | 0.38 | 1.12 | −0.35 |

[11] Recall from the last row of Table 3 (columns 11–12) that the rich account for 25% of the residual sums

## Concluding Comments

Henri Theil was one of the leading contributors to the development of modern econometrics. These contributions included econometric methodology, aggregation theory, the evaluation of forecasts, quantitative economic policy, information theory and its applications to economics, management science, index numbers, and the analysis of consumer demand. In recognition of these contributions, Bewley refers to Theil as a "founding father" of econometrics. The impact of Theil's research is difficult to overstate, with three of his books designated "Citation Classics." According to Raj and Koerts (p. xvii), his citations "often place[d] Theil among the top 10 researchers (ranked according to the number of times cited) in the world in various disciplines."

In this paper, we focused on Theil's work in demand analysis and paid particular attention to his pioneering research on cross-country consumption comparisons. A key aspect of that work was the estimation of a system of demand equations under the assumption that tastes were the same in different countries. We reviewed Theil's justification for this assumption and then provided some evidence that indicates that in subsequent work it might be appropriate to allow the coefficients of cross-country demand equations to vary with country groups (such as the "rich" and the "poor"). At the same time, however, our data also reveal that a surprisingly large part of the variation in international consumption patterns

of squares for the world, whereas the poor account for the remaining 75%. This might suggest giving to the rich three times more weight than the poor, so that $\lambda = .75$. If we define international consumers in this alternative way, then interpolating linearly from Table 5, yields the following (unweighted) sums of squared residuals ($\times 10^4$): Rich, 0.231; Poor, 1.112; Rich + Poor, 1.343. Comparing these figures with the SS from the demand equations with the individual country coefficients (.216, .643, and .859 for the rich, poor, and the world, respectively, all $\times 10^4$, from row 9, columns 11–13 of Table 3) yields the following percent increases: Rich, 7; Poor, 73; Rich + Poor, 56. Relative to the results with $\lambda = .5$ discussed above, using $\lambda = .75$ improves the situation for the rich and worsens it for the poor and the world.

**Table 7.** More Sums of Squared Residuals from Demand Equations

| Type of Residual | All Coefficients Zero | | | Estimated Coefficients for Individual Country Groups | | | Same Coefficients for Both Country Groups | | |
|---|---|---|---|---|---|---|---|---|---|
| | Rich | Poor | Rich + Poor | Rich | Poor | Rich + Poor | Rich | Poor | Rich + Poor |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| Total $\times 10^4$ | | | | | | | | | |
| 1. Unweighted | 99.496 | 135.201 | 234.697 | 0.216 | 0.643 | 0.859 | 0.416 | 0.774 | 1.190 |
| 2. Weighted | 10.400 | 12.106 | 22.506 | 0.015 | 0.057 | 0.072 | 0.038 | 0.077 | 0.115 |
| Percent Change | | | | | | | | | |
| 3. Unweighted | 0.00 | 0.00 | 0.00 | −99.78 | −99.52 | −99.63 | −99.58 | −99.43 | −99.49 |
| 4. Weighted | 0.00 | 0.00 | 0.00 | −99.86 | −99.53 | −99.68 | −99.64 | −99.36 | −99.49 |

Note: The weights in rows 2 and 4 are budget shares.

can be explained by differences in incomes and relative prices.

Another building block of Theil's cross-country research was the assumption of preference independence, whereby the consumer's utility function is the sum of $n$ subutility functions, one for each good. We discussed in the paper how it was once thought that this assumption was much too restrictive and almost certain to be rejected by the data. However, more recent research has highlighted problems with the older tests and has shown that, at a minimum, the case against preference independence is now not nearly as strong as was once thought. As in much of his other work, Theil was therefore ahead of his time in his willingness to invoke the assumption of preference independence as part of a creative and influential research program.

## References


Barnett, W. A. "Theoretical Foundations for the Rotterdam Model." *Review of Economic Studies* 46(1979):109–30.

Barten, A. P. "Consumer Demand Functions Under Conditions of Almost Additive Preferences." *Econometrica* 32(1964):1–38.

———. "The Systems of Consumer Demand Functions Approach: A Review." *Econometrica* 45(1977):23–51.

Bewley, R. "Mr. Henri Theil: An Interview with the International Journal of Forecasting." *International Journal of Forecasting* 16(2000):1–16.

Chen, D. *World Consumption Economics.* Singapore: World Scientific Publishing, 1999.

Chung, C.-F., and E. Lopez. "A Regional Analysis of Food Consumption in Spain." *Economics Letters* 26(1988):209–13.

Clements, K.W. "Alternative Approaches to Consumption Theory." *Applied Demand Analysis: Results from System-Wide Approaches.* H. Theil and K.W. Clements. Cambridge, MA: Ballinger Press, 1987.

Clements, K.W., and D. Chen. "Fundamental Similarities in Consumer Behaviour." Perth, Australia: Department of Economics, The University of Western Australia, Discussion Paper 94.03, 1994.

———. "Fundamental Similarities in Consumer Behaviour." *Applied Economics* 28(1996):747–57.

Clements, K.W., and S. Selvanathan. "Understanding Consumption Patterns." *Empirical Economics* 19(1994):69–110.

Clements, K.W., and H. Theil. "A Cross-Country Analysis of Consumption Patterns." Chicago, IL: Report of the Centre for Mathematical Studies in Business and Economics, The University of Chicago, 1979. Published in H. Theil. *Studies in Global Econometrics.* Dordrecht: Kluwer Academic Publishers, 1996.

Clements, K.W., W. Yang, and S.W. Zheng. "Is Utility Additive? The Case of Alcoholic Beverages." *Applied Economics* 29(1997):1163–67.

Deaton, A. S. "A Reconsideration of the Empirical Implications of Additive Preferences." *Economic Journal* 84(1974):338–48.

———. "Econometric Issues for Tax Design in Developing Countries." *The Theory of Taxation for Developing Countrie.* D. Newbery and N. Stern, eds. New York: Oxford University Press, 1987.

Friedman, M. *Price Theory: A Provisional Text.* Chicago, IL: Aldine Press, 1962.

Houthakker, H. S. "Additive Preferences." *Econometrica* 28(1960):244–57.

Kravis, I.B., A.W. Heston, and R. Summers. *World Product and Income: International Comparisons of Real Gross Product.* Baltimore, MD: Johns Hopkins University Press, 1982.

Laitinen, K. "Why is Demand Homogeneity So Often Rejected?" *Economics Letters* 1(1978):187–91.

Leser, C.E.V. "Family Budget Data and Price-Elasticities of Demand." *Review of Economic Studies* 9(1941):40–57.

Meisner, J.F. "The Sad Fate of the Asymptotic Slutsky Symmetry Test for Large Systems." *Economics Letters* 2(1979):231–33.

Mountain, D.C. "The Rotterdam Model: An Application in Variable Space." *Econometrica* 56(1988):477–84.

Raj, B., and J. Koerts, eds. *Henri Theil's Contributions to Economics and Econometrics.* Three volumes. Dordrecht, The Netherlands: Kluwer Academic Publishers, 1992.

Selvanathan, E.A. "Further Results on the Aggregation of Differential Demand Systems." *Review of Economic Studies* 58(1991):799–805.

Selvanathan, S. "A Monte Carlo Test of Preference Independence." *Economics Letters* 25(1987): 259–61.

———. *A System-Wide Analysis of International Consumption Patterns.* Boston, Dordrecht, The Netherlands, and London: Kluwer Academic Publishers, 1993.

Somermeijer, W.H. "Een 'Verdeel'-Model." Unpublished paper, Netherlands Central Bureau of Statistics, 1956.

———. "A Method for Estimating Price and Income Elasticities from Time Series and its Application to Consumers' Expenditures in the Netherlands, 1949–1959." *Statistical Studies* (Netherlands Bureau of Statistics) 13(1962):30–53.

Stigler, G.J., and G.S. Becker. "De Gustibus Non Est Disputandum." *American Economic Review* 67(1977):79–90.

Stone, R. "Linear Expenditure Systems and Demand Analysis: An Application to the Pattern of British Demand." *Economic Journal* 64(1954):511–27.

Theil, H. "Qualities, Prices and Budget Enquires." *Review of Economic Studies* 19(1952):129–47.

———. "The Information Approach to Demand Analysis." *Econometrica* 33(1965):67–87.

———. *Theory and Measurement of Consumer Demand.* Two volumes. Amsterdam: North Holland Press, 1975/1976.

———. *The System-Wide Approach to Microeconomics.* Chicago, IL: The University of Chicago Press, 1980.

———. "World Product and Income: A Review Article." *Journal of Political Economy* 91(1983):505–17.

———. "Evidence from International Consumption Comparisons." *Applied Demand Analysis: Results from System-Wide Approaches.* H. Theil and K.W. Clements, eds. Cambridge, MA: Ballinger Press, 1987a.

———. "The Econometrics of Demand Systems." *Applied Demand Analysis: Results from System-Wide Approaches.* H. Theil and K.W. Clements, eds. Cambridge, MA: Ballinger Press, 1987b.

———. *Studies in Global Econometrics.* Dordrecht, The Netherlands: Kluwer Academic Publishers, 1996.

Theil, H., and K.W. Clements. *Applied Demand Analysis: Results from System-Wide Approaches.* Cambridge, MA: Ballinger Press, 1987.

Theil, H., and H. Neudecker. "Substitution, Complementarity and the Residual Variation around Engel Curves." *Review of Economic Studies* 25(1957):114–23.

Theil, H., and F.E. Suhm. *International Consumption Comparisons: A System-Wide Approach.* Amsterdam: North Holland Press, 1981.

Theil, H., C.-F. Chung, and J.L. Seale, Jr. *International Evidence on Consumption Patterns.* Greenwich and London: JAI Press, Inc., 1989.

Working, H. "Statistical Laws of Family Expenditure." *Journal of the American Statistical Association* 38(1943):43–56.

Yuen, W.-C. "Food Consumption in Rich Countries." *World Consumption Economics.* D. Chen, ed. Singapore: World Scientific Press, 1999.

## Appendix: The Data and Some Further Explorations

Table A1 lists the 31 countries used in the paper. The first 18 countries (the United States to Spain) are members of the OECD and are ranked in terms of gross domestic product (GDP) per capita; the remaining 13 countries (Israel to Zimbabwe) are listed, again ranked according to GDP per capita. The table also contains six alternative groupings of countries into "rich" and "poor." According to the first definition, the countries listed from the United States to Iceland are classified as rich and the remaining countries poor. In definition two, Spain is moved from the poor to the rich, and so on.

All computations in the paper are based on definition two of the country groups given in Table A1. Clements and Chen (1994) use the other five definitions to recompute the budget shares and elasticities and find only minor changes. We also used these alternative groups to redo the results of this paper and found that, in the main, they were not particularly sensitive. Furthermore, we analyzed the effect of individual commodities by redoing the computations underlying Table 7 by successively omitting each commodity; again, the results were not overly sensitive to the inclusion/exclusion of any one good.

**Table A1.** Alternative Definitions of Rich and Poor Countries

| Country | Mean Per Capita GDP in International Dollars in 1985 Prices | Definition of Country Groups: 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 1. USA | 13,012 | Rich | Rich | Rich | Rich | Rich | Rich |
| 2. Switzerland | 12,224 | Rich | Rich | Rich | Rich | Rich | Rich |
| 3. Canada | 10,879 | Rich | Rich | Rich | Rich | Rich | Rich |
| 4. Australia | 9,659 | Rich | Rich | Rich | Rich | Rich | Rich |
| 5. Sweden | 9,538 | Rich | Rich | Rich | Rich | Rich | Rich |
| 6. Denmark | 9,109 | Rich | Rich | Rich | Rich | Rich | Rich |
| 7. France | 9,086 | Rich | Rich | Rich | Rich | Rich | Rich |
| 8. Norway | 8,898 | Rich | Rich | Rich | Rich | Rich | Rich |
| 9. Germany | 8,548 | Rich | Rich | Rich | Rich | Rich | Rich |
| 10. UK | 8,466 | Rich | Rich | Rich | Rich | Rich | Rich |
| 11. Japan | 8,237 | Rich | Rich | Rich | Rich | Rich | Rich |
| 12. Belgium | 7,925 | Rich | Rich | Rich | Rich | Rich | Rich |
| 13. Austria | 7,520 | Rich | Rich | Rich | Rich | Rich | Rich |
| 14. Italy | 7,512 | Rich | Rich | Rich | Rich | Rich | Rich |
| 15. Netherlands | 6,881 | Rich | Rich | Rich | Rich | Rich | Rich |
| 16. Finland | 6,702 | Rich | Rich | Rich | Rich | Rich | Rich |
| 17. Iceland | 6,673 | Rich | Rich | Rich | Rich | Rich | Rich |
| 18. Spain | 5,381 | Poor | Rich | Rich | Rich | Rich | Rich |
| 19. Israel | 8,077 | Poor | Poor | Rich | Rich | Rich | Rich |
| 20. Hong Kong | 7,035 | Poor | Poor | Poor | Rich | Rich | Rich |
| 21. Singapore | 6,420 | Poor | Poor | Poor | Poor | Rich | Rich |
| 22. Puerto Rico | 5,831 | Poor | Poor | Poor | Poor | Poor | Rich |
| 23. Mexico | 4,939 | Poor | Poor | Poor | Poor | Poor | Poor |
| 24. Malta | 4,398 | Poor | Poor | Poor | Poor | Poor | Poor |
| 25. Columbia | 3,053 | Poor | Poor | Poor | Poor | Poor | Poor |
| 26. Ecuador | 2,809 | Poor | Poor | Poor | Poor | Poor | Poor |
| 27. Taiwan | 2,677 | Poor | Poor | Poor | Poor | Poor | Poor |
| 28. Korea | 2,271 | Poor | Poor | Poor | Poor | Poor | Poor |
| 29. Thailand | 1,795 | Poor | Poor | Poor | Poor | Poor | Poor |
| 30. Sri Lanka | 1,469 | Poor | Poor | Poor | Poor | Poor | Poor |
| 31. Zimbabwe | 1,290 | Poor | Poor | Poor | Poor | Poor | Poor |