with Engel curves

(21)

This is Muellbauer's PIGL class; equation (21), in an equivalent Box-Cox form, has recently appeared in the literature as the "generalized Working model", see Tran van Hoa, Ironmonger, and Manning (1983) and Tran van Hoa (1983).

I shall return to these and similar models below, but for the moment note how the construction of these models allows empirical knowledge of demands to be built into the specification of preferences. This works at a less formal level too. For example, prior information may relate to the shape of indifference curves, say that two goods are poor substitutes or very good substitutes as the case may be. This translates directly into curvature properties of the cost function; 'kinks' in quantity space turn into 'flats' in price space and vice versa so that the specification can be set accordingly. For further details, see the elegant diagrams in McFadden (1978).

The duality approach also provides a simple demonstration of the generic properties of demand functions which have played such a large part in the testing of consumer rationality, see Section 2 below. The budget constraint implies immediately that the demand functions *add-up* (trivially) and that they are zero-degree *homogeneous* in prices and total expenditure together (since the budget constraint is unaffected by proportional changes in p and x). Shephard's Lemma (9) together with the mild regularity conditions required for Young's Theorem implies that

(21)

$$\frac{ah_i}{dP_j} - \frac{d^2c}{aP_j aP,} \qquad \frac{d^2c}{aP, di+,} \quad all,'$$

so that, if s_{ij}, the Slutsky substitution term is $dh,/ de_0$ the matrix of such terms, 8, is *symmetric.* Furthermore, since $c(u, p)$ is a concave function of p, S must be *negative semi-definite.* (Note that the homogeneity of $c(u, p)$ implies that p lies in the nullspace of 8). Of course, S is not directly observed, but it can be evaluated using (12); differentiating with respect to p_i gives the *Slutsky equation.*

$$\frac{dg_i}{T9p} + ag_i \tag{23}$$

Hence to the extent that dg_i/ap_j and $dg,/dx$ can be estimated econometrically, symmetry and negative semi-definiteness can be checked. I shall come to practical attempts to do so in the next section.