

static linear expenditure system, i.e.

$$x_k = \beta_k + \gamma_k \sum_{j=1}^n x_j + v_k \quad (35)$$

where  $v_k = E v_k$ ,  $\beta_k = E \beta_k$ , and it is assumed, as is reasonable, that  $\beta_k \neq 0$ . This not only relates the parameters in the static version (33) to their intertemporal counterparts, but it also gives valuable information about the structure of the error term in (32). Given this, the bias introduced by ignoring the simultaneity between  $x_k$  and  $p_k q_k$  can be studied. For the usual reasons, it will be small if the equations fit well, as Prais (1959) argued in his reply to Summers (1959). But there is a rather more interesting possibility. It is easily shown, on the basis of (35), that

$$\text{Cov}(E v_k, E v_j) = E C_{ik} - S_{pik} \quad (36)$$

where  $C_{ik}$  is the (assumed constant) covariance between  $v_k$  and  $v_j$ , i.e.

$$\text{Cov}(v_k, v_j) = a_{kj} \quad (37)$$

where  $a_{kj}$  is the Kronecker delta. Clearly, the covariance in (36) is zero if  $E v_k = E v_j$ ,  $\beta_k = \beta_j$ . One specialized theory which produces exactly this relationship is Theil's (1971b, 1974, 1975a, 1975b, pp. 56-90, 1979) "rational random behaviour" under which the variance, covariance matrix of the errors  $v_k$  is rendered proportional to the Slutsky matrix by consumers' trading-off the costs of exact maximization against the utility losses of not doing so. If this model is correct, there is no simultaneity bias, see Deaton (1975a, pp. 161-8) and Theil (1976, pp. 4-6, 80-82) for applications. However, most econometricians would tend to view the error terms as reflecting, at least in part, those elements *not* allowed for by the theory, i.e. misspecifications, omitted variables and the like. Even so, it is not implausible that (36) should be close to zero since the requirement is that error covariances between each category and total expenditure should be proportional to the marginal propensity to spend for that good. This is a type of "error separability" whereby omitted variables influence demands in much the same way as does total outlay.

In general, simultaneity will exist and the issue deserves to be taken seriously; it is likely to be particularly important in cross-section work, where occasional large purchases affect both sides of the Engel curve. Ignoring it may also bias the other tests discussed below, see Altfield (1985).

