general as any, i.e.

$$b,!(p)+a_i(p)x+\text{cip(p)}x^2, \tag{80}$$

where $p)= b,(p)pe\ ,,,(p)$ and $d?(p) = d_i(p)0,,,(p)$. This is the "quadratic expenditure system" independently derived by Howe, Pollak and Wales (1979), Pollak and Wales (1978) and (1980). The cost function underlying (80) may be shown to be

$$c(u, p) = a(p) \qquad 1^3(P) \qquad + y(p) \tag{81}$$

where the links between the a, and on the one hand and the a, /3 and y on the other are left to the interested reader. (With lne(u, $p$) on the left hand side, (81) also generates the form (79)). This specification, like (79), is also of considerable interest for time-series analysis since, in most such data, the range of variation in $x$ is much larger than that in relative prices and it is to be expected that a higher order of approximation in x than in $p$ would be appropriate. Indeed, evidence of failure of linearity in time-series has been found in several studies, e.g. Carlevaro (1976). Nevertheless, in Howe, Pollak and Wales' (1979) study using U.S. data from 1929-1975 for four categories of expenditure, tests against the restricted version represented by the linear expenditure system yielded largely insignificant results. On grouped British cross-section data pooled for two separate years and employing a threefold categorization of expenditures, Pollak and Wales (1978) obtain a $x^2$ values of 8.2 (without demographics) and 17.7 (with demographics) in likelihood ratio tests against the linear expenditure system. These tests have 3 degrees of freedom and are notionally significant at the 5% level (the 5% critical value of a xi variate is 7.8) but the study is based on only 32 observations and involves estimation of a 3 X 3 unknown covariance matrix. Hence, given the discussion in Section 2.6 above, a sceptic could reasonably remain unconvinced of the importance of the quadratic terms for this particular data set.

Another source of functional forms for Engel curves is the study of conditions under which it is possible to aggregate over consumers and I shall discuss the topic in Section 5 below.

### *3.2. Modelling demographic effects*

In cross-section studies, households typically vary in much more than total expenditure; age and sex composition varies from household to household, as do the numbers and ages of children. These demographic characteristics have been