for the Rotterdam system, if the underlying theory is correct, it might be expected that its approximation by (58) would estimate derivatives conforming to the theoretical restrictions. From (59), homogeneity requires $\sum_j c_{ij} = 0$ and symmetry $c_{ij} = c_{ji}$. Negative semi-definiteness of the Slutsky matrix can also be imposed (globally for the Rotterdam model and at a point for the other models) following the work of Lau (1978) and Barten and Geyskens (1975).

The AIDS, translog, and Rotterdam models far from exhaust the possibilities and many other flexible functional forms have been proposed. Quadratic logarithmic approximations can be made to distance and cost functions as well as to utility functions. The direct quadratic utility function $u = (q - a)'(q - a)$ is clearly flexible, though it suffers from other problems such as the existence of "bliss" points, see Goldberger (1967). Diewert (1973b) suggested that $\psi^*(r)$ be approximated by a "Generalized Leontief" model

$$\psi^*(r) = \left\{\delta_0 + 2\sum \delta_k r_k^{1/2} + \sum\sum \gamma_{ij} r_i^{1/2} r_j^{1/2}\right\}^{-1} \tag{62}$$

This has the nice property that it is globally quasi-convex if $\delta_k \geq 0$ and $\gamma_{ij} \geq 0$ for all i, j; it also generalizes Leontief since with $\delta_0 = \delta_k = 0$ and $\gamma_{ij} = 0$ for $i \neq j$, $\psi^*(r)$ is the indirect utility function corresponding to the Leontief preferences (2). Berndt and Khaled (1979) have, in the production context, proposed a further generalization of (62) where the $\frac{1}{2}$ is replaced by a parameter, the "generalized Box-Cox" system.

There is now a considerable body of literature on testing the symmetry and homogeneity restrictions using the Rotterdam model, the translog, or these other approximations, see, e.g. Barten (1967), (1969), Byron (1970a), (1970b), Lluch (1971), Parks (1969), Deaton (1974a), (1978), Deaton and Muellbauer (1980b), Theil (1971a), (1975b), Christensen, Jorgensen and Lau (1975), Christensen and Manser (1977), Berndt, Darrough and Diewert (1977), Jorgenson and Lau (1976), and Conrad and Jorgenson (1979). Although there is some variation in results through different data sets, different approximating functions, different estimation and testing strategies, and different commodity disaggregations, there is a good deal of accumulated evidence rejecting the restrictions. The evidence is strongest for homogeneity, with less (or perhaps no) evidence against symmetry over and above the restrictions embodied in homogeneity. Clearly, for any one model, it is impossible to separate failure of the model from failure of the underlying theory, but the results have now been replicated frequently using many different functional forms, so that it seems implausible that an inappropriate specification is at the root of the difficulty. There are many possible substantive reasons why the theory as presented might fail, and I shall discuss several of them in subsequent sections. However, there are a number of arguments questioning this sort of