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Estimation of collective household models with Engel curves

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ABSTRACT

The structural consumer demand methods used to estimate the parameters of collective household models are typically either very restrictive and easy to implement or very general and difficult to estimate. In this paper, we provide a middle ground. We adapt the very general framework of [Browning, M., Chiappori, P.A., Lewbel, A., 2004. Estimating Consumption Economies of Scale, Adult Equivalence Scales, and Household Bargaining Power, Boston College Working Papers in Economics 588] by adding a simple restriction that recasts the empirical model from a highly nonlinear demand system with price variation to a slightly nonlinear Engel curve system. Our restriction has an interpretation in terms of the behaviour of household scale economies and is testable. Our method identifies the levels of (not just changes in) household resource shares, and a variant of equivalence scales called indifference scales. We apply our methodology to Canadian expenditure data.

1. Introduction

Dating back at least to Becker (1965, 1981), 'collective household' models are those in which the household is characterised as a collection of individuals, each of whom has a well defined objective function, and who interact to generate household level decisions. Here we focus on methods by which household level consumption data are used to recover information about individual household members. Examples include Chiappori (1988, 1992), Bourguignon and Chiappori (1994), Browning et al. (1994), Browning and Chiappori (1998), Vermeulen (2002), Browning et al. (2004), Lise and Seitz (2004) and Cherchye et al. (2008). These models are very useful because typical micro-data sources only have information on household level choices, but the objects of interest are based on the preferences of, and constraints faced by, the individuals who together make up the household.

Unfortunately, the structural models used to estimate these objects are either extremely restrictive and easy to estimate, or are very general but difficult to estimate. For example, in Chiappori (1992), households consume a purely public and purely private good and nothing else, yielding a model where the response of household member resource shares to changes in variables such as wages can be easily estimated. In contrast, Browning et al. (2004), hereafter BCL, provides a model in which households consume a vector of goods ranging from purely private to very shareable, and show how to recover via demand system estimation both the resource shares and indifference scales (which are a variant of equivalence scales analogous to cost-of-living indices) for each household member. Unfortunately, this model is highly nonlinear in prices, expenditures and other characteristics, and is consequently difficult to estimate, both numerically and in terms of data requirements.

In this paper, we provide a middle ground. Our model is only a little more restrictive than BCL, but is easy to estimate. Specifically, we propose a version of BCL in which all the objects of interest can be obtained from estimates of Engel curves that are nearly linear in parameters. Basically, we offer a way to obtain identification without observing price variation, so that in our model the demand system reduces to a system of Engel curves. In this model, the nonlinearity is encompassed by a single parameter, and we can still recover the resource shares and indifference scales.

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In the version of the BCL model we consider, the quantity of a household's demand for any consumption good is based on summing the demands of each household member for that good, and scaling the result with a Barten (1964) type scale. The Barten scale reflects the degree to which the good is shared among household members, that is, the degree of publicness or privateness of the good within the household. Each household member is allocated a *resource share*, that is, a share of the total resources (total expenditures) the household has to spend on consumption goods. Each household member determines their own demand for each consumption good by maximizing their own utility function, subject to a total budget constraint equal to the member's resource share of the total household budget, and facing a vector of Lindahl (1919) type shadow prices for goods. These shadow prices differ from market prices (by the Barten scales) because of economies of scale to consumption. In particular, shadow prices will be lower than market prices for goods that are shared or consumed jointly. Given each member's budget constraint within the household, BCL uses ordinary consumer surplus methods to obtain *indifference scales* defined as the fraction of household expenditure that puts an individual living alone on the same indifference curve that she would attain living in the household. Resource shares and indifference scales are two objects of interest for each individual in a household, and BCL shows that both these objects are identifiable from data on household budgets and market prices. We extend their results by providing identification without observing market prices in data without market price variation.

Unlike most empirical models in the collective household literature, BCL identifies and estimates the level of resource shares, not just how those shares vary with so-called distribution factors. They do this by combining data on people living alone with data on couples. Lise and Seitz (2004) also identify the level of resource shares (though not indifference scales) by combining singles and couples data. They too require price data for identification, which they obtain by defining demand systems in terms of just two goods, consumption and leisure, with wage differences providing the required relative price variation. Another application of BCL's model requiring price variation is Cherchye et al. (2008).

Like BCL, our model does not consider marriage markets or matching. In particular, we do not model the connection between resource shares and the application of bargaining power or threat points in decisions to either marry or divorce, and so do not analyze the possibly endogenous process that determines who is single and who is married in our data. Our results, e.g., our estimates of the fraction of household resources that are controlled by wives with varying amounts of income, are therefore conditional upon the outcome of marriage markets, and we do not explicitly model the constraints that marriage markets might impose on these resource shares. One reason for this is that an analysis of those constraints would require more explicit modeling of the household bargaining process than our methodology otherwise requires.

Our model obtains identification without price variation. Specifically, we show that combining BCL's general model with Barten (1964) scales for sharing goods and an Independence of Base assumption as in Blundell et al. (1998) yields the simple model

$$\mathbf{w}(x) = \mathbf{h} + \sum_j \eta_j \mathbf{w}_j \left(x - \ln I_j\right)$$

where $\mathbf{w}(x)$ is a household's vector of Engel curve budget shares given log total expenditures x, $\mathbf{h}$ is a vector of constants, $\mathbf{w}_j(x)$ is the Engel curve budget shares of household member j, and the parameters of interest, η_j and I_j, are member j's resource share and indifference scale, respectively. Estimation only requires parameterizing this model, adding demographic and error terms, and combining data on singles living alone to estimate $\mathbf{w}_j(x)$ along with collective household data to estimate $\mathbf{w}(x)$.

2. The model

We begin by summarizing the BCL model of household demand equations. In general, we use lower-case to denote logged quantities, bold to denote vectors, superscripts to index goods and subscripts to index people and households. Let j denote individuals $j = 1, \dots, J$ and let $\mathbf{p} = \left[p^1, \dots, p^K\right]'$ be the K-vector of logged market-prices. Let x denote logged total expenditure, subscripted for households or individuals. Let $w_j^k(\mathbf{p}, x)$ denote person j's budget share demand function for good k, that is, if person j were living alone he/she would spend the fraction $w_j^k(\mathbf{p}, x)$ of (unlogged) total expenditures e^x on the good k, for $k = 1, \dots, K$.

Assume that the household has economies of scale to consumption (that is, sharing and jointness of consumption) of a Barten (1964) type. Specifically, there exists a K vector of constants $\boldsymbol{\alpha} = \left[\alpha^1, \dots, \alpha^K\right]'$, called log barten scales, such that the total log quantity of a good k that is consumed by the members of the household equals the log quantity of the good purchased by the household minus α^k. For example, suppose that a married couple ride together in a car (sharing the consumption of gasoline) half the time the car is in use. Then the total consumption of gasoline (as measured by summing the private equivalent consumption of each household member) is 3/2 times the purchased quantity of gasoline. Equivalently, if there had been no sharing of auto usage, so every member always drove alone, then the household would have had to purchase 50% more gasoline to have each member travel the same distance as before. In this example, we would have $\alpha^k = \ln(2/3)$ for k being gasoline. Thus α^k can be interpreted as the degree of "publicness" of good k within the household. A purely private good k would have $\alpha^k = \ln(1) = 0$, while a good that is shared has $\alpha^k < 0$, and the greater is the degree to which it is shared, the larger in magnitude is α^k.

Let $w^k(\mathbf{p}, x, \boldsymbol{\alpha})$ denote the budget share for good k of a household which is comprised of individuals $j = 1, \dots, J$, and has Barten economies of scale parameters $\boldsymbol{\alpha}$. If the household has e^x dollars to allocate toward purchasing goods, the household will spend the fraction $w^k(\mathbf{p}, x, \boldsymbol{\alpha})$ of e^x on the good k, for $k = 1, \dots, K$. Individuals living alone are assumed to have no economies of scale to consumption, and so have log Barten scale parameters equal to zero. For each good k and person j, let $w_j^k(\mathbf{p}, x)$ denote the budget share demand function of a household consisting just of person j living alone.

BCL prove that, subject to some technical conditions, if household purchase decisions are assumed to be Pareto efficient and if goods are shared by household members by the above Barten technology, then the household having expenditures x and facing logged market prices $\mathbf{p}$ will have purchased budget shares for each good k given by

$$w^k(\mathbf{p}, x, \boldsymbol{\alpha}) = \sum_j \eta_j(\mathbf{p}, x, \boldsymbol{\alpha}) w_j^k \left(\boldsymbol{\alpha} + \mathbf{p}, x + \ln \eta_j(\mathbf{p}, x, \boldsymbol{\alpha})\right) \tag{1}$$

where $\eta_j(\mathbf{p}, x, \boldsymbol{\alpha})$ is the resource share of person j in the household and $\sum_j \eta_j(\mathbf{p}, x, \boldsymbol{\alpha}) = 1$. The interpretation of this result is that efficiency is obtained by having each household member act as if they maximized their own utility function given a fraction η_j of the household's total expenditures e^x (which is why we call η_j a resource share) and facing log shadow prices $\boldsymbol{\alpha} + \mathbf{p}$ which reflect the economies of scale from sharing.

We will consider households comprised of people who are observable both as single individuals and as members of collective households. This means that for each value of $\mathbf{p}$ and x we can observe the budget shares w_j^k for people living singly, and the budget shares w^k for the household. BCL shows that the remaining parameters of the model, the Barten scales $\boldsymbol{\alpha}$ and the resource shares η_j, are identifiable from this data as long as