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Household Income Sharing, Joint Consumption and the Expenditure Patterns of Australian Retired Couples and Single People

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Abstract

What level of household income is required so that a household member will have the same level of consumption as when living alone? The answer to this question depends on the extent to which household income is directed towards the consumption needs of the particular person, together with the extent to which there is shared consumption of household goods. This paper proposes a framework which permits data and assumptions obtained from several sources to be used together to identify these different relationships. This framework is applied to estimate the intra-household distribution of income and the economies of sharing for Australian married couples over retirement age.

The main conclusions of the paper are that income is shared relatively evenly (and the hypothesis of equal sharing cannot be rejected), and that on average couples require about one and half times the income of singles to reach the same living standard. This suggests that current Australian pension payments to singles are relatively too low.

1 Introduction

What level of household income is required for a person living with other people to be as well off as when they live alone? This question is of central relevance to policies which seek an equitable treatment of people living in different demographic circumstances. However there is little agreement about how to estimate the ‘consumer equivalence scales’ that summarise these income relativities, or indeed about whether the question can be sensibly answered at all.

Typically, the concept of welfare inherent in such comparisons is based upon commodity consumption and this focus is continued in the present paper. However many economists have argued that this represents an unduly narrow view of personal welfare maximisation. People often choose to incur the costs of having children in exchange for the ‘joys of parenthood’, or take on the inefficiencies of living alone in exchange for personal autonomy. If they are better off after making this choice, why should policies compensate them for their additional commodity costs?

Nonetheless, the commodity-based costs associated with different demographic arrangements continue to be of interest to policy makers. One reason for this is that they are often interested in the living standards of people, such as children, who have little choice over their demographic status. As well, social norms about the rights of individuals to choose their demographic status without incurring economic penalties may be important. This is particularly the case for the elderly, where a goal of pension policy might be to permit both singles and couples to live in their preferred demographic relationship with the same material standard of living.

Finally, social goals of poverty alleviation are usually defined in the context of consumption levels. Since policy is typically not very effective in altering demographic choices, poverty alleviation must take consumer equivalence scales into account in setting rates of payment. In other words, social welfare functions may well have a more restricted set of arguments than individual welfare functions.[1] For all these reasons, the impact of

1 See Pollak and Wales (1979) for a statement of the revealed preference argument. Nelson (1993) and Bradbury (1996) discuss the issues raised here further.

household structure on personal commodity consumption remains an important issue.

In considering this relationship between personal consumption and household income, there are at least four issues to be considered. First is the intra-household distribution of income, how is income directed towards the consumption of the individual members?

Second is the joint consumption of commodities in multi-person households. The purchase of a single unit of a shared good may provide a unit of consumption for every individual in the household. Thus, for a given income, the total level of personal consumption will be greater in a larger household. At the same time, there will be substitution effects as the goods which are shared become relatively cheaper in the larger household.

Third, there may be similar economies of sharing of household production. For example, the time input to food preparation may be the same when cooking for one or two people.

Finally, it may be the case that individuals living in different household types actually have different preferences with respect to commodity consumption. This could occur if these preferences were not separable from preferences over demographic structure so that there was selection of people with different preferences into different family types. A more fundamental difficulty for welfare comparisons arises if preferences actually change as individuals move from one family type to another.

For example, people who become parents may ‘develop’ a preference for spending money on activities with their children. However, in principle at least, many of these apparent preference changes can be rationalised within an economic model based on stable preferences. Thus parents may go to the theatre less often because the cost of this has gone up (once child minding costs are included). Similarly, we might consider a preference for spending time with one’s child as a fixed preference, but model non-parents as if their consumption of this commodity in the current period is rationed.

In this paper, the impacts of household production and such ‘taste changes’ are set to one side and attention is confined to the intra-household distribution of income and the joint consumption of household commodities. Whilst the existing literature on these topics is voluminous, the research results have only been of limited use to policy makers. A key reason for this is that personal consumption is usually unobservable, and can only be inferred with the aid of strong assumptions. Though the use of assumptions is not unusual in the process of policy formation, current approaches to estimating consumer equivalence scales are limited in that they either cannot incorporate the effects described above, or, if the model is sufficiently general, there is very little economic transparency in the assumptions used.

The goal of this paper is to present a new framework for looking at these questions: a framework which permits a flexible mix of estimation and calibration to be used to derive and test models of intra-household consumer behaviour and welfare. In the next section, a household welfare model incorporating income sharing and the impact of shared consumption is introduced. The remainder of the paper then provides an application of this model to the situation of Australian single and married people over retirement age.

Unlike much of the existing literature which sets out to estimate the degree of sharing of each commodity, this paper starts out with a set of assumptions about commodity sharing and tests whether behaviour is consistent with these assumptions. In this case these assumptions are provided by the author’s examination of (initially) a 25 commodity disaggregation. With such a detailed disaggregation it is possible to provide plausible upper and lower bounds for the degree of sharing of each commodity group. It is intended that this analysis will be refined in the future by drawing on research from household budget studies considering a much more detailed commodity disaggregation.[2] Such an approach is the only way that researchers are likely to obtain estimates which both have the precision required for policy application and are consistent with actual consumer behaviour.

In Section 3 of the paper, these sharing assumptions are used to derive easily calculated Paasche and Laspeyres equivalence scales based upon the simple Barten model of household demand (corresponding to the price indices of the same names). Section 4 then introduces a more fully

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2 A major study drawing up budget standards for Australian families is currently under way at the Social Policy Research Centre at the University of New South Wales. See Bradshaw (1993) for a discussion of the budget standards methodology.

specified model of intra-household income allocation and consumption using a version of the almost ideal demand system. This is then estimated using data from a single household expenditure survey together with the above-mentioned sharing assumptions and external estimates of price responses. After some adjustments, a model is developed which provides a plausible account of household consumption patterns, though a full accounting of food consumption will require a model incorporating home production effects.

The main conclusions of this investigation are first, household income is relatively evenly shared between retired husbands and wives and second, at the preferred sharing assumptions, married couple households require 1.5 times the income of single person households to reach the same welfare level. This is lower than the ratio implicit in the current Australian Age Pension.

2 A General Model

We start with an extension of the household welfare model of Samuelson (1956). Each individual j is assumed to have a stable current period welfare function $u_j = U_j(q_{1j}, q_{2j}, \ldots, q_{Ij})$ describing their preferences over commodities q_{ij}. If they live alone, their consumption is chosen so as to maximise u_j subject to a budget constraint $\sum_i p_i q_{ij} \leq y_j$.

In a household of J individuals, however, household consumption is chosen so as to maximise a separable function of the individual welfare levels $U(u_1, u_2, \ldots, u_J)$ subject to a budget constraint $\sum_i p_i Q_i(q_{i1}, q_{i2}, \ldots, q_{iJ}) \leq y$. The function $Q_i(q_{i1}, q_{i2}, \ldots, q_{iJ})$ represents the household purchase requirement for commodity q_i. For goods which cannot be shared, it is simply the sum of the personal consumption amounts q_{ij}. However, for goods which have some degree of joint consumption, or sharing, the purchase requirement will be less than this.

The household welfare function $U(.)$ can be interpreted in several ways. Most straightforwardly, it might be considered to represent the preferences of a 'caring' but 'non-paternalistic'[3] household head who controls household consumption. Becker (1981) shows that this interpretation can hold even when the other individuals have some control over their own consumption.

Alternately, if $U(.)$ is additive (which is the case in the example considered below), then the solution to this household decision problem is identical to the outcome of a Pareto efficient allocation of consumption between the household members.[4] The function $U(.)$ can then be interpreted as a summary of the relative bargaining strengths of the individuals in the household. 'Bargaining strength' in this context should be interpreted broadly, including the impact of non-paternalistic altruistic feelings for the welfare of other household members.

In general, $U(.)$ might also be a function of variables influencing bargaining within the household such as wage rates, private incomes, and social norms of within-household distribution. Incorporation of these would make the present model similar to that of the 'collective consumption' literature.[5] For the empirical example considered in this paper there is little observable variation in these variables, and so they are not included.

The Joint Consumption Technology

The idea of representing the shared nature of consumption via a 'household purchase function', $Q_i(q_{i1}, q_{i2}, \ldots, q_{iJ})$, was first proposed by

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3 Non-paternalistic means that the decision maker may care for the welfare level of other members (as denoted by $U_j(.)$), but does not seek to influence their consumption directly.

4 The first order equivalence of these two formulations is discussed by Panzar and Willig (1976). The first order condition of the Pareto efficient allocation will also satisfy the Arrow-Enthoven second order conditions (e.g. Chiang, 1984) if the functions $U_i(.)$ are quasiconcave and if the overall budget constraint is quasiconvex. The latter condition is fulfilled because of the convexity of each $Q_i(.)$ function (see below).

5 See for example Chiappori (1988, 1992), Browning et. al (1993) and Apps and Rees (forthcoming).

Lau (1985). Following him, it is assumed that the function has the following properties.

- *Single-consumer equivalence*: $Q_i(0, q_{ij}, 0, \ldots, 0) = q_{ij}$

- *Monotonicity*: $\frac{\partial Q_i}{\partial q_{ij}} \geq 0$.

- *Symmetry*: *Q*(.) is symmetric in its arguments. This simplifying assumption ignores phenomena such as only same-sex siblings being able to share bedrooms.

- *Quasiconvexity*: *Q*(.) is quasi-convex. In the context of the previous axioms, this is equivalent to assuming that, for a given quantity of a good purchased by the household, as personal consumption levels are made more equal the total of individual consumption will increase (or stay the same). This rules out certain situations of congestion – for example the noise interference caused by two radios being used simultaneously in the same room.

- *Homogeneity*. *Q(*.) is homogenous of degree 1. This simplifying assumption rules out 'economies of scale' of the production function type.

From these axioms, the following additional properties can be derived.

- *Minimum bound:* The quantity purchased by the household must be at least as great as the amount consumed by every individual. That is, $Q_i(q_{i1}, q_{i2}, \ldots, q_{iJ}) \geq \max(q_{i1}, q_{i2}, \ldots, q_{iJ})$. This follows from the single-consumer equivalence and monotonicity properties.

- *Subadditivity:* The sum of services received by individuals is always greater than or equal to the quantity purchased. That is $\sum_j q_{ij} \geq Q_i(q_{i1}, q_{i2}, \ldots, q_{iJ})$. This follows from the single-consumer equivalence, monotonicity and quasi-convexity properties. If subadditivity did not apply, it would imply that individuals will have a higher total consumption level when living in separate households than when living together.

- *Convexity.* The function $Q_i(q_{i1}, q_{i2}, \ldots, q_{iJ})$ is convex in its arguments. This is implied by quasi-convexity and homogeneity (Berge, 1963 p.208).

- *Sub-differentiability.* If the consumption of all members except for one is held constant, then household purchase requirements cannot increase at a faster rate than the increase in the consumption of the remaining individual. That is, if *Q(.)* is differentiable, $\partial Q_i / \partial q_{ij} \leq 1$. [*Proof for differentiable Q(.)*: Let $q = (q_1, q_2, \ldots, q_J)$ be an arbitrary vector of personal consumption levels of a particular commodity in the household. Let q^0 be another consumption vector for that same commodity with $q_1^0 = q_1$ and $q_j^0 = 0 \; \forall j \neq 1$. Convexity implies that $Q(q^0) \geq Q(q) + \sum_j \frac{\partial Q(q)}{\partial q_j}\left(q_j^0 - q_j\right)$. The right-hand side of this expression simplifies to $Q(q) + \frac{\partial Q(q)}{\partial q_1} q_1 - \sum_j \frac{\partial Q(q)}{\partial q_j} q_j$. But homogeneity implies that $\sum_j \frac{\partial Q(q)}{\partial q_j} q_j = Q(q)$ and single consumer equivalence requires that $Q(q^0) = q_1$. Substituting gives the result $\frac{\partial Q(q)}{\partial q_1} \leq 1$]

Denoting $\frac{\partial Q_i}{\partial q_{ij}}$ by s_{ij}, it is straightforward to show that in the first order conditions for the household maximisation problem, the effective (or shadow) price of commodity *i* for person *j* in the household is now $p_i s_{ij}$. Because of sub-differentiability, this shadow price must always be less than, or equal to, the market price. When the good is fully ‘public’ the purchase function is not differentiable, but similar conclusions apply (Nelson, 1986).

Using Euler’s theorem (and assuming differentiability), the homogeneity property allows the budget constraint to be written in terms of these shadow prices as

$$y = \sum_j \left(\sum_i q_{ij} p_i s_{ij}\right) = \sum_j y_j \tag{1}$$

This description provides a natural way to describe the allocation of household income amongst household members. It should be remembered, however, that the shadow prices in this expression will usually vary with the consumption levels of the household members.

Examples

Some simple examples of household purchase functions include

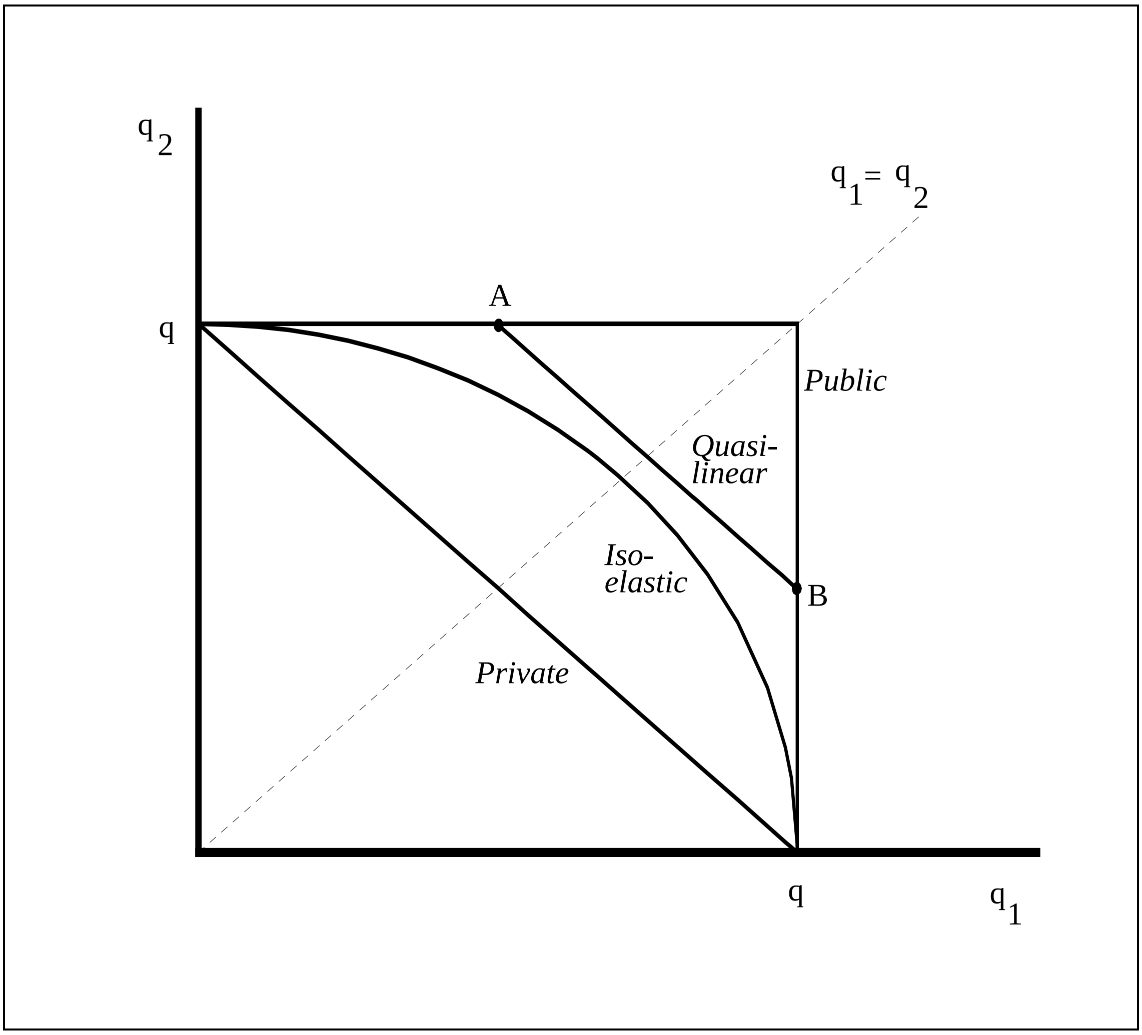
• Private	$q_i = \sum_j q_{ij}$
• Public	$q_i = \max_j (q_{ij})$
• Quasi-linear	$q_i = \max\left\{\frac{1}{1+(J-1)(1-t_i)} \sum_j q_{ij}, \max_j (q_{ij})\right\}$
• Iso-elastic	$q_i = \begin{cases} \left(\sum_j q_{ij}^{1/r_i}\right)^{r_i} & 0 < r_i \leq 1 \\ \max_j (q_{ij}) & r_i = 0 \end{cases}$

The first formulation is the conventional private good assumption. The second describes the situation where the good is 'public' within the household, with consumption by one member not detracting from the consumption of another. If we assume non-satiation of preferences, this can be re-written as $q_i = q_{ij} \forall j$ with each member of the household consuming the full amount of the household-public good purchased.

The last two expressions are different ways of describing goods which are partly shared within the household. When the scale parameters t or r equal 1, the good is private, and the household demand is simply the sum of the individual demands, whilst when t or r equal 0, the good is pure public. These functions are illustrated in Figure 1 for a two person household (with $r = t = 0.5$).

The quasi-linear purchase function implies that a fixed fraction (1-t_i) of the household purchase of a commodity is allocated to public consumption within the household. The remainder is allocated to individuals for private consumption. If personal consumption levels are sufficiently similar so

Figure 1: Household Consumption Possibility Frontiers for a Single Commodity



that consumption is located strictly on the diagonal portion of the budget constraint (rather than at points A or B in Figure 1), then the purchase function for commodity *i* is simply $q_i = \frac{1}{1+(J-1)(1-t_i)} \sum_j q_{ij}$. The shadow price for commodity *i* is then independent of the consumption levels of other household members, and is $s_i = p_i \,/\, (1+(J-1)(1-t_i))$. The assumption that consumption does not occur at end-points A or B is more likely to be unrealistic the more public is the good (i.e. in Figure 1, the diagonal portion of the budget constraint shrinks as the good becomes more public).

A simple example of this type of allocation might be a television set which is used for two hours a day. In the first hour, everyone in the household agrees that they want to watch the same program, and so consumption by one person is non-rival to that of other people (assuming there are enough seats in the TV room). In the second hour, however, everyone has a different opinion of what they want to watch. Hence the second hour of TV viewing by one person must be at the expense of the consumption of someone else.

In general, however, we might expect a less discontinuous pattern of congestion externalities than implied by a quasi-linear budget constraint. For the television example, we might expect the probability of being able to watch what you want diminishing in a smooth fashion as the number of people in the household and the amount of viewing by the other people increases. In this case, the iso-elastic formulation is a more appropriate model. In the empirical example below, both the quasi-linear and iso-elastic purchase functions are employed.[6]

Equivalence Scale Identification

Consider a household with J people and facing market prices p. Define a cost function $c_j(u_j, p, J)$ as the expenditure (on their consumption alone) required for the jth individual to attain a welfare level u_j. Now consider another household with J^* people, the first J of whom are identical to those in the first household. For these J people the individual preference orderings $U_j(.)$ are assumed invariant with respect to the family composition of their household (see the discussion of Section 1).

If person j receives a share $\Theta_j(u_j, p, J^*, J)$ of household income, then the household must have an income of $c_j(u_j, p, J^*)/\Theta_j(u_j, p, J^*, J)$ in order for that person to reach a welfare level u_j. A household equivalence scale for the j th person can then be defined as

$$m_j(u_j, p, J^*, J) = \frac{c_j(u_j, p, J^*)}{c_j(u_j, p, J)\,\Theta_j(u_j, p, J^*, J)} \qquad j \le J < J^* \qquad (2)$$

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6 An alternative quasi-linear budget constraint (with possible applicability to the estimation of the costs of children) is $q_i = t_i \sum_j q_{ij} + (1 - t_i) \max_j(q_{ij})$, see Bradbury, 1995). In this case the shadow price for the person who consumes most of the commodity is identical to the market price.

Note that the scale can be different for every person who is in both family types. For example, the costs of a child may be born unequally by the husband and wife.

In the remainder of this paper, attention is confined to a simple model where $J = 1$ and $J^* = 2$. If both people can live individually there are two scales, comparing the situation of each person when living alone and when together.

In general, the direct identification of the equivalence scale is not possible without the use of additional assumptions about the household welfare function and/or the technology of joint consumption. In particular, the commonly used Rothbarth and Barten equivalence scale models can be derived as restricted special cases of the model used here.

The Rothbarth, or adult good model, has been used extensively to estimate the additional costs of children.[7] It can be derived from the above model if the household is considered as having two classes of individuals, adults and children, it is assumed that there is no joint consumption, and there is at least one 'adult good' which is only consumed by adults (e.g. adult clothing). Consumption of the adult good thus serves as an indicator of the adults' welfare level, and hence identifies the equivalence scale.

The assumption of no joint consumption is a clear limitation of the Rothbarth model.[8] Nelson (1992) shows that if some goods in the household are pure public, then substitution effects mean that the Rothbarth method will produce biased estimates of the cost of children. The same effect occurs when goods are semi-public. Whilst it is not possible to derive an unambiguous direction for this bias, it can be shown that unless there are significant complementarity relationships (or the adult good is inferior), the assumption of no joint consumption leads to the Rothbarth method overestimating the costs of children. This is because the adult good is relatively more expensive in the household with children, the

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7 For some examples, see Rothbarth (1943), Deaton and Muellbauer (1986), Gronau (1988), Deaton *et al* (1989) and Bradbury (1992). The translation model of Pollak and Wales (1981) is closely related, but does not permit child costs to vary with income.

8 Econometric problems, such as the small proportion of the budget actually spent on pure adult goods, also make estimation of the model difficult.

adults will substitute away from it, and the Rothbarth method will thus assume them to have a lower welfare level than they actually have (Bradbury 1995).

On the other hand, if we assume that individuals within the household have identical preferences, and that the household welfare function is symmetric, we arrive at the model of Barten (1964) (see Nelson, 1988). These assumptions are very limiting in the context of child costs and this is why many authors have been critical of the strong substitution relationships implied by the Barten model (see Brown, 1964, Muellbauer, 1977, and Nelson, 1993, for more discussion of the limitations of the Barten model). When comparing single and multiple adult households, however, Barten's model may serve as a useful first approximation. In the next section the Barten assumptions are used to derive some simple bounds for the consumer equivalence scale relating couples to single adults.

3 Simple Estimates

In the remainder of the paper, the framework outlined above is applied to a consideration of the consumption patterns of single and two adult households with members over retirement age. Equivalence scales for these two household types are particularly relevant for policy decisions such as the setting of age pension rates. The data for this analysis is drawn from the 1988-89 Household Expenditure Survey conducted by the Australian Bureau of Statistics. Single men are included if aged 65 or more, women if aged 60 or more, and couples if both husband and wife have reached these ages.[9] So as to control for wealth effects on consumption patterns, only home-owner (or purchaser) households are included. This includes four-fifths of retired households.

Since there is no observable price variation in this data set, it is not possible to identify even the simple Barten model without additional assumptions. However, there is no reason why the parameters of the household purchase function need be identified from behaviour alone. The purchase function is essentially a *technological* feature of the extent of joint consumption for particular commodities. In many cases, therefore, it

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9 These are the eligibility ages for the Australian Age Pension.

may be possible to define purchase functions for particular commodities on the basis of the researcher's general knowledge of the consumption technology applicable to the population being studied. This is the approach adopted here.

In order to introduce sensible assumed values for the purchase function parameters, it is necessary to use a much more disaggregated commodity classification than is commonly employed. In Table 1 some 25 different commodity groups have been identified by disaggregating on the basis of conventional commodity classifications, separate consumption by men and women, and variations in the degree to which goods can be shared.[10] For each of these groups, a low, preferred, and high shadow price (s_i) is shown (assuming equal consumption by husband and wife). From the axioms of Section 2, these shadow prices must always lie between 0.5 (public) and 1 (private) inclusive. In some cases (e.g. clothing) the scale economies are quite unambiguous, though in other cases the difference between plausible high and low scales is broader. When husband and wife have equal consumption of commodity *i*, the couple household must purchase $2s_i$ of that commodity in order for each member to consume a single unit.

In principle, more detailed research such as undertaken by household budget studies could be used to obtain more precise estimates. To take one example, household expenditure on fuel predominantly comprises water heating, home heating/cooling and cooking. The first of these has little joint consumption (unless they 'shower with a friend!'), while joint consumption is substantial for the others. Data collected by the utility industries on the relative importance of these different components could be used to provide more precise scale economy bounds than given here.

Whilst it is thus possible that quite strong prior values can be obtained for detailed commodity classifications, it is usually not practical to include even 25 commodities in the estimation of a demand system. The present analysis is based upon an aggregation of the 25 commodities into the 17 groups shown in Table 1. Where there is more than one sub-group within

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10 Following Australian Bureau of Statistics conventions, investment outlays such as mortgage principal repayments and capital housing expenditures are excluded. In addition purchases of cars and boats are excluded from analysis because of their particularly 'lumpy' nature.

[Table at end]

[Table at end]

each group, the overall scales are calculated as budget share-weighted averages of the individual scales. This implies, *inter alia*, the absence of any substitution effect within each group.

The observed budget shares for single men, single women and married couples over retirement age are shown in Table 2. Several features are immediately apparent. Couples tend to spend a lower proportion of their income on goods such as housing which have a high degree of joint consumption, and women have different tastes than men (not just for clothing).

If we ignore gender differences in consumption patterns and assume the Barten assumptions to be correct, then the assumptions in Table 1 can be combined with these budget shares to obtain some simple upper and lower bounds for the equivalence scale between singles and couples.

Setting market prices to unity, an average person living alone and with income $\bar{y}^0$ consumes $q_i^0 = w_i^0 \bar{y}^0$ of each commodity and reaches welfare level u^0 (where w_i^0 is the 'autarchic' budget share). In the couple household, the Barten assumptions imply that the husband and wife consume the same amount of each commodity and that income is equally shared between them. When the couple household purchases a quantity q_i, each person faces prices s_i, consumes $q_i^1 = q_i / 2s_i$ and reaches a welfare level of u^1. Personal consumption can then be expressed in terms of household budget shares and income as $q_i^1 = w_i^1 \bar{y}^1 / 2s_i$.

Moving from a single person to a couple household, a person experiences a fall in effective prices ($s_i \leq 1$). A Laspeyres equivalence scale (corresponding to a Laspeyres price index[11]) for the cost of a couple relative to a single person can then be defined as $m_L = 2\sum_i q_i^0 s_i \big/ \sum_i q_i^0 = 2\sum_i w_i^0 s_i$. That is, the average shadow price, weighted by the single budget shares, times two (since the equivalence scale is defined in terms of household incomes, and each individual receives half the income).

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11 See for example, Deaton and Muellbauer (1980a: 170-173).

Table 2: Expenditure Shares: Singles and Couples Over Age Pension Age

	Expenditure Shares			
	Couples	Single Men	Single Women	All Households
Men's clothing	0.013	0.024	0.000	0.009
Women's clothing	0.023	0.000	0.038	0.027
Housing	0.091	0.143	0.137	0.115
Fuel	0.045	0.053	0.056	0.051
Prepared food	0.133	0.103	0.111	0.121
Personal food	0.153	0.131	0.136	0.144
Alcohol	0.033	0.064	0.008	0.026
Tobacco	0.012	0.016	0.009	0.011
Furnishings	0.062	0.062	0.062	0.062
Household services and operation	0.068	0.069	0.094	0.079
Health	0.064	0.058	0.062	0.062
Transport fares	0.004	0.012	0.006	0.006
Vehicle running expenses	0.104	0.111	0.066	0.089
Recreation, shared	0.051	0.045	0.041	0.046
Recreation, personal	0.064	0.048	0.067	0.064
Personal care	0.025	0.010	0.033	0.027
Miscellaneous	0.056	0.051	0.072	0.062
Number of Cases	445	94	387	926
Mean total expenditure ($/week)	288	179	184	233
Average age (men)	71.9	73.8		72.2
Average age (women)	68.8		71.3	70.0

Since q_i^0 will not necessarily be the welfare maximising quantity when facing prices s_i, the true equivalence scale at welfare level u^0, must be less than m_L (or equal if there is no substitution).

Similarly, a Paasche equivalence scale can be calculated using couple consumption patterns as weights. This is defined as $m_P = 2\sum_i q_i^1 s_i \Big/ \sum_i q_i^1 = 2\Big/\sum_i w_i^1 \frac{1}{s_i}$. That is, twice the harmonic mean shadow price, weighted by couple income shares. This scale will be a lower bound for the true equivalence scale calculated at welfare level u^1. If preferences are homothetic, or if $u^1 = u^0$ these two bounds can be combined as $m_P \le m \le m_L$. Whilst neither of these conditions hold precisely, it is probable that average welfare levels will be reasonably close in single person and couple retired households. This is because the age pension forms the main component of aged incomes, and Australian pension relativities are explicitly set so as to lead to similar welfare levels.

Table 3: Simple Equivalence Scale Bounds

Price Index	Relative Prices for Couples		
	Low	Preferred	High
Paasche	1.37	1.50	1.66
Laspeyres	1.38	1.51	1.67

Hence it reasonable to use the average Paasche and Laspeyres equivalence scales as bounds on the true equivalence scale, at least for the population considered here. Table 3 calculates these two indices at the upper and lower bounds of the sharing assumptions in Table 1.

Notable in the table is the small difference between the Paasche and Laspeyres indices. This is consistent with a low degree of price substitution in consumer behaviour, though it could also conceivably be a result of income effects.[12] The equivalence scale does differ significantly, however, between the low and high sets of assumed scale economies. It is interesting to note, nonetheless, that the equivalence scale implicit in the Australian Age Pension is at one extreme of this range (1.67). If we were to take the 'preferred' prices as our benchmark, a relative increase in the pension payment for singles is required to permit them the same living standard as couples.

However, the assumptions on which this conclusion is based are demonstrably false. Consumption patterns do differ between men and women, demand is not homothetic and income sharing is not necessarily equal. In the next section, a more fully specified consumer demand system is introduced to examine these issues.

12 It can readily be shown that if the individual welfare functions are homothetic with zero substitution, then $m_L = m = m_P$ where m is the true equivalence scale. It is also interesting to note that an alternative plausible method for calculating an equivalence scale might be to calculate the arithmetic average of the commodity specific scales with the couple income shares as weights. Such a 'naive' scale leads to a higher estimate of the equivalence scale (1.40, 1.54, 1.69 at the three price assumptions respectively) than supported by the theory.

4 The SI/AI Household Demand System

The welfare model of Section 2 implies that, in general, the sharing of resources in two-adult households will be a function of all the factors influencing consumption patterns. This may not have an analytical solution. One special case where it is possible to model the income allocation in a relatively simple fashion arises when personal preferences can be represented in the ‘Gorman generalised polar form’, and the household welfare function is directly additive.[13]

An example of this is used in this section, where it is assumed that the household welfare function is directly additive and that the preferences of each individual can be represented by the substitution independent variation of the ‘almost ideal’ demand system (SI/AI) (Keller 1984, Deaton and Muellbauer, 1980). In this model, the cross-price parameters γ_{ik} of the almost ideal system are defined as $\gamma_{ik} = \varepsilon_0 \varepsilon_i (\delta_{ik} - \varepsilon_k)$, where δ_{ik} is the Kroneker delta and $\sum_{i=1}^{I} \varepsilon_i = 1$. The effect of this simplification is to keep cross-price effects relatively small and to prevent any goods from being Hicks-Allen complements.

This consumer demand model has cost and indirect utility functions of

$$\log C_j(u_j, p_j) = (1-u_j)\log a_j(p_j) + u_j \log b_j(p_j) \tag{10}$$

$$V_j(y_j, p_j) = \log\left({y_j}/{a_j(p_j)} \right) \Big/ \left(\log b_j(p_j) - \log a_j(p_j) \right) \tag{11}$$

where u_j is the welfare level, y_j the income and p_j the vector of prices facing individual j and

$$\begin{aligned} \log a_j(p_j) &= \alpha_{0j} + \textstyle\sum_i \alpha_{ij} \log p_{ij} + \frac{\varepsilon_{0j}}{2} \sum_i \varepsilon_{ij} (\log p_{ij})^2 - \frac{\varepsilon_{0j}}{2} \left(\sum_i \varepsilon_{ij} \log p_{ij} \right)^2 \\ \log b_j(p_j) &= \log a_j + \beta_{0j} \textstyle\prod_i p_{ij}^{\beta_{ij}} \end{aligned} \tag{12}$$

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13 See Deaton and Muellbauer (1980a: 131) and Gorman (1959) in the context of commodity aggregation.

with the additional constraints $\sum_{i=1}^{I} \alpha_{ij} = 1$ and $\sum_{i=1}^{I} \beta_{ij} = 0$ and with the male and female clothing parameters set to zero for the appropriate people. When person *j* is living alone, their budget share demand functions are

$$w_{ij}(y,p) = \alpha_{ij} + \varepsilon_{0j}\varepsilon_{ij}\left(\log p_i - \sum_k \varepsilon_{kj} \log p_k\right) + \beta_{ij}\left(\log y - \log a_j\right) \quad (13)$$

where y is household income and p_i is the market price of commodity *i*. Taste changes with age are incorporated into the model by making α_{ij} a linear affine function of the age of the respective person (minus 70), though for notational convenience this is suppressed here.

In the SI/AI system, goods are luxuries when $\beta_{ij} > 0$, and the compensated own price elasticity is

$$e_{ij} = \left[\varepsilon_0 \varepsilon_{ij}(1-\varepsilon_{ij}) - w_{ij}(1-w_{ij}) + \beta_{ij}^2\left(\log y - \log a_j\right)\right] / w_{ij} \quad (14)$$

The parameter ε_{0j} provides a general index of the degree of price substitution. When $\varepsilon_{0j} = 0$ own-price elasticities are close to –1 and when $\varepsilon_{0j} < 0$ elasticities tend to be stronger (more negative). It is possible to represent zero substitution at a single price/income point (e.g. if $\varepsilon_{0j} = 1$, $\varepsilon_{ij} = w_{ij}$, $p = 1$ and $\log y = \alpha_{0j}$), but this must imply positive own-price elasticities at other prices or incomes. Unfortunately, this lack of global concavity makes the estimation process more difficult.

For the combined household, the household welfare function is defined as a weighted average[14] of the individual welfare levels

$$u = \delta_1 u_1 + \delta_2 u_2 \quad (15)$$

This is maximised subject to a global budget constraint $y = \sum_i p_i Q_i(q_{i1}, q_{i2})$. Using the assumptions of Section 2, the budget constraint can be written as

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14 This model could be extended by making δ_j a function of external influences on household decision making (such as private incomes and wage rates), as in the bargaining literature.

$$y = y_1 + y_2 = \sum_i p_i s_{i1} q_{i1} + \sum_i p_i s_{i2} q_{i2} \qquad (16)$$

where $s_{ij} = \frac{\partial Q_i}{\partial q_{ij}} \leq 1$. Though s_{ij} is, in general, a function of q_{i1} and q_{i2}, at the optimum we can take the shadow price as fixed and define a solution as follows. Denote the vector of shadow prices $(p_1 s_{1j}, p_2 s_{2j}, \ldots)$ at the optimum by p_j^* and define $z_j = y_j / a_j(p_j^*)$. Equation (11) can then be substituted into (15) to yield the upper level of the household maximisation problem

$$\max u = \left(\frac{\delta_1}{\beta_{01}} \prod_i (p_i s_{i1})^{-\beta_{i1}} \right) \log z_1 + \left(\frac{\delta_2}{\beta_{02}} \prod_i (p_i s_{i2})^{-\beta_{i2}} \right) \log z_2$$

subject to (17)

$$y = a_1 z_1 + a_2 z_2$$

Note that whilst the household welfare function is directly additive in welfare, it is concave in real income (z). The Cobb-Douglas form of this expression implies a proportionate sharing rule, $y_j = \Theta_j y$ where

$$\Theta_1 = 1 \Big/ \left(1 + \phi \prod_i (p_i s_{i1})^{\beta_{i1}} (p_i s_{i2})^{-\beta_{i2}} \right)$$

$$\text{with } \phi = \frac{\delta_2}{\delta_1} \frac{\beta_{01}}{\beta_{02}} \text{ and } \Theta_2 = 1 - \Theta_1 \qquad (18)$$

Though ϕ is empirically identifiable, δ_1, δ_2, β_{01}, and β_{02} cannot be separately identified. With this model, prices influence the sharing rule only to the extent to which personal demands are non-homothetic.[15] Using the separability of the household welfare function, personal consumption within the two person household is described by equation (13), but with y_j replacing y and p^*_i replacing p_i. That is,

$$w_{ij}^* = s_{ij} p_i q_{ij} / y_j = w_{ij}\left(\Theta_j y, p_j^*\right) \qquad (19)$$

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15 One interesting alternative specification is to assume that demands are homothetic and Leontief (zero substitution). In this case it can be shown that, if the household welfare function is strongly concave (inequality averse), the household will allocate more income towards a household member when a good for which they are a relatively large consumer increases in price. The reverse occurs if the household welfare function is only weakly concave. See Bradbury (forthcoming).

Since $q_i = s_{i1}q_{i1} + s_{i2}q_{i2}$, the observed budget shares in the two person household are

$$w_i = p_i q_i / y = \Theta_1 w_{i1}(\Theta_1 y, p^*) + \Theta_2 w_{i2}(\Theta_2 y, p^*) \qquad (20)$$

In general, however, the shadow price multipliers s_{ij} are not fixed but depend upon the consumption of commodity i by each household member. Assuming an iso-elastic form of the household purchase function, the multipliers for person 1 are

$$s_{i1} = \frac{\partial q_i}{\partial q_{i1}} = \left(1 + \left(\frac{q_{i1}}{q_{i2}}\right)^{-\frac{1}{r_i}}\right)^{r_i - 1}$$

with (21)

$$\frac{q_{i1}}{q_{i2}} = \frac{\Theta_1 s_{i2} w_{i1}(\Theta_1 y, p_1^*)}{\Theta_2 s_{i1} w_{i2}(\Theta_2 y, p_2^*)}$$

with an symmetrical representation for the second person. The full demand system is found as a result of simultaneously satisfying this relationship together with equations (13), (18), (19) and (20).

Given sufficient variability, equation (13) is sufficient to identify the α, β and ε parameters, and the income distribution parameter ϕ can be identified by examining whether household consumption (20) is more like that of single men or women. Denoting all these parameters by the vector Γ, the remaining three sets of equations can be summarised as

$$\begin{aligned}
&\Theta_j = \Theta_j(p, s_1, s_2, \Gamma) \quad j = 1,2 \\
&w_{ij}^* = w_{ij}\left(\Theta_j y, p, s_j, \Gamma\right) \quad j = 1,2; i = 1 \ldots I \qquad (22) \\
&s_{ij} = s_{ij}\left(\Theta_1, \Theta_2, s_{i1}, s_{i2}, w_{i1}^*, w_{i2}^*, r_i\right) \quad j = 1,2; i = 1 \ldots I
\end{aligned}$$

where s_j is the vector of price multipliers for person j. Given Γ and r (the vector of scale economy parameters) and provided the cost function is concave, these equations can be solved numerically to yield the price multipliers s_{ij} as a function of Γ, r and y. These new shadow prices can then be inserted into the estimation equation and the model estimated in an iterative fashion.

To begin the iteration, it is assumed that shadow prices are fixed at the prices given when $q_1 = q_2$ (from equation (21) this implies $s_{i1} = s_{i2} = 2^{r_i - 1}$). This is equivalent to assuming that the budget constraint takes the quasi-linear form. Equations (13), (18), (19) and (20) are then fitted to the observed household-level data on expenditure shares using a maximum likelihood estimator, obtaining an estimate for the parameters of the individual welfare functions and the intra-household income share parameter ϕ.

These parameter estimates are then used to find the values of s_{ij} which satisfy the system (22) for the mean value of y (and age).[16] The new price multipliers obtained are then treated as fixed once again, and the process is repeated until the result converges. In practice, convergence is fairly rapid. The weak relationship between (shadow) prices and the household sharing rule, together with the independent determination of the demand function parameters in the single person households, mean that changes in shadow prices only have a minor influence on estimation of the demand function parameters.

Once the parameters of this system are either assumed or estimated, the equivalence scale can be derived in a straightforward manner. When person j lives alone with income y and facing market prices, they have a welfare level of $u_j = V_j(y,p)$, where $V_j(.)$ has the form given in (11). The personal income required to attain this same welfare level when they live with a partner is given by the cost function defined with respect to shadow prices $C_j(u_j,p^*)$ (equation (10)). This will be equal to a fraction Θ_j of the required household income. Hence the equivalence scale of married relative to single is given by $C_j(V_j(y,p),p^*)/\Theta_j y$ or, (at unit market prices)

$$m_j = \Theta_j^{-1} \exp\begin{pmatrix} (s_j^* - 1)(\log y - \alpha_{0j}) + \sum_i \alpha_{ij} \log s_{ij} + \\ \frac{\varepsilon_{0j}}{2} \sum_i \varepsilon_{ij} (\log s_{ij})^2 - \frac{\varepsilon_{0j}}{2} \left(\sum_i \varepsilon_{ij} \log s_{ij} \right)^2 \end{pmatrix} \qquad (23)$$

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16 In principle, shadow prices could be separately estimated for every household rather than just for the mean. However, special adjustments would need to made at the extremes of the sample (where negative budget shares might be predicted). Because of the added complexity (and the lack of precision of estimates away from the mean) this is not done here.

where $s_j^* = \prod_i s_{ij}^{\beta_{ij}}$. If goods with little joint consumption (high s_{ij}) tend to be necessities, ($\beta_{ij} < 0$) the equivalence scale will decrease with income (food is an example, clothing a counter-example).

If budget shares are constant with income, the equivalence scale will similarly be independent of income. In this case, the above expression becomes a simple function of the geometric mean shadow price,

$$m_j = \Theta_j^{-1} \prod_i s_{ij}^{\overline{w}_{ij}} \tag{24}$$

where $\overline{w}_{ij}$ is the arithmetic average of the budget share when person j is living alone, and when in a couple. In the homothetic case at least, this places the SI/AI demand system neatly between the Paasche and Laspeyres indices described in the previous section, since it uses the average of the two budget shares, and the geometric mean always lies between the arithmetic and harmonic means.

5 Testing the Theory

Is this model of household consumption consistent with observed behaviour, and what does that behaviour tell us about income sharing and the equivalence scale? This section investigates these questions using the data on single and couple expenditure patterns introduced in Section 3.

Estimation of the household consumption model requires the integration of this behavioural data with the joint consumption assumptions of Section 3 and external estimates of price responses. For the latter we begin with estimates for Australia reported by Rimmer and Powell (1992). They estimated a time-series demand system for six commodity groups, food, alcohol/tobacco, clothing, durables, rent and other. The compensated own-price elasticities for these commodity groups (-0.44, -0.63, -0.81, -0.91, -0.76 and -0.47 respectively) are assumed to apply to the corresponding commodity groups used here. Men and women are assumed to have the same price elasticities, and a simplified version of equation (14) is then used to define the ε parameters.[17] An alternative specification of the ε parameters is also considered below.

One commonly encountered problem in estimating the AI demand system is that the parameters α_{01} and α_{02} are difficult to separately identify from the other α parameters. This was found to be the case here, and these two parameters have been arbitrarily set to a value of 4, implying that $55 per week is required in order to produce a minimal utility level for both men and women. Sensitivity testing of this assumption is also undertaken below.

Using these assumptions and the iterative estimation method described above, an initial estimation (model 1) leads to an estimate of 1.09 for Φ (std error = 0.12).[18] This implies an income share for men (Θ_1) of 47 per cent and equivalence scales of 1.55 and 1.47 for men and women respectively (see Table 8). The difference in scales follows primarily from the non-equal income share, with men requiring a higher total household income to offset their lower income share. However, since Φ is not significantly different from 1 (which implies equal sharing when demand is homothetic), the difference in equivalence scales is also likely to be non-significant.

The price values and elasticities for this model are summarised in Table 4. This table shows the assumed shadow prices when consumption is equal, the assumed (approximate) compensated own-price elasticity for single men and women and the implied shadow prices for married men and women, and price elasticities at the income and prices facing the average married couple.

Note that the shadow prices for men are generally lower than for women (apart from high male-demanded goods such as alcohol and private vehicles). This follows from their lower income share which implies a lower quantity of consumption, which in turn implies a lower shadow price (from the convexity properties of the household purchase function).

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17 That is, all the β_{ij} are assumed zero, and w_{ij} set to the mean budget shares for single men and women respectively.

18 All market prices are fixed at unity. The SAS Model procedure was used for the non-linear FIML estimates.

[Table at end]

The shared nature of household consumption thus means that the low income member is not as badly off as their income share might suggest.

This result is dependent upon the strict convexity of the iso-elastic purchase function. In Table 8, model 1a shows the equivalence scale obtained from the first step of the iterative procedure. This first step uses a quasi-linear budget constraint which has equal shadow prices for husband and wife. Though the income share for men is essentially unchanged, the difference between the equivalence scale for men and that for women is much greater than in model 1, because of the partial 'free riding' permitted by the iso-elastic purchase function in that model. Since the assumptions of the quasi-linear budget constraint will usually be violated by goods with high degrees of sharing,[19] the iso-elastic result in model 1 is a more appropriate description of household consumption.

The next step is to test whether the model and assumptions are consistent with observed behaviour. Given the assumptions of joint consumption and price elasticities, the household purchase model assumes that the consumption patterns for couples are a function of the same parameters that determine consumption for single men and women, together with the sharing parameter. The model can therefore be compared with an alternative model which imposes no such restriction on couple consumption. This unrestricted demand system for the three family types has 154 parameters (45 for men, 45 for women and 64 for couples)[20] and a log-likelihood statistic of 22,490. The restricted model, on the other hand has a log-likelihood statistic of 22,410 for 91 parameters (154 + 1 – 64).[21]

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19 That is, for shared goods, the interval between points A and B in Figure 1 will become short, and it becomes more likely that consumption will not take place strictly between these two points. See Bradbury (1995) for an estimation using a quasi-linear model.

20 For singles: 15 α_i, 15 β_i and 15 parameters for age (for men, women's clothing parameters are fixed at zero, and contrariwise for women). For couples: 16 α_i, 16 β_i, 16 for husband's age and 16 for wife's age.

21 This is conditional upon the shadow prices estimated in the last loop of the iterative procedure, though the log-likelihood at the first iteration with equal shadow prices is almost identical (22,409).

The likelihood ratio test thus implies that the model assumptions produce a significant loss of fit.[22]

Since Φ is not significantly different from 1, a convenient way to assess the reason for the poor fit is to fix Φ at 1, and to estimate a set of models which move in a stepwise fashion from the unrestricted to the restricted model. This is summarised in Table 5. Model 1 in the table is the initial model described above. Model 2 is an unrestricted model with the predicted budget shares for couples also included in the couple equation. This means that the couple-specific parameters can be used to indicate where the model and behaviour diverge.

Model 3 is the same as model 2 but without the couple-specific age parameters. The likelihood ratio test shows that, as a group, the couple age parameters are significant at the 2% level. The parameter estimates for model 2 show that, compared to the levels predicted on the basis of the expenditure patterns of singles, couples increase their male clothing and furniture budget shares as the husband’s age increases, but decrease their health care budget share. These patterns may represent violations of the separability assumption with, for example, wives’ insisting that their husbands replace their old clothes. However, each of these interactions on its own is only just significant at the 5% level.

Model 4 removes the couple income-interaction terms (which as a group are not significant) leaving only the couple-specific constant terms. These are shown in Table 6. The most significant deviations are for housing and shared food. This initial model over-estimates the housing budget share for couples by almost four percentage points, under-estimates the budget share of shared food by just over three percentage points and the share of personal food by 1.3 percentage points, and over-estimates the budget for personal transport by 0.7 percentage points. This latter bias is matched by an under-estimation of the budget for shared transport of a similar magnitude (though the latter is not statistically significant). These are clearly large deviations from the predicted values.

22 That is, $2 \times (22{,}490–22{,}410) = 160 >> 92 = \chi^2_{63,1\%}$.

Table 5: Alternative Models

No.	Description	Φ Fixed at 1?	Log Likelihood	Param-eters
	Using Initial Sharing and Price Elasticity Assumptions			
1	Restricted	no	22,410	91
2	Unrestricted (i.e. including couple age, income and constant terms)	yes	22,490	154
3	With couple income and constant terms	yes	22,465	122
4	With couple constant terms	yes	22,453	106
5	Restricted (model 1 with Φ fixed)	yes	22,409	90
	Using Alternative Sharing Economy Assumptions			
6	With couple constant terms	yes	22,453	106
	Using Alternative Price Elasticity Assumptions			
7	With constant couple terms	yes	22,453	106
8	Restricted	yes	22,428	91

Given the numerous assumptions used to arrive at these estimates, there are a number of possible explanations for this poor fit with behaviour. Most fundamentally, there may be important aspects of household preferences or behaviour that are not included in the theory. The most obvious example is the omission of home production. The sharing of food preparation may be why couples spend more than predicted on shared and prepared foods. Interestingly, couples also spend more than predicted on personal food rather than substituting away from this towards prepared foods. Sharing of home production thus seems to lead to married people consuming a greater quantity or (more likely) quality of food than single adults.

Staying within the scope of the present model, however, it is also possible that the 16 degrees of freedom represented by the couple-specific parameters could be used to estimate either a set of scale economy parameters, or a set of price response parameters which produce a fit as good as the unrestricted model. But both sets of parameters have

[Table at end]

theoretical bounds. The scale economy parameters, r_i, must lie between 0 and 1, or a narrower range if we accept the bounds proposed in Table 1. Similarly, (at least at the mean of the sample) the ε parameters should produce a concave cost function, including non-positive compensated own-price elasticities.

Setting these parameters free while imposing these bounds is computationally difficult. However, it is possible to explore these issues in a more limited fashion. The first step involves fixing the sharing economy parameters at the side of the range in Table 1 which will minimise the residual terms reported in Table 5. The required direction of change is ascertained from the direct price terms in equation (13) (assuming equal shadow prices). Where this equation suggests only a small change in price is required, the sharing economies are left at their original value. These new sharing assumptions are shown in the middle panel of Table 6 along with the couple-specific parameters obtained when model 4 is re-estimated.[23] These residuals are only marginally changed from their values in the first panel. In other words, altering the sharing parameters within plausible ranges has a negligible effect upon the model fit.

What of the price responses? The assumptions used for these are based on much weaker evidence than the shadow prices. Examining the couple-specific parameters in Table 6 in the context of equations (13) and (14) (and ignoring the impact of real income on budget shares), suggests that the absolute price elasticity for housing may be too large and the absolute price elasticity for the two transport goods too low. On the other hand, it is unlikely that the poor fit of prepared food is due to an incorrect price response, since the shadow price for prepared food is near the average for all commodities, and so a very large change in the price elasticity would be required to change the predicted value significantly.

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23 For computational convenience, the housing shadow price is set at 0.51 rather than 0.5. To assume the latter would necessitate an alternative method of setting shadow prices since this implies a right-angle household purchase function. In this situation shadow prices can be defined as the prices which would lead to $q_{i1}=q_{i2}=q_i$ (subject to the constraint that $s_{i1}+s_{i2}=0.5$). Preliminary analysis using this approach showed only a small difference to the results shown here.

For housing in particular, it is quite plausible that the absolute price elasticity for aged people will be much smaller than for the population as a whole. Many older people have strong attachments to their home and wish to remain in the same dwelling when their partner dies (or when market prices change for that matter). Their expenditures on maintenance and taxes, which comprise the bulk of housing costs in this sample, thus continue at much the same level as before, despite the large change in the effective price of housing services. We might also speculate that the absolute price elasticity for transport among the aged will be greater than average, since less of their travel is associated with relatively inflexible work-related commuting.

In the light of these observations, the last panel of Table 6 shows estimates equivalent to model 4, but now using price elasticities of –0.3, –2.0 and -2.0 for housing and the two transport goods respectively (compared to -0.76, –0.47 and –0.91). Though prepared food is still underestimated by this revised model, no other budget share has a significant couple constant (though alcohol and shared recreation goods come close).[24]

Model 8 then repeats the estimation of model 1 (the restricted model), but with these alternative price elasticities and fixing Φ at 1. The implied own-price elasticities for married men and women are shown in Table 7. For housing in particular, these elasticities are significantly weaker (less negative) with the elasticity for men positive. This is because the weak price elasticity permits the low price for housing to produce a significant drop in the budget share which in turn alters the elasticity (see equation (14)).

Whilst the convexity of the budget constraint permits the convergence of the price solution in the face of this weak convexity in the cost function, this is not the case when the estimation is repeated with Φ not fixed. The first iteration produces an estimate for Φ of 1.16 with a standard error of 0.12 (Θ_1=0.46). This lower income share leads to a lower shadow price for men, a lower housing budget share, and hence a positive price elasticity.

24 Note that the couple-specific constants must sum to zero, and so the poor fit of the food equation must imply negative coefficients for at least some of the other commodities.

Table 7: Revised Price Elasticities: Restricted Model Estimates (Model 8)

		Couples: shadow price at mean		Couples: own-price elasticity at mean	
i	Commodity	Men (s_{i1})	Women (s_{i2})	Men	Women
1	Men's clothing	1.00	1.00	-0.82	
2	Women's clothing	1.00	1.00		-0.81
3	Housing	0.49	0.61	0.06	-0.14
4	Fuel	0.67	0.73	-0.30	-0.32
5	Prepared foods	0.81	0.79	-0.41	-0.37
6	Personal foods	0.91	0.91	-0.44	-0.40
7	Alcohol	0.99	0.85	-0.64	-0.63
8	Tobacco	1.00	1.00	-0.62	-0.63
9	Furnishings and equipment	0.61	0.63	-0.83	-0.73
10	Household services and operation	0.54	0.75	-0.34	-0.41
11	Medical care and health	0.97	0.97	-0.48	-0.50
12	Transport fares	1.00	1.00	-2.63	-2.53
13	Vehicle running expenses	0.67	0.58	-1.91	-1.67
14	Shared recreation goods	0.71	0.49	-0.58	-0.39
15	Personal recreation goods	0.83	0.87	-0.53	-0.47
16	Personal care	0.90	0.98	-0.55	-0.51
17	Miscellaneous	0.64	0.81	-0.41	-0.47

In principle, the use of cost function with better global convexity properties should remove this estimation difficulty. In the present case, however, it seems reasonable to fix Φ at 1 since none of the estimates suggest that it is significantly different from this (in either a statistical or substantive sense).[25]

Table 8 shows the different equivalence scales (and income sharing estimates) obtained from the different estimation models used here. In addition, a number of sensitivity tests are shown describing the impact of changing the sharing parameters or the assumptions about the α_0 parameters in the demand functions. Since not of all these lead to concave cost functions, only the quasi-linear estimates are shown.

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25 The first iteration estimate is a good approximation for the final estimate. For model 1 the first iteration estimate of Φ was 1.10 (cf. 1.09 for the final estimate).

Table 8: Income Sharing and Equivalence Scales for Men and Women

	Model	Φ	Male Income Share (Θ_1)	Male equivalence scale	Female equivalence scale	Average of male and female scales
	Using Initial Sharing and Price Elasticity Assumptions					
1	Restricted	1.09	0.47	1.55	1.47	1.51
1a	Quasi-linear model	1.10	0.47	1.59	1.41	1.50
2	Unrestricted (ie including couple age, income and constant terms)	1	0.49	1.51	1.48	1.50
4	With couple constant terms	1	0.49	1.51	1.48	1.49
5	Restricted (model 1 with Φ fixed)	1	0.49	1.52	1.50	1.51
	Using Alternative Price Elasticity Assumptions					
7	With constant couple terms	1	0.49	1.51	1.48	1.50
8	Restricted	1	0.49	1.51	1.50	1.50
	Alternative Price Elasticity Assumptions: Quasi-linear Purchase Function					
9	Quasi-linear version of model 8	1.16	0.46	1.64	1.37	1.51
10	With lower bound shadow prices	1.06	0.48	1.43	1.30	1.37
11	With upper bound shadow prices	1.24	0.44	1.87	1.48	1.68
12	With α_{0j}=(0,0)	1.21	0.45	1.67	1.36	1.51
13	With α_{0j}=(0,4)	1.17	0.46	1.63	1.38	1.51
14	With α_{0j}=(4,0)	1.21	0.45	1.68	1.35	1.51

All of these models fail to adequately predict food consumption. In the light of this, the equivalence scale with the clearest interpretation is that derived from model 2 (models 4 and 7 have broadly similar interpretations). This imposes no restrictions on couple consumption patterns and so the parameters which determine the equivalence scale come from the demand patterns of single men and women only. Hence the equivalence scale for model 2 can be interpreted as indicating the income required by couples if they behaved as predicted by the theory. That is, it ignores any of the home production influences on couple consumption. Such an equivalence scale may well be the most relevant for policy makers who do not wish pensions to be responsible for compensating single people for their loss of home production time.

In any event, the average of the male and female equivalence scales is insensitive to all model variations apart from changes to the shadow prices. In addition, there are negligible changes to the equivalence scales as income or age changes.[26] Indeed the conclusions are essentially the same as obtained from the Paasche and Laspeyres scales shown in Table 3.

Different model specifications do lead to variations in the estimation of Φ, and hence the income share within the household. However, none of these are significantly different from 1.0. For model 9, for example, the standard error for Φ translates to an approximate 95 per cent confidence interval of the male income share of from 42% to 52%. Though the power of the test is not very strong, it is still sufficient to detect any substantively important variations from equal sharing using the modest sample size of the current study.

This present sample does point towards men receiving a somewhat smaller share of household expenditure. Even if this were found in other samples, it would not imply that husbands are worse off than are wives. Even if welfare is restricted to the domain of commodity consumption, the model says nothing about the relative welfare levels of men and women. Rather, such a result would simply imply that single men need lower incomes than single women to obtain the same (commodity based) living standard as when each is married. Broader conclusions about relative welfare levels must involve other assumptions as well as consideration of home production effects and other benefits of living together and apart. Finally, as noted above, a proper modelling of the 'free rider' effect via the iso-elastic household purchase function would mean that the true equivalence scales for men and women are closer together than implied by the estimates in the last 5 models of Table 8.

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26 For model 8, the scales at y = \$180pw, male age = 72 and female age = 70 are 1.505 and 1.499 for men and women respectively. Reducing income to \$125pw (single pension income level) changes the scales to 1.501 and 1.512. Reducing ages to 67 and 65 has even less impact.

6 Discussion

There are several conclusions arising from the analysis presented in this paper. Most generally, the results show that it is possible to develop an economically plausible framework which explains most of the differences in consumption patterns between singles and couples at quite a detailed level of disaggregation. A more elaborate (but not necessarily more policy relevant) model incorporating scale economies in home production would be required to fully describe the differences in consumption patterns.

The household welfare model described here also provides empirical information about two important aspects of household welfare, the sharing of income within the household and the magnitude of equivalence scales for single and married households with older members.

The pattern of income sharing is identified by examining whether the expenditure patterns of couples are more like those of single men, or more like those of single women (after taking account of joint consumption and associated income and price effects). If couple expenditure patterns were more like those of single men, for example, this would provide evidence that household consumption is directed more in line with the preferences of men rather than women. Note that this concept of ‘income sharing’ may or may not be related to the receipt of income by individual members, and indeed need not even be related to the question of who has the greatest power in deciding household expenditure patterns. For example, it could be the case that women make all the household expenditure decisions, but that they altruistically only purchase goods that they know their husbands will like. This would show up as a greater share of household income accruing to husbands.

As it turns out, the 1988-89 Australian HES data indicates that couples have expenditure patterns which are in-between those of single men and women. Though this sample suggests that women have a slightly greater share of income, the hypothesis of equal sharing cannot be rejected.

Though the full pattern of expenditures has some impact, this result is primarily determined by the expenditures on men’s and women’s clothing, as these are the two commodities where male and female consumption patterns differ most. Indeed, if we are prepared to assume a separable structure in the household welfare function, then having a single commodity which is consumed by only one individual is sufficient to identify income sharing (as per the Rothbarth model). Additional data on male and female consumption of other commodities would make the estimates more precise, or alternatively provide evidence that the separability hypothesis is false. Nonetheless, separability seems a reasonable starting point.[27]

It should be remembered, nonetheless, that the income distribution is not the same as the relative welfare level. Men and women may have different nutritional and social requirements in order to reach the same socially defined level of functioning. In addition, welfare is based upon more than commodity consumption. In particular, evidence suggests that older women may have less leisure when married than when single because of their greater role in home production, while the opposite applies to men (Bittman, 1991).

The equivalence scale estimates achieved here are primarily identified from the assumptions in Table 1 about the technology of sharing associated with 17 different commodity groups. Using the maximum and minimum sharing parameters shown there, couples over retirement age are estimated to require between 1.37 to 1.68 times the income of single people (averaging across men and women) in order to attain the same living standard, with a preferred value of 1.50. This result does not vary with income or age. Despite the fact that the assumptions of the Barten model are not met, simple weighted price indices derived from this model produce essentially the same conclusion. In future work it is planned that that the assumptions of Table 1 will be further refined by drawing upon the results of a major study of household budgets currently under way in Australia.[28]

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27 The key implication of separability is that male and female preferences are stable in moving from single to married households. Thus the model permits the household to direct income towards the needs of one member, but assumes that given this distribution (and the shadow prices) this member will have the same consumption preferences as when single.

28 Note that the equivalence scale results using the method described here need not be the same as those produced by conventional budget standard methodology. Budget standards are typically based upon assumptions about the quantity consumed as well as (implicitly at least) the commodity-specific relativities between each family type. The method outlined here only draws upon the latter set of assumptions, using behavioural data to provide the expenditure weights.

Interestingly, the Australian Age Pension has a fixed relativity between couples and singles which is at the extreme end of this range (1.67). If the preferred estimates reported above are accepted, this would suggest that the relative equity goals of the pension system would be enhanced by increasing payments to single pensioners (or reducing payments to couples).[29] This result is consistent with anecdotal and focus group evidence about the perceived drop in living standards experienced by pensioners whose spouse has died (Barber et al, 1994; Patterson and Wolffs, 1995).

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29 This conclusion is strengthened when we note that relatively public capital goods such as mortgage principal repayments, and car and boat purchases are excluded from the analysis.

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Table 1: Sharing Assumptions

Commodity group	Included commodities (largest expenditures listed first)	Within-group budget share	Sharing Economies (0.5 = pure public, 1 = pure private) Low	Preferred	High
1 Men's clothing			1.00	1.00	1.00
2 Women's clothing			1.00	1.00	1.00
3 Housing	Repairs and maintenance, land and water supply taxes		0.50	0.55	0.65
4 Fuel	Electricity, gas etc (not transport fuels)		0.60	0.70	0.80
5 Prepared foods	Foods that require preparation and/or are perishable such as flour, rice, pasta, vegetables, bread, unprocessed meat and milk		0.70	0.80	0.90
6 Personal foods			0.83	0.91	1.00
	Restaurants, take-away food	*0.13*	*1.00*	*1.00*	*1.00*
	Biscuits, fruit, processed meat, breakfast cereals, cakes, non-alcoholic drinks, dairy products (other than milk), spreads, tea, coffee, confectionary, tinned fish, etc	*0.87*	*0.80*	*0.90*	*1.00*
7 Alcohol			0.90	0.95	1.00
8 Tobacco			1.00	1.00	1.00
9 Furnishings and equipment			0.57	0.62	0.67
	Lounge room and kitchen furniture, major appliances and household tools	*0.25*	*0.50*	*0.55*	*0.60*
	Floor coverings, curtains, other furniture	*0.75*	*0.60*	*0.65*	*0.70*
10 Household services and operation			0.60	0.65	0.75
	Gardening services, nails, screws etc.	*0.05*	*0.50*	*0.52*	*0.55*
	Telephone and post, soaps and detergents (not personal), gardening products etc.	*0.93*	*0.60*	*0.65*	*0.75*
	Toilet paper and tissues	*0.02*	*0.90*	*0.95*	*1.00*

(continued)

Table 1: Sharing Assumptions (continued)

Commodity group	Included commodities (largest expenditures listed first)	Within-group budget share	Sharing Economies (0.5 = pure public, 1 = pure private) Low	Preferred	High
11 Medical care and health			0.96	0.97	1.00
	Insurance	*0.14*	*1.00*	*1.00*	*1.00*
	Dental and medical fees and medications	*0.86*	*0.95*	*0.97*	*1.00*
12 Transport fares	Air, bus, rail fares etc (excluding holiday fares)		1.00	1.00	1.00
13 Vehicle running expenses			0.58	0.62	0.67
	Vehicle registration and insurance, vehicle accessories etc	*0.17*	*0.50*	*0.50*	*0.50*
	Operating costs such as petrol, vehicle servicing etc	*0.83*	*0.60*	*0.65*	*0.70*
14 Shared recreation goods	Shared goods such as newspapers, televisions, stereos and associated suppplies; pets, general holiday expenditures		0.50	0.60	0.70
15 Personal recreation goods	Books, magazines, gambling, sports, admission charges, and holiday travel		0.75	0.85	0.95
16 Personal care	Haircuts, toiletries and cosmetics etc		0.90	0.95	1.00
17 Miscellaneous			0.62	0.73	0.84
	Gifts, misc property payments, personal advertising, etc	*0.24*	*0.50*	*0.55*	*0.60*
	Clothing related (not identified by sex), alimony payments, jewellery and accessories, education fees, professional association subscriptions, etc.	*0.14*	*0.90*	*0.95*	*1.00*
	Miscellaneous commodities and services nec, stationery, fees and fines, non-housing interest payments, etc	*0.62*	*0.60*	*0.75*	*0.90*

Table 4: Initial Estimation: Price Assumptions and Results

i	Commodity	Assumed shadow price with equal consumption	Assumed own-price elasticity for single men and women	Couples: shadow price at mean		Couples: own-price elasticity at mean	
				(s_{i1})	(s_{i2})	Men	Women
1	Men's clothing	1.00	-0.81	1.00	1.00	-0.82	
2	Women's clothing	1.00	-0.81	1.00	1.00		-0.81
3	Housing	0.55	-0.76	0.45	0.64	-0.74	-0.76
4	Fuel	0.70	-0.47	0.66	0.74	-0.29	-0.31
5	Prepared foods	0.80	-0.44	0.80	0.80	-0.41	-0.37
6	Personal foods	0.91	-0.44	0.91	0.92	-0.44	-0.40
7	Alcohol	0.95	-0.63	0.99	0.86	-0.64	-0.65
8	Tobacco	1.00	-0.63	1.00	1.00	-0.63	-0.63
9	Furnishings and equipment	0.62	-0.91	0.58	0.67	-0.83	-0.73
10	Household services and operation	0.65	-0.47	0.52	0.77	-0.30	-0.41
11	Medical care and health	0.97	-0.47	0.97	0.98	-0.47	-0.49
12	Transport fares	1.00	-0.47	1.00	1.00	-0.33	-0.33
13	Vehicle running expenses	0.62	-0.91	0.71	0.53	-0.89	-0.90
14	Shared recreation goods	0.60	-0.47	0.67	0.53	-0.57	-0.42
15	Personal recreation goods	0.85	-0.47	0.81	0.88	-0.51	-0.47
16	Personal care	0.95	-0.47	0.89	0.98	-0.53	-0.51
17	Miscellaneous	0.73	-0.47	0.61	0.83	-0.38	-0.47

Table 6: Difference Between Predicted and Actual Couple Budget Shares

	Commodity	Initial Model (4)				Alternative Sharing Assumptions (6)			Alternative Price Elasticities (7)		
		s_i at equality	Own price elasticity(a)	Couple constant(b)	t	s_i at equality	Couple constant(b)	t	Own-price elasticity(a)	Couple constant(b)	t
1	Men's clothing	1.00	-0.81	0.001	0.4	1.00	0.001	0.5	-0.81	0.000	0.3
2	Women's clothing	1.00	-0.81	0.003	0.8	1.00	0.003	0.9	-0.81	0.003	0.7
3	Housing	0.55	-0.76	-0.039	-4.2	0.51	-0.038	-4.1	-0.30	-0.010	-1.1
4	Fuel	0.70	-0.47	-0.002	-0.8	0.70	-0.002	-0.8	-0.47	-0.004	-1.4
5	Prepared foods	0.80	-0.44	0.031	5.5	0.90	0.024	4.3	-0.44	0.027	4.9
6	Personal foods	0.91	-0.44	0.014	2.4	1.00	0.008	1.5	-0.44	0.010	1.7
7	Alcohol	0.95	-0.63	-0.007	-1.6	0.90	-0.006	-1.4	-0.63	-0.008	-1.8
8	Tobacco	1.00	-0.63	-0.002	-0.7	1.00	-0.002	-0.7	-0.63	-0.002	-0.8
9	Furnishings and equipment	0.62	-0.91	-0.005	-0.5	0.57	-0.002	-0.2	-0.91	-0.005	-0.5
10	Household services and operation	0.65	-0.47	-0.003	-0.7	0.65	-0.002	-0.4	-0.47	-0.005	-1.2
11	Medical care and health	0.97	-0.47	0.001	0.2	0.97	0.003	0.5	-0.47	-0.001	-0.1
12	Transport fares	1.00	-0.47	-0.007	-2.5	1.00	-0.007	-2.4	-2.00	-0.003	-1.2
13	Vehicle running expenses	0.62	-0.91	0.009	1.2	0.67	0.010	1.2	-2.00	-0.003	-0.4
14	Shared recreation goods	0.60	-0.47	0.011	1.8	0.70	0.009	1.5	-0.47	0.010	1.6
15	Personal recreation goods	0.85	-0.47	-0.002	-0.3	0.85	0.001	0.1	-0.47	-0.004	-0.4
16	Personal care	0.95	-0.47	0.001	0.2	1.00	0.001	0.2	-0.47	0.000	0.1
17	Miscellaneous	0.73	-0.47	-0.004	nc	0.73	-0.002	nc	-0.47	-0.005	nc

Notes:
(4,6,7) The numbers in brackets refer to the models in Table 5.
nc Not calculated.
(a) Approximate compensated own-price elasticity for single men and women.
(b) The couple constant terms show the amount by which the household distribution model underestimates the couple budget share.