Do Family Bonds Bind?

Testing the Unitary and Collective Models of Household Behaviour on South African Data

Abstract:

The following paper tests the unitary and collective models of household behaviour on South African data. Unitary and Collective rationality are tested through nested likelihood-ratio tests on non-linear seemingly unrelated regressions that are based on the models proposed by Bourguignon, Browning and Chiappori (2009). The unitary model is rejected for South African households consisting out of two adult members, regardless of the presence of a child. The collective model of household behaviour cannot be rejected for these households, however. Furthermore, the paper uses the estimates for the collective model to infer the effect of changes to various distributional factors on household bargaining and expenditure. This is the first attempt at explicitly testing the unitary and collective models of household behaviour for an African country.

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1. Introduction

Modern economics, characterised by the subjective theory of value, describes the individual as the primary decision maker in the economy (Samuelson, 1947:90). It is this insight that forms the basis of, among others, micro-economics, game theory, the Lucas critique, the rational expectations school and the micro-foundations approach to modern macroeconomics. In this context, the primacy of the individual is neither a declaration of the supremacy of individualistic morality nor is it a concept denying the impact of social institutions on the individual; rather it is a methodological condition requiring economic science to explain phenomena by referring to the actions and interactions of individuals. When understood in this light modern economics requires methodological individualism in order to make any analysis complete.[1] Without denying the importance of the individual in economic analysis, it is also accepted that individuals do not live in isolation and can be seen to care and be affected by the decisions of others. Thus, although the individual may be selfish in the attainment of his or her own utility, there is no *a priori* reason to assume that this utility does not include that of others, specifically those with whom the individual shares a home with. The fact that individuals do not necessarily live in isolation does not mean that methodological individualism should be discarded, rather it reinforces the need for this methodology as the decisions and consequences of collective action are the result of individual interaction.

The household is often used as the main unit of account in many economic and policy analyses, this is especially seen in poverty, inequality and labour supply literature. The unitary model of household behaviour is used whenever any analysis treats the household as though it is a utility maximising individual. This model of household behaviour assumes away intra-household interaction and treats the household as an entity only interacting with the outside world. The unitary model thus violates the concept of methodological individualism as the different household members are not characterised by their own utility functions or preferences. Where this violation is not accounted for the welfare indicators and policy proposals stemming from the analysis may lead to inaccurate or downright contradictory results. Against the unitary model, the collective model of household behaviour instigated by Chiappori (1988) models the household as a collection of individuals, each with

[1] See Hodgson (2007) for a discussion on the different meanings and correctness of the term methodological individualism.

their own utility functions, thereby treating the household as a collective interacting with the outside world and within itself.

The following paper employs the models and methodology suggested by Bourguignon, Browning and Chiappori (2009) and Bourguignon, Browning, Chiappori and Lechene (1993) on South African data. Wave 1 of the National Income Dynamic Study 2008 (NIDS) is used to test the unitary and collective models of household behaviour. Unitary and Collective rationality are tested through nested likelihood-ratio tests on non-linear seemingly unrelated regressions that are based on the models proposed by Bourguignon, Browning and Chiappori (2009). The unitary model is rejected for South African households consisting out of two adult members, regardless of the presence of a child. This result is due to the rejection of distribution factor independence of household demands. The collective model of household behaviour cannot be rejected for these households, however. To the knowledge available this is the first attempt at explicitly testing the unitary and collective models of household behaviour on South African data. The paper thus forms a starting point into what may be developed into fully specified structural models of labour supply, poverty and intra-household welfare allocation.

The paper is organised as follows: Section 2 gives a literature review of the various models of household behaviour, giving specific attention to the unitary and cooperative collective models that will be formalised in section 3. Section 4 describes the subsample of the NIDS used for the econometric methodology set out in section 5. Section 6 gives the empirical results along with a brief discussion of the impact of distribution factors on two select commodities. The paper concludes with section 8.

2. Literature Review

In economics the household is often analysed as either an entity interacting with the outside economy or an entity interacting within itself (Chiappori, 1992:440). Examples of the former is most often found in poverty, inequality and labour analysis while the latter is usually only found in specialised literature on intra-household allocation or game theory (see for example Armstrong *et al*¸ 2008; OECD, 2009; Lundberg & Pollack, 1994; Haddad *et al*, 1997; Duflo, 2000). There is no doubt that the household plays a crucial role in the economy, there is thus a necessity for a formal model that incorporates both the interaction of household members between each other and the outside economy. This section provides a literature review of the unitary and collective models of household behaviour. As the formal models are given below, only the intuition and empirical evidence of these models will be discussed.

2.1.The Unitary Model

Becker (1981) was possibly the first to formalise household behaviour with the extension of standard neoclassical consumer demand models to families, although prior to him Samuelson (1956) already used the household welfare function as an allegory for social indifference curves. Within both Becker's and Samuelson's respective frameworks the household is assumed to maximise a joint welfare function, where the marginal rate of substitution is equal across all pairs of goods (Samuelson, 1956:10-11; Becker, 1991:32; Thomas, 1990:636). Although the general intuition of these frameworks is not incorrect, the joint welfare function stemming from them is based on a single set of preferences, subject to a joint budget constraint. Thus, the household is viewed as a single utility maximising individual, although it may allow for differing prices for the various household members (Alderman *et al*, 1995:3). In this way, although the unitary model may implicitly acknowledge the existence of different individuals within the household, the household is modelled as though it is a single individual (Chiappori, 1997:40; Fortin & Lacroix, 1997:935; Vermeulen, 2002:535-536). This modelling approach results in restrictive assumptions on those processes that determine intra-household welfare allocation has important policy implications to be discussed further below (Chiappori & Donni, 2009:4; Haddad *et al*, 1997a:5; Alderman *et al*, 1995:3). In this way, the essence of a unitary model is not necessarily its abstract theoretical content, but rather the formal, methodological and empirical consequences of its assumptions. It is then exactly on these assumptions along with welfare economic arguments that the unitary model is criticised.

The unitary model is often used in economic analysis as it allows the household to be treated in the same way that an individual would, meaning that the familiar assumptions, axioms and methodology of neoclassical consumer theory can be applied (Vermeulen, 2002:533; Chiappori, 1992:440; Samuelson, 1956:11). Neoclassical consumer theory, however, applies to individuals and not to groups (Browning & Chiappori, 1998:1241). Further, it is known from Arrow's Impossibility Theorem that group preference relations do not necessarily behave as those for individuals and thus cannot be modelled in the same way (Jehle & Reny, 2011:272-279; Browning & Chiappori, 1998:1241). As the unitary model treats the household in this fashion, it is said to fall short of methodological individualism, at least in so far as it does not give methodological consequence to the utility functions of different household members. The lack of methodological consequence is a direct result of the arbitrary aggregation of utility functions into a social welfare function (Apps & Rees, 1996:201; Chiappori, 1992:440; Fortin & Lacroix, 1997:933). Several theories attempt to explain how individual preferences aggregate into a household preference function. Samuelson (1956:10), for example, states that familial bonds tie the preference relations of different household members into a household welfare function. The welfare function is then achieved through mutual consent that determines each member's deservingness to consume (Samuelson, 1956:10). This formulation, however, does not give a clear indication of how the consensus on deservingness to consume would be reached (Haddad *et al*, 1997:5). Against Samuelson's model Becker (1991:297) suggests that the deservingness of consumption of the different household members should rather be incorporated into each member's preference function. In Becker's (1991:297) model, however, the deservingness of consumption incorporated into each member's preference function is identical to that of the altruistic head, meaning that the household is methodologically unitary (Chiappori, 1997:40). It is for this reason that household behaviour under the benevolent dictator, common preferences as well as altruism models are labelled unitary (Alderman *et al*, 1995:3; Vermeulen, 2002:534).

Although the unitary model fails methodological individualism, the examples above show that it can offer some insights into the intra-household distribution of welfare (Haddad *et al*, 1997:1; Alderman *et al*, 1995:3). As the household maximises a single unique utility function, it may specialise in the accumulation of human capital, household production effort, labour supply and consumption across members for efficiency gains, such as higher total income (Alderman *et* al, 1995:3; Becker, 1991:31-48, 54-79; Haddad *et al*, 1997:3-4). On Bangladesh, data Pitt *et al* (1990:1155), for example, show that labour specialisation may lead to higher nutrient allocation to those with higher earnings potential. Besides efficiency reasons, intra-household inequality may also be the result of household preferences, which are an arbitrary aggregation of individuals, as discussed above (Alderman *et al*¸ 1995:3). Since efficiency gains are allowed to interact with household preferences and the process of determining these preferences is ignored, the unitary model puts the household into a black box (Chiappori, 1997:51).

Aside from the methodological and welfare-analytical consequences of the unitary model, it is often rejected empirically. In terms of informal theory, the literature on domestic violence and spousal abuse seems to indicate that the assumptions of either a benevolent dictator or altruism in the household cannot be generalisable to the entire population (Alderman *et al*, 1995:11).[2]. In terms of formal theory, the unitary model of household behaviour results in the testable restrictions of Slutsky symmetry, income pooling and the negativity of price responses on demand systems (Browning *et al*, 1994:1068-1069).

The Slutsky symmetry condition requires that there is symmetry in the compensated cross wage effects of the different household members in terms of labour supply (Fortin & Lacroix, 1997:936). The unitary model also implies that all household resources including income, labour, capital and land are pooled together (Alderman *et al*, 1995:3; Thomas, 1990:636). This restriction is known as the income pooling hypothesis and implies that the intra-household allocation of resources is independent of the person receiving non-labour income. Fortin and Lacroix (1997) as well as Browning and Chiappori (1998) reject both of these restrictions for Canadian data, where the former found income pooling to hold for couples with pre-school age children and the latter could not reject Slutsky symmetry for single person households. The income pooling hypothesis has also been rejected for French and Brazilian data by Bourguignon *et al* (1992) and Thomas (1990) respectively.

Duflo (2000) implicitly rejects the income pooling hypothesis for South Africa in a study on the correlation between child health and roll-out of the South African state old age pension grant. Through the use of non-parametric tests she shows that the state old age pension program had a significant impact on the height-for-age ratio for girls, but only where the recipient of the pension was female (Duflo, 2000:397-398). In a later article Duflo (2003:21-23) confirms these findings and also reaffirms that the pension program has no significant impact on the health for boys independent of the recipient of the pension. Case *et al* (2000) show, on South African data, that younger children are significantly more likely to benefit from higher resource control by a biological mother than other groups of children would. They also indicate that the presence of a biological mother in the household to only affects food spending where the children in the household are below the age of 12 (Case *et al*, 2000:797). Where children are above this age the mother's presence has an insignificant effect on intra-household allocation (Case *et al*, 2000:797). Wittenberg (2009) implicitly rejects the unitary model and uses an arguably more general non-unitary framework to analyse the intra-household allocation of work and leisure based on the South African time use survey.

[2] See for example Tauchen *et al* (1991) and Farmer and Tiefenthaler (1997) for economic models of domestic violence.

2.2. Non-Unitary Models: Cooperative and Non-Cooperative Approaches to Household Behaviour

In order to address the issues unanswered by the unitary model, two distinct game-theoretical frameworks have developed in the literature (Fortin & Lacroix, 1997:934). The first employs non-cooperative game theory, specifically Cournot-Nash equilibria, to model the household as a collection of individuals, each seeking to maximise an own utility function subject to an own budget constraint, where the actions of the other household members are treated as a given (Chiappori & Donni, 2009:5, 44). These non-cooperative models may lead to outcomes that are not Pareto efficient, especially where contracts are seen as non-binding and unenforceable (Alderman *et al*, 1995:4-5; Lundberg & Pollack, 1994:134-136; Chiappori & Donni, 2009:5).

The non-cooperative model has theoretical and practical drawbacks. It can be argued that the household is an example of an infinitely repeated, or at minimum an indefinitely repeated, game (Browning & Chiappori, 1998:1243). In this case, it is reasonable to assume that the members of the household have knowledge of the preferences of the other members, implying that the Folk theorem should hold on aggregate (Gibbons, 1992:88-99). Practically, these models often require strict assumptions on traditional gender roles in order to explain the division of labour, specialisation and allocation of resources within the household (Alderman *et al*, 1995:5; Lundberg & Pollack, 1993:994). While these caveats are not particularly devastating, data limitations are. Cherchye *et al* (2009) derive testable restrictions for different degrees of cooperation in the household. In a later paper, they also extend these tests for different assumptions of the degree of caring between household members (Cherchye *et* al, 2010). In both papers, they apply revealed preference techniques that test the spectrum of cooperative-cooperative models through mixed integer programming (Cherchye *et al*, 2009:5; 2010:18, 33). While their approach does not require panel data, price data is required for identification.[3] The collective approach discussed below is thus preferred only to the extent that current data limitations inhibit a more comprehensive approach.

A second non-unitary model is the cooperative game-theory based collective model introduced by Mansur and Brown (1980). The cooperative-collective model of household behaviour, from here on only referred to as the collective model, also characterises the household as a collection of individuals. It assumes that all outcomes are Pareto efficient

[3] Price data is of both private and public goods are required, where the price of the latter is augmented through Lindahl pricing (Cherchye *et al*, 2009:12-13, 18).

independent of the process that determines the intra-household welfare allocation (Chiappori, 1988:64; 1992:442; Bourguignon *et al*¸ 2009:504). In this way no individual can be made better off without another being worse off either within or by dissolution of the household (Alderman *et al*, 1995:5). The assumption of Pareto optimality is attractive for the same reasons that the non-cooperative model is unattractive, further this assumption is arguably a natural extension of the assumption of individual utility maximisation found in consumer theory (Browning & Chiappori, 1998:1243). Thus, the collective model offers a framework within to examine intra-household decision making, without any further untestable restrictions on the process determining intra-household resource and welfare allocation (Alderman *et al*, 1995:5; Chiappori, 1992:442-443; Bourguignon *et al*, 2009: 510; Chiappori & Ekeland, 2009: 764-765).

A simple version of the collective model sees a two person household jointly deciding how much to spend on pure public goods, after this the expenditure on semi-public and private goods or determined according to some utility weighting factor or sharing rule (Alderman *et al*, 1995:5). In distinction to the unitary model, the collective model allows for and tests the determinants of this utility weighting factor. Crucially, for a model to be a collective model the utility weighting factor must be dependent on total income, prices and distribution factors (Bourguignon *et al*, 2009:503-505; Chiappori & Donni, 2009:13). Distribution factors are those factors which affect the distribution of power in the household, but do not affect the preferences or total income (Bourguignon *et al*, 2009:506). Examples of distribution factors include the relative wages or ownership of property between the spouses as well as other extra-environmental factors such as the sex ratio, divorce laws and marriage market in the area the household is situated (Bourguignon *et al*, 2009:503; Browning *et al*, 1994:1075; Browning *et al*, 2011:224; Chiappori & Ekeland, 2009:766).

There is wide empirical support for the collective model of household behaviour. Both Fortin and Lacroix (1997) and Browning and Chiappori (1998) fail to reject the collective model on Canadian data, where the former rejected the collective model for couples with pre-school age children. Bourguignon *et al* (1993) cannot reject the collective hypothesis for French data while Blundell *et al* (2007) fail to reject the collective model on United Kingdom data. To the knowledge available there is no literature available that explicitly test the collective model on South African households. The study by Bertrand *et al* (2000) on the relationship between public policy, intra-household resource allocation and labour supply that have come close to a collective model, although most of conditions they test for are undoubtedly unitary. They extend the initial model testing for the impact of pension income on household labour supply to include the source of the non-labour income (Bertrand *et al*, 2007:21-23, 27). By using this extension they show that female pension eligibility have significantly worse effects on male employment than male pension eligibility does (Bertrand *et al*, 2007:27).

3. Formal Results and Testable Restrictions

As stated above, both the unitary and collective models of household behaviour result in testable restrictions. The following section discusses these restrictions in general and then goes on to focus on the testable restrictions to be applied in the model of section 5. The theoretical model is specifically formulated for two decision-maker households, where all observable expenditure is on private goods (Bourguignon *et al*, 2009:505).

It is assumed that both persons in the household wish to maximise a joint utility function (1), subject to a budget constraint in (2). In this specification, each household member's utility function, u^m $m = g, h$ in (8), is caring in the Beckerian sense (Bourguignon *et* al, 2009:513). The precise implication of the caring assumption will be discussed further below.

$$\max_{\boldsymbol{q}^g,\boldsymbol{q}^h} \theta(\boldsymbol{a}, \boldsymbol{d}, Y)\, u^g(\boldsymbol{q}^g, \boldsymbol{q}^h, \boldsymbol{Q}, \boldsymbol{a}) + u^h(\boldsymbol{q}^g, \boldsymbol{q}^h, \boldsymbol{Q}, \boldsymbol{a}) \tag{1}$$

subject to

$$\boldsymbol{p}'(\boldsymbol{q}^g + \boldsymbol{q}^h + \boldsymbol{Q}) = Y = y^g + y^h + y^k \tag{2}$$

The household's welfare is thus dependent on the vectors of non-assignable private consumption items $\boldsymbol{q}^m \in \mathbb{R}^n_+$**,** public consumption items $\boldsymbol{Q} \in \mathbb{R}^n_+$, preference factors $\boldsymbol{a}$**,** distribution factors $\boldsymbol{d}$ $1 \ldots K$ and total income, Y. In this context, private consumption items must be rival in the sense that one person's consumption of the item must reduce the other's, excludability and assignability are thus not required (Browning *et al*, 2006:7).[4] Total income, Y, is the sum of exogenous private assignable incomes, y^m, and non-assignable income, y^k. While total income enters the budget constraint individual incomes do not, thus y^m or $\frac{y^m}{Y}$

[4] Where expenditure is assignable, the process of finding the sharing rule is made far less complicated, see Bourguignon *et al* (2009:517-518).

may be used as distribution factors (Bourguignon *et al*, 2009:511). As cross section data does not regularly include prices, all prices are set to unity.[5]

The Pareto weight, $\theta(\boldsymbol{a}, \boldsymbol{d}, Y)$, is bound between zero and unity and is dependent on total income, preferences and distribution factors.[6] By definition this weight corresponds to the decision power or utility weight of member g in expenditure on market items (Browning *et al*, 2006:8; Browning *et al*, 2011:128). Where the Pareto weight increases, for example, there will be a movement along the Pareto frontier so that g gains higher utility at the expense of h. Including Pareto weight into the maximisation problem implies that derived demand does not need to satisfy the standard conditions of consumer theory (Browning *et al*, 2011:129). Fujii and Inshikawa (2012) show that where the marginal rate of substitution between any two private goods are independent of the amount of public goods consumed, maximisation of the function (1) is equivalent to maximisation of private utility functions u^m. This result will not be derived here.

3.1.General Results

The unitary and collective models of household behaviour are formally distinguished by what enters the Pareto weight (Browning *et al*, 2006:6).[7] Where the Pareto weight is constant, meaning that household demand is distribution factor independent and income is pooled, as in (3.1) and (3.2) respectively, the household is in the unitary setting and (1) can be rewritten as in (3) (Browning *et al*, 2011:213). In this case, household demand can be shown to satisfy the standard conditions of homogeneity, adding-up, symmetry and negativity of the Slutsky matrix (Browning *et al*, 2011:125).

$$W(\,u^g, u^h) \tag{3}$$

[5] Setting all prices to unity is not problematic for private goods. Public goods differ from private goods in that, unlike the latter, where different members face identical prices and consume different quantities, household members consume the same amount of the public goods, but may be willing to pay different marginal prices for said good. Thus Lindahl Prices are required for public goods (Browning *et al*, 2011:177).

[6] Where price data is available it should also be included in the Pareto weight.

[7] Browning *et al* (2006) argue that income pooling is neither necessary nor sufficient for the unitary model and that distribution factor independence is the only testable restrictions. In a later work, Browning *et al* (2011:223-225) argue in the opposite direction, by showing that the income pooling hypothesis is necessary but not sufficient for the unitary model. They then go on to argue that Slutsky symmetry tests, the type advocated for by Browning *et al* (2006), may be misleading as it may be rejected due to functional form issues (Browning *et al*, 2011:223). Thus, for purposes of this paper and in the absence of price variation, it is acceptable that only distribution factor independence is tested (Browning *t al*, 2011:224).

$$\because \frac{\partial\theta(\boldsymbol{a})}{\partial d_k} = 0\ \forall k\ \ and\ \ \frac{\partial W}{\partial d_k} = 0\ \forall k \tag{3.1}$$

$$\because \frac{\partial\theta(\boldsymbol{a})}{\partial y^m} = 0\ and\ \frac{\partial W}{\partial y^m} = 0\ \forall m = g, h \tag{3.2}$$

In the case where the household utility function is distribution factor independent, but the weighting factor is dependent on total income, the non-unitary model would be observationally equivalent to the unitary model in cross-section data (Bourguignon e*t al*, 2009:509). Thus, in the absence of price variation distribution factor independence, shown in restriction (3.1), must be rejected for the model to be decidedly non-unitary.

The Pareto efficiency assumption of the collective model can be shown to result in strong testable restrictions (Bourguignon *et al*, 2009:510). Bourguignon *et al* (2009) show that where $(\boldsymbol{q}^g, \boldsymbol{q}^h, \boldsymbol{Q})$ are functions of $(\boldsymbol{d}, \boldsymbol{a}, Y)$, these functions are compatible with collective rationality if there exists two utility functions, $u^g(\boldsymbol{q}^g, \boldsymbol{q}^h, \boldsymbol{Q}, \boldsymbol{a})$ and $u^h(\boldsymbol{q}^g, \boldsymbol{q}^h, \boldsymbol{Q}, \boldsymbol{a})$, such that, for every $(\boldsymbol{d}, \boldsymbol{a}, Y)$, the vector $(\boldsymbol{q}^g, \boldsymbol{q}^h, \boldsymbol{Q})$ is Pareto efficient. Thus, where any other consumption bundle, $(\widehat{\boldsymbol{q}}^g, \widehat{\boldsymbol{q}}^h, \widehat{\boldsymbol{Q}})$, is weakly preferred to the bundle $(\boldsymbol{q}^g, \boldsymbol{q}^h, \boldsymbol{Q})$ for a specific $(\boldsymbol{d}, \boldsymbol{a}, Y)$, then it must be the case that $(\widehat{\boldsymbol{q}}^g, \widehat{\boldsymbol{q}}^h, \widehat{\boldsymbol{Q}})$ requires higher expenditure than $(\boldsymbol{q}^g, \boldsymbol{q}^h, \boldsymbol{Q})$. Formally, if

$$u^m\left(\widehat{\boldsymbol{q}}^g, \widehat{\boldsymbol{q}}^h, \widehat{\boldsymbol{Q}}\right) \geq u^m(\boldsymbol{q}^g, \boldsymbol{q}^h, \boldsymbol{Q}, \boldsymbol{a})$$

then

$$\boldsymbol{p}'\left(\widehat{\boldsymbol{q}}^g + \widehat{\boldsymbol{q}}^h + \widehat{\boldsymbol{Q}}\right) > \boldsymbol{p}'(\boldsymbol{q}^g + \boldsymbol{q}^h + \boldsymbol{Q})$$

The first consequence of this result is that Pareto-efficient allocations are fully described when θ varies in $\mathbb{R}^n_+$, meaning that household demand for good *i*, denoted by $\boldsymbol{C}_i$, can be written as in (4), where $\boldsymbol{q}_i = \boldsymbol{q}_i^g + \boldsymbol{q}_i^h$ (Bourguignon *et al*, 2009:513).

$$\boldsymbol{q}_i(a, Y, d) = \boldsymbol{C}_i[\boldsymbol{a}, Y, \theta(\boldsymbol{a}, \boldsymbol{d}, Y)]\ \ \forall i = 1, \dots, n \tag{4}$$

Holding Y constant, differentiating (4) in terms of the distribution factors yields (5) and (6).

$$\frac{\partial \boldsymbol{q}_i(\boldsymbol{a},\boldsymbol{d},Y)}{\partial d_k} = \frac{\partial \boldsymbol{C}_i[\boldsymbol{a},Y,\theta(\boldsymbol{a},\boldsymbol{d},Y)]}{\partial \theta}\frac{\theta(\boldsymbol{a},\boldsymbol{d},Y)}{\partial d_k} \tag{5}$$

$$\frac{\partial \boldsymbol{q}_i(\boldsymbol{a},\boldsymbol{d},Y)}{\partial d_l} = \frac{\partial \boldsymbol{C}_i[\boldsymbol{a},Y,\theta(\boldsymbol{a},\boldsymbol{d},Y)]}{\partial \theta}\frac{\theta(\boldsymbol{a},\boldsymbol{d},Y)}{\partial d_l} \tag{6}$$

So that they yield proportionality condition as in (7), which requires that the impact of the distribution factors be constant across all demands (Browning *et al*, 2011:161).

$$\frac{\boldsymbol{q}_{i,d_k}}{\boldsymbol{q}_{i,d_l}} = \frac{\theta_{d_k}(\boldsymbol{a},\boldsymbol{d},Y)}{\theta_{d_l}(\boldsymbol{a},\boldsymbol{d},Y)}\ \forall\ i \ldots n\ and\ k \neq l \tag{7}$$

3.2.The Sharing Rule

The intuitive appeal of the Pareto weight is somewhat offset by its inobservability in cross-section data, as it describes welfare and not consumption distribution within the household. With additional assumptions, an equivalent concept of a sharing rule, which describes that process whereby goods are allocated between the household members, may be employed to test the collective framework (Browning *et al*, 2011:169).

Where each individual's utility function is given by (8), their respective egotistic preferences are given by the felicity function σ^m that is defined over their own consumption of a good (Bourguignon *et al*, 2009:513). Where the utility functions take this form it is assumed that individual consumption of certain items have little externalities and that altruism is restricted to work through the felicity function, which has the separability property as in (9) (Bourguignon *et al*, 2009:513).

$$u^m(\boldsymbol{q},\boldsymbol{Q},\boldsymbol{a}) = \zeta^m[\sigma^g(\boldsymbol{q}^g,\boldsymbol{Q};\boldsymbol{a}),\sigma^h(\boldsymbol{q}^h,\boldsymbol{Q};\boldsymbol{a}),\boldsymbol{a}] \tag{8}$$

$$\sigma^m(\boldsymbol{q}^m,\boldsymbol{Q};\boldsymbol{a}) = f^m[v^m(\boldsymbol{q}^m;\boldsymbol{a}),\boldsymbol{Q};\boldsymbol{a}] \tag{9}$$

Following Bourguignon *et al* (2009:514), where $(\boldsymbol{q}^g,\boldsymbol{q}^h)$ are functions of $(\boldsymbol{d},\boldsymbol{a},Y)$ that is compatible with collective rationality then there exists a function $\rho(\boldsymbol{a},\boldsymbol{d},Y)$ such that $\boldsymbol{q}^m$ is the solution to the maximisation of the standard indirect utility function, v^m, in (9) as shown in (10).[8]

$$v^m(\boldsymbol{q}^m; \boldsymbol{a}) \tag{10}$$

subject to

$$\boldsymbol{p}'\boldsymbol{q}^{\boldsymbol{m}} = Y^m = \rho(\boldsymbol{a}, \boldsymbol{d}, Y)$$

Here, Y^m is the proportion of total household income allocated to member m for private consumption, thus:

$$Y^g + Y^h = Y = y^g + y^h + y^k$$

In this framework, Y^m is the sharing rule. The intuition behind this is simply that the total income that each member receives for private consumption is determined by the sharing rule, which is a function of preferences, distribution factors and total household income. As the sharing rule satisfies the adding up identity each member's income share can be rewritten as $Y^g = \rho(\boldsymbol{a}, \boldsymbol{d}, Y)$ and $Y^h = Y - \rho(\boldsymbol{a}, \boldsymbol{d}, Y)$ (Bourguignon *et al*, 1993:141-143).

As prices are assumed away, the consumption of good i by member m is given by that member's total budget alone and must depend on the same arguments as the sharing rule. Individual demands, for specific goods, can thus be written as in (11) and (12) where α_i and β_i denote the Engel curves for good i of members g and h respectively (Bourguignon *et al*, 1993:142-143; Bourguignon *et al*, 2009:515).[9]

$$\boldsymbol{q}_i^g(\boldsymbol{a}, \boldsymbol{d}, Y) = \alpha_i[Y^g; \boldsymbol{a}] = \alpha_i[\rho(\boldsymbol{a}, \boldsymbol{d}, Y); \boldsymbol{a}] \tag{11}$$

$$\boldsymbol{q}_i^h(\boldsymbol{a}, \boldsymbol{d}, Y) = \beta_i[Y^h; \boldsymbol{a}] = \beta_i[Y - \rho(\boldsymbol{a}, \boldsymbol{d}, Y); \boldsymbol{a}] \tag{12}$$

Household demand for private good i must be the sum of the two individual demands, $\boldsymbol{q}_i = \boldsymbol{q}_i^g + \boldsymbol{q}_i^h$, and can thus be written as (13).

$$\boldsymbol{q}_i(\boldsymbol{a}, \boldsymbol{d}, Y) = \alpha_i[\rho(\boldsymbol{a}, \boldsymbol{d}, Y); \boldsymbol{a}] + \beta_i[Y - \rho(\boldsymbol{a}, \boldsymbol{d}, Y); \boldsymbol{a}] \tag{13}$$

[8] Note here total income, *Y*, is used instead of total expenditure as in Bourguignon *et al* (2009). Total income is used only to be consistent with the model estimated in the empirical section. This has no bearing on the results, but is important for identification in systems regressions (Boruguignon *et al*, 1993:147-148).

[9] To stay consistent with the empirical section demand for good $\boldsymbol{q}_i$ is kept in vector form as consumption categories are estimated.

Keeping total household income constant and differentiating (13) by any distribution factor yields (14), which can then be shown to be consistent with the proportionality condition as in (15).

$$\boldsymbol{q}_{i,d_k} = (\alpha_i' - \beta_i')\left[\rho_{d_k}\right] \;\; \forall i = 1, \dots, n \; and \; k = 1, \dots, K \tag{14}$$

$$\frac{\boldsymbol{q}_{i,d_k}}{\boldsymbol{q}_{i,d_l}} = \frac{\rho_{d_k}(\boldsymbol{a}, \boldsymbol{d}, Y)}{\rho_{d_l}(\boldsymbol{a}, \boldsymbol{d}, Y)} = \frac{\theta_{d_k}(\boldsymbol{a}, \boldsymbol{d}, Y)}{\theta_{d_l}(\boldsymbol{a}, \boldsymbol{d}, Y)} = \frac{\boldsymbol{q}_{j,d_k}}{\boldsymbol{q}_{j,d_l}} \forall i \neq j \; and \; k \neq l \tag{15}$$

This framework also shows the observational equivalence of a total income dependent, but distribution factor independent, sharing rule. The implications for distribution factor independence of household demands are the same as those for the maximisation function, in (3.2), as shown in (16). The derivative of (13) in terms of total income yields (17) which need not be equal to zero where the $\rho_Y = 0$.

$$\boldsymbol{q}_{i,d_k} = 0 \;\; \forall i = 1, \dots, n \; and \; k = 1, \dots, K \tag{16}$$

$$\boldsymbol{q}_{i,Y} = [\alpha_i' - \beta_i']\rho_Y + \beta_i' \tag{17}$$

3.3.Testable Restrictions

Two distribution factors are required in order to test the proportionality condition resulting from the collective hypothesis (Bourguignon *et al*, 2009:511). It is assumed that demand for a good i is given by (18), where , s, z and **a** denote total household income, two distribution factors and a vector of preference factors respectively. The vector $\boldsymbol{\pi_i}$ corresponds to the impact of preference factors, **a**, on the demand for good i, while τ_{ti} and ψ_{ki} denote the same for household income variable t of good i and distribution factor k of good i respectively. Appendix A and B shows that collective rationality requires that (18) be equivalent to either (19) or (20).[10] (19) implies that the sharing rule is necessarily non-linear and takes the form of (21) while (20) implies a linear sharing rule that must take the form of (22) (Bourguignon *et al*, 1993:154-155).

$$\boldsymbol{q_i} = \boldsymbol{\pi_i}\mathbf{a} + \tau_{1i}Y + \tau_{2i}Y^2 + \psi_{1i}s + \psi_{2i}z + \psi_{3i}s^2 + \psi_{4i}z^2 + \psi_{5i}sY + \psi_{6i}zY + \psi_{7i}zs \tag{18}$$

[10] (20.1) and (20.2) simply sets the coefficient of the different distribution factors equal to one as shown in Appendix B.

$$\boldsymbol{q}_i = \boldsymbol{\pi_i}\mathbf{a} + \tau_{1i}Y + \tau_{2i}Y^2 + \lambda_i(\psi_{11}s + \psi_{21}z + \psi_{31}s^2 + \psi_{41}z^2 + \psi_{51}\mathrm{Ys} + \psi_{61}\mathrm{Yz} + \psi_{71}\mathrm{sz}) \tag{19}$$

$$\boldsymbol{q}_i = \boldsymbol{\pi_i}\mathbf{a} + \tau_{1i}Y + \tau_{2i}Y^2 + \lambda_i(s + \psi_{21}z) + \upsilon_i(s + \psi_{21}z)^2 + \omega_i Y(s + \psi_{21}z) \tag{20.1}$$

$$\boldsymbol{q}_i = \boldsymbol{\pi_i}\mathbf{a} + \tau_{1i}Y + \tau_{2i}Y^2 + \lambda_i(z + \psi_{11}s) + \upsilon_i(z + \psi_{11}s)^2 + \omega_i Y(z + \psi_{11}s) \tag{20.2}$$

$$\rho(\boldsymbol{a}, s, z, Y) = \iota[Y, D(z, s)] \tag{21}$$

$$\rho(\boldsymbol{a}, s, z, Y) = \varphi[Y, z + s] \tag{22}$$

The unitary model simply implies that $\psi_{ki} = \ldots = \psi_{Kn} = 0 \;\; \forall i = 1, \ldots, n \; and \; k = 1, \ldots, K$.

4. Data Description

The following section describes the subsample of the National Income Dynamic study of 2009, the choice of consumption items as well as the choice of preference and distribution factors before continuing to the empirical part of the paper.

The National Income Dynamic Study (NIDS) of 2009 is the first wave of a panel that documents a wide range of socio-economic factors of South African households (Leibbrandt *et al*, 2009: 4). The 7305 participating households were asked to give information on household and individual income and expenditure in the 30 days before questioning. The short nature of the time-period documented reduces the problem of recall bias, which is often prevalent in studies based on a longer period (Argent, 2009:4). This advantage does not come without a cost, however. Infrequency of purchases may cause lumpiness in expenditure data on durables and semi-durables as well as some forms of income data (Browning & Chiappori, 1998:1262; Browning *et al*, 1994:1082; Bourguignon *et al*, 1993:147). Infrequency of purchases is problematic as these categories may contain several zero expenditure observations without necessarily providing information on preferences (Bourguignon *et al*, 1993:147). Furthermore, these items are usually relatively expensive, so that if the household happened to consume the item in the month prior to the interview, the amount spent may seem disproportional relative to other goods. The problem of lumpiness is exacerbated by poverty in South Africa, as many households cannot afford certain categories of goods. As the collective model in the above section is not solved for corner solutions, the proportion of zero observations is the primary motivation for the exclusion of expenditure categories. All attempts are made to reduce the proportion of zero expenditure observations to below 33% per consumption category. The reduction was achieved by including items that are either substitutes or compliments to the other consumption goods in a certain category. Consumption items were excluded if more than 60% of the observations reported zero values. All consumption categories are private in nature so as to be consistent with the model of the above section.

The seven expenditure categories included are communication, clothing, entertainment, food, medical expenditure, personal care and tobacco and alcohol. The proportion of zero expenditure categories in food, communication and personal care items is unproblematic as these are non-durable consumption items. Food contains expenditure on all food items except alcohol while communication only includes cell-phone and telephone expenditure. As clothing is a semi-durable and somewhat expensive good, zero observations are quite common. This problem is solved by adding expenditure on cleaning agents to clothing expenditure, as the former is used to maintain the latter. Expenditure on clothing is thus the sum of shoe and clothing expenditure, account payments on shoes and clothing, expenditure on fabric for clothing along with expenditure on washing and cleaning agents. Total entertainment expenditure includes expenditure on reading materials, movies, music and television. It may be argued that this item is public, but in this case it is argued that the item is private in nature as entertainment preferences may differ among members. Medical expenditure is the sum of expenditure on medical aid, medical supplies, medical professionals and life insurance expenditure.

Socio-demographic factors such as the presence of a child, home-ownership status along with the age and education of the adult members are used as preference factors (Browning *et al*, 2011:228). The grant recipient status of the household is a dummy variable taking a value of one where the household receives grant income and zero otherwise. Home ownership status, on the other hand, takes on a value of one where the household's home is fully paid off and zero otherwise. South Africa's high unemployment rate necessitates the inclusion of additional preference factors, as the assumption of full employment, used in other studies, is both implausible and sample restrictive (Bourguignon *et al*, 1993:146). The sample thus includes households where no members, one member or two members are employed. The inclusion of these types of households necessarily blurs preference and distribution factors in the case where the latter is determined by income shares. This problem is exacerbated by the fact that the unitary model is by definition contained in the collective model and, as previously mentioned, the former is not completely silent on intra-household allocation of resources (Alderman *et al*, 1995:2-3). As the formal distinction between the unitary and collective models emanates from the difference between these factors, the additional preference factors are included so that any impact through the distribution factors must be inconsistent with the unitary model (Browning *et al*, 2006:9). The additional factors included are the hours worked by each of the spouses as well as the grant recipient status of the household. Hours worked consists of the sum of hours worked in primary, secondary, casual and self-employment. This variable controls for the costs of going to work that may be dependent on the wage rates of the spouses. Common examples include food expenditure that is necessary for the employed household member to remain productive or the clothing expenditure required for the employed member's work (Browning & Chiapporri, 1998:1255).

Assignable male and female income shares are used as distribution factors. Although the NIDS technically allows for all income to be assigned, income from capital flows are not assigned to any of the household members. The reasoning is mainly an observational one, as it is often the case that one spouse invests the partner's money. Although this already says something about the household's power structure, it does not give any indication of how this relationship is formed. The assignable income sources are the sum of labour market and grant income sources. Labour market income for each spouse is the monthly take-home pay from their main job, casual job, self-employment, profit from main business, bonus income and income from private or foreign pensions. Non-labour market income includes state old age pension grants, foster care grants, child support grants, care dependency grants and disability grants.

As the model of the above section pertains to households with two decision makers, the sample is restricted to include only households with two adult members. One advantage of NIDS above larger datasets, such as the Income and Expenditure Survey, is the availability of information on the relationship between household members. The sample is restricted to households where the adult members are spouses. Due to size constraints, this restriction necessitated the inclusion of households with one child under the age of 16. Finally, households who failed to report on any of the included consumption or income items due to refusal, ignorance or loss of information were excluded from the sample.

The table below gives the weight adjusted sample statistics of the households included in the subsample.

Table 1. Sample Statistics

	Median	Mean	Std. Dev.
Age			
Female	33	38.28	14.64
Male	37	42.25	14.51
Difference	-3	-3.97	6.44
Years of Education			
Female	11	9.77	3.96
Male	11	9.24	4.91
Difference	0	0.53	4.82
Weekly Hours of Work			
Female	0	12.11	20.47
Male	20	25.10	25.81
Difference	0	-12.98	30.04
Income			
Female	200.00	1808.60	5217.90
Male	1355.22	5333.99	11209.59
Share of Total Income			
Female	3.03%	17.80%	23.36%
Male	46.19%	44.38%	36.01%
Log of Total Income[11]	3800	4587.39	
Total Income	3800	11662.47	19341.69
Household	**Percentage**		
Owns Property	43.61%		
Receives Social Grants	31.31%		
has One Child	42.97%		

5. Econometric Methodology

The collective and unitary models are tested by way of non-linear seemingly unrelated regression. Thus, a non-linear version of Zellner's seemingly unrelated regression analysis is used to fit a system of demand equations through Stata's feasible non-linear generalised least squares estimator (StataCorp, 2011: 1363, 1365; Zellner, 1962; Zellner & Huang, 1962;

[11] The exponent the mean and median of the log of total income is reported.

Zellner, 1963). Similar to the linear form, the errors of the dependent variables in the systems are allowed to be correlated meaning that the coefficients of the independent variables are comparable across equations (StataCorp, 2011: 2114). Application of the proportionality restrictions is made possible by the non-linear nature of the estimation approach. The natural logarithm of all expenditure and income variables is used throughout.

Three separate systems of regressions are used following equations (18), (19) and (20) above, for the unrestricted and two restricted equations respectively. A likelihood ratio test is then used to test whether the restricted models are nested within the unrestricted models. Where the null hypothesis that the restricted model is nested within the unrestricted model cannot be rejected the same holds for the collective model. The econometric form of the unrestricted equation is shown (23) below;

$$\begin{aligned}\boldsymbol{q}_i = c_i &+ \pi_{1i}\text{Age}_f + \pi_{2i}\text{Age}_m + \pi_{3i}\text{Education}_f + \pi_{4i}\text{Education}_m + \pi_{5i}\text{Grant} \\ &+ \pi_{6i}\text{Home Ownership} + \pi_{7i}\text{Hours}_f + \pi_{8i}\text{Hours}_m + \tau_{1i}Y + \tau_{2i}Y^2 \\ &+ \psi_{1i}s + \psi_{2i}z + \psi_{3i}s^2 + \psi_{4i}z^2 + \psi_{5i}sY + \psi_{6i}zY + \psi_{8i}zs\end{aligned} \tag{23}$$

where c_i is a good specific constant, π_{hi} denotes preference factor, τ_{hi} denotes income variable and ψ_{hi} denotes distribution factor h of good i. The natural logarithm of income is represented by Y, while male and female income shares are denoted by s and z respectively. The restricted model that is consistent with a non-linear sharing rule, as shown in (19) and (21), takes the form of (24) below. The proportionality restriction is enforced through λ_i for each good, so that the distribution factors have the same coefficients across equations. λ_1 is set to unity to allow for identification of the coefficients on the restricted distribution factors. Identification in this form results in normalisation on the first good's coefficients in the restricted regressions and has no impact on the outcome of the likelihood ratio-test.

$$\begin{aligned}\boldsymbol{q}_i = c_i &+ \pi_{1i}\text{Age}_f + \pi_{2i}\text{Age}_m + \pi_{3i}\text{Education}_f + \pi_{4i}\text{Education}_m + \pi_{5i}\text{Grant} \\ &+ \pi_{6i}\text{Home Ownership} + \pi_{7i}\text{Hours}_f + \pi_{8i}\text{Hours}_m + \tau_{1i}Y + \tau_{2i}Y^2 \\ &+ \lambda_i(\psi_1 s + \psi_2 z + \psi_3 s^2 + \psi_4 z^2 + \psi_5 sY + \psi_6 zY + \psi_8 zs)\end{aligned} \tag{24}$$

The estimable form implied by a linear sharing rule is shown in (25). Identification in this case requires that the coefficients on either the male or female income share variables to be restricted to unity. Thus all equations have restrictions, although this implies that the sharing rule only identifies change in income share of the female normalised to male income share. In (26) male income share is normalised to female income share.

$$\boldsymbol{q}_i = c_i + \pi_{1i}\text{Age}_f + \pi_{2i}\text{Age}_m + \pi_{3i}\text{Education}_f + \pi_{4i}\text{Education}_m + \pi_{5i}\text{Grant} + \pi_{6i}\text{Home Ownership} + \pi_{7i}\text{Hours}_f + \pi_{8i}\text{Hours}_m + \tau_{1i}Y + \tau_{2i}Y^2 + \lambda_i(s + \psi_2 z) + \upsilon_i(s + \psi_2 z)^2 + \omega_i Y(s + \psi_2 z) \tag{25}$$

$$\boldsymbol{q}_i = c_i + \pi_{1i}\text{Age}_f + \pi_{2i}\text{Age}_m + \pi_{3i}\text{Education}_f + \pi_{4i}\text{Education}_m + \pi_{5i}\text{Grant} + \pi_{6i}\text{Home Ownership} + \pi_{7i}\text{Hours}_f + \pi_{8i}\text{Hours}_m + \tau_{1i}Y + \tau_{2i}Y^2 + \lambda_i(\psi_1 s + z) + \upsilon_i(\psi_1 s + z)^2 + \omega_i Y(\psi_1 s + z) \tag{26}$$

Testing the unitary hypothesis far simpler, as the only requirement is that $\psi_{ki} = \ldots = \psi_{Kn} = 0$. That is the coefficients on the distribution factors are equal to each other and equal to zero across all regressions.

6. Results

The following section briefly discusses the impact of preference factors and total income on household demands. As all coefficients are broadly consistent over all systems a variable is regarded as statistically significant if it is significant in any of the systems. The results of the test of the unitary and collective models are then given after which the implications for specific goods are discussed. The regression output the unrestricted equation (24) is shown in Appendix C1, while the output for the collective model implied by the non-linear sharing rule, (25), is shown in Appendix C2. Appendix C3 and C4 reports the regression output for the collective model implied by the linear sharing rule for normalized for the female and male shares respectively.

6.1. Preference Factors and Household Income

The relative sizes and signs of the coefficients on the preference factors are generally equivalent across the unrestricted and restricted regression equations as can be seen in Appendices C1 through C4. Female age is significantly positively correlated with entertainment expenditure at the 5% level, while a positive relationship of about the same size is observed for personal care expenditure at just above the 10% in the restricted equation. In the unrestricted equation male age is significantly negatively correlated with clothing and entertainment expenditure, while the unrestricted equation shows a large positive relationship between male age and medical expenditure at slightly above 10% level. The number of years of education of the female is significantly positively correlated with entertainment expenditure while being significantly negatively correlated with personal care expenditure. Male education, on the other hand, is significantly positively correlated with expenditure on communication, food, medication and personal care. The relatively large coefficient on medication expenditure, indicating that each additional year of male education is correlated with about a 12% increase in medical expenditure holding all else constant, is likely a result of the state of the inequality in the health industry.[12] Hours worked by the female household member is negatively correlated with food and medical expenditure, while hours worked by the male does not seem to be significantly correlated with any expenditure category. Holding all else constant, households with children spends around 20% more on food than childless households. The presence of children does not seem to affect preferences in a statistically significant way for any other expenditure categories. On aggregate households that receive some form of grant income spend around 80% less on alcohol and tobacco, 118% less on communication and 15% less on food than households that do not receive grant income. This result is likely, at least in part, due to the lower income that these households receive. Home ownership status is associated with lower expenditure on alcohol and tobacco and while being correlated with lower expenditure on personal care at slightly above the 10% level.

The coefficients on the total income variables show a jointly significant concave relationship between total income and clothing, communication, food and personal care expenditure. This result is to be expected for normal goods, as it implies that expenditure on these items increases at a decreasing rate as total income increases. The relationship is convex for alcohol, entertainment and medical expenditure. The coefficients on these items may be interpreted as indicating the luxury nature of these items. This interpretation is due to the fact that expenditure on these categories decreases initially, after increasing at an increasing rate as total household income increases.

6.2. Unitary and Collective rationality

In table 2, the unitary model is rejected through the rejection of distribution factor independence, which is a generalisation of the income pooling hypothesis (Bourguignon *et al*, 2009:509). This result implies that the distribution factors are jointly significant across all regressions. The table also reports the likelihood ratio tests. Neither the normalised-linear or non-linear specification of the collective model can be rejected at the 10% level. It should be

[12] See Ataguba and McIntyre (2012) for a discussion on the equitability of South Africa's health system.

noted that the existence of a non-linear sharing rule compatible with collective rationality cannot be rejected at any appropriate level of significance. Based on these results, the non-linear sharing rule seems like a more appropriate model to use to investigate the effect of distributional factors on household decision making.

Table 2. Unitary and Collective Model Test Results

Restriction	Non-Linear (24)	Linear F (25)	Linear M (26)	Unitary
Degrees of Freedom	36	27	27	49
Likelihood-Ratio χ^2	44.01	36.67	36.67	76.80
Probability	0.1688	0.1014	0.1014	0.0068

6.3. Household Demands and the Sharing Rule

The figures below give an intuitive representation on the impact of distribution factors on selected household commodities for the collective model implied by the non-linear sharing rule in (24).[13] All of the figures have expenditure in Rand on the y-axis while the x-axis denotes the income share of the respective household members. These results are not part of the main thesis and are merely an application of the results.

In figures 1 and 2, below, the impact of distribution factors on alcohol and tobacco expenditure is shown for mean male and female income shares respectively at the 25th, 50th and 75th income percentiles. In both of the figures expenditure increases with income, indicated by a movement of the darker curve to the lighter dashed curves. The details of both figures are given in table 3. The slope is calculated as the average rate of change, defined as $\frac{1}{m}\sum_{n=1}^{m}\frac{q_{i,n+1}-q_{i,n}}{d_{k,n+1}-d_{k,n}}$ where $q_{i,n}$ denotes expenditure item i at value n of distribution factor k, for a specified section of the figure.[14] In figure 1, the turning point, after which increases in female income share starts to be associated with lower expenditure, occurs at lower income shares as the household moves up the income distribution. This result is also seen in figure 2, for male income share, although the difference is much less pronounced. The difference in turning points of female and male income shares is most pronounced for higher income households.

Before the turning point, the average slope of female income share decreases as the household moves up the income distribution. The opposite is seen in figure 2 for changes in male income share, however. After the turning point, the average rate of change decreases for

[13] See Appendix C2 for the regression output on which these figures are based.
[14] All other values are set to their respective mean levels.

both male and female income share as the household moves from the 25th to 75th percentile of the income distribution. It is also clear that at all three levels of the income distribution considered, the average rate of change in alcohol and tobacco expenditure for changes in female income share is larger in absolute terms than it is for changes in male income share. Taken together, these results may be interpreted to indicate that males have a weakly stronger preference for expenditure on alcohol and tobacco than females.[15] This result holds amongst all household, but is specifically pronounced in households higher in the income distribution.

Figure 1. Female Income Share and Alcohol and Tobacco Expenditure[16]

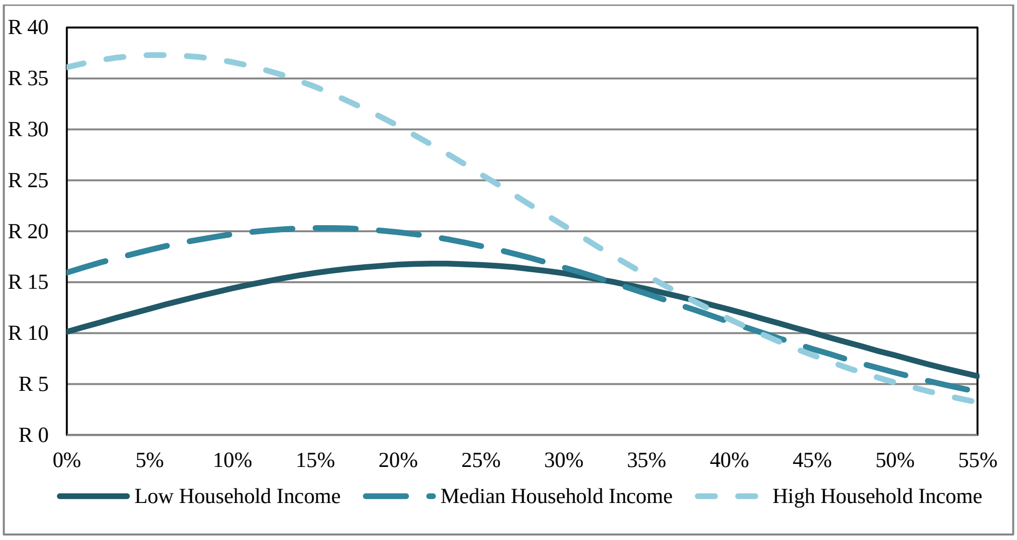
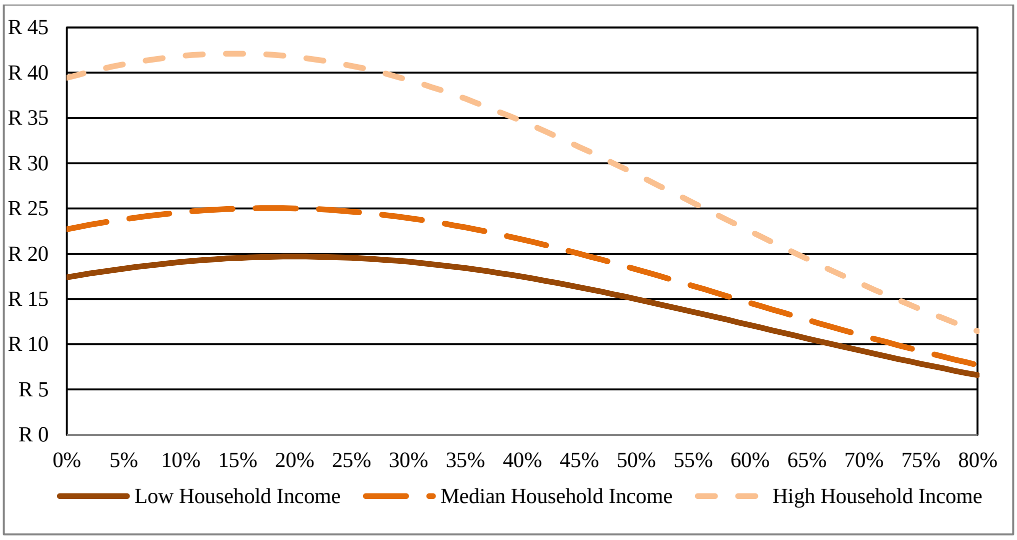


Figure 2. Male Income Share and Alcohol and Tobacco Expenditure[17]



[15] This paper does not derive Engel curves, although it is theoretically possible as shown in Bourguignon *et al* (2009:522-523). Also note, that there is no *a priori* reason to assume that the distribution factors should have opposite effects consumption on certain items. It is entirely imaginable that changes in income shares have similar effects in term of direction, but that these effects are of different sizes.

[16] Male Income share is set to its mean level in this figure.

[17] Female Income share is set to its mean level in this figure.

Table 3. Figure 1 and 2 Details

	Intercept	Turning Point	Avg. Slope Before Turning Point	Avg. Slope After Tuning Point
Female Income Share at 25% of Inc. Dist.	10.59	0.22	30.35	-33.47
Female Income Share at 50% of Inc. Dist.	16.43	0.16	27.35	-41.27
Female Income Share at 75% of Inc. Dist.	36.49	0.06	19.82	-69.57
Male Income Share at 25% of Inc. Dist.	17.41	0.20	11.46	-21.84
Male Income Share at 50% of Inc. Dist.	22.72	0.18	12.95	-27.97
Male Income Share at 75% of Inc. Dist.	39.44	0.15	17.87	-47.18

In Figure 3, the turquoise shaded lines show changes in alcohol and tobacco expenditure for changes in female income shares, hereafter z, for given levels of male income share, hereafter s, at median total household income. The orange lines show the impact of z for given values of s at median total household income. As the intercept for each of the lines are at 0% of the relevant spouse's income share, a movement of any of the lines indicate changes in expenditure for changes in the other spouse's income share. The change in the intercept where the line *Fl* moves to *Fm*, for example, shows the small increase in alcohol and tobacco expenditure as male income share increases from 25% to 50% in the case where female household member has no share in assignable income. Where the income share of the other spouse is fixed to 25%, male income share is associated with higher levels of alcohol and tobacco expenditure than female income share. This trend is reversed at higher levels of income share allocation. While the absolute result is interesting, the slope of the lines indicates the proportional impact of changes in each member's distribution factor on alcohol and tobacco expenditure. At any level of the other spouse's income share, change in alcohol expenditure for changes in income share is steeper for the female household member than for the male, after the turning point. This result is seen when comparing *Ml, Mm* and *Mh* to *Fl, Fm* and *Fh* respectively. Where these results are taken together, it may be argued that changes in the sharing rule due to changes in the distribution factors indicate that male spouses have a greater preference for alcohol and tobacco than female spouses.

Figures 4 and 5 below give the same information as figures 1 and 2 above, but for household medical expenditure. In both of the figures, only household's at the top end of the income distribution are greatly affected by distribution factors. Holding all else constant, these households also consume around four to five times more than households at the 50^{th} and 25^{th} percentile of the income distribution. Although the figures show that medical expenditure increases with increasing income shares, comparing figures 4 and 5 shows that this increase is larger for increases in female than for male income share at mean income shares.

Figure 3. Relative Impact of Male and Female Income Shares on Alcohol and Tobacco Expenditure at Median Total Income

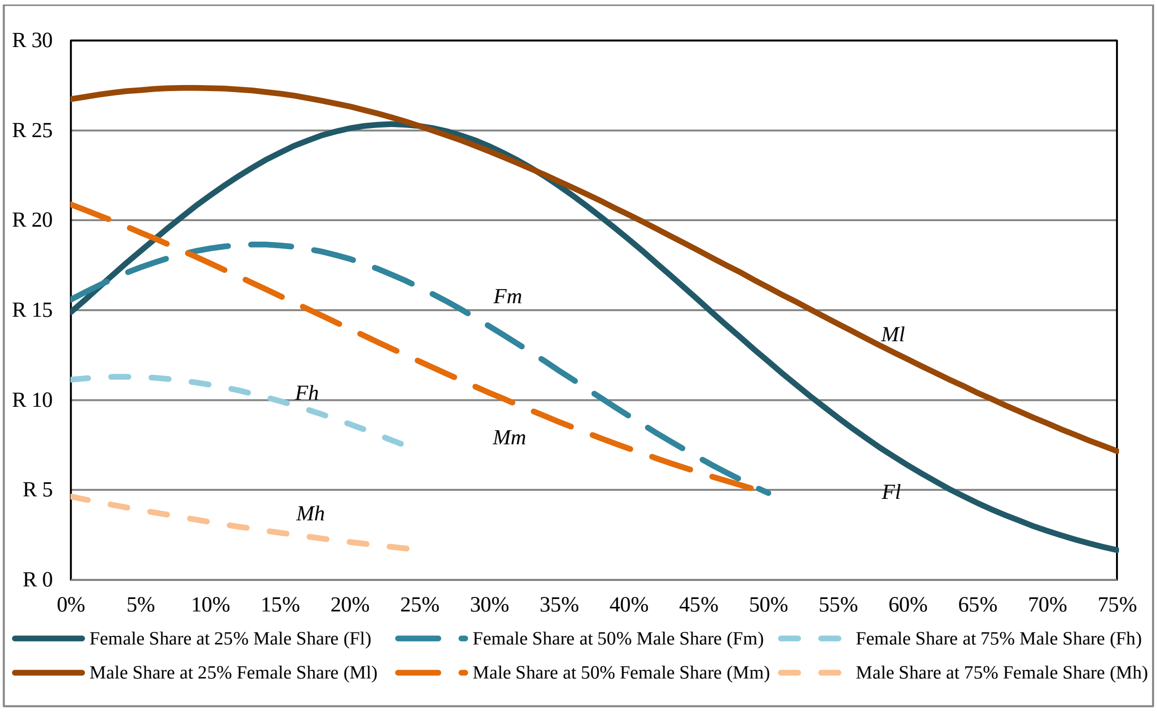
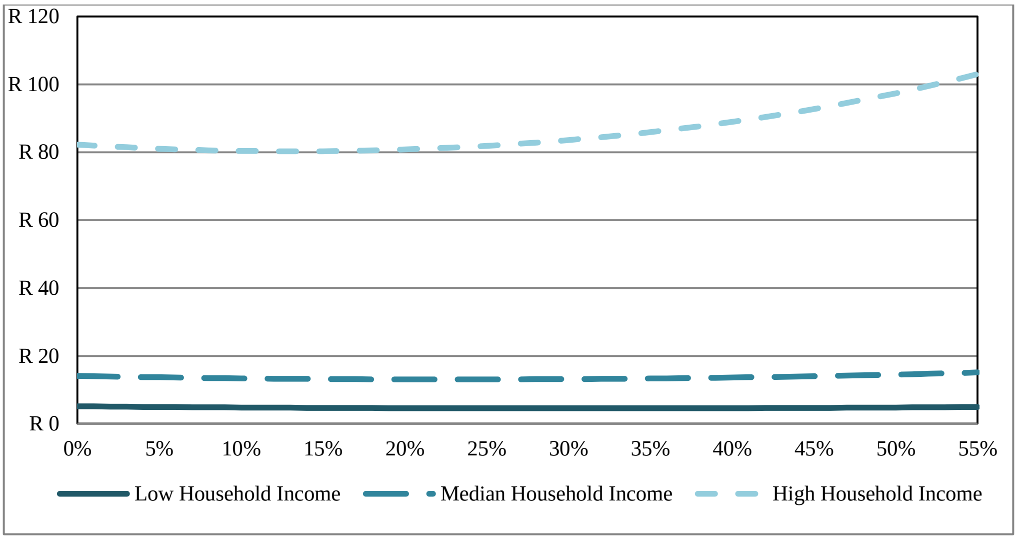


Figure 4. Female Distribution Factors and Medical Expenditure[18]



[18] Male Income share is set to its mean level in this figure.

Figure 5. Male Distribution Factors and Medical Expenditure[19]

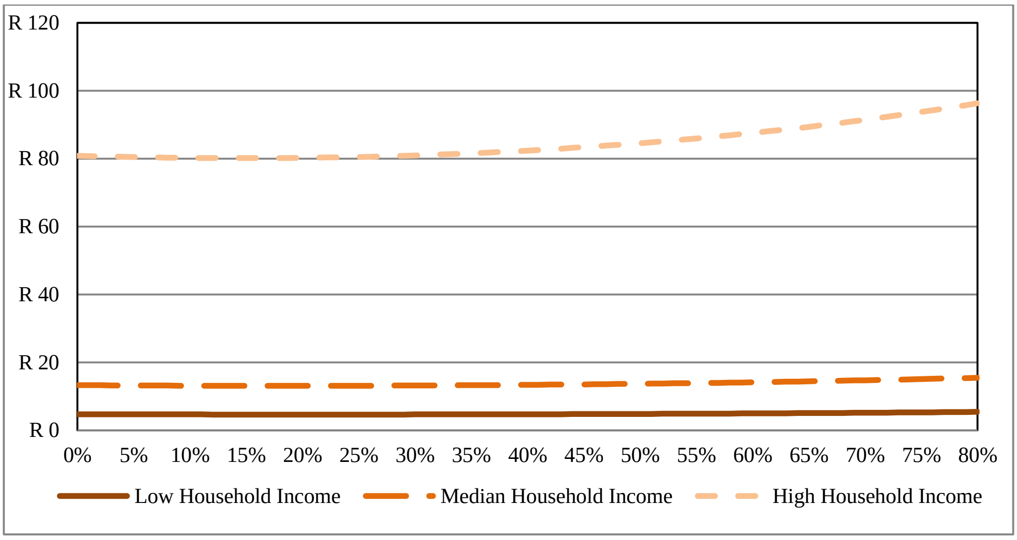


Table 4. Figure 4 and 5 Details

	Intercept	Turning Point	Avg. Slope Before Turning Point	Avg. Slope After Tuning Point
Female Income Share at 25% of Inc. Dist.	5.15	0.30	-2.05	1.71
Female Income Share at 50% of Inc. Dist.	14.09	0.23	-4.43	6.41
Female Income Share at 75% of Inc. Dist.	82.26	0.13	-15.33	54.09
Male Income Share at 25% of Inc. Dist.	4.71	0.20	-0.41	1.29
Male Income Share at 50% of Inc. Dist.	13.27	0.18	-1.01	3.82
Male Income Share at 75% of Inc. Dist.	80.89	0.15	-4.98	24.88

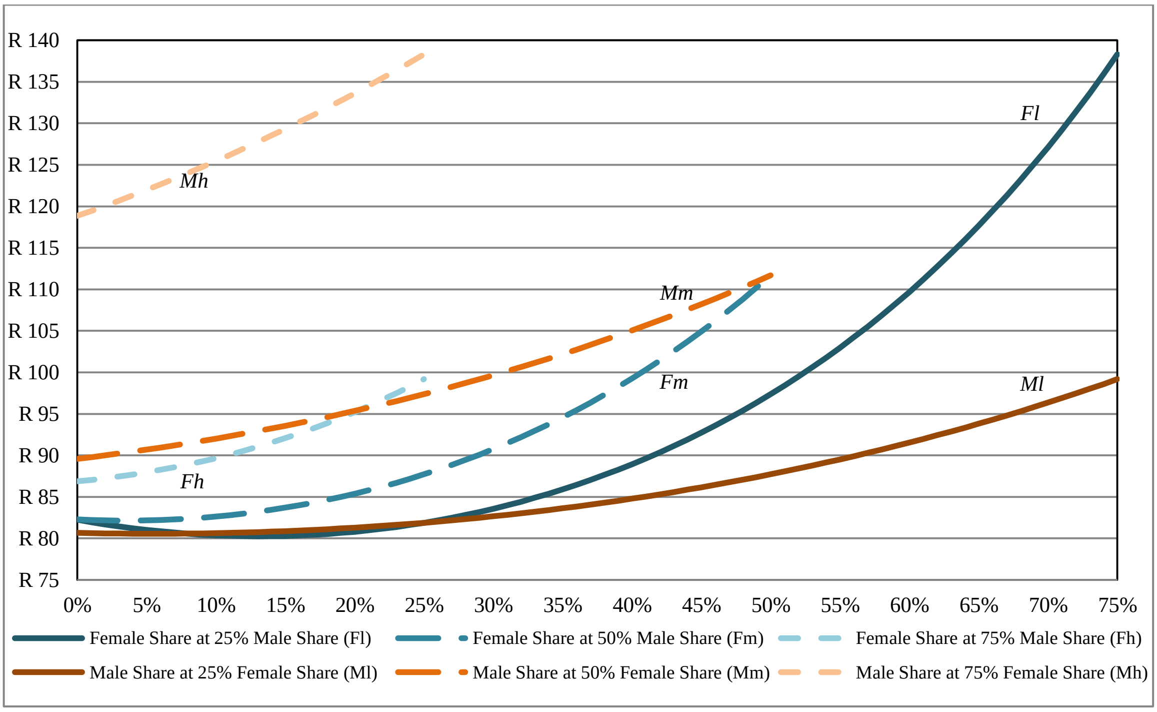
Table 4, above, is interpreted in the same way as table 3. It is clear that the intercept is higher for female income share than for male income share at all three levels of the income distribution included. While the turning point, after which an increase in the relevant spouse's income share is associated with an increase in medical expenditure, is higher for female income share than male income share at the 25th and 50th percentile, this is not the case at the 75th percentile of the income distribution. The lines indicating Female income share's association with medical expenditure is between three and four times steeper than those for male income share.

Figure 6 is interpreted in the same way as figure 3. The starting values of each line, thus indicates the impact of the spouse whose income is held constant on expenditure where other spouse's income share is zero. The figure again follows the trend of figures 4 and 5, and

[19] Female Income share is set to its mean level in this figure.

indicates that higher female income share is correlated with higher medical expenditure as *Ml* moves to *Mh*. While *Fl* and *Fm* are steeper than *Ml* and *Mm*, respectively this is not the case for households where one of the spouses has a high income share. This is interesting, as it indicates that a change in male income share in households where the female earns 75% of the assignable income has a larger positive impact on medical expenditure than the case where the male earns 75% and female income share increases. Taken together, these results may be interpreted as indicating that female spouses prefer medical expenditure more than male spouses.

Figure 6. Relative Impact of Male and Female Income Shares on Medical Expenditure at the 75% Percentile of the Total Income Distribution



7. Conclusion

This paper showed, for the first time, that the unitary model of household behaviour can be rejected for two adult person households in South Africa, independent of the presence of a child. Collective rationality could not be rejected for these households, however. While the paper did not identify the sharing rule, the estimates of the collective model are used to discuss the impact of changes in distribution factors on goods. The paper has implications for specifically poverty, inequality and labour supply analysis in so far as it implies that South African households cannot be treated as though the distribution of income and power within the household are irrelevant. Where panel data sets such as NIDS are updated annually and made to include price data, structural models of household behaviour may be derived to identify the sharing rule and give more accurate accounts of intra-household consumption and labour supply decisions. These advances would also allow for the entire spectrum of household models to be tested in a way similar to that proposed by Cherchye *et al* (2009; 2010). Where datasets are updated in this way, the results of this paper may form a useful starting point into a better understanding of intra-household decision making in South Africa.

9. Bibliography

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Appendix A[20]

Where the functional form is:

$$\boldsymbol{q_i} = \boldsymbol{\pi_i}\mathbf{a} + \tau_{1i}Y + \tau_{2i}Y^2 + \psi_{1i}s + \psi_{2i}z + \psi_{3i}s^2 + \psi_{4i}z^2 + \psi_{5i}sY + \psi_{6i}zY + \psi_{7i}zs \quad (18)$$

Then:

$$\frac{\boldsymbol{q}_{i,z}}{\boldsymbol{q}_{i,s}} = \frac{\rho_z(\boldsymbol{a},\boldsymbol{d},Y)}{\rho_s(\boldsymbol{a},\boldsymbol{d},Y)} = \frac{\psi_{2i} + 2\psi_{4i}z + \psi_{6i}Y + \psi_{8i}s}{\psi_{1i} + 2\psi_{3i}s + \psi_{5i}Y + \psi_{8i}z}$$

Thus:

$$\frac{\psi_{2i} + 2\psi_{4i}z + \psi_{6i}Y + \psi_{7i}s}{\psi_{1i} + 2\psi_{3i}s + \psi_{5i}Y + \psi_{7i}z} = \frac{\psi_{21} + 2\psi_{41}z + \psi_{61}Y + \psi_{71}s}{\psi_{11} + 2\psi_{31}s + \psi_{51}Y + \psi_{71}z}$$

So that:

$$(A1)\psi_{11}\psi_{2i} = \psi_{21}\psi_{1i}$$

$$(A2)Y: \psi_{51}\psi_{2i} + \psi_{11}\psi_{6i} = \psi_{61}\psi_{1i} + \psi_{21}\psi_{5i}$$

$$(A3)Y^2: \psi_{51}\psi_{6i} = \psi_{61}\psi_{5i}$$

$$(A4)z: \psi_{71}\psi_{2i} + 2\psi_{11}\psi_{4i} = 2\psi_{41}\psi_{1i} + \psi_{21}\psi_{7i}$$

$$(A5)z^2: \psi_{71}\psi_{4i} = \psi_{41}\psi_{7i}$$

$$(A6)s: 2\psi_{31}\psi_{2i} + \psi_{11}\psi_{7i} = \psi_{71}\psi_{1i} + 2\psi_{21}\psi_{3i}$$

$$(A7)s^2: \psi_{31}\psi_{7i} = \psi_{71}\psi_{3i}$$

$$(A8)\text{sz}: 4\psi_{31}\psi_{4i} + \psi_{71}\psi_{7i} = 4\psi_{41}\psi_{3i} + \psi_{71}\psi_{7i}$$

$$(A9)\text{zY}: 2\psi_{51}\psi_{4i} + \psi_{71}\psi_{6i} = 2\psi_{41}\psi_{5i} + \psi_{61}\psi_{7i}$$

$$(A10)\text{sY}: 2\psi_{31}\psi_{6i} + \psi_{51}\psi_{7i} = 2\psi_{61}\psi_{3i} + \psi_{71}\psi_{5i}$$

Using: (A1), (A3), (A5) and (A7) let:

[20] Appendix A and B is based on the Appendix in Bourguignon *et al* (1993:153-155). It differs from their results in that a more general functional form is used and that the later methodology of Bourguignon *et al* (2009) is applied to complete the proof.

$$\psi_{1i}/\psi_{11} = \psi_{2i}/\psi_{21} = \lambda_i$$

$$\psi_{5i}/\psi_{51} = \psi_{6i}/\psi_{61} = \omega_i$$

$$\psi_{7i}/\psi_{71} = \psi_{4i}/\psi_{41} = \psi_{3i}/\psi_{31} = \upsilon_i$$

Then:

$$\text{(A2)}\ (\psi_{11}\psi_{61} - \psi_{21}\psi_{51})(\omega_i - \lambda_i) = 0$$

$$(A4)(\psi_{71}\psi_{21} - 2\psi_{41}\psi_{11})(\lambda_i - \upsilon_i) = 0$$

$$(A6)(\psi_{11}\psi_{71} - 2\psi_{21}\psi_{31})(\lambda_i - \upsilon_i) = 0$$

$$(A8)4\psi_{31}\psi_{41}(0) = 0$$

$$(A9)(2\psi_{51}\psi_{41} - \psi_{61}\psi_{71})(\upsilon_i - \omega_i) = 0$$

$$(A10)(\psi_{71}\psi_{51} - 2\psi_{31}\psi_{61})(\upsilon_i - \omega_i) = 0$$

The solution to (A2) is either that:

$$\omega_i = \lambda_i$$

or

$$\psi_{11}\psi_{61} = \psi_{21}\psi_{51}$$

Similarly for (A4):

$$\upsilon_i = \lambda_i$$

or:

$$\psi_{71}\psi_{21} = 2\psi_{41}\psi_{11}$$

Similarly for (A6):

$$\upsilon_i = \lambda_i$$

$$\psi_{11}\psi_{71} = 2\psi_{21}\psi_{31}$$

(A9):

$$\upsilon_i = \omega_i$$

$$2\psi_{51}\psi_{41} = \psi_{61}\psi_{71}$$

and (A10):

$$\psi_{71}\psi_{51} = 2\psi_{31}\psi_{61}$$

If the first solution of all of the above conditions are used then:

$$\upsilon_i = \omega_i = \lambda_i$$

$$\psi_{1i}/\psi_{11} = \frac{\psi_{2i}}{\psi_{21}} = \psi_{5i}/\psi_{51} = \psi_{6i}/\psi_{61} = \psi_{7i}/\psi_{71} = \frac{\psi_{4i}}{\psi_{41}} = \psi_{3i}/\psi_{31} = \upsilon_i = \omega_i = \lambda_i$$

Then

$$\boldsymbol{q}_i = \boldsymbol{\pi_i}\mathbf{a} + \tau_{1i}x + \tau_{2i}x^2 + \frac{\psi_{11}}{\psi_{11}}\psi_{1i}s + \frac{\psi_{21}}{\psi_{21}}\psi_{2i}z + \frac{\psi_{31}}{\psi_{31}}\psi_{3i}s^2 + \frac{\psi_{41}}{\psi_{41}}\psi_{4i}z^2 + \frac{\psi_{51}}{\psi_{51}}\psi_{5i}\mathrm{Ys} + \frac{\psi_{61}}{\psi_{61}}\psi_{6i}\mathrm{Yz} + \frac{\psi_{71}}{\psi_{71}}\psi_{7i}\mathrm{sz}$$

So that:

$$\boldsymbol{q}_i = \boldsymbol{\pi_i}\mathbf{a} + \tau_{1i}Y + \tau_{2i}Y^2 + \lambda_i(\psi_{11}s + \psi_{21}z + \psi_{31}s^2 + \psi_{41}z^2 + \psi_{51}\mathrm{Ys} + \psi_{61}\mathrm{Yz} + \psi_{71}\mathrm{sz}) \qquad (19)$$

Appendix B

Solution 2 in the Scenario of Appendix A is given where:

$$\upsilon_i \neq \omega_i \neq \lambda_i$$

Then

$$\psi_{71}\psi_{21} = 2\psi_{41}\psi_{11}$$

$$\psi_{11}\psi_{71} = 2\psi_{21}\psi_{31}$$

$$2\psi_{51}\psi_{41} = \psi_{61}\psi_{71}$$

$$\psi_{71}\psi_{51} = 2\psi_{31}\psi_{61}$$

If the quadratic form is:

$$\boldsymbol{q}_i = \boldsymbol{\pi_i}\mathbf{a} + \tau_{1i}Y + \tau_{2i}Y^2 + \psi_{1i}s + \psi_{2i}z + \psi_{3i}s^2 + \psi_{4i}z^2 + \psi_{5i}\mathrm{Ys} + \psi_{6i}\mathrm{Yz} + \psi_{7i}\mathrm{sz}$$

Then:

$$\boldsymbol{q}_i = \boldsymbol{\pi_i}\mathbf{a} + \tau_{1i}Y + \tau_{2i}\mathrm{Y} + \frac{\psi_{1i}}{\psi_{11}}\left(\psi_{11}s + \frac{\psi_{2i}}{\psi_{1i}}\psi_{11}z\right) + \frac{\psi_{3i}}{\psi_{31}}\left(s^2 + \frac{\psi_{4i}}{\psi_{3i}}\psi_{31}z^2 + \frac{\psi_{7i}}{\psi_{3i}}\psi_{31}\mathrm{sz}\right) + \frac{\psi_{5i}}{\psi_{51}}Y\left(\psi_{51}s + \frac{\psi_{6i}}{\psi_{5i}}\psi_{51}z\right)$$

$$\boldsymbol{q}_i = \boldsymbol{\pi_i}\mathbf{a} + \tau_{1i}Y + \tau_{2i}Y^2 + \lambda_i\left(\psi_{11}s + \frac{\psi_{2i}}{\psi_{1i}}\psi_{11}z\right) + \upsilon_i\left(s^2 + \frac{\psi_{4i}}{\psi_{3i}}\psi_{31}z^2 + \frac{\psi_{7i}}{\psi_{3i}}\psi_{31}\mathrm{sz}\right) + \omega_i Y\left(\psi_{51}s + \frac{\psi_{6i}}{\psi_{5i}}\psi_{51}z\right)$$

Recall:

$$\frac{\psi_{2i}}{\psi_{1i}} = \frac{\psi_{21}}{\psi_{11}}$$

$$\psi_{7i}/\psi_{3i} = \psi_{71}/\psi_{31}$$

$$\psi_{4i}/\psi_{3i} = \psi_{41}/\psi_{31}$$

$$\psi_{6i}/\psi_{5i} = \psi_{61}/\psi_{51}$$

Thus:

$$\boldsymbol{q}_i = \boldsymbol{\pi_i}\mathbf{a} + \tau_{1i}Y + \tau_{2i}Y^2 + \lambda_i(\psi_{11}s + \psi_{21}z) + \upsilon_i(s^2 + \psi_{41}z^2 + \psi_{71}\mathrm{sz}) + \omega_i Y(\psi_{51}s + \psi_{61}z)$$

Setting $\psi_{11} = \psi_{31} = \psi_{51} = 1$ implies $\psi_{71} = 2\psi_{21}$ and $\psi_{21} = \psi_{61} = \psi_{41}$, thus:

$$\boldsymbol{q}_i = \boldsymbol{\pi_i}\mathbf{a} + \tau_{1i}Y + \tau_{2i}Y^2 + \lambda_i(s + \psi_{21}z) + \upsilon_i(s + \psi_{21}z)^2 + \omega_i Y(s + \psi_{21}z) \quad (20.1)$$

Similarly setting $\psi_{21} = \psi_{41} = \psi_{61} = 1$ results in

$$\boldsymbol{q}_i = \boldsymbol{\pi_i}\mathbf{a} + \tau_{1i}Y + \tau_{2i}Y^2 + \lambda_i(z + \psi_{11}s) + \upsilon_i(z + \psi_{11}s)^2 + \omega_i Y(z + \psi_{11}s) \quad (20.2)$$

Appendix C1. Unrestricted Equation Regression Output (23)

	Communication	**Clothing**	**Entertainment**	**Food**	**Medical**	**Personal Care**	**Alcohol and Tobacco**
Constant	-4.9904	-5.3878	1.6742	1.3656	-1.9951	-5.5046	1.7224
	(3.957)	(3.967)	(3.440)	(1.249)	(4.343)	(3.797)	(5.741)
Presence of Child	-0.2553	0.2860	0.0667	0.1997**	-0.1120	0.3230	0.1265
	(0.306)	(0.291)	(0.341)	(0.095)	(0.444)	(0.289)	(0.400)
Age of Female	0.0146	0.0106	0.0330	-0.0030	-0.0169	0.0265	-0.0100
	(0.018)	(0.014)	(0.021)	(0.006)	(0.026)	(0.020)	(0.026)
Age of Male	-0.0106	**-0.0280***	**-0.0359***	0.0021	0.0398	-0.0135	0.0204
	(0.020)	(0.017)	(0.019)	(0.006)	(0.025)	(0.020)	(0.025)
Education of Female	0.0219	0.0186	0.0989***	0.0019	-0.0305	-0.0602*	-0.0608
	(0.041)	(0.029)	(0.038)	(0.009)	(0.043)	(0.032)	(0.046)
Education of Male	**0.0616***	0.0356	-0.0040	**0.0303*****	**0.1172*****	**0.0787****	0.0122
	(0.034)	(0.033)	(0.045)	(0.011)	(0.042)	(0.031)	(0.044)
Grant Recipient	**-1.1872****	-0.4207	-0.1032	**-0.1509***	-0.4892	-0.1763	**-0.8172****
	(0.463)	(0.418)	(0.387)	(0.087)	(0.369)	(0.389)	(0.386)
Owns Home	-0.4298	-0.0661	0.1032	-0.0478	-0.4115	-0.4935	**-0.9591****
	(0.343)	(0.345)	(0.318)	(0.090)	(0.388)	(0.328)	(0.398)
Hours Worked Female	0.0001	0.0001	0.0000	**-0.0069*****	-0.0097	0.0071	0.0036
	(0.008)	(0.008)	(0.008)	(0.002)	(0.009)	(0.008)	(0.011)
Hours Worked Male	0.0006	0.0064	0.0014	0.0002	-0.0097	0.0015	0.0065
	(0.006)	(0.006)	(0.006)	(0.002)	(0.008)	(0.007)	(0.009)
Household Income (Y)	1.1198	**1.8363****	-1.0026	**0.7990*****	-0.3893	1.0675	-0.4255
	(0.913)	(0.933)	(0.862)	(0.292)	(1.049)	(0.985)	(1.348)
Household Income Squared	-0.0191	-0.0786	**0.1089****	-0.0198	**0.1057***	-0.0112	0.0696
	(0.052)	(0.054)	(0.049)	(0.017)	(0.058)	(0.063)	(0.076)
Male Income share	-0.7011	0.4987	-2.5044	0.0511	-2.7204	2.5676	3.8881
	(2.795)	(2.460)	(2.526)	(0.997)	(3.732)	(2.795)	(4.785)
Female Income Share	**9.6098****	1.8390	-4.8066	1.2625	-6.8284	2.6512	**19.0857*****
	(4.614)	(4.007)	(3.591)	(1.048)	(4.441)	(4.463)	(6.153)
Male Income Share Sqared	-1.2782	-1.8996	-0.9403	-0.0540	-0.9681	-1.7871	-3.5604
	(1.776)	(1.561)	(2.069)	(0.620)	(2.252)	(1.803)	(2.556)
Female Income Share Squared	**-6.1075****	-1.8090	1.2112	-0.1661	7.2397*	1.0789	**-8.1477****
	(3.065)	(2.865)	(2.724)	(0.799)	(3.797)	(3.119)	(3.613)
Y * Male income Share	0.3015	0.1178	0.4324	-0.0135	0.3837	-0.1388	-0.1606
	(0.325)	(0.308)	(0.307)	(0.095)	(0.360)	(0.334)	(0.484)
Y * Female Income Share	-0.5794	-0.0390	0.5350	-0.1603	0.0854	-0.3906	**-1.7509*****
	(0.467)	(0.380)	(0.407)	(0.108)	(0.454)	(0.392)	(0.646)
Male * Female Income Share	-5.7320	-4.0755	-1.4652	0.4837	3.1328	-2.7217	-6.4116
	(3.749)	(3.316)	(3.769)	(1.019)	(5.092)	(3.487)	(4.459)
R2	0.4526	0.2774	0.4920	0.6357	0.5807	0.3586	0.1926
RMSE	1.903	1.735	1.869	0.538	2.257	1.879	2.366
N	458	458	458	458	458	458	458
% of Zero Obs	27.70%	12.77%	57.90%	0%	53.12%	32.37%	49.23%

Appendix C2. Unrestricted Equation Regression Output (24)

	Communication	**Clothing**	**Entertainment**	**Food**	**Medical**	**Personal Care**	**Alcohol and Tobacco**
Constant	-5.4823 (3.567)	-4.8918 (3.840)	1.6783 (3.113)	1.4387 (1.124)	-0.1087 (4.074)	-3.3329 (3.910)	2.0678 (5.681)
Presence of Child	-0.2036 (0.304)	0.3138 (0.306)	0.1119 (0.342)	**0.1952**** (0.098)	-0.0955 (0.453)	0.3257 (0.293)	0.1126 (0.399)
Age of Female	0.0105 (0.018)	0.0150 (0.013)	**0.0356*** (0.020)	-0.0027 (0.006)	-0.0074 (0.027)	0.0323 (0.021)	-0.0061 (0.026)
Age of Male	-0.0087 (0.020)	**-0.0313*** (0.017)	**-0.0382**** (0.019)	0.0021 (0.006)	0.0366 (0.026)	-0.0142 (0.020)	0.0185 (0.025)
Education of Female	0.0159 (0.040)	0.0198 (0.026)	**0.0985***** (0.036)	0.0032 (0.009)	-0.0134 (0.041)	**-0.0526*** (0.031)	-0.0554 (0.045)
Education of Male	**0.0657**** (0.033)	0.0364 (0.033)	-0.0003 (0.044)	**0.0302***** (0.011)	**0.1264***** (0.042)	**0.0814***** (0.030)	0.0129 (0.044)
Grant Recipient	**-1.1621***** (0.448)	-0.4944 (0.436)	-0.1559 (0.358)	-0.1379 (0.088)	**-0.6526*** (0.343)	-0.2439 (0.361)	**-0.8651**** (0.370)
Owns Home	-0.2722 (0.387)	-0.0159 (0.383)	0.2424 (0.366)	-0.0638 (0.092)	-0.4250 (0.380)	-0.5487 (0.344)	**-0.9945**** (0.395)
Hours Worked Female	-0.0012 (0.007)	0.0003 (0.006)	-0.0010 (0.006)	**-0.0065***** (0.002)	**-0.0159*** (0.009)	0.0063 (0.007)	0.0027 (0.010)
Hours Worked Male	0.0052 (0.006)	0.0040 (0.006)	0.0025 (0.006)	0.0001 (0.002)	-0.0099 (0.007)	0.0001 (0.007)	0.0051 (0.009)
Household Income (Y)	1.1419 (0.850)	1.6010* (0.921)	-1.1980 (0.785)	**0.7844***** (0.264)	-1.0493 (0.996)	0.5791 (0.956)	-0.5543 (1.339)
Household Income Squared	-0.0101 (0.050)	-0.0590 (0.053)	**0.1322***** (0.046)	-0.0199 (0.015)	**0.1463**** (0.057)	0.0111 (0.058)	0.0761 (0.076)
λ_i		0.5564 (0.401)	-0.4047 (0.565)	0.1345 (0.133)	-0.3704 (0.665)	0.5560 (0.460)	**2.6248*** (1.517)
Male Income Share	1.4763 (1.369)						
Female Income Share	**7.9256*** (4.168)						
Male Income Share Sqared	-1.1631 (0.844)						
Female Income Share Squared	**-3.8388*** (2.330)						
Y * Male income Share	-0.0649 (0.126)						
Y * Female Income Share	**-0.6579*** (0.340)						
Male * Female Income Share	-2.9531 (2.021)						
R2	0.4434	0.2714	0.4865	0.6334	0.5704	0.3503	0.1902
RMSE	1.919	1.742	1.879	0.539	2.285	1.891	2.370
RMSE Difference	0.016	0.007	0.010	0.002	0.028	0.012	0.004
N	458	458	458	458	458	458	458
% of Zero Obs	27.70%	12.77%	57.90%	0%	53.12%	32.37%	49.23%

Appendix C3. Unrestricted Equation Regression Output (25)

	Communication	**Clothing**	**Entertainment**	**Food**	**Medical**	**Personal Care**	**Alcohol and Tobacco**
Constant	-4.1887 (4.129)	-4.5470 (4.091)	1.9314 (3.551)	1.2402 (1.273)	-2.5687 (4.461)	-4.9137 (3.960)	2.5785 (5.965)
Presence of Child	-0.1703 (0.311)	0.3383 (0.313)	0.1043 (0.338)	**0.1979**** (0.097)	-0.1172 (0.439)	0.3335 (0.288)	0.1980 (0.404)
Age of Female	0.0173 (0.018)	0.0151 (0.014)	**0.0349*** (0.020)	-0.0028 (0.006)	-0.0152 (0.026)	0.0303 (0.021)	-0.0018 (0.026)
Age of Male	-0.0123 (0.020)	**-0.0303*** (0.017)	**-0.0367*** (0.019)	0.0019 (0.006)	0.0392 (0.025)	-0.0148 (0.020)	0.0156 (0.026)
Education of Female	0.0254 (0.041)	0.0203 (0.029)	**0.1007***** (0.038)	0.0022 (0.009)	-0.0291 (0.044)	**-0.0607*** (0.033)	-0.0570 (0.047)
Education of Male	**0.0670**** (0.032)	0.0356 (0.032)	0.0011 (0.043)	**0.0297***** (0.011)	**0.1224***** (0.041)	**0.0783***** (0.029)	0.0082 (0.044)
Grant Recipient	**-1.2286**** (0.483)	-0.3815 (0.442)	-0.1556 (0.379)	-0.1281 (0.083)	-0.5231 (0.355)	-0.1642 (0.383)	**-0.6351*** (0.369)
Owns Home	-0.2781 (0.340)	0.0630 (0.336)	0.2123 (0.330)	-0.0428 (0.082)	-0.3046 (0.375)	-0.4139 (0.314)	**-0.7400*** (0.380)
Hours Worked Female	-0.0022 (0.007)	0.0019 (0.007)	-0.0031 (0.007)	**-0.0061***** (0.002)	-0.0131 (0.009)	0.0079 (0.009)	0.0113 (0.010)
Hours Worked Male	-0.0005 (0.006)	0.0035 (0.005)	0.0033 (0.005)	0.0000 (0.002)	-0.0042 (0.008)	0.0009 (0.007)	-0.0001 (0.009)
Household Income (Y)	0.7251 (0.974)	1.5420 (0.975)	-1.2083 (0.898)	**0.8201***** (0.300)	-0.4039 (1.094)	0.9164 (0.984)	-0.7899 (1.413)
Household Income Squared	0.0143 (0.054)	-0.0572 (0.054)	**0.1287***** (0.050)	-0.0208 (0.017)	**0.1146*** (0.061)	-0.0020 (0.060)	0.0967 (0.080)
λ_i	**2.0113*** (1.219)	0.0775 (0.763)	-0.8960 (0.757)	0.1846 (0.254)	-1.2392 (0.979)	0.5058 (0.935)	**3.1524*** (1.870)
υ_i	-0.2364 (0.237)	0.0071 (0.121)	0.0442 (0.127)	0.0025 (0.033)	0.2739 (0.288)	0.0854 (0.127)	-0.1743 (0.222)
ω_i	-0.1467 (0.103)	-0.0218 (0.076)	0.1007 (0.090)	-0.0253 (0.025)	0.0274 (0.090)	-0.1050 (0.099)	**-0.3580*** (0.193)
Female Income Share	**4.6196**** (1.973)						
R2	0.4453	0.2680	0.4879	0.6337	0.5765	0.3541	0.1708
RMSE	1.916	1.746	1.877	0.539	2.268	1.886	2.398
RMSE Difference	0.013	0.011	0.007	0.001	0.011	0.007	0.032
N	458	458	458	458	458	458	458
% of Zero Obs	27.70%	12.77%	57.90%	0%	53.12%	32.37%	49.23%

Appendix C3. Unrestricted Equation Regression Output (26)

	Communication	**Clothing**	**Entertainment**	**Food**	**Medical**	**Personal Care**	**Alcohol and Tobacco**
Constant	-4.1887	-4.5470	1.9314	1.2402	-2.5687	-4.9137	2.5784
	(4.129)	(4.091)	(3.551)	(1.273)	(4.461)	(3.960)	(5.965)
Presence of Child	-0.1703	0.3383	0.1043	**0.1979****	-0.1172	0.3335	0.1980
	(0.311)	(0.313)	(0.338)	(0.097)	(0.439)	(0.288)	(0.404)
Age of Female	0.0173	0.0151	**0.0349***	-0.0028	-0.0152	0.0303	-0.0018
	(0.018)	(0.014)	(0.020)	(0.006)	(0.026)	(0.021)	(0.026)
Age of Male	-0.0123	**-0.0303***	**-0.0367***	0.0019	0.0392	-0.0148	0.0156
	(0.020)	(0.017)	(0.019)	(0.006)	(0.025)	(0.020)	(0.026)
Education of Female	0.0254	0.0203	**0.1007*****	0.0022	-0.0291	**-0.0607***	-0.0570
	(0.041)	(0.029)	(0.038)	(0.009)	(0.044)	(0.033)	(0.047)
Education of Male	**0.0670****	0.0356	0.0011	**0.0297*****	**0.1224*****	**0.0783*****	0.0082
	(0.032)	(0.032)	(0.043)	(0.011)	(0.041)	(0.029)	(0.044)
Grant Recipient	**-1.2286****	-0.3815	-0.1556	-0.1281	-0.5231	-0.1642	**-0.6351***
	(0.483)	(0.442)	(0.379)	(0.083)	(0.355)	(0.383)	(0.369)
Owns Home	-0.2781	0.0630	0.2123	-0.0428	-0.3046	-0.4139	**-0.7400***
	(0.340)	(0.336)	(0.330)	(0.082)	(0.375)	(0.314)	(0.380)
Hours Worked Female	-0.0022	0.0019	-0.0031	**-0.0061*****	-0.0131	0.0079	0.0113
	(0.007)	(0.007)	(0.007)	(0.002)	(0.009)	(0.009)	(0.010)
Hours Worked Male	-0.0005	0.0035	0.0033	0.0000	-0.0042	0.0009	-0.0001
	(0.006)	(0.005)	(0.005)	(0.002)	(0.008)	(0.007)	(0.009)
Household Income (Y)	0.7251	1.5420	-1.2083	**0.8201*****	-0.4039	0.9164	-0.7899
	(0.974)	(0.975)	(0.898)	(0.300)	(1.094)	(0.984)	(1.413)
Household Income Squared	0.0143	-0.0572	**0.1287*****	-0.0208	0.1146*	-0.0020	0.0967
	(0.054)	(0.054)	(0.050)	(0.017)	(0.061)	(0.060)	(0.080)
λ_i	**9.2912****	0.3581	-4.1393	0.8528	-5.7248	2.3368	**14.5625****
	(4.130)	(3.516)	(3.116)	(1.065)	(4.094)	(3.980)	(6.009)
υ_i	**-5.0450***	0.1514	0.9434	0.0530	**5.8446***	1.8218	-3.7206
	(2.781)	(2.587)	(2.660)	(0.708)	(3.362)	(2.500)	(3.207)
ω_i	**-0.6777***	-0.1008	0.4653	-0.1168	0.1265	-0.4850	**-1.6540*****
	(0.403)	(0.348)	(0.366)	(0.102)	(0.428)	(0.364)	(0.630)
Male Income share	**0.2165****						
	(0.092)						
R2	0.4453	0.2680	0.4879	0.6337	0.5765	0.3541	0.1708
RMSE	1.916	1.746	1.877	0.539	2.268	1.886	2.398
RMSE Difference	0.013	0.011	0.007	0.001	0.011	0.007	0.032
N	458	458	458	458	458	458	458
% of Zero Obs	27.70%	12.77%	57.90%	0%	53.12%	32.37%	49.23%