the review of income and wealth

Review of Income and Wealth
Series 67, Number 3, September 2021
DOI: 10.1111/roiw.12483

HOUSEHOLD COMPOSITION AND PREFERENCES: A COLLECTIVE APPROACH TO HOUSEHOLD CONSUMPTION

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This paper tests whether preferences over bundles of market goods are different for single persons and members of couples. We use a collective model which incorporates economies of scale in consumption. Detailed individual consumption data enable us to estimate a model that allows individual preferences for some goods to depend on household composition. The hypothesis that singles and couple members of the same gender have the same preferences is rejected. This suggests that preferences may change when household composition changes. We produce indifference scales for members of couples and a refined poverty line measure for couples. Indifference scales for women and men are respectively 81 and 59 percent of their household's expenditure. These measures are highly sensitive to the preference equality assumption.

JEL Codes: D13, I31, I32

Keywords: collective model, economies of scale, equivalence scales, poverty analysis, welfare comparisons

1. Introduction

Households consisting of two (or more) persons make expenditure decisions in a fundamentally different way than single-person households. When people start living together, they are faced with the concept of sharing in two distinct ways. First, the members of the newly formed household will no longer have complete discretion over their household's expenditure. Instead household members share control over the budget. Second, the household members share in the use of some purchased goods. The multiple-person household thereby realizes a more efficient use of goods compared to a single-person household. Since the publication of the studies by Chiappori (1988, 1992) and Apps and Rees (1988) such ideas have been

Notes: This paper makes use of data from the LISS panel. The LISS panel data were collected by CentERdata (Tilburg University, The Netherlands) through its MESS project funded by the Netherlands Organization for Scientific Research. We gratefully acknowledge comments on earlier versions of this paper from two anonymous referees, Raun van Ooijen, Marcos Rangel, Adriaan Soetevent, Arthur van Soest, and Frederic Vermeulen, and conference participants at the 2016 SOM conference, 2016 ESPE conference, and 2017 SEHO conference.

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formalized in collective household decision-making models. These models can partially explain why single-person and couple households allocate resources differently. An issue that has received little attention in the collective modeling literature is whether living with others makes certain goods intrinsically more attractive. This paper examines what role preference differences play in explaining differences in expenditure patterns of single persons and members of childless couples. Using a data set with individual consumption data, we test whether preferences of single persons and couple members are equal, controlling for gender.

We use a model based on Browning *et al*. (2013) (BCL hereafter) that allows preferences over the consumption of a subset of individually assignable goods and services to depend on the composition of the household. Decisions are made in cooperation as in Chiappori (1988). The consumption allocation is Pareto efficient. Efficiency gains from shared consumption are modeled as economies of scale in a household production process as in BCL.

Data used in this study come from the Longitudinal Internet Studies for the Social Sciences (LISS). The LISS data record expenditure on an exhaustive set of goods. We group this expenditure data into five non-assignable categories and three individually assignable categories per household member. In our sample 36% of total expenditure on goods other than housing or utilities is recorded at the individual level.

The LISS data reveal two key facts about the expenditure patterns of singles and couples that we would like to explain. First, couples allocate a smaller budget share to non-assignable goods (e.g. housing and utilities) than singles. Prior studies have shown that such differences can be rationalized using a model that includes a form of economies of scale in consumption. We use the model of BCL and modify it to account for the second fact: Couples allocate a larger budget share to leisure expenditure than singles, but couples and singles allocate roughly the same budget shares to other assignable goods. The basic model proposed in BCL cannot rationalize this pattern, as it imposes the assumption that singles and couple members have the same preferences.

Our innovation is to weaken this assumption by allowing preference parameters appearing only in assignable goods demand functions to differ between singles and members of couples. For a given budget and prices, singles and couple members allocate the budget differently among assignable goods but similarly among non-assignable goods. We refer to the original assumption as full household composition independence of preferences (HCIP) and the weakened assumption as partial HCIP. We use the model identified under partial HCIP to test the nested full HCIP assumption, and reject it. Partial HCIP better explains allocation patterns overall, and in particular the difference between singles and couples in terms of the allocation to assignable goods.

We find that imposing full HCIP substantially biases estimates of the collective model. Economies of scale are overestimated, and the bargaining power of women in couples is underestimated. These estimates can be used to produce such policy relevant measures as indifference scales and poverty rates. We calculate indifference scales for couple members in the spirit of BCL. Indifference scales tell us how much income a person would need living alone to be as well-off as he or she would be when living as part of a couple. Based on estimates from the partial

HCIP model we calculate average indifference scales of 81 percent and 59 percent of household expenditure for women and men in couples, respectively. Indifference scales based on the full HCIP model are found to be strongly upward biased, and their values are 87 percent and 79 percent for women and men, respectively.

We calculate a refined poverty line for couples using indifference scales. The refined poverty line is based on the idea that both couple members should be kept indifferent to being single at the singles poverty line. A couple can be above a conventional couples poverty line, but have an intra-household distribution that leaves one member worse off than a single person at the singles poverty line. The refined threshold rules this out. We calculate the poverty rate under both the conventional and refined poverty lines and contrast the two approaches. Furthermore, we find that the poverty rates are biased downward when poverty lines based on the full HCIP model are used.

The previous discussion highlights two reasons why testing HCIP is important. First, estimates based on HCIP are biased if the assumption is rejected. Second, household composition dependence of preferences can help explain budget allocation differences in the cross section and over time. Studies such as Hamermesh (2002) and Stancanelli and Van Soest (2016) reveal that there are complementarities to partners' leisure time. It seems a small leap to suggest that there could also be externalities in the goods and services enjoyed during joint leisure. One way of capturing these externalities is to allow that household composition affects individuals' taste for goods, services, and activities that can be enjoyed together.

Identifying separate preferences for singles and couples can be challenging. Consumption expenditure data tend to be collected at the household level, through household surveys. Differences in expenditure patterns of single and multiple person households can be attributed to preference differences, economies of scale in consumption, or the relative influence of the members of a multiple-person household. In practice the identification of collective models is achieved by making one or more strong assumptions. For example, Browning *et al*. (1994) and Lise and Seitz (2011) assume that couples share income equally when members earn equal wages. Lewbel and Pendakur (2008) and Bargain and Donni (2012) identify a BCL-style model by assuming Independence of Base (IB). IB implies that a household member's share of total expenditure is independent of the level of total expenditure; see, for example, Lewbel (1989). IB is rejected in de Ree *et al*. (2013). Cherchye *et al*. (2012a) assume that preferences of members of an elderly couple are the same as elderly widow(ers). In BCL the model is identified by assuming that all preference parameters are the same for singles and couple members. For a given budget and prices, singles and couple members allocate the same budget shares to goods.

Dunbar *et al*. (2013) estimate a collective model under the Similarity Across Types (SAT) assumption. Within a system of linear Engel scales their SAT assumption is a restriction on the slopes of (a subset of) Engel scales. Intercept parameters are allowed to depend on household composition. SAT thus places a comparatively weak assumption on preferences. However, these household composition dependent intercept parameters reflect both preference differences and scale economies. SAT therefore does not permit a pure test of whether preferences depend on household composition.

The partial HCIP assumption shares the advantages of full HCIP. HCIP allows a collective model to be identified in situations without price variation, labor supply data, or information on couple members' outside options (e.g. marriage market data). In contrast to SAT, preferences, economies of scale, and bargaining parameters can be separately identified. In contrast to IB, HCIP does not impose strong restrictions on the shape of Engel curves. HCIP does not impose that utility is separable in the consumption levels (of groups) of goods. When expenditure data for more than one assignable good per household member are observed (as is the case in the LISS data), full HCIP can be weakened to partial HCIP. The latter uses variation in the allocation among the assignable goods to identify household composition dependent preference parameters. Variation in the non-assignable goods budget shares of singles identifies all other preference parameters. Variation in the non-assignable goods budget shares of couples identifies the sharing rule and economies of scale. Crucially, the ability to separate preference differences from effects of economies of scale allows us to perform a clean test of HCIP.

The paper is structured as follows. In Section 2 we start off with a discussion of the LISS data set; its properties, and its limitations. Section 3 describes the empirical implementation of a BCL-style model with household composition dependent preferences. Section 4 starts with a discussion of the test of HCIP and several other hypotheses related to preferences. Subsequently, we calculate and discuss expenditure shares, indifference scales, and poverty thresholds for members of couples. Section 5 concludes and discusses implications for future work.

2. DATA

We use data from the LISS panel administered by CentERdata (Tilburg University, The Netherlands). The LISS panel is a representative sample of Dutch individuals who participate in monthly Internet surveys. The panel is based on a true probability sample of households drawn from the population register. Households that could not otherwise participate are provided with a computer and Internet connection. A longitudinal survey is fielded in the panel every year, covering a large variety of domains, including work, education, income, housing, time use, political views, values, and personality. We use information on education, income, and personal characteristics from these yearly studies in addition to data from the Time Use and Consumption (TUC) module used in Cherchye *et al.* (2012a,b). The TUC module contains detailed information on average monthly household and individual expenditures over the previous year. Data are available on a number of assignable and non-assignable goods.

The population of interest consists of childless singles and childless couples where members are below the age of retirement of 65 (for the interval of time considered). We use the first three waves (2009, 2010, and 2012) of the TUC module.[1] We pool the waves of data and correct for the resulting correlation between errors

[1]We do not use later waves because these only record total expenditure on assignable goods per household member. Having multiple assignable goods per household member is crucial for our identification strategy.

of observations of the same household by using standard errors clustered at the household level.

Household-level expenditure data are recorded in the TUC module for the following non-assignable goods: mortgage interest and amortization, rent, utilities, transport and means of transport, insurance, alimony and child support, servicing debts and loans, cleaning and maintenance of the house and garden, food consumed at home, joint vacations and day trips, and other non-assignable goods. The present study focuses on the allocation of total expenditure over goods and services. We therefore disregard the expenditures made to service debts and loans (except mortgage payments) and expenditures on alimony and child support. Expenditures on "other" non-assignable goods are disregarded because we cannot check whether this category actually contains non-assignable expenditures and it represents a small expenditure category. We group the remaining goods into five non-assignable goods categories: housing, utilities, transport, insurance, and food consumed at home.

We obtain the housing category by combining expenditures on mortgage payments, rent, and cleaning and maintenance of the house. Rent is a good measure of the cost of enjoying a house, but mortgage interest and amortization is not. Unfortunately we do not have access to imputed rent. As in Cherchye *et al.* (2012b), we stick with mortgage payments as homeowners' cost of enjoying their home. We use homeownership as a taste shifter in part to control for the effects of ignoring the difference between mortgage and rent. Furthermore, homeownership is allowed to affect the division of expenditure between partners.

Each respondent was asked to report expenditures for his or her personal consumption on a number of assignable goods. These assignable goods are expenditure on food and drinks outside the house, tobacco products, clothing, personal care products and services, medical care and health care cost not covered by insurance, expenditure on leisure time activities, schooling, donations and gifts, and other assignable goods. Medical care costs are disregarded because they do not represent the outcome of individual choice. Schooling, donations and gifts, and other assignable goods are disregarded because the vast majority of the sample reports zero expenditures, and many of the other respondents report negligible amounts. We group the remaining goods into three assignable goods categories: expenditure on leisure, clothing, and personal care.

We obtain the "leisure expenditure" category by combining expenditure on "leisure activities," "food and drinks outside of the home," and "tobacco".[2] A problem arises with regard to vacation expenditure. For singles all vacation expenditure is included in the "leisure activities" category. If a couple member takes some vacations with and other vacations without their partner, then their vacation expenditure is split across the assignable good "leisure activities" and the non-assignable good "joint vacations." To make the "leisure expenditure" category comparable across household types, we assign half of a couple's expenditure on "joint vacations" to each member's "leisure expenditure." As a justification, note that couple members usually undertake the same activities on joint vacations and

[2]Preliminary analysis revealed that "leisure expenditure" and "food and drinks" have partial derivatives with respect to total expenditure that are positive, significant, and quantitatively similar.

TABLE 1
Observations per Sample Selection Criterion

	Singles		Couples		
Selection criterion	Women	Men	Women	Men	Total
Base sample[a]	1266	1143	1461	1461	5331
Non-assignable good missing	897	827	1085	1085	3894
Assignable good missing	860	794	976	985	3615
Infeasible housing	825	763	972	980	3540
Total expenditure=0	812	750	968	973	3503
Missing explanatory variables	780	727	911	916	3334
Partner was discarded	780	727	847	847	3201

[a]Single or part of a heterosexual couple where both partners participate.

spend equally on most major items (e.g. food, flight, accommodation). We check robustness of our results to removing expenditure on "joint vacations."

In Table 1 we report the loss of observations due to a number of sample selection criteria. First, an observation is discarded if expenditure on any assignable or non-assignable good category is entirely missing. We do not impute expenditure categories. In most cases households missing one (non-)assignable category missed all (non-)assignable categories. In couples each member had the option of indicating that they were not the person who knew about a particular non-assignable good category. Unfortunately, in some couples both members chose this option, and the corresponding expenditure level is missing. Second, we discard observations with zero reported expenditure on the sum of mortgage and rent if the household is renting a home or lives in a cost-free home. Third, we consider only observations with non-zero total assignable and non-assignable goods expenditure. Fourth, we discard observations with missing explanatory variables. Finally, if the spouse of a member of a couple has incomplete data, then that member's data are not used. The final sample consists of 780 observations on single women, 727 observations on single men, and 847 observations on couples.

Descriptive statistics for monthly expenditure on the non-assignable and assignable goods are reported in Table 2. The table reveals two key facts about the expenditure patterns of single-person households and couples. First, couples on average allocate a significantly smaller budget share to non-assignable goods than single-person households (0.76 compared to 0.84). Second, couples on average allocate a substantially larger budget share to leisure expenditure than single-person households (0.16 compared to 0.10). However, couples allocate roughly the same budget share as single-person households to other assignable goods. The model introduced in Section 3 explains these key facts.

Table 2 also reports descriptive statistics for background variables. We use background variables to model heterogeneity in individual preferences and to explain the intra-household distribution of expenditure by couples. The taste shifters we include are a homeownership dummy, a higher education dummy, and age. Homeownership could make expenditure on cleaning and maintenance, furnishing, and insurance more attractive relative to other goods. We use a dummy that is equal to 1 if the household lives in an owned home. Education may affect

TABLE 2
Descriptive Statistics

Singles	Women		Men		All[a]		
Variable	Mean	SD	Mean	SD	Mean	SD	t-stat[b]
Household expenditure (€/month)	1335	523	1357	517	1346	520	
Non-assignable goods[c] *(total)*	0.84	0.10	0.84	0.10	0.84	0.10	
Housing	0.37	0.13	0.36	0.14	0.36	0.13	
Utilities	0.14	0.06	0.12	0.07	0.13	0.06	
Transport	0.06	0.05	0.07	0.07	0.07	0.06	
Insurance	0.12	0.07	0.12	0.07	0.12	0.07	
Food at home	0.15	0.07	0.16	0.08	0.16	0.08	
Assignable goods[c] *(total)*	0.16	0.10	0.16	0.10	0.16	0.10	
Leisure	0.08	0.07	0.11	0.09	0.10	0.08	
Clothing	0.05	0.05	0.04	0.05	0.05	0.05	
Personal care	0.03	0.02	0.02	0.02	0.02	0.02	
Taste shifters							
Homeowner	0.43	0.49	0.50	0.50	0.46	0.50	
Higher education[d]	0.44	0.50	0.31	0.47	0.38	0.49	
Age	48.24	12.81	46.66	11.74	47.51	12.39	
Observations	780		727		1507		
Couples Women Men All[a]							
Household expenditure (€/month)					2225	776	
Non-assignable goods[c] *(total)*					0.76	0.11	−16.62*
Housing					0.29	0.14	−12.50*
Utilities					0.11	0.05	−8.00*
Transport					0.07	0.05	2.64*
Insurance					0.13	0.07	2.59*
Food at home					0.16	0.07	0.52
Assignable goods[c] *(total)*	0.12	0.07	0.12	0.07	0.24	0.11	16.62*
Leisure	0.07	0.05	0.08	0.06	0.16	0.10	16.56*
Clothing	0.03	0.03	0.02	0.03	0.06	0.05	5.89*
Personal care	0.02	0.02	0.01	0.01	0.03	0.02	4.09*
Taste shifters							
Homeowner	0.78	0.42	0.78	0.42	0.78	0.42	
Higher education[d]	0.24	0.43	0.36	0.48	0.30	0.46	
Age	49.08	12.79	51.19	12.49	50.12	12.66	
Distribution factors							
Wife-husband age difference					−2.11	3.85	
Wife's income share					0.30	0.20	
Married					0.79	0.41	
Observations	847		847		1694		

Source: CentERdata. Based on own calculations.

[a]In the "All" column the non-assignable goods budget shares of men and women in couples have been added up.

[b]The *t*-statistic for a two sample *t*-test on the corresponding budget shares of single person ($N = 1507$) and couple ($N=847$) households.

[c]$p < 0.01$.

[d]Shares of household expenditure.

*Higher education is a dummy equal to 1 if the respondent completed a higher vocational or university level degree.

preferences by promoting healthy choices, or through an individual's peer/social network. The higher education dummy equals 1 if the respondent has received a degree in the higher education system (higher vocational or university level). We use the (demeaned) age in years as our age variable.

Following Chiappori (1992) and BCL we model the intra-household distribution of resources by means of a sharing rule. We use a number of variables that have been suggested in the literature to affect the sharing rule. We allow some of these variables to only affect the intra-household distribution, so-called distribution factors in the terminology of collective models. As distribution factors we use the wife-husband age difference, the wife's share of net household income, and a married couple dummy. We use a homeownership dummy, separate higher education dummies for the wife and husband, and total household expenditure as additional explanatory variables in the sharing rule.

3. Empirical Model

The contribution of this paper to the collective modeling literature is not of a theoretical but of an empirical nature. BCL forms the theoretical basis for our empirical analysis. Appendix A summarizes their model.

3.1. *Parametric Specification*

We specify a parametric model with limited interaction between prices of goods. Our starting point is a simplified version of the Almost Ideal Demand System of Deaton and Muellbauer (1980). We restrict to zero the parameters of products between the logarithms of prices that normally appear in such a model. We are not able to identify substitution effects given the limited price variation in the TUC module. Consequently, price changes have an income effect only on demand. We obtain an individual indirect utility function given by equation (1)

$$V^k(x^k, \boldsymbol{p}, \boldsymbol{z}^k) = \frac{\ln x^k - \ln a^k(\boldsymbol{p}, \boldsymbol{z}^k)}{b^k(\boldsymbol{p})} \tag{1}$$

where $k = sf, sm, cf, cm$ and

$$\ln a^k(\boldsymbol{p}) = \alpha_0 + \sum_{i=1}^{G} \alpha_i^k(\boldsymbol{z}^k) \ln p_i, \tag{2}$$

$$b^k(\boldsymbol{p}) = \prod_{i=1}^{G} p_i^{\beta_i^k(z^k)}.$$

where $\boldsymbol{p}$ is the vector of market prices for all goods, $\boldsymbol{z}^k$ is a vector of taste shifters, and x^k is (individual) total expenditure. The superscript $k = sf, sm, cf, cm$ is used to distinguish between functions, variables, and parameters for single women, single men, women in couples, and men in couples. We have $G_A = 3$ assignable goods per household member and 5 non-assignable goods. Separate budget shares are used for the wife and the husband's expenditure on each assignable good. Therefore, we obtain a system of $G = 3.2+5 = 11$ household-level budget shares. We index goods as $g = 1, \ldots, G_A, \ldots, 2 \cdot G_A, \ldots, G$.

Individual demand functions can be found by applying Roy's Identity to the indirect utility function. We multiply the individual demand function by p_g/x^k to find the budget shares

$$(3) \qquad w_g^k = \frac{p_g q_g}{x^k} = a_g^k(z^k) + \beta_g^k(z^k)(\ln x^k - \ln a^k(\boldsymbol{p}, z^k)) \quad \text{for } g = 1, \ldots, G.$$

We introduce heterogeneity in preferences by letting the intercept and slope of budget shares depend on taste shifters

$$\alpha_g^k(\boldsymbol{z}^k) = \alpha_{g,c}^k + \boldsymbol{\alpha}_{g,z}^{k\prime}\boldsymbol{z}^k,$$
$$\beta_g^k(\boldsymbol{z}^k) = \beta_{g,c}^k + \boldsymbol{\beta}_{g,z}^{k\prime}\boldsymbol{z}^k,$$

We need the restrictions $\sum_{i=1}^G \alpha_{i,c}^k = 1$, $\sum_{i=1}^G \boldsymbol{\alpha}_{i,z}^k = \boldsymbol{0}$, $\sum_{i=1}^G \beta_i^k = 0$,$\sum_{i=1}^G \boldsymbol{\beta}_{i,z}^k = \boldsymbol{0}$, in order for the systems to satisfy adding up. When estimating the model, we leave out one good as suggested in Barten (1968, 1969) and Pollak and Wales (1969). Parameters that appear in the excluded budget share are recovered using the adding-up restrictions.

3.1.1. Individual Demand

We normalize all prices in equation (3) to 1 and rewrite budget shares for singles as

$$(4) \qquad w_g^k = (\alpha_{g,c}^k - \alpha_0\beta_{g,c}^k) + (\boldsymbol{\alpha}_{g,z}^k - \alpha_0\boldsymbol{\beta}_{g,z}^k)'\boldsymbol{z}^k + \beta_{g,c}^k \ln x + \boldsymbol{\beta}_{g,z}^{k\prime}\boldsymbol{z}^k \ln x$$

for $k = sf, sm$ and $g = 1, \ldots, G$.

If we fix α_0, then the remaining parameters can be estimated from a model that is linear in reduced form parameters. The econometric model would be substantially simplified. As Deaton and Muellbauer (1980) noted, when prices are unity the parameter α_0 can be interpreted as the logarithm of subsistence spending in the Almost Ideal Demand System. Banks *et al.* (1997) argue that the minimum expenditure observed in the sample places an upper bound on (log) subsistence expenditure, and can therefore be used to fix α_0. We deviate somewhat from this practice and choose to set α_0 equal to the log of the 5th percentile of the distribution of total spending in single-person households. Our justification of this more conservative approach is that some individuals in the sample may spend less than the subsistence level. Since the 5th percentile is a somewhat arbitrary choice, we have checked robustness of the results to the choice of α_0. The results are qualitatively unchanged by choices of α_0 as high as the 25th percentile of total expenditure.

3.1.2. Couples Demand

We can recover estimates of the sharing rule and economies of scale in consumption of non-assignable goods from the budget shares of couples. The general form of these budget shares is derived in Appendix B. Here we introduce a functional form for the share of expenditure going to the wife and the consumption technology. The consumption technology relates consumed quantities of non-assignable goods $q_g^{k,N}$ to purchased quantities $y_g^{k,N}$. We use a linear consumption technology

$$q_g^{k,N} = d_g^{-1} y_g^{k,N} \qquad \text{for } g = 2 \cdot G_A + 1, \dots, G$$

which results in effective prices given by $\pi_g = d_g p_g^N$. We follow Cherchye *et al.* (2012a) and impose these restrictions by using the functional form

$$\pi_g = d_g = \frac{1 + \frac{e^{\delta_g}}{1+e^{\delta_g}}}{2} \qquad \text{for } g = 2 \cdot G_A + 1, \dots, G$$

for economies of scale and estimating the parameters δ_g. In a preliminary analysis we were able to identify Barten scales albeit poorly, as the data lack price variation. We simplify the analysis by assuming that economies of scale parameters δ_g are all equal. In other words, we estimate an Engel scale for non-assignable goods.

We assume that the sharing rule is given by the logistic function

$$\eta(\boldsymbol{s}) = \frac{e^{\boldsymbol{\kappa}'\boldsymbol{s}}}{1 + e^{\boldsymbol{\kappa}'\boldsymbol{s}}}$$

where $\eta(\boldsymbol{s}) = \frac{x^{cf}(\boldsymbol{s})}{x}$ and $\boldsymbol{s}$ contains the age difference between wife and husband, the wife's share of net household income, a married couple dummy, a homeownership dummy, the logarithm of total household expenditure, and a dummy for wife and husband's education.

The choice of sharing rule and the assumption that $\delta_g = \delta$ for all non-assignable goods allows us to rewrite the household expenditure shares as functions of the parameters $\boldsymbol{\kappa}$ and δ (derivations in Appendix B). We get

$$(5) \qquad w_g^h = \frac{p_g y_g^{cf}}{x} = \eta(\boldsymbol{\kappa}) \cdot w_g^{cf}(\delta, \boldsymbol{\kappa}, \boldsymbol{\zeta}^{cf}) \quad \text{for } g = 1, \dots, G_A,$$

$$(6) \qquad w_g^h = \frac{p_g y_g^{cm}}{x} = (1 - \eta(\boldsymbol{\kappa})) \cdot w_g^{cm}(\delta, \boldsymbol{\kappa}, \boldsymbol{\zeta}^{cm}) \quad \text{for } g = G_A + 1, \dots, 2 \cdot G_A,$$

$$(7) \qquad \begin{aligned} w_g^h = \frac{p_g y_g^{h}}{x} &= \eta(\boldsymbol{\kappa}) \cdot w_g^{cf}(\delta, \boldsymbol{\kappa}, \boldsymbol{\zeta}^{cf}) \\ &+ (1 - \eta(\boldsymbol{\kappa})) \cdot w_g^{cm}(\delta, \boldsymbol{\kappa}, \boldsymbol{\zeta}^{cm}) \quad \text{for } g = 2 \cdot G_A + 1, \dots, G, \end{aligned}$$

where $\boldsymbol{\zeta}^k = [\boldsymbol{\zeta}_1^k, \ldots, \boldsymbol{\zeta}_{G_H}^k]$, $\boldsymbol{\zeta}_g^k = [\alpha_{g,c}^k, \boldsymbol{\alpha}_{g,z}^{k\prime}, \beta_{g,c}^k, \boldsymbol{\beta}_{g,z}^{k\prime}]$ and

$$
\begin{aligned}
w_g^{cf} = \frac{\pi_g q_g}{\eta^{cf} x} &= \alpha_g^{cf}(\boldsymbol{z}^{cf}) \\
&+ \beta_g^{cf}(\boldsymbol{z}^{cf}) \left[\ln(\eta(\boldsymbol{\kappa})x) - \alpha_0 - \sum_{i=G_A+1}^{G} \alpha_i^{cf}(\boldsymbol{z}^{cf}) \ln \pi(\delta) \right],
\end{aligned} \tag{8}
$$

$$
\begin{aligned}
w_g^{cm} = \frac{\pi_g q_g}{\eta^{cm} x} &= \alpha_g^{cm}(\boldsymbol{z}^{cm}) \\
&+ \beta_g^{cm}(\boldsymbol{z}^{cm}) \left[\ln((1-\eta(\boldsymbol{\kappa}))x) - \alpha_0 - \sum_{i=G_A+1}^{G} \alpha_i^{cm}(\boldsymbol{z}^{cm}) \ln \pi(\delta) \right]
\end{aligned} \tag{9}
$$

for $g = 1, \ldots, G$. Equations (8) and (9) contain couple members' budget shares defined relative to individual total expenditure $\eta^k x$. However, we do not observe this type of budget shares since individual total expenditure consists in part of unobservable non-assignable goods expenditure. We do observe the left-hand side of equations (5)–(7). These are the budget shares defined relative to total household expenditure. We find equations (5) and (6) by multiplying equations (8) and (9) by η^k. We find equation (7) by multiplying equations (8) and (9) by η^k and adding up.

To identify the sharing rule parameters $\boldsymbol{\kappa}$ and effective price of non-assignable goods consumption π (or more accurately the underlying parameter δ) we assume that preference parameters of singles and couples members in the non-assignable goods budget shares are equal. In terms of equations (8) and (9) this amounts to

$$
\begin{aligned}
w_g^{cf} &= \alpha_g^{sf}(\boldsymbol{z}^{cf}) \\
&+ \beta_g^{sf}(\boldsymbol{z}^{cf}) \left[\ln(\eta(\boldsymbol{\kappa})x) - \alpha_0 - \sum_{i=G_A+1}^{G} \alpha_i^{sf}(\boldsymbol{z}^{cf}) \ln \pi(\delta) \right],
\end{aligned}
$$

$$
\begin{aligned}
w_g^{cm} &= \alpha_g^{sm}(\boldsymbol{z}^{cm}) \\
&+ \beta_g^{sm}(\boldsymbol{z}^{cm}) \left[\ln((1-\eta(\boldsymbol{\kappa}))x) - \alpha_0 - \sum_{i=G_A+1}^{G} \alpha_i^{sm}(\boldsymbol{z}^{cm}) \ln \pi(\delta) \right].
\end{aligned}
$$

In Appendix C we place the HCIP assumption in a more general context and discuss identification.

3.2. *Estimation*

The collective model described in this section can be estimated based on the system of linear Engel scales for singles given by equation (4) and the system for couples given by equations (5)–(7). The HCIP assumption imposes restrictions across systems. It is therefore more efficient to estimate the systems jointly than to estimate the singles and couples system sequentially. We follow BCL in that we minimize the sum of the GMM criterion functions for the systems of Engel scales of singles and couples. Household income (net of taxes) is used as an instrument for total household expenditure. Standard errors are clustered at the household level to correct for the correlation between error terms of households observed in multiple waves.

When estimating the systems of Engel scales, we exclude one budget share from the system of single men and single women. The preference parameters from the excluded budget share are recovered by imposing the adding-up restrictions (see Barten, 1969). We also exclude one budget share of men in couples and one budget share of women in couples. The reason is that we need couple members' unobserved individual budget shares, given in equation (5) and (6), to add up as well.[3] Therefore, we impose 8 restrictions per household type and gender for a total of 32 restrictions.

The estimation strategy consists of three steps. First, the singles system is estimated by GMM using an identity weighting matrix. Second, we minimize the sum of the GMM criterion functions for the singles system and the couples system. An identity weighting matrix is used for the couples system, while the optimal weighting matrix is used for the singles system (based on the residuals from the first step). This step produces consistent estimates of couple exclusive parameters. Furthermore, we obtain residuals for the couples system. Finally, we estimate the two systems jointly once more using the optimal weighting matrices (based on the second step residuals). In each step we impose the partial HCIP constraints explicitly. Estimation is performed with Matlab's "fmincon" command using an interior point algorithm.

The joint system is nonlinear in parameters. To address the possibility of ending up in the local but not global minimum we use the global search algorithm available in Matlab's global optimization toolbox. The algorithm cannot guarantee that we find the global minimum. However, it at least informs us of the presence of other local minima. The lowest local minimum we find is found from various starting points in the parameter space. In fact a majority of the starting points considered lead to the lowest minimum.

3.3. *Indifference Scales*

Indifference scales in the spirit of BCL are the share of household expenditure that a specific household member needs as disposable income to make himself or herself as well-off in a single-person household as he or she is in the multiple-person household. A member of a couple is indifferent between being part of a couple households with expenditure x and a single-person household with expenditure x_*^{sf} if he or she can attain the same indifference curve. In mathematical terms we solve

$$V^{cf}(x_*^{sf}, \boldsymbol{p}, \boldsymbol{z}^{cf}) = V^{cf}(\eta^{cf} x, \boldsymbol{\pi}, \boldsymbol{z}^{cf}) \tag{10}$$

for x_*^{sf}, which we will refer to as indifference expenditure. Indifference scales equal x_*^{sf}/x for women in couples and x_*^{cm}/x for men in couples. Equation (10) avoids

[3]In a model with HCIP the adding-up restrictions for singles guarantee adding up for couple members. In our model the adding-up restrictions for couple members need to be imposed.

comparing V^{sf} to V^{cf}, as that would imply an interpersonal utility comparison. Given the partial HCIP assumption, we could equivalently write equation (10) in terms of V^{sf}.[4] We use the solution to equation (10) to calculate indifference scales.

Note that when prices are normalized to 1 in equation (10) we have

$$\ln a^{sf} = \alpha_0, \qquad b^{sf} = 1,$$

$$\ln a^{cf}(z^{cf}) = \alpha_0 + \sum_{i=2\cdot G_A+1}^{G} \alpha_i^{cf}(z^{cf}) \ln \pi, \qquad b^{cf}(z^{cf}) = \prod_{i=2\cdot G_A+1}^{G} d^{\beta_i(z^{cf})}.$$

The left-hand side of equation (10) is given by

$$V^{cf}(x_*^{sf}, z^{cf}) = \ln x_*^{sf} - \alpha_0, \tag{11}$$

for $k = cf$, cm and the right-hand side of equation (10) is given by

$$V^{cf}(x_*^{sf}, z^{cf}) = \frac{\ln \eta^{cf} x - \ln a^{cf}(z^{cf})}{b^{cf}(z^{cf})}. \tag{12}$$

Substituting equations (11) and (12) into equation (10), we can find a solution for (log) indifference expenditure

$$\ln(x_*^{sf}) = \frac{\ln \eta^{cf} x - \sum_{i=2\cdot G_A+1}^{G} \alpha_i^{cf}(z^{cf}) \ln \pi}{b^{cf}(z^{cf})} + \left(1 - \frac{1}{b^{cf}(z^{cf})}\right)\alpha_0, \tag{13}$$

and for (log) indifference scales

$$\ln\left(\frac{x_*^{sf}}{x}\right) = \frac{\ln \eta^{cf} - \sum_{i=2\cdot G_A+1}^{G} \alpha_i^{cf}(z^{cf}) \ln \pi}{b^{cf}(z^{cf})} + \left(\frac{1}{b^{cf}(z^{cf})} - 1\right)(\ln x - \alpha_0). \tag{14}$$

We can calculate indifference scales based on (the exponential function of) equation (14). We can apply the same procedure to find the indifference scales for men.

4. Results

4.1. *Structural Parameters and Preference Changes*

For a discussion of endogeneity and instrument relevance see Appendix D. In Appendix E we present the full set of preference parameters. Here we test

[4]Partial HCIP ensures that the share devoted to non-assignable goods for any given level of effective expenditure is the same for either set of preferences. Under the Engel scale assumption the budget share of non-assignables is the only preference-based factor affecting indifference scales.

several hypotheses about these parameters. The partial HCIP model imposes the restrictions

$$\alpha_g^{cf}(z^{cf}) = \alpha_g^{sf}(z^{cf}) \qquad \beta_g^{cf}(z^{cf}) = \beta_g^{sf}(z^{cf})$$
$$\alpha_g^{cm}(z^{cm}) = \alpha_g^{sm}(z^{cm}) \qquad \beta_g^{cm}(z^{cm}) = \beta_g^{sm}(z^{cm})$$

on equations (5)–(7) for $g = 2 \cdot G_A + 1, \ldots, G$. The assumptions tested below impose additional restrictions.

First, we test the hypothesis that all the allocation preferences of men and women are equal. With respect to partial HCIP we impose the additional restrictions

$$\alpha_g^{sm}(z^{sm}) = \alpha_g^{sf}(z^{sm}) \qquad \beta_g^{sm}(z^{sm}) = \beta_g^{sf}(z^{sm})$$
$$\alpha_g^{cm}(z^{cm}) = \alpha_g^{cf}(z^{cm}) \qquad \beta_g^{cm}(z^{cm}) = \beta_g^{cf}(z^{cm}).$$

$G = 1, \ldots, G$. We find a Likelihood Ratio statistic of $\chi^2_{72} = 438.87$ and reject the hypothesis at the 1% level. The test suggests that men and women have significantly different preferences toward allocating a budget. This underlines the importance of using a collective approach to study household behavior. Collective models allow the different preferences of household members to play a role in decision making.

We now test full HCIP against partial HCIP. Full HCIP implies that all preference parameters of singles and members of couples of the same gender are equal

$$\alpha_g^{cf}(z^{cf}) = \alpha_g^{sf}(z^{cf}) \qquad \beta_g^{cf}(z^{cf}) = \beta_g^{sf}(z^{cf})$$
$$\alpha_g^{cm}(z^{cm}) = \alpha_g^{sm}(z^{cm}) \qquad \beta_g^{cm}(z^{cm}) = \beta_g^{sm}(z^{cm}).$$

for $g = 1, \ldots, 2 \cdot G_A$. We reject full HCIP assumption at the 1% level ($\chi^2_{32} = 156.78$).[5] In contrast to Bargain and Donni (2012) we find that preferences of singles and couple members are significantly different.[6] Individuals in single-person households do not seem to have the same preferences toward allocating a given budget as their same gender counterparts in couples. Section 4.3 discusses the implied behavioral differences between single persons and couple members of the same gender. In Appendix F we test full household composition independence of intercept and slope parameters against the SAT specification.

Finally, we can test whether indifference scales are Independent of Base (IB) expenditure. From equation (14) we see this is the case if the sharing rule (η^{cf}) is independent of total expenditure (x), and $b^k(z^k) = 1$ for $k = cf, cm$. The latter implies that $\sum_{i=2 \cdot G_A+1}^{G} \beta_{i,c}^k = 0$ and $\sum_{i=2 \cdot G_A+1}^{G} \boldsymbol{\beta}_{i,z}^k = \mathbf{0}$ hold jointly. We reject the IB assumption at the 1% level ($\chi^2_{55} = 358.40$). The fact that we need not make the IB assumption to identify our collective model may help explain why we find

[5]This finding is robust to excluding expenditure on joint vacations from the analysis. Full results for the model without expenditure on joint vacations are available upon request.

[6]Bargain and Donni (2012) are able to reject the equal preferences assumption at the 5 percent level but not the 1%. They have a sample of reasonable size and conclude that the assumption is not rejected. Our sample is of a similar size, but we find stronger evidence against the null hypothesis of equal preferences.

TABLE 3
Sharing Rule and Economies of Scale

	Param.	Std.Err.	AME on share
Constant	0.2900**	0.0687	
Wife-husband age difference	0.0002	0.0041	0.0000
Wife's income share	0.0986	0.0773	0.0238
Married	0.0301	0.0434	0.0073
Homeowner	−0.0529	0.0622	−0.0128
Log(HH expenditure)	−0.3293*	0.1357	−0.0813
Wife higher education	0.1946**	0.0602	0.0469
Husband higher education	−0.0739	0.0425	−0.0180
Economies of scale			
Effective price	0.6492**	0.0102	

Std. Err reported are clustered standard errors, $**p < 0.01$ $*p < 0.05$. AME means average marginal effect.

significant evidence against preference equality, whereas Bargain and Donni (2012), who make the IB assumption, find weaker evidence.

The test results discussed earlier have important implications for the indifference scales calculated in Section 4.4. Women have stronger preferences for non-assignable goods than men. Indifference scales, which increase with the budget share assigned to non-assignable goods, are therefore on average higher for women than men. Moreover, we find that as the size of the budget increases women's preferences (on average) shift away from non-assignable goods, whereas the opposite is true for men.[7] Men demand more housing and transport compared to women as household expenditure increases. Indifference scales vary strongly with total expenditure. In couples with larger budgets the indifference scales of women and men are more similar. Rejection of full HCIP in favor of the partial HCIP has implications for indifference scales because the two models predict different levels of economies of scale and sharing as we discuss later.

4.2. *Economies of Scale and Sharing*

Table 3 reports the results for the sharing rule and economies of scale. We estimate an Engel scale for non-assignable good consumption (π^N) equal to 0.65, with a 95% confidence interval of 0.62–0.68. On average a couple spends 79% of its budget on non-assignable goods. This hypothetical couple would therefore need to spend 21+79/0.65≈143 percent of their household budget to privately purchase their current consumption bundle when they are living apart. This figure lies between the square root scale (1.41) and the OECD-modified equivalence scale (1.50) from Hagenaars *et al.* (1994). BCL refers to 143–100 percent = 43 percent as the relative economies of scale in consumption. In their preferred specification relative scale economies equal 52 percent. Cherchye *et al.* (2012a) find relative scale economies of 38 percent for the Dutch elderly population. Though our sample consists of working-age individuals, we find it reassuring that our estimate of scale economies is close to theirs.

[7]The model predicts opposite shifts in preferences for non-assignable goods to explain a feature of the underlying data: We observe that over the cross section, the budget share for women's assignable goods increases more quickly with a couple's budget than the budget share for men's assignable goods.

We confirm earlier findings that the wife has more control over a couple's expenditure pattern than the husband. The wife's predicted share has an average of 58 percent and a standard deviation of 3 percent in our sample. The minimum and maximum expenditure shares are, respectively, 48 percent and 69 percent. In only 12 out of 847 cases do we predict that the husband has more influence on expenditure than the wife. The wife's average share of expenditure varies little across age groups (by either wife's or husband's age). The average share is respectively 61, 58, 57, and 55 percent in the household expenditure quartiles. The average expenditure share found here is slightly lower than the 63% expenditure share found in both BCL for Canada and Cherchye *et al*. (2012a) for the elderly population of the Netherlands. Studies in developing economies tend to find that women have lower expenditure shares than men; see, for example, Dunbar *et al*. (2013). We suspect differences in gender equality and female labor force participation, and culture may explain the difference in women's estimated expenditure shares. In a study of UK households, Lise and Seitz (2011) find that at the mean of their data women receive about 40 percent of full household income net of public good expenditure. We do not view our result as contrary to theirs. In our study women control 58% of expenditure gross of public goods expenditure. Compared to men, women are found to have a strong preference for non-assignable goods. These goods are mostly public in nature. Removing public goods from the analysis mechanically lowers women's expenditure shares.

Turning to the sharing rule variables, we see that the higher education dummies and household expenditure stand out. Highly educated women (who completed a degree in higher vocational or university-level education) control a 5 percentage point higher share than lower-educated women. The corresponding effect of husband's education on the husband's share is weaker at 2 percentage point and significant only at the 10 percent level. We control for relative income (and total expenditure), so education effects do not run through income. In contrast to earlier studies, we find a significant negative effect of household expenditure on the wife's share of expenditure. A unit increase in the logarithm of household expenditure is associated with an 8 percentage point lower share of expenditure for the wife.

We can see the influence of weakening the HCIP assumption by comparing the partial HCIP results to the results found for full HCIP.[8] In the full HCIP model the Engel scale for non-assignable goods is 52 percent. Relative scale economies are 71 percent. Economies of scale are considerably larger than implied by the OECD-modified equivalence scales and our partial HCIP results. The wife's share of expenditures is on average 53 percent for full HCIP. The full HCIP assumption thus leads to overestimation of economies of scale and underestimation of inequality in the household.

We find a Hansen-Sargan J statistic for partial HCIP equal to 218.42. We reject the over-identifying restrictions at the 1 percent level (129 degrees of freedom). Such a finding is common in the demand system literature; see, for example, Browning and Meghir (1991), Browning *et al*. (1994) and BCL. Essentially we jointly test restrictions imposed by utility maximization, the collective household model, and our identifying assumption. The Hansen-Sargan test unfortunately does not suggest a specific improvement to the model.

[8]The results for full HCIP are available on request.

4.3. *Allocation Differences Decomposed*

In Figure 1 we present a visual decomposition of single-couple member allocation differences. The lines represent the predicted shares of the individual budget (see equations (8) and (9)) as a function of the individual budget (ηx). We focus on the budget shares of low-educated, home-owning women aged 49 (the mean). The solid line corresponds to a single woman, whereas the dashed line corresponds to a woman in a couple. The dotted line corresponds to a woman with the preferences of a couple member who does not enjoy economies of scale. It is the budget share of a woman in a couple evaluated at market prices.

The influence of preference differences is represented by the vertical distance between the solid (single at market prices) and dotted lines (couple at market prices). We allow both the intercept and slope of our Engel curves to be household composition dependent. We therefore observe both a vertical shift and a change in curvature of the budget share. Preference differences induce couple members to allocate a larger share of the budget to leisure than singles at any level of expenditure. The differences widen at higher levels of expenditure. The opposite effect can be observed for the clothing budget share. Personal care expenditures initially rise as a share of the budget and then fall at higher levels of expenditure.

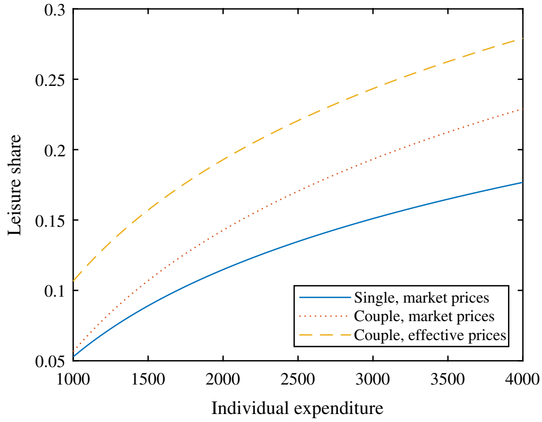
The effect of economies of scale, at a given preference set, is to make couple members behave as if they have a larger budget. This effect is visualized by a horizontal shift from the dotted line (couple at market prices) to the dashed line (couple at effective prices). The horizontal shift follows from the fact that the effective expenditure term in equation (8) (the term in square brackets) is decreasing in the effective price of non-assignable goods π. A leftward shift indicates a luxury good, and a rightward shift indicates a necessity. We predict a greater share for leisure, clothing, and personal care due to economies of scale since each of these goods is classified as a luxury.

The decomposition of predicted allocation differences shows that the role of preference differences is substantial compared to the role of economies of scale. This result is not specific to low-educated, home-owning women. Household composition dependence of preferences enriches the model considerably.

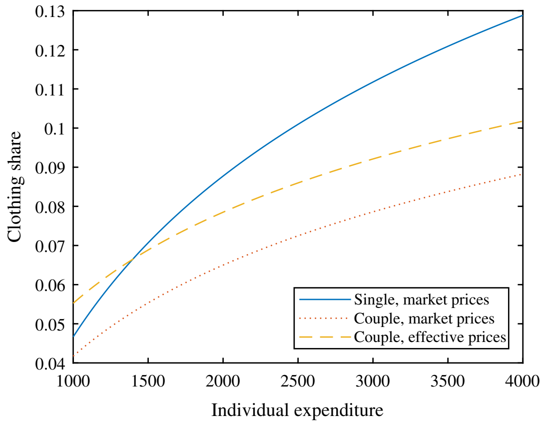
4.4. *Indifference Scales*

In this section we closely look at the indifference scales implied by our results. On average women in couples need 81 percent and men need 59 percent of total household expenditure to be materially as well-off when living alone. Table 4 presents average indifference scales per household expenditure decile for our sample of couples.

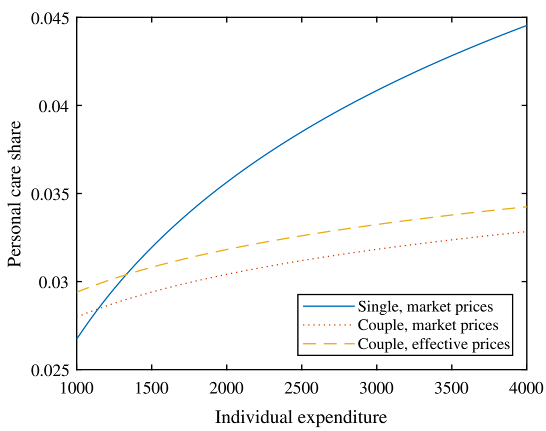
An indifference scale is determined mainly by an individual's expenditure share and his or her preference for non-assignable goods; see equation (14). The latter determines what share of his or her budget an individual devotes to non-assignable goods. By assumption couple members only enjoy economies of scale in the consumption of non-assignable goods. Indifference scales compensate for these lost economies of scale. Therefore, they are larger when the budget share devoted to non-assignable goods is larger. The 22 percentage point difference between female and male average indifference scales reflects women's larger expenditure shares and their stronger preference for non-assignable goods. As household



(a) Leisure



(b) Clothing



(c) Personal care

Figure 1. Predicted Budget Shares
[Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 4
Mean Indifference Scales by Household Expenditure Decile

Decile	1	2	3	4	5	6	7	8	9	10
Wife	0.91	0.87	0.84	0.83	0.81	0.80	0.79	0.79	0.77	0.73
Husband	0.52	0.56	0.58	0.58	0.59	0.60	0.61	0.61	0.63	0.67

expenditure increases, this difference shrinks for two reasons. First, expenditure shares of women decrease, while those of men increase. Second, women develop a weaker taste for non-assignable goods as household expenditure increases, while the opposite is true for men.

A couple on average needs 141 percent of their household expenditure when living alone to be materially as well-off as they are as part of a couple. This can be interpreted as a measure of economies of scale at the household level. Interestingly this measure is virtually constant above the fourth expenditure decile. As expenditure increases, the expenditure share of the husband increases. The husband has a weaker preference for non-assignable goods than his spouse. However, husbands develop a stronger taste for non-assignable goods as expenditure increases. Initially the net effect on the household-level budget share of non-assignable goods is negative. After the fourth decile, the two effects virtually cancel out.

The indifference scales calculated in this paper may be compared to those of BCL for Canada and Cherchye *et al.* (2012a) for the elderly population of the Netherlands. The latter finds that average indifference scales for female (male) Dutch retirees vary between 76 (45) and 83 (42) percent for, respectively, the first and fourth household expenditure quartiles. BCL find higher indifference scales for women (83%) and men (66%). Our indifference scales lie between their estimates primarily because our economies of scale measure lies between theirs. The indifference scales of women and men are closer to each other in our study due to more equal sharing. Furthermore, average indifference scales in the full HCIP model are equal to 87 and 79 percent for women and men, respectively. For men imposing full HCIP thus leads to a 20 percentage point increase in average indifference scales.

We now check whether the average indifference scales calculated in this paper are numerically close to equivalence scales used in publications by Statistics Netherlands (CBS) and The Netherlands Institute for Social Research (SCP). In a recent publication about poverty in the Netherlands (SCP and CBS, 2014), the institutes use an equivalence scale for two-adult households relative to a single person of 1.37. This implies that a single person needs a share of 1/1.37 = 0.73 to be equally well-off as a couple household. The two members of a couple would jointly need 1.46 for the same purpose. The indifference scales above instead imply that on average men need a share of 0.59, women need a share of 0.81, and a couple jointly needs a share of 1.41 of household expenditure when living apart. Equivalence scales overestimate the latter share by only 5 percentage points relative to indifference scales. However, equivalence scales underestimate (overestimate) the average share of household expenditure needed by women (men) by 8 (14) percentage points. The large gender gap reflects intra-household inequality. Equivalence scales perform poorly because they ignore intra-household inequality.

Table 4 reveals that the CBS–SCP equivalence scale of 0.73 underestimates the needs (as singles) of 91% of women in our sample. Moreover, the needs of most men are overestimated. The needs of 39% of women and 79% of men are, respectively, underestimated and overestimated by more than 10% of their total household expenditure. Of particular concern is the group of working-age women in the lower expenditure quartile. For women in the lower half of the household expenditure distribution the needs as singles are on average underestimated by 13% of their current household expenditure. This figure increases to almost 15% for women in the lowest expenditure quartile. Equivalence scales perform especially poorly for these groups because they do not vary with household expenditure.

4.5. *Poverty Lines*

In the remainder of the section we show what implications our findings have for an analysis of the poverty rate. To sketch the problem with traditional poverty rate analysis we will use SCP and CBS (2014) as an example. CBS and SCP use poverty lines that take the needs of a single person as the reference point. Poverty lines for multiple-person households are derived from the singles poverty line by multiplying the latter by equivalence scales. SCP and CBS (2014) report a singles poverty line of $x^s_{pov} =$ €1010, an equivalence scale for couples (relative to singles) of E=1.37 and thus a couples poverty line of $x^c_{pov} =$ €1390. This approach can be justified if the members of a couple with expenditure $x^c_{pov} = E \cdot x^s_{pov}$ are indifferent to living as single persons each with expenditure equal to x^s_{pov}. The approach above assumes that there is no intra-household inequality in couples. When there is intra-household inequality in couples, we cannot be sure that couples with expenditure $x \geq x^c_{pov}$ will allocate this budget in such a way that both members are weakly better off than a single person with expenditure x^s_{pov}.

The goal of this section is to construct a couples poverty line that accounts for intra-household inequality. Such a poverty line can be used in the usual way, by comparing household income to the poverty line measure. To construct such a poverty line we start from the indifference condition

$$V^{cf}(x^s_{pov}, \boldsymbol{p}, \boldsymbol{z}^{cf}) = V^{cf}(x^{cf}_*, \boldsymbol{\pi}, \boldsymbol{z}^{cf}). \tag{15}$$

In Section 4.4 we solved this same condition for expenditure as a single person given a level of individual expenditure as a couple member. Here we solve the condition for individual expenditure as a couple member x^{cf}_* given expenditure as a single person at the poverty line x^s_{pov}. Taking roughly the same steps as in Section 4.4 we find

$$\ln x^{cf}_* = b^{cf}(\boldsymbol{z}^{cf}) \ln (x^s_{pov}) + \sum_{i=2 \cdot G_A+1}^{G} \alpha^{cf}_i(\boldsymbol{z}^{cf}) \ln \pi + \left(b^{cf}(\boldsymbol{z}^{cf}) - 1\right) \alpha_0, \tag{16}$$

We define what we call the naive couples poverty line as $x^c_{pov} = x^{cf}_* + x^{cm}_*$ where x^{cm}_* solves the male version of equation (16). The poverty line is naive in the sense that in practice couples do not choose the allocation $\eta^{cf} = x_*^{cf}/x_{pov}^c$ and $\eta^{cm} = x_*^{cm}/x_{pov}^c$ at the poverty line. With respect to the level of the poverty line this naive approach is the most conservative way of including intra-household inequality. In theory, the solutions for x_*^{cf} and x_*^{cm} can be used for individual-level poverty analysis by comparing them to individual expenditure of couple members. Following the approach described earlier we find that women (men) need on average €694 (€731) as part of a couple to be as well-off as they would be living alone at the poverty line of €1010. The naive version of the couples poverty line is estimated at €1425. The naive poverty line is remarkably close to the €1390 poverty line used in SCP and CBS (2014).

If we want to construct a more sophisticated poverty line, then we need to impose that, in addition to solving the two indifference conditions, the unknowns $x_*^{cf} = \eta^{cf} x_{pov}^c$ and $x_*^{cm} = \eta^{cm} x_{pov}^c$ must satisfy the sharing rule we have estimated earlier. This leaves the system underdetermined. We have two indifference conditions to solve but only one unknown x_{pov}^c. In other words, we cannot implement a specific sharing rule and keep both members exactly indifferent. We therefore replace equation (16) by

$$\ln x_*^{cf} \leq b^{cf}(z^{cf}) \ln (x_{pov}^s) + \sum_{i=2\cdot G_A+1}^{G} \alpha_i^{cf}(z^{cf}) \ln \pi + \left(b^{cf}(z^{cf}) - 1\right) \alpha_0,$$

and/or do the same to the man's indifference condition.[9] A practical implementation is to start from the naive solution of x_{pov}^c, predict the expenditure shares at the naive solution $\eta^{cf} x_{pov}^c$ and $\eta^{cm} x_{pov}^c$, and then increase x_{pov}^c until both $\eta^{cf} x_{pov}^c$ and $\eta^{cm} x_{pov}^c$ are greater than or equal to the naive solutions x_*^{cf} and x_*^{cm}. The sophisticated couples poverty line equals €1781. The higher poverty line results from the more stringent requirement that both members of the couples should be kept indifferent to living at the singles poverty line given the intra-household distribution at the poverty line.[10] Some people may see the intra-household distribution of resources as a private affair. They may argue that intra-household inequality should not be a consideration when constructing a poverty line. The naive poverty line is constructed in line with their views.

In households with expenditure between the naive and sophisticated poverty line at least one member is worse off than a single person at the poverty line given the household's predicted intra-household distribution. This implies that conventional poverty analysis misclassifies members of couples as out of poverty. To illustrate the scope of the problem, we calculate poverty rates based on national accounts data. CBS publishes median levels of household disposable income by

[9]If the inequality form of both conditions is used, then we can find a poverty line by minimizing the squared distance between the left-hand side and right-hand side of equation (4.5) and its male equivalent with respect to x_{pov}^c.

[10]The naive approach implies an intra-household distribution where men control 51 percent of expenditure while we estimate that men control about 41 percent of expenditure at the naive poverty line. The sophisticated couples poverty line therefore approximately equals €731/0.41.

income decile. We calculate approximate poverty rates based on these medians.[11] We find that in 2013 the poverty rate for working-age singles was approximately 21%. This is in line with the 20.6% poverty rate reported by CBS. The poverty rate for couples is approximately 3% based on the CBS–SCP or naive poverty line, and 9% based on the sophisticated poverty line. Depending on which poverty line is used, the poverty rate for couples can differ by a factor of more than three.[12]

The naive and refined poverty line can be used together to obtain an upper bound on the number of individuals living in poverty. In most couples below the naive poverty line both members are in poverty. In couples close to the naive poverty line one member is not in poverty if the intra-household distribution is sufficiently unequal. In couples between the two poverty lines the intra-household distribution of resources ensures that one member is in poverty while the other is not. Therefore, an upper bound for the couple member poverty rate is given by (3+9)/2 = 6 percent based on CBS data. An exact number can be found by predicting each couple member's individual budget and comparing it to the couple member poverty lines.

To demonstrate the bias induced in poverty analysis by using estimates based on full HCIP we have estimated poverty line measures for full HCIP. Due to stronger economies of scale in the full HCIP model, the couple member poverty lines drop to €577 for women and €599 for men. These are reductions by €117 and €132 respectively. The naive and sophisticated couples poverty lines decrease by €250 and €471 respectively. This implies that a substantial number of households are reclassified from poor to non-poor. Poverty lines and poverty rates fall because full HCIP overestimates economies of scale.

Household composition dependence of preferences is important for poverty analysis. We have shown that ignoring household composition dependence of preferences can lead to substantial bias in estimates of economies of scale and the sharing rule. Poverty analysis is very sensitive to this bias.

5. CONCLUSION

This paper uses a collective model of household consumption to explain differences in the consumption allocation patterns of single-person and couple households. We use the model of BCL to explain the allocation of expenditure to five

[11]The poverty rate for household type $k = sf,sm,c$ is approximated as $r^k_{pov} = \sum_{g=1}^{n-1} S^k_g + S^k_n/2 + (S^k_n + S^k_{n+1})/2 \cdot (x^k_{pov} - M^k_n)/(M^k_{n+1} - M^k_n)$, where S^k_g is the share of households of type k that are in group g = 1, …, 10, M^k_g is median income of household of type k in group g, and $M^k_n < x^k_{pov} < M^k_{n+1}$.

[12]As a robustness check we exclude expenditure on joint vacations, a component of leisure expenditure, and reestimate the model. All variables for singles are unaffected by this change. For couples the mean budget share devoted to leisure expenditure almost halves. The mean budget shares of non-assignable goods increase. The model rationalizes these changes in a predictable way. Relative to the baseline, we estimate that couple members have weaker preferences for leisure expenditure and stronger preferences for non-assignable goods. The estimate of economies of scale in non-assignable goods also increases. This implies higher indifference scales (0.83 for women and 0.68 for men), lower poverty lines (naive €1330, and sophisticated €1470), and a lower incidence of poverty for couples (naive 3% and sophisticated 4%).

non-assignable and three assignable goods categories (per household member) by Dutch households in the LISS panel. We explain two key facts observed in the data. First, couples allocate a smaller share of their budget to non-assignable goods than singles. Second, couples allocate a larger share of their budget to leisure expenditure than singles. However, couples and singles assign roughly the same shares to other assignable goods. To explain this second fact we modify the model to allow individual preferences to depend on household composition. We are able to reject the hypothesis that preferences of singles and members of couples are the same controlling for gender. The model with household composition dependent preferences explains allocation patterns significantly better than a model without it.

The wife's share of consumption expenditure is estimated to be 58 percent on average, which is somewhat lower than in comparable studies. We estimate that due to economies of scale couple members effectively pay a 35 percent lower price than singles for non-assignable goods. Members of couples that split up would need to pay 43 percent more to jointly purchase the bundle of goods they purchased as a couple.

We construct a set of indifference scales based on the collective model with household composition dependent preferences. Indifference scales are on average equal to 81 percent of household expenditure for women and 59 percent for men. These results are in line with comparable studies. We compare indifference scales to the equivalence scales used by CBS and SCP. Within our sample, CBS–SCP equivalence scales underestimate the needs of 39 percent of women in couples by more than 10 percent of their total household expenditure. The needs of working-age women in the lowest household expenditure quartile are underestimated by more than 15 percent of their household expenditure. Strong underestimation of the needs of this group is particularly undesirable since this group is already relatively poor.

We discuss the implications of economies of scale, intra-household inequality, and household composition dependent preferences for the analysis of poverty. A traditional poverty rate analysis only accounts for differences in economies of scale between household types. Generally, a couples poverty line is found by equivalence scaling the single-persons poverty line. Instead, we construct a couples poverty line as the expenditure level that allows both members of the couple to be (at least) as well-off when living in the couple as they would be living alone at the singles poverty line. We calculate a naive and a sophisticated version of the poverty line. The naive version is the lowest expenditure level that could, in theory, be used to make both members as well-off. The sophisticated version makes both members at least as well-off for the actual intra-household distribution we predict holds at the poverty line. The naive poverty line for couples is estimated at €1425, slightly higher than the CBS–SCP couples poverty line of €1390. The sophisticated version was estimated at €1781. In households with expenditure between these poverty lines at least one member is worse off than a single person at the poverty line given the households predicted intra-household distribution. This implies that there is substantial scope to misclassify members of couples as out of poverty when using a traditional couples poverty line. Based on national statistics we calculate a naive couples poverty rate of 3 percent, and a sophisticated couples poverty rate of 9 percent. Furthermore, we show that imposing (full) household composition independence of preference substantially biases estimates of poverty lines for couples downward.

The approach taken in this paper could be improved upon. Although we were able to identify Barten scales, the estimates of these scales were imprecise. We restricted Barten scales to a common value. While the loss of fit was small, the restriction does affect the extent to which individuals can re-optimize after a household composition change. As a consequence indifference scales may be somewhat too high. A longer data set with relative price variation would help identify Barten scales. The model may also be extended by including children. This would allow us to explain the demand for child goods, the additional demand for non-child goods, and investigate whether preferences differ between couples with and without children. Finally, the model could be extended to include the labor supply decision. The current analysis is partial in the sense that it treats labor supply and income as exogenous. In reality total expenditure, labor supply, and income are determined simultaneously with the consumption decision. The extended model could also be used to test whether preferences for the allocation of potential expenditure over goods and leisure depend on household composition. This may enhance our understanding of the differences between the labor supply of singles and members of couples.

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Supporting Information

Additional supporting information may be found in the online version of this article at the publisher's web site:

Appendix A: Theory
Appendix B: Derivations
Appendix C: HCIP in general
Appendix D: Endogeneity
Appendix E: Preference parameters
Appendix F: Similarity Across Types