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The economies of scale of living together and how they are shared – Estimates based on a collective household model

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Abstract

How large are the economies of scale of living together? And how do partners share their resources? The first question is usually answered by equivalence scales. Traditional estimation and application of equivalence scales assumes equal sharing of income within the household. This paper uses data on financial satisfaction to simultaneously estimate the sharing rule and the economy of scale parameter in a collective household model. The estimates indicate substantial scale economies of living together, especially for couples who have lived together for some time. On average, wives receive almost 50% of household resources, but there is heterogeneity with respect to the wives' contribution to household income and the duration of the relationship.

JEL Classification : D12, C21, D19

Key Words : Collective Household Models, Sharing Rule, Equivalence Scale, Subjective data

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1. Introduction

How large are the economies of scale associated with living together? And how do households allocate resources to their members? These questions are important for many economic topics such as designing welfare benefits, determining alimony and life insurance payments (Lewbel, 2003), measuring inequality and poverty, and measuring the willingness to pay for public goods (Munro, 2005). Traditionally, the analysis is based on equivalence scales which allow to compare well-being across households with different sizes. Within household distribution of well-being is not an issue, i.e. it is implicitly assumed to be equally distributed. However, if there is unequal distribution of well-being within the household, traditional equivalence scales are biased and misleading in practice. In order to address this problem a richer model of household behaviour is necessary.

From a theoretical point of view, models of household behavior can be classified in two main groups. One strand is the general household utility framework, which goes back to Becker (1974, 1981) and Samuelson (1956). This unitary framework is based on the assumptions that husband and wife have identical preferences[1] and household utility is maximized subject to a single budget constraint. Accordingly, it is irrelevant who earns the money in the household. Redistribution of income within the household does not change household behaviour. This so-called income pooling assumption has been frequently tested and rejected. Example include Attanasio and Lechene (2002), Browning et al. (1994), Donni (2007), Fortin and Lacroix (1997), Lundberg et al. (1997), Phipps and Burton (1998), Thomas (1990) and Ward-Batts (2008). However, as Browning et al. (2006) point out, rejecting income pooling is not sufficient in order to reject the unitary model.

The second strand refers to the collective models of household behavior. The main assumption of this approach is that the individuals within a household have distinct preferences, which have to be considered separately. The standard collective approach assumes that the outcomes of decision making within the household are Pareto efficient (Chiappori, 1988, 1992).[2] A standard result of welfare theory is that Pareto efficient decisions can be written as a constrained maximization of the weighted sum of individual utilities

[1] Alternatively, there can also be an altruistic dictator who controls a larger share of the family income.

[2] Alternative models include cooperative household models as proposed by McElroy and Horney (1981) or Manser and Brown (1979), who describe household behavior as result of a Nash-bargaining game, where the bargaining power depends on the emerging expenditure patterns on the options outside marriage. Non-cooperative household models describe household behavior as a non-cooperative game with no binding and enforceable contracts between the household members and resulting inefficiencies.

$\mu U^f(x^f)+U^m(x^m)$. The Pareto weight μ may depend on prices, total expenditures and on so-called distribution factors. These are defined as variables with no direct influence on preferences, technology or the budget constraint. From a bargaining perspective, the Pareto weight μ can be seen as a measure of the influence of household member *f* on the decision process. One difficulty with using μ as a measure of the weight given to member *f* is that the magnitude of μ will depend on arbitrary cardinalizations of the utility functions *U*.

Recently, Browning, Chiappori and Lewbel (2008, BCL hereafter) have shown that under specific assumptions there exists a unique Pareto weight corresponding to any sharing rule function η and vice versa. The sharing rule is defined as the fraction of household resources that are at the disposal (usually for consumption) of household member *f*. The household behaviour can be described as allocating the fraction η to member *f* and the fraction (1-η) to member *m*. The sharing rule η is invariant to cardinalizations of the utility function. This concept of a sharing rule is part of the standard collective household model. The BCL model is richer than the standard collective models due to the inclusion of a consumption technology function. BCL derive the conditions necessary to estimate the consumption technology function, the sharing rule, and individual preferences and estimate their model using functional form assumptions for these functions.

The BCL model is hard to estimate, and consequently several simplifications have been proposed, either in terms of theoretical restrictions (Lewbel and Pendakur, 2008) or in terms of estimation method (Cherchey et al., 2008). Lise and Seitz (2007) also follow the BCL approach, but focus on the demand for leisure and a composite consumption good. A different approach, also following the main ideas of BCL, has been suggested by Alessie, Crossley, and Hildenbrand (2006, ACH hereafter). They use subjective data on income satisfaction to estimate the parameters of the individual utility functions, the sharing rule and a consumption technology parameter. Subjective data are increasingly used in the happiness literature (see Frey and Stutzer, 2002, for an overview), but also in the collective household framework (e.g. Browning and Bonke, 2009, and Lührmann and Maurer, 2007). Our paper extends the ACH approach. By using a transformation of the income satisfaction variable proposed by Van Praag and Ferrer-i-Carbonell (2006) we are able to directly estimate the structural parameters of the household consumption technology and resource allocation process by nonlinear least squares.

Using data from the Swiss Household panel we find substantial scale economies of living together, especially for couples who have lived together for some time. Total private consumption exceeds household income by almost 50%. The consumption share of a wife increases significantly with her contribution to household income. On average, a wife has a share of almost 0.5 of total private consumption. If she contributes half of household income the consumption share is significantly larger than 0.5, and if she contributes only 25% of household income, her consumption share is significantly below 0.5.

The paper is structured as follows: Section 2 outlines the theoretical model. Section 3 describes the data, and the empirical model and the results are in section 4 and 5. Section 6 concludes.

2. A simple structural collective household model

We specify a collective household model which attempts to capture both returns to scale in household consumption and unequal allocation of resources within the household. As stated in the introduction collective household models are based on individual preferences that are aggregated into household utility according to some rule. Hence we first have to specify individual preferences. Following ACH we assume that individual indirect utility can be described by the PIGLOG specification

$$V = \frac{1}{b(p)}\left(\log x - a(p)\right) = \alpha(p) + \beta(p)\log x\,, \qquad (1)$$

where p denotes prices and x total consumption expenditure. Because we do not observe prices in the data we treat β as a constant parameter. Furthermore, α is specified as a function of observable individual characteristics. The empirical indirect utility function of person i is specified as

$$V_i = \alpha(z_i) + \beta \ln x_i + \varepsilon_i\,, \qquad (2),$$

where V_i is utility, z_i are observable characteristics, and ε_i is the error term. Throughout this section we assume that V is observable. To simplify notation we drop the individual subscript i unless it is necessary for clarity.

This specification implies that preferences are egoistic, that is people only care about their own consumption. Single individuals are assumed to consume their income in each period, i.e.

$$x = y^h\,, \qquad (3)$$

where y^h denotes household income.

The level of individual consumption in couple households, however, may depend on a sharing rule and returns to scale. Returns to scale exist if total private consumption of both household members *f* and *m* exceeds household income. This effect can be captured by writing

$$(x^m + x^f) = y^h / A \text{ or } A(x^m + x^f) = y^h, \tag{4}$$

where x^j denotes consumption of person $j = f,m$. The scalar A can be seen as representing a household consumption technology that transforms household income y^h into total household consumption $(x^m + x^f)$. If $A = 1$ there are no returns to scale (all consumption is private). The logical lower bound for A is 0.5 (all consumption is public). The specification adopted in this paper is a simple version of the more complex consumption technology used by BCL, who estimate a collective household model using expenditure data. By contrast to their model we assume that A is a constant.[3] The parameter A captures the fact that some goods are at least partly public, e.g. housing, household operation, transportation or newspapers. In other words, A^{-1} is an overall returns to scale factor.

Given (4) we can write individual consumption of wife and husband as

$$x^f = \eta^f y^h A^{-1} \text{ and } x^m = (1-\eta^f) y^h A^{-1} \tag{5}$$

where η^f is the sharing rule that determines which share of $y^h A^{-1}$ is allocated to the wife.

The sharing rule depends on so-called distribution factors d (see e.g. Browning, Chiappori and Lechene, 2003). We specify a simple linear sharing rule given by

$$\eta^f = \gamma^0 + \gamma^d d, \tag{6}$$

where γ^d is a vector of unknown parameters. As distribution factors, we may use the ratio of female income to household income, the age difference between the spouses, and the duration of the relationship. While the first two distribution factors are commonly used in the

[3] BCL specify $z_j = \mathbf{A}(q_j^f + q_j^m) + a$, where z_j is an observable vector of household j's consumption of n goods, q_j^f and q_j^m are unobservable vectors of private consumption of both spouses. $\mathbf{A}$ is an n x n nonsingular matrix and a is a n-vector. This linear consumption technology nest familiar cases, e.g. the well-known Barten scales if $\mathbf{A}$ is diagonal and $a = 0$. By contrast to BCL we can only identify an aggregate consumption technology, i.e. $\mathbf{A}$ is diagonal with identical elements A. Assuming the budget constraint holds with equality we have $y_j = p' z_j = (p'\mathbf{A}q_j^f + p'\mathbf{A}q_j^m)$. Given the restriction on $\mathbf{A}$ this simplifies to $A(x_j^f + x_j^m) = y_j$.

collective household literature, the duration of the relationship has not been used yet as far as we know. [4]

Combining equations (2), (5), and (6) gives the indirect utility function for singles and both members of couples as follows. For singles, we get as in (2)

$$V = \alpha(z) + \beta \ln y^h + \varepsilon \tag{7}$$

For females in couples we get

$$\begin{aligned} V &= \alpha(z) + \beta\left\{\ln\left[(\gamma^0 + \gamma^d d) y^h A^{-1}\right]\right\} + \varepsilon \\ &= \alpha(z) + \beta \ln y^h + \beta\left[\ln\left(\gamma^0 + \gamma^d d\right) - \ln A\right] + \varepsilon \end{aligned}, \tag{8}$$

while for males we have

$$\begin{aligned} V &= \alpha(z) + \beta\left\{\ln\left[\left(1 - \left(\gamma^0 + \gamma^d d\right)\right) y^h A^{-1}\right]\right\} + \varepsilon \\ &= \alpha(z) + \beta \ln y^h + \beta\left[\ln\left(1 - \left(\gamma^0 + \gamma^d d\right)\right) - \ln A\right] + \varepsilon \end{aligned} \tag{9}$$

The term in square brackets is individual consumption determined by household income, the returns to scale and the sharing rule. The model is estimated by nonlinear least squares using equation (7) for singles, equation (8) for women in couples, and equation (9) for men in couples. Identification is obtained by restricting α and β to be identical in the three equations. This identification assumption has been made by Browning et al. (2008), Lise and Seitz (2007), Lewbel and Pendakur (2008), Cherchye et al. (2008), and Alessie et al. (2006).

Equivalence and indifference scales

Traditionally, an equivalence scale is defined as the ratio of the expenditures (or income) of two different household types with the same standard of living. Formally, this corresponds to the ratio of the cost functions of two household types evaluated at the same utility level. This requires comparability of the utility levels of different households. The impossibility of inter-household utility comparison lies at the heart of the well-known identification problem of equivalence scales.[5] As BCL state, the notion of household utility is flawed because individuals have utility, not households.

If we cast our model in this framework then household indirect utility may be written as

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4 Recently, Bonke and Uldall-Hansen (2006) have shown that the probability of income pooling increases with the duration of the relationship.

5 See e.g. Lewbel and Pendakur (2008b)

$$V^h = \alpha(z) + \beta \ln x^h + \delta C\,, \qquad (10)$$

where C is a dummy equal to one for couples, and δ is the utility effect of being a couple. This expression reduces to individual utility for single households given in eq. (2). The corresponding log cost function is given by

$$\ln x^h = V^h / \beta - \alpha(z) / \beta - \delta / \beta \cdot C \qquad (11)$$

The resulting log equivalence scale if we take the couple as the reference household is

$$\ln x^s - \ln x^c = \delta / \beta\,,$$

where x^c denotes expenditures of the couple household and x^s are expenditures of the single household. In other words, the log equivalence scale is the utility effect of being a couple scaled by the marginal utility of log income. The traditional equivalence scale is simply $\exp(\delta / \beta)$, which can easily be estimated by regressing utility (as measured by income satisfaction) on log income and a dummy for living in a couple. It measures the proportion of the expenditures (or income) of a couple household a single household needs to be as well off. The small literature on estimating equivalence scales using satisfaction with income data generally provides this estimate (see e.g. van Praag and van der Sar, 1988, Charlier, 2002, Schwarze, 2003, Stewart, 2009). While this approach does not suffer from the usual identification problem that arises when equivalence scales are estimated from consumption data (provided utility is adequately measured), the problem of having specified a household utility function remains.

Let us reinterpret the results of estimating eq. (10) in terms of the individual utility model described above. Given our assumption that preferences do not change when the family situation changes δ cannot be a preference parameter. However, consumption expenditures do change when the living situation changes, i.e. for individuals living in a couple private consumption is given by $x^k = \eta^k y^h A^{-1},\ k = f, m$ as shown in eq. (5). Traditional equivalence scales are based on the assumption of equal sharing, i.e. $\eta^f = \eta^m = 0.5$. Then δ is an estimate of $\beta \ln(0.5A^{-1})$ (see eqs. 8 and 9), and $\exp(\delta / \beta) = 0.5A^{-1}$. In this interpretation, the equivalence scale is equal to half the returns to scale factor. In other words, this approach identifies the equivalence scale under the restriction of equal sharing of consumption.

BCL introduce indifference scales as opposed to traditional equivalence scales. An indifference scale equates the utility of an individual living alone to the utility of the same person if she lived in a couple. In other words, it determines the expenditure change necessary to put the individual on the same indifference curve in both living situations. Taking the couple as point of reference, the indifference scale measures the proportion of household income an individual living in a couple would require to reach the same utility when living alone. This is the relevant statistic for issues like alimony, life insurance, and pensions payments. In our specification, the indifference scale is obtained by setting $V(y^s) = V(\eta y^c A^{-1})$. Independent of any transformations of the utility function, the indifference scales are $\theta^f = \eta A^{-1}$ for women and $\theta^m = (1-\eta)A^{-1}$ for men. Under the restriction that η = 0.5 equivalence scales and indifference scales are formally identical if the analysis is based on estimating the indirect utility function as opposed to the usual approach based on estimating demand systems. If $\eta \neq 0.5$ the estimate of the equivalence scale is biased because there is no unique indifference scale for both spouses in a couple household. The indifference scales are can only be identified if we explicitly model individual preferences as described above.

3. Data

The data source is the Living in Switzerland Survey conducted by the Swiss Household Panel (SHP).[6] This survey is based on a representative sample of the population of permanent Swiss residents. It has been conducted annually since 1999 and covers objective questions on resources, social position, and participation as well as subjective questions on satisfaction, values and evaluations.[7]

Our analysis is based on data from the years 2000 to 2006.[8] The main selection rules we impose are that all single persons are employed, that all men in couples are employed, and that all persons are aged between 20 and 60. After eliminating missing observations, the sample used for our analysis consists of 3’361 single households and 1357 couple households (of which 863 are married). Although the data set is a panel we don not exploit its panel nature in this paper because panel attrition is severe. More than 50% of the individuals have only one observation, and 75% have at most two observations.

6 See also www.swisspanel.ch.

7 There is a household and an individual questionnaire. The household questionnaire includes questions about housing, living standard, financial situation, the household structure and family organization, whereas the individual questionnaire covers topics such as household and family, health and life events, social origin, education, work, income, integration and social networks, politics and values, as well as leisure and internet use.

8 Since not all necessary variables are available for the first wave in 1999, this wave is excluded from this study.

We use the answer to the following survey question to measure individual satisfaction with income:

Overall, how satisfied are you with your financial situation, if 0 means "not at all satisfied" and 10 "completely satisfied?

The satisfaction levels are categorized in eleven groups, ranging from zero (not at all satisfied) to ten (completely satisfied). Figure 1 displays the distribution of reported financial satisfaction levels by sex and marital status. By and large, the distributions are rather similar across these cases. Women more often report the highest satisfaction levels 9 and 10, whereas men have a larger fraction reporting the levels 7 and 8. This is reflected in the higher means of income satisfaction reported in Table 1.

Figure 1: Frequencies of reported levels of satisfaction with financial situation

Data source: Swiss Household Panel, 2000-2006.

Table 1 reports descriptive statistics of the person- and household-specific characteristics included in the regression analysis. We differentiate between 6 types of individuals: single women and men, husbands and wives in legally married couples, and partners in cohabiting couples that are not married. Net annual income is defined as labor as well as non-labor income net of taxes. Single women earn 17% less than single men but are on average more satisfied with their financial situation. Married couples on average have a somewhat higher income than non-married cohabiting couples. Married couples are older, but on average less educated than non-married couples. There is a significant difference in the average satisfaction level between married and cohabiting couples, who are similar to singles with respect to financial satisfaction. Regarding the distribution factors we observe that married couples on average have a much larger duration of their relationship, but also smaller female contributions to total household income. This is partly due to a higher share of non-working wives, but also to the higher share of part-time working wives.

Table 1: Descriptive statistics of person- and household specific characteristics

	Singles		Cohabiting couples		Married couples	
	Men	Women	Men	Women	Men	Women
Net annual household income (in SF)	71’297.46 (37’484.06)	59’357.82 (26’563.43)	122’363.30 (94’991.94)		127’718.00 (77’385.9)	
Income share of woman (in%)			0.42 (0.17)		0.30 (0.19)	
Duration of relationship			6.74 (4.70)		18.59 (11.31)	
Age difference (m – f)			2.564 (4.960)		2.008 (3.982)	
Out of labor force	0	0	0	0.06	0	0.14
Age	39.54 (9.13)	40.63 (10.48)	34.68 (8.09)	32.13 (8.28)	45.01 (10.12)	42.99 (10.45)
Low education	0.08	0.12	0.04	0.06	0.05	0.19
High education	0.34	0.22	0.40	0.32	0.33	0.17
French speaking	0.23	0.27	0.24	0.23	0.26	0.27
Swiss	0.88	0.88	0.85	0.84	0.87	0.86
Financial satisfaction	6.86	7.05	7.02	7.14	7.48	7.67
Number of households	1592	1769	494		863	

Data source: Swiss Household Panel, 2000-2006.
Own calculations
Sample means (standard deviations in parentheses)

The data also contain a variable indicating who is mainly responsible for household finances. This question is only answered by one person per household, hence it is not available for both partners in a couple. This information is not used in estimation, but we analyze ex post whether the estimated sharing rules are correlated with the way the household finances are managed. Table 2 presents a descriptive analysis of the financial responsibility variable.

Table 2: Distribution of responsibility for household income

	Cohabiting couples			Married couples		
	Proportion of households	Mean of wife's contribution to household income	Mean of duration of relationship	Proportion of households	Mean of wife's contribution to household income	Mean of duration of relationship
Woman	0.17	0.45	6.6	0.29	.31	20.5
Man	0.13	0.43	6.8	0.32	.26	18.4
Together	0.50	0.42	6.3	0.37	.32	17.3
Separately	0.20	0.38	7.8	(0.02)	(.40)	(11.1)

Data source: Swiss Household Panel, 2000-2006.
Own calculations
Numbers in parentheses are computed with less than 20 observations

Half of the cohabiting couples manage household income together, while this is the case for only 37% of the married couples. Furthermore, in one fifth of the cohabiting couples the partners manage their income separately. In the remaining 30% one partner is mainly responsible for household income. This fraction is twice as large in married couples, while separate financial responsibility hardly ever is the case.

4. Empirical model

In section 2 we derived a structural individual-level model for indirect utility. In deriving the model we assumed that utility is observable. If we are willing to accept that individual satisfaction with the financial situation of the household is a valid approximation of the individual indirect utility, we can estimate the structural utility parameters. The recent surge in happiness research is based on this assumption. Such measures have repeatedly been validated by psychologists to be a reasonable proxy for utility (see c.f. Frey and Stutzer (2002) for a survey). But the question remains whether it is possible to compare satisfaction levels across individuals. Since individuals are given a well-defined scale for their evaluation it is conceivable that they reply in a comparable manner. At least, this approach seems to work well in a variety of settings (see e.g. Diener and Suh, 1997). The empirical analysis also controls for potential systematic differences in answering behavior by age, gender, nationality, and region of residence. Finally, measurement errors are also prevalent in consumer expenditure data.

Satisfaction responses are observed on an ordinal scale. A natural estimator in this case would be an ordered response model, e.g. ordered probit. However, if we want to estimate the structural parameters directly we need a different estimation method due to the nonlinearity of the utility function with respect to the parameters A and γ. An obvious alternative approach would be to simply use the reported satisfaction levels as the dependent variable in a nonlinear regression model. The drawback is that this will attach cardinal values to the reported satisfaction levels, with equal distances between satisfaction levels and a restricted support of the dependent variable.

Recently, van Praag and Ferrer-i-Carbonell (2006) have proposed to replace the equidistant responses to satisfaction questions by suitable transformations that take account of the sample distribution of the reported satisfaction levels. The transformed variable can be used as the dependent variable in a linear regression. Van Praag and Ferrer-i-Carbonell call this procedure Probit-OLS (POLS) approach. A detailed discussion of POLS is given in their paper.

The transformation of the original response $v \in \{1, 2, ..., k\}$ into the new dependent variable involves three steps:

a) compute the relative frequencies of discrete responses $p_i \; , i = 1, 2, ..., k$

b) compute z_i, $i = 1, 2, ..., k-1$ such that $p_i = \Phi(z_i) - \Phi(z_{i-1})$, where $z_0 = -\infty$ and $z_k = \infty$

c) compute $\overline{v} = E(V \mid z_{i-1} < V \leq z_i) = \dfrac{\phi(z_{i-1}) - \phi(z_i)}{\Phi(z_i) - \Phi(z_{i-1})}$

The transformed variable $\overline{v}$ is used in the regression analysis as left-hand side variable instead of the original *v*. Obviously, $\overline{v}$ is still an ordinal variable, but not equidistant. Rather, the distance depends on the sample probabilities of the satisfaction levels. The estimated coefficients can now be interpreted as shifting the thresholds that generate the sample distribution of responses, exactly as in the ordered probit model.

Van Praag and Ferrer-i-Carbonell (2006) do not formally prove that their transformation yields consistent estimates. However, both heuristically and in several applications they show that POLS is virtually identical to the traditional ordered probit analysis up to a scale factor. If we are mainly interested in marginal effects or in ratios of coefficients, POLS seems to give identical results compared to ordered probit.

As far as we know the performance of POLS in a nonlinear setting has not been analyzed yet. We conducted some Monte Carlo simulations[9] and found that the estimates of the utility parameters α and β of course depend on the scaling of the dependent variable. However, in all simulations we obtained unbiased estimates of γ and *A*. Replicating the reduced form approach of ACH both in the Monte Carlo analysis and with our data also yields almost

[9] The data generation process was designed to mimic the theoretical model of section 2. We generated a continuous latent utility which was split into 11 categories such that the empirical distribution of the ordinal responses was replicated.

identical estimates of the structural parameters regardless of estimation strategy (Bütikofer et al., 2009). This makes intuitive sense because monotone transformations of the dependent variable will change the intercept and slope of the estimated utility function, but not the transformation of household income into individual consumption. The question whether this is true for only modest monotone transformation is left to future research.

5. Results

In this section we present and discuss the empirical results. We proceed in two steps. First, we present a descriptive nonparametric analysis in the spirit of the literature of semiparametric estimation of equivalence scales. This provides a non-formal test of our identification assumptions. Second, we estimate the structural parameters directly by nonlinear least squares. Based on this we discuss the properties of the estimated sharing rules and equivalence scales.

5.1. Nonparametric analysis

In this section we provide a descriptive nonparametric analysis. We estimate the relationship between reported income satisfaction and log of household income by local linear regression, separately for single females, single males, females in couple and males in couples. Figure 2 shows the estimated regression lines.

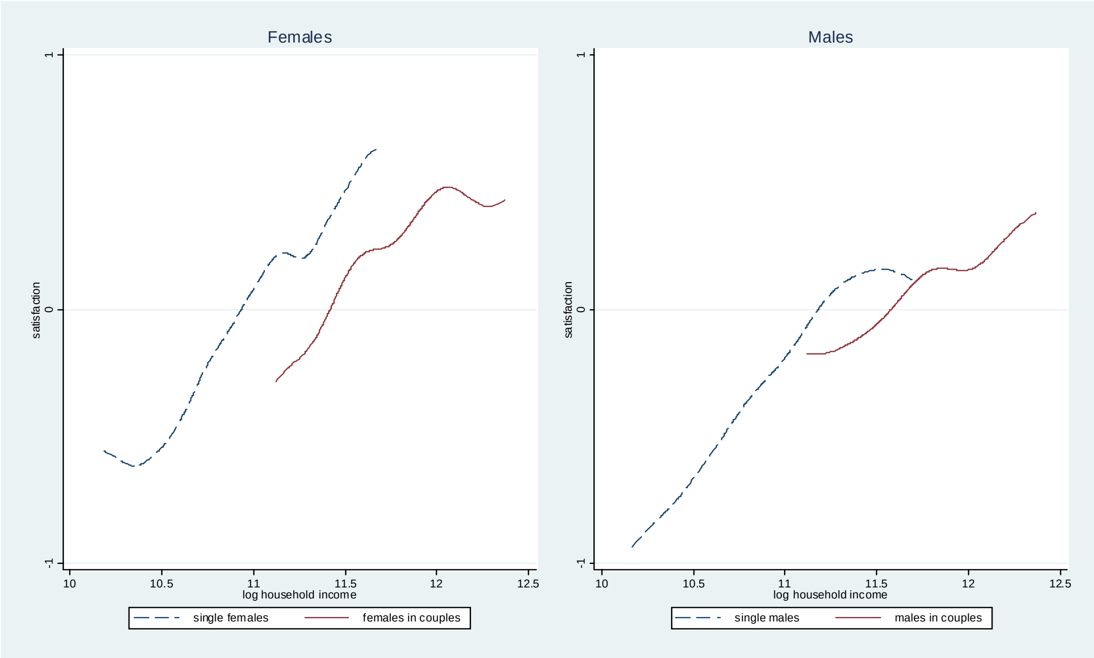
By and large, in all four cases the regression lines are almost linear with similar slopes (except at the boundaries of the support of the independent variable). This is important for the following analysis because identification of A and γ hinges on a constant slope.

The literature of semiparametric estimation of equivalence scales (e.g. Pendakur, 1999, Stengos et al, 2006) is based on nonparametric estimates of Engel curves. The log equivalence scale is estimated as the horizontal shift of , say, the Engel curve of singles, in order to make it lie on the Engel curve of couples.[10] This shift parameter is estimated parametrically by minimizing some loss function with respect to this parameter. A necessary condition to identify the equivalence scale is shape invariance of the Engel curves. By analogy, we can apply the same idea to estimate the equivalence scale based on the estimated regression lines in Figure 2. By contrast to the Engel curve based estimation, we can estimate the shift parameters separately for women and men. Under the maintained assumption that the consumption technology parameter A is the same for men and women, the estimate of the shift

[10] The price elasticity of the equivalence scale (the vertical shift of the Engel curves) is estimated simultaneously.

parameter should not differ significantly. If there is a difference it is due to unequal sharing of household income between spouses. Hence this procedure generates a simple test of equal sharing within the household.

Figure 2: Nonparametric regression of transformed income satisfaction on log household income



Data source: Swiss Household Panel, 2000-2006.
All regressions employ the local linear regression method with cross-validated bandwidth and the Gaussian kernel. Data were trimmed at the 5% and 95% percentiles of the corresponding distributions of log household income. Dependent variable is the POLS transformed satisfaction with income

We also estimated the equivalence scale parametrically by OLS. This simply involves a regression of the POLS-transformed satisfaction $\overline{v}$ on log household income and a couple dummy (and possibly further control variables) and computing the horizontal shift parameter as δ/β (see section 2).

The results of the estimated shift parameters and the implied equivalence scales are displayed in Table 3. For both genders we report three sets of results: the OLS based and the semiparametric estimates[11] without further control variables, and OLS based results with further control variables. There is a difference between the female and male equivalence scales, which is significant at the 10% level if no further control variables are used. This is true both for the OLS based and the semiparametric estimates. With further controls, however, the difference becomes insignificant. The simple test therefore is inconclusive with respect to the equal sharing hypothesis. However, as the results in the next section suggest this test result may be caused by the fact that on average the sharing rule is in fact almost 0.5. In order to gain more information we now turn to the estimation of the structural model described in section 2.

Table 3: Estimates of the shift parameter and the implied equivalence scales

	Females			Males		
	without controls		with controls	without controls		with controls
	OLS	Semi-parametric	OLS	OLS	Semi-parametric	OLS
Shift parameter	-.438	-0.50	-.388	-.276	-0.26	-.304
equivalence scale	**.645***	**0.61***	**.678**	**.758**	**0.77**	**.738**

Standard errors in parentheses
Estimated equation is $\overline{v} = \beta_0 + \beta \ln y + \delta C + controls + u$
shift parameter = δ/β
equivalence scale = exp(*shift parameter*)
Controls include age, age squared, education dummies, dummies for foreigner and French speaking
*: *significantly different from corresponding male estimate at 10% level*

5.2. Estimation of structural model

In this section we discuss the estimation of the structural model. The dependent variable is the transformed income satisfaction $\overline{v}$. The estimated model consists of eq. (7) for singles, eq. (8) for females in couples, and eq. (9) for males in couples. The model is estimated by nonlinear least squares with standard errors adjusted for clustering due to the panel structure of the data. Table 4 displays the estimation results. As distribution factors we use the female contribution to household income and the duration of the relationship. We also experimented with total household income and the age difference between partners as distribution factors, but both turned out to be completely insignificant in the sharing rule. The female contribution to household income enters the sharing rule linearly. We tested this against a spline function of the contribution and could not reject the linear effect. The distribution factors are both normalized to mean zero. Hence, γ^0 is an estimate of the share of total household consumption a wife with mean of female contribution to income and mean duration of the relationship receives. The first set of results refers to all couples. In the second and third

[11] The semiparametric estimates are obtained by minimizing the loss function proposed by Stengos et al. (2007). The nonparametric functions which are horizontally translated are those shown in Figure 2.

column, couples are differentiated according to whether they are legally married or cohabiting without being married.[12]

In column 1 of Table 4 the consumption technology parameter *A* is 0.68. This estimate indicates that the sum of individual private consumption of both spouses exceeds household income by 47% (1/0.68 = 1.47). It suggests substantial returns to scale of living together. The parameters of the sharing rule are all significant. At the mean of the distribution factors, women have a consumption share of 0.48, which is not significantly different from 0.5. This share increases significantly with the woman's contribution to household income and the duration of the relationship. Increasing the female income contribution by 10%-points increases her consumption share by roughly 4%-points. Ten more years of relationship also increase the consumption share by roughly 4%-points.

Table 4: Regression results structural model: nonlinear least squares

	(1) All		(2) Married couples		(3) Cohabiting couples	
A	0.680***	(0.0430)	0.618***	(0.0457)	0.865***	(0.0679)
γ^0	0.483***	(0.0240)	0.494***	(0.0260)	0.458***	(0.0296)
wife's income contribution (γ^1)	0.398***	(0.0815)	0.353***	(0.0946)	0.474***	(0.143)
duration of relationship (γ^2)	0.0479**	(0.0148)	0.0446**	(0.0165)	-0.0594	(0.0504)
log household income (β)	0.583***	(0.0418)	0.601***	(0.0430)	0.614***	(0.0503)
female	0.182***	(0.0447)	0.183***	(0.0446)	0.202***	(0.0461)
age	-0.0342*	(0.0141)	-0.0408**	(0.0153)	-0.0346*	(0.0168)
age squared/100	0.0535**	(0.0172)	0.0590**	(0.0185)	0.0478*	(0.0209)
low education	-0.0629	(0.0585)	-0.0709	(0.0613)	-0.0885	(0.0710)
high education	0.0751	(0.0386)	0.0675	(0.0428)	0.132**	(0.0447)
french speaking	-0.222***	(0.0381)	-0.230***	(0.0408)	-0.228***	(0.0445)
foreign	-0.188***	(0.0488)	-0.214***	(0.0518)	-0.148*	(0.0617)
Constant	-5.963***	(0.498)	-6.003***	(0.515)	-6.143***	(0.586)
Observations	6075		5087		4349	
adj. R^2	0.13		0.14		0.11	

Standard errors in parentheses
Estimation also used time dummies. Standard errors are adjusted for clustering by persons.
** p<0.10, ** p<0.05, *** p<0.01*

Column 2 of Table 4 displays the results for legally married couples. Compared to column 1 there is a smaller estimate of *A* which corresponds to a larger return to scale factor of 1.61. By contrast, for cohabiting couples the estimated *A* is much larger implying a return to scale factor of only 1.16 (column 3). This finding may be explained by the fact that married couples, on average, have lived together much longer which allowed them to improve their consumption technology. This is also reflected by the estimate for the distribution factor

[12] We also estimated the model in two steps, first on singles only and plugging these estimates into the second step to estimate *A* and γ. This procedure is less efficient and yields almost identical results. We also experimented with different

"duration of relationship", which is important for married couples, but completely irrelevant for cohabiting couples. The effect of the female partner's contribution to household income on the sharing rule, on the other hand, is stronger for cohabiting couples.

The estimated sharing rule

In Table 5 we present calculations of how the sharing rule changes with the distribution factors as well as the distribution of the estimated sharing in our sample. We compute the estimated shares at income contributions of 0, 25%, 50% and 60%.[13] If the female contribution to household income is 50% her consumption share is 0.54 and significantly larger than 0.5 at the 10% level. It drops to 0.44 if the woman only contributes 25% of household income and increases to 58% if the contributes 60% of household income. If she does not contribute to household income at all her estimated consumption share is 0.35. These estimates are significantly different from 0.5 at the 5% level.

The differences by civil status are also reflected in the estimated sharing rules displayed in Table 5. The consumption shares of the females are larger in married couples at all levels of contribution to household income. A married woman contributing 50% to household income has a consumption share of 0.56, and this estimate is significantly larger than 0.5. If a married woman contributes 25% to household income her consumption share of 0.47 is not significantly smaller than 0.5. Without contributing to household income a married woman's consumption share is 0.39.

By contrast, a woman in a cohabiting couple has a consumption share of almost exactly 0.5 if she contributes 50%. to household income. It does not increase significantly if her income contribution increases to 60%. On the other hand, with small income contributions the female consumption share is rather small, dropping to 0.26 if she does not contribute at all. However, this estimate has a rather large standard error.

selections of singles (excluding divorced and widowed individuals, excluding those who are in a relationship but do not live together), but again results are robust with respect to the definition of a single person.

[13] We did not use a contribution of 75% because only 1% of the sample have a contribution of at least 75%.

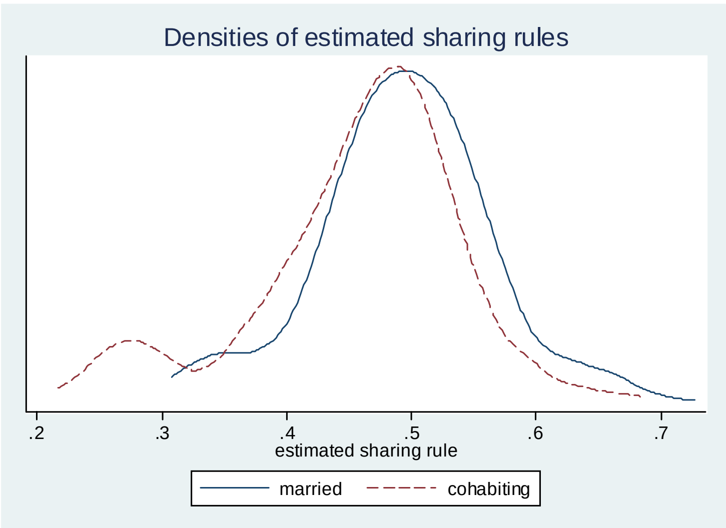
Table 5: The estimated sharing rule

	All		Married Couples		Cohabiting couples	
	η		η		η	
income contribution =0 [a]	.345**	(.037)	.386**	(.039)	.259**	(.065)
income contribution =0.25 [a]	.444**	(.025)	.474	(.027)	.378**	(.037)
income contribution =0.50 [a]	.544*	(.026)	.562**	(.031)	.497	(.033)
income contribution =0.60 [a]	.584**	(.032)	.598**	(.038)	.544	(.041)

Standard errors in parentheses
[a] *Sharing rules are evaluated at the mean of the years of relationship*
* *denotes significant difference from 0.5 at 10% level,* ** *denotes significant difference at 5% level*

Figure 5 shows Kernel density estimates of the predicted sharing rules. The density of the female share in married couples lies to the right of the corresponding density for cohabiting couples. Further analysis reveals that almost 75% of all females in cohabiting couples have an income share less than 0.5. Overall, the distribution of estimated income shares mimics the female contribution to household income much closer in cohabiting couples than in married couples. This may be explained by the result that married couples generate much larger returns to scale which allows them to redistribute more consumption from males to females.

Figure 3: Distribution of estimated sharing rules



Data source: Swiss Household Panel, 2000-2006.
Based on regression results of Table 4.

In Table 6 we analyze how the estimated shares correlate with the reported responsibility for household income. We regress the predicted female shares on the indicators for financial responsibilities, controlling for household income and the age difference of the partners. None of these variables have been used to estimate the sharing rule. Recall that only one person per household responded to the financial responsibility question.

For married couples we find that if there is only one partner responsible for household finances she or he is able to shift about one percent of household consumption to her or his own use compared to joint financial responsibility. This result makes intuitive sense and gives some credibility to the estimated sharing rules. In cohabiting couples, separate management of individual incomes reduces the female consumption share by 0.03, which probably is caused by the fact that couples with separate financial responsibilities also have the smallest female income contribution (see Table 2).

Table 6: Relationship of estimated sharing rule with responsibility for household income

	Married couples		Cohabiting couples	
Woman decides	0.011*	(0.006)	0.010	(0.010)
Man decides	-0.015***	(0.006)	0.006	(0.011)
Separate decisions	-		-0.029***	(0.010)
Household income (ln)	0.034***	(0.005)	0.029***	(0.009)
Age difference	-0.002***	(0.001)	-0.002**	(0.001)
Constant	0.098	(0.063)	0.123	(0.109)
Observations	843		494	
adj. R^2	0.07		0.04	

Data source: Swiss Household Panel, 2000-2006.
OLS regression coefficients
Standard errors in parentheses
* *p < 0.10,* ** *p < 0.05,* *** *p < 0.01*

Indifference scales

Table 7 displays the estimated indifference scales introduced in section 2. Obviously, the indifference scale always sum up to the return to scale factor A^{-1}, with the estimated consumption shares as weights. At the mean of the distribution factors the female indifference scale is 0.71 and the male indifference scale is 0.76. In other words, a woman needs 71% of household income to reach the same utility when she lives alone, while a man needs 76%. The difference is rather small and not significantly different from zero. When we evaluate the indifference scales at other values of the woman's contribution to household income, the differences become larger. If the woman does not contribute to household income her scale drops to 0.51, i.e. she would need half of household income to be as well off when living alone. The husband, on the other hand, would need almost all of household income in that situation. The opposite result emerges when the woman contributes 60% of household income. In this case she would require 86% of total household income to be as well off when living alone, while her husband would only need 61%.

As expected, the indifference scales for married couples are larger than the indifference scales for cohabiting couples. At the mean of the distribution factors both partners of a married couple would need roughly 80% of household income if they were to live alone. With equal contributions to household income, the wife would need 90% of household income to be on the same indifference curve, whereas the husband would only need 70%. If the woman contributes 60% to household income she would need almost all of total household income to be as well off alone. By contrast, if the man contributes all household income, he would need all of it when living alone.

By contrast, female partners in cohabiting couples only need about half of household income to be as well off as living alone (computed at the means of the distribution factors). Their male partners would need 63%. If both partners contribute 50% to household income they both would need about 57% of household income when living alone. None of the differences are significant. With small income contributions, the female indifference scale becomes relatively small (0.43 if she contributes 25% of household income), and even with a income contribution of 60% her indifference scale is only 0.63.

Table 7: Indifference scales

	(1) All				(2) Married Couples				(3) Cohabiting couples			
	female		male		female		male		female		male	
mean income contribution [a]	.71	(.05)	.76	(.05)	.80	(.07)	.82	(.07)	.52	(.05)	.63	(.06)
income contribution = 0 [a]	.51	(.06)	.96**	(.08)	.62	(.08)	.99**	(.10)	.30	(.08)	.86**	(.10)
income contribution = 0.25 [a]	.65	(.05)	.81*	(.06)	.76	(.07)	.85	(.07)	.43	(.05)	.72**	(.07)
income contribution = 0.50 [a]	.80	(.06)	.67*	(.05)	.91	(.08)	.71*	(.07)	.57	(.06)	.58	(.06)
income contribution = 0.60 [a]	.86	(.07)	.61**	(.05)	.97	(.10)	.65**	(.08)	.63	(.07)	.53	(.06)

Own calculations based on parameter estimates in Table 4
Standard errors in parentheses
[a] *indifference scales are evaluated at the mean of the years of relationship*
The indifference scale is proportion of household income an individual needs if she or he moves from living in a couple to living alone
* *denotes significant difference at 10% level,* ** *denotes significant difference at 5% level*

Comparison to previous research

In this section we briefly discuss the results from other papers based on the BCL approach. BCL use Canadian expenditure data from 1974 – 1992. They specify a richer consumption technology that differs across consumption goods, i.e. they estimate good-specific Barten scales. As distribution factors, BCL use the wife’s contribution to household income, the age difference between the spouses, a home-ownership dummy, and total household expenditure. They compute an overall measure of the economies of scale in consumption that varies between 1.27 and 1.41 (see Table 4 in BCL).[14] Our estimate is 1.47 (= 1/*A*). BCL's benchmark estimate of the sharing rule is 0.65, which appears to be quite large. BCL argue that this may be explained by the fact that household demand functions look more like women's demand functions than men's demand functions (p. 31). The estimated indifference scales vary between 0.58 and 0.74 for women, and 0.50 and 0.70 for men, depending on the restrictions imposed on the model.

Cherchye et al. (2008) analyse expenditure data for Dutch pensioners from 1978 – 2004. They compute the same overall measure of the economies of scale of living in couple as BCL. On average, this measure is 1.32. The average income share of the female is 0.49. They use real total expenditure and the education difference as distribution factors. The indifference scales for women in couples increase from 0.49 (evaluated in the bottom total real expenditure quartile) to 0.82 (evaluated in the top total real expenditure quartile). For men, the reverse pattern can be observed, i.e. the indifference scales drop from 0.81 to 0.50.

Lewbel and Pendakur (2008) estimate a simplified version of the BCL model also using Canadian expenditure data (1990 and 1992, no price variation). The simplification is achieved by imposing a shape invariance restriction on the Engel curves. They obtain estimates of the scale economy parameter of 0.70 for women and of 0.78 for men with average characteristics, but the estimates are very imprecise. Their benchmark estimate of the sharing rule is in the range of 0.36 – 0.46. As distribution factors, Lewbel and Pendakur use the female contribution to household income, and male and female age and education. Overall, their results are close to ours.

ACH is closest to our paper in term of methodology. They estimate a reduced form version of the model described in section 2 for 10 European countries.[15] Compared to our results the estimates of *A* in ACH are rather small, often below 0.6, in some cases even below 0.5. On the other hand, their estimate of the sharing rule evaluated at the mean of the distribution factors is above 0.5 in almost all cases. The estimates which are most similar to ours refer to the UK with estimates of $A = 0.69$ and a mean sharing rule of 0.49 (Table 6 in ACH).

[14] Their overall measure *R* is defined as (equivalent expenditures/actual expenditures) – 1; hence *R* is in the range 0.27 – 0.41 in their Table 4.

[15] The structural parameters can be obtained from the reduced form parameters by a straightforward minimum distance step (c.f. their paper).

6. Conclusions

Based on a collective household model, this paper provides estimates of the returns to scale of living together and of the rule of sharing consumption among spouses. Household income is transformed into individual consumption by a consumption technology (the returns of scale) and the rule that determines how much each member receives. An individual living alone has the same utility from his income as an individual living in a couple who receives individual income according to the above transformation. Assuming that preferences do not change by living together, it is possible to identify the returns to scale and the sharing function from data on singles and couples. This identification result is one of the major contributions of Browning, Chiappori, and Lewbel (2008). In this setup, it is possible to identify so-called indifference scales which allow to make welfare comparisons between the same person in different living conditions.

We use data on financial satisfaction as a measure of indirect utility received from individual consumption. The estimated consumption technology parameter in our preferred specification implies that scale economies increase the sum of individual consumption of both members to 1.47 times household income. The estimated sharing rule is somewhat smaller than 0.5 at the mean, but above 0.5 if the women contributes exactly 50% to household income. It varies significantly both with the wife's contribution to household income and with the duration of the relationship. At the mean of the estimated sharing rule the female indifference scale is 0.71, while the male indifference scale is 0.76. These numbers measure which proportion of the couple's total income each member would need to be as well off when living alone.

There is heterogeneity of the results with respect to the civil status of couples. Married couples have a better consumption technology and a more equalizing sharing rule than couples that are not (yet) married. This leads to indifference scales that are much larger for married couples than for cohabiting couples. Both partners in married couples require about 80% of total household income in order to be as well off when living alone. This percentage is much smaller for cohabiting couples, where the female partners only need about 52% and male partners about 63% of total household income. These numbers are evaluated at the means of the estimated sharing rule.

The analysis can be extended in several ways. More work needs to be done with respect to estimation of models with satisfaction data, especially nonlinear models with panel data. Another extension would be to consider more flexible specifications for individual utility. If the data are available a very promising extension would be a combination of subjective satisfaction data with expenditure data.

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