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CFS Working Paper No. 2008/24

Confronting the Robinson Crusoe paradigm with household-size heterogeneity

Christos Koulovatianos[1], Carsten Schröder[2], and Ulrich Schmidt[3]

August 7, 2008

Abstract:
Modern macroeconomics empirically addresses economy-wide incentives behind economic actions by using insights from the way a single representative household would behave. This analytical approach requires that incentives of the poor and the rich are strictly aligned. In empirical analysis a challenging complication is that consumer and income data are typically available at the household level, and individuals living in multimember households have the potential to share goods within the household. The analytical approach of modern macroeconomics would require that intra-household sharing is also strictly aligned across the rich and the poor. Here we have designed a survey method that allows the testing of this stringent property of intra-household sharing and find that it holds: once expenditures for basic needs are subtracted from disposable household income, household-size economies implied by the remainder household incomes are the same for the rich and the poor.

JEL Classification: C42, E21, D12, E01, D11, D91, D31, I32

Keywords: Linear Aggregation, Representative Consumer, Equivalence Scales, Survey Method, Household-Size Economies

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Governments, corporations, and the public are eager to know about the performance prospects of a national or regional economy as a whole, in order to evaluate and develop economic policies and business strategies. Macroeconomic analysis seeks to understand the incentives behind aggregated economic choices in the overall economy. The mainstream macroeconomic paradigm *(1)* relies upon an artificial construct, the "representative consumer" *(2-5)*, whose choices always coincide with actual aggregated choices under any commodity prices. This idea links the behavior of the "small" (the household as a microeconomic unit) with the "large" (aggregated choices of households), motivating that the study of aggregate demanded quantities of a consumer basket reveals an accurate summary of incentives behind economic actions in the overall economy. The necessary and sufficient conditions underlying the existence of a representative consumer are extremely stringent, requiring that incentives driven by needs and wants of the rich and the poor are strictly aligned *(6)*.

In empirical analysis of macroeconomic models a difficulty is that consumer and income data are typically available at the household level, and individuals in multi-member households have the potential to share goods within the household (housing, home appliances, transportation, etc.). Whenever intra-household sharing takes place, larger households need lower per-capita income in order to attain a certain level of material comfort *(7)*, i.e., household-size economies are achieved. For maintaining the cornerstone assumption of modern macroeconomic theory, an extremely stringent condition is necessary to hold: once expenditures for basic needs of larger or smaller household types are subtracted from disposable household income, household-size economies implied by

the remainder household incomes should be the same for the rich and the poor *(6)*. Here we have designed a survey method that allows the testing of this stringent property of intra-household sharing. The method is equipped with a tool to test whether respondents understand the survey's questions and communicate credible information.

Alignment of incentives and choices

In classical economics, incentives behind consumer choices of households are captured by utility functions: functions that relate the consumed quantities of goods with ordinal evaluations of material comfort. These functions possess structure that leads to a unique best choice for households that are price-takers. Mainstream macroeconomics focuses on the utility that an infinitely-lived dynasty (seen as a household) obtains by the consumption flow of a composite commodity basket throughout an infinite horizon.

Using the neoclassical paradigm for household behavior that can be incorporated into macroeconomic environments with production, first, we fully characterize the class of utility functions of heterogeneous households that leads to the existence of a representative consumer: a fictitious consumer whose preferences represent an entire community-preference profile (the set of utility functions of all household types), and whose choices always coincide with actual aggregated choices under any price regime. These preferences are the same as the "Gorman preferences" indicated as sufficient for the existence of a representative consumer in other studies *(3-5)*. We show *(6)* that the requirement that a representative consumer exists in the presence of household-size heterogeneity implies that a linear relationship necessarily links all equivalent incomes

(EIs) in an economy: household incomes that equalize the level of material comfort of persons living in different household types.

Approach for estimating economies of household size

To quantify household-size economies is to estimate EIs. Economies of household size take place if the additional expenditure needed by a household with an additional member to keep its level of material comfort at the same level as before is less than 100% of the EI of a one-member household. For this reason, from a set of EIs of different household types, it is plausible to view the EI of a one-member household as a benchmark and call it reference income (RI). Based on household-level income data, the one-member-household EI can be assigned to each household member and all individuals of an economy can be viewed as living in separate one-member households.

There is no general agreement on a method to determine which EIs should be used in official statistics. Econometricians use consumer expenditure data of different household types and make assumptions in order to build demand systems that identify when two households with different demographic composition have the same level of material comfort. Results are sensitive to these assumptions *(10-11)*. Thus, the OECD and the U.S. Bureau of Labor Statistics (BLS) use an expert who assigns EIs to different household types relying on her/his intuition, insights, and familiarity with descriptive statistics from household data *(12)*. Still, experts disagree *(13)*. For these reasons we have designed a survey method where we ask respondents to provide us with their own assessments of EIs for a set of household types.

The motivation of our survey relies on the idea that respondents are experienced at recognizing the connection between a household's demographic composition and the level of material comfort that income can buy for its members. In this sense, respondents are 'real-life experts' in assessing EIs. Pooling diverse insights of a large number of respondents may correct potential biases of a single expert. Our method is equipped with a tool that tests whether people 'mean what they say' *(14)*.

It is an open question as to whether people are 'expert enough' to answer the following type of question: "What is the net monthly household income that can make a household with two adults and a child attain the same level of material comfort as that of a one-member household with a net monthly income of $2,000?" Respondents must have sufficient information to assess EIs for households with a demographic composition and a level of material comfort that differ from their own actual experiences. Otherwise, estimates of EI may suffer from limited information bias (LIB). Moreover, respondents should demonstrate sufficient understanding in answering the question about assessing EIs. To test for this crucial aspect of survey effectiveness, we also pose an equivalent assessment problem using different means of representation, and then cross-check for consistency.

Survey design

Our questionnaire consists of two main parts *(6)*. In Part A, we pre-assign a net monthly income for a one-member household, a reference income (RI), and ask respondents to state EIs for seven other household types. Each respondent is randomly assigned one of several RIs. The question asked is of the following type: "What is the net monthly household income that can make a household with two adults and a child attain the same level of material comfort as that of a one-member household with a net monthly income of $2,000? What income would one need if, instead, there were two children in the household?"

In Part B we pose an equivalent assessment problem to this of Part A, using different means of representation to cross-check for consistency: Likert-scale evaluations *(15)* of material comfort. The question we ask is: "Consider that the net monthly household income of a household with two adults and one child is $5,500. State a number from 1 to 100 that best characterizes the level of material comfort of this household, given that '10' is 'very bad,' '50' is 'sufficient,' and '90' is 'very good.'" Respondents receive such a question for the one-member household and the seven household types of Part A. Household incomes evaluated in Part B were obtained through a previous pilot study in Germany using the same RIs as in Part A *(16)*. If a respondent states a Likert-scale value for a household type with pre-assigned income Y that is higher than what she/he stated for the one-member household with the RI in Part B, then, in Part A, this respondent should have stated an EI for that household type that is lower than Y.

Testing whether "people mean what they say"

The existence of a common, "cardinal" perception of verbal characterizations such as "good" or "bad" is not guaranteed *(9)*. This problem can make stated Likert-scale values in Part B noisy across individuals. To suppress such inter-respondent noise we construct the variable "normalized Likert-scale evaluation" (NLSE). The NLSE uses the stated Likert-scale value concerning the one-member household as a benchmark, and measures the deviation of each other Likert-scale value stated *by the same respondent* from this benchmark. If people "mean what they say," the NLSE should be negatively correlated with deviations of the stated EIs from the RIs provided in Part A *(17)*.

Consistency between responses in Parts A and B of the survey is tested through the inclusion of NLSE in regression analysis. In our sample, NLSE exhibits low variation across respondents, and a large fraction of respondents have NLSE values equal to or near zero *(6)*. All coefficients of NLSE are negative (see Table 1) and exclusion tests are always rejected ($P<0.001$), supporting the premise that the survey elicits credible information *(6)*. The reason why NLSE should be included as a conditioning variable in the regression is that it can control for deviant opinions by some respondents about household-size economies, e.g., about the costs of children *(18)*. Nevertheless, the estimated NLSE coefficients indicate that such effects are small.

Testing for LIB

To test for LIB, we distinguish answers from respondents who state an EI for the household type and/or living standard that is the same as their own, from answers given about the same household type and/or living standard by respondents whose characteristics are different. The presence of LIB is tested in regression analysis through a test of exclusion of dummy variables that identify this relationship between respondents' personal characteristics and the features of households that respondents evaluate. Generally, LIB does not exist, or it is small when present: only in 2 tests out of 21 cases LIB dummy coefficients are significant ($P<0.05$), and only in one case the exclusion test is rejected ($P<0.01$) *(6)*. Still, in these two cases the impact of LIB on EI estimates is small. LIB tests show that respondents exhibit a sufficient ability to evaluate hypothetical households with characteristics different from their own. The NLSE tests in conjunction with these LIB tests show that the agreement concerning EI assessments among the groups of respondents distinguished by the LIB dummy variables is not due to common misunderstanding.

In regression analysis we use a large set of other personal characteristics of the respondents as conditioning variables. Education plays a small role, with the more educated respondents stating higher EIs, but only for household types with children. Probably, more educated parents pursue higher education for their children. Respondents who live in the former East Germany stated moderately higher EI values in all cases *(19)*. No other personal characteristics appear robust *(6)*.

Patterns of Household-Size Economies

The scatter plots of responses in Part A of the survey appear in Figure 1. They suggest that the relationship between EI and RI is linear: for all seven household types, a sixth-degree polynomial least-squares curve is hardly distinguishable from a linear fit (for the fourth RI (EUR 2,750) only, the polynomial fit indicates a slight deviation downwards).

F tests of the linear specification in regression analysis indicate that the linear specification is never rejected at $P<0.01$: test statistics vary within the moderate values from 2.36 to 3.60, and the coefficients of RI dummy variables are small. All straight lines appearing in Figure 1 have a positive intercept ($P<0.001$), indicating the presence of fixed costs in consumption (e.g., minimum housing rents, basic nutrition, heating, etc.). Fixed costs in consumption are a plausible explanation about why household-size economies are smaller when the RI is low *(20)*. When income is low, household members are forced to spend higher shares of income on vital needs, such as food and clothing, minimum housing space, expenditures with, plausibly, low sharing potential.

This linear relationship among EIs is also present in all pilot studies we have previously run in six countries, appearing in Figures 2 and 3. Figures 2 and 3 present the scatter plots for purchasing-power-parity (PPP) adjusted Euros for Germany in year 2006. A sixth-degree polynomial fit is visually close to a line, and the linear specification test passes ($P<0.001$) in all 42 cases examined *(6)*. What distinguishes these pilot studies from the

present survey is that smaller samples have been used and each respondent stated EIs for all RIs.

Conclusions

A challenge with estimating household-size economies is that the extent to which people share goods within a household is a 'black box,' difficult to observe or measure directly. Our survey instrument in its pilot form, where the same respondent is called to evaluate five different RIs, revealed a robust linear pattern between EIs and RIs (see Figures 2 and 3). This regularity is astonishing, but it could be that respondents approximate the connection between RI and EI using a linear rule of thumb, and that the average of such linear mappings is still linear. Yet, when each of five independent groups of respondents evaluate a different RI, finding the linear pattern between RI and EI again (see Figure 1), supports the premise that such a simple pattern pervades economic incentives and decisions. This interpretation of the finding is validated by the fact that respondents must think of what decisions members of hypothetical households make before stating their EI assessments.

The surprising simple relationship among EIs lends support to the stringent assumption made by macroeconomists, that the rich and the poor have the same orientation in their incentives and actions, responding similarly to, say, oil-price changes: so, whole aggregate demands in markets may behave as if driven by a single representative individual. Yet, having EIs linearly related is only a reconfirmation of a necessary condition that should hold if the Robinson Crusoe paradigm is true, not a solid proof of

the paradigm itself. So, further study and more stringent tests of the paradigm are needed. Most importantly, why this surprisingly simple pattern is present begs for an answer, which might come from evolutionary theory, sociological theory of social norms, or from evolutionary biology examining the natural tendency of humans to imitate/cooperate.

Not least, quantifying household-size economies is of separate value on its own: it is potentially useful to epidemiological studies assessing how social inequalities and stressors affect health outcomes in a society *(21)*; to studies examining the connection between child poverty and child outcomes *(22)*; to the development of sociological and ethnological theories of the structure of the family and cultural transmission *(23-24)*; to economic explanations of fertility trends *(25)*; to the design of welfare systems for children and single parents *(26-27)*. In particular, for the formulation of applied models that address policy issues related to marriage decisions *(28)*, fertility *(29)*, and labor participation decisions *(30)*, accurate estimates of household-size economies are an essential prerequisite and 'goodness-of-fit' criterion. Our study has suggested and tested a reliable instrument to estimate household-size economies.

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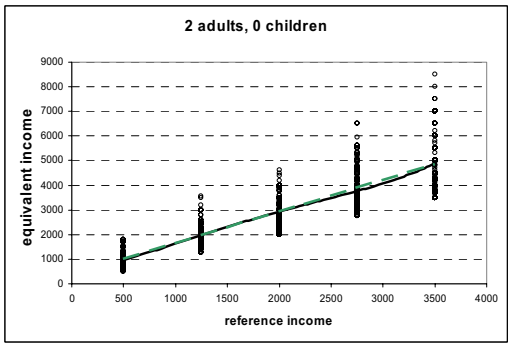
Table 1. Summary of ordinary least squares regressions. Endogenous variable: ratio of equivalent income stated by respondents divided by reference income. Number of observations: 2,042; p-values of F-tests in brackets. *** p<0.001, ** p<0.01, * p<0.05.

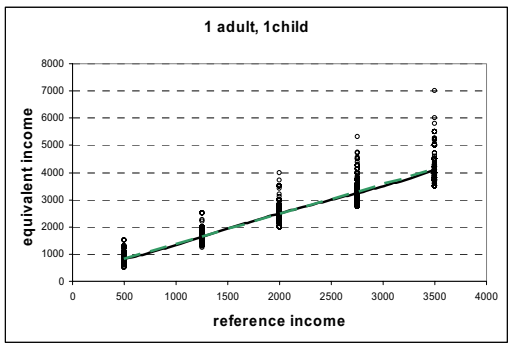
	Household type						
	1 adult, 1 child	1 adult, 2 children	1 adult, 3 children	2 adults, 0 children	2 adults, 1 child	2 adults, 2 children	2 adults, 3 children
Constant	1.06***	1.12***	1.20***	1.42***	1.44***	1.53***	1.61***
Reciprocal of reference income	269.74***	498.34***	728.85***	329.38***	592.99***	839.25***	1,079.86***
Dummy reference income equals 1,250 Euros	0.00	-0.00	-0.02	0.03	0.00	-0.02	-0.04
Dummy reference income equals 2,000 Euros	0.02*	0.02	0.02	0.00	-0.00	-0.00	-0.02
Dummy reference income equals 2,750 Euros	-0.02*	-0.04**	-0.07**	-0.05*	-0.08**	-0.11***	-0.13***
Normalized Likert-scale evaluation	-0.04***	-0.07***	-0.10***	-0.05***	-0.07***	-0.09***	-0.13***
Same family type of respondent	0.04	-0.01	-0.14*	0.02	0.02	0.01	0.01
Same living standard of respondent	-0.01	-0.03	-0.03	-0.04	-0.00	-0.03	-0.05
Same family type and living standard of respondent	-0.06	0.13	-0.03	0.05	-0.16*	-0.02	-0.04
Adjusted R^2	0.46	0.53	0.54	0.30	0.46	0.52	0.54
F test statistic for exclusion of all reference-income dummy variables	2.36 [0.07]	3.07* [0.03]	3.29* [0.02]	3.60* [0.01]	3.37* [0.02]	3.45* [0.02]	3.51* [0.01]

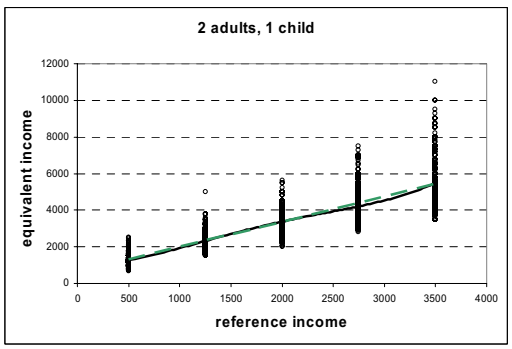
Figure 1. Scatter plots of stated EIs in Part A of the survey for each RI and each family type.

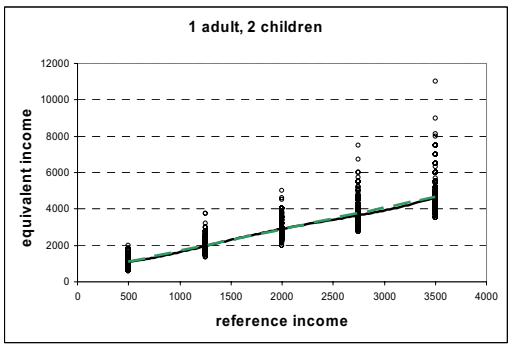
—— 6th degree polynomial fit.

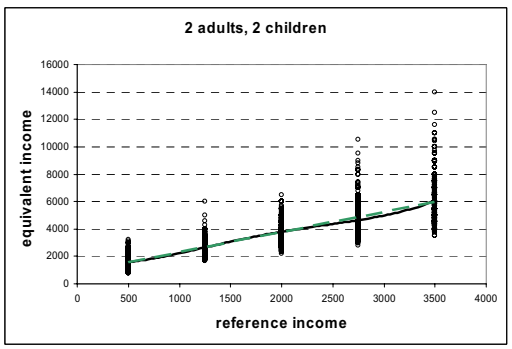
- - - linear regression.

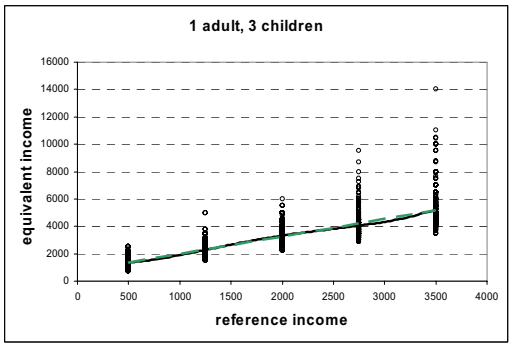












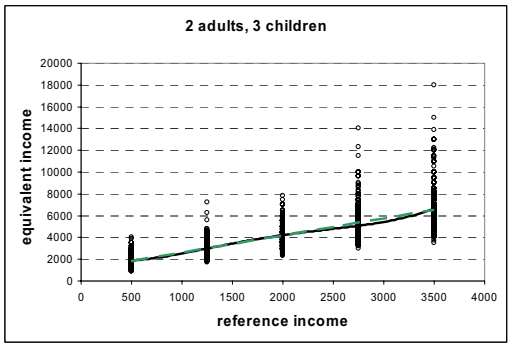


Figure 2. Scatter plots of stated equivalent incomes.
6th degree polynomial fit
France
China
Germany

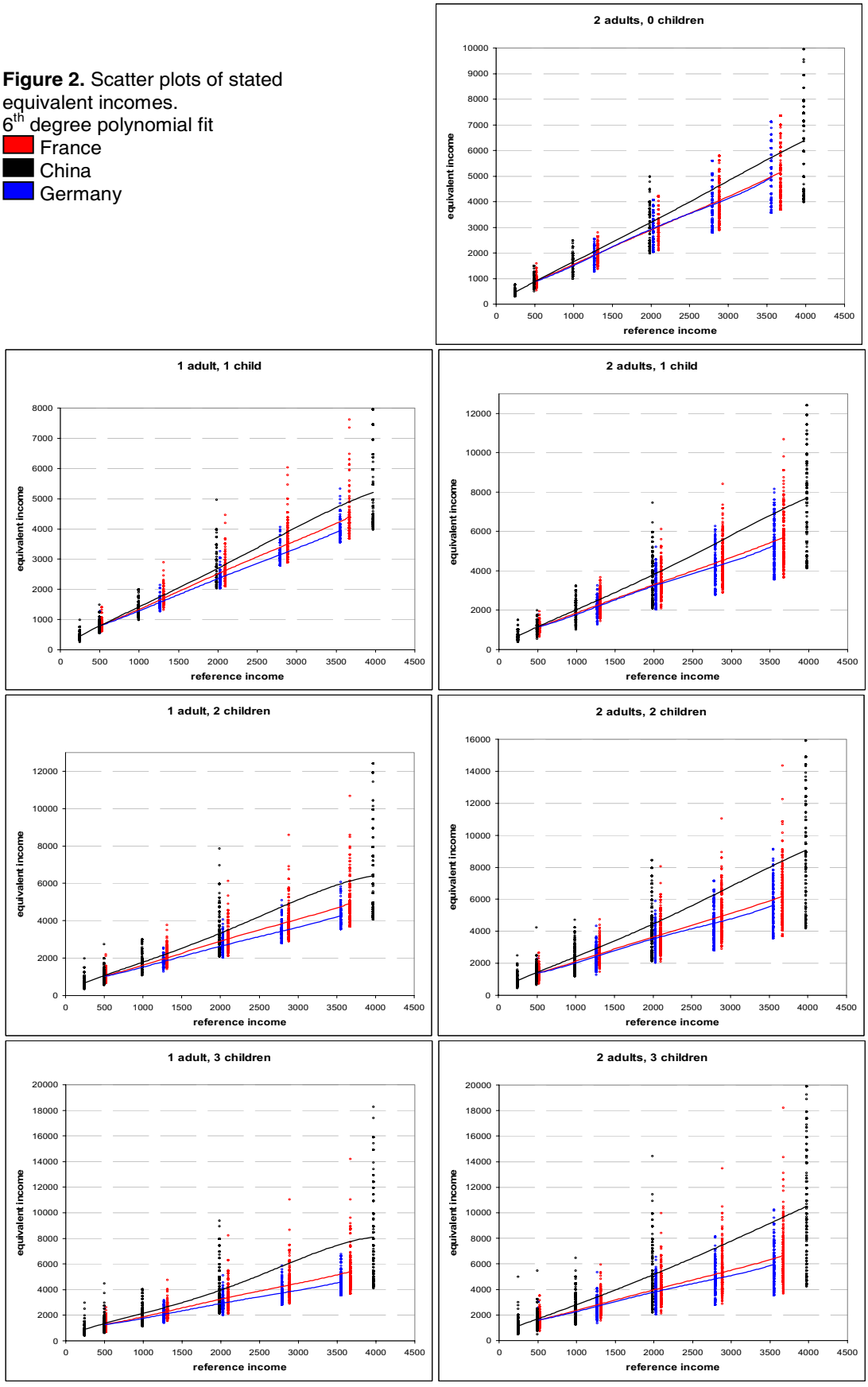
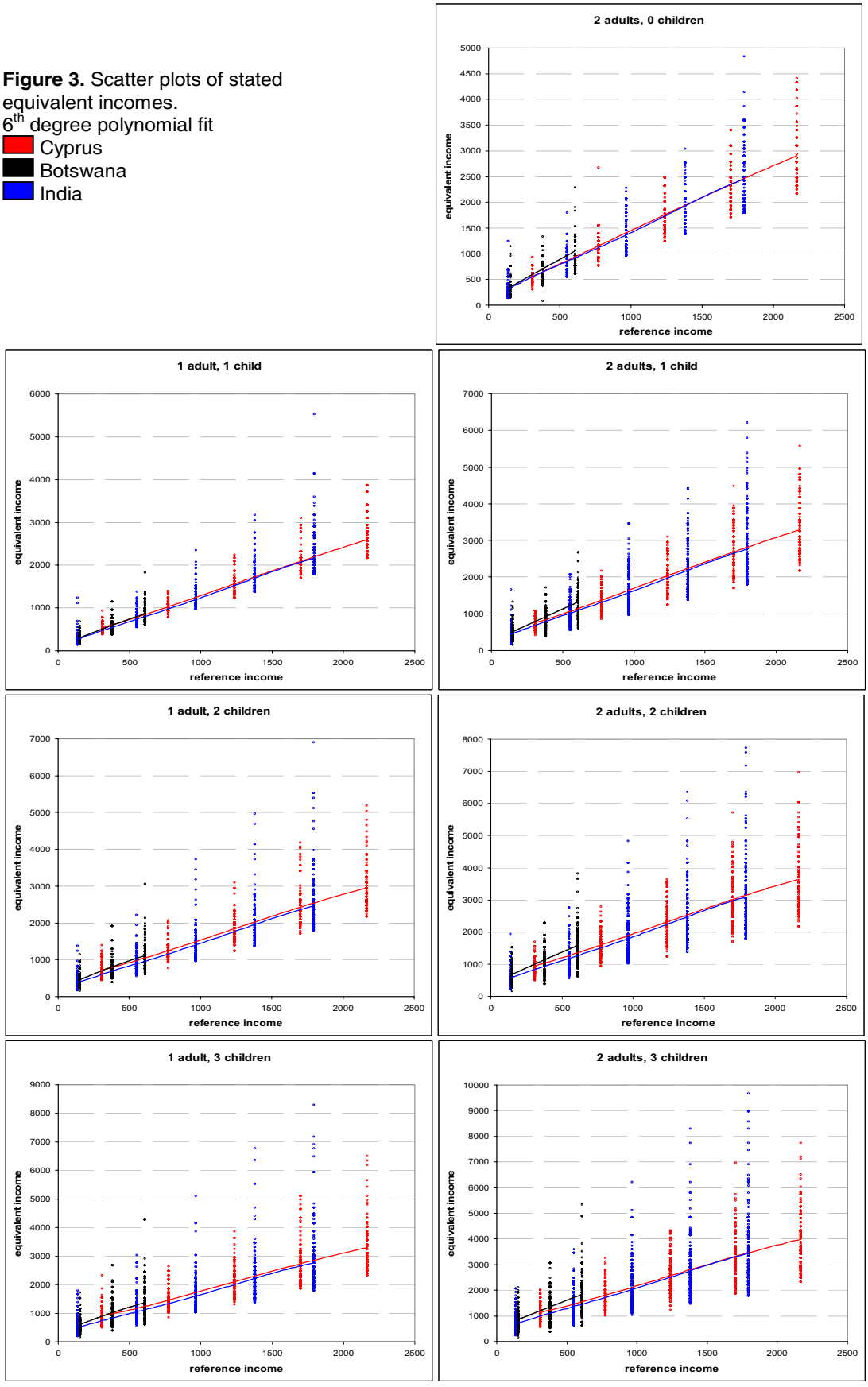


Figure 3. Scatter plots of stated equivalent incomes.
6th degree polynomial fit
Cyprus
Botswana
India



Supporting Material

for

"Confronting the Robinson Crusoe paradigm with household-size heterogeneity"

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Part 1: Theoretical Results

Objective. Using the neoclassical paradigm for household behavior that can be incorporated into macroeconomic environments with production, first, we fully characterize the class of utility functions of heterogeneous households that leads to the existence of a representative consumer: a fictitious consumer whose preferences represent an entire community-preference profile (the set of utility functions of all household types), and whose choices always coincide with actual aggregated choices under any price regime. Then, we show that the requirement that a representative consumer exists in the presence of household-size heterogeneity implies that equivalent incomes (EIs) are necessarily linked through a linear relationship.

Background studies and new results presented in this study. For a set of heterogeneous households that live for one period and decide once and for all about the consumption of different consumer goods, Gorman *(S1)* has shown that the indifference curves of a representative consumer are non-intersecting if, and only if, Engel curves for all traded commodities are always linear and parallel across all households for any given price regime. In a later study Gorman *(S2)* has shown that, for Engel curves to be linear and parallel, utility functions must meet a particular functional property; this property has led Pollak *(S3)* to a complete characterization of the set of utility functions of households that allow the existence of a representative consumer, under the assumption that all utility functions are additively separable with respect to each different good. Concerning households that act for more than one period, in particular for households that are infinitely-lived dynasties, previous work has focused on households that consume a single composite consumer basket and

accumulate financial wealth over time: Chatterjee *(S4)* and Caselli and Ventura *(S5)* have identified household utility functions that are sufficient for the existence of a representative consumer. Here we complete their work by showing the set of utility functions that is also *necessary* for the existence of a representative consumer (see Theorem 1 below in this Supporting Material). With this new comprehensive result, we can firmly claim that, following the mainstream macroeconomic paradigm, the existence of a representative consumer in the presence of household-size heterogeneity implies that EIs are necessarily linked through a linear relationship.

Description of the Economic Environment

Time is continuous and the time horizon is infinite, $t \in [0, \infty)$. Households are all infinitely-lived and comprise a constant set $\mathcal{I}$ of different types, with generic element i. The set of household types can be countable, finite, or a continuum. It can also be that all households are of the same type, but in all cases there is a "large" number of households, making each of them having negligible impact on the aggregate economy, or else, all households are price-takers. Assume a measure $\mu : \mathcal{I} \to [0, 1]$, which has a density, $d\mu$, with,

$$\inf \{d\mu(i) \mid i \in \mathcal{I}\} > 0 \ . \tag{1}$$

So, if $\mathcal{I}$ is finite, $d\mu(i) > 0$ for all $i \in \mathcal{I}$, whereas if $\mathcal{I}$ is a compact interval, $d\mu(i)$ is continuous on $\mathcal{I}$ and bounded away from 0. Households of different types can differ with respect to their initial endowment of capital claims (assets) and also with respect to their labor productivity which is given by the exogenous function of time, $\theta^i : \mathbb{R}_+ \to \mathbb{R}_+$. Asset holdings for household $i \in \mathcal{I}$ at time 0 are denoted as a_0^i.

There is a single private consumable good. Household preferences of each $i \in \mathcal{I}$, are given by the general additively-separable utility function with a common across households

rate of time preference captured by the positively-valued function $\rho : \mathbb{R}_+ \to \mathbb{R}_{++}$, where

$$U^i\left(\left(c^i(t)\right)_{t\geq 0}\right) = \int_0^\infty e^{-\int_0^t \rho(\tau)d\tau} u^i\left(c^i(t)\right) dt \ . \tag{2}$$

Assumption 1 *For all $i \in \mathcal{I}$, $u^i : \mathbb{R}_+ \to \mathbb{R}$, is twice-continuously differentiable and such that $u_1^i(c) > 0$ and $u_{11}^i(c) < 0$ on some interval, $\mathbb{C}^i \subseteq \mathbb{R}_+$, with both $u_1^i(c) < \infty$ and $-\infty < u_{11}^i(c)$ for all $c \in \mathbb{C}^i \subseteq \mathbb{R}_+$, with $\underline{c}^i \equiv \inf(\mathbb{C}^i) < \sup(\mathbb{C}^i) \equiv \bar{c}^i$.*

Assumption 1 secures that, for all $i \in \mathcal{I}$, there is a choice domain, $\mathbb{C}^i \subseteq \mathbb{R}_+$, which is an interval, and where standard desirable properties of momentary utility functions are present. Assumption 2 allows households to choose consumption paths such that, asymptotically, the consumption level is non-decreasing.

Assumption 2 $\int_0^\infty e^{-\int_0^t \rho(\tau)d\tau} dt < \infty$ *for all $i \in \mathcal{I}$.*

All households are endowed with the same amount of time at each moment, supplied for labor inelastically. The momentary time endowment is normalized to one, without leading to loss of generality: if a household is larger and more than one members work, given that labor supply is inelastic, personal labor incomes within the household can be summed up and the household's total labor income can be used instead.

For any given price vector $(r(t), w(t))_{t\geq 0} >> 0$, with $r(t)$ being the interest rate and $w(t)$ the labor wage per unit of time at each moment, the budget constraint faced by household $i \in \mathcal{I}$ is,

$$\dot{a}^i(t) = r(t)\, a^i(t) + \theta^i(t)\, w(t) - c^i(t) \ , \tag{3}$$

for all $t \geq 0$, ($\dot{x}(t) \equiv dx(t)/dt$ for any variable x) and the transversality condition is,

$$\lim_{t\to\infty} e^{-\int_0^t r(\tau)d\tau} a^i(t) = 0 \ . \tag{4}$$

We define the domains of wealth- and productivity heterogeneity at any given price vector, for which the existence of a representative consumer is conceptually relevant. That is the domain that guarantees interiority of solutions to each individual optimization problem. The following assumption states this formally.

Assumption 3 *Given a community preference profile captured by the collection of functions* $(u^i)_{i\in\mathcal{I}}$ and ρ, *the domain of, (i) initial distribution of assets* $(a_0^i)_{i\in\mathcal{I}}$, *(ii) the collection of labor-productivity functions* $\left(\theta^i\right)_{i\in\mathcal{I}}$, *and (iii) prices* $(r(t), w(t))_{t\geq 0}$, *is restricted so that the optimization problems of all households* $i \in \mathcal{I}$ *are well-defined, and the solution to each individual problem is interior for all* $t \geq 0$.

Given Assumption 3, maximizing (2) subject to the constraints (3) and (4) for any given a_0^i is an optimal-control problem with necessary optimality conditions given by,

$$\dot{c}^i(t) = -\frac{u_1^i\left(c^i(t)\right)}{u_{11}^i\left(c^i(t)\right)}\left[r(t) - \rho(t)\right] \ , \tag{5}$$

together with (3) and (4), that lead to decision rules of the form,

$$c^i(t) = C^i\left(a^i(t)\ , t \,\middle|\, \left(r(\tau), w(\tau), \theta^i(\tau)\right)_{\tau\geq t}\right) \ , \tag{6}$$

i.e., consumption rules at each moment are memoryless, depending only on current personal assets and current and future prices. Assumptions 1 and 3 have a particular connection, that is revealed from equation (5). The term $-\frac{u_1^i\left(c^i(t)\right)}{u_{11}^i(c^i(t))}$ must always be well-defined in order to have interiority. Thus, to meet Assumption 3 (interior solutions), it is necessary that $c^i(t) \in \mathbb{C}^i$, for all $t \geq 0$, and all $i \in \mathcal{I}$.

Definition 1 *Given a community preference profile captured by the collection of functions* $(u^i)_{i\in\mathcal{I}}$, and ρ, *complying with Assumptions 1 and 2, a representative consumer (denoted by "RC") is a (fictitious) consumer who has time-separable preferences,* $\int_0^\infty v^{RC}(c(t),t)\,dt$, *with* $v_1^{RC}(c,t), v_{11}^{RC}(c,t)$ *and* $v_{12}^{RC}(c,t)$ *existing, and with* $v_1^{RC}(c,t) < \infty$ *and* $-\infty < v_{11}^{RC}(c,t), v_{12}^{RC}(c,t)$ *for all consumption levels,* $c \in \mathbb{C}^{RC} \equiv \left\{c \in \mathbb{R}_+ \middle| c = \int_{\mathcal{I}} c^i d\mu(i)\ ,\ c^i \in \mathbb{C}^i,\ i \in \mathcal{I}\right\}$, *for all* $t \geq 0$, *and who possesses the economy-wide aggregate wealth and productivity at all times, and whose demand functions coincide with the aggregate demand functions of the economy at all times, namely,*

$$c^{RC}(t) = C^{RC}\left(\int_{\mathcal{I}} a^i(t)\,d\mu(i),\ t\ \middle|\ \left(r(\tau), w(\tau), \int_{\mathcal{I}} \theta^i(\tau)\,d\mu(i)\right)_{\tau\geq t}\right) =$$

$$= \int_{\mathcal{I}} C^i\left(a^i(t)\ ,\ t\ \middle|\ \left(r(\tau), w(\tau), \theta^i(\tau)\right)_{\tau\geq t}\right) d\mu(i)\ , \qquad (7)$$

for all $t \geq 0$, *for the complete domain of prices* $(r(t), w(t))_{t\geq 0}$, *initial distributions of assets,* $(a_0^i)_{i\in\mathcal{I}}$, *and functions* $\left(\theta^i : \mathbb{R}_+ \to \mathbb{R}\right)_{i\in\mathcal{I}}$ *that comply with Assumption 3.*

This is a rather strong representative-consumer concept: it focuses on solving only one household's problem using standard optimal-control techniques, in order to derive aggregate demands at all times. Our goal is to examine conditions on the community preference profile that are necessary and sufficient for the existence of social preferences (representative-consumer preferences) consistent with the independence axiom of Koopmans *(S6)*: if two different intertemporal paths have a common outcome at a certain point in time, preferences over these two paths should always, and solely, be determined by comparing them with

remaining outcomes at that particular date that differ. In other words, the focus of our analysis is to characterize community preference profiles where social preferences are time-separable and, at each separate point in time, non-intersecting social indifference curves exist.

Assumption 4 $\bigcap_{i\in\mathcal{I}} \mathbb{C}^i$ *is non-empty and not a singleton.*

Assumption 4 places a weak constraint on the scope of preference heterogeneity. It says that nobody's bliss point (if any), should be lower than or equal to anyone else's subsistence level of consumption (if any), hence $\bigcap_{i\in\mathcal{I}} \mathbb{C}^i$ is an interval. Since the consumable good is considered to be a composite good (a consumer basket), Assumption 4 is not unreasonably restrictive.

The main result

Theorem 1 *Under Assumptions 1 through 4, a representative consumer exists if and only if*

$$u^i(c) = \begin{cases} \frac{(\alpha c+\beta_i)^{1-\frac{1}{\alpha}}-1}{\alpha\left(1-\frac{1}{\alpha}\right)} & \text{with } \alpha > 0 \text{ and } \beta_i \in \mathbb{R} \text{ or } \alpha < 0 \text{ and } \beta_i \in \mathbb{R}_{++} \\ \text{or} & \\ -e^{-\frac{1}{\beta_i}c} & \text{with } \beta_i > 0 \end{cases}, \tag{8}$$

for all $i \in \mathcal{I}$. The representative consumer has the common, across households, rate of time preference, $\rho(t)$, at all times, and momentary utility function given by,

$$u^{RC}(c) = \begin{cases} \frac{(\alpha c+\beta_{RC})^{1-\frac{1}{\alpha}}-1}{\alpha\left(1-\frac{1}{\alpha}\right)} & \text{for } \alpha \neq 0 \\ -e^{-\frac{1}{\beta_{RC}}c} & \text{else} \end{cases}, \tag{9}$$

with

$$\beta_{RC} = \int_{\mathcal{I}} \beta_i d\mu(i) \ .$$

The proof of Theorem 1 appears at the end of this supplementary information. Theorem 1 states comprehensively that the existence of a representative consumer rests upon particular functional forms and common parameter values: the elasticity of intertemporal substitution,

α, should be the same across all households; households can differ only with respect to their subsistence consumption or bliss point of consumption; yet, it is either that all households have some subsistence consumption, or that all households have some bliss point, but bliss points and consumption subsistence levels cannot coexist in the same community preference profile.

These restrictions on the community preference profile, $(u^i)_{i\in\mathcal{I}}$, lead to *common orientation of incentives and actions of rich and poor, or large versus small, households*. In particular, the *consumption decision rules* of all household types, $i \in \mathcal{I}$, are of the form,

$$c^i(t) = b(t)\, a^i(t) + \zeta^i(t) \ ,$$

i.e., they *are always linear in financial wealth, $a^i(t)$, and parallel across all households* (see the sufficiency part in the proof of Theorem 1 below).

Introducing household-size heterogeneity and the necessity of the linear relationship across EIs

Consider the unitary-model for households *(S7)*, that individuals in multi-member households maximize a common objective function, a standard assumption in mainstream macroeconomics. Moreover, for simplicity, assume that $\rho(t) = \rho$ for all t, another standard assumption of the macroeconomic paradigm, and also that households of the same size all have the same utility function. If a representative consumer exists, then utility functions should fall in the class given by Theorem 1. Focusing on the case where $r(t) = \bar{r} = \rho$ for all t, and with $w(t) = \bar{w}$, and $\theta^i(t) = \bar{\theta}^i$ for all t, a steady-state condition for all households, (5) and (3) imply that

$$c^i = \bar{r}a^i + \bar{w}\bar{\theta}^i = y^i \ , \tag{10}$$

where y^i is the income of household i in the steady state. In our survey questionnaire, asking respondents about monthly incomes refers to the above steady state conditions where households consume their incomes. Substituting (10) for different household types in the utility functions given by Theorem 1,

$$u^i(c) = \begin{cases} \omega_i \frac{(\alpha c+\beta_i)^{1-\frac{1}{\alpha}}-1}{\alpha\left(1-\frac{1}{\alpha}\right)} & \text{with } \alpha > 0 \text{ and } \beta_i \in \mathbb{R} \text{ or } \alpha < 0 \text{ and } \beta_i \in \mathbb{R}_{++} \\ \text{or} & \\ -\omega_i e^{-\frac{1}{\beta_i}c} & \text{with } \beta_i > 0 \end{cases},$$

where ω_i is a weight depending on household size, in a steady-state equilibrium, setting $u^i(y^i) = u^j(y^j)$ for all $i, j \in \mathcal{I}$, leads to

$$y^j = \chi_{i,j} + \psi_{i,j} y^i \ ,$$

which is the linear relationship among EIs for all household types.

Proof of Theorem 1

Part 1: Necessity

Fix any function $\rho : \mathbb{R}_+ \to \mathbb{R}_{++}$, and any collection $(u^i)_{i\in\mathcal{I}}$, with properties complying with Assumptions 1, 2, and 4. Assume that a representative consumer exists with some momentary utility function $v^{RC} : \mathbb{C}^{RC} \times \mathbb{R}_+ \to \mathbb{R}$, of the form $v^{RC}(c(t), t)$, at each point in time. Under Assumption 3, from Definition 1 and (5) it must be that,

$$\frac{v_1^{RC}\left(\int_{\mathcal{I}} c^i(t)\, d\mu(i), t\right)}{v_{11}^{RC}\left(\int_{\mathcal{I}} c^i(t)\, d\mu(i), t\right)}\left[r(t) + \frac{v_{12}^{RC}\left(\int_{\mathcal{I}} c^i(t)\, d\mu(i), t\right)}{v_1^{RC}\left(\int_{\mathcal{I}} c^i(t)\, d\mu(i), t\right)}\right] = \int_{\mathcal{I}} \mu(i)\frac{u_1^i(c^i(t))}{u_{11}^i(c^i(t))} di\,[r(t) - \rho(t)]\ , \tag{11}$$

where the term

$$-\frac{v_{12}^{RC}\left(\int_{\mathcal{I}} c^i(t)\, d\mu(i), t\right)}{v_1^{RC}\left(\int_{\mathcal{I}} c^i(t)\, d\mu(i), t\right)}$$

is the temporal rate of time preference of the representative consumer.

(Necessity) Step 1: preliminary characterization of the function $\int_0^\infty v^{RC}(c(t), t)\, dt$.

According to Definition 1, the existence (and the implied preference primitives) of the representative consumer should be independent from any price regime. The case where $r(t) = \rho(t)$ for all $t \geq 0$, should always be included in the price domain. To see this, fix any moment in time, $t \in \mathbb{R}_+$, pick any household $i \in \mathcal{I}$, and multiply her budget constraint, (3), by the integrating factor $e^{-\int_t^\tau r(s)ds}$, integrate over all $\tau \in [t, \infty)$, and apply the transversality condition, to obtain,

$$\int_t^\infty e^{-\int_t^\tau r(s)ds} c^i(t)\, d\tau = a^i(t) + \int_t^\infty e^{-\int_t^\tau r(s)ds}\theta^i(\tau)\, w(\tau)\, d\tau\ . \tag{12}$$

For the case $r(t) = \rho(t)$ for all $t \geq 0$, under Assumption 3, (5) implies that $\dot{c}^i(t) = 0$ for all $t \in \mathbb{R}_+$, and all $i \in \mathcal{I}$, so, (12) implies that

$$c^i(t) = \hat{c}^i = \frac{a^i(t) + \int_t^\infty e^{-\int_t^\tau \rho(s)ds} \theta^i(\tau) w(\tau) d\tau}{\int_t^\infty e^{-\int_t^\tau \rho(s)ds} d\tau} \text{ , for all } t \geq 0. \tag{13}$$

For the given preference profile, $(u^i)_{i\in\mathcal{I}}$, (13) implies that there are always $\left(a_0^i, \theta^i\right)_{i\in\mathcal{I}}$ and $(w(t))_{t\geq 0}$ securing that $\hat{c}^i \in \mathbb{C}^i$ for all $i \in \mathcal{I}$, and for all $t \geq 0$. So, the case $r(t) = \rho(t)$ for all $t \geq 0$, is always part of the domain complying with Assumption 3, for any $(u^i)_{i\in\mathcal{I}}$ that satisfies Assumptions 1, 2, and 4.

Thus, set $r(t) = \rho(t)$ for all $t \geq 0$ and pick an appropriate $\left(a_0^i, \theta^i\right)_{i\in\mathcal{I}}$ and $(w(t))_{t\geq 0}$ securing that $\hat{c}^i > \underline{c}^i$ for all $i \in \mathcal{I}$, and for all $t \geq 0$, and also set,

$$c \equiv \int_{\mathcal{I}} \hat{c}^i d\mu(i) \ .$$

Equations (11) and (13) imply that the necessary optimality conditions of the representative consumer are,

$$-\frac{v_{12}^{RC}(c,t)}{v_1^{RC}(c,t)} = \rho(t) \ .$$

So, standard Riemann integration with respect to t over the time interval $[0,t]$ implies that,

$$v_1^{RC}(c,t) = e^{-\int_0^t \rho(\tau)d\tau} v_1^{RC}(c,0) \ ,$$

or,

$$v^{RC}(c,t) = e^{-\int_0^t \rho(\tau)d\tau} v^{RC}(c,0) \ ,$$

ignoring the constant, since this is a utility function. Setting,

$$u^{RC}(c) \equiv v^{RC}(c,0) \ ,$$

we conclude that the objective of the representative consumer must be of the form,

$$U^{RC}\left((c(t))_{t\geq 0}\right) = \int_0^\infty e^{-\int_0^t \rho(\tau)d\tau} u^{RC}(c(t)) dt \ . \tag{14}$$

For notational ease, let $f^{RC}:\mathbb{C}^{RC}\to\mathbb{R}_{++}$ and $(f^i:\mathbb{C}^i\to\mathbb{R}_{++})_{\,i\in\mathcal{I}}$, with

$$f^{RC}(\cdot)=-\frac{v_1^{RC}(\cdot)}{v_{11}^{RC}(\cdot)}\qquad\text{and}\qquad f^i(\cdot)=-\frac{u_1^i(\cdot)}{u_{11}^i(\cdot)}\quad\text{for all } i\in\mathcal{I}.$$

Combining (14) with (11), it is,

$$f^{RC}\left(\int_{\mathcal{I}}c^i(t)\,d\mu(i)\right)=\int_{\mathcal{I}}f^i\left(c^i(t)\right)d\mu(i)\ , \tag{15}$$

for all $(c^i(t)\in\mathbb{C}^i)_{i\in\mathcal{I}}$ that are consumer-equilibrium choices and $t\geq 0$.

(Necessity) Step 2: characterization of $f^{RC}:\mathbb{R}_+\to\mathbb{R}_{++}$ *and* $(f^i:\mathbb{R}_+\to\mathbb{R}_{++})_{\,i\in\mathcal{I}}$. In this step we show that,

$$(15)\Leftrightarrow\left\{\begin{array}{c} f^i(c)=\alpha c+\beta_i\ ,\ \text{ and,}\\ f^{RC}(c)=\alpha c+\int_{\mathcal{I}}\beta_i d\mu(i)\ ,\\ \text{for some }\alpha\in\mathbb{R}\text{ and some }\beta_i\in\mathbb{R},\text{ for all }i\in\mathcal{I}\end{array}\right\}. \tag{16}$$

The sufficiency part of (16) is straightforward. For the necessity part of (16), let (15) hold, being the only information available concerning $f^{RC}:\mathbb{R}_+\to\mathbb{R}_{++}$ and the collection $(f^i:\mathbb{R}_+\to\mathbb{R}_{++})_{\,i\in\mathcal{I}}$. Suppose that $r(t)=\rho(t)$ for all $t\geq 0$, and, given (13), find a common distribution of $\left(a_0^i,\theta^i\right)_{i\in\mathcal{I}}$ and $(w(t))_{t\geq 0}$, where $a_0^i=a_0$ and $\theta^i=\theta$, so that $c^i(t)=\tilde{c}$ for all $i\in\mathcal{I}$, and all $t\geq 0$, also with $\tilde{c}\in\bigcap\limits_{i\in\mathcal{I}}\mathbb{C}^i$.

Let,

$$\Phi^{RC}(c)\equiv f^{RC}(c)-f^{RC}(\tilde{c})\ , \tag{17}$$

and,

$$\Phi^i(c) \equiv f^i(c) - f^i(\tilde{c}) \ , \ \text{for all } i \in \mathcal{I} \ . \tag{18}$$

For this distribution, (15) implies that,

$$f^{RC}(\tilde{c}) = \int_{\mathcal{I}} f^i(\tilde{c}) \, d\mu(i) \ . \tag{19}$$

Given (1), set $\underline{\mu}$ such that,

$$0 < \underline{\mu} \leq \inf \{ d\mu(i) \mid i \in \mathcal{I} \} \ . \tag{20}$$

Pick any arbitrary household type $i \in \mathcal{I}$, keep prices as before, and modify the previous distribution by adding to $\underline{\mu}$ of this household type different wealth or productivity that yields $c^i(t) = (\tilde{c} + \Delta c) \in \underset{i \in \mathcal{I}}{\cap} \mathbb{C}^i$, for all $t \geq 0$. Since prices are the same, $c^j(t) = \tilde{c}$, for all $j \in \mathcal{I} \backslash \{i\}$ and for some households of type i with density $d\mu(i) - \underline{\mu}$, and for all $t \geq 0$. Combining (15), (19), (17) and (18), it is,

$$\Phi^{RC}\left(\underline{\mu}\Delta c + \tilde{c}\right) = \underline{\mu}\Phi^i(\Delta c + \tilde{c}) \ . \tag{21}$$

Since the choices of $i \in \mathcal{I}$, Δc, and $\tilde{c} \in \underset{i \in \mathcal{I}}{\cap} \mathbb{C}^i$, were arbitrary, and since we can construct the same distribution of consumption choices for all $i \in \mathcal{I}$, (21) holds for all $i \in \mathcal{I}$, so,

$$\Phi^i(c) = \Phi(c) \quad \text{for all } c \in \underset{i \in \mathcal{I}}{\cap} \mathbb{C}^i \text{ and for all } i \in \mathcal{I}. \tag{22}$$

Given (13), we are able to construct any interior optimal path with distribution of consumptions with $c^i(t) = c \in \underset{i \in \mathcal{I}}{\cap} \mathbb{C}^i$ for all $i \in \mathcal{I}$, and all $t \geq 0$. Therefore, (15), (19), and (22) imply that,

$$\Phi^{RC}(c) = \Phi^i(c) = \Phi(c) \quad \text{for all } c \in \underset{i \in \mathcal{I}}{\cap} \mathbb{C}^i \text{ and for all } i \in \mathcal{I} \ , \tag{23}$$

and,

$$\Phi\left(\int_{\mathcal{I}} c^i(t) \, d\mu(i)\right) = \int_{\mathcal{I}} \Phi\left(c^i(t)\right) d\mu(i) \ , \quad \text{for all } \left(c^i(t) \in \underset{i \in \mathcal{I}}{\cap} \mathbb{C}^i\right)_{i \in \mathcal{I}} \text{, and } t \geq 0 \ , \tag{24}$$

holding for the whole domain of wealth/labor-productivity heterogeneity and prices where household choices fall in the interval $\underset{i\in\mathcal{I}}{\cap}\mathbb{C}^i$ (see Assumption 4) and are interior. Equation (24) enables us to further characterize Φ. In particular,

$$(24) \Leftrightarrow \Phi \text{ is affine on } \underset{i\in\mathcal{I}}{\cap}\mathbb{C}^i. \tag{25}$$

The sufficiency part of (25) is straightforward, so for the necessity part of (25) let's set,

$$z^i \equiv c^i - \tilde{c}\ , \tag{26}$$

with $\tilde{c}$ defined as above for an arbitrary $\tilde{c} \in \underset{i\in\mathcal{I}}{\cap}\mathbb{C}^i$, in the case where $r(t) = \rho(t)$ for all $t \geq 0$. So, fix $\tilde{c}$ and set,

$$\Psi(z) \equiv \Phi(z) - \Phi(0)\ , \tag{27}$$

since we know that for the transformed variable, z, the choice of 0 falls in the class of interior solutions to a distribution in the domain of $(u^i)_{i\in\mathcal{I}}$, namely the case where all households choose $\tilde{c} \in \underset{i\in\mathcal{I}}{\cap}\mathbb{C}^i$ at all times. We now show that Ψ is a linear functional. For any partition of households, irrespective of their household types, say, $\mathcal{I}_1, \mathcal{I}_2 \subset \mathcal{I}$, with $\mathcal{I}_1 \cap \mathcal{I}_2 = \emptyset$, and $\int_{\mathcal{I}_1} d\mu(i) = \mu$, retaining $r(t) = \rho(t)$ for all $t \geq 0$, provide the same a_0 and a labor-productivity function θ to all $i \in \mathcal{I}_1$, so that consumption is equal to $(\Delta c + \tilde{c}) \in \underset{i\in\mathcal{I}}{\cap}\mathbb{C}^i$ for all $i \in \mathcal{I}_1$ at all times, provide to the remaining households $\tilde{a}_0$ and a labor-productivity $\tilde{\theta}$, so that their consumption is equal to $\tilde{c} \in \underset{i\in\mathcal{I}}{\cap}\mathbb{C}^i$ for all $i \in \mathcal{I}_2$ at all times. Then, $z^i = \Delta c$ for all $i \in \mathcal{I}_1$, and $z^i = 0$ for all $i \in \mathcal{I}_2$, so,

$$\Phi(\mu\Delta c) = \Phi(\mu\Delta c + (1-\mu)\,0)\ ,$$

and (24) and (27) imply that,

$$\Phi(\mu\Delta c) = \mu\Phi(\Delta c) + (1-\mu)\,\Phi(0)\ ,$$

or,

$$\Psi\left(\mu\Delta c\right)=\mu\Psi\left(\Delta c\right)\ . \tag{28}$$

Notice that the choices of Δc and μ were arbitrary. So, we can take any $\mu_1,\mu_2\in(0,1)$ with $\left(\mu_1\Delta c+\tilde{c}\right),\left(\mu_1\Delta c+\tilde{c}\right)\in\underset{i\in\mathcal{I}}{\cap}\mathbb{C}^i$ and $\frac{\mu_2}{\mu_1}=\xi\in\mathbb{R}_+$. Repeating the same steps, (28) yields $\Psi\left(\mu_1\Delta c\right)=\mu_1\Psi\left(\Delta c\right)$ and $\Psi\left(\xi\mu_1\Delta c\right)=\xi\mu_1\Psi\left(\Delta c\right)$, or,

$$\Psi\left(\xi\mu_1\Delta c\right)=\xi\Psi\left(\mu_1\Delta c\right),\quad\text{for all }\xi\in\mathbb{R}_+\ . \tag{29}$$

Since Ψ is a univariate function, (29) is sufficient to prove that Ψ is linear. So, let,

$$\Psi\left(z\right)=\alpha z\ ,\quad\alpha\in\mathbb{R},$$

and, due to the linearity of Ψ, the transformation (26) can be ignored, having (27) and (23) implying that, $\Phi\left(c\right)=\alpha c+\Phi\left(0\right)$. But since (17) and (18) imply that $\Phi\left(\tilde{c}\right)=0$, $\Phi\left(0\right)=-\alpha\tilde{c}$. So,

$$\Phi^{RC}\left(c\right)=\Phi^i\left(c\right)=\Phi\left(c\right)=\alpha c-\alpha\tilde{c}\ ,\ \ \alpha\in\mathbb{R},\text{ for all }c\in\underset{i\in\mathcal{I}}{\cap}\mathbb{C}^i\text{ and for all }i\in\mathcal{I}\ . \tag{30}$$

Using (30) we show that,

$$\Phi^i\left(c\right)=\Phi\left(c\right)=\alpha c-\alpha\tilde{c}\ ,\ \ \alpha\in\mathbb{R},\text{ for all }c\in\mathbb{C}^i\text{ and for all }i\in\mathcal{I}\ . \tag{31}$$

To prove (31), consider the case where an arbitrary $c^j\in\mathbb{C}^j$ is such that $c^j\leq\inf\left(\underset{i\in\mathcal{I}}{\cap}\mathbb{C}^i\right)$ or $c^j\geq\sup\left(\underset{i\in\mathcal{I}}{\cap}\mathbb{C}^i\right)$ for some $j\in\mathcal{I}$, whenever any of the two is possible (i.e. whenever $\inf\left(\underset{i\in\mathcal{I}}{\cap}\mathbb{C}^i\right)>0$, or $\sup\left(\underset{i\in\mathcal{I}}{\cap}\mathbb{C}^i\right)<\infty$). It is always that there exists some $\mu\in(0,1)$, with $\mu\leq d\mu\left(j\right)$, such that $\left(\mu c^j+\left(1-\mu\right)\tilde{c}\right)\in\underset{i\in\mathcal{I}}{\cap}\mathbb{C}^i$. So, retaining $r\left(t\right)=\rho\left(t\right)$ for all $t\geq0$, provide a level a_0 and a labor-productivity function θ to a mass μ of type $j\in\mathcal{I}$, so that consumption is equal to c^j at all times, and also provide to the remaining households $\tilde{a}_0$

and a labor-productivity $\tilde{\theta}$, so that their consumption is equal to $\tilde{c} \in \bigcap_{i \in \mathcal{I}} \mathbb{C}^i$ at all times. Combining (15), (17), (18) and (19), it is,

$$\mu \Phi^j \left(c^j \right) = \Phi^{RC} \left(\mu c^j + (1 - \mu) \tilde{c} \right) \ .$$

But since $(\mu c^j + (1 - \mu) \tilde{c}) \in \bigcap_{i \in \mathcal{I}} \mathbb{C}^i$, (30) implies that $\Phi^{RC} (\mu c^j + (1 - \mu) \tilde{c}) = \alpha (\mu c^j + (1 - \mu) \tilde{c}) - \alpha \tilde{c}$, or

$$\Phi^j \left(c^j \right) = \alpha c^j - \alpha \tilde{c} \ .$$

Since the choices of $j \in \mathcal{I}$ and $c^j \in \mathbb{C}^j$ were arbitrary, (31) is proved.

Combining (18) with (31) it is,

$$f^i (c) = \alpha c - \alpha \tilde{c} + f^i (\tilde{c}) \quad \text{for all } c \in \mathbb{C}^i \text{ and all } i \in \mathcal{I} \ . \tag{32}$$

Now that all f^i's are completely characterized over their domains, $\mathbb{C}^i$, we can consider the case of $c = 0$, irrespective from whether $0 \in \mathbb{C}^i$ or not, in order to set the intercepts of all f^i's. Equation (32) implies,

$$f^i (\tilde{c}) = \alpha \tilde{c} + f^i (0) \ . \tag{33}$$

Setting $f^i (0) = \beta_i$ for some $\beta_i \in \mathbb{R}$, for all $i \in \mathcal{I}$, a final combination of (32) with (33), and also setting $\beta_{RC} = \int_{\mathcal{I}} \beta_i d\mu (i)$ (consistently with (15)), completes the proof of (16).

(Necessity) Step 3: characterization of $(u^i : \mathbb{R}_+ \to \mathbb{R}_{++})_{i \in \mathcal{I}}$ *and* $u^{RC} : \mathbb{R}_+ \to \mathbb{R}_{++}$.

In light of (16), we derive the functional forms of utility for all household types through Riemann integration. There are two general cases, these of $\alpha \neq 0$ and $\alpha = 0$. (The case where $\alpha = 1$ is also of special interest, but the particular functional form of $(u^i)_{i \in \mathcal{I}}$ and u^{RC} that result in this case, can be derived from the more general functional forms that apply to $\alpha \neq 0$.)

For the case where $\alpha \neq 0$, (16) implies that,

$$\frac{u_{11}^{i}(c)}{u_{1}^{i}(c)} = -\frac{1}{\alpha c + \beta_i} ,$$

and the indefinite Riemann integral of this expression with respect to c yields,

$$\ln\left[u_{1}^{i}(c)\right] = -\frac{1}{\alpha}\ln\left(\alpha c + \beta_i\right) + \kappa_i ,$$

where κ_i is some constant in $\mathbb{R}$, that can be household-specific, and integrating once more, it is,

$$u^{i}(c) = e^{\kappa_i}\frac{\left(\alpha c + \beta_i\right)^{1-\frac{1}{\alpha}}}{\alpha\left(1-\frac{1}{\alpha}\right)} + \kappa ,$$

where κ is, again some constant. Setting $e^{\kappa_i} = 1$, without loss of generality, and κ accordingly, we obtain the result of (8). The special case where $\alpha = 1$, is known to yield the result that $u^{i}(c) = \ln\left(\alpha c + \beta_i\right) + \kappa$, through computing the limit of the above expression for $\alpha \to 1$ using L'Hôpital's rule. The preferences of the representative consumer are derived in the same way.

For the case where $\alpha = 0$,

$$\frac{u_{1}^{i}(c)}{u_{11}^{i}(c)} = -\frac{1}{\beta_i} ,$$

and in order for $u_{1}^{i} > 0$ and $u_{11}^{i} < 0$ to hold, it must be that $\beta_i > 0$. So,

$$\ln\left[u_{1}^{i}(c)\right] = -\frac{1}{\beta_i}c + \kappa_i ,$$

and,

$$u^{i}(c) = -\frac{e^{\kappa_i}}{\beta_i}e^{-\frac{1}{\beta_i}c} + \kappa ,$$

so, setting $\frac{e^{\kappa_i}}{\beta_i} = 1$ and $\kappa = 0$ yields the corresponding function in (8). With the same reasoning for the representative consumer, the proof of the necessity part is complete.

Part 2: Sufficiency

The particular functional forms given by (8) enable a complete analytical characterization of the demand functions of all households at all times. Again, two cases must be examined separately, this of $\alpha \neq 0$ and the case where $\alpha = 0$.

Under the assumption that $\alpha \neq 0$, (5), implies,

$$\dot{c}^i(t) = \left[\alpha c^i(t) + \beta_i\right]\left[r(t) - \rho(t)\right] \ ,$$

so, multiplying this expression by the integrating factor $e^{-\alpha \int_t^\tau [r(s)-\rho(s)]ds}$ and integrating over the interval $[t, \tau]$ for any $\tau \in [t, \infty)$, yields,

$$c^i(\tau) = c^i(t)\, e^{\alpha \int_t^\tau [r(s)-\rho(s)]ds} + \beta_i e^{\alpha \int_t^\tau [r(s)-\rho(s)]ds} \int_t^\tau e^{-\alpha \int_t^\tau [r(s)-\rho(s)]ds} \left[r(s) - \rho(s)\right] ds \ .$$

Multiplying this last expression by $e^{-\int_t^\tau r(s)ds}$, integrating over all $\tau \in [t, \infty)$, and combining the result with (12), gives,

$$c^i(t) = \frac{a^i(t) + \int_t^\infty e^{-\int_t^\tau r(s)ds}\theta^i(\tau)\, w(\tau)\, d\tau}{\int_t^\infty e^{\int_t^\tau [(\alpha-1)r(s)-\alpha\rho(s)]ds} d\tau} -$$

$$- \frac{\beta_i \int_t^\infty e^{\int_t^\tau [(\alpha-1)r(s)-\alpha\rho(s)]ds} \int_t^\tau e^{-\alpha \int_t^\tau [r(s)-\rho(s)]ds} \left[r(s) - \rho(s)\right] ds d\tau}{\int_t^\infty e^{\int_t^\tau [(\alpha-1)r(s)-\alpha\rho(s)]ds} d\tau} \ , \quad (34)$$

which can be linearly aggregated across all a^i's, θ^i's and β_i's, proving that a representative consumer exists, as long as Assumption 1 holds, which keeps all individual demands taking the form of (34).

For the case where $\alpha = 0$, when all individual utilities fall in the class of $u^i(c) = -e^{-\frac{1}{\beta_i}c}$, (34) implies that,

$$c^i(t) = \frac{a^i(t) + \int_t^\infty e^{-\int_t^\tau r(s)ds}\theta^i(\tau)\, w(\tau)\, d\tau - \beta_i \int_t^\infty e^{-\int_t^\tau r(s)ds} \int_t^\tau \left[r(s) - \rho(s)\right] ds d\tau}{\int_t^\infty e^{-\int_t^\tau r(s)ds} d\tau} \ , \quad (35)$$

which can also be linearly aggregated across all a^i's, θ^i's and β_i's, completing the proof of the theorem. *Q.E.D.*

Part 2: Empirical Analysis

Objective. To obtain estimates of EIs from individual responses reflecting how intra-household sharing of goods affects individual material comfort, and to test the survey's effectiveness.

Concept that captures household-size economies, central in regression analysis: equivalence scale (ES). Dividing the EI of a household type by the reference income (RI) gives this household's ES. Given that the ES of the one-member household is equal to one, ESs directly inform us about the percentage change in household income required to maintain the household's material comfort as household members are added. If adding a person to a household requires an increase in income which is less than 100% of the corresponding RI in order to keep material comfort constant, then there are household-size economies. So, the higher the household-size economies, the lower the corresponding ES for a household.

Description of the Survey Method, Sampling Strategy, and Plan of Analysis

A detailed description of the survey instrument appears in the section "Survey Instrument Documentation" at the end of this Supporting Material.

Main Evaluation Task (MET). Part A of the questionnaire formulates the MET. It is necessary to examine demographic and descriptive income statistics from the country being studied in order to determine appropriate household types and reference incomes (RIs) to use in Part A. In Germany, the eight household types that were chosen represent 86.05% of the overall number of households, as seen in Table S1, based on the most recent German Income and Expenditure Survey (EVS) of 2003 *(S8).* The EVS, provided by the German Statistical Office in five-year intervals, contains representative household-level information

on income, wealth, and expenditures for several types of goods. The RIs provided in Part A were determined so as to cover a broad range of the disposable-income distribution for single-childless-adult households in Germany. The amount of EUR 500 per month is the level of total social assistance for a one-member household in Germany. Specifically, the level of monetary social assistance in 2006 for a single, childless adult is EUR 345 per month (see Article 20, Paragraph 2, 2a, 3, Sozialgesetzbuch II (SGB II - "Social Security Code") *(S9)*). In addition, households receive housing allowances. The level of housing allowances is contingent upon the rent and also upon the income and wealth of the single, childless adult. A reasonable number is ca. EUR 160. The amount of EUR 1,250 corresponds to the 41st percentile of the one-member-household monthly disposable-income distribution, EUR 2,000 to the 76th, EUR 2,750 to the 89th, and EUR 3,500 to the 94th percentile. Each respondent was provided with only one RI to evaluate in Part A (by random assignment).

Limited Information Bias (LIB) and Sampling Strategy. In order to enable tests of LIB that have sufficient statistical power, the sampling strategy should ensure that there are enough respondents who live in each of the household types that appear as hypothetical households in Part A. Since the RIs chosen in Part A cover a wide range of one-member-household disposable incomes, sampling should be such that, for each household type, the respondents' household income represents a wide range of the economy's household incomes.

Let respondent i belong to household type h and let Y_i be the disposable household income of respondent i. From responses to Part A, we calculate five average EIs for household type h, each corresponding to an RI. We identify the average EI for household type h that is closest to Y_i. This identified average EI corresponds to an RI that should give the same level of material comfort for the one-member household. If this particular RI coincides with the RI that was randomly assigned to i in Part A, then i performed the MET for hypothetical

households with material comforts close to his/her own. We use this identification procedure to create the dummy variables,

$LIB_{mc,i} = 1$ if respondent i's material comfort is closest to the material comfort of the one-member household, based on the RI that respondent i evaluated in Part A; 0 otherwise; and

$LIB_{h,i} = 1$ if respondent i belongs to household type h, and the dependent variable in the regression refers to household type h; 0 otherwise.

Variables $LIB_{h,i}$, $LIB_{mc,i}$, and the product $LIB_{h,i} \cdot LIB_{mc,i}$, serve as conditioning variables in the regression analysis of the stated EIs from Part A, and test for LIB.

Normalized Likert-scale Evaluation (NLSE). Part B of the questionnaire asks for Likert-scale evaluations of material comfort. The value corresponding to the NLSE of respondent i for a household type h is given by,

$$NLSE_i^h = \ln\left(\frac{L_i^h}{L_i^*}\right)$$

where L_i^h denotes respondent i's stated Likert-scale value for household type h, and L_i^* denotes the Likert-scale value given by the same respondent, i, for the one-member household. The NLSE is effective in suppressing noise from *Heterogeneity in Respondent Perceptions of Verbal Characterizations (HRPVC* – see the Results of this section of the Supporting material). Each respondent was provided with only one RI to evaluate in Part B, again randomly assigned. The RIs in Part A are assigned independently from those assigned in Part B. This feature of the survey design helps to avoid the possibility that the NLSE is spuriously correlated with the dependent variable in the regression analysis appearing in Table 1 in the text. Spurious correlation may result from having the same respondent focusing on the same level of material comfort in the evaluations of Parts A and B: some respondents may consciously

attempt to provide consistent responses between Parts A and B, instead of focusing on the evaluation question in each Part.

Regression Analysis. Our regression model is,

$$ES_i^h = f^h(RI_i) + b_0^h RI\_Dummies_i + b_1^h NLSE_i^h + b_2^h LIB_{h,i} + b_3^h LIB_{mc,i}$$

$$+b_4^h (LIB_{h,i} \cdot LIB_{mc,i}) + b_5^h Personal\_Characteristics_i + \varepsilon_i^h \quad (36)$$

The dependent variable is defined as,

$$ES_i^h = \frac{EI_i^h}{RI_i}$$

where EI_i^h is the EI stated by respondent i about household type h, given that respondent i was asked to state EIs using a one-member household with RI equal to RI_i as a benchmark. Because an EI divided by RI is an ES, ES_i^h is i's assessment of the ES concerning household type h, given the RI level that was assigned to i in Part A of the questionnaire.

The function $f^h(RI_i)$ in equation (36) is a proposed candidate for offering an accurate explanation of the relationship between RIs and ESs. The term ε_i^h is the error term. Definitions and roles of all conditioning variables in equation (1) are:

> $RI\_Dummies_i$. This is a set that can include up to four dummy variables related to RI_i, the RI assigned to respondent i in Part A. If, for example, the RI equal to EUR 2,000 is included in this set, then the *RI_Dummy(=EUR 2,000)* takes the value of 1 for all respondents who where assigned RI equal to 2,000 EUR, and 0 otherwise. If the function $f^h(RI)$ in equation (36) is $f^h(RI) = a^h$, where a^h is a constant number, then $RI\_Dummies_i$ can contain up to four RI dummy variables. If $f^h(RI)$ is of the form $f^h(RI) = a^h + g^h(RI)$, where a^h is a constant and $g^h(RI)$ is a monotonic function of RI, then $RI\_Dummies_i$ can contain up to

three RI dummy variables, since four RI dummy variables together with a constant are perfectly correlated with $g^h(RI)$. The conditioning set $RI\_Dummies_i$ is the instrument for conducting the specification test for any candidate function $f^h(RI)$: if there is any variation in that is left unexplained by $f^h(RI)$ in regression (36), then it should be captured by $RI\_Dummies_i$; so a test of exclusion of $RI\_Dummies_i$ reveals whether $f^h(RI)$ satisfactorily captures the dependence of ESs on RI. If the function $f^h(RI) = a^h$ passes the specification test, then the hypothesis that ESs depend on RI is rejected. Independence of ESs from RI, called "Independence of Base" *(S10)*, or "Equivalence Scale Exactness," *(S11)*, has been a working hypothesis serving the econometric identification of consumer demand systems that use consumption data from different household types. Later studies on econometric demand systems relax this hypothesis *(S12-13)*.

$NLSE_i^h$. If the sign of b_1^h in regression (36) is negative, then a necessary condition behind the hypothesis that respondents understand the MET finds affirming evidence. Moreover, the estimator of b_1^h may control for some respondents' deviant opinions about, e.g., the cost of partners or children, so a test of exclusion of the NLSE in the regression provides information about the possible presence of such deviant evaluations.

$LIB_{h,i}$, $LIB_{mc,i}$, $(LIB_{h,i} \cdot LIB_{mc,i})$. A coefficient t-student test and a test of exclusion of each of these three variables test LIB. If none of b_2^h, b_3^h, and b_4^h, is significantly different from zero, then LIB does not prevent respondents from effectively performing the MET for hypothetical households.

$Personal\_Characteristics_i$. This is a set of conditioning variables referring to personal characteristics of the respondents. A coefficient t-student test and a

test of exclusion of each of these variables indicate whether any characteristics of the respondents affect their assessments of EI.

Research sample and results

Research Sample

The survey's sample consists of 2,042 respondents from all regions of Germany, collected by the research institute "FORSA" ("Gesellschaft für Sozialforschung und statistische Analysen mbH" - Research Institute for Social Research and Statistical Analyses), in 2006. The FORSA institute routinely conducts surveys with a representative online panel of about 10,000 German households. FORSA has stored an extensive set of socio-economic and demographic variables for each participating household. This enables a pre-screening of respondents' personal and household characteristics. Households were provided with web TVs when internet was not available. Completion times ranged from about 10 to 25 minutes.

The sampling procedure is targeted to obtain enough respondents who live in each of the household types that appear as hypothetical households in Part A. Table S2 shows the number of respondents from each family type. Table S2 also compares the percentages of respondents from each household type in the sample with the percentages of household types in the overall German population. This comparison reveals that pre-screening of respondent characteristics is efficient. The household type consisting of 1 adult with 3 children has been more than six times over-represented in the sample compared to the German population. Even so, there were only 19 respondents from households with 1 adult and 3 children. For the other seven household types, respondent numbers are sufficiently high to conduct the LIB

test concerning how the household type that a respondent belongs to may affect assessments of EI: the role of in regressions should be reliable.

Table S3 shows the household-type distribution of respondents who are included in the $LIB_{mc,i}$ dummy variable. This is a total of 415 respondents, the sum of the entries in the first column of Table S3. Each entry in the first column of Table S3 shows the number of respondents in the $(LIB_{h,i} \cdot LIB_{mc,i})$ dummy variable for each household type. Apart from single-adult households with two or three children, LIB tests based on the $(LIB_{h,i} \cdot LIB_{mc,i})$ dummy variable have sufficient statistical power.

Table S4 presents an outline of the socio-economic and demographic attributes of the respondents. The sample encompasses a broad variety of characteristics within each of these attributes. The intended over-representation of respondents having children has contributed considerably to the high percentage of female respondents.

Results

Heterogeneity in Respondent Perceptions of Verbal Characterizations (HRPVC). Table S5 presents the descriptive statistics of Likert-scale values stated in Part B for all household types and RIs. The means and medians across household types for a given reference income are close to each other. This lends support to the results of the pilot survey that was run in advance to define the EIs that were provided in Part B *(S14)*: respondents of the present survey also perceive the average incomes stated by the respondents of the pilot survey as EIs.

Figure S1 depicts information from the first column of Table S5, which refers to the one-member household. Each box in Figure S1 is defined by the value of the first and third quartile, so each box contains 50% of the values around the median. A dash within a box

represents the median response, while each vertical line spans the range of responses. Except for RI = EUR 2,750, the range of responses covers the whole Likert-scale interval that was provided (from 1 to 100). In particular, for the distribution of responses corresponding to RI = EUR 1,250, both the mean and the median lie in the middle of the range, and the two middle quartiles are distanced symmetrically from the median by 20 points in the Likert scale. So, while Figure S1 shows that there is positive correlation between income and subjective perceptions of living standards, the noisiness of the Likert-scale values indicates the presence of HRPVC. Such noisiness justifies concerns about the effectiveness of using 'raw' Likert-scale values for interpersonal comparisons and about their role as conditioning variables in regressions *(S15-17)*.

The descriptive statistics of NLSE are given by Table S6 and Figures S2 to S6. By the definition of NLSE, noise stemming from HRPVC should be suppressed. Table S6 confirms this suppressive effect of the NLSE.

Regressions and associated tests. In Tables S7 and S8 we report regression results presented in Table 1 in the text in more detail.

Motivated by Figure 1 in the text, the functional form in equation (36) that was tested for specification effectiveness is,

$$f^h\left(RI\right) = a^h + \frac{b^h}{RI} \ . \tag{37}$$

Equation (37) has been suggested as a means of demand-system and fixed-cost identification. The properties of equation (37) have been named "Generalized Absolute Equivalence Scale Exactness (GAESE)" *(S13)*. Yet, GAESE cannot be tested a priori based on a demand-system analysis only. Employing the functional form given by equation (37) for $f^h\left(RI\right)$, ordinary least-squares (OLS) regressions can be used. The OLS results can be summarized

as follows:

$RI\_Dummies_i$, specification test of (37). Since the functional form given by (37) includes a constant and a monotonic function of RI, no more than three dummy variables were used. None of the results concerning specification tests of (37) is sensitive to the selection of RIs for this set of three RI dummy variables. The RI dummy variable at RI = EUR 2,750 is always significant, yet has only a small influence on the estimates of ES. The exclusion tests concerning all three RI dummy variables have moderately low F-test statistics. None of these tests rejects exclusion with a confidence level of 99% or more. In sum, equation (37) gives a reasonable specification for $f^h(RI)$, which has meaningful intuition. Coefficient b^h in (37) can be interpreted as fixed costs in consumption, *in addition* to the fixed costs of the one-member household. The constant a^h in equation (37) is a measure of household-size economies after controlling for the presence of household-type specific fixed costs in consumption. As household income increases, fixed costs become a smaller share of a household's budget. In other words, ES is a *decreasing* function of RI.

$NLSE_i^h$. All NLSE coefficients have a negative sign and all tests of exclusion are rejected (P<0.001). These findings support the effectiveness of the survey method. Moreover, the size of all NLSE coefficients is small, indicating that respondents' deviant opinions about household-size economies do not affect the estimators of coefficients and in equation (37) to a large extent.

$LIB_{h,i}$, $LIB_{mc,i}$, $(LIB_{h,i} \cdot LIB_{mc,i})$. Only two out of 21 dummy variables related to testing LIB are significant, but with small coefficients. Only one exclusion test is rejected (P<0.01) – for the household type with 2 adults and 1 child. These

findings offer supporting evidence that respondents' own household type and/or level of material comfort do not bias their assessments of EIs in Part A.

Personal_Characteristics$_i$. With two exceptions, Table S8 shows that respondents' personal characteristics do not appear statistically significant in the regressions. Respondents living in the New Laender report slightly higher ESs. More educated respondents also state slightly higher ESs for hypothetical household types with children. All the coefficients are small.

Explanatory power of the regressions. The regressions fit the data quite well; they explain 30-54% of the total variation of stated ESs. Small standard errors for coefficients a^h and b^h in equation (37) indicate a broad consensus across respondents concerning the MET.

Pilot Studies

The breakdown of the samples in pilot studies appears in Tables S9a and S9b. Table S10 summarizes the Seemingly Unrelated-Regressions (SUR) and the tests for a linear relationship between EI and RI using data from pilot studies *(S14, S18)*, and which appear in Figures 2 and 3 in the text. The complete questionnaire appears in Appendix A.1 of a previous study *(S14)*.

In Botswana the questionnaire consisted of questions about three reference incomes instead of five. Because several languages (mainly Setswana and Kalanga, but also Sekgalagadi) are used in Botswana, interviewers had to resort to oral interviews. The response rate with five reference incomes was low and given our planned budget and time constraints we modified the questionnaire so as to increase the response rate. For the purpose of testing the income dependence of equivalence scales three reference incomes serve this task well. For testing the linear relationship between EIs and RIs, three reference incomes are mar-

ginally sufficient for such a test. Nevertheless, we include this country in this study as complementary information.

Sampling of pilot studies

The questionnaire, the sampling strategy and sampling regions for Germany, France, and Cyprus appear in previous studies *(S14, S18)*. The sampling region in China was the urban area of Hangzhou and several towns in the province of Zhejiang. In India the sample was collected from cities and villages of three states of south India, Tamil Nadu, Andhra Pradesh, and Karnataka. The cities where our respondents were surveyed are Chennai (Madras) in Tamil Nadu, Hyderabad (Andhra Pradesh), and Bangalore in Karnataka. The questionnaire was provided in the languages of Tamil (Tamil Nadu), Telegu (Andhra Pradesh), in the English language (respondents from Karnataka preferred English instead of our questionnaires provided in the language Kannada) and elderly respondents were given the option of a questionnaire in Hindi. In Botswana sampling was from the capital Gaborone and villages around it. Apart from questionnaires provided in English, a large part of the respondents were interviewed orally, mainly in the languages Setswana and Kalanga. Sample surveys typically lasted between 20-35 minutes, as respondents had to evaluate 5 different RIs.

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Table S1. Distribution of household types in Germany. Data refer to the overall population and are taken from the German Income and Expenditure Survey in 2003.

	Household type								
	1 adult, 0 children	1 adult, 1 child	1 adult, 2 children	1 adult, 3 children	2 adults, 0 children	2 adults, 1 child	2 adults, 2 children	2 adults, 3 children	Other
Number of households (in thousands)	14,031.1	931.4	356.3	45.4	11,208.4	2,440.9	2,963.2	808.3	5,312.8
% of population	36.83	2.44	0.94	0.12	29.42	6.41	7.78	2.12	13.95

Table S2. Distribution of household types of respondents in the survey sample (first two rows). The last row refers to the overall German population, using data from the most recent German Income and Expenditure Survey in 2003. Numbers appearing in the third row are percentages of the sum of households belonging to the eight household types presented in this table.

	Household type							
	1 adult, 0 children	1 adult, 1 child	1 adult, 2 children	1 adult, 3 children	2 adults, 0 children	2 adults, 1 child	2 adults, 2 children	2 adults, 3 children
Number of respondents	445	125	57	19	415	396	434	151
% of respondents	21.79	6.12	2.79	0.93	20.32	19.39	21.25	7.39
% of population in 2003	42.80	2.84	1.09	0.14	34.19	7.45	9.04	2.47

Table S3. Distribution of respondents having an adjusted disposable household income that is similar to the reference income they were asked to evaluate in Part A of the questionnaire. The adjusted disposable household income is the disposable household income divided by the estimated equivalence scale for the respondent's household type. The estimated equivalence scale is the average equivalence scale from responses to Part A.

Respondent's household type	Number of respondents	Percentage of overall sample	Percentage of all respondents who belong to the same household type
1 adult, 0 children	88	4.31	19.78
1 adult, 1 child	26	1.27	20.80
1 adult, 2 children	15	0.73	26.32
1 adult, 3 children	5	0.24	26.32
2 adults, no children	77	3.78	18.55
2 adults, 1 child	77	3.78	19.44
2 adults, 2 children	93	4.55	21.43
2 adults, 3 children	34	1.67	22.52

Table S4. Description of the personal characteristics of the 2,042 respondents in the survey. [a] Respondents who have completed schooling sufficient for general qualification for entrance to a German University; [b] Respondents who stated that they have an occupation, and they either did not state their occupation type, or their occupation type did not fit in the other working categories; [c] Respondents who stated that they are non-working, and they either did not state their status, or their status did not fit in the other categories.

		Number of respondents	% of respondents
Region	Former West Germany	1,541	75.5
	Former East Germany	501	24.5
Gender	Male	465	22.8
	Female	1,577	77.2
Education	No degree	42	2.1
	Basic level of schooling (9 years)	587	28.7
	Secondary School	926	45.3
	Advanced technical college	119	5.8
	High School [a]	163	8.0
	Completed technical school or university	205	10.0
Occupational Status	Self employed	43	2.1
	Civil servant	57	2.8
	White collar	583	28.6
	Blue collar	180	8.8
	Pupil, student, trainee	23	1.1
	Working, other[b]	52	2.5
Status of non-working	Pensioner	327	16.0
	Unemployed	152	7.4
	Housewife/man	452	22.1
	Obligatory military / public service	101	4.9
	Non-working, other[c]	72	3.5
Family after-tax income class	Less than 500 EUR	36	1.8
	Between 500 and 1000 Euros	239	11.7
	Between 1,000 and 1,500 Euros	385	18.9
	Between 1,500 and 2,000 Euros	437	21.4
	Between 2,000 and 2500 Euros	382	18.7
	Between 2,500 and 3,000 Euros	242	11.9
	Between 3,000 and 3,500 Euros	159	7.8
	Between 3,500 and 4,000 Euros	68	3.3
	Between 4,000 and 4,500 Euros	44	2.2
	4,500 Euros or more	50	2.4
Age group	Between 18 and 40 years	863	42.3
	Between 40 and 60 years	831	40.7
	60 years or older	348	17.0
Partner in the household	Yes	1,396	68.4
	No	646	31.6
Number of children in the household	0	860	42.1
	1	521	25.5
	2	491	24.0
	3 or more	170	8.3

Table S5. Descriptive statistics of stated Likert-scale values. Number of respondents for each reference income: 428 (500 Euros); 422 (1,250 Euros); 385 (2,000 Euros); 402 (2,750 Euros); 405 (3,500 Euros).

Reference income		Household type							
		1 adult, 0 children	1 adult, 1 child	1 adult, 2 children	1 adult, 3 children	2 adults, 0 children	2 adults, 1 child	2 adults, 2 children	2 adults, 3 children
500 Euros	Mean	17.60	20.03	22.58	23.43	24.37	24.43	24.96	27.38
	Median	10	10	15	15	20	20	20	20
	Std	19.77	19.76	19.87	20.37	21.14	20.98	21.54	23.18
	StdError	0.96	0.95	0.96	0.98	1.02	1.01	1.04	1.12
	Min	1	1	1	1	1	1	1	1
	Max	100	100	100	100	100	100	100	100
	First Quartile	5	10	10	10	10	10	10	10
	Third Quartile	20	30	30	30	36	30	35	40
1,250 Euros	Mean	51.24	48.81	49.62	49.81	56.92	56.89	57.31	55.85
	Median	50	50	50	50	52.5	55	60	55
	Std	25.19	23.74	22.83	23.24	22.72	21.85	22.58	24.17
	StdError	1.23	1.16	1.11	1.13	1.11	1.06	1.10	1.18
	Min	1	1	1	1	1	1	1	1
	Max	100	100	100	100	100	100	100	100
	First Quartile	30	30	30	30	40	40	40	40
	Third Quartile	70	68.75	68.75	70	70	70	70	70
2,000 Euros	Mean	73.76	68.42	66.99	63.37	77.18	75.73	74.70	72.70
	Median	80	70	70	65	80	80	80	75
	Std	23.74	22.77	22.47	23.14	19.84	19.35	19.98	22.31
	StdError	1.21	1.16	1.15	1.18	1.01	0.99	1.02	1.14
	Min	1	1	1	1	1	1	1	1
	Max	100	100	100	100	100	100	100	100
	First Quartile	60	50	50	50	69	65	60	60
	Third Quartile	90	90	85	80	90	90	90	90
2,750 Euros	Mean	87.60	85.28	81.72	78.66	89.03	87.67	86.13	83.59
	Median	95	90	85	80	92.5	90	90	90
	Std	17.75	16.95	18.00	19.95	14.58	14.64	15.92	18.81
	StdError	0.89	0.85	0.90	0.99	0.73	0.73	0.79	0.94
	Min	10	15	20	10	20	40	30	15
	Max	100	100	100	100	100	100	100	100
	First Quartile	80	80	70	70	80	80	80	70
	Third Quartile	100	100	100	100	100	100	100	100
3,500 Euros	Mean	91.63	88.59	87.28	84.42	93.59	92.28	89.99	87.28
	Median	100	100	90	90	100	100	100	100
	Std	16.27	17.23	17.00	18.53	12.26	14.07	15.84	19.14
	StdError	0.81	0.86	0.84	0.92	0.61	0.70	0.79	0.95
	Min	1	1	1	1	1	1	1	1
	Max	100	100	100	100	100	100	100	100
	First Quartile	90	80	80	75	90	90	87	80
	Third Quartile	100	100	100	100	100	100	100	100

Table S6. Descriptive statistics of Normalized Likert-scale Evaluations.

Reference income		Household type						
		1 adult, 1 child	1 adult, 2 children	1 adult, 3 children	2 adults, 0 children	2 adults, 1 child	2 adults, 2 children	2 adults, 3 children
500 Euros	Mean	0.23	0.41	0.46	0.51	0.51	0.52	0.61
	Median	0.00	0.00	0.00	0.14	0.20	0.12	0.29
	Std	0.62	0.83	0.92	0.87	0.90	1.03	1.06
	StdError	0.03	0.04	0.04	0.04	0.04	0.05	0.05
	Min	-1.79	-1.79	-2.08	-1.20	-1.79	-3.91	-2.30
	Max	3.00	3.91	4.09	3.91	3.91	4.09	4.25
	First Quartile	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Third Quartile	0.41	0.69	0.84	0.69	0.69	1.10	1.10
1,250 Euros	Mean	-0.03	0.00	0.00	0.17	0.18	0.18	0.12
	Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Std	0.38	0.48	0.58	0.48	0.53	0.59	0.72
	StdError	0.02	0.02	0.03	0.02	0.03	0.03	0.03
	Min	-1.61	-2.20	-2.64	-1.61	-2.20	-2.20	-4.50
	Max	2.30	3.00	3.40	3.69	3.40	3.91	4.09
	First Quartile	-0.22	-0.22	-0.22	0.00	-0.11	-0.15	-0.18
	Third Quartile	0.00	0.18	0.18	0.29	0.34	0.34	0.34
2,000 Euros	Mean	-0.06	-0.09	-0.17	0.08	0.07	0.05	-0.01
	Median	0.00	-0.05	-0.13	0.00	0.00	0.00	0.00
	Std	0.26	0.34	0.47	0.33	0.38	0.43	0.58
	StdError	0.01	0.02	0.02	0.02	0.02	0.02	0.03
	Min	-1.95	-1.95	-4.25	-2.20	-2.20	-2.20	-4.38
	Max	1.39	1.61	1.95	2.08	2.14	2.20	2.30
	First Quartile	-0.15	-0.22	-0.34	-0.05	-0.11	-0.13	-0.21
	Third Quartile	0.00	0.00	0.00	0.14	0.13	0.13	0.13
2,750 Euros	Mean	-0.02	-0.07	-0.12	0.03	0.02	0.00	-0.05
	Median	0.00	0.00	-0.05	0.00	0.00	0.00	0.00
	Std	0.14	0.21	0.31	0.26	0.28	0.32	0.38
	StdError	0.01	0.01	0.02	0.01	0.01	0.02	0.02
	Min	-0.59	-0.85	-2.20	-0.92	-0.81	-1.10	-1.25
	Max	1.10	1.39	1.39	1.95	2.08	2.20	2.30
	First Quartile	-0.06	-0.15	-0.22	0.00	-0.05	-0.11	-0.17
	Third Quartile	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3,500 Euros	Mean	-0.04	-0.05	-0.09	0.04	0.02	-0.02	-0.07
	Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Std	0.17	0.18	0.24	0.27	0.19	0.23	0.36
	StdError	0.01	0.01	0.01	0.01	0.01	0.01	0.02
	Min	-2.30	-0.92	-1.50	-0.69	-0.92	-1.32	-4.32
	Max	1.39	1.39	1.61	4.09	1.39	1.39	1.39
	First Quartile	-0.05	-0.11	-0.16	0.00	0.00	-0.05	-0.11
	Third Quartile	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table S7. Summary of ordinary least squares regressions. Endogenous variable: equivalence scales stated by respondents. Number of observations: 2,042. Standard Errors in parentheses. P-values of F-tests in brackets. *** P<0.001, ** P<0.01, * P<0.05.

	Household type						
	1 adult, 1 child	1 adult, 2 children	1 adult, 3 children	2 adults, 0 children	2 adults, 1 child	2 adults, 2 children	2 adults, 3 children
Constant	1.06*** (0.03)	1.12*** (0.05)	1.20*** (0.08)	1.42*** (0.06)	1.44*** (0.07)	1.53*** (0.09)	1.61*** (0.11)
Reciprocal of reference income	269.74*** (9.77)	498.34*** (16.28)	728.85*** (23.45)	329.38*** (15.91)	592.99*** (20.81)	839.25*** (27.41)	1,079.86*** (34.34)
Dummy reference income 1,250 Euros	0.00 (0.01)	-0.00 (0.02)	-0.02 (0.03)	0.03 (0.02)	0.00 (0.03)	-0.02 (0.03)	-0.04 (0.04)
Dummy reference income 2,000 Euros	0.02 (0.01)	0.02 (0.02)	0.02 (0.02)	0.00 (0.02)	-0.00 (0.02)	-0.00 (0.03)	-0.02 (0.03)
Dummy reference income 2,750 Euros	-0.02* (0.01)	-0.04** (0.02)	-0.07** (0.02)	-0.05* (0.02)	-0.08** (0.02)	-0.11*** (0.03)	-0.13*** (0.04)
Normalized Likert scale evaluation	-0.04*** (0.01)	-0.07*** (0.01)	-0.10*** (0.02)	-0.05*** (0.01)	-0.07*** (0.02)	-0.09*** (0.02)	-0.13*** (0.02)
Dummy for same household type of respondent	0.04 (0.02)	-0.01 (0.05)	-0.14* (0.06)	0.02 (0.03)	0.02 (0.03)	0.01 (0.04)	0.01 (0.08)
Dummy for same material comfort of respondent	-0.01 (0.01)	-0.03 (0.02)	-0.03 (0.03)	-0.04 (0.02)	-0.00 (0.03)	-0.03 (0.04)	-0.05 (0.04)
Dummy for same household type and material comfort of respondent	-0.06 (0.04)	0.13 (0.11)	-0.03 (0.11)	0.05 (0.05)	-0.16* (0.07)	-0.02 (0.08)	-0.04 (0.14)
Adjusted R^2	0.46	0.53	0.54	0.30	0.46	0.52	0.54
F test statistic for exclusion of all reference income dummy variables	2.36 [0.07]	3.07* [0.03]	3.29* [0.02]	3.60* [0.01]	3.37* [0.02]	3.45* [0.02]	3.51* [0.01]
F test statistic for exclusion of the normalized Likert scale evaluation	14.79*** [0.00]	30.79*** [0.00]	37.72*** [0.00]	14.37*** [0.00]	18.90*** [0.00]	24.76*** [0.00]	43.96*** [0.00]
F test statistic for exclusion of dummy for same household type	2.98 [0.08]	0.05 [0.82]	1.28 [0.26]	0.35 [0.55]	0.66 [0.42]	0.02 [0.88]	0.03 [0.87]
F test statistic for exclusion of dummy for same material comfort	0.31 [0.58]	3.06 [0.08]	1.79 [0.18]	3.09 [0.08]	0.30 [0.85]	0.96 [0.33]	1.28 [0.26]
F test statistic for exclusion of dummy for same household type and material comfort	1.96 [0.16]	1.96 [0.16]	0.01 [0.91]	1.21 [0.27]	7.56** [0.01]	0.09 [0.77]	0.11 [0.74]

Table S8. Summary of ordinary least squares coefficients and F-tests for exclusion referring to personal characteristics of respondents. Endogenous variable: equivalence scales stated by respondents. Number of observations: 2,042. Standard Errors of coefficients in parentheses. P-values of F-tests in brackets. Boldface characters for coefficients that have P-values below 5%.
*** P<0.001, ** P<0.01, * P<0.05.

Variable	Values	1 adult, 1 child		1 adult, 2 children		1 adult, 3 children	
Region	1: Former East Germany 0: Former West Germany	0.02	(*0.01*)	**0.04***	(***0.02***)	**0.05***	(***0.02***)
		F=3.11	[0.08]	**F=4.47**	**[0.03]**	**F=4.81**	**[0.03]**
Gender	1: female 0: male	-0.01	(*0.01*)	-0.00	(*0.02*)	-0.00	(*0.02*)
		F=0.55	[0.46]	F=0.01	[0.92]	F=0.00	[0.96]
Education	1: no degree ... 6: compl. tech. school/university	**0.01*****	(***0.00***)	**0.02*****	(***0.01***)	**0.03*****	(***0.01***)
		F=13.57	**[0.00]**	**F=14.26**	**[0.00]**	**F=16.89**	**[0.00]**
Self employed	1: yes 0: no	-0.00	(*0.02*)	-0.00	(*0.04*)	-0.02	(*0.07*)
		F=0.02	[0.90]	F=0.00	[0.98]	F=0.07	[0.80]
Civil servant	1: yes 0: no	0.01	(*0.03*)	0.01	(*0.05*)	0.01	(*0.06*)
		F=0.26	[0.61]	F=0.08	[0.78]	F=0.03	[0.87]
Blue collar	1: yes 0: no	-0.01	(*0.02*)	-0.02	(*0.03*)	-0.04	(*0.04*)
		F=0.13	[0.72]	F=0.53	[0.47]	F=0.85	[0.36]
Pupil, student, trainee	1: yes 0: no	0.02	(*0.05*)	0.06	(*0.08*)	0.07	(*0.11*)
		F=0.20	[0.65]	F=0.75	[0.39]	F=0.50	[0.48]
Working, other	1: yes 0: no	0.00	(*0.03*)	0.01	(*0.05*)	0.05	(*0.08*)
		F=0.01	[0.92]	F=0.11	[0.75]	F=0.57	[0.45]
Pensioner	1: yes 0: no	0.00	(*0.02*)	-0.00	(*0.02*)	-0.01	(*0.03*)
		F=0.08	[0.78]	F=0.01	[0.92]	F=0.04	[0.85]
Unemployed	1: yes 0: no	0.01	(*0.02*)	-0.00	(*0.03*)	-0.02	(*0.04*)
		F=0.22	[0.64]	F=0.01	[0.93]	F=0.29	[0.59]
Housewife/man	1: yes 0: no	-0.01	(*0.01*)	-0.02	(*0.02*)	-0.03	(*0.03*)
		F=0.85	[0.36]	F=1.17	[0.28]	F=1.00	[0.32]
Obligatory military / public service	1: yes 0: no	0.03	(*0.03*)	0.03	(*0.04*)	0.02	(*0.06*)
		F=1.93	[0.17]	F=0.67	[0.41]	F=0.10	[0.75]
Non-working, other	1: yes 0: no	0.03	(*0.03*)	0.04	(*0.04*)	0.03	(*0.06*)
		F=1.88	[0.17]	F=1.18	[0.28]	F=0.38	[0.54]
Number of adults in the respondent's household	1: one adult 2: two adults	0.00	(*0.01*)	-0.01	(*0.02*)	-0.02	(*0.03*)
		F=0.08	[0.78]	F=0.08	[0.78]	F=0.60	[0.44]
Number of children in the respondent's household	0: no children … 3: three or more children	0.01	(*0.01*)	0.01	(*0.01*)	0.02	(*0.01*)
		F=1.10	[0.30]	F=2.61	[0.11]	F=3.67	[0.06]
Family after-tax income	1: lowest income class … 10: highest income class	0.00	(*0.00*)	0.00	(*0.00*)	0.00	(*0.01*)
		F=0.06	[0.81]	F=0.04	[0.84]	F=0.01	[0.93]
Age	Age of respondent in years	-0.00	(*0.00*)	-0.00	(*0.00*)	-0.00	(*0.00*)
		F=0.53	[0.47]	F=0.08	[0.77]	F=0.04	[0.85]

Table S8 (continued).

Variable	Values	2 adults, 0 children		2 adults, 1 child		2 adults, 2 children		2 adults, 3 children	
Region	1: Former East Germany 0: Former West Germany	**0.04***	**(0.02)**	**0.06***	**(0.02)**	**0.08****	**(0.03)**	**0.10****	**(0.04)**
		F=5.33	**[0.02]**	**F=6.42**	**[0.01]**	**F=8.40**	**[0.00]**	**F=7.34**	**[0.01]**
Gender	1: female 0: male	-0.01	(0.02)	-0.01	(0.02)	-0.01	(0.03)	-0.01	(0.04)
		F=0.55	[0.46]	F=0.21	[0.64]	F=0.11	[0.74]	F=0.05	[0.83]
Education	1: no degree …. 6: compl. tech. School or university	0.01	(0.01)	**0.02****	**(0.01)**	**0.03****	**(0.01)**	**0.03****	**(0.01)**
		F=2.54	[0.11]	**F=7.52**	**[0.01]**	**F=6.88**	**[0.01]**	**F=7.54**	**[0.01]**
Self employed	1: yes 0: no	0.05	(0.05)	0.04	(0.08)	0.00	(0.10)	-0.03	(0.12)
		F=0.85	[0.36]	F=0.31	[0.58]	F=0.00	[0.97]	F=0.07	[0.80]
Civil servant	1: yes 0: no	-0.02	(0.05)	0.01	(0.06)	0.00	(0.07)	0.00	(0.09)
		F=0.11	[0.74]	F=0.06	[0.81]	F=0.00	[0.98]	F=0.00	[0.96]
Blue collar	1: yes 0: no	-0.01	(0.03)	-0.01	(0.04)	-0.05	(0.05)	-0.08	(0.06)
		F=0.06	[0.80]	F=0.11	[0.74]	F=0.99	[0.32]	F=1.73	[0.19]
Pupil, student, trainee	1: yes 0: no	-0.03	(0.08)	0.06	(0.13)	0.12	(0.15)	0.12	(0.16)
		F=0.13	[0.72]	F=0.38	[0.54]	F=1.04	[0.31]	F=0.71	[0.40]
Working, other	1: yes 0: no	0.04	(0.05)	0.06	(0.07)	0.08	(0.10)	0.11	(0.12)
		F=0.56	[0.45]	F=1.03	[0.31]	F=1.17	[0.28]	F=1.38	[0.24]
Pensioner	1: yes 0: no	0.01	(0.03)	0.01	(0.04)	-0.02	(0.04)	-0.01	(0.05)
		F=0.05	[0.82]	F=0.08	[0.78]	F=0.18	[0.67]	F=0.01	[0.92]
Unemployed	1: yes 0: no	-0.05	(0.03)	-0.04	(0.04)	-0.07	(0.05)	-0.06	(0.07)
		F=2.77	[0.10]	F=1.21	[0.27]	F=1.86	[0.17]	F=1.02	[0.31]
Housewife/man	1: yes 0: no	-0.03	(0.02)	-0.04	(0.03)	-0.05	(0.04)	-0.06	(0.04)
		F=1.80	[0.18]	F=1.82	[0.18]	F=1.91	[0.17]	F=1.83	[0.18]
Obligatory military / public service	1: yes 0: no	-0.01	(0.04)	-0.03	(0.05)	-0.01	(0.07)	-0.01	(0.08)
		F=0.07	[0.79]	F=0.44	[0.51]	F=0.05	[0.82]	F=0.04	[0.84]
Non-working, other	1: yes 0: no	-0.06	(0.04)	-0.04	(0.05)	-0.05	(0.06)	-0.07	(0.08)
		F=2.00	[0.16]	F=0.66	[0.42]	F=0.63	[0.43]	F=0.82	[0.37]
Number of adults in the respondent's household	1: one adult 2: two adults	0.01	(0.02)	0.01	(0.02)	0.00	(0.03)	0.01	(0.04)
		F=0.31	[0.58]	F=0.20	[0.65]	F=0.01	[0.93]	F=0.03	[0.85]
Number of children in the respondent's household	0: no children … 3: three or more children	-0.01	(0.01)	-0.01	(0.01)	0.00	(0.02)	0.01	(0.02)
		F=0.69	[0.41]	F=0.77	[0.38]	F=0.00	[0.95]	F=0.23	[0.63]
Family after-tax income	1: lowest income class … 10: highest income class	-0.00	(0.00)	0.00	(0.01)	0.00	(0.01)	-0.00	(0.01)
		F=0.12	[0.73]	F=0.05	[0.83]	F=0.02	[0.89]	F=0.00	[0.98]
Age	Age of respondent in years	**-0.00***	**(0.00)**	**-0.00***	**(0.00)**	-0.00	(0.00)	-0.00	(0.00)
		F=5.20	**[0.02]**	**F=4.83**	**[0.03]**	F=2.86	[0.09]	F=2.53	[0.11]

Table S9a. Breakdown of the samples in Germany, Cyprus, and France

		Germany		Cyprus		France	
		Sample: 167 obs.		Sample: 130 obs.		Sample: 223 obs.	
		N	%	N	%	N	%
Gender	Male	96	57.49	73	56.15	117	52.47
	Female	71	42.51	57	43.85	106	47.53
Partner in the household	Yes	97	58.08	75	57.69	154	69.06
	No	70	41.92	55	42.31	69	30.94
Living with parents	Yes	---	---	37[a]	28.46	---	---
	No	---	---	93	71.54	---	---
Number of children in the household	0	123	73.65	82	63.08	102	45.74
	1	18	10.78	18	13.85	45	20.18
	2	15	8.98	23	17.69	46	20.63
	3 or more	11	6.59	7	5.38	30	13.45
Family after-tax income class	1	32	19.16	9	6.92	18	8.07
	2	44	26.35	25	19.23	30	13.45
	3	37	22.16	24	18.46	41	18.39
	4	37	22.16	31	23.85	49	21.97
	5	17	10.18	41	31.54	85	38.12
Occupational group	Welfare recipient or unemployed	7	4.19	2	1.54	7	3.14
	Blue-collar worker	10	5.99	2	1.54	6	2.69
	White-collar worker	83	49.70	40	30.77	48	21.52
	Civil servant	13	7.78	40	30.77	29	13.00
	Pupil, student, trainee	34	20.36	30	23.08	102	45.74
	Self-employed	7	4.19	13	10.00	13	5.83
	Pensioner	10	5.99	0	0.00	6	2.69
	Housewife, -man	3	1.80	3	2.31	12	5.38
Education	Below 9 years of education	1	0.60	4	3.08	0	0.00
	Completed Extended Elementary School	21	12.57	8	6.15	13	5.83
	Completed Special Secondary School	39	23.35	---	---	43	19.28
	Completed Secondary School	65	38.92	65	50.00	37	16.59
	Technical School/University degree	41	24.55	53[b]	40.77	130	58.30
Number of siblings during childhood	0	31	18.56	9	6.92	37	16.59
	1	55	32.93	34	26.15	72	32.29
	2	47	28.14	40	30.77	59	26.46
	3 or more	34	20.36	47	36.15	55	24.66

Note. The threshold of the first "family-after tax income class" is the country-specific poverty line for a single childless adult. Then, we add increments such that the mean of the third income class is about the mean household income in the respective country.

[a] One of the respondents who were living with their parents also had a partner and two children.

[b] 14 out of the 53 highly educated respondents in Cyprus had finished a technical school (3 years of higher education).

Table S9b. Breakdown of the samples in China, India, and Botswana

		Botswana		China		India	
		Sample: 159 obs.		Sample: 196 obs.		Sample: 214 obs.	
		N	%	N	%	N	%
Gender	Male	70	44.03	130	66.33	136	63.55
	Female	89	55.97	66	33.67	78	36.45
Partner in the household	Yes	89	55.97	146	74.49	---	---
	No	70	44.03	50	25.51	---	---
Number of adults in the household	1	---	---	---	---	12	5.61
	2	---	---	---	---	73	34.11
	3	---	---	---	---	35	16.36
	4	---	---	---	---	56	26.17
	5	---	---	---	---	22	10.28
	6	---	---	---	---	10	4.67
	7 or more	---	---	---	---	6	2.80
Number of children in the household	0	48	30.19	159	81.12	74	34.58
	1	26	16.35	27	13.78	48	22.43
	2	40	25.16	7	3.57	62	28.97
	3 or more	45	28.30	3	1.53	30[a]	14.02
Family after-tax income class	1	10	6.29	42	21.43	4	1.87
	2	18	11.32	47	23.98	22	10.28
	3	48	30.19	56	28.57	24	11.21
	4	42	26.42	32	16.33	39	18.22
	5	41	25.79	19	9.69	37	17.29
	6	---	---	---	---	88	41.12
Occupational group	Welfare recipient or unemployed	30	18.87	4	2.04	8	3.74
	Blue-collar worker	19	11.95	11	5.61	26	12.15
	White-collar worker	24	15.09	5	2.55	41	19.16
	Civil servant	53	33.33	5	2.55	23	10.75
	Pupil, student, trainee	15	9.43	140	71.43	54	25.23
	Self-employed	13	8.18	28	14.29	42	19.63
	Pensioner	2	1.26	0	0.00	9	4.21
	Housewife, -man	3	1.89	3	1.53	8	3.74
	Farmer	---	---	---	---	3	1.40
Education	No schooling	---	---	4	2.04	1	0.47
	Basic schooling	5	3.14	16	8.16	3	1.40
	Completed Primary School	7	4.40	9	4.59	15	7.01
	Completed Junior High School	21	13.21	13	6.63	44	20.56
	Completed High School	39	24.53	147	75.00	93	43.46
	Technical School/University degree	87	54.72	7	3.57	58	27.10
Number of siblings during childhood	0	31	19.50	71	36.22	33	15.42
	1	20	12.58	58	29.59	52	24.30
	2	27	16.98	35	17.86	47	21.96
	3 or more	81	50.94	32	16.33	82	38.32
Age group	Less than 20	---	---	---	---	49	22.90
	Between 20 and 40	---	---	---	---	127	59.35
	40 or more	---	---	---	---	38	17.76
Living area	Urban	107	67.30	104	53.06	190	88.79
	Rural	52	32.70	92	46.94	24	11.21

Note. The threshold of the first "family-after tax income class" is the country-specific poverty line for a single childless adult. Then, we add increments such that the mean of the third income class is about the mean household income in the respective country.

[a] In India. 8 households have 4 children. 2 households have 5 children, 3 households have 6 or more children.

Table S10. Summary of seemingly unrelated regressions. Endogenous variable: equivalence scales stated by respondents. Standard errors in parentheses. P-values of F-tests in brackets.
*** P<0.001, ** P<0.01, * P<0.05.

	Germany (835 observations)						
	1 adult, 1 child	1 adult, 2 children	1 adult, 3 children	2 adults, 0 children	2 adults, 1 child	2 adults, 2 children	2 adults, 3 children
Constant	0.99*** (0.02)	1.03*** (0.04)	1.09*** (0.06)	1.27*** (0.04)	1.26*** (0.06)	1.30*** (0.07)	1.36*** (0.09)
Reciprocal of reference income	271.22*** (8.70)	482.93*** (14.83)	698.54*** (22.10)	215.65*** (16.25)	460.07*** (20.27)	674.65*** (25.43)	886.86*** (32.62)
Dummy reference income 1,270 Euros	-0.01 (0.01)	-0.01 (0.02)	-0.02 (0.03)	-0.00 (0.02)	-0.01 (0.03)	-0.01 (0.04)	-0.01 (0.05)
Dummy reference income 2,032 Euros	0.01 (0.01)	0.01 (0.02)	0.01 (0.04)	0.03 (0.03)	0.02 (0.03)	0.03 (0.04)	0.02 (0.05)
Dummy reference income 2,794 Euros	-0.00 (0.01)	-0.01 (0.02)	-0.01 (0.04)	-0.02 (0.03)	-0.02 (0.03)	-0.02 (0.04)	-0.02 (0.05)
Adjusted R^2	0.61	0.63	0.62	0.24	0.46	0.53	0.54
F test statistic for exclusion of all reference income dummy variables	0.30 [0.83]	0.30 [0.82]	0.22 [0.88]	0.87 [0.46]	0.54 [0.66]	0.46 [0.71]	0.22 [0.88]

	France (1,115 observations)						
	1 adult, 1 child	1 adult, 2 children	1 adult, 3 children	2 adults, 0 children	2 adults, 1 child	2 adults, 2 children	2 adults, 3 children
Constant	1.03*** (0.03)	1.07*** (0.05)	1.08*** (0.07)	1.26*** (0.04)	1.26*** (0.06)	1.25*** (0.08)	1.24*** (0.10)
Reciprocal of reference income	234.33*** (10.56)	437.75*** (17.86)	621.02*** (25.08)	202.54*** (14.63)	411.23*** (19.94)	604.04*** (26.93)	786.70*** (34.67)
Dummy reference income 1,312 Euros	-0.01 (0.02)	-0.02 (0.03)	-0.02 (0.04)	0.00 (0.02)	0.01 (0.03)	0.00 (0.04)	-0.01 (0.05)
Dummy reference income 2,100 Euros	0.01 (0.02)	0.01 (0.03)	0.01 (0.04)	-0.00 (0.02)	-0.00 (0.03)	-0.00 (0.04)	-0.00 (0.05)
Dummy reference income 2,887 Euros	-0.00 (0.02)	-0.00 (0.03)	-0.01 (0.04)	-0.02 (0.02)	-0.01 (0.03)	-0.01 (0.04)	-0.02 (0.06)
Adjusted R^2	0.38	0.42	0.43	0.20	0.35	0.39	0.40
F test statistic for exclusion of all reference income dummy variables	0.43 [0.73]	0.36 [0.78]	0.26 [0.85]	0.21 [0.89]	0.16 [0.92]	0.05 [0.98]	0.04 [0.99]

	Cyprus (650 observations)						
	1 adult, 1 child	1 adult, 2 children	1 adult, 3 children	2 adults, 0 children	2 adults, 1 child	2 adults, 2 children	2 adults, 3 children
Constant	1.08*** (0.05)	1.19*** (0.09)	1.28*** (0.14)	1.24*** (0.07)	1.31*** (0.10)	1.43*** (0.14)	1.52*** (0.17)
Reciprocal of reference income	192.68*** (9.22)	351.77*** (15.89)	519.77*** (23.82)	168.68*** (12.35)	321.83*** (16.84)	499.02*** (23.29)	661.18*** (29.20)
Dummy reference income 774 Euros	-0.03 (0.02)	-0.04 (0.04)	-0.07 (0.06)	0.01 (0.03)	-0.02 (0.04)	-0.03 (0.06)	-0.06 (0.07)
Dummy reference income 1,238 Euros	-0.00 (0.02)	0.00 (0.04)	-0.00 (0.06)	0.02 (0.03)	0.01 (0.04)	0.01 (0.06)	0.01 (0.08)
Dummy reference income 1,702 Euros	0.01 (0.02)	0.02 (0.04)	0.02 (0.06)	0.02 (0.03)	0.02 (0.05)	0.03 (0.06)	0.03 (0.08)
Adjusted R^2	0.48	0.51	0.50	0.30	0.45	0.49	0.52
F test statistic for exclusion of all reference income dummy variables	0.76 [0.52]	0.73 [0.53]	0.76 [0.52]	0.15 [0.93]	0.26 [0.85]	0.30 [0.82]	0.40 [0.75]

Table S10 (continued).

	India (1,070 observations)						
	1 adult, 1 child	1 adult, 2 children	1 adult, 3 children	2 adults, 0 children	2 adults, 1 child	2 adults, 2 children	2 adults, 3 children
Constant	1.09*** (0.10)	1.25*** (0.15)	1.39*** (0.22)	1.19*** (0.11)	1.19*** (0.16)	1.32*** (0.22)	1.31*** (0.29)
Reciprocal of reference income	110.65*** (6.69)	200.92*** (9.67)	308.39*** (14.48)	134.11*** (7.39)	245.18*** (10.72)	357.38*** (14.45)	467.95*** (18.95)
Dummy reference income 552 Euros	-0.01 (0.04)	-0.01 (0.06)	-0.02 (0.09)	0.01 (0.05)	-0.00 (0.07)	-0.02 (0.09)	-0.02 (0.12)
Dummy reference income 967 Euros	-0.02 (0.04)	-0.02 (0.06)	-0.03 (0.09)	-0.02 (0.05)	-0.02 (0.07)	-0.03 (0.09)	-0.04 (0.12)
Dummy reference income 1,381 Euros	0.01 (0.04)	0.01 (0.06)	0.02 (0.10)	0.01 (0.05)	0.01 (0.07)	0.01 (0.10)	0.01 (0.13)
Adjusted R^2	0.28	0.38	0.39	0.31	0.42	0.46	0.47
F test statistic for exclusion of all reference income dummy variables	0.15 [0.93]	0.07 [0.97]	0.08 [0.97]	0.15 [0.93]	0.07 [0.98]	0.09 [0.96]	0.05 [0.99]

	China (980 observations)						
	1 adult, 1 child	1 adult, 2 children	1 adult, 3 children	2 adults, 0 children	2 adults, 1 child	2 adults, 2 children	2 adults, 3 children
Constant	1.47*** (0.11)	1.67*** (0.22)	1.93*** (0.37)	1.49*** (0.12)	1.80*** (0.20)	2.13*** (0.31)	2.68*** (0.44)
Reciprocal of reference income	139.39*** (8.09)	295.82*** (16.83)	411.41*** (27.73)	78.42*** (9.27)	227.80*** (15.01)	386.69*** (23.30)	529.31*** (33.52)
Dummy reference income 497 Euros	0.03 (0.03)	0.01 (0.06)	-0.05 (0.09)	0.02 (0.03)	-0.02 (0.05)	-0.09 (0.08)	-0.17 (0.11)
Dummy reference income 993 Euros	0.01 (0.03)	-0.04 (0.06)	-0.19* (0.10)	-0.01 (0.03)	-0.08 (0.05)	-0.16* (0.08)	-0.23* (0.12)
Dummy reference income 1,987 Euros	0.00 (0.03)	-0.02 (0.06)	-0.16 (0.10)	-0.03 (0.03)	-0.09 (0.05)	-0.15 (0.09)	-0.19 (0.12)
Adjusted R^2	0.31	0.32	0.27	0.15	0.29	0.32	0.29
F test statistic for exclusion of all reference income dummy variables	0.32 [0.81]	0.24 [0.87]	1.56 [0.20]	0.56 [0.64]	1.10 [0.35]	1.68 [0.17]	1.75 [0.16]

	Botswana (477 observations)						
	1 adult, 1 child	1 adult, 2 children	1 adult, 3 children	2 adults, 0 children	2 adults, 1 child	2 adults, 2 children	2 adults, 3 children
Constant	1.40*** (0.15)	1.56*** (0.28)	1.61*** (0.44)	1.15*** (0.24)	1.47*** (0.31)	1.56*** (0.43)	1.75*** (0.59)
Reciprocal of reference income	115.85*** (9.75)	233.90*** (17.48)	351.55*** (26.97)	122.06*** (14.57)	249.05*** (19.01)	388.31*** (26.73)	527.51*** (36.21)
Dummy reference income 381 Euros	0.03 (0.04)	0.07 (0.08)	0.10 (0.12)	0.01 (0.07)	0.01 (0.09)	0.03 (0.12)	0.01 (0.16)
Adjusted R^2	0.31	0.32	0.32	0.18	0.33	0.38	0.38
F test statistic for exclusion of all reference income dummy variables	0.69 [0.41]	0.68 [0.41]	0.63 [0.43]	0.01 [0.91]	0.02 [0.88]	0.08 [0.78]	0.01 [0.93]

Figure S1. Box plots of stated Likert-scale values for the reference household.

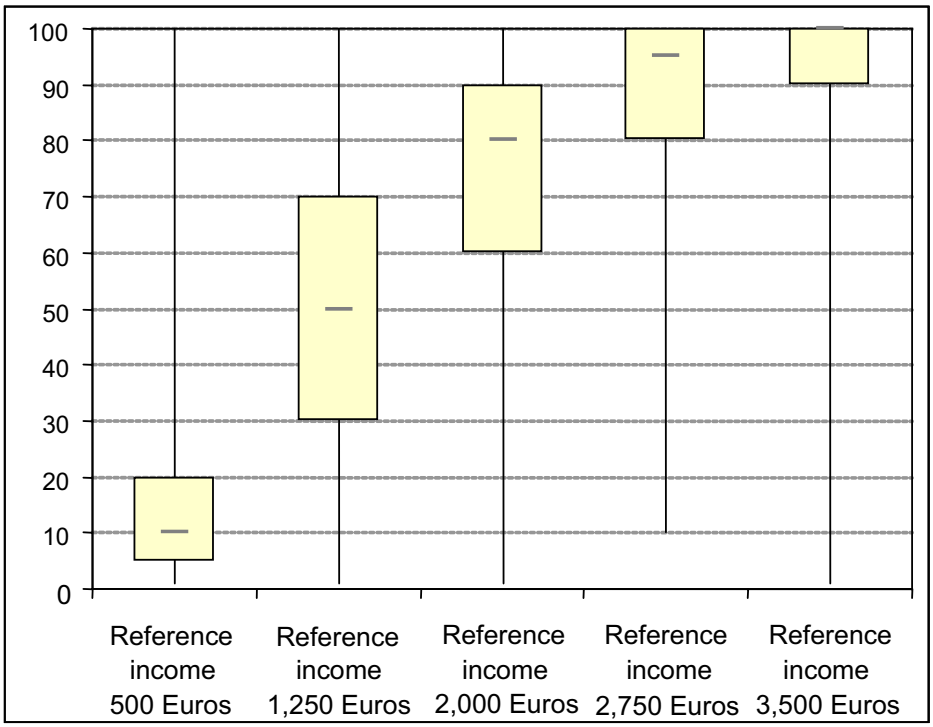


Figure S2. Box plots of Normalized Likert-scale Evaluations for different household types at a reference income of 500 Euros.

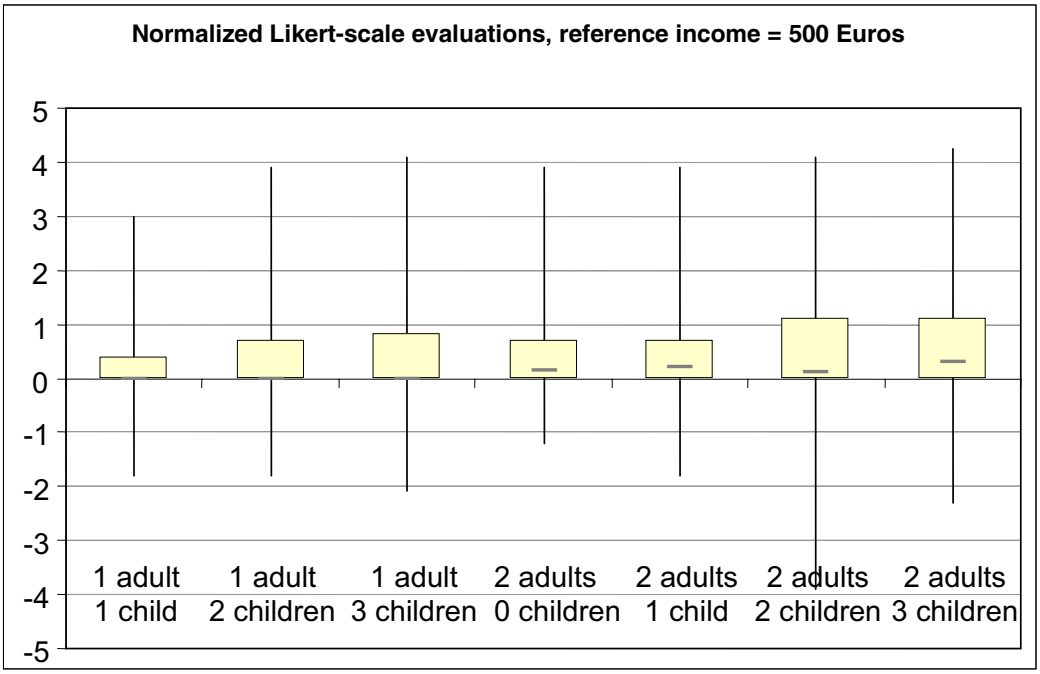


Figure S3. Box plots of Normalized Likert-scale Evaluations for different household types at a reference income of 1,250 Euros.

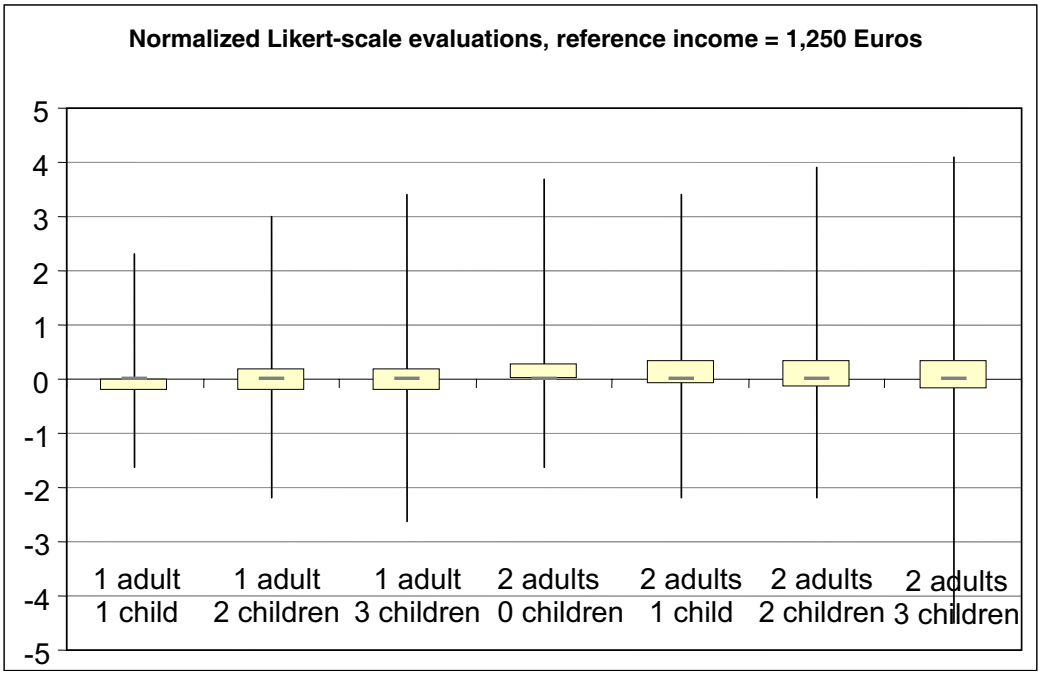


Figure S4. Box plots of Normalized Likert-scale Evaluations for different household types at a reference income of 2,000 Euros.

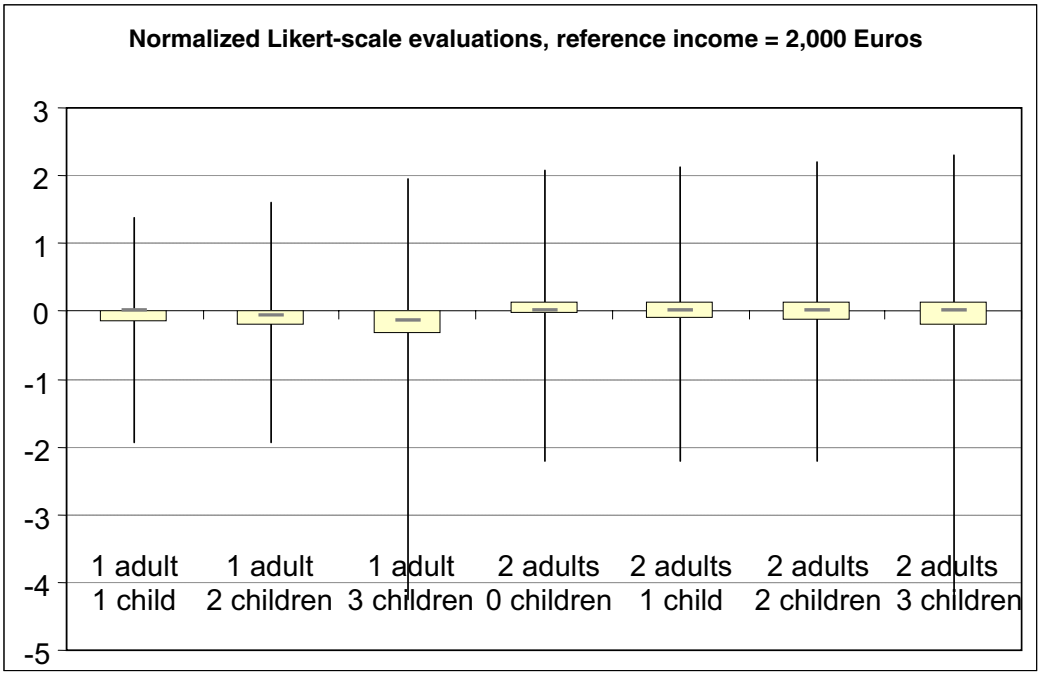


Figure S5. Box plots of Normalized Likert-scale Evaluations for different household types at a reference income of 2,750 Euros.

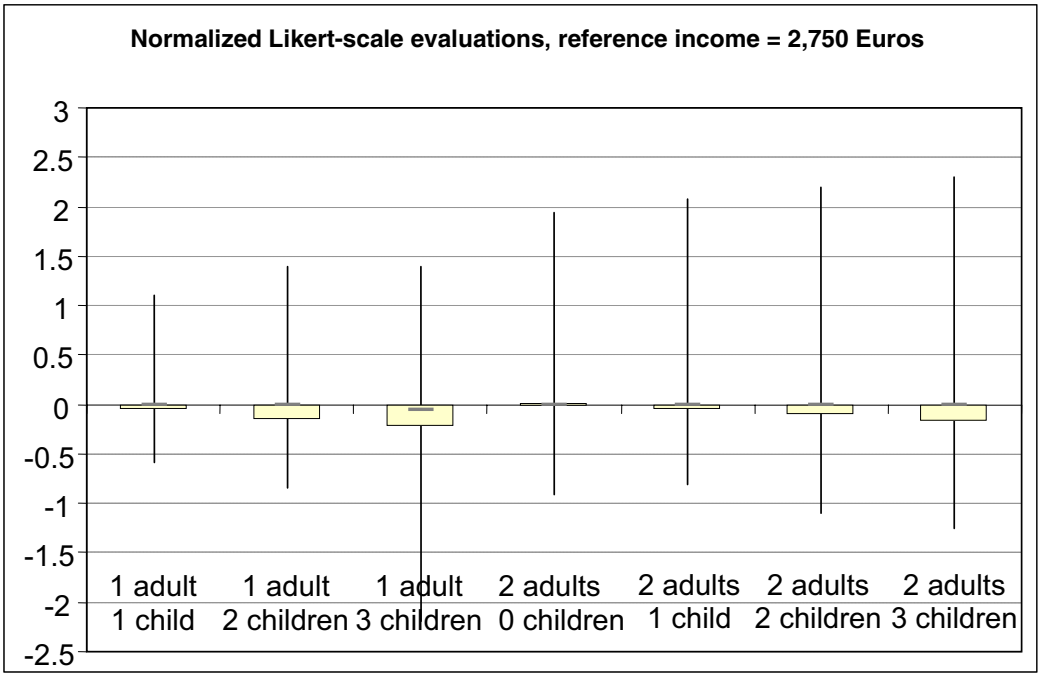
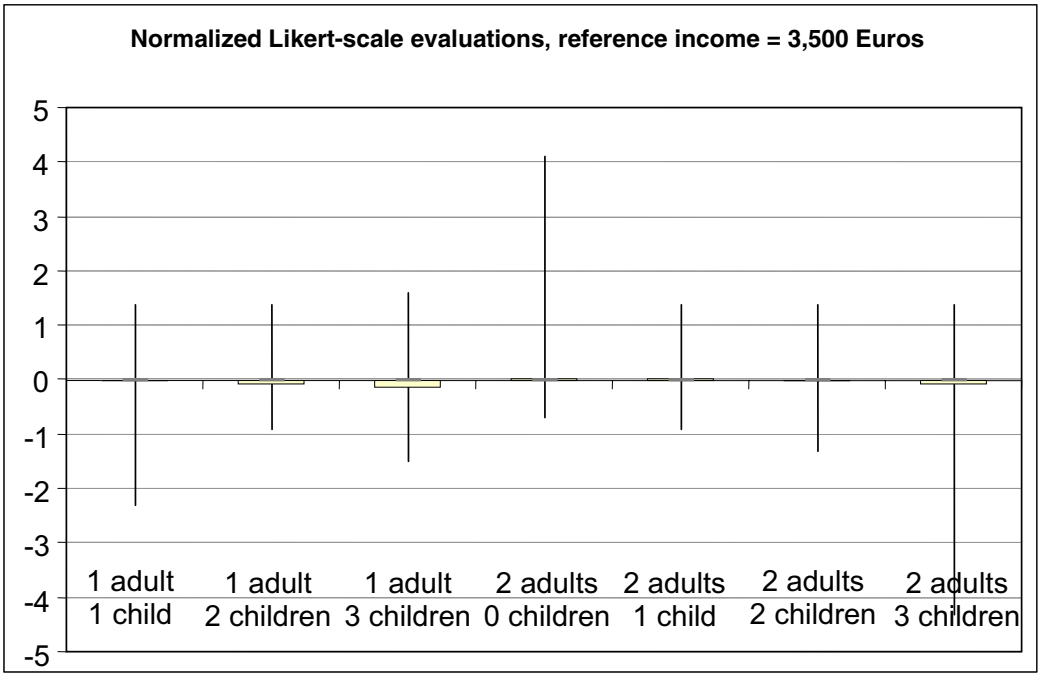


Figure S6. Box plots of Normalized Likert-scale Evaluations for different household types at a reference income of 3,500 Euros.



Survey Instrument Documentation

Information on the connection between a household's demographic composition and the level of material comfort that its income can buy for its members is important for researchers in diverse disciplines. This survey instrument is designed so as to obtain direct estimates of this connection from respondents.

The survey was implemented in automated and electronic form by a professional research institute, FORSA ("Gesellschaft für Sozialforschung und statistische Analysen mbH" – Research Institute for Social Research and Statistical Analyses). Each participating household was equipped with a "set-top-box" that provided Internet access and that was linked to the household's television set.

An introduction addressed to respondents provides a short explanation of the survey topic and a clarification of the concepts that follow. The actual questionnaire consists of two Parts, Part A and Part B. Part A contains the main evaluation task: to provide incomes that equalize the level of material comfort across different hypothetical household types. Part B poses the same assessment problem as in Part A, but using a different means of communication. Respondents are asked to assess the material comfort of different hypothetical household types with specific income levels on Likert scales.

Key advantages of the survey instrument:

- Direct assessments of incomes that equalize the level of material comfort of different household types, enabling the quantification of household-size economies.
- Posing the same evaluation problem using different means of communication in Parts A and B allows for a test of the effectiveness of the survey instrument, suggested in Part A.
- Relevance of the main evaluation task with observable characteristics of the respondent enables a test of effectiveness of the survey instrument. The socio-economic and demographic composition of the respondent's household, may limit her/his available information and ability to evaluate hypothetical household types and levels of material comfort, thus contaminating the results due to a limited-information bias. Comparing answers from respondents whose socio-economic and demographic characteristics are close to those of the hypothetical households they examine with answers from all other respondents enables a test for limited-information bias.
- Low respondent burden: respondents can complete the questionnaire (Introduction, Parts A and B) in about 10-25 minutes.
- High flexibility: Parts A and B can be adjusted easily so as to encompass other hypothetical household types and levels of material comfort.

Introduction for the respondents

Purpose of the survey
In general, different household types may need different incomes in order to attain the same level of material comfort. Since assessing such incomes in an objective way is difficult, we would like to ask you for your personal evaluation of these incomes for a number of different household types. Please note that in this questionnaire there are no “right” or “wrong” answers. So, your answers should only reflect your personal judgements.

[Technical note to the researcher. Respondents click a button to switch to the next screen.]

Instruction
You will frequently read the expression “monthly net household income.” Such a “monthly net household income” is the income amount a household has at its disposal after paying taxes and social security contributions (health insurance contributions, compulsory long term care insurance contributions, unemployment insurance contributions, and contributions to the pension system).

“Monthly net household income” encompasses:
Salary and earnings,
Income from being self-employed,
Pensions,
Unemployment benefits and social benefits,
Accommodation allowance,
Child allowances,
Incomes from rent and lease, and
Other incomes such as returns on investment, interest, etc.

[Technical note to the researcher. Respondents click a button to go to the next screen.]

PART A

Now, please think about a situation where a single, childless adult has a monthly net household income of 500 Euros.

In this survey, there are seven other household types:
with 1 adult and 1 child
with 1 adult and 2 children
with 1 adult and 3 children
with 2 adults and no children
with 2 adults and 1 child
with 2 adults and 2 children
with 2 adults and 3 children

Assume that adults are ages 35 to 55 and children are ages 7 to 11.

[Technical note to the researcher. Respondents click a button to go to the next screen.]

Which monthly net household income would each of these seven household types need in order to attain the same level of material comfort as the single, childless, adult household with the monthly net household income of 500 Euros?

You should state this monthly net household income for each household type in the table that will follow on the next screen. Please note that your answers should reflect only your personal judgements.

[Technical note to the researcher. Respondents click a button to go to the next screen.]

Which monthly net household income would each household type need in order to attain the same level of material comfort as the single, childless, adult household with the monthly net household income of 500 Euros?

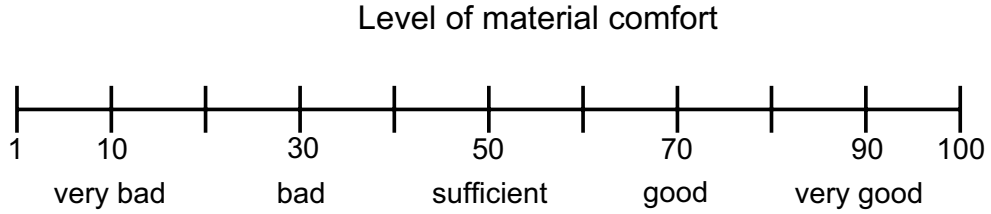
Please state income amounts in Euros.

1 adult without children	500 Euros
1 adult, 1 child	
1 adult, 2 children	
1 adult, 3 children	
2 adults, no children	
2 adults, 1 child	
2 adults, 2 children	
2 adults, 3 children	

[Technical note to the researcher. The reference income level provided in the table is randomly assigned to the respondents. If a respondent does not report an income amount for a household type, there is a reminder: "please fill in income amounts in all empty cells of the table." If a respondent's entries are not numbers, there is a reminder: "please state numbers only." If a respondent states income amounts that are decreasing inversely with household size, a box opens: "Usually, larger household types also need higher incomes in order to attain a specific living standard. Please, make sure that you are not stating how much income should be added compared to a smaller household type, but how much the total net household income should be. Please make sure that the entries you made are indeed total net household incomes." This box opens only once, and its intention is to reduce misunderstandings by respondents. However, if a respondent did not adjust the entries she/he made in the table, she/he was free to do so. Respondents click a button to go to the next screen.]

PART B

We will show you several household types with a given monthly net household income. Please evaluate the material comfort that these monthly net household incomes bring to the different household types on a scale ranging from 1 to 100 points. The values of this scale have the following meaning:



Please complete the following table by evaluating the monthly net income of each household type on the scale of 1-100.

All values between 1 and 100 are permissible.

	Level of material comfort (in points)
1 adult, no children with 3,500 Euros	
1 adult, 1 child with 3,900 Euros	
1 adult, 2 children with 4,200 Euros	
1 adult, 3 children with 4,550 Euros	
2 adults, no children with 4,850 Euros	
2 adults, 1 child with 5,250 Euros	
2 adults, 2 children with 5,550 Euros	
2 adults, 3 children with 5,850 Euros	

[Technical note to the researcher. The numbers provided in this table are estimates of average equivalent incomes for five reference income levels from an independent study. The five reference incomes are the same as the reference income levels in Part A. So, altogether, five profiles of equivalent incomes (including a reference income for the single, childless, adult household) were evaluated by the survey sample, one profile per respondent. One out of these five equivalent-income profiles was randomly assigned to a respondent. If a respondent reports less than eight Likert scale values, there is a reminder: "please fill in all empty cells of the table." If a respondent's answers do not fall in the given range of the Likert scale (1-100), there is a reminder to "please state numbers between 1 and 100 only."]

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