the review of income and wealth

Review of Income and Wealth
Series 65, Number 4, December 2019
DOI: 10.1111/roiw.12386

REFERENCE INCOME EFFECTS IN THE DETERMINATION OF EQUIVALENCE SCALES USING INCOME SATISFACTION DATA

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We estimate household equivalence scales, i.e. the needs of additional adults and children relative to a single adult, using income satisfaction data from the German Socio-Economic Panel. We extend previous studies applying this approach by taking reference income into account. This allows separating needs-based from reference effects in the determination of income satisfaction. We show that this adjustment helps to overcome a bias causing an overestimation of adults' and an underestimation of children's needs-based equivalence weights. Our results indicate that controlling for income comparisons substantially increases children's equivalence weight relative to that of adults.

JEL Codes: I32, J13, D31

Keywords: equivalence scale, income satisfaction, relative income

1. Introduction

Changes in the household structure, such as having a child or moving in with a partner, considerably alter a household's needs. Equivalence scales capture this relationship between a household's needs and its composition. More specifically, they reflect the differences in the expenditures of households of different sizes and composition, when all these households "attain the same level of utility or standard of living" (Lewbel and Pendakur, 2018, p. 3873). They are applied to make household incomes comparable whenever the welfare derived from income is of greater interest than the absolute level of income, e.g. in income inequality and poverty analyses as well as in the design of redistributive policies. Today, a variety of equivalence scales are in use, although the debate continues which of these scales captures best how a household's needs change when persons join or leave the household.

It is possible to distinguish three approaches to determine equivalence scales. Each method has its strengths, but also some fundamental shortcomings, which

Note: The authors would like to thank Christine Lücke, the editor, two anonymous referees as well as participants at various conferences and seminars for their comments and suggestions. All remaining errors are, of course, our own.

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we will discuss only very briefly here (for further discussions, see Bradbury, 1989; Coulter et al., 1992a, and van Praag and Warnaar, 1997). The first approach is to let experts assess the needs of households with different structures (expert scales). This can, for example, be done by compiling baskets of goods which are supposed to allow households of different composition to enjoy the same standard of living. A well-known example of expert scales is the OECD scale (OECD, 2005). The main shortcoming of expert scales is that they are based entirely on rather arbitrary judgments and generally lack a consistent theoretical or empirical foundation. The second approach is to empirically estimate equivalence scales from *objective* data, e.g. by using the share of expenditure on particular goods to proxy welfare (Deaton and Muellbauer, 1986) or estimating a system of demands (McClements, 1977). These scales are often derived from sophisticated theoretical models and are based on empirical evidence. However, as noted, among others, by Pollak and Wales (1979), they suffer from identification problems and rely heavily on the assumptions of the underlying model. The third approach uses *subjective* data and relies on survey responses to questions asking for subjective evaluations, either of own household income or of how much income would be needed to reach a particular level of welfare (for an overview, see Bradbury, 1989). These methods also build on empirical evidence but rely on a different set of assumptions, most importantly that people correctly evaluate their "welfare" or "standard of living" when assigning verbal labels to their actual or hypothetical levels of income (see e.g. Coulter et al., 1992b, and van Praag and van der Sar, 1988).

In recent years, the subjective method has received increasing attention. For example, Schwarze (2003), van Praag and Ferrer-i-Carbonell (2004) and Biewen and Juhasz (2017) all use data on self-reported satisfaction with household income from the German Socio-Economic Panel to analyze how income satisfaction depends on actual household income as well as household size and/or structure and to determine an equivalence scale by calculating the income compensation necessary to hold satisfaction constant as family size/structure changes. These studies generally find high economies of scale compared to commonly used expert scales. In particular, children are assigned much lower equivalence weights than those found in expert scales or in benefit levels of real-world welfare systems. Schwarze (2003), for example, finds that a second child requires an increase in household income of less than 10 percent of the income needs of a single adult, whereas a second adult receives a weight of around 30 percent.

In this paper, we show that the low equivalence weights previous studies have assigned to children can be explained by considering the role of social comparisons in the determination of income satisfaction. While previous studies assume that income satisfaction is a valid proxy for the extent to which household members are able to satisfy their needs, we argue that income satisfaction is also influenced by factors that do not reflect a household's objective standard of living. If inequality and poverty analyses or social policymaking are primarily concerned about objective living standards, instead of their subjective evaluations, such factors should not impact estimated equivalence scales. Bradbury (1989) argues that social comparisons constitute such a factor. It has been convincingly shown that comparisons with other people are of utmost importance when evaluating one's income satisfaction (Clark et al., 2008).

We suggest a modification of the standard method that filters out social comparison effects in the estimation of equivalence scales and closes the gap in the equivalence weights of adults and children. We propose to perceive satisfaction with household income as an aggregate of "needs satisfaction," i.e. the satisfaction with one's absolute level of income because it enables consumption of goods and services, and of "status satisfaction," i.e. the satisfaction with how one's income compares to that of a reference group. We argue that when one determines the monetary compensation necessary to hold income satisfaction constant as family size changes, one obtains the amount necessary to offset the effect on a *weighted average* of needs and status satisfaction. If one is more concerned about the satisfaction of material needs than about status concerns, one has to take the distinction between these two subdimensions of income satisfaction into account and control for relative income effects. Whether this increases or decreases estimated equivalence weights depends on whether the income adjustment necessary to keep needs satisfaction constant as an additional person enters the household is above or below this additional person's impact on the household's reference income. If children increase reference income by less than they increase the household's needs, the equivalence weights assigned to children in previous studies tend to underestimate the purely needs-based equivalence weights. Using data from the German Socio-Economic Panel (SOEP), we demonstrate the importance of this effect empirically. Our results indicate that the difference in equivalence weights assigned to adults and children generally disappears, or their relation even reverses, once we take relative income effects into account. Reference effects are important and equivalence scale parameters change in the predicted direction in all specifications.

The paper is structured as follows. In the next section, we briefly review the related literature. In Section 3, we present the econometric model used in the estimation of equivalence scales and discuss the bias resulting from the omission of reference effects. Section 4 introduces the data and Section 5 provides descriptive statistics. In Section 6, we describe the construction of reference income. Our main empirical analysis as well as extensions and robustness checks are presented in Sections 7 and 8. Section 9 concludes.

2. Related Literature

In this section, we briefly review the two strands of the literature we combine in our analysis. We first discuss studies using the subjective approach to estimate equivalence scales which take differences between adults and children into account. Then, we briefly review the literature on reference effects in the determination of subjective well-being.

2.1. *The subjective approach to estimating equivalence scales*

Equivalence scales can be estimated using either objective (e.g. demand) or subjective data. Subjective data include, e.g. people's satisfaction with their own income, evaluations of hypothetical alternative situations, as well as the income people think would be needed to obtain a particular level of welfare for their own or hypothetical families (for a review, see Bradbury, 1989). For example,

the "income evaluation question" (IEQ), introduced by Van Praag (1971), asks respondents to state the different income amounts they would need to regard their net household income as "very good," …, "sufficient," …, or "very bad."

Van Praag and van der Sar (1988) review studies that use the IEQ to estimate equivalence scales and show that it is not necessary to assume cardinality of utility within this framework. A closely related concept is the "minimum income question" that asks respondents about the "smallest income they would need to make ends meet each month" (Goedhart et al., 1977). As Melenberg and van Soest (1996) have pointed out, the problem with these two questions is that respondents have to evaluate hypothetical situations. Since most of them are not, and might never have been, in a situation where they can just "make ends meet" or where their actual incomes correspond to the IEQ's extreme answers "very good" or "very low," it is difficult for them to answer these questions consistently. Steiger et al. (2004) conduct a qualitative study with cognitive interviews to illustrate the difficulties people have when answering the minimum income question.

To overcome this problem, more recent studies have used questions that ask people to report their satisfaction with their actual household income and to reply on a pre-defined scale. A key assumption is that individuals evaluate their equivalent income when answering the satisfaction question, rather than the absolute level of income (Schwarze, 2003). Melenberg and van Soest (1996) show that using income satisfaction data leads to substantially lower estimated economies of scale, and thus higher equivalence weights, than using the IEQ. Charlier (2002) demonstrates that estimates using income satisfaction data yield results that are fairly close to the modified OECD scale, whereas if data on satisfaction with life in general is used, the estimated equivalence weights appear to be very low.

The income satisfaction approach has been used to estimate equivalence scales that differentiate between adults and children. Schwarze (2003) uses data from the SOEP to estimate an equivalence scale of the form S^e, where S is the household size and e is the equivalence elasticity (Buhmann et al., 1988). He extends this approach by allowing the equivalence elasticity to depend on the number of children in the household and finds that children receive a lower weight than additional adults. While the first additional adult in a (former) one-person household receives a weight of 34 percent of the first adult, the first child of a single (couple) is given a weight of only 30 (17) percent of the first adult and the second child has a weight of 14 (8) percent. Overall, Van Praag and Ferrer-i-Carbonell (2004) find qualitatively similar results, with lower weights when using the German SOEP and higher weights when using the British Household Panel Study (BHPS).

Biewen and Juhasz (2017) propose using nonlinear techniques to estimate more flexible specifications of equivalence scales. Using income satisfaction data from the SOEP, they also find that the first additional adult is given more weight than children (35 percent for an additional adult and 13 percent for each child in the OECD-type specification). Bollinger et al. (2012), using BHPS data, find large economies of scale in the core (married or cohabiting) couple but much smaller economies of scale, or even diseconomies of scale, for children and additional adults. The key explanation for this finding is that it is conceivable that goods, in particular housing, cannot be shared to the same degree outside the core couple as within. In addition, there might be some child-specific goods, which are not shared

with adults and may be outgrown rapidly. Furthermore, the authors find that the needs of children vary with age, suggesting a U-shaped pattern, with 8-12 year olds being associated with the lowest additional needs. Charlier (2002) and Melenberg and Van Soest (1996) also estimate higher weights for children at the age of 12 than at the age of 6. On the contrary, Rojas (2007), using Mexican data, finds that younger children receive larger weights than teenagers.

Table 1 summarizes the equivalence weights estimated in studies that explicitly differentiate between adults and children. In most specifications, the weight assigned to children depends on the total number of household members. We report the necessary income increase for two relevant cases, namely for the first child in a one- and a two-adult household. Most studies, especially those using recent panel data from developed countries, have in common that they find smaller equivalence weights for adults and children than those assigned by commonly used expert scales (OECD scale, square root scale). Strikingly, children generally receive substantially smaller equivalence weights than adults (where the findings by Bollinger et al. (2012) are a notable exception).

2.2. *Reference Income*

There is overwhelming evidence that people's subjective well-being depends, inter alia, on how their income compares to some benchmark (for an overview, see Clark et al., 2008). This benchmark, or "income aspiration," is formed based on own past income (habituation) and the income of comparable others (social comparison). Stutzer (2004) shows empirically that income aspirations are affected through both channels and that the negative effect of higher aspirations on satisfaction with life is of a similar magnitude as the positive effect of own income, suggesting that a proportional change in both leaves well-being unchanged.

There is, however, no consensus on the exact composition of the reference group or how to best construct reference income. A few studies have empirically examined the composition of relevant reference groups. Clark and Senik (2010) explicitly analyze who is in the reference group using data from the European Social Survey. When having to evaluate their satisfaction with their own labor income, most respondents report that they compare themselves more to colleagues than to, e.g. family members or friends. Goerke and Pannenberg (2015), using data from a pretest module of the SOEP where respondents report how important various reference groups are for them as well as how they perceive their income relative to these reference groups, find that the most important reference groups are colleagues at the workplace, other people in the same occupation and friends. Furthermore, the respondents' life satisfaction depends on how they perceive their income in comparison to the income of these reference groups. However, absolute income always remains important too. Since both studies focus on individual labor income, it remains unclear, however, to what extent these insights transfer to satisfaction with household income.

If the specific composition of the reference group and actually perceived relative income positions are unknown, reference incomes have to be estimated. Clark et al. (2008) argue that a natural candidate for the reference income is the income of "people like me" which may be calculated as a group average of people with similar

TABLE 1
OVERVIEW OF ESTIMATED EQUIVALENCE WEIGHTS OF ADULTS AND CHILDREN

Scale/Author	Specification/Subsample	Data	Weight given to the additional household member (1st adult = 1)		
			2nd adult	1st child (in 2 adult/1 adult household)	2nd child (in 2 adult/1 adult household)
Expert Scales					
OECD			0.50	0.30	0.30
Square root			0.41	0.32/0.41	0.27/0.32
Subjective Approach					
Schwarze (2003)	Pooled sample	SOEP	0.34	0.17/0.30	0.08/0.14
	Fixed effects		0.28	0.13/0.24	0.06/0.11
Bollinger et al. (2012)	Men	BHPS	0.15	1.12/1.64	0.68/1.22
	Women		0.31	1.17/1.52	0.41/0.78
Rojas (2007)	Child (<12)	Mexican	0.39	0.41/0.53	0.33/0.38
	Teenager (12-18)	ENIGH	0.39	0.24/0.32	0.21/0.25
Biewen and Juhasz (2017)	OECD-type	SOEP	0.35	0.13	0.13
Van Praag and Ferrer-i-Carbonell (2004)		SOEP	0.23	0.16/0.13	0.10/0.08
		BHPS	0.37	0.23/0.17	0.15/0.11
Melenberg and van Soest (1996)*		Dutch Soc.-Ec. Panel	0.88	0.76/na	0.61/na
Charlier (2002)*		SOEP	0.43	0.28/0.36	0.15/0.17

*Equivalence weights reflect the case that the first child is 12 years old and the second child is 6 years old.

Note: To ease the comparison of the various studies, we converted results such that they can be consistently interpreted as the equivalence weights relative to the first adult.

observable characteristics (e.g. Ferrer-i-Carbonell, 2005) or using a Mincer earnings equation in which a similar set of characteristics is used to predict incomes of observationally similar individuals (e.g. Clark and Oswald, 1996; Senik, 2008).

Ferrer-i-Carbonell (2005) investigates the impact of "comparison household income" on individual well-being. Her results, based on data from the SOEP, suggest that the average income of the reference group is equally important as own household income in determining life satisfaction. The reference group consists of individuals with a similar education, age and region of residence. Furthermore, Ferrer-i-Carbonell (2005) provides empirical support for an asymmetric reference effect. While people feel worse if they fall below average, they do not gain much from higher incomes if they already have an above-average income.

In addition to the reference income, as defined so far, the income rank of the individual within the reference group may play an important role in the determination of satisfaction (Clark et al., 2009). Boyce et al. (2010) explicitly differentiate between the reference-income hypothesis and the rank-income hypothesis. Using BHPS data, their evidence suggests that the income rank is more important than both absolute and reference income.

D'Ambrosio and Frick (2007) emphasize that beyond considering income ranks, which only reflect the position of individuals in the income distribution, one might wish to account for distances in incomes by looking at relative deprivation, a measure of the differences in household incomes between an individual and all richer individuals. In their analysis of SOEP data, they find that relative deprivation negatively affects income satisfaction, and that the satisfaction effect is stronger than that of absolute levels of equivalent income. D'Ambrosio and Frick (2012) show that also the income gap between the respondent and all poorer individuals affects satisfaction with income and life in general. The impact of this "inverse" relative deprivation measure on income and life satisfaction is positive, but weaker than that of relative deprivation.

While most studies examine reference effects only with respect to comparisons of individual-level income, the latter two studies are part of a relatively small strand of the literature (also including, e.g. Senik, 2008; Clark et al., 2009) that specifically addresses household-level comparisons. These studies consistently show that income comparisons at the household level matter for people's satisfaction with their income and life in general. Thus, it seems reasonable to examine reference effects when using data on satisfaction with household income.

3. Econometric Model

In this section, we present the econometric model used in our analysis. We first describe the subjective approach to derive equivalence scales directly from income satisfaction data. Then we discuss the role of relative income intuitively and develop a formal model that accounts for its effects explicitly.

3.1. *Direct estimation of equivalence scales (without relative income effects)*

To illustrate the subjective approach to estimate equivalence scales, let us assume that income satisfaction is determined by:

$$S_{it} = \alpha + \beta_1 f\left(\frac{Y_{it}}{HHeq\left(a_{it}, k_{it}\right)}\right) + X'_{it}\theta + \varepsilon_{it} \tag{1}$$

where S_{it} is income satisfaction reported by household i at time t, Y_{it} is household income, $HHeq\left(.\right)$ is the household's total equivalence weight (as a function of household size and composition, i.e. of the number of adults a_{it} and children k_{it}), X_{it} is a vector of other personal and household characteristics, and ε_{it} is an i.i.d. error term. The function $f\left(.\right)$ allows for nonlinearities in the relationship between equivalent income and income satisfaction (e.g. due to diminishing marginal satisfaction with income). To estimate this model, we have to make explicit assumptions about the functional forms of $HHeq\left(.\right)$ and $f\left(.\right)$. In the following, we will apply two commonly used functional forms for $HHeq\left(.\right)$: a constant-elasticity scale and a fixed-weights scale.

3.1.1. Linear Model (constant-elasticity scale)

A commonly used scale assumes that household size affects a household's total equivalence weight with a constant elasticity (see Buhmann et al., 1988):

$$HHeq\left(a_{it}, k_{it}\right) = \left(a_{it} + k_{it}\right)^e \tag{2}$$

In its simplest form, there is no distinction between adults and children, such that a_{it} and k_{it} enter with equal weights. e is the equivalence scale elasticity with respect to household size. The well-known square-root scale is a special case, with $e = 1/2$.

This functional form was used by Schwarze (2003) to estimate the equivalence elasticity from income satisfaction data. Its advantage is that it allows rewriting equation (1) as a linear regression equation if we assume that the relationship between equivalent income and income satisfaction is logarithmic, i.e. $f(x) = \ln x$. Equation (1) can then be written as

$$\begin{aligned} S_{it} &= \alpha + \beta_1 \ln\left(\frac{Y_{it}}{\left(a_{it} + k_{it}\right)^e}\right) + X'_{it}\theta + \varepsilon_{it} \\ &= \alpha + \beta_1 \ln Y_{it} - \beta_1 e \ln\left(a_{it} + k_{it}\right) + X'_{it}\theta + \varepsilon_{it} \end{aligned} \tag{3}$$

The equivalence scale elasticity e can subsequently be calculated by dividing the estimated regression coefficients on $\ln\left(a_{it} + k_{it}\right)$ and $\ln Y_{it}$, i.e. $e = \beta_1 e / \beta_1$.

Schwarze (2003) also proposes a modification of (2) that differentiates between adults and children in the estimation of the equivalence scale elasticity. He assumes that the equivalence scale elasticity depends linearly on the number of children: $e = e_a - bk_{it}$. In this specification, e_a is the equivalence scale elasticity of a household consisting of adults only. A positive (negative) b reflects that households with children have a lower (higher) equivalence scale elasticity than an adults-only household with an equal number of members.

The advantage of modeling the equivalence weight differences between adults and children via a linear adjustment of the scale elasticity is that the regression equation can, again, be written in linear form:

$$
\begin{aligned}
S_{it} &= \alpha + \beta_1 \ln\left(\frac{Y_{it}}{\left(a_{it}+k_{it}\right)^{e_a - bk_{it}}}\right) + X_{it}'\theta + \varepsilon_{it} \\
&= \alpha + \beta_1 \ln Y_{it} - \beta_1 e_a \ln\left(a_{it}+k_{it}\right) + \beta_1 b k_{it} \ln\left(a_{it}+k_{it}\right) + X_{it}'\theta + \varepsilon_{it}
\end{aligned} \tag{4}
$$

As in (3), the parameters of interest, i.e. the equivalence elasticity for a household without children, e_a, as well as the adjustment parameter when children are present, b, can be calculated by dividing the respective regression coefficients: $e_a = \beta_1 e_a / \beta_1$ and $b = \beta_1 b / \beta_1$.

3.1.2. Nonlinear Model (fixed-weights scale)

Another commonly used scale is the fixed-weights scale, of which the OECD scale is the best-known example (OECD, 2005). Fixed-weights scales assume that a household's equivalence weight is linear in the number of additional adults and children:

$$
HHeq\left(a_{it}, k_{it}\right) = 1 + \delta_a\left(a_{it} - 1\right) + \delta_k k_{it} \tag{5}
$$

δ_a and δ_k directly represent the equivalence weights of additional adults and children, respectively, relative to the first adult in the household. The (modified) OECD scale sets $\delta_a = 0.5$ and $\delta_k = 0.3$.

Assuming a logarithmic relationship between equivalent income and income satisfaction, the corresponding regression model can be written as

$$
S_{it} = \alpha + \beta_1 \ln\left(\frac{Y_{it}}{1 + \delta_a\left(a_{it} - 1\right) + \delta_k k_{it}}\right) + X_{it}'\theta + \varepsilon_{it} \tag{6}
$$

Since the parameters δ_a and δ_k enter nonlinearly, equation (6) has to be estimated using nonlinear estimation techniques. We apply nonlinear least squares (using Stata's `nl` command).

3.2. *The role of relative income: an intuitive approach*

Suppose that satisfaction with household income depends both on the absolute level of consumption, i.e. the extent to which household members are able to satisfy their personal needs and wants ("needs satisfaction"), as well as on how the family's household income compares to that of a relevant reference group ("status satisfaction"). For example, income satisfaction could be constructed as a weighted average of needs satisfaction and status satisfaction. When examining households of different sizes, the change in household income necessary to keep income satisfaction constant would then have to compensate for changes in needs as well as status satisfaction. The estimated equivalence scale would thus

represent the hypothetical compensation for (an average of) both effects. If we are only interested in the income adjustment necessary to keep the household's needs satisfaction constant when an additional member joins the household, we would obtain biased estimates if the extent to which this person affects the household's reference income deviates from this person's additional needs.

This bias can go in either direction. When an additional person joins a household, this household's reference group may change. It might be the case that the difference between the new and the old reference group's average household income exceeds the amount by which this person increases the consumption needs of the household. In this case, the equivalence weight obtained by (1) is an overestimate of the person's purely needs-based equivalence weight. The reverse case is also conceivable, where an additional household member's needs exceed the change in reference income. In this case, the person's needs-based equivalence weight will be underestimated.

To illustrate how the differential effects on a household's needs and reference income might affect the estimation of needs-based equivalence weights of adults and children, let us consider the following two hypothetical examples:

1. Consider a single person who is now forming a household with a partner. The absolute needs of the household increase. To the extent that there are gains from shared consumption, the income required to satisfy needs will not double, though. Suppose it increases by 60 percent. Assume further that the new reference group consists of two-adult households, for which the reference income is twice as large. Depending on how the individual weighs needs and status satisfaction, income satisfaction will be kept constant only if household income increases by something between 60 percent and 100 percent. This income adjustment would overcompensate needs satisfaction and undercompensate status satisfaction, but exactly compensate their weighted average.
2. Consider the case of a couple deciding to have a child. Suppose that the child increases the household's needs also by 60 percent (of the first adult's needs). The household's reference income might increase because comparable households receive government child benefits etc., but it might also decrease, for example because in households with children, the secondary earner tends to work fewer hours. Let us assume that the total effect on the household's reference income is an increase of 10 percent. To keep income satisfaction constant, an income compensation of something between 10 percent and 60 percent is needed. In this case, needs satisfaction is undercompensated, but status satisfaction is overcompensated.

As these two cases illustrate, the direction of the bias depends on whether an individual's contribution to a household's needs is above or below her contribution to the household's reference income.

3.3. *The role of relative income: formal analysis*

Formalizing the intuition laid out in the preceding subsection, we extend model (1) by assuming that income satisfaction depends additively on the

household's equivalent income (transformed by a function $f(.)$ - "needs satisfaction") and on relative income Y_{it}/Y_{it}^{ref} (transformed by a function $g(.)$ - "status satisfaction"), where Y_{it}^{ref} denotes the household's reference income:

$$S_{it} = \alpha + \beta_1 f\left(\frac{Y_{it}}{HHeq\left(a_{it},k_{it}\right)}\right) + \beta_2 g\left(\frac{Y_{it}}{Y_{it}^{ref}}\right) + X_{it}'\theta + \varepsilon_{it} \tag{7}$$

Whether the estimates of the equivalence weights of adults and children are biased if the function $g(.)$ is ignored in the estimation, and the direction of this bias, depends on the determinants of reference income.

We want to illustrate the bias for the linear model.[1] As before, we assume that $f(.)$ and $g(.)$ are both logarithmic functions. To ease the exposition, we assume here that relative income is constructed using the same functional form as the household equivalence weight, but with potentially different parameters. This assumption applies only to this section's theoretical illustration of the bias, and will be relaxed in the empirical analysis. If $Y_{it}^{ref} = \omega\left(a_{it}+k_{it}\right)^{e_2}$, where e_2 is the household-size elasticity of reference income and ω denotes the average earnings of the equivalent of the first household member, (7) can be written as:

$$\begin{aligned} S_{it} &= \alpha + \beta_1 \ln\left(\frac{Y_{it}}{\left(a_{it}+k_{it}\right)^{e_1}}\right) + \beta_2 \ln\left(\frac{Y_{it}}{\omega\left(a_{it}+k_{it}\right)^{e_2}}\right) + X_{it}'\theta + \varepsilon_{it} \\ &= \alpha - \beta_2 \ln\omega + \left(\beta_1+\beta_2\right)\ln Y_{it} - \left(\beta_1 e_1 + \beta_2 e_2\right)\ln\left(a_{it}+k_{it}\right) + X_{it}'\theta + \varepsilon_{it} \end{aligned} \tag{8}$$

Indicating the parameters estimated in the model without reference income (equation (3)) by a tilde, comparing (8) and (3) shows that

$$\begin{aligned} \tilde{\alpha} &= \alpha - \beta_2 \ln\omega \\ \tilde{\beta}_1 &= \beta_1 + \beta_2 \\ \tilde{\beta}_1 \tilde{e} &= \beta_1 e_1 + \beta_2 e_2 \end{aligned} \tag{9}$$

The estimated scale elasticity in the model without reference income is a weighted average of the scale elasticities in the needs-based component, e_1, and that of the reference component, e_2:

$$\tilde{e} = \frac{\beta_1}{\beta_1+\beta_2} e_1 + \frac{\beta_2}{\beta_1+\beta_2} e_2 \tag{10}$$

If the contribution of an additional household member to the household's reference income is larger than the associated increase in the household's needs, i.e. $e_2 > e_1$, ignoring reference effects causes an overestimation of the needs-based scale elasticity in the model without reference income: $\tilde{e} > e_1$.

The approach chosen by Schwarze (2003) to incorporate differences between adults and children into the linear model can be extended to the case with reference

[1]An analogous formal reasoning applies to the nonlinear model, see Appendix 1.

effects as well. Again applying the simplifying assumption that relative income has an analogous functional form as household equivalent income, but with potentially different parameters, the satisfaction equation is then written as

$$
\begin{aligned}
S_{it} &= \alpha + \beta_1 \ln\left(\frac{Y_{it}}{(a_{it}+k_{it})^{e_{a1}-b_1 k_{it}}}\right) + \beta_2 \ln\left(\frac{Y_{it}}{\omega(a_{it}+k_{it})^{e_{a2}-b_2 k_{it}}}\right) + X'_{it}\theta + \varepsilon_{it} \\
&= \alpha - \beta_2 \ln\omega + (\beta_1+\beta_2)\ln Y_{it} - (\beta_1 e_{a1} + \beta_2 e_{a2})\ln(a_{it}+k_{it}) \\
&\quad + (\beta_1 b_1 + \beta_2 b_2)\, k_{it} \ln(a_{it}+k_{it}) + X'_{it}\theta + \varepsilon_{it}
\end{aligned} \tag{11}
$$

Comparing (11) and (4) shows that the coefficients estimated without reference effects (indicated by tildes) are biased if the scale elasticities differ between household needs and reference incomes:

$$
\tilde{e}_a = \frac{\beta_1}{\beta_1+\beta_2} e_{a1} + \frac{\beta_2}{\beta_1+\beta_2} e_{a2}, \tilde{b} = \frac{\beta_1}{\beta_1+\beta_2} b_1 + \frac{\beta_2}{\beta_1+\beta_2} b_2 \tag{12}
$$

In particular, if additional adults increase reference incomes relatively more than they increase household needs $(e_{a2} > e_{a1})$, then the purely needs-based weight of additional adults is overestimated in the model without reference effects. Analogously, if the contribution of children to a household's reference income is less than their impact on needs (in the sense that their adjustment factors in the scale elasticities differ, with $b_2 > b_1$), the equivalence weight of children will be underestimated.

3.4. *Estimation of equivalence scales with relative income effects*

Equation (11) cannot be estimated directly because it would not be possible to estimate the needs components (β_1, e_{a1}, b_1) and status components (β_2, e_{a2}, b_2) of the model separately. When estimating an empirical version of (7), we thus follow a two-stage procedure. In the first stage, we obtain estimates of a household's reference income.[2] We use two approaches commonly applied in the literature. In the first approach, one assumes that a household's reference income is the average income of all households with whom this household shares a number of important characteristics, such as household composition, age, education, region of residence etc. (McBride, 2001; Stutzer, 2004; Ferrer-i-Carbonell, 2005). In the second approach, one assumes that reference incomes can be predicted from a Mincer earnings regression of household income (Clark and Oswald, 1996; Senik, 2008). Both approaches yield estimates of reference income $Y_{it}^{ref}(a_{it}, k_{it}, Z_{it})$, depending on the number of adults and children in the household (a_{it}, k_{it}) and other household characteristics (Z_{it}).[3] The details of how we construct reference incomes are presented in Section 6. Since the reference income included in the second stage regression is an estimated variable, it is necessary to bootstrap the

[2]As mentioned in Section 3.3, we model the determination of reference income and household equivalence weights using different functional forms to allow their separate identification.

[3]Some household characteristics could appear in both vectors X_{it} and Z_{it} if they matter for the determination of reference income and have an additional, direct effect on income satisfaction.

standard errors. We include the first stage (estimation of the reference income) in the bootstrap procedure in all cases.

Estimated reference incomes Y_{it}^{ref} are then used in the second stage to estimate an empirical version of (7). This can be done in both the linear and the nonlinear model. Extending the linear model (4) by including a relative income effect yields:

$$S_{it} = \alpha + \beta_1 \ln Y_{it} - \beta_1 e_a \ln\left(a_{it} + k_{it}\right) + \beta_1 b k_{it} \ln\left(a_{it} + k_{it}\right) + \beta_2 \ln\left(\frac{Y_{it}}{Y_{it}^{ref}\left(a_{it}, k_{it}, Z_{it}\right)}\right) + X_{it}'\theta + \varepsilon_{it} \tag{13}$$

The needs-based equivalence scale parameters can then be retrieved from $e_a = \beta_1 e_a / \beta_1$ and $b = \beta_1 b / \beta_1$. Analogously, also the nonlinear model (6) can be extended by including relative income effects:

$$S_{it} = \alpha + \beta_1 \ln\left(\frac{Y_{it}}{1 + \delta_a\left(a_{it} - 1\right) + \delta_k k_{it}}\right) + \beta_2 \ln\left(\frac{Y_{it}}{Y_{it}^{ref}\left(a_{it}, k_{it}, Z_{it}\right)}\right) + X_{it}'\theta + \varepsilon_{it} \tag{14}$$

The parameters δ_a and δ_k can then be directly interpreted as needs-based equivalence weights.

In equations (13) and (14), both the household's equivalence weight and its reference income depend on the number of adults and children. The model's parameters are identified as long as the estimated reference income Y_{it}^{ref} is not a perfect linear combination of the other variables explaining S_{it}. This is ensured if the exclusion restriction applies that there are some exogenous variables that affect income satisfaction only through their impact on reference income without having a direct effect on income satisfaction, i.e. some variables must appear only in Z_{it} but not in X_{it} (Clark et al., 2008). We argue that some personal characteristics we use in the first stage of our estimations satisfy this restriction, in particular the level of education, age, gender, and labor market participation. Even though these variables certainly affect the composition of people's reference groups, and thus their reference income, it seems reasonable to assume that men and women, younger and older people, as well as persons with higher or lower educational attainments do not systematically differ in the financial means they require to satisfy their material needs. Under this assumption, identification of all parameters in (13) and (14) is feasible.

4. Data

We use data from the German Socio-Economic Panel (SOEP), an annual representative panel survey of German private households (for a general introduction see Wagner et al., 2007). Our analysis covers the years 1984 to 2013. Each year, the SOEP interviews about 20,000 individuals from about 11,000 households who provide information on their objective life circumstances, such as income, employment status, level of education etc., as well as on their subjective

evaluations of various life domains, e.g. how satisfied they are with their job, family life, health, personal and household income, and life in general. We restrict the sample to people who are at least 18 years old.

Our dependent variable is income satisfaction. This subjective measure captures individual responses to the question "*How satisfied are you with your household income?*," on a scale ranging from zero to ten. Compared to self-reported general life satisfaction, which captures many aspects of life, this measure strongly emphasizes satisfaction of a household's financial resources and is therefore more suitable for the assessment of household equivalence scales (Charlier, 2002). Furthermore, there are two questions in the questionnaire asking separately about satisfaction with personal income and satisfaction with household income. This emphasizes that respondents should focus on the household as a whole and not just on their individual situation when evaluating their household income.

Our main explanatory variables are household income and family composition. We use a measure of net monthly household income, obtained from the following question:

> *"If you look at the total income of all of the members of your household: what is your monthly household income today? Please state the net monthly income, which means after deductions for taxes and social security. Please include regular income such as pensions, housing allowances, child benefits, grants for higher education, maintenance payments, etc."*

This question provides a quite precise definition of what is meant by net household income, which limits the scope of interpretation available to the respondent and therefore enhances reliability of this variable. To prevent an undue influence of implausibly low and extraordinarily high values of reported household income, we drop the lowest and highest percentile of households in each year's income distribution. To facilitate intertemporal and regional comparability of incomes, we calculate real household incomes (in 2007 euros), using consumer price indices specific to former East and West Germany. The regional differentiation captures persistent price differences between former East and West Germany. We obtain the price indices by combining two datasets. The first dataset, released by the German Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR, 2009), contains county-level information on price levels in 2007, which we aggregate to population-weighted averages for East and West Germany. We combine this information with time-series data from the German Statistical Office on changes in consumer prices in East and West Germany to obtain time-series of regional price levels and adjust household incomes accordingly.[4]

The SOEP also contains comprehensive information on a household's composition. We define "children" as all individuals below the age of eighteen in the

[4]A detailed description of how regional price indices have been constructed is available upon request. Our main results also hold true when inflation-adjustment is conducted on the basis of a single national consumer price index.

household, i.e. they do not necessarily have to be biological children of the household head. However, we exclude households where all members are under 18 or where either the household head or his or her partner are minors. This implies a loss of 72 observations. With the SOEP allowing us to identify a respondent's relation to the household head, we are able to restrict our sample further to focus on a very narrow definition of families. We include only one- or two-adult-households with or without minor children in our analysis, where the two adults living within the same households must be partners. We thus ignore all households with adult members besides the household head and his or her partner, e.g. households with grown-up children living in the household.[5] After applying these sample restrictions, we retain 316,240 observations from 46,976 individual respondents living in 29,381 households.

Other explanatory variables used in this study include age, sex, the level of education (measured as the years of education, derived from personal qualifications), the region of residence, and labor market status (employed, unemployed, non-participating, retired).

5. Descriptive Statistics

Table A1 in Appendix 2 summarizes the share of eight common household types in the total number of households, their mean income satisfaction as well as mean household income. Childless couples indicate the highest average income satisfaction. The presence of children in the household tends to be associated with lower mean income satisfaction both in one- and two-adult households. Nevertheless, couples with children are, on average, more satisfied with their income than single adults without children. Mean household income generally increases in the number of family members (except for the first child in a one-adult household), especially so in the number of adults, but relatively little in the number of children.

Table A2 in Appendix 2 lists mean values of other explanatory variables used in this study, separated by household type. While there are some significant differences in the average age and labor force status of their members, mean education levels are quite similar across household types.

6. Construction Of Reference Incomes

In the literature on the well-being effects of income comparisons, there are generally two different approaches to construct a person's reference income.

The first approach assumes that individuals compare their household income to the average income of a pre-specified reference group, consisting of people with whom they share a number of important characteristics. This approach has been

[5]We also conducted analyses with a more broadly defined sample containing also households consisting of more than two adults. Additional adults could be partners, grown-up children, other relatives or non-relatives. The results suggest that the equivalence weights for non-partner adults are considerably higher than those for partners. Our main hypothesis, however, that the relative equivalence weight of children increases when one controls for relative income effects continues to hold.

used by McBride (2001), Ferrer-i-Carbonell (2005) and Stutzer (2004), for instance. In the following, we call this the "cell average approach." In delimiting the different reference groups, we essentially follow the procedure suggested by Ferrer-i-Carbonell (2005), where reference groups contain individuals of similar age, living in the same region and having a similar level of education. In our study, we distinguish between two regions, East and West Germany, between four education levels (< 10, 11, 12, >12 years of education) and five age groups (under 25, 25-34, 35-44, 45-65, 66 and older).[6] By constructing reference groups for each year separately, we avoid the problem of people implausibly comparing themselves to people with similar characteristics in earlier or later survey years (see FitzRoy et al., 2014; Mujcic and Frijters, 2015). Following our argument, people evaluate their household income in relation to the average income of other households with a similar composition.[7] An individual's reference group therefore includes only people who live in similarly structured households. To avoid having too few observations in some reference groups by requiring people to have exactly the same number of children (in addition to being similar in age, region of residence and education), we do not differentiate reference groups based on the number of children. Instead, we only distinguish between households according to the number of adults and whether or not there are children in the household.[8]

For the cell average approach, let R_{it} denote the set of person-time identifiers of individuals in the reference group of individual i at time t and let $n\left(R_{it}\right)$ denote the number of individuals in this reference group. The reference groups are constructed as outlined above. The reference income of individual i at time t is then defined as:

$$Y_{it}^{ref} = \frac{1}{n\left(R_{it}\right)} \sum_{j \in R_{it}} Y_j \text{with } R_{it} = \left\{ \left(j,t\right) : a_{jt} = a_{it}; \text{sgn}\left(k_{jt}\right) = \text{sgn}\left(k_{it}\right); Z_{jt} = Z_{it} \right\} \tag{15}$$

The second approach predicts an individual's reference income with a Mincer earnings equation, as in the studies by Clark and Oswald (1996) and Senik (2008). While this relies on stronger assumptions about the functional relationship between personal and household characteristics and reference income, it allows including a larger number of determinants of reference income, in particular the number of children. Using OLS, we regress household income on the respondents' age, age squared, sex, the number of years of education, partnership (including the partner's sex), the number of children living in the household, a dummy for being retired and one for being out of the labor force. By not including a separate dummy

[6]We also analyzed floating age brackets, as proposed by McBride (2001), which gave virtually identical results to fixed age brackets.

[7]Average incomes are determined using the cross-sectional weighting factors provided by the SOEP.

[8]In an attempt to retain sufficiently many observations in each reference group, we do not control for sex in the cell average approach. Including this variable does not seem to change equivalence scale parameters considerably, leaving them to stay in line with our hypothesis, but substantially reduces precision.

for unemployment, we assume that the unemployed compare themselves to the employed. We also include year as well as state dummies. We refer to this as the "individual Mincer approach."

In the individual Mincer and the cell average approach, we do not take into account the characteristics of a respondent's partner. This could be considered a shortcoming since cell averages and the estimated coefficients in the Mincer approach merge information on households with sometimes very different partner characteristics. Consequently, the estimated reference household incomes for two partnered respondents belonging to the same household may be very different. This problem is alleviated by calculating expected earnings at the household level instead of for each partner separately. To do so, we divide our sample into two subsamples according to the number of adult members and regress household income on the household head's characteristics as well as his or her partner's information in the subsample with two adults. We call this extended approach the "household Mincer approach." Formally, we estimate the following regression equation in the first stage of the analysis:

$$Y_{it} = \alpha_M + \phi_M a_{it} + \varphi_M k_{it} + Z'_{it}\theta_M + \nu_{it} \tag{16}$$

In the individual (household) Mincer approach, the unit of observation i is the individual (household) and the vector Z_{it} contains the respondent's (both partners') characteristics that influence household income. As we discussed in Section 3.4, identification in the second stage of the model requires that Z_{it} contains some variables that do not appear in the second-stage regression (in X_{it}), i.e. they have to be correlated with household income Y_{it} but have no direct impact on income satisfaction beyond their impact via Y_{it}^{ref}. We argue that this is true for education, age, gender, and labor market participation.[9] The reference income Y_{it}^{ref} is then defined as the predicted household income from regression (16).

Detailed regression results for the Mincer equations are provided in Table A3 in Appendix 2. All coefficients carry signs that correspond to economic intuition. In line with our argument, we find the effect of an additional adult on predicted household income, i.e. reference income, to be much stronger than that of a child in both approaches. Predicted household incomes from both Mincer specifications (individual and household Mincer) are highly correlated with each other as well as with reference incomes determined using the cell average approach (see Table A4 in Appendix 2).

These common procedures to determine reference incomes rely on indirect methods, and therefore on restrictive assumptions. Constructed reference incomes, however, might pick up effects other than social comparisons (Clark et al., 2008, 111f). For example, if they are determined using average incomes of similar people living in the same region, they might be distorted due to differences in local public goods provision. To take this possibility into account, we include regional fixed effects (at the level of German federal states) in our regressions. Another possibility relevant for our study is that predicted incomes could reflect a baseline income

[9]The cell-average approach would also be identified without this assumption, as the reference income is not a linear function of the respective explanatory variables.

level, from which a person temporarily deviates, but to which he or she expects to return soon. For a given level of own income, higher reference incomes might then not cause less but more satisfaction. This issue will be addressed in robustness checks where we also examine the role of time-means of own and reference incomes (Section 8.1), which helps to distinguish between temporary deviations from one's own baseline income and comparisons with a reference income level. In any case, these caveats have to be kept in mind when interpreting our results.

7. Estimation Results

We now turn to our empirical results. We analyze how the inclusion of relative income affects the estimated equivalence weights of adults and children first in the linear model and then in the nonlinear model.

7.1. *The linear model*

The regression results for the linear model are presented in Table 2. We follow Schwarze (2003) and estimate the linear specification using an ordered logit model.[10] As discussed in Section 3, the estimated coefficients on the logarithm of income, the logarithm of the number of household members and its interaction with the number of children can be used to derive the equivalence scale parameters e_a and b. They combine to form the equivalence scale elasticity e, which is reported in the table's last row.

The first two columns represent variants of the model without reference income (equation (4)). In column 1, we do not take reference effects into account at all. In column 2, we follow the literature and linearly add a number of control variables. This reduces the estimated baseline elasticity from 0.494 to 0.389. It also appears to cause a slightly larger downward adjustment when children are in the household, resulting in an even smaller equivalence scale elasticity for children. Even though the adjustment of the scale elasticity if children are present appears rather small, the difference becomes sizable when converting it into equivalence weights. For example, if a second person joins a one-person household, the household's equivalence weight rises by 30.9 percent if the second person is an adult, but only by 28.5 percent if it is a child. These estimates are relatively close to those found by Schwarze (2003, Table 3) in his pooled ordered logit analysis of SOEP data.

It should be noted that, even though some of the control variables in column 2 are also potential determinants of reference income, simply adding them as linear controls generally does not avoid the bias when estimating needs-based equivalence weights if income satisfaction is a composite of needs and status satisfaction. Instead, reference incomes have to be modeled explicitly in a way that allows them to vary with household composition.

In columns 3 to 5 of Table 2, we report results of estimating equation (13), where we use the three underlying reference income specifications described in Section 6. In all three approaches, we obtain estimated coefficients of similar

[10]Estimating the model using OLS gives qualitatively identical results.

TABLE 2
ORDERED LOGIT REGRESSION RESULTS—LINEAR SPECIFICATION

	Dependent Variable: Satisfaction with household income				
	(1)	(2)	(3)	(4)	(5)
	No reference effect		Cell averages	Individual Mincer	Household Mincer
ln household income (β_1)	2.070***	2.212***	1.525***	1.679***	1.669***
	(0.020)	(0.022)	(0.039)	(0.033)	(0.038)
ln household members ($-\beta_1 e_a$)	-1.023***	-0.861***	-0.631***	-0.694***	-0.734***
	(0.030)	(0.030)	(0.040)	(0.037)	(0.040)
Children * ln household members ($\beta_1 b$)	0.025***	0.059***	-0.039***	-0.029***	-0.023**
	(0.009)	(0.009)	(0.011)	(0.010)	(0.011)
ln relative income	–	–	0.745***	0.581***	0.660***
			(0.041)	(0.035)	(0.044)
Age	–	-0.055***	–	–	–
		(0.003)			
Age squared	–	0.001***	–	–	–
		(0.000)			
Female	–	0.153***	–	–	–
		(0.010)			
Unemployed	–	-0.747***	–	–	–
		(0.024)			
OLF	–	0.145***	–	–	–
		(0.017)			
Retired	–	0.384***	–	–	–
		(0.030)			
Years of education	–	-0.001	–	–	–
		(0.003)			
N	316,240	310,363	310,356	310,274	295,462
Pseudo R^2	0.062	0.074	0.063	0.063	0.063
$e_a = \beta_1 e_a / \beta_1$	0.494***	0.389***	0.413***	0.413***	0.440***
	(0.013)	(0.012)	(0.020)	(0.018)	(0.018)
$b = \beta_1 b / \beta_1$	0.012***	0.027***	-0.026***	-0.017***	-0.014**
	(0.004)	(0.004)	(0.007)	(0.006)	(0.007)
$e = e_a - bk$	0.494-0.012k	0.389-0.027k	0.413+0.026k	0.413+0.017k	0.440+0.014k

Note: Standard errors in parentheses, all clustered by households. Columns 3 to 5 report bootstrapped standard errors based on 1000 replications. All regressions include a constant term, year and state fixed effects (not explicitly reported).

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

TABLE 3
NONLINEAR LEAST SQUARES REGRESSION RESULTS—NONLINEAR SPECIFICATION

	Dependent Variable: Satisfaction with household income				
	(1)	(2)	(3)	(4)	(5)
	No reference effect		Cell averages	Individual Mincer	Household Mincer
Scale parameter adult	0.356***	0.310***	0.198***	0.210***	0.247***
	(0.014)	(0.012)	(0.023)	(0.020)	(0.021)
Scale parameter child	0.258***	0.122***	0.332***	0.294***	0.310***
	(0.009)	(0.007)	(0.015)	(0.012)	(0.013)
Equivalent income	2.289***	2.390***	1.537***	1.753***	1.747***
	(0.021)	(0.023)	(0.045)	(0.038)	(0.042)
Relative income	–	–	0.978***	0.739***	0.827***
			(0.049)	(0.041)	(0.049)
Age	–	-0.058***	–	–	–
		(0.003)			
Age squared	–	0.001***	–	–	–
		(0.000)			
Female	–	0.142***	–	–	–
		(0.011)			
Unemployment	–	-0.974***	–	–	–
		(0.028)			
Out of labor force	–	0.137***	–	–	–
		(0.018)			
Retired	–	0.425***	–	–	–
		(0.031)			
Years of education	–	-0.007*	–	–	–
		(0.004)			
N	316,240	310,363	310,356	310,274	295,462
adj. R^2	0.230	0.272	0.236	0.236	0.237

Note: Standard errors in parentheses, all clustered by households. Columns 3 to 5 report bootstrapped standard errors based on 1000 replications. All regressions include a constant term, year and state fixed effects (not explicitly reported).

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

magnitudes. This corresponds to the observation that all the reference income measures are highly correlated (Appendix 2, Table A4). We find that for each definition of reference income, both absolute as well as relative household income have a strong, significantly positive effect on income satisfaction.

A closer look at the implied equivalence scale parameters reveals changes that support our hypotheses. The weight attached to an additional adult is unambiguously lower than that suggested by a model ignoring reference effects entirely as in column 1. Not controlling for reference income thus seems to overestimate an adults' equivalence weight. On the other hand, the deduction to be made for children becomes negative when reference effects are being considered, such that children end up with higher equivalence weights than adults. Ignoring reference effects thus underestimates a child's equivalence weight relative to that of an adult. It is also informative to compare these results with the model of column 2. Even though the set of control variables used in the model of column 2 and that used in the construction of reference income are nearly identical, the results differ substantially—in particular for children—because the model in column 2 cannot account for the differential impact of adults and children on needs and reference income. Following our theoretical reasoning, we therefore believe that the parameter estimates of columns 3 to 5 represent better approximations of needs-based equivalence scale parameters. They suggest that the equivalence weight of a child is slightly, but statistically significantly larger than that of an adult. In case that either of them is the second person in the household, the equivalence weight of an adult ranges between 33.1 and 35.7 percent and that of a child ranges between 34.7 and 37.0 percent.

7.2. *The nonlinear model*

We present the results of the nonlinear model in Table 3. The equivalence weights are now estimated directly via nonlinear least squares and can be read off the first two rows of the table. In column 1, we again consider a model taking neither reference income nor comparison-relevant control variables into account. The equivalence weight of a partner adult is found to be about 36 percent of the first adult. The estimated equivalence weight of a child is estimated to be just about two thirds of that of the partner adult. This result changes substantially when further control variables are included in the regression. As can be seen in column 2, the equivalence weights of adults and children are both smaller than in column 1. Their magnitudes resemble those obtained by Biewen and Juhasz (2017). Most notably, we also find a large difference between the equivalence weights of additional adults and children. Additional adults and children receive weights of 31 and 12 percent of the first adult, respectively.

This finding is reversed when reference incomes are incorporated explicitly. The findings of estimating equation (14) are reported in columns 3 to 5. As in the linear model, the household's absolute equivalent income as well as relative household income have a strong and positive relation with income satisfaction. Compared to columns 1 and 2, the equivalence weight of an additional adult decreases whereas the weight of a child strongly increases in all three approaches. Indeed, children are assigned greater weights than adults with the former ranging

between 29 to 33 and the latter ranging between 20 and 25 percent. This confirms our hypotheses that ignoring reference income effects overestimates adults' needs while it underestimates the needs of children.

8. Robustness Tests

We now examine whether our main result—adults receive lower and children relatively higher equivalence weights when we take reference effects into account—is robust to changes in our model's specification. Due to the convenience of having equivalence weights estimated directly, we present the results only for the nonlinear framework. We checked that conducting the same tests in the linear framework yields similar results. Only when we turn to the inclusion of individual fixed effects, the results for the linear and nonlinear specification will be presented.

8.1. *Alternative Specifications*

The results of seven robustness tests are presented in Table 4. The first column presents a model where, based on the reference groups determined in the "cell average approach," relative income is replaced by the percentile rank within the corresponding reference group's income distribution, which was found to have an impact on satisfaction by Clark et al. (2009) and Boyce et al. (2010). The regression results suggest that income satisfaction increases as the rank within the reference income distribution rises and thus also support the claim that relative income positions matter. The change in the definition of the reference effect results in a slight increase in the equivalence weight of adults and a slight decrease in the weight of children (compared to Table 3, column 3). Hence, the difference in both parameters becomes smaller. With the weight for children still turning out to be larger than that for adults, our main result proves robust to this redefinition of the status component.

Instead of capturing individuals' positions within their reference groups by their percentile ranks, one could alternatively measure status effects by looking at income differences to others within the same reference group. While our relative income variable encompasses a person's relative distance to mean income within the reference group, one could also be interested in this person's income gaps with each of its members. In Table 4, column 2, we therefore consider an individual's relative deprivation within her own cell-based reference group instead of relative income. We follow Chakravarty (1997) in defining relative deprivation as the sum of the income gaps between the individual and all richer individuals, normalized by total income in that group. D'Ambrosio and Frick (2007) found that relative deprivation within a single nation-wide reference group has a significantly negative and even stronger impact on income satisfaction than equivalent income. This result is confirmed by our analysis of relative deprivation within many small reference groups differentiated by personal and household characteristics. However, our results concerning the implied equivalence scale do not change much with the alternative specification of status concerns. Both equivalence scale parameters

TABLE 4
ALTERNATIVE SPECIFICATIONS I

	Dependent Variable: Satisfaction with household income						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Percentile rank within reference group	Relative Deprivation	Probit-adjusted	Including mean relative income	Including mean equivalent income	Including mean relative and equivalent income	Lagged equivalent and relative income
Scale parameter adult	0.232***	0.235***	0.276***	0.249***	0.239***	0.244***	0.274***
	(0.020)	(0.021)	(0.021)	(0.021)	(0.027)	(0.023)	(0.031)
Scale parameter child	0.302***	0.353***	0.327***	0.313***	0.316***	0.315***	0.328***
	(0.013)	(0.015)	(0.014)	(0.013)	(0.017)	(0.015)	(0.020)
Equivalent income	1.727***	1.613***	0.746***	1.739***	1.335***	1.541***	1.584***
	(0.037)	(0.038)	(0.019)	(0.043)	(0.050)	(0.053)	(0.058)
Relative income	-	-	0.348***	0.484***	0.914***	0.632***	0.687***
			(0.021)	(0.047)	(0.050)	(0.056)	(0.069)
Percentile rank	0.010***	-	-	-	-	-	-
	(0.000)						
Relative Deprivation	-	-2.284***	-	-	-	-	-
		(0.098)					
Mean relative income	-	-	-	0.526***	-	0.370***	-
				(0.045)		(0.067)	
Mean equivalent income	-	-	-	-	0.463***	0.222***	-
					(0.035)	(0.053)	
N	310,119	310,365	295,462	295,462	295,462	295,410	200,388
adj. R^2	0.235	0.239	0.232	0.238	0.238	0.239	0.191

Note: Standard errors in parentheses, all clustered by households. Column 1 and 2 use the cell average approach; Columns 3-7 employ the household Mincer approach. All columns report bootstrapped standard errors based on 1000 replications. All regressions also include a constant term, year and state fixed effects (not explicitly reported).

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

slightly increase as compared to Table 3, column 3. The weight assigned to children remains larger than that for adults.

One could be worried that the nonlinear least squares results suffer from having to assume cardinality of the income satisfaction data. To take into account the ordinal nature of the dependent variable also in the nonlinear model, we carry out a probit-adjustment before running the nonlinear least squares regression (van Praag and Ferrer-i-Carbonell, 2004). As can be seen in column 3, the estimated equivalence weights are larger than those derived in Table 3, column 5, and they move closer towards each other.[11]

Changes in one's income relative to some reference group might have very different effects, depending on whether this change is perceived as temporary or permanent. A simple, albeit only approximate way to distinguish between temporary and permanent effects is to simultaneously control for an individuals' relative income and for the time-mean of this person's relative income while in the panel (van Praag et al., 2003). We find that the time-invariant mean relative income as well as temporary deviations from it positively affect income satisfaction (column 4). The estimated equivalence scale parameters, however, change only very little.

In a similar way, we can distinguish between permanent and temporary changes in equivalent income by including the time-mean of an individual's equivalent income besides the current-period equivalent income. This analysis is complicated by the fact that mean equivalent income as a regressor is a function of the equivalence scale, which has to be determined in the regression itself. To solve this technical endogeneity problem, we use an iterative approach: we first calculate mean equivalent incomes using arbitrary starting values of the scale parameters of adults and children.[12] We then conduct the regression analysis and use the resulting estimated scale parameters to recalculate mean equivalent incomes. We then run the regression again with the new mean equivalent income and obtain new estimates of the scale parameters. This process continues until convergence in the pre- and post-regression scale parameters of adults and children is achieved. The results from this analysis are presented in column 5 of Table 4. We find that mean equivalent income has a significantly positive but smaller impact on income satisfaction than temporary deviations from it. The implied equivalence weights, however, are not greatly affected by the inclusion of mean equivalent income.

The same holds true when both, mean equivalent and mean relative income, are included in the analysis (column 6). Both measures continue to have a significantly positive effect on income satisfaction but do not produce any sizeable changes in the equivalence scale parameters.

To account for the possibility that income and satisfaction vary together driven by a common external force, we also regress income satisfaction on lagged income variables. The results reported in column 7 show that lagged equivalent and lagged relative income are significantly positively related to current-year income satisfaction. The implied equivalence weights for adults and children are both slightly larger than in the specification using current-period income variables. In

[11]For this and the following robustness checks, we present estimates for the "household Mincer" approach only. We checked that the other approaches yield similar results.

[12]The use of alternative combinations of starting values led to virtually identical results.

accordance with our previous results, children receive a higher equivalence weight than adults.

There are a number of extensions to our baseline model that help us to further evaluate the robustness of our results while giving some valuable insights into household economies of scale and reference income effects. One common extension in the literature concerns the age structure of children in the household. We differentiate between three groups: children that are 0 to 5 years, 6 to 13 years, and 14 to 17 years old. We estimate equivalence scale parameters for each of these groups by incorporating them separately into our specification of equivalent income. The results of this extension are shown in Column 1 of Table 5. While the equivalence parameter for children aged 6 to 13 years is basically identical to that of younger children, the weight of a child belonging to the oldest group appears strikingly high. It exceeds the parameter for a partner considerably, thus suggesting that teenagers have rather large personal material needs. This implies that households with teenagers enjoy considerably lower economies of scales than with partners or younger children.

We now add more flexibility to the functional relationship between reference income and income satisfaction. Firstly, we allow for asymmetric reference effects by interacting relative income with a dummy variable that indicates whether the household's income is above or below its reference value as in Ferrer-i-Carbonell (2005). The results in Table 5, column 2, suggest that a higher relative income has positive effects on satisfaction for both, individuals with household income above and below the reference point. However, the positive effect is much stronger in the latter case. Hence, relatively rich individuals seem to gain much less additional income satisfaction from getting richer than do individuals that are relatively poor. Nevertheless, the estimated equivalence weights are still very similar to our previous results.

In a second adjustment to increase flexibility of the reference effect, we allow the reference income effect to vary with the number of adults living within a household. We estimate coefficients reflecting the reference effect separately by interacting relative income with a dummy variable indicating the number of adults in the household. We are thus able to investigate whether individuals living in single and couple households systematically differ from each other in the sense of how much importance they assign to their relative household income. The results of this extension, presented in column 3 of Table 5, indeed indicate such a difference. It can be seen that the relative income effect is considerably greater for singles than for individuals living in couple households. This could either be interpreted as evidence for our reference income measure being less precise when the number of adults increases, or it could reflect the problem that personal success also matters for income satisfaction. An adult living in a partnership may derive less satisfaction from an increase in household income than a single, because it may not be directly attributed to her but to her partner's increased earnings. One might also claim that individuals living in a partnership simply do not care as much about relative income positions as singles do. No matter what the exact reason is, it can be seen that, although there is a difference in relative income effects, the equivalence weights do not change significantly.

TABLE 5
Alternative Specifications II

	Dependent Variable: Satisfaction with household income		
	(1) Age-dependent parameters	(2) Asymmetric reference effect	(3) Reference effect by number of adults
Scale parameter adult	0.252*** (0.021)	0.258*** (0.021)	0.264*** (0.020)
Scale parameter child 0-5	0.285*** (0.019)	–	–
Scale parameter child 6-13	0.279*** (0.015)	–	–
Scale parameter child 14-17	0.427*** (0.020)	–	–
Scale parameter child	–	0.325*** (0.014)	0.313*** (0.013)
Equivalent income	1.762*** (0.043)	1.735*** (0.042)	1.751*** (0.042)
Relative income	0.814*** (0.049)	–	–
Above reference income	–	0.244*** (0.062)	–
Below reference income	–	1.241*** (0.060)	–
One-adult relative income	–	–	1.051*** (0.057)
Two-adult relative income	–	–	0.730*** (0.052)
N	295,462	295,462	295,462
adj. R^2	0.237	0.239	0.237

Note: Standard errors in parentheses, all clustered by households. All columns employ the household Mincer approach and report bootstrapped standard errors based on 1000 replications. All regressions also include a constant term, year and state fixed effects (not explicitly reported);
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

8.2. *Sample Restrictions*

Table 6 lists the results obtained from conducting our analysis of the non-linear model on differently restricted samples. One matter of concern could be that our sample includes some individuals that have a partner who does not live within the same household. Leaving them in our sample and treating them as single adults may be problematic. The results in column 1 of Table 6 show that once we remove these individuals from our sample the parameter for adults increases by almost four percentage points as compared to the estimate in column 5 of Table 3. As the weight of children does not change considerably, both parameters end up being very close to each other.

Table 6
Sample Restrictions

	Dependent Variable: Satisfaction with household income		
	(1) Excluding individuals, having a partner outside of the household	(2) Excluding households with a change in family structure in the preceding or subsequent two years	(3) Only households with no payments to relatives outside of the household
Scale parameter adult	0.285***	0.256***	0.242***
	(0.022)	(0.038)	(0.025)
Scale parameter child	0.314***	0.363***	0.288***
	(0.014)	(0.025)	(0.015)
Equivalent income	1.743***	1.474***	1.740***
	(0.044)	(0.070)	(0.054)
Relative income	0.836***	1.168***	0.912***
	(0.051)	(0.080)	(0.061)
N	281,728	125,926	173,990
adj. R^2	0.234	0.233	0.237

Note: Standard errors in parentheses, all clustered by households. All columns employ the household Mincer approach and report bootstrapped standard errors based on 1000 replications. All regressions also include a constant term, year and state fixed effects (not explicitly reported);
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

The birth of a baby or the point in time when a grown-up child moves out may be anticipated and could thus affect satisfaction with household income well before the actual event. Similarly, individuals that have experienced such changes may require some time to adjust to the new situation their household is in. To ensure that our results are not affected by such anticipation and adjustment effects, we use the panel structure of our data and exclude all observations of households that have experienced or will experience a change in their structure either two years before or after the year of observation. This involves a great reduction of our sample size by nearly 170,000 observations. Nevertheless, our results prove robust to this sample adjustment. As the equivalence weight of children increases more than that of adults, we find that an even larger income increment is needed for children relative to additional adults than in the full sample.

One last sample restriction concerns households facing external financial obligations, e.g. alimony payments. These payments may be voluntary or due to legal obligations, but they do mean that household income is shared among more individuals than those captured by our specification of the equivalence scale. In column 3, we therefore present results based on a sample of households, whose members explicitly stated that they have not made any payments to relatives or other persons outside of the household during the year of observation. This sample restriction causes a loss of 121,472 observations, but does not greatly affect our estimates. The equivalence scale parameters for children and adults are slightly reduced, and the difference between them is narrowed down.

8.3. *Individual Fixed Effects*

The panel structure of the SOEP in principle allows us to control for the unobserved heterogeneity of individuals. In the main part of the paper, however, we chose to conduct pooled cross-sectional analyses. There are several reasons for this decision. Restricting one's attention to within-person effects might be less informative than looking at between-person effects if changes in household structure are anticipated. In this case, knowing that one wants to have a child in the future might affect income satisfaction already before the child is born. Likewise, expecting that a grown-up child will move out of the parental household in the near future could increase the parent's satisfaction with their income already before the child actually moves out (or children might need informal financial support even after they have moved out). With such intertemporal spillovers, examining within-person satisfaction changes in a narrow time interval surrounding changes in household structure might cause an underestimation of the true impact of additional household members, which might be better captured by comparing different households. Moreover, our procedure to decompose needs and status effects relies on identifying variation in reference incomes that are not driven by changes in household structure. However, most variables needed to identify such independent variation in reference incomes do not change (much) over time, in particular gender and education. This makes the identification of relative income effects, and thus of needs-based equivalence scales, difficult. Nevertheless, we can check to what extent our cross-sectional

results are robust to including individual fixed effects in the linear and nonlinear specifications.

There are several challenges related to the fixed effects estimation in the present context. First of all, we have to choose from a variety of approaches to consistently estimate the fixed effects ordered logit model in the linear framework. One option is the Chamberlain (1980) estimator which allows a consistent estimation of the model by transforming the ordinal dependent variable into a binary one. Schwarze (2003) uses this approach and collapses income satisfaction into a binary variable indicating whether an individual's satisfaction is above or below the average income satisfaction of the entire sample. A shortcoming of the Chamberlain estimator is that individuals that have not experienced a change in the binary variable drop out from the sample, which implies a sizeable loss in the number of observations. Baetschmann et al. (2015) have developed a method that makes use of the consistency of the Chamberlain estimator but circumvents this severe loss of information. Their approach is to dichotomize the ordinal dependent variable at every possible cut-off point. Instead of having to separately estimate as many Chamberlain-type regressions as there are potential cut-off points, Baetschmann et al. (2015) show that consistent estimates can be obtained from running a consolidated regression in which the coefficients of the Chamberlain-type subregressions are restricted to be identical. Technically, this is achieved by replacing every observation with multiple copies of itself, where each copy's income satisfaction variable is dichotomized at a different cut-off, and then running a conditional logit estimation on this extended sample with standard errors clustered at the level at which the observations were duplicated ("blow-up and cluster"). In contrast to the Chamberlain estimator, only a small number of individuals drop out from the regression, namely those who are observed only once and those who indicate a constant level of income satisfaction in all years observed. The results based on the "blow-up and cluster"-method are reported in Table 7, where we cluster at the household level in which the "blown-up" observations are nested.[13] Comparing them to the ordered logit results in Table 2, remarkable similarities but also differences appear. Interestingly, the coefficient on the logarithm of household income is basically unchanged in all specifications when individual fixed effects are accounted for. On the other hand, the equivalence scale parameters of adults and children are significantly reduced across all specifications. This result corresponds to the findings of Schwarze (2003). In line with our general argument, however, we find that accounting for relative income effects in the fixed-effects setting leads to children receiving greater equivalence weights relative to additional adults as compared to when status concerns are ignored or not modelled explicitly. This is because relative income continues to have a significantly positive effect on satisfaction. Our main result is thus confirmed in the linear model with individual fixed effects.

In the nonlinear model, we take individual fixed effects into account by demeaning all variables, i.e. we subtract the person-specific time-mean of each variable from the current-year observation. We then estimate the equivalence scale parameters from the nonlinear model employing the transformed data.

[13]A Chamberlain estimation with a dichotomization at the sample mean of income satisfaction yields very similar results (Table A5 in the appendix).

TABLE 7
BLOW-UP-AND-CLUSTER REGRESSION RESULTS—LINEAR SPECIFICATION INCLUDING FIXED EFFECTS

	Dependent Variable: Satisfaction with household income				
	(1)	(2)	(3)	(4)	(5)
	No reference effect		Cell averages	Individual Mincer	Household Mincer
ln household income (β_1)	2.272***	2.265***	1.839***	1.708***	1.696***
	(0.028)	(0.029)	(0.055)	(0.051)	(0.054)
ln household members	-0.728***	-0.745***	-0.435***	-0.306***	-0.344***
($-\beta_1 e_a$)	(0.043)	(0.043)	(0.054)	(0.056)	(0.055)
Children* ln household	0.019	0.033**	-0.028	-0.041**	-0.031*
members ($\beta_1 b$)	(0.014)	(0.013)	(0.014)	(0.015)	(0.015)
ln relative income	–	–	0.533***	0.715***	0.802***
			(0.054)	(0.051)	(0.056)
Age	–	-0.054***	–	–	–
		(0.005)			
Age squared	–	0.000***	–	–	–
		(0.000)			
Unemployed	–	-0.850***	–	–	–
		(0.027)			
OLF	–	-0.143***	–	–	–
		(0.020)			
Retired	–	0.103**	–	–	–
		(0.034)			
Years of education	–	0.001	–	–	–
		(0.012)			
N	298,678	293,378	293,374	293,295	279,190
Pseudo R^2	0.063	0.070	0.063	0.065	0.064
$e_a = \beta_1 e_a / \beta_1$	0.321***	0.329***	0.236***	0.179***	0.203***
	(0.018)	(0.018)	(0.025)	(0.030)	(0.029)
$b = \beta_1 b / \beta_1$	0.008	0.015*	-0.015	-0.024**	-0.019*[a]
	(0.006)	(0.006)	(0.008)	(0.009)	(0.009)
$e = e_a - bk$	0.321-0.008k	0.329-0.015k	0.236+0.015k	0.179+0.024k	0.203+0.019k

Note:. Standard errors in parentheses, all clustered by households. Columns 3 to 5 report bootstrapped standard errors based on 1000 replications. All regressions include a constant term and state fixed effects (not explicitly reported).

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

Analogously to the case where we controlled for mean-equivalent income above, we face a technical endogeneity problem: demeaning equivalent income necessitates information on equivalent income at all points in time, which depend on the equivalence scale that has to be determined in the regression. We apply the same iterative approach as outlined above. Setting arbitrary starting values for the equivalence weights of adults and children, we calculate mean equivalent incomes and run the regression. The estimated equivalence weights are then used to recalculate mean equivalent incomes and rerun the regression until the weights used to calculate mean equivalent incomes and the resulting estimates have converged. The results of the fixed-effects analysis of the nonlinear model are provided in Table 8. They confirm the findings derived from the linear model. Again, we find that the estimated coefficients on equivalent and relative income are affected relatively little by the inclusion of individual fixed effects. Their magnitude slightly decreases but continues to be significantly positive. All equivalence scale parameters turn out to be smaller than their counterparts from the regression without fixed effects. But while the equivalence weight of a child is only about one third of that of an additional adult in the specifications without relative income (columns 1 and 2), the difference in these weights narrows down as relative income is included. While it becomes statistically insignificant in the individual Mincer approach, the results from the cell-average and Household Mincer approach suggest that the equivalence scale parameter for adults remains somewhat larger than that for children—but to a far lesser extent than suggested by models not accounting for relative incomes. Thus, while the estimations with fixed effects affect the magnitude of the estimated equivalence weights, they nevertheless support the robustness of our main results. Taking reference effects into account reduces, or even reverses, the gap in equivalence weights between adults and children.

9. Concluding Remarks

In this study, we have illustrated that equivalence scales derived from data on income satisfaction may capture effects that go beyond differences in needs. Neglecting the separate identification of these effects generally causes biased estimates of equivalence weights. More specifically, we have provided evidence that income satisfaction depends only partly on the degree to which needs are satisfied, and that social comparisons are another important determinant of income satisfaction. If family size influences not only a household's needs, but also its reference group, the estimation of a purely needs-based equivalence scale requires taking reference effects explicitly into account. Previous studies, which did not control for relative income, typically obtained much smaller equivalence weights for children than for additional adults. Our results suggest that this difference arises because children affect a household's needs in a similar way as additional adults, but have only a small effect on the household's reference income. We propose a model that explicitly separates the two effects. Separate identification of the two effects requires that some socio-economic characteristics affect households' reference incomes, but are not directly related to their needs (exclusion restrictions). In this study, we assume that this is the case for age, gender, education, and labor market participation. With this method to estimate

TABLE 8
NONLINEAR LEAST SQUARES INCLUDING INDIVIDUAL FIXED EFFECTS (DEMEANING)

	Dependent Variable: Satisfaction with household income				
	(1)	(2)	(3)	(4)	(5)
	No reference effect		Cell averages	Individual Mincer	Household Mincer
Scale parameter adult	0.270***	0.263***	0.172***	0.109***	0.112***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Scale parameter child	0.109***	0.091***	0.116***	0.105***	0.101***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Equivalent income	1.927***	1.917***	1.543***	1.416***	1.383***
	(0.012)	(0.013)	(0.036)	(0.034)	(0.035)
Relative income	–	–	0.444***	0.605***	0.696***
			(0.039)	(0.035)	(0.039)
Age	–	-0.052***	–	–	–
		(0.002)			
Age squared	–	0.000***	–	–	–
		(0.000)			
Unemployment	–	-0.830***	–	–	–
		(0.017)			
Out of labor force	–	-0.116***	–	–	–
		(0.011)			
Retired	–	0.071***	–	–	–
		(0.018)			
Years of education	–	-0.000	–	–	–
		(0.006)			
N	316,240	310,363	310,356	310,274	295,462
adj. R^2	0.085	0.098	0.086	0.087	0.086

Note:. Standard errors in parentheses, all clustered by households. In columns 1 and 2, standard errors have been adjusted for a reduction in the degrees of freedom due to within transformation of the data. Columns 3 to 5 report bootstrapped standard errors based on 1000 replications. All regressions include a constant term and state fixed effects (not explicitly reported).

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

purely needs-based equivalence scales, we obtain lower equivalence weights for adults and higher relative weights for children, such that, overall, we do not find that children receive smaller weights than adults. Additional adults and children typically receive similar weights of 30 to 40 percent in the linear and 20 to 35 percent in the nonlinear model.

We do not want to suggest that previous attempts to recover equivalence scales from subjective data have been flawed, per se. As Coulter et al. (1992a) already argued, there is no universally applicable equivalence scale, because which scale is "true" is ultimately a normative judgment about which effects should, or should not, be considered. In this study, we intend to raise awareness that what estimated equivalence scales actually measure might not be what they were meant to measure. One can say that previous studies determined the compensation needed to keep income satisfaction constant across household structures. However, since income satisfaction seems to be determined not only by needs fulfilment, but also by income comparisons with others and status considerations, it is debatable whether all these effects should be seen as welfare-relevant and should thus affect the equivalence scale. This is ultimately a normative question that our analysis cannot answer. Our contribution is to show how the needs-based part of income satisfaction can be separated from its income-comparison part if one is interested in the necessary incomes that allow families of different sizes to achieve the same level of needs fulfillment, and one is willing to accept that this does not necessarily imply that income satisfaction is equalized across households, our estimates might be a better guide than those of previous studies.

Having included reference incomes, the large difference between adults and children found in other studies disappears and often even reverses. The estimated equivalence weight of children resembles the weight the modified OECD scale assigns to children. The estimated weight of adults, however, is lower than suggested by the OECD scale. This may be due to the exclusion of households containing non-partner adults. Thus, the weight of the second adult should be interpreted only as the weight of an additional adult who is the partner of the first adult. This weight might be different from the weight of a non-partner adult. When including other adults who are not partners, we obtain a scale where adults, once again, receive higher weights than children.

Further research is required to deepen our understanding of the reference effects assessed in this paper and to investigate reference effects in the evaluation of satisfaction with household income in general. A crucial aspect is the determination of the correct reference group. It may be possible, too, that income comparisons are carried out on a number of different levels, e.g. neighbors, colleagues, or family members, which could have implications for the equivalence scale estimates. Apart from interpersonal comparisons, it may also be relevant to consider intertemporal comparisons with oneself to see if expectations or the adaptation to household arrangements or incomes are important factors in the evaluation of household income. Taking such aspects into account as well as investigating other channels through which income satisfaction may be affected, could help to understand even better what is actually being measured by equivalence scales derived

from income satisfaction data. Given a normative agreement on what an equivalence scale should capture, a better understanding of what determines income satisfaction will be helpful for determining even more precise estimates of equivalence weights.

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Supporting Information

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

Appendix 1. The role of relative income. formal analysis for the nonlinear model

Appendix 2. Additional Tables

Table A1. Mean Income Satisfaction And Household Income, By Household Type

Table A2. Mean Values Of Important Control Variables By Household Type

Table A3. Detailed Regression Results For Mincer Equations

Table A4. Correlation Between Differently Constructed Reference Income Measures

Table A5. Binary Logit Regression Results—Linear Specification Including Fixed Effects