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Using Panel Data on Income Satisfaction to Estimate the Equivalence Scale Elasticity

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ABSTRACT

Using Panel Data on Income Satisfaction to Estimate the Equivalence Scale Elasticity [*]

In this paper a new method to estimate the equivalence scale elasticity using individual panel data on income satisfaction will be developed. In contrast to other subjective approaches, the present one benefits from the fact that no direct cardinal individual welfare function has to be specified. In addition, panel data enables different scale use by the respondents to be controlled. The approach gives straightforward evidence: Obviously there is an optimal elasticity at which people feel satisfied with their income.

JEL Classification: C23, D31, I31

Keywords: Equivalence scales, income satisfaction, panel data

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1. The equivalence scale elasticity – An unsolved puzzle

Theoretical and empirical work have shown that measures of income inequality and income poverty heavily depend on the equivalence scale chosen (e.g., Coulter et al. 1992b, Buhmann et al. 1988, Burkhauser et al. 1996). In general, equivalence scales are intended to measure the variation in income needed to bring households of different compositions to the same welfare level. The main arguments are economies of scale in household formation and increasing utility when having children by choice. Buhmann et al. (1988) have shown that nearly all equivalence scales can be approximated by h^e where h is household size and $e[0,1]$ is the scale elasticity parameter. Equivalent household income Y^e then can be expressed as $Y^e = Y/h^e$ where Y is total household income[1]. If e equals 1, equivalent income equals per capita income, while e equal to 0 implies no adjustment for needs. The larger the e, the higher the scale rate relative to that for a single person household will be.

In applied inequality analysis researchers often make use of so-called expert scales, where different weights are assigned to different household members. Most of these scales depend not only on household size – as the Buhmann et al. (1988) formulation – but in addition on other household characteristics such as age. The scale proposed by the OECD, e.g., assigns a weight of one to the first adult, 0.5 to further adults and 0.3 for children under 15 years of age. Computing the elasticity e from expert scales (see Buhmann et al. 1988 and Table 4 below) shows values between 0.53 and 0.66 for the OECD scale and between 0.82 and 0.87 for another expert scale derived from the German social assistance program.

Using expert scales to analyze income inequality and poverty, however, is not satisfactory because the results then will depend on an arbitrarily chosen scale. Although it is widely accepted, that there is no unique true equivalence scale because equivalence scales are part of social evaluation (e.g., Coulter et al. 1992a), they should at least be based on data observed from individuals and households. Indeed, many researchers have tried to estimate equivalence scales, e.g., the equivalence scale elasticity, from individual data based on economic theory.

Two strands of estimating equivalence scales can be distinguished: Based on consumer theory the scale can be obtained from consumption data by estimating a system of consumer demand

[1] Please note that the equivalence scale elasticity is independent from income. This assumption will be made throughout the paper. For a discussion on dependency between the scale and income, see, e.g., Aaberge and Melby (1998).

equations (for an overview see, e.g., Nelson 1992, 1993; for an estimation for Germany see Merz et al. 1993). Blundell and Lewbel (1991), however, have shown that this approach suffers from identification problems (for a broader discussion see Coulter et al. 1992a).

Another approach is to estimate the scale directly or indirectly from subjective income-evalutation data (Van Praag 1968). This approach, however, is not well accepted by economists for different reasons (e.g., Seidl 1994). To get the equivalence scale elasticity, these approaches compare the utility levels of households with different characteristics with the utility level of a reference household. Utility is derived from subjective income data, or to put it in another way, from stated preferences. Therefore, an utility function must be explicitly assumed. The Van Praag approach, e.g., assumes people have lognormal cardinal utility functions. The parameters of the utility function are empirically derived from subjective income evaluation questions (e.g., "´What income would you, in your circumstances, consider to be ´very bad´, ´bad´, ´insufficent´, ´sufficient´, ´good´, ´very good´"). Another problem is that nearly all of these analyses use cross-sectional data and thus are not able to control for different scale use by the respondents.

In this paper a new method is proposed where some of the problems discussed above can be solved: The equivalence scale elasticity will be estimated directly from individual panel data on income satisfaction. Although income satisfaction is a type of subjective data, the approach is designed in a way that income satisfaction does not have to interpreted as a form of direct or indirect utility function. In addition, panel estimation methods allow for controlling different scale use by the respondents. The basic idea of the paper, to estimate the scale elasticity from income satisfaction data, will be outlined in section 2, where the data of the German Socio-Economic Panel Study (GSOEP) will also be described. The econometric model will be developed in section 3 and the results are discussed in section 4.

2. Data on income satisfaction and motivation of the idea

Although economists are very critical of satisfaction data, as this type of data will measure stated rather than revealed preferences, satisfaction data was more frequently used by economists in recent years. Frey and Stutzer (2000) give an overview and also support using satisfaction data in empirical economics.

The present approach is based on a survey question on income satisfaction which is included in a similar form in many household surveys today:

How satisfied are you currently with the following areas of your life?
(Please answer by using the following scale, in which 0 means completely dissatisfied, and 10 means completely satisfied.)
How satisfied are you with your ...

health

....

household income

....

environmental conditions in your area.

The basic hypothesis of this paper is that if individuals are to evaluate their household income, they evaluate Y^e rather than Y because they anticipate increasing returns to scale or enjoy additional utility when having children. Let $S(Y^e)$ be income satisfaction measured on an ordinal scale [0,10]. Assuming decreasing marginal utility (satisfaction) of income, the model can be written as:

(1) $$S_i = ß_0 + ß_1 \ln Y_i^e + ß_2 X_i + e_i$$

where X are household and individual characteristics determining satisfaction with income, and e is a well-behaved error term. Obviously the specification of the model implies the assumption that family members share income equally (see Jenkins 1991 for a discussion).

Estimations of model (1) will provide first intuitive evidence for the basic hypothesis. The data used here comes from the German Socio-Economic Panel Study (GSOEP). The GSOEP is a representative longitudinal micro-data base covering a wide range of socio-economic information on households in Germany. The first wave of data was collected from approximately 6,000 families in the western states in 1984. Foreigners were oversampled. After the German re-unification in 1989 the GSOEP was extended by about 2,200 families from the eastern states. All samples are multi-stage random samples which are regionally clustered. The respondents (households) were selected at random. Principally, an interviewer tries to obtain face-to-face interviews[2]. For all estimates an unbalanced panel design covering the years 1992 to 1997 is used. Respondents who answered at least two times are included. In addition, the sample is restricted to those respondents who filled out the household-questionnaire. This restriction is necessary because only those persons gave information on both overall net household income asked by the household-questionnaire and satisfaction with household income asked by the personal-questionnaire.

Table 1 first shows estimates for the coefficients of model (1) by pooled OLS-regressions. More appropriate methods will be discussed below. A series of estimates is provided for various values of equivalent income computed with different values for the scale elasticity *e*. All regressions include age, age squared, sex, the employment status, education, nationality, ethnic characteristics and time effects as additional variables.

Table 1: The impact of equivalent household income on income satisfaction

Variable	e=1.0	e=0.8	e=0.5	e=0.3	e=0.2	e=0.0
$\ln Y^e$	1.439 (0.023)	1.825 (0.025)	2.214 (0.260)	2.189 (0.025)	2.095 (0.024)	1.818 (0.022)
R^2	0.1856	0.2135	0.2477	0.2531	0.2501	0.2366
$\ln Y^e$ $\ln h$	2.209 (0.026) 1.472 (0.025)	2.209 (0.026) 1.030 (0.023)	2.209 (0.026) 0.367 (0.022)	2.209 (0.026) -0.074 (0.022)	2.209 (0.026) -0.295 (0.0231)	2.209 (0.026) -0.737 (0.0253)
R^2	0.2533	0.2533	0.2533	0.2533	0.2533	0.2533

n=37891. All regressions include age, age squared, sex, employment status, education, nationality and time effects as additional variables. Standard errors in parentheses.
GSOEP 1992-1997.

The top part of Table 1 shows that the estimated coefficient for equivalent income depends on the elasticity chosen. Moreover, it can be seen that the explanatory power of the regression (measured by R^2) also depends on the elasticity. R^2 first increases with decreasing elasticity. When setting *e* lower than 0.3, however, R^2 decreases. The regression results in the bottom part of Table 1 additionally include the size of the household. Here, the coefficient for equivalent household income shows the “true” effect of income on satisfaction with income: The coefficient is always the same, regardless of the elasticity chosen. This is also true for the value of R^2. Obviously, the size of the household serves as a correcting factor. When elasticity is equal to one (i.e., equivalent income corresponds to per capita income), the estimated sign of the household size variable is significantly positive: Given per capita household income, satisfaction with income increases with size of the household due to scaling effects or – more theoretically – due to utility spent by children. The estimated coefficient for the household size variable decreases – though it is still positive – until the elasticity is 0.5. When setting *e*

[2] The GSOEP data used in this study are available as a “scientific use”-file (see Wagner, Burkhauser, and Behringer 1993). For further information please contact the German Institute for Economic Research (DIW),

lower than 0.3 the estimated sign for the household size variable changes to negative. Obviously, scaling effects implied by the equivalence income are now higher as anticipated by the respondents. In summary, it can be argued that an optimum elasticity between 0.3 and 0.5, which the respondents would choose, exists.

3. Estimating the scale elasticity directly from satisfaction data

To estimate the optimal elasticity, the basic hypothesis discussed above can be incorporated more explicitly in model (1). Remembering that $Y^e = Y/h^e$ model (1) can be written as

$$(2) \qquad S_i = ß_0 + ß_1 \ln\left(\frac{Y_i}{h_i^e}\right) + ß_2 X_i + e_i$$

Rearranging (2) we have

$$(3) \qquad S_i = ß_0 + ß_1 \ln Y_i - ß_1 e \ln h_i + ß_2 X_i + e_i$$

This model can be estimated by OLS or more appropriate as an ordered probit model. e should take values between 0 and 1 – note that this is not a necessary condition – and thus the estimated coefficient $ß_1 e$ should be negative unless $ß_1$ is expected to be positive. Parameter e, the equivalence scale elasticity, can then be identified as $ß_1 e / ß_1$.

The scale estimated here is only dependent on size of the household. However, equivalence scales might reflect both economies of size and differences in household characteristics. Following Coulter et al. (1992b), the equivalence scale elasticity can then be written as $e = a + b(X)$, where a is a basic scale parameter and $b(X)$ is a function of household characteristics. An important characteristic of the household is the number of children. The utility associated with a child theoretically reduces the additional income necessary to maintain a given standard of living. This argument is only true, however, when people have children by choice and not unplanned. The argument can be expressed by the specification $e = a - bk$, where k is the number of children. Given household size, the elasticity will decrease with the number of children. Incorporating this relationship for e in (2) we have:

$$(4) \qquad S_i = ß_0 + ß_1 \ln Y_i - ß_1 a \ln h_i + ß_1 b k_i \ln h_i + ß_2 X_i + e_i$$

The parameters a and b can be identified as $ß_1 a/ß_1$ and $ß_1 b/ß_1$. The elasticity of the scale now depends on the number of children in the household and can be computed as $e = a - bk$.

Berlin: http://www.diw.de/soep/.

Two problems remain. First, it has often been argued that people rate their income relative to the income of others rather than according to the neoclassical utility theory. This might not be a problem as long as this effect is captured wholly by the estimated coefficient $ß_1$, which measures the impact of income on satisfaction, because $ß_1$ is not of interest here. Second, the scale may be used by the respondents in a different way (this is the ordinal-cardinal debate analogous to this in the utility theory). This may lead to inconsistent estimations of the parameters if unobserved characteristics and included explanatory variables (e.g., household income) are correlated.

The panel data available here enables model (3) to be estimated as a fixed effect model (model (4) can be specified analogous) and thus to control for some of the problems mentioned above:

(5) $$S_{it} = ß_0 + ß_1 \ln Y_{it} + ß_1 e \ln h_{it} + ß_2 X_{it} + a_i + m_{it}$$

where a_i is the fixed effect controlling for inter-individual differences in scaling and anchoring of the responses, intrinsic differences in scaling and unobserved variables. As long as these differences are constant over time, (5) gives unbiased estimators. Unfortunately, there is no ready formulation of a fixed effect ordered probit estimator available (see also Winkelmann and Winkelmann 1998). So far, the probit model can only be estimated as a pooled model. However, (5) can be estimated instead as a fixed effects metric model.

Table 2 shows the estimated coefficients for model (3). As before, all regressions include age, age squared, sex, education, employment status, nationality and ethnic variables, and time effects as additional variables. They will not be shown here. The coefficients of interest are $ß_1$ and $ß_1 e$. Both are at least significant at the 5% level. As expected, $ß_1$ has a positive sign and $ß_1 e$ has a negative sign. Both coefficients are absolutely higher estimated by pooled OLS as compared to pooled ordered probit. The relation $ß_1 e/ ß_1$, i.e., the scale elasticity *e*, however, is nearly identical for both estimations methods. From the pooled ordered probit a value of 0.345 for *e* is computed, while the value based on OLS is 0.334. This supports a metric interpretation of the satisfaction scale. The last column of Table 2 shows the fixed effects panel estimates of the parameters. The estimated parameters are absolutely lower as compared to the pooled OLS estimates. This is an often observed result. However, the estimated coefficients are still statistically significant. The scale elasticity computed from the fixed effects regression is 0.341 and thus somewhat higher than from pooled OLS.

Table 2: Estimates of the equivalence scale elasticity from longitudinal data

Variable	Pooled Ordered Probit	Pooled OLS	Fixed Effects
Intercept	-9.7816 (0.1125)	-9.4772 (0.2060)	-
$ß_1$ (ln$Y$)	1.1334 (0.0140)	2.2099 (0.0259)	1.518 (0.0308)
$ß_1 e$ (ln$h$)	-0.3908 (0.0131)	-0.7375 (0.0253)	-0.5173 (0.0463)
R^2 /log L	-77069.39	0.2533	0.834
$e= ß_1 e/ ß_1$	0.345	0.334	0.341

n=37891. All regressions include age, age squared, sex, employment status, education, nationality and time effects as additional variables.
Standard errors in parentheses.
GSOEP 1992-1997.

Table 3: Estimates of the equivalence scale elasticity from longitudinal data: The influence of children in the household

Variable	Pooled Ordered Probit	Pooled OLS	Fixed Effects
Intercept	-10.069 (0.1155)	-9.9752 (0.2111)	-
$ß_1$ (ln$Y$)	1.1660 (0.0143)	2.2663 (0.0264)	1.529 (0.0309)
$ß_1 a$ (ln$h$)	-0.5092 (0.0169)	-0.9554 (0.0326)	-0.6033 (0.0516)
$ß_1 b$ ($k$ln$h$)	0.05438 (0.0049)	0.1010 (0.0095)	0.0635 (0.0169)
R^2 /log L	-77008.77	0.2555	0.845
$e = a – bk$ $a = ß_1 a/ ß_1$ $b= ß_1 b/ ß_1$	0.436 – 0.047k	0.421 – 0.045k	0.395 – 0.042k

n=37891. All regressions include age, age squared, sex, employment status, education, nationality and time effects as additional variables.
Standard errors in parentheses.
GSOEP 1992-1997.

The estimated elasticity shown by Table 2 is constant across household size. Thus, it does not matter whether a household consists of four adults or two adults and two young children. Assuming that children spend extra utility or economies of scale are higher for children as for adults, however, this result might be insufficient. Thus, Table 3 depicts estimated coefficients related to model (4), where the number of children enters the regression in form of an interaction effect. Again, all coefficients are statistically significant. The estimated parameters $ß_1 a$ and $ß_1 b$ have expected signs. The equivalence scale elasticity can be computed as $e = a –$

bk, where *k* is the number of children in the household. Parameter *a* is something like a baseline elasticity which will be lowered *b* times for each child in the household. Thus, the elasticity is higher for a four adult household than for a two adult and two children household. The estimated value for *a* is 0.395 (fixed effects estimation) and 0.042 for *b*.

4. Discussion

The question remaining is, how does the estimated elasticity fit to the extensive literature on equivalence scales. Buhmann et al. (1988) summarized the existing literature and found that the estimated scale elasticity covers a wide range between 0.2 and 0.8. Consumption-oriented econometric estimates are most often higher (between 0.23 to 0.57 with mean 0.40) than estimates based on subjective evaluation data (between 0.12 and 0.36 with mean 0.24). Expert scales, in contrast, imply significantly higher scale elasticity with mean around 0.7.

Table 4 compares different equivalent scales for various types of households. Three so called expert scales, an econometric expenditure scale for Germany (see Merz et. al. 1993), a subjective scale estimated along the Van Praag approach for Germany (see Van Praag et al. 1982) and the subjective scale approach presented in this paper, are compared. The top part of Table 4 depicts the weights assigned to each household type, while the bottom part shows the elasticity derived from the weights (or vice versa).

Using income satisfaction data, the estimated equivalence scale elasticity is a constant value of 0.34. Controlling for children, the elasticity is 0.4 and constant for households consisting of adults only. The elasticity is estimated lower for households, where some of the members are children, and the elasticity decreases slightly with an increasing number of children. As compared to the other subjective scale in Table 4, the elasticity estimated in the present paper is higher. This is also true when comparing the results with other subjective scales not presented in Table 4[3]. Comparing the estimated elasticity to those computed from expert scales, it first can be seen that for almost all expert scales the elasticity is higher and, thus, expert scales obviously underestimate the economies of scale coming from living together in a household. Second, it can be seen that almost all expert scales increase with household size. This seems to be misleading from a theoretical point of view because increasing elasticity means diseconomies of scale rather than economies of scale.

The presented approach to estimate the equivalence scale elasticity from individual income satisfaction data gives straightforward evidence: Obviously there is an optimal elasticity at which people feel satisfied with their income. In contrast to other subjective approaches, the present one benefits from the fact that no direct cardinal individual welfare function has to be specified. In addition, panel data enables different scale use by the respondents to be controlled.

Table 4: Comparison of different equivalence scales for certain types of household: Weights and elasticity

Type of Household/ Scale	1 Adult	2 Adults	3 Adults	4 Adults	2 Adults 1 Kid	2 Adults 2 Kids	2 Adults 3 Kids
Weights							
Per Capita (= *h*)	1.0	2.0	3.0	4.0	3.0	4.0	5.0
OECD Scale[1)]	1.0	1.5	2.0	2.5	1.8	2.1	2.4
Social Assist. Germany[2)]	1.0	1.8	2.6	3.4	2.45	3.1	3.75
US-Poverty Line[3)]	1.0	1.29	1.57	2.01	1.55	1.99	2.35
Econom. Expenditure[4)]	1.0	1.49	1.73	1.89	1.61	1.72	1.84
Subjective scale (MIQ)[5)]	1.0	1.20	1.35	1.45	1.35	1.45	1.54
This paper[6)]: e	1.0	1.27	1.45	1.60	1.45	1.60	1.73
$e = a - bk$	1.0	1.32	1.54	1.73	1.47	1.53	1.54
Elasticity (e)[7)]							
OECD Scale[1)]	1.0	0.58	0.63	0.66	0.54	0.53	0.54
Social Assist. Germany[2)]	1.0	0.84	0.87	0.88	0.82	0.82	0.82
US-Poverty Line[3)]	1.0	0.36	0.41	0.50	0.39	0.49	0.53
Econom. Expenditure[4)]	1.0	0.57	0.50	0.46	0.43	0.39	0.38
Subjective scale (MIQ)[5)]	1.0	0.26	0.27	0.27	0.27	0.27	0.27
This paper[6)]: e	1.0	0.34	0.34	0.34	0.34	0.34	0.34
$e = a - bk$	1.0	0.40	0.40	0.40	0.35	0.31	0.27

1) First adult has weight 1.0, every further adult 0.5, children 0.3. – 2) First adult has weight 1.0, further adults 0.8, children (7-10 years old of age). – 3) See Merz et al. 1993. – 4) Utility based equivalence scale estimated along an extended linear expenditure system (Source: Merz et al. 1993). – 5) Based on the Minimum Income Question Approach (Source: Van Praag et al. 1982, Merz et al. 1993). – 6) Estimated parameters from fixed effects regression, see Table 2 and 3. – 7) In the present paper e is estimated directly. For the other scales e is computed as ln(*weights*)/ln(h).

[3] Krause (1994) also estimate the elasticity using income satisfaction data from the GSOEP. However, he obtains the elasticity indirectly based on cross section estimates on income satisfaction.

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