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A note on interdependent happiness

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1. Introduction

While this paper was written a wide-spread and often heated discussion took place in Germany concerning the high salaries of top managers. Is a single man or woman worth (in terms of payment) as much as 100 or more workers? This question was not only asked by the media but also by the German president and by the chancellor. Comments expressed the concern that the "social cohesion" could be endangered by such tremendous inequality. Earlier similar discussions concerned the privileges of civil servants or delegates of the Bundestag or other groups. We may conclude from such discussions that the individual well-being does not only depend on individual variables but that comparisons with others (with respect to income and beyond) play a decisive role. In this paper we use data about the average happiness in 71 countries (Table A1) in order to support such a view. In particular we want to point out that it is the variance of happiness itself which determines the level of happiness within a country.

Happiness or life satisfaction is defined as the answer to the following (or similar) question: "Taking all things together, how satisfied or dissatisfied are you currently with your life as a whole?" This answer is scored on a 3–11-point verbal or numerical scale. Until recently, economists were rather sceptical about using this concept. In the last 10 years or so, however, the number of scientists and studies concerned with happiness (or life satisfaction) has grown exponentially. It has been generally accepted that this concept may have the potential to close the gap between theories and measurement of personal utility or social welfare. A typical result of happiness studies is the dependency of personal happiness on income at a certain point in time, and, in contrast, the independence of average income and average happiness over time (Veenhoven, 1993)—although income has multiplied in the course of time. The natural explanation of this "surprising" fact is that it is *relative* income in a group or a society which matters (Clark and Oswald, 1996; Van Praag and Ferrer-i-Carbonell, 2004; Charness and Grosskopf, 2001). Kingdon and Knight (2007) show that the sign of the effect may depend on the "closeness" of the reference group.

The assumption that relative income matters can also be found in theoretical explanations of microeconomic field studies and experiments. The most prominent among such theories are the "inequality aversion" theories of Fehr and Schmidt (1999) and Bolton and Ockenfels (2000). The authors of these papers have even claimed that inequality aversion is the dominant motive in social decisions. Though other authors (Charness and Rabin, 1999; Kritikos and Bolle, 2001; McCabe et al., 2003; and others) have shown that there are other important motives ("pure" altruism or reciprocity) which determine decisions in some situations, there is hardly any experimenter who doubts that inequality aversion *is* a strong motive.

Happiness studies and theories of inequality aversion both measure inequality with respect to income. Veenhoven and Kalmijn (2005), however, point out that inequality of income may be counteracted or strengthened by inequality in other respects such as health, education, etc. The basic question is: Do these differences affect people directly or only indirectly via happiness? Are people affected by differences in income, health, education, etc. or are they affected by differences in happiness? Do I envy someone because

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he is richer than I am or (intrinsically) because I assume that he is happier?

Veenhoven and Kalmijn (2005, p. 421) propose an "inequality adjusted" happiness index for countries which is defined as ". . . a linear combination of the mean happiness value and the standard deviation . . .". We have a different point of view. If my happiness is influenced by the happiness of my neighbour or by the average happiness of a reference group, then the measured happiness (the answers to the happiness question) already *contains* the influence of differences in happiness within his peer group (on average within society). We would *explain* the happiness scores (partly) by the standard deviation or variance of happiness within the country.

At first glance, such a self-reference might seem contradictory. It isn't! Becker (1974) proposed such a system of interrelated happiness (utility in his case). i's utility U_i depends on i's income[1] E_i and all (relevant) others' utilities U_k, i.e. $U_i = U_i(E_i, U_1, \ldots, U_{i-1}, U_{i+1}, \ldots, U_n)$. Under complete information, this system of interdependent utilities can be "solved" so that $U_i = V_i(E_1, \ldots, E_n)$. This does not mean that the two approaches are equivalent. Under certain circumstances (for example under incomplete information) behaviour can only be explained by an original interdependency of utilities[2] and not by $V_i(E_1, \ldots, E_n)$. One of the interesting consequences of Becker's model is the famous Rotten Kid Theorem (Becker, 1974; Bergstrom, 1989). Becker's model has frequently been used to explain intergenerational transfers and bequest (e.g. Lindbeck and Weibull, 1988). Further implications are derived by Bolle (1991). A simple version of such a system which modifies the two models of inequality aversion mentioned above is developed in Section 2. Section 3 is an empirical investigation of the determinants of happiness including the standard deviation of happiness. Section 4 concludes.

2. Interdependent happiness

Fehr and Schmidt (1999) who base their theory strongly on Loewenstein et al. (1989) assume the following utility function[3] of person i.

$$U_i = a_i x_i - \frac{1}{n-1} \sum_{j \in G_i - \{i\}} [b_i \max\{x_i - x_j, 0\} + c_i \max\{x_j - x_i, 0\}] \quad (1)$$

where U_i = i's utility (happiness), x_k = k's income ($k = i, j$), $a_i, b_i, c_i > 0$, $b_i \le c_i$. G_i is the relevant social group, e.g. the participants of an experiment. $|G_i| = n$.

While under Fehr and Schmidt's assumptions the sum in (1) consists of V-shaped functions, a negative c_i would describe a decreasing function and $c_i = -b_i$ even a linear dependency of utility on relative income. If, in empirical investigations, we only allow for linear or non-linear decreasing functions then, of course, we either find such a relation or we find an insignificant influence of relative income.

[1] Note that, in Becker's notation, income has a very general meaning.

[2] In "normal" dictator games, a dictator can divide a cake of a known size between a beneficiary and himself. Typically, dictators give amounts between nothing and half of the cake, but never more. With a cake size of €10, we find a lot of divisions where the beneficiary gets between €0.50 and €2.50. Kritikos and Bolle (2005) conduct dictator experiments, on the one hand, with a known cake of €10, and on the other hand with a size of the cake which the beneficiary does not know. He only knows that it may be €1.15 or €10. Those dictators who have to divide €10 often give amounts close to €0.60 but rarely amounts between €0.60 and €2.50: Apparently they pretend to have a cake size of €1.15 and to have chosen an equal split. Such behaviour cannot be explained by dictators who are motivated by their own and others' income; it can, however, be explained by dictators who care about others' utility/happiness which is larger if others believe that they have been treated fairly.

[3] Bolton and Ockenfels (2000) propose a slightly different approach which relies on comparisons with the mean instead of pairwise comparisons. In addition, they allow for more general functional forms.

Table 1
Average personal values versus estimated values of others. Overconfidence = relative difference between average personal and estimated values. Quality of estimation = average squared relative difference between average personal values and individually estimated values.

	Income	Satisfaction with studies	Permanent relationship	Health	Happiness
Average personal	€565.81	7.49	49.13%	8.09	7.54
Estimation of others	€487.81	6.23	46.42%	6.96	6.92
Overconfidence	0.14	0.17	0.06	0.14	0.08
Quality of estimation	0.11	0.15	0.13	0.06	0.05

Fehr and Schmidt's (1999) model and the similar model by Bolton and Ockenfels (2000) have been shown by these authors as well as by other researchers to be capable of explaining a great number of experimental results. There have also been critical voices (Kritikos and Bolle, 2001) which do not deny the relevance of the fairness motives expressed by these model but state that there are additional important motives. Here we will use the Fehr and Schmidt model as it can express the hypothesis that people compare themselves with others. Instead, however, comparing *incomes* as in their original model, we follow Becker's (1974) suggestion that others' *utility* (happiness) is decisive for social behaviour.

Assuming that differences in happiness (utility) count and assuming that utility (happiness) has more sources than only income, we propose the following individual happiness relationship.

$$H_i = A_i - \frac{1}{n_i - 1} \sum_{j \in G_i - \{i\}} [B \max\{H_i - H_j, 0\} + C \max\{H_j - H_i, 0\}] \quad (2)$$

where H_i = i's happiness, A_i = "autonomous" happiness, possibly depending on i's income, health, etc. and G_i = group of family, friends, colleagues, and neighbours of i. If $G_i = \{i\}$ then $H_i = A_i$, i.e. i's happiness is independent of others' happiness and thus (in this approach) dependent only on i's own situation.

Do people really have sufficient information about the happiness of their friends and neighbours? This question is often posed in relation with Becker's (1974) approach to interdependent utility. Diener and Lucas (1999) and Sandvik et al. (1993) find significant correlations between self-rated happiness and estimates from a peer group, i.e. others do know (to a certain extent) how happy I am.

Interdependencies of happiness could also be based on others' income, health, security, etc. Are such "objective" variables better known than happiness? We asked 200 students from our university what their income was, how much rent they paid, whether they were single, and how they evaluated their health, life satisfaction (happiness), and their satisfaction with their studies (on a 11-point scale from 0 = worst to 10 = best). In addition, we asked them to estimate the average income of their fellow students, the percentage of those who were single, and to evaluate their fellow students' health, life satisfaction, and their satisfaction with their studies. An English translation of the questionnaire is provided in Appendix A. Filling in the questionnaires lasted about 5 min and was rewarded with a candy bar (worth 50€ cents). After removing all incomplete questionnaires, 148 remained. These are the basis of Table 1.

We added the average rent the other students paid to the stated income of those students who lived with their parents. This delivered a better fit between average incomes and average estimated incomes than without such a correction.

It is well known that an overconfidence bias is present in such questionnaire studies. Most people think they are better drivers and that they are more intelligent, healthier, and happier than average. Overconfidence with respect to happiness, however, is considerably lower than for income and health. Measured by the squared relative differences, the estimation quality of happiness is better than for all other variables. We conclude that if we assume interpersonal dependencies, information is an argument in favour of happiness instead of against its usage.

Eq. (2) describes the connection of "steady state" variables H_i. Alternatively, the left side could denote happiness in period $t+1$ while on the right side we find happiness scores in period t. Then happiness scores H_i are "adjusted" by a hypothetical dynamic process based on (2), i.e. the "new" H_i is determined by the "old" H_i and H_j. Such an adjustment process may involve many overlapping peer groups G_i. Convergence of the adjustment process is assumed.[4]

For the sake of tractability we assume reciprocal relations (if k is a peer of i, then i is a peer of k) and that B and C are the same for all i. Let H and A describe the average of H_i and A_i. Then we get

$$\begin{aligned} H &= A - \frac{1}{n(n-1)} \sum_{\substack{i,j \in G_i \\ i \neq j}} [B \max\{H_i - H_j, 0\} + C \max\{H_j - H_i, 0\}] \\ &= A - (B+C) \cdot \delta \end{aligned} \tag{3}$$

with δ = mean pair distance of happiness in G.

We assume that i's peer group G_i is "typical" for the respective society. Peer groups may be more homogenous than society as a whole with respect to income and education but probably not with respect to health, partnership, and other characteristics. The consequence of peer groups being more homogeneous than society would be that, if we substitute the peer group's δ by the society's δ, $B+C$ does not measure the strength of inequality aversion exactly but contains a correction factor of δ.

Fehr and Schmidt's hypothesis of inequality aversion is $B,C>0$. Then inequality has a negative influence on average utility. But even under the weaker assumption $B+C>0$, we get this negative influence. Therefore, even if individuals enjoy being happier than their peers, average happiness in a group may decrease with increasing inequality (measured by δ).

(3) will serve as the hypothesis for the empirical investigation in the next section. An alternative to δ would be the usage of measures of differences in income, health, education, etc. In the empirical investigation in the next section we introduce the Gini coefficient as a possible substitute for δ, but it turns out to possess little explanatory power.

3. Empirical investigation

The basic assumption in this section is that the average happiness scores of countries are comparable. If they are in fact comparable, then it would make sense to ask what determines the differences among countries. In Section 2 we have derived consequences of interdependent happiness (inequality aversion). For the "macro" approach of comparing country averages we assume that δ is sufficiently closely approximated by the standard deviation of happiness found in national surveys. Note that, by using this approach we do not assume that people know the average happiness, its standard deviation, the income distribution, etc. within their respective countries. The hypothesis is that they know *proxies* of these values for the people in their peer groups, that happiness scores are "adjusted" via a dynamic process,[5] and that the average of the peer groups is close to the averages of happiness, income, etc. measured by surveys and by the statistical offices of the respective countries. The question of whether the standard deviation of subjective happiness scores is an appropriate measure of inequality of happiness is not much different from the question of whether the Gini coefficient is an appropriate measure for inequality of incomes.

The question of whether happiness scores are meaningful at all, and of whether individual comparisons, group comparisons and national comparisons make sense has not ultimately been decided upon. Diener et al. (1995a) investigates these questions, and concludes that national comparisons should be used, however with caution (Diener and Oishi, 2004). He uses such data (Diener et al., 1995b) in the same way as other researchers (Welsch, 2002; Frey et al., 2007), i.e. without majors doubts. A collection of studies with national comparisons can be found on Ruut Veenhoven's webpage.[6] Recent support of the reliability of happiness measures is Krueger and Schkade (2008). Bolle and Kemp (2008) support the usage of national happiness data after investigating the evaluation of the same (imagined) situations by students from four countries with large differences in national happiness. Such a strong support makes happiness scores at least as comparable (among countries) and reliable as proxies for "political rights", "corruption", "education", etc. which are widely used in empirical studies.

We used a data set from the "World Data Base of Happiness" provided by Ruut Veenhoven from the Erasmus University in Rotterdam.[7] Ad hoc plausibility and the results of micro-studies on the determinants of happiness (Easterlin, 1974; Frey et al., 2007) guided our choice of the initial set of variables (Table A1). Table 2 shows that all variables are significantly correlated with life satisfaction—except the Gini coefficient of income differences. We chose the data about life satisfaction measured on a 10-point numerical scale from 1990 to 2000 because the number of data points is the largest and because variances determined directly from a detailed numerical scale seem to be more reliable than variances derived from verbal scales. The statistical computations were carried out by The SAS System.

Since δ is unavailable in the data set we need a proxy variable which has the same informational content as δ and is numerically close to it. δ measures the mean pair distance of happiness in G and can be directly linked to the mean absolute deviation. On the other hand the data set contains the standard deviation of happiness. Both quantities are common statistical measures of variability. The use of s instead of δ can also be interpreted as a measurement error. In this case we write $\delta = s + \upsilon$, where υ is a new residual that captures the approximation. This substitution has no impact on the results of the study.

The purpose of the following empirical study is to find econometric evidence for the model derived in the previous section. We start with a simple linear regression model to capture the impact of the explanatory variables on happiness.[8] The linear model is a standard benchmark in econometric analysis and provides useful insights into the relationships between the variables. However, we found clear evidence of strong correlations between the explanatory variables (see Table 2). This leads to technical difficulties of estimation and misleading conclusions from the regression model. For this reason, we apply several approaches to reduce the regression model without substantial loss of information. To provide further support for the final model we use factor analysis and construct two artificial aggregated variables which explain most of the

[4] Conditions for convergence (stability of the steady state) are discussed in Bolle (1991).

[5] Essentially, these assumptions are not more demanding than the assumptions of macroeconomic models based on equilibrium prices and quantities as well as on functional relationships between average values.

[6] http://www2.eur.nl/fsw/research/veenhoven/.

[7] Veenhoven, R., World Database of Happiness, File States of Nations, Erasmus University Rotterdam. Available at: http://worlddatabaseofhappiness.eur.nl, accessed: 08/2007.

[8] It is well known that average happiness and the standard deviation of happiness in countries are negatively correlated and that there are also correlations with many other variables (Ott, 2005).

Table 2
List of data. For details of the definition of the variables see http://worlddatabaseofhappiness.eur.nl/statnat/statnat_fp.htm.

Nation name	1999–2000 life satisfaction, 10-step numerical scale	1999 life expectancy at birth	1999–2000 standard deviation 10-step life satisfaction	Suppression of political rights scale 0–20	1999 adult literacy rate (% age 15 and above)	1998 public health expenditure (as % of GDP)	1999 income inequality (Gini)	1999 income per head. Corrected by Purchasing Power (USD)	2000 % unemployed of labor force	1998 corruption perception index. Scale 0–10
Albania	5.17	73.0	2.25	9	84.0	3.5	28.2	3.189	25.00	na
Algeria	5.67	69.3	2.86	11	66.6	2.6	35.3	5.063	31.00	na
Argentina	7.33	73.2	2.26	3	96.7	4.9	52.2	12.277	21.50	7.00
Austria	8.02	77.9	1.91	2	99.0	5.8	30.0	25.089	4.80	2.50
Bangladesh	5.78	58.9	2.18	7	40.8	1.7	31.8	1.483	40.00	na
Belarus	4.81	68.5	2.21	12	99.5	4.9	30.4	6.876	17.00	6.10
Belgium	7.56	78.2	2.06	3	99.0	7.9	25.0	25.443	7.20	4.60
Bosnia	5.77	na	2.39	9	na	na	26.2	na	40.00	na
Britain	7.40	77.5	1.94	3	99.0	5.9	36.0	22.093	5.20	1.30
Bulgaria	5.34	70.8	2.69	5	98.3	3.8	31.9	5.071	18.00	7.10
Canada	7.80	78.7	1.85	2	99.0	6.3	33.1	26.251	7.60	0.80
Chile	7.12	75.2	2.16	4	95.6	2.7	57.1	8.652	9.20	3.20
China	6.53	70.2	2.47	13	83.5	na	44.7	3.617	20.00	6.50
Croatia	6.46	73.6	2.33	5	98.2	na	29.0	7.387	21.70	na
Czech. Rep.	7.06	74.7	1.95	3	99.0	6.7	25.4	13.018	9.80	5.20
Denmark	8.24	76.1	1.82	2	99.0	6.7	24.7	25.869	5.10	na
Egypt	5.36	66.9	3.35	11	54.6	na	34.4	3.420	12.00	7.10
Estonia	5.90	70.3	2.19	3	98.0	na	37.2	8.355	12.40	4.30
Finland	7.87	77.4	1.68	2	99.0	5.2	26.9	23.096	8.50	0.40
France	6.93	78.4	2.03	3	99.0	7.3	32.7	22.897	9.10	3.30
Germany	7.61	77.6	1.79	3	99.0	7.9	28.3	23.742	9.80	na
Greece	6.67	78.1	2.19	4	97.1	4.7	35.4	15.414	10.30	5.10
Hungary	5.69	71.1	2.44	3	99.3	5.2	24.4	11.430	5.80	5.00
Iceland	8.05	79.1	1.59	2	99.0	7.2	na	27.835	2.80	0.70
India	5.14	62.9	2.23	5	56.5	na	32.5	2.248	8.80	7.10
Indonesia	6.96	65.8	2.06	7	86.3	0.7	34.3	2.857	10.60	8.00
Iran	6.38	68.5	2.41	12	75.7	1.7	43.0	5.531	16.30	na
Iraq	5.23	na	2.41	na	na	na	na	na	na	na
Ireland	8.17	76.4	1.81	2	99.0	4.5	35.9	25.918	4.30	na
Ireland-N	8.07	na	1.70	na	na	na	na	na	na	1.80
Israel	7.03	78.6	2.17	4	95.8	6.0	35.5	18.440	10.40	2.90
Italy	7.17	78.4	2.11	3	98.4	5.6	36.0	22.172	9.10	5.40
Japan	6.48	80.8	1.97	3	99.0	5.9	24.9	24.898	5.40	4.20
Jordan	5.64	70.1	2.54	8	89.2	5.3	36.4	3.955	25.00	5.30
Kyrgisthan	6.48	67.4	2.57	11	97.0	2.9	29.0	2.573	7.20	na
Latvia	5.27	70.1	2.39	3	99.8	4.2	32.4	6.264	7.60	7.30
Lithuania	5.09	71.8	2.64	3	99.5	4.8	31.9	6.656	12.50	na
Luxembourg	7.87	77.2	1.85	2	99.0	5.4	30.8	42.769	4.10	1.30
Macedonia	5.12	73.0	2.72	7	94.0	5.5	28.2	4.651	37.00	na
Malta	8.21	77.9	1.62	2	91.8	na	na	15.189	7.00	na
Mexico	8.13	72.4	2.40	5	91.1	na	54.6	8.297	6.00	6.70
Moldova	4.57	66.6	2.32	6	98.7	6.4	36.2	2.037	8.00	na
Montenegro	5.64	na	2.39	na	na	na	na	na	na	na
Morocco	6.05	67.2	2.56	9	48.0	1.2	39.5	3.419	19.00	6.30
Netherlands	7.88	78.0	1.32	2	99.0	6.0	32.6	24.215	3.00	1.00
Nigeria	6.87	51.5	2.32	8	62.6	0.8	50.6	853	28.00	8.10
Pakistan	4.85	59.6	1.46	11	45.0	0.9	33.0	1.834	17.80	7.30
Peru	6.44	68.5	2.40	6	89.6	2.4	49.8	4.622	15.40	5.50
Philippines	6.67	69.0	2.54	5	95.1	1.7	46.1	3.805	10.20	6.70
Poland	6.37	73.1	2.48	3	99.7	4.7	31.6	8.450	18.10	5.40
Portugal	6.98	75.5	1.96	2	91.9	5.2	38.5	16.064	4.70	3.50

Puerto Rico	8.49	0.0	1.97	na	na	na	na	na	12.00	na
Romania	5.23	69.8	2.77	4	98.0	na	30.3	6.041	8.30	7.00
Russia	4.74	66.1	2.56	10	99.5	1.2	45.6	7.473	17.90	7.60
S-Africa	5.81	53.9	2.72	3	86.0	3.3	59.3	8.908	37.00	4.80
Saudi Arabia	7.28	71.3	2.27	14	76.1	na	na	10.815	25.00	na
Serbia	5.62	na	2.46	na	na	na	na	na	32.00	0.90
Singapore	7.13	77.4	1.72	10	92.1	1.2	42.5	20.767	4.60	5.80
S-Korea	6.21	74.7	2.32	4	97.6	2.3	31.6	15.712	3.10	na
Slovakia	6.03	73.1	2.22	3	99.0	5.7	25.8	10.591	17.20	6.10
Slovenia	7.23	75.3	2.15	3	99.6	6.6	28.4	15.977	11.00	na
Spain	7.04	78.3	1.91	3	97.6	5.4	32.5	18.079	11.30	3.90
Sweden	7.65	79.6	1.85	2	99.0	6.7	25.0	22.636	4.00	0.50
Tanzania	3.87	51.1	3.22	8	74.7	1.3	38.2	501	na	8.10
Turkey	5.62	69.5	2.80	9	84.6	na	40.0	6.380	13.80	6.60
Uganda	5.62	na	2.47	11	na	na	43.0	na	na	na
Ukraine	4.56	68.1	2.60	8	99.6	3.6	29.0	3.458	8.80	7.20
USA	7.65	76.8	1.84	2	99.0	5.8	40.8	31.872	5.80	2.50
Venezuela	7.52	72.7	2.50	8	92.3	2.6	49.1	5.495	17.00	7.70
Vietnam	6.52	na	2.06	13	na	na	36.1	na	na	na
Zimbabwe	3.94	na	2.74	11	na	na	56.8	na	70.00	na

variation in happiness. This approach does not require the dropping of variables but yet allows the strength assessment of the individual impacts. Finally, we apply a nonparametric regression to obtain a completely data-driven functional form between the variables in the final model. This relaxes the strong assumption of linearity. All these methods provide evidence in favour of the derived model. Next we report details on the performed analysis.

Simple regression of happiness on all independent variables can be misleading due to multicollinearity effects. Several variance inflation factors exceed 5 and the condition index is equal to 95.8. This implies that the multicollinearity can seriously affect the standard errors of the estimated parameters. To eliminate variables from the regression we used several techniques. First, due to the weak correlation with the dependent variable, the Gini coefficient is dropped from the model. Second, we consider the partial correlation coefficients of Type I. We eliminate the variables step-by-step with respect to the criterium of maximum explanatory power measured by the squared partial correlation coefficient, if this is lower than 0.1. The criterium drops the variables for which more than 96.6% of the individual explanatory power can be explained by the rest of the variables. The reduced model contains the average income, the standard deviation of happiness, and life expectancy at birth as explanatory variables. The new model exhibits no strong evidence of multicollinearity. Life expectancy at birth, however, is insignificant with a p-value of 0.12. After also dropping this variable, the model which ultimately results contains only average income and the standard deviation of happiness as explanatory variables.

$$\begin{array}{l} H = 7.75 + 0.59\bar{x} - 0.88s \quad \text{adj. } R^2 = 0.56 \\ (< 0.0001)\ (< 0.0001)\ (< 0.001) \end{array} \tag{4}$$

where $\bar{x}$ denotes the average income in 10,000$/year, s the standard deviation, and the values in parentheses denote the p-values of the significance tests. The estimation is based on 62 observations without missing values. The standard deviation of the residuals is 0.74.

If we exclude s from the model, the adjusted R^2 decreases by approximately 5% in absolute terms. Also note that, due to the elimination of the other 7 variables, the adjusted R^2 decreased by only 6%. This implies that the eliminated variables had little impact on life satisfaction. Fig. 1 shows the scatter plot of the predicted values of happiness versus the residuals. We argue that there are no obvious trends in the residuals and we conclude that the model is well specified. However, the QQ-plot in Fig. 2 provides some evidence that the residuals deviate from the assumption of normality. The two extreme values in the right tail correspond to the observations for Mexico and Venezuela.

There may be other variables than the nine in our model exerting (significant) influence on autonomous happiness. Although we cannot identify their direct influence, the influence of their variance is contained in the happiness scores and the variance of the happiness scores (if our model applies). Therefore, these unobservable

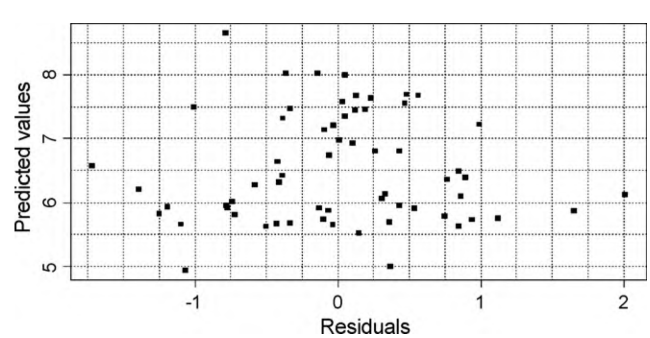

Fig. 1. The scatter plot of the predicted values of happiness and the residuals.

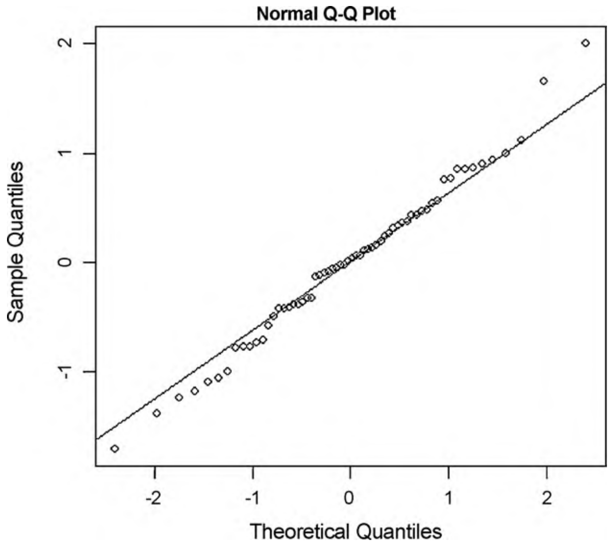

Fig. 2. The QQ-plot of the residuals.

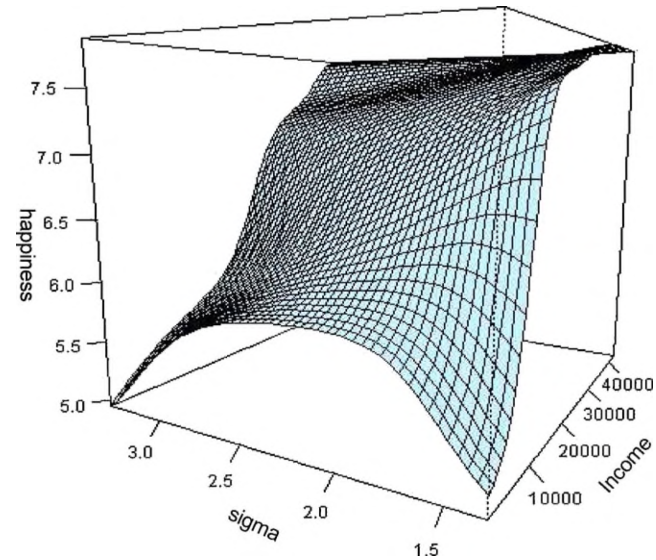

Fig. 3. The surface of the nonparametric kernel regression of happiness on *s* (sigma) and income.

influences also contribute to the explanatory power of *s* and may have influenced the above described process of variable selection in favour of *s*.

We assume the elimination method we used to be the most appropriate one, but nonetheless we tested an alternative. SPSS offers the elimination of variables according to the significance level of single variables. The result is the same as reported above. As a completely different approach we carried out a factor analysis of the highly correlated explanatory variables (although the number of data points is relatively small). From the principal components analysis we found that two factors explain more than 70% of the variance. The economic interpretation of the results of our factor analysis (with varimax rotation) is not straightforward. We observed for the first factor that the income is positively loaded (0.58) in contrast to a very small loading in the standard deviation *s* (0.01). Moreover, the loading of *s* in the second factor (0.96) is contrasted against the negative loading of income (−0.66). This supports the evidence that the impact of income on life satisfaction is opposite to that of the standard deviation of happiness. A regression of happiness on these two factors delivers, however, an R^2 of only 0.44, i.e. about 0.12 less than the regression (4).

At last, we apply a nonparametric regression model to obtain a completely data-driven form of the relationship between happiness, income and *s*. Nonparametric regression requires no specific assumptions about the form of the relationship (such as linearity). Here we used a Nadaraya–Watson regression estimator with Gaussian kernel and least-squares cross-validation criteria to determine the optimal bandwidth. The obtained nonparametric regression surface is plotted in Fig. 3. It allows for several interesting insights into the relationship among the variables. Additional evidence in favour of the proposed model is deduced from the observation that happiness generally decreases with increasing *s* and fixed income. This is, however, not the case for a small region with low income and low *s*. Furthermore, we conclude from the curvature of the surface that the impact of *s* becomes weaker for higher income, i.e. the happiness of the individuals with high income is less exposed to the inequality of happiness. The income is the only dominant factor in this case, but *s* becomes more important if income decreases. Altogether, this investigation supports our model but suggests that non-linear modifications may be necessary.

Let us finally address two further objections against the model estimated above. One is that not for all countries all data are available. Thus, the intermediate estimation results are based on samples of different sizes. However, note that the model selection procedure does not compare the alternative models, but merely searches for the correct model specification without the effect of multicollinearity. Therefore, increasing the sample size step-by-step in this procedure does not have negative consequences as the *comparing* of goodness-of-fit measures does. The evaluation using R^2 aims to offer clues about the fit of the model, but is not used for model selection. Furthermore, by comparing the R^2s of the full model (fewer observations) with that of the final model (more observations), we obtain an unfavourable comparison recording a decrease in R^2 (but only of 6 percentage points).

The other objection is that the mean and the variance of country scores are structurally correlated because the happiness variable is truncated at 0 and 10 and nearly all means are in the interval [5,10]. This objection cannot be falsified in principle but we can show that it is neither necessary nor plausible. First, let us assume the interval [0,10] to be the "real" interval of happiness scores. There are families of distributions (for example all one-parameter families) where mean and standard deviation obey a functional relationship. But there are other families for which this is not the case. Examples are a set of beta distributions or the sum of binominal distributions with different parameters. Depending on the set and the a-priori distribution of parameters, there may be a correlation of the mean and the standard deviation, but there also may not be.

Second, people may place their "real" happiness scores in a different interval $[a,b]$. For $-\infty < a < b < +\infty$, it seems plausible that they adjust the intervals to [0,10] using a linear transformation—without any consequences for existing or non-existing correlations. The situation may be different if $a = -\infty$, $b = \infty$. The adjustment to the required interval [0,10] must be non-linear. A simple transformation which may cause a rather strong bias is a linear transformation which attaches the scores outside [0,10] to the endpoints. Assuming (for the sake of simplicity) that the "real" scores are normally distributed it is easy to compute the "real" values (μ, σ) from the measured values (m, s). For $m > 5$ this leads to $\mu > m$ and $\sigma > s$. For $m < 5$ the opposite holds. As our set of (m, s) values has a bias toward larger values s, the computed (μ, σ) have a smaller correlation ($r = -0.32$) than the original data ($r = -0.69$), but the correlation is still highly significant ($p = 0.007$). Thus, the correlation between mean and standard deviation even survives this rather unfavourable recalculation. Note, that this calculation is only a check for the existence of the correlation. Without any real hints that a special non-linear transformation is applied,[9] it seems to be most sensible to use the original data. Finally, we agree with Kalmijn and Veenhoven (2005, p. 358) who conclude with respect to such a *structural* relationship "... that, theoretically, the standard deviation is dependent on the value of the mean happiness rating, but that in most practical situations this type of dependency is fairly weak."

4. Conclusion

Theoretical considerations (Becker, 1974) as well as experimental studies suggest that utilities (happiness scores) are interdependent. After a modification of the Inequality Aversion Theory of Fehr and Schmidt (1999), we state that average happiness in a country is influenced by the standard deviation of happiness. In an empirical investigation of 71 countries we found average income and the standard derivation of happiness to be the only significant variables. The standard derivation s varies in our sample from 1.6 to 3.2. If s increases by 0.1, happiness (measured on a scale from 0 to 10) decreases by 0.09. If average annual income (which varies from $3000 to $42,000) increases by $1000, then happiness increases by 0.06.

Originally, inequality stems from different endowments in income, health, etc. It is taken into effect, however, through the resulting inequality of happiness and an induced adjustment process derived from (2). Our study shows that *inequality* of happiness (which also captures the influence of unobserved variables) is one of the main determinants of the *level* of happiness.

Appendix A

See Table A1.

Table A1
Intercorrelations between the selected variables. The three numbers in each cell are the correlation coefficient. The two-sided p-value and the number of data points. $p = 0.000$ means $p < 0.0005$.

		1	2	3	4	5	6	7	8	9
1	1999–2000 life satisfaction, 10-step numerical scale									
2	Standard deviation of 1	−0.69 0.000 71								
3	1999 life expectancy at birth	0.64 0.000 62	−0.55 0.000 62							
4	Suppression of political rights, scale 0–20	−0.50 0.000 66	0.46 0.000 66	−0.51 0.000 62						
5	1999 adult literacy rate (% age 15 and above)	0.33 0.009 62	−0.25 0.050 62	0.64 0.000 62	−0.56 0.000 62					
6	1998 public health expenditure (as % of GDP)	0.43 0.001 52	−0.42 0.002 52	0.69 0.000 52	−0.69 0.000 52	0.63 0.000 52				
7	1999 Income inequality (Gini Index, scale 0–100)	−0.03 0.802 63	0.27 0.032 63	−0.36 0.005 59	0.26 0.041 63	−0.19 0.155 59	−0.53 0.000 51			
8	1999 Income per head, corrected by Purchasing Power (USD)	0.72 0.000 62	−0.68 0.000 62	0.73 0.000 62	−0.63 0.000 62	0.50 0.000 62	0.65 0.000 52	−0.28 0.033 59		
9	2000 % unemployed of labor force	−0.51 0.000 65	0.46 0.000 65	−0.61 0.000 61	0.50 0.000 63	−0.51 0.000 61	−0.40 0.004 51	0.33 0.010 60	−0.57 0.000 61	
10	1998 corruption perception index, scale 0–10	−0.64 0.000 49	0.63 0.000 49	−0.66 0.000 47	0.66 0.000 47	−0.45 0.002 47	−0.70 0.000 40	0.33 0.028 46	−0.83 0.000 47	0.38 0.009 47

[9] We asked 35 students about their preferences for scales of happiness. We offered a four-categories verbal scale (16 agreed), an 11-point numerical scale (12 agreed), and an infinite interval (2 agreed). Five students chose the option of defining scales themselves (mostly 2- or 3-catagories scales).

Questionnaire

1. *Faculty*: Business&Economics € Cultural sciences € Law € Others €

2. *Semester*: ....

3. *Age*: .... years

4. *Sex*: Male € Female €

5. *Housing*: Shared apartment/ dormitory € at home (with parents) €
Own apartment €

6. *Rent*: Euro ....

7. *Monthly income* (including rent): Euro ....

8. *Academic Studies*: On a scale from 0 (I don't like it at all) to 10 (I really enjoy it), how would you rate you satisfaction?
€0 €1 €2 €3 €4 €5 €6 €7 €8 €9 €10

9. *Partner*: Are you involved in a permanent relationship?
€Yes €No

10. *Health*: On a scale from 0 (seriously ill) to 10 (completely healthy) how would you rate yourself?
€0 €1 €2 €3 €4 €5 €6 €7 €8 €9 €10

11. *Happiness*: On a scale from 0 (completely unhappy) to 10 (completely happy) how would you rate yourself?
€0 €1 €2 €3 €4 €5 €6 €7 €8 €9 €10

Please *estimate*:

13. What is the average *income* (including rent) of your fellow students?
Answer: Euro ....

14. On average how much do your fellow students *like* their *studies*? On a scale from 0 (they don't like it at all) to 10 (they really enjoy it), how would you rate them?
€0 €1 €2 €3 €4 €5 €6 €7 €8 €9 €10

15. What percentage of your fellow students are involv ed in a *permanent relationship*?
Answer: ...... %

16. On average how *healthy* do your fellow students feel? On a scale from 0 (completely unhealthy) to 10 (completely healthy) how would you rate them?
€0 €1 €2 €3 €4 €5 €6 €7 €8 €9 €10

17. On average how *happy* are your fellow students? On a scale from 0 (completely unhappy) to 10 (completely happy) how would you rate them?
€0 €1 €2 €3 €4 €5 €6 €7 €8 €9 €10

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