Available online at www.sciencedirect.com
SCIENCE DIRECT®
Ecological Economics 52 (2005) 111–125
ECOLOGICAL ECONOMICS
www.elsevier.com/locate/ecolecon

ANALYSIS

Climate and happiness

Katrin Rehdanz[a,*], David Maddison[b]

[a]Centre for Marine and Climate Research, Hamburg University, Hamburg, Germany
[b]Department of Economics, University of Southern Denmark, Odense, Denmark

Received 19 April 2003; received in revised form 4 June 2004; accepted 18 June 2004
Available online 8 December 2004

Abstract

Climate is an important input to many human activities. Climate affects heating and cooling requirements, health, clothing and nutritional needs as well as recreational activities. As such, it is to be expected that individuals will have a preference for particular types of climate. This paper analyses a panel of 67 countries attempting to explain differences in self-reported levels of happiness by reference to, amongst other things, temperature and precipitation. Various indices are used for each of these variables, including means, extremes and the number of hot, cold, wet and dry months. Using a panel-corrected least squares approach, the paper demonstrates that, even when controlling for a range of other factors, climate variables have a highly significant effect on country-wide self-reported levels of happiness. On the basis of these results, it is determined that differential patterns of anthropogenically induced climate change might alter dramatically the distribution of happiness between nations, with some countries moving towards a preferred climate and others moving further away. We find that high-latitude countries included in our dataset might benefit from temperature changes. Countries already characterized by very high summer temperatures would most likely suffer losses from climate change.

Keywords: Amenity value; Climate change; Happiness; Wellbeing

JEL classification: R19; Q29

1. Introduction

The socioeconomic and ecological impacts of the enhanced greenhouse effect are manifold (Smith et al., 2001; Tol, 2002). Efforts to reduce greenhouse gas emissions are perceived to be very costly. Tackling the problem of future climate change is one of the most challenging issues of this century and has major implications for development policies and environmental management. However, little is known about people's preferences for a particular climate or their willingness to pay to avoid negative impacts of climate change. This paper tries to address this problem from a new perspective.

* Corresponding author. ZMK, Research Unit Sustainability and Global Change, Hamburg University, Bundesstrasse 55, 20146 Hamburg, Germany. Tel.: +49 40 42838 7047; fax: +49 40 42838 7009.
E-mail address: rehdanz@dkrz.de (K. Rehdanz).

0921-8009/$ - see front matter
doi:10.1016/j.ecolecon.2004.06.015

Climate affects humans through a variety of channels. Weather and climate influence societal (e.g., civilization, culture and migration), psychological (e.g., aggression, cognition and mental illness), physiological (e.g., health, allergies, diet and nutrition), economic (e.g., energy production, tourism and agriculture) and ecological conditions (e.g., fauna and flora).[1] Climate change would affect all of these.

Research work on the economic consequences of climate change has generally focused on changes in productivity in sectors such as agriculture, energy and tourism. Little attention has been drawn to climate as an input to household activities. In general, the effects of a changing climate might be positive or negative, depending on time and place.

To determine how good or bad climate change is, indicators are needed. So far, measurements of the amenity value of climate have mainly been derived by using environmental valuation techniques such as the hedonic price approach or the household production function approach. These methods derive the preferences for environmental goods through studies of related markets and household expenditure patterns, respectively. However, both methods have some major shortcomings and, their applications to the amenity value of climate are few in number.

This paper proposes a different approach. It analyses a panel of 67 countries in an attempt to explain differences in self-reported levels of well-being. Mindful of existing research, a large number of other explanatory variables are included to control for differences in economic, cultural, institutional and demographic circumstances in addition to differences in climate. Climate is represented by indices of temperature and precipitation. This is the first study using cross-national data on self-reported happiness to evaluate the amenity value of climate and to put it in the context of climate change.

The paper is organized as follows. Section 2 starts with a brief literature review of studies into the determinants of happiness and the amenity value of climate. In Section 3, the data used in the analysis are discussed. Section 4 reports on the econometric results, and, in Section 5, the econometric estimates are used to calculate the impact of climate change for two different time periods: 2010–2039 and 2040–2069. Section 6 concludes.

2. Literature review

2.1. Happiness in economics

In standard economic theory, more income enables individuals to consume additional goods and services. This supposedly leads to higher levels of well-being, and consequently the pursuit of economic growth has in most countries been the major objective of economic policy. There is, however, growing evidence that happiness and not income is the ultimate objective of most people (see, amongst others, Ng, 1997). Income moreover explains only a low proportion of the variation in happiness between people (Easterlin, 1995; Oswald, 1997).

Much of this evidence is derived from the growing literature on the determinants of life satisfaction and subjective well-being, also conceived as happiness or overall enjoyment of life.[2] Happiness is not only subjective but also is an assessment by the individual of all parts of his or her life, including circumstances and comparisons to others, past experience and expectations of the future. Although it is left completely to the individual to explain his or her level of subjective well-being, there seems to be a correspondence in what makes people happy, nationally and internationally, which makes intercountry comparisons possible.

The research on the determinants of happiness has developed for more than a century.[3] Easterlin (1974), however, was one of the first economists empirically studying reported levels of happiness. Since the late 1990s, the research on the determinants of happiness increased substantially in economics, indicating economists' awareness of the importance of this area of research (Easterlin, 2002; Frey and Stutzer, 2002). A

[1] There are a vast number of studies in each of these different disciplines. For an overview of some hundred studies, see Parker (1995).

[2] As is generally the case nowadays, we use the terms happiness, well-being and life satisfaction interchangeably throughout this study. See Veenhoven (2000) for the specific meanings of the terms.

[3] A bibliography containing several hundred studies on happiness, well-being and life satisfaction is available on the Internet, see http://www.eur.nl/fsw/research/happiness/hap_bib/src_sub.htm.

recent issue of the *Journal of Economic Behaviour and Organization* was entirely devoted to the theme.

There is a long history of discussion regarding whether subjective well-being is measurable. Today, there is the general belief that data on subjective well-being are valid and can be used for formal analyses (Di Tella et al., 2003). Empirical work has furthermore shown that happiness is not a purely personal issue but that economic conditions, like unemployment, inflation and income, have a strong impact on people's subjective well-being.[4] Clark and Oswald (1994) showed that unemployed people are significantly less happy than those with a job (see also Winkelmann and Winkelmann, 1998; Di Tella et al., 2001; Ouweneel, 2002). Inflation was also found to have a statistically significant negative effect on happiness, another trade-off between inflation and unemployment (see Di Tella et al., 2001).

One of the most closely examined economic indicators is income. On average, people living in richer countries tend to be happier than those living in poor countries. However, the relationship between happiness and income seems to be nonlinear, exhibiting diminishing marginal happiness. Over time, happiness appears to be relatively unrelated to income. Substantial real per capita income growth over the last decades has led to no significant increases in subjective well-being. Such findings have been explained by aspiration theory, whereby subjective well-being depends on ones relative position compared to others. Therefore, "raising the income of all does not increase the well-being of all" (Easterlin, 1995). Subjective well-being is determined by the gap between aspiration and achievement. However, over time, aspirations adjust in proportion to higher income levels (see, e.g., Easterlin, 2001). Among others, Daly (1987) used Easterlin's findings of the cancelling effect of growth on welfare over time to argue for a change in social priorities. He defined the 'Easterlin Paradox' as one of the ethicosocial limits to growth next to biophysical limits.

Recent economic studies have included a range of other variables to test their influence on happiness. The political, economic and personal freedoms of a country have been found to be an additional determinant of happiness (Frey and Stutzer, 2000). In addition, differences in environmental quality were discovered to determine happiness. Van Praag and Baarsma (2001) studied the external effects due to aircraft noise nuisance at the Amsterdam Airport Shiphol and found a trade-off ratio between happiness and exposure to noise. Air pollution has also been found to reduce happiness (Welsch, 2002).

2.2. The amenity value of climate

So far, measurements of the amenity value of climate to households have been derived mainly by using environmental valuation techniques such as the hedonic price approach or the household production function approach.

The hedonic price approach is based on the assumption that perfectly mobile individuals would relocate to eliminate the net advantages of different locations (for an overview, see Palmquist, 1991; Freeman, 1993). Consequently, Rosen (1974) and Roback (1982) argue that the household's implicit valuation of a marginal change in the level of an amenity can be inferred from the household's chosen location on the hedonic property price and wage schedule. Since then, the hedonic approach has been widely applied to estimate the economic value of nonmarket goods, but only very few studies have deliberately set out to measure the amenity value of climate to households. Examples include Hoch and Drake (1974); Roback (1982), Blomquist et al. (1988), Englin (1996), Nordhaus (1996), Cragg and Kahn (1997, 1999) for the United States. Unfortunately, differences in the specification of climate variables frustrate attempts to compare the results of different studies. One of the few studies for Europe is Maddison and Bigano (2003).

One of the reasons why the number of studies using the hedonic approach to estimate the amenity value of climate is small and mainly referring to the United States is the basic assumption that no barriers to mobility exist. Climate variables, however, are often relatively undeviating over large distances at which point the assumption of unhindered mobility becomes untenable. An alternative approach is to make cross-country comparisons using the household

[4] Personal issues include for example optimism, extraversion and self-esteem; demographic factors include age, gender and marital status. These factors have been extensively investigated by psychologists. See, e.g., Diener et al. (1999).

production approach (Smith, 1991). The method assumes that households combine marketed goods and environmental amenities by using a given 'household production technology' (Becker, 1965) and relies on differences in household expenditure patterns between households located in different areas to discover these technologies.

Only very few studies have used the household production approach to valuing climate amenities (Shapiro and Smith, 1981; Kravis et al., 1982). In the first paper to explicitly address the problem of climate change using this technique, Maddison (2003) investigated the role of climate in determining differences in consumption patterns for 88 different countries. Interestingly, he found that high-latitude countries benefit from limited climate change, whereas low-latitude countries would suffer significant losses. Unfortunately, all household production function studies rest on the untestable assumption of demand dependency (Bradford and Hildebrandt, 1977). Upon reflection, this assumption seems implausible: changes in climate might be of value to the household even if they do not result in a reallocation of spending.

There is one other study which uses neither the hedonic approach nor the household production function approach but is of relevance to the work presented in this paper. Frijters and Van Praag (1998) estimated the effects of climate on well-being in Russia using 'hypothetical equivalence scales.' This technique invites households to state how much income they would require to reach a labelled welfare level. These amounts are then analysed to uncover the determinants of households' subjective well-being. They find climate to be one important determinant of households' standard of living in Russia and that households strongly dislike cold winters and hot summers.

3. Empirical analysis

Data on self-reported levels of happiness (or well-being) are provided by the World Database of Happiness (Veenhoven, 2001). This database contains information on the average level of well-being for different countries and years. It is obtained from surveys asking for the level of self-reported happiness in a particular country. Our dataset contains data on a four-item response category and includes 185 observations obtained in 67 different countries between 1972 and 2000.[5] Also available were observations for a three- and five-item response category. However, the number of observations for the five-item response category was limited to only a very few observations (44 observations for 27 countries). Observations for the three-item category were restricted by their relevance to the present (the most recent observations refer to 1984).

The least happy countries tend to be the Eastern European ones. The least happy country was Bulgaria in 1996 and Moldova also in 1996 with scores of 2.33 and 2.40, respectively, followed by Russia with a score of 2.41 in 1998. The happiest countries tend to be Western European ones and, in particular, Iceland. The happiest countries were Venezuela in 1996 with a score of 3.47, Iceland in 1996 and the United States in 1995, both with a score of 3.40 followed by the Netherlands with a score of 3.39 for 1990.

We now turn to the independent variables to be used in our attempt to explain variations in happiness between countries and over time. The empirical model first and foremost includes GDP per capita in 1995 USD converted using market exchange rates. Note that using purchasing power parity exchange rates was also considered, but the results obtained were not as good. Most of the countries with cold winters in our dataset are former communist countries, the inhabitants of which are now very unhappy because of the economic decline that they have experienced. To avoid the risk of confounding, a variable was created to indicate whether and to what extent past income has been above the level reached in the survey year. This variable is strictly nonnegative.[6] Further economic variables, like the annual growth rate in GDP, the percentage of unemployed as well as the inflation rate, were included.

[5] The replies are ranked from 1 to 4 as follows: 'not at all happy'=1, 'not very happy'=2, 'quite happy'=3, 'very happy'=4 (Veenhoven, 2001).

[6] Taking the example of Bulgaria, GDP per capita in 1996 was $1394.18 compared to $1888.29 in 1990. The difference of $494.11 is the shortfall in income. For 1997, the shortfall in income compared to the previous high is $582.36. Obviously, for those countries that have experienced uninterrupted economic growth, the shortfall-in-income-relative-to-previous-high variable is always 0.

To measure cultural differences, the proportions of different religions are included: Buddhist, Hindu, Muslim, Christian, and Orthodox; as well as an index of freedom measured as political rights and civil liberty.[7] The index ranges from 1 (low level of freedom) to 7 (high level of freedom). Demographic differences are included using life expectancy as a measure of health status along with literacy rates as a measure of education. We consider it self-evident that these variables might have an effect on happiness. Population density, the proportion of the population living in urban areas as well as the proportion of the population over 65 and less than 15 years are also included.[8] All of these variables have been used by other researchers in an attempt to reveal the influences on happiness.

Various indices are used to describe climate. We experiment with annually averaged mean monthly precipitation, annually averaged mean temperature, mean temperature of the coldest month, mean temperature of the hottest month, mean precipitation of the driest month, mean precipitation of the wettest month, the number of cold months, the number of hot months, the number of dry months and the number of wet months.[9]

Fig. 1 shows average happiness levels and the historical mean temperature of the coldest month for the countries included in the dataset. The clear positive relationship indicates that higher temperatures in the coldest month increase peoples' happiness. This diagram also makes clear the importance of controlling for the reverse economic growth that former communist countries have experienced. The countries with the coldest winters are almost all former communist countries.

Monthly records for temperature and precipitation for each country's major city (or cities) are taken from Landsberg (1969); Pearce and Smith (1994) and miscellaneous Internet sources for some smaller countries. For some cities, the data were population-weighted to obtain one record per country. Others applying this method include Maddison (2003), although this method clearly suits urbanized countries more than those in which the majority of the population continues to live in rural areas. Table A1 in the Appendix reports the climate records as well as the population weights if applicable. Although other climate data representing the average climate of a country are available, it does not take into account to what extent particular areas of a country are populated. This is especially important for large and climatically different countries, like Canada, the United States or Russia. The majority of Canadians live close to the US border and not in the Arctic Circle.[10]

The absolute latitude of the country is included to account for the variation in the hours of daylight across the seasons. It refers to the capital city of the particular country. The information is taken from the World Gazetteer. A time trend is included to test whether there are any autonomous changes in reported happiness over time. The data are presented in Table 1. Note that some missing values (mainly for unemployment, literacy rates and the religious variables) have been imputed using first-order regression techniques. These techniques use regression analysis on nonmissing observations to predict the value of missing variables. The range of the variables, their means and standard deviations are presented in Table 2. This table is based on the data with some values imputed.

4. Results

Including too many climate variables in the model at once leads to problems of multicollinearity. Therefore, three different specifications were tested, each containing four different climate variables. In the first

[7] The data on the proportion of different religions was taken from "World Religions" Infoplease.com. See http://www.infoplease.com/ipa/A0855613.html. The freedom index was provided by Freedom House (2002).

[8] Data on GDP per capita is taken from World Resources Database along with data on population, population density, urban population, population above 65 and under 15 years, literacy and life expectancy. The data on the rate of unemployment comes from the International Labor Office. Inflation rates and annual growth rates are obtained from World Development Indicators 2001.

[9] Cold or hot months are those with average mean temperature below freezing or above 20 °C. Wet or dry months are those with average mean precipitation above 100 mm or below 30 mm. These values were chosen in light of the values for the calculated means for the coldest/hottest as well as driest/wettest month for all 185 observations. See Table 2.

[10] More appropriate would have been to use climatically homogenous areas rather than countries. So far, most data is available only on at the level of the country.

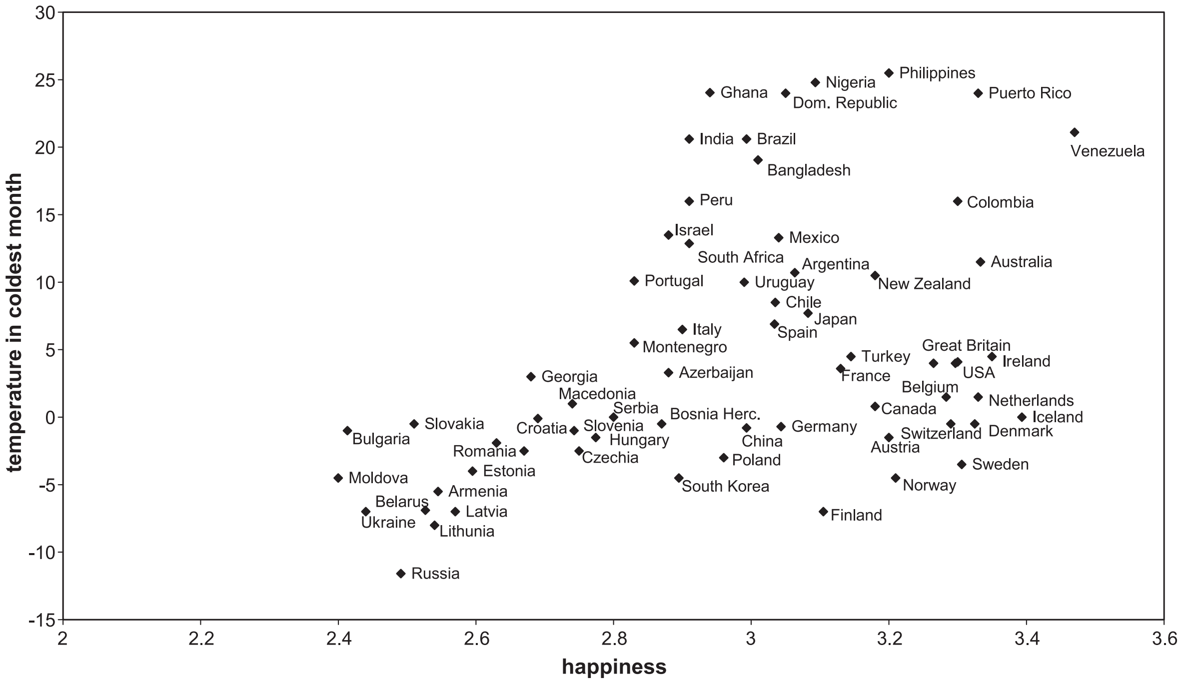

Fig. 1. Relationship between temperature in the coldest month (°C) and average happiness.

model, mean temperature in the hottest and coldest month was included as well as mean precipitation in the wettest and driest month. The second specification includes the number of hot, cold, wet and dry months as count variables. The third specification contains annually averaged temperature and precipitation along with their squared values. Including squared terms enables us to test whether people prefer a mild climate rather than one characterized by extremes (see, e.g., Maddison and Bigano, 2003).

The following model is estimated over all i countries and all t periods:[11]

$$\mathrm{HAPPY}_{it} = \alpha + \beta_1 \times \mathrm{GDPCAP}_{it} + \beta_2 \times \mathrm{GDPCAP}_{it}^2 + \ldots + \varepsilon_{it}$$

The explanatory variables are all included in their levels apart from GDP per capita included as a linear and a quadratic variable to capture any possible curvature with respect to the dependent variable. In view of the fact that observations are repeatedly drawn from the same countries, the model is estimated using panel-corrected least squares invoked by the ⟨cluster⟩ option in the STATA computer package. This deals with any correlation between the disturbances for observations drawn from the same country as well as providing heteroscedasticity-consistent standard errors. As the number of observations per country varies, sampling weights were used to give countries contributing fewer observations but possessing large populations, correspondingly, greater weight. This makes very little difference to any of the coefficient estimates, and the results of the unweighted regressions are not reported here.

All three models pass the RESET test for functional form calculated by including the squared value of the predicted value in an auxiliary regression. Model 1 obtained the highest R^2 compared to other model specifications. Table 3 contains the regression results.

Deferring discussion of the other variables, it is seen that the climate variables are jointly significant for all model specifications. In model 1, higher mean temperatures in the coldest month increase happiness, whereas higher mean temperatures in the hottest

[11] We also tested different functional forms, including the semilog and logistic transformation, the latter of which explicitly accounts for the limited nature of the dependent variable. The results obtained are similar to those of the linear specification.

Table 1
Definition of the variables

Variable	Definition
Happy	Average score of self-reported happiness
GDPCAP	GDP per capita in 1995 USD converted using market exchange rates
Growth	Annual GDP growth rate (%)
GDPMAX	Shortfall in income compared to previous high
Inflation	Annual inflation rate (%)
Unemployed	Annual rate of unemployment (%)
Year	Calendar year of the survey
Popden	Population density in persons per square kilometre
Pop65	Proportion of the population over 65 years
Pop15	Proportion of the population under 15 years
Urban	Percentage of the population living in urban areas
Lifeexp	Life expectancy in years
Literate	Percentage of the adult population who are literate
Freedom	Index of personal freedoms
Buddhist	Proportion of the population who are Buddhist
Hindu	Proportion of the population who are Hindu
Muslim	Proportion of the population who are Muslim
Christ	Proportion of the population who are Christian or Jewish
Orthodox	Proportion of the population who follow Orthodox religions
Latitude	Absolute latitude in degrees
AnnTemp	Annually averaged mean temperature (°C)
MaxTemp	Average mean temperature in hottest month (°C)
MinTemp	Average mean temperature in coldest month (°C)
Hot	Months when average mean temperature exceeds 20 °C
Cold	Months when average mean temperature is below 0 °C
ANNPREC	Annually averaged mean precipitation (mm)
MAXPREC	Average mean precipitation in wettest month (mm)
MINPREC	Average mean precipitation in driest month (mm)
Wet	Months when average mean precipitation exceeds 100 mm
Dry	Months when average mean precipitation is below 30 mm

Source: see text.

month decrease happiness. The variables describing differences in precipitation are jointly insignificant. In model 2, more months with very little precipitation are found to reduce happiness significantly.[12] This might reflect the fact that climate could have an indirect effect on happiness through landscape effects. Attempts to combine the best elements of models 1 and 2 did not result in a statistically significant increase in fit, with neither temperature nor precipitation variables dominating. In model 3, none of the climate variables is individually significant. These findings are in line with Cushing (1987) who investigated the determinants of population migration decisions by using different specifications of temperature. He found temperature extremes provided the best description of climate, whereas annual temperature provided the worst.

Elsewhere in the equations, GDP per capita is statistically significant. Its square has the expected sign but is not significant. The variable measuring the

[12] A sensitivity analysis on the specification of the climate variables contained in model 2 reveals that the results are fairly robust. Increasing the temperature threshold by 1 °C for cold months, this variable becomes significant and shows the expected sign. Reducing precipitation in dry months by 10 mm, the estimated coefficient is still significant. Increasing precipitation by 10 mm for dry months, the variable becomes insignificant. The estimates for wet months are always insignificant.

Table 2
Summary of the data

Variable	Mean	Standard deviation	Minimum	Maximum
Happy	2.99	0.28	2.33	3.47
GDPCAP	13529.11	11874.23	284	46821
Growth	2.37	4.19	−11.89	14.91
GDPMAX	104.66	341.63	0.00	2109.48
Inflation	32.51	109.22	−0.09	1061.59
Unemployed	7.89	6.91	0.1	69.8
Year	1991.70	6.05	1972	2000
Popden	115.63	115.03	2	839
Pop65	0.11	0.039	0.03	0.18
Pop15	0.23	0.07	0.15	0.45
Urban	70.70	15.47	18.88	97.05
Lifeexp	72.23	5.58	48.21	79.96
Literate	92.42	15.40	1	100
Freedom	2.28	1.49	1	7
Buddhist	0.02	0.13	0.00	0.84
Hindu	0.01	0.09	0.00	0.83
Muslim	0.06	0.16	0.00	0.98
Christ	0.66	0.33	0.00	1.00
Orthodox	0.09	0.23	0.00	0.98
Latitude	44.69	12.95	4.63	64.14
AnnTemp	11.59	5.64	3.9	27.2
MaxTemp	20.45	3.78	11.5	31.3
MinTemp	2.51	8.58	−12.0	25.5
Hot	2.18	3.35	0	12
Cold	1.31	1.61	0	5
AnnRain	66.99	27.83	3.6	181.2
MaxRain	112.44	73.46	8.0	515.4
MinRain	36.04	17.62	0	79
Wet	1.43	2.61	0	10
Dry	1.16	2.16	0	12

Source: see text.

Table 3
Regression results

Variable	Model 1 Coefficient	T statistic	Model 2 Coefficient	T statistic	Model 3 Coefficient	T statistic
Constant	1.08E+01	2.33	8.37E+00	1.90	8.60E+00	1.89
GDPCAP	2.37E−05	3.24	2.21E−05	2.54	2.70E−05	3.56
$GDPCAP^2$	−2.25E−10	−1.51	−2.00E−10	−1.17	−2.96E−10	−1.90
Growth	5.25E−03	1.57	2.34E−03	0.59	3.90E−03	0.97
GDPMAX	−5.81E−05	−0.99	−2.57E−05	−0.41	−4.76E−05	−0.70
Inflation	7.55E−05	0.71	6.76E−05	0.62	8.40E−05	0.76
Unemployed	3.20E−03	1.33	3.79E−04	0.20	1.11E−03	0.47
Year	−4.37E−03	−1.92	−3.56E−03	−1.60	−3.67E−03	−1.61
Popden	−4.60E−05	−0.33	1.00E−04	0.92	−4.01E−05	−0.23
Pop65	−1.59E+00	−1.77	−1.32E+00	−1.41	−6.27E−01	−0.58
Pop15	6.22E−01	0.84	1.68E+00	2.45	1.84E+00	2.28
Urban	9.70E−04	0.59	1.56E−03	1.11	2.33E−03	1.50
Lifeexp	1.07E−02	1.57	1.77E−02	2.52	1.38E−02	1.81
Literate	2.95E−04	0.25	−5.83E−04	−0.49	−7.86E−04	−0.59
Freedom	1.29E−02	0.85	1.49E−02	1.00	6.34E−03	0.39
Buddhist	−3.72E−01	−1.74	−3.39E−01	−2.46	−5.17E−01	−3.68
Hindu	−1.83E−01	−0.75	6.28E−02	0.31	6.03E−03	0.03
Muslim	1.33E−01	0.79	1.05E−01	0.83	1.19E−01	0.92
Christ	−5.85E−02	−0.36	1.18E−02	0.10	−3.21E−02	−0.26
Orthodox	−1.51E−01	−0.95	−2.17E−01	−1.77	−2.10E−01	−1.65
Latitude	1.42E−03	0.50	−1.59E−03	−0.60	−3.47E−03	−0.91
MaxTemp	−1.81E−02	−2.05				
MinTemp	1.39E−02	2.81				
MaxRain	4.16E−04	1.73				
MinRain	7.05E−04	0.65				
Cold			−2.50E−02	−1.47		
Hot			9.37E−04	0.11		
Dry			−2.24E−02	−3.02		
Wet			−5.44E−03	−0.62		
AnnTemp					4.74E−03	0.35
$AnnTemp^2$					−4.08E−04	−0.75
AnnRain					2.89E−03	1.59
$AnnRain^2$					−4.61E−06	−0.35
No. of observations	185		185		185	
R-squared	0.7918		0.7871		0.7718	
F test ($P>F$)[a]	0.0011		0.0081		0.0070	
Reset test ($P>F$)	0.0822		0.4479		0.1469	

Source: see text.
[a] *F* test for joint significance of climate variables.

shortfall in income has the expected sign but is not significant. The variables describing the proportion of religions are significant for models 2 and 3 for the proportion of Buddhists. This suggests that a greater fraction of Buddhists in a country is associated with a greater degree of unhappiness. Serving as a proxy for health status, life expectancy is significant for model 2, indicating that better health greatly improves happiness. It is also seen that happiness increases as the proportion of individuals under the age of 15 increases (significant for models 2 and 3). This reinforces the findings of earlier studies. The variable describing political rights and personal freedoms is not significant. Unemployment, inflation, population density, literacy rates, urban populations and latitude do not significantly influence self-reported happiness. There are no significant autonomous changes in happiness over time.

5. The influence of climate change

In this section, we use the first regression equation containing the hottest, coldest, wettest and driest month to calculate the change in real GDP per capita necessary to hold happiness at its current levels in the face of predicted changes in climate for two different time slices: 2010–2039 and 2040–2069.[13] The calculations are limited to the countries represented in the dataset to avoid the risks associated with out of sample prediction. The predictions for temperature and precipitation change (deviations from 1961–1990) are available on a monthly basis and indicate that the majority of the warming is expected to occur during winter months and in high-latitude countries. Very warm summers will become more frequent, and very cold winters will become increasingly rare. Geographically, differences in rainfall are likely to become more pronounced with increased precipitation in high latitudes. Furthermore, rainfall is expected to become more seasonal with drier summers and wetter winters. The changes in mean temperature in the hottest and coldest month as well as the changes in mean precipitation in the wettest and driest month for the two time slices are presented in Table A2 in the Appendix.

In Table 4, two different sets of calculations are displayed. The first two columns show the calculations for predicted changes in temperature only. The last two columns display the calculations for changes in temperature and precipitation combined. A negative sign indicates that income has to be reduced to compensate for the change in climate (that is, climate change increases happiness).

Examining the first two columns of Table 4 shows that most countries would lose from climate change as temperature is expected to increase over time. Only very few countries in high latitudes, like Canada, Norway, Finland, Sweden or Iceland, are likely to gain from limited changes in temperature. Furthermore, there are some countries in Eastern Europe and Middle East, like Armenia, Azerbaijan, Georgia or Ukraine, for which the expected change in minimum temperature is more pronounced than the changes in maximum temperature and which might gain from small changes as well. Note that the ability of individuals living in climatically diverse countries to relocate might limit the losses from climate change.

Turning to the last two columns, the calculations, including changes in temperature as well as precipitation, show that the gains and losses are generally more pronounced for countries with either very low temperatures in the coldest month or very high temperatures in the hottest month. In this simulation, even more countries might benefit from limited climate change, in particular, countries in Northern Europe, like Denmark, Great Britain and Ireland. Countries for which precipitation is expected to increase in previously dry months, like Peru, Venezuela or India, are also likely to gain from limited climate change.

The results also indicate that the calculations are sensitive to climate change predictions. A country like Bangladesh is likely to lose when looking at the calculations for changes in temperature in isolation (first two columns of Table 4). When including changes in precipitation patterns, Bangladesh might gain especially in the second time slice (fourth column of Table 4). This gain occurs because precipitation in the driest month is predicted to recover to today's level and also because precipitation in the wettest month is predicted to increase significantly (see Table A2 in the Appendix). If precipitation in the driest month would decrease further compared to the first time slice, Bangladesh would still lose.

Depending on the climate model estimates applied and the time slices used, the impacts of an enhanced greenhouse effect differ for the countries covered by the analysis. However, the overall result, namely, that those countries in high latitudes are the ones expected to gain, finds support in the literature (Maddison, 2003). He also found high-latitude countries likely to benefit from global temperature increases, whereas countries located in the tropics would have to expect large increases in the cost of living. The results also resonate with those of Frijters and Van Praag (1998) who found that Russians disliked cold winters and hot summers. So, although it would be wrong to

[13] The data were provided by Larry J. Williams and Michael E. Schlesinger (COSMIC) and is calculated as the average of 14 general circulation models. It is scaled to a projected global mean temperature increase of 0.620 °C for the first time slice and 1.024 °C for the second.

Table 4
The predicted impact of climate change

Country	Constant happiness change in GDP per capita (1995 USD) changes in temperature		Constant happiness change in GDP per capita (1995 USD) changes in temperature and precipitation	
	2039	2069	2039	2069
Argentina	155.93	263.10	138.58	233.85
Armenia	−36.23	−67.89	−75.89	−135.27
Australia	89.53	147.46	78.12	128.00
Austria	166.51	286.01	123.35	247.42
Azerbaijan	−51.45	−77.16	−74.63	−116.75
Bangladesh	68.82	115.74	−17.25	−79.69
Belarus	−36.23	−67.89	−64.94	−116.33
Belgium	65.02	116.58	15.66	32.88
Bosnia-Hercegovina	210.55	363.28	158.89	276.68
Brazil	46.43	94.18	58.26	114.05
Bulgaria	257.17	444.92	244.03	421.09
Canada	−261.80	−445.37	−354.08	−591.61
Chile	142.81	233.43	102.21	163.55
China	45.17	74.74	1.14	−0.14
Colombia	82.77	148.31	12.36	29.12
Croatia	241.06	417.26	219.44	380.28
Czechia[a]	121.66	206.31	89.95	151.70
Czechoslovakia[a]	121.66	206.31	89.95	151.70
Denmark	3.86	−1.85	−81.79	−147.89
Dominican Republic	78.54	126.73	65.02	103.48
Estonia	4.94	−3.16	−31.93	−65.78
Finland	−246.26	−424.45	−356.60	−612.47
France	150.43	254.62	123.77	210.12
Georgia	−36.23	−67.89	−86.01	−152.52
Germany[a]	68.40	116.16	12.70	21.61
Ghana	104.32	168.62	71.36	119.54
Great Britain	56.15	87.41	−26.87	−53.56
Hungary	195.30	336.09	158.89	273.71
Iceland	−87.27	−152.52	−188.69	−323.90
India	43.48	78.54	−28.52	−43.86
Ireland	74.31	121.66	−28.35	−53.14
Israel	254.62	427.90	241.48	401.53
Italy	187.25	309.77	203.77	337.37
Japan	25.24	40.23	−81.79	−142.00
Latvia	−36.23	−67.89	−88.11	−155.47
Lithuania	−36.23	−67.89	−76.73	−136.53
Macedonia	241.06	417.26	253.78	440.66
Mexico	142.39	243.60	166.08	283.89
Moldova	111.93	182.17	65.02	102.63
Montenegro	241.06	417.26	272.43	470.46
Netherlands	49.81	80.23	−4.73	−12.02
New Zealand	95.87	156.35	38.54	59.10
Nigeria	154.23	259.71	180.48	304.25
Northern Ireland	82.34	144.93	17.68	34.86
Norway	−168.09	−286.98	−271.45	−463.11
Peru	17.81	24.77	−60.30	−66.20
Philippines	46.86	72.62	12.53	14.47
Poland	87.84	141.54	26.08	36.51
Portugal	199.96	350.11	218.17	368.38
Puerto Rico	63.33	103.90	37.86	60.37
Romania	247.84	414.29	233.85	389.63
Russia	−36.23	−67.88	−75.89	−127.69
Serbia	241.06	417.26	219.44	395.15
Slovakia	121.66	206.31	136.46	230.89
Slovenia	241.06	417.26	189.37	328.87
South Africa	138.58	238.51	158.04	272.01
South Korea	−17.72	−27.97	−95.27	−160.09
Spain	232.16	393.88	268.19	453.43
Sweden	−169.77	−282.79	−272.29	−457.92
Switzerland	163.12	286.43	146.19	258.02
Turkey	277.10	466.20	298.31	500.27
USA	69.24	132.66	24.60	57.42
Ukraine	−36.23	−67.89	−74.63	−133.16
Uruguay	163.97	289.40	147.04	260.14
Venezuela	59.10	101.36	−33.07	−55.25

Source: see text.

[a] The climate and the predicted climate change for East and West Germany are so similar to those for Germany (reunified) that the calculated change in GDP is equivalent. The same holds for Czechia and Czechoslovakia.

place too much weight on the results of any one analysis, the results presented here are not at odds with those already in the literature.

6. Conclusion

This study has demonstrated that climate variables can be used to explain differences in self-reported subjective well-being. The results suggest that people would prefer higher mean temperatures in the coldest month and lower temperatures in the hottest month. In a different model specification, we found people living in regions with many dry months would prefer more precipitation. Modest global warming with higher winter temperatures would increase peoples' happiness, particularly, for those living in the North. Those living in regions already characterized by very high temperatures would lose out. In general, our results support earlier findings that high-latitude countries benefit from limited climate changes, whereas low-latitude countries would suffer losses.

It is remarkable that climate variables were found significant, although the number of observations is restricted and the number of included variables is quite large. However, empirical results are never unimpeachable, and the choice of independent variables is guided in the main by factors that previous researchers considered to be important. Moreover, the selection of variables depends to a certain extent on data availability. The limited number of studies investigating the amenity value of climate makes comparisons to other research work difficult. As this is the first study relating differences in self-reported levels of happiness to climate conditions, our findings should be viewed as provisional.

This analysis needs to be extended in several ways. The analysis has been restricted to the country level. However, climate and climate change differ not only between countries but also within countries. It would be interesting to see how climate would affect people's happiness in different regions of a country. Second, there are other consequences of climate change apart from changes in temperature and precipitation, which are likely to have an effect on people's happiness. There are, for example, induced effects, like the increase of extreme weather events. These have not been taken into consideration in this analysis. Furthermore, we did not look into the time it would take people to adapt to a new climate and the temporary discomfort this may cause. All this is deferred to future research.

Acknowledgement

This paper benefited greatly from comments by Richard Tol. Furthermore, we would like to thank Malte Schwoon for his assistance. A version of this paper was presented at the Conference on "The Paradoxes of Happiness in Economics," Milan, March 21–23, 2003. The Michael Otto Foundation for Environmental Protection and the Berufungsfond of the BWF provided welcome financial support. All errors and opinions are ours.

Appendix A

Table A1
Records used to compute climate record

Name	Climate record	Population (×1000)
Argentina	Buenos Aires	10,728
	Cordoba	1055
	Rosario	1016
Armenia	Yerevan	
Australia	Sydney	3531
	Melbourne	2965
	Brisbane	1125
	Perth	1083
	Adelaide	1013
Austria	Vienna	
Azerbaijan	Baku	
Bangladesh	Dacca	4770
	Chittagong	1840
Belarus	Minsk	
Belgium	Brussels	
Bosnia-Hercegovina	Sarajevo	
Brazil	Sao Paulo	16,832
	Rio de Janeiro	11,141
	Belo Horizonte	3446
	Recife Porto	2945
	Alegre Salvador	2924
Bulgaria	Sofia	2362
Canada	Toronto	3427
	Montreal	2921
	Vancouver	1381
Chile	Santiago	
China	Shanghai	12,320
	Beijing	9750
	Tianjin	5459
	Shenyang	4285
	Wuhan	3493
	Guangzhou	3359
	Chongquing	2832
	Harbin	2668
	Chengdu	2642
Colombia	Bogota	4185
	Medellin	1506
Croatia	Zagreb	
Czechia	Prague	
Czechoslovakia	Prague	
Denmark	Copenhagen	
Dominican Republic	Santo Domingo	
Estonia	Tallinn	
Finland	Helsinki	
France	Paris	8510
	Lyon	1170
	Marseilles	1080

(continued on next page)

Appendix A (*continued*)

Name	Climate record	Population (×1000)
Georgia	T'Bilisi	
Germany East	Berlin	
Germany West	Berlin	2075
	Hamburg	1594
	Munich	1189
Germany	Berlin	3301
	Hamburg	1594
	Munich	1189
Ghana	Accra	
Great Britain	London	
Hungary	Budapest	
Iceland	Reykjavik	
India	Calcutta	9194
	Bombay	8243
	Delhi	5729
	Madras	4289
	Bangalore	2922
	Ahmadabad	2548
	Hyderabad	2546
Ireland	Dublin	
Israel	Haifa	
Italy	Rome	2817
	Milan	1464
	Naples	1203
Japan	Tokyo	11,829
	Yokohama	2993
	Osaka	2636
	Nagoya	2116
Latvia	Riga	
Lithuania	Vilnus	
Macedonia	Skopje	
Mexico	Mexico City	18,748
	Guadalajara	2587
	Monterrey	2335
	Pueblo	1218
Moldova	Chisinau	
Montenegro	Podgogica	
Netherlands	De Bilt	
New Zealand	Auckland	
Nigeria	Lagos	1097
	Ibadam	1060
Northern Ireland	Belfast	
Norway	Oslo	
Peru	Lima-Callao	
Philippines	Manila	
Poland	Warsaw	
Portugal	Lisbon	1612
	Oporto	1315
Puerto Rico	San Juan	
Romania	Bucharest	

Appendix A (*continued*)

Name	Climate record	Population (×1000)
Russia	Moscow	8967
	St. Petersburg	5020
	Novgorod	1438
	Novosibirsk	1436
Serbia	Belgrade	
Slovakia	Bratislava	
Slovenia	Ljubljana	
South Africa	Cape Town	1912
	Johannesburg	1762
South Korea	Seoul	
Spain	Madrid	3123
	Barcelona	1694
Sweden	Stockholm	
Switzerland	Zurich	
Turkey	Istanbul	5495
	Ankara	2252
	Izmir	1490
USA	New York	18,120
	Los Angeles	13,770
	Chicago	8181
	San Francisco	6042
	Philadelphia	5963
	Detroit	4620
	Dallas	3766
	Boston	3736
	Washington	3734
	Houston	3642
	Miami	3001
	Cleveland	2769
	Atlanta	2737
	Saint Louis	2467
	Seattle	2421
	Minneapolis	2388
	San Diego	2370
	Baltimore	2343
	Pittsburgh	2284
	Phoenix	2030
	Ukraine	Kiev
Uruguay	Montivideo	
Venezuela	Caracas	3247
	Maracaibo	1295

Source: Philip's Atlas of the World (1992).

Appendix A2

Table A2
Predicted changes in temperature and precipitation

	Change in minimum temperature (°C)		Change in maximum temperature (°C)		Change in minimum precipitation (mm)		Change in maximum precipitation (mm)	
Country	2039	2069	2039	2069	2039	2069	2039	2069
Argentina	0.63	1.07	0.69	1.17	0.62	1.05	-0.07	-0.11
Armenia	0.93	1.58	0.67	1.13	0.56	0.95	1.31	2.23
Australia	0.60	1.02	0.58	0.98	0.85	1.44	-0.79	-1.35
Austria	0.78	1.33	0.82	1.40	2.28	2.70	-1.41	-2.39
Azerbaijan	0.93	1.57	0.65	1.11	0.10	0.17	1.16	1.97
Bangladesh	0.57	0.97	0.53	0.90	-1.46	-0.83	7.38	12.54
Belarus	0.93	1.58	0.67	1.13	0.91	1.54	0.10	0.17
Belgium	0.81	1.37	0.71	1.21	1.99	3.39	-0.57	-0.97
Bosnia-Hercegovina	0.68	1.16	0.80	1.37	1.56	2.61	0.29	0.49
Brazil	0.53	0.89	0.47	0.81	-1.05	-1.79	1.12	1.90
Bulgaria	0.64	1.09	0.83	1.42	1.06	1.81	-1.06	-1.80
Canada	1.25	2.12	0.62	1.05	2.01	3.18	1.87	3.17
Chile	0.60	1.03	0.65	1.10	0.46	0.79	1.54	2.63
China	0.74	1.26	0.63	1.07	0.65	1.11	1.40	2.38
Colombia	0.43	0.72	0.44	0.75	0.13	0.22	3.78	6.42
Croatia	0.68	1.16	0.84	1.44	1.14	1.94	-0.70	-1.19
Czechia	0.83	1.40	0.80	1.35	1.72	2.93	-1.10	-1.87
Czechoslovakia	0.83	1.40	0.80	1.35	1.72	2.93	-1.10	-1.87
Denmark	0.81	1.39	0.63	1.07	2.45	4.17	0.74	1.26
Dominican Republic	0.45	0.77	0.45	0.76	-0.40	-0.67	1.45	2.46
Estonia	0.86	1.47	0.67	1.13	0.91	1.54	0.56	0.95
Finland	1.21	2.06	0.61	1.03	1.85	3.15	3.20	5.44
France	0.73	1.24	0.76	1.29	1.77	3.00	-1.50	-2.55
Georgia	0.93	1.58	0.67	1.13	0.91	1.54	1.31	2.23
Germany	0.83	1.41	0.73	1.24	2.26	3.84	-0.66	-1.13
Ghana	0.51	0.88	0.53	0.90	1.06	1.58	0.07	0.12
Great Britain	0.76	1.29	0.66	1.11	1.63	2.77	1.97	3.35
Hungary	0.77	1.31	0.85	1.45	0.07	0.12	1.96	3.34
Iceland	1.03	1.75	0.68	1.15	1.61	2.74	3.05	5.18
India	0.60	1.02	0.52	0.89	0.08	0.14	3.97	6.75
Ireland	0.69	1.18	0.63	1.07	1.90	3.24	2.64	4.48
Israel	0.54	0.92	0.75	1.27	0.50	1.00	-0.08	-0.15
Italy	0.68	1.16	0.77	1.30	-0.91	-1.54	0.62	1.05
Japan	0.67	1.15	0.55	0.94	1.09	1.86	4.26	7.25
Latvia	0.93	1.58	0.67	1.13	1.41	2.39	0.56	0.95
Lithuania	0.93	1.58	0.67	1.13	1.03	1.75	0.56	0.95
Macedonia	0.68	1.16	0.84	1.44	-0.60	-1.08	0.29	0.49
Mexico	0.51	0.87	0.58	0.99	-0.77	-1.31	-0.04	-0.07
Moldova	0.51	0.87	0.54	0.91	1.62	2.75	-0.08	-0.14
Montenegro	0.68	1.16	0.84	1.44	-1.22	-2.08	0.29	0.49
Netherlands	0.81	1.38	0.69	1.17	2.01	3.41	-0.31	-0.52
New Zealand	0.55	0.94	0.55	0.93	1.39	2.36	0.91	1.54
Nigeria	0.49	0.83	0.58	0.98	0.01	0.01	-1.50	-2.55
Northern Ireland	0.69	1.18	0.64	1.10	1.90	3.24	0.45	0.76
Norway	1.09	1.85	0.62	1.05	2.53	4.30	1.62	2.76
Peru	0.54	0.93	0.44	0.75	2.09	1.45	0.90	2.72
Philippines	0.40	0.68	0.37	0.62	1.66	2.82	-0.86	-1.46
Poland	0.81	1.38	0.74	1.25	2.25	3.83	-0.30	-0.52

(continued on next page)

Appendix A2 (*continued*)

	Change in minimum temperature (°C)		Change in maximum temperature (°C)		Change in minimum precipitation (mm)		Change in maximum precipitation (mm)	
Country	2039	2069	2039	2069	2039	2069	2039	2069
Portugal	0.62	1.04	0.74	1.26	-0.06	-0.09	-0.93	-0.88
Puerto Rico	0.45	0.77	0.43	0.73	-0.40	-0.67	2.12	3.61
Romania	0.72	1.23	0.88	1.49	0.51	0.87	-0.05	-0.08
Russia	0.93	1.58	0.67	1.13	1.28	1.91	0.10	0.17
Serbia	0.68	1.16	0.84	1.44	1.14	1.44	-0.70	-1.19
Slovakia	0.83	1.40	0.80	1.35	0.16	0.27	-1.10	-1.87
Slovenia	0.68	1.16	0.84	1.44	1.56	2.66	0.29	0.49
South Africa	0.62	1.06	0.66	1.13	-0.64	-1.09	-0.02	-0.04
South Korea	0.73	1.24	0.54	0.92	0.53	0.91	3.53	6.00
Spain	0.63	1.07	0.79	1.34	-0.61	-1.03	-1.01	-1.71
Sweden	1.08	1.83	0.61	1.04	2.19	3.73	2.15	3.66
Switzerland	0.76	1.29	0.80	1.37	1.58	2.68	-1.72	-2.92
Turkey	0.58	0.99	0.81	1.37	-1.09	-1.85	0.65	1.10
USA	0.79	1.33	0.70	1.20	0.36	0.61	1.92	3.26
Ukraine	0.93	1.58	0.67	1.13	0.96	1.64	0.56	0.95
Uruguay	0.59	1.00	0.67	1.15	-0.17	-0.29	1.26	2.14
Venezuela	0.47	0.80	0.44	0.75	0.79	1.34	3.91	6.65

Source: see text.

References

Becker, G.S., 1965. A theory of the allocation of time. The Economic Journal 75, 493–517.

Blomquist, G.C., Berger, M.C., Hoehn, J.P., 1988. New estimates of quality of life in urban areas. The American Economic Review 78 (1), 89–107.

Bradford, D.F., Hildebrandt, G.G., 1977. Observable preferences for public goods. Journal of Public Economics 8, 111–131.

Clark, A.E., Oswald, A.J., 1994. Unhappiness and unemployment. The Economic Journal 104, 648–659.

Cragg, M.I., Kahn, M.E., 1997. New estimates of climate demand: evidence from location choice. Journal of Urban Economics 42, 261–284.

Cragg, M.I., Kahn, M.E., 1999. Climate consumption and climate pricing from 1940 to 1990. Regional Science and Urban Economics 29, 519–539.

Cushing, B.J., 1987. A note on specification of climate variables in models of population migration. Journal of Regional Science 27, 641–649.

Daly, H.E., 1987. The economic growth debate: what some economists have learned but many have not. Journal of Environmental Economics and Management 14, 323–336.

Diener, E., Suh, E.M., Lucas, R.E., Smith, H.L., 1999. Subjective wellbeing: three decades of progress. Psychological Bulletin 125, 276–302.

Di Tella, R., MacCulloch, R.J., Oswald, A.J., 2001. Preferences over inflation and unemployment: evidence from surveys of happiness. The American Economic Review 91 (1), 335–341.

Di Tella, R., MacCulloch, R.J., Oswald, A.J., 2003. The macroeconomics of happiness. The Review of Economics and Statistics 85, 809–827.

Easterlin, R.A., 1974. Does economic growth improve the human lot? Some empirical evidence. In: David, P.A., Reder, M.W. (Eds.), Nations and households in economic growth: essays in honor of Moses Abramovitz. Academic Press, New York, pp. 89–125.

Easterlin, R.A., 1995. Will raising the incomes of all increase the happiness of all? Journal of Economic Behavior and Organization 27, 35–47.

Easterlin, R.A., 2001. Income and happiness: towards a unified theory. The Economic Journal 111, 465–484.

Easterlin, R.A., 2002. Happiness in economics. Cheltenham, United Kingdom. 244 pp.

Englin, J., 1996. Estimating the amenity value of rainfall. Regional Science 30, 273–283.

Freedom House, 2002. Freedom in the World 1972–2002. Freedom House, New York. http://www.freedomhouse.org/.

Freeman, A.M., 1993. The measurement of environmental and resource values: theory and methods. Resources for the Future, Washington, DC. 516 pp.

Frey, B.S., Stutzer, A., 2000. Happiness, economy and institutions. The Economic Journal 110, 918–938.

Frey, B.S., Stutzer, A., 2002. Happiness and economics. Princeton University Press, Princeton. 200 pp.

Frijters, P., Van Praag, B.M.S., 1998. The effects of climate on welfare and wellbeing in Russia. Climatic Change 39, 61–81.

Hoch, I., Drake, J., 1974. Wages, climate, and the quality of life. Journal of Environmental Economics and Management 1, 268–295.

Kravis, I., Heston, A., Summer, R., 1982. World product and income: international comparisons of real gross product. The Johns Hopkins University Press, Baltimore.

Landsberg, H., 1969. World survey of climatology. Elsevier, Amsterdam. 266 pp.

Maddison, D.J., 2003. The Amenity Value of Climate: The Household Production Function Approach Resource and Energy Economics vol. 25, pp. 155–175.

Maddison, D.J., Bigano, A., 2003. The amenity value of the Italian climate. Journal of Environmental Economics and Management 45, 319–332.

Ng, Y.-K., 1997. A case for happiness, cardinalism, and interpersonal comparability. The Economic Journal 107, 1848–1858.

Nordhaus, W.D., 1996. Climate amenities and global warming. In: Nakicenovic, N., Nordhaus, W.D., Richels, R., Toth, F. (Eds.), Climate change: integrating science, economics, and policy. International Institute for Applied Systems Analysis, Laxenburg, pp. 3–45.

Oswald, A.J., 1997. Happiness and economic performance. The Economic Journal 107, 1815–1831.

Ouweneel, P., 2002. Social security and wellbeing of the unemployed in 42 nations. Journal of Happiness Studies 3, 167–192.

Palmquist, R.B., 1991. Hedonic methods. In: Braden, J.B., Kolstad, C.D. (Eds.), Measuring the demand for environmental quality. Elsevier, Amsterdam, pp. 77–120.

Parker, P.M., 1995. Climate effects on individual, social, and economic behaviour: a physioeconomic review of the research across disciplines. Greenwood Press, Westport. 291 pp.

Pearce, E., Smith, C., 1994. The World weather guide. Helison, Oxford. 453 pp.

Philip's Atlas of the World, 1992. Philip, London.

Roback, J., 1982. Wages, rents, and the quality of life. Journal of Political Economy 90 (6), 1257–1278.

Rosen, S., 1974. Hedonic prices and implicit markets: product differentiation in pure competition. Journal of Political Economy 82, 34–55.

Shapiro, P., Smith, T., 1981. Preferences on non market goods revealed through market demands. Advances in Applied Microeconomics: A Research Annual 1, 105–122.

Smith, J.B., Schellnhuber, H.-J., Monirul Qader Mirza, M., 2001. Vulnerability to climate change and reasons for concerns: a synthesis. In: IPCC (Ed.), Climate change 2001: impacts, adaptation, and vulnerability. Cambridge University Press, Cambridge, pp. 913–967.

Smith, V.K., 1991. Household production function and environmental benefit estimation. In: Braden, J.B., Kolstadt, C.D. (Eds.), Measuring the demand for environmental quality. Elsevier, Amsterdam, pp. 41–76.

Tol, R.S.J., 2002. Estimates of the damage costs of climate change: Part 1. Benchmark estimates. Environmental and Resource Economics 21, 47–73.

Van Praag, B.M.S., Baarsma, B.E., 2001. The shadow price of aircraft noise nuisance: a new approach to the internalization of externalities. Discussion Paper TI 2001-010/3, Tinbergen Institute, Amsterdam.

Veenhoven, R., 2000. The four qualities of life: ordering concepts and measures of the good life. Journal of Happiness Studies 1, 1–39.

Veenhoven, R., 2001. World database of happiness. http://www.eur.nl/fsw/research/happiness/.

Welsch, H., 2002. Preferences over prosperity and pollution: environmental valuation based on happiness surveys. Kyklos 55 (4), 473–494.

Winkelmann, L., Winkelmann, R., 1998. Why are the unemployed so unhappy? Evidence from panel data. Economica 65, 1–15.