Grün, Carola; Grunewald, Nicole

Conference Paper

Subjective Well Being and the Impact of Climate Change

Proceedings of the German Development Economics Conference, Hannover 2010, No. 61

Provided in cooperation with:
Verein für Socialpolitik

Subjective Well Being and the Impact of Climate Change

(Draft)

Authors: Carola Grün and Nicole Grunewald[1]
Department of Economics, University of Göttingen, Germany

Abstract

We analyze the relationship between subjective well-being as a non-income welfare measure and climate variables such as temperature, precipitation rates or cloud covered days. Therewith, we estimate the effects from events related to climate change on subjective well-being and point out possible welfare losses and gains due to climate change.

Even though that there is a growing number of research done on well-being in terms of income measures and climate change, there is only little research done on the effect of climate change and non-income measures such as subjective well-being. Further those studies lack some comparison. Except Rehdanz and Maddison (2005) all studies turn to national analyses when analyzing the influence of climate on subjective well-being. So far there are very few studies on middle- and none on low-income countries done, but at the same time extreme weather events may especially affect people in poorer countries. Therefore, we test this relationship for low and middle-income countries in Latin America and put the results in comparison to earlier studies.

We apply survey data from the World Value Survey and Latinobarometro which cover the years 1985-2008. In a panel study we estimate subjective well-being in Latin America and control for gender, age, marital status and income. Further we introduce climate variables such as the deviation from the mean temperature and precipitation rates as to analyze how the rising variance in climate affects subjective well being.

Keywords: Subjective Well Being, Climate Change
JEL Classification: I30, Q54

---

[1] Corresponding author: ngrunew@uni-goettingen.de

Index

List of Figures

List of Tables

List of Appendix

1 Introduction

Today, climate change related risks for growth and development are widely acknowledged. The likely consequences of rising sea levels, increasing mean temperatures, more extreme weather events, desertification etc. have been investigated and attempts have been made to assess the economic costs of climate change. Early studies estimated substantial cost of 2% of global income by 2100 (e.g. Pearce et al. 1996) but largely ignored potential benefits of global warming and the mitigating effects of adaptation. Depending on the assumptions made, recent studies which explicitly consider the more complex interplay between climate change and economic responses vary a lot regarding the predicted costs. For example, the Stern Report (2006) on the economics of climate change forecasts large damages which are equivalent to 5% of global GDP per year. Other studies arrive at much lower costs of 0.2% of global income (Mendelsohn, Williams, 2004; Tol, 2002). Since there are many uncertainties regarding the magnitude of climate change effects and when they will fully materialize, the underlying assumptions need to be clearly spelled out when interpreting these estimates.

In terms of regional distribution of climate change effects, previous studies concluded that some countries and regions are more vulnerable than others. In particular, countries with a relatively large agricultural sector and regions located in low latitudes will be affected more severely. Since both facts apply to many developing countries, it is safe to reason that the poorest in Africa and Southeast Asia will have to face the bulk of damages from climate change, whereas estimates for advanced countries suggest zero or even positive net market impacts (Mendelsohn et al., 2006).

Evaluating the economic costs is a useful exercise to gauging the financial consequences of climate change and evaluating alternative mitigation strategies. However, to fully capture overall welfare impacts of climate change, a solely monetary approach is unlikely to suffice. Conceptual as well as empirical research has demonstrated that welfare is not necessarily an objective phenomenon that can be captured by monetary measures alone, but rather an encompassing concept and closely associated with the subjective assessment of the current state of being (Frey and Stutzer, 2002; Kapteyn, Kooreman and Willemse, 1987). Extensive empirical research on determinants of subjective wellbeing (SWB) verified the impact of individual, regional and national factors on personal welfare. It is now very well understood that besides financial resources, SWB is determined by personal characteristics like age, gender, education, health, attitudes and beliefs as well as the broader economic conditions like inflation, unemployment rate, and the level of income inequality (Dolan, Peasgood and White, 2007).

Few studies have looked at the impact of environmental aspects like pollution and climatic conditions on SWB and results suggest that these factors are equally important (e.g. Ferrer-i-Carbonell, Gowdy, 2007; Frijters, van Praag, 1998). A study very close to our project is Rehdanz and Maddison (2005). Using data on happiness provided by the World Database of Happiness (Veenhoven, 2001), they analyse the impact of climate variables for 67 countries over the period 1972-2000. Regarding variables on the climatic conditions, they apply various indices on temperature and precipitation as well as locational parameters like absolute latitude. Results obtained from a panel-corrected least squares approach demonstrate the strong influence of climate variables on self-reported levels of happiness. With the help of predicted changes in temperatures and precipitation levels by 2039 and 2069, they calculate the change in income required to keep happiness at a constant level. Their results support earlier findings that high-latitude countries will benefit from limited climate change, but low-latitude countries are likely to suffer most.

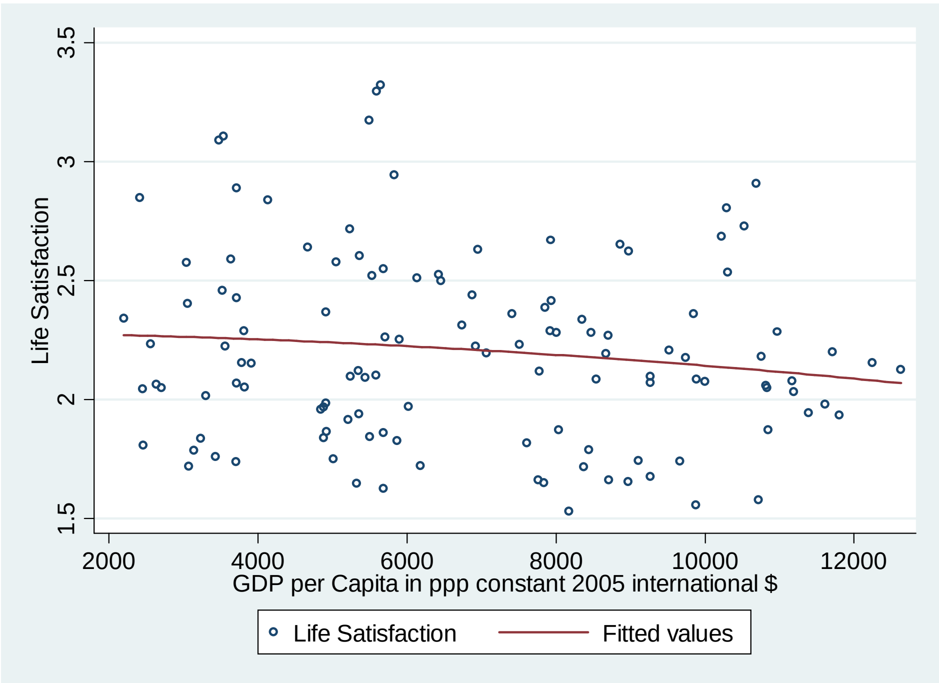
Although our research question is similar to Rehdanz and Maddison (2005), our study differs in a number of points. First, we will use an alternative indicator for measuring SWB and hence will be able to test the robustness of their results. Second, our study is regionally focussed on Latin America and the more homogeneous group of countries with similar historical background may facilitate a comparative analysis of life satisfaction. Third, we will rely on alternative climate data from the Tyndall° Centre of Climate Change Research. Apart from actual and predicted temperature and precipitation data for the period 1901-2100, we have information on percentage of cloud covered days and ground evaporation. Again, this will allow us to test the sensitivity of previous results. Finally, our analysis will not only add to the understanding of determinants of SWB, but we will also attempt assessing the welfare impact of different climate scenarios.

2 Related Literature

2.1 Welfare Theory and Subjective Well-Being

Easterlin (1974) is among the first ones to conclude that human well-being does not depend exclusively on income. He therefore compares changes in income and in SWB across countries and over time. Within countries he finds a positive relationship between income and SWB, but when analyzing across countries this relationship diminishes. Therefore, within countries the wealthier individuals are on average the happier ones. Meanwhile, between countries the wealthiest are not necessarily the happiest, which is called the Easterlin Paradox.

Figure 1: Life Satisfaction and Income in Latin America



Source: Latinobarometro 2009

Easterlin (1974) points out that this could be due to the fact that individuals compare their own wealth with the wealth of their surroundings. So, if someone else gains in welfare than one might feel relatively less well off. Frey and Stutzer (2002) analyze the relationship between SWB and income in a cross county setting. They find that income on average contributes to SWB but at diminishing rates. Hence, one may expect large gains SWB at lower levels of income. They also explain why this is the case. First, individuals' aspirations adjust and therefore one always wants more. And second, those wants are insatiable. Frey and Stutzer (2000) point to the importance of good institutions as being beneficial to SWB. Di

Tella et al. (2003) and Di Tella and MacCulloch (2006) test the effect of a sound macro-economic environment on SWB. They find that recessions create strong psychic loses besides the decline in GDP and the rise in unemployment. Finally, Di Tella and MacCulloch (2008) bring together macro and micro variables and disproof the Easterlin Paradox. After controlling for macroeconomic stability, crime rates, environmental degradation, working hours and life expectancy they find increasing rates of SWB with income even across countries.

2.2 Subjective Well-Being and the Environment

Frijters and van Praag (1998) are among the first ones to analyze the impact of climate variables on SWB. They analyze the impact of changes in temperature, humidity and precipitation with a panel of 3727 households in Russia to find that an increase in average temperature could lead to lower heating expenses. Nevertheless, they report problems of mulitícoliniarity among the climate variables. Welsch (2002) was one of the first to analyze the relationship between SWB and environmental pollution. He analyzes the effect of various pollutants among 54 countries in 1995 and concludes that multicoliniarity among the pollutants is very strong. Welsch (2006) redoes his study with a panel of 10 European countries to find significant negative results which differ among the pollutants. Rehdanz and Maddison (2005) analyze SWB and climate change on a cross country level. They analyze a panel of 67 countries and conclude that those countries living in the north would generally benefit from slightly higher mean temperatures. Rehdanz and Maddison (2008) extend their study to a national analysis of the 15 German states and pollution of the air as well as disturbances by noise to conclude that those disturbances are not capitalized into property prices. Ferrer-i-Carbonell and Gowdy (2007) analyze the relationship between SWB and environmental awareness with a panel from the British Household Panel Survey. They find that environmental awareness is positively correlated with SWB meanwhile environmental concerns are negatively correlated. Smyth et al. (2008) analyze SWB and pollution levels in urban China. Brereton et al. (2008) analyze again the relationship between SWB and climate variables but point the attention to spatial variables like proximity to the coast and find that climate has a significant impact on well-being.

2.3 Shortcomings of Subjective Well-Being Measures

Besides the advantage that with the SWB approach individual welfare is measured and differences in income as well as other dimensions of life are controlled for, there are still some concerns about this approach. First of all, there are two common measures of SWB. The one which focuses on life satisfaction and the one which aims to measure happiness are currently applied in the literature. Stevenson and Wolfers (2008) point out that those measures should not be treated equally since they tend to measure different things. The former takes account on the individual's perception of how his or her life has been so far, meanwhile the later aims on the current situation when the individual is asked. "How happy are you with your life?" This difference in the perception of the question might explain the low correlation between the two variables.

Another mayor issue is the inconsistency of the data. Krueger and Schkade (2008) tested the correlation between test and the re-test results and concluded that there is either a strong unobserved bias when answering the questions or the people are very inconsistent in their perception of SWB. As a matter of climate and therewith cloudy or rainy days, we control for those influences but nevertheless the data should be treated with care. Rojas (2008) compares real income and SWB measures in Mexico and find that 12% of the observed households consider themselves to be poor meanwhile they are not income poor and vice versa. The reason for this non-compliance could be based on the fact that the evaluation of SWB is very sensitive to comparisons. Even a relatively rich person feels poor in a neighborhood of extremely rich people and a moderately well off person feels rich in a poor one.

Last but not least Ferrer-i-Carbonell and Frijters (2004) address methodological issues and point out that the assumption of cardinal or ordinal scales makes little difference but allowing for fixed effects changes the results. Besides all the shortcomings there is also a improved availability of data on SWB and especially the use of panel data may overcome some of those shortcomings.

3 Empirical Approach

3.1 Data

The data we apply is from the Latinobarometro, which covers 18 Latin American countries over the period from 1995 until 2008.[2] The survey contains about 1000-1200 households per wave and country. For creating a panel survey we averaged the data for each country and year.[3] The SWB variable life satisfaction is coded on a scale of 1 to 4. The question is: "In general, would you say you are satisfied with your life? Would you say you are: 1 Very satisfied, 2 Fairly satisfied, 3 Not very satisfied, 4 Not satisfied at all".

Table 1 Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Life Satisfaction (Country Average)	140	2.18	0.38	1.53	3.32
GDP per Capita (Country Average in log)	122	8.73	0.45	7.70	9.44
Age (Country Average)	140	39.34	2.71	34.66	48.45
Married (Percentage)	140	58.53	5.44	47.43	75.12
Unemployed (Percentage)	140	77.31	5.95	64.42	93.00
Temperature (Annual Mean in C°)	140	22.41	4.44	8.31	26.20
Temperature (Annual Max in C°)	140	27.93	4.33	12.96	31.36
Temperature (Annual Min in C°)	140	16.89	4.70	3.66	21.89
Precipitation (Annual Total in mm)	140	1698.60	681.30	596.03	2836.79
Cloud Covered Days (Percentage)	140	56.23	10.33	41.67	78.38
Vapor Pressure (Annual Mean in Hecta Pascal's)	140	20.80	5.40	7.15	27.64

Source: Latinobarometro and Tyndall° Centre of Climate Change Research 2009

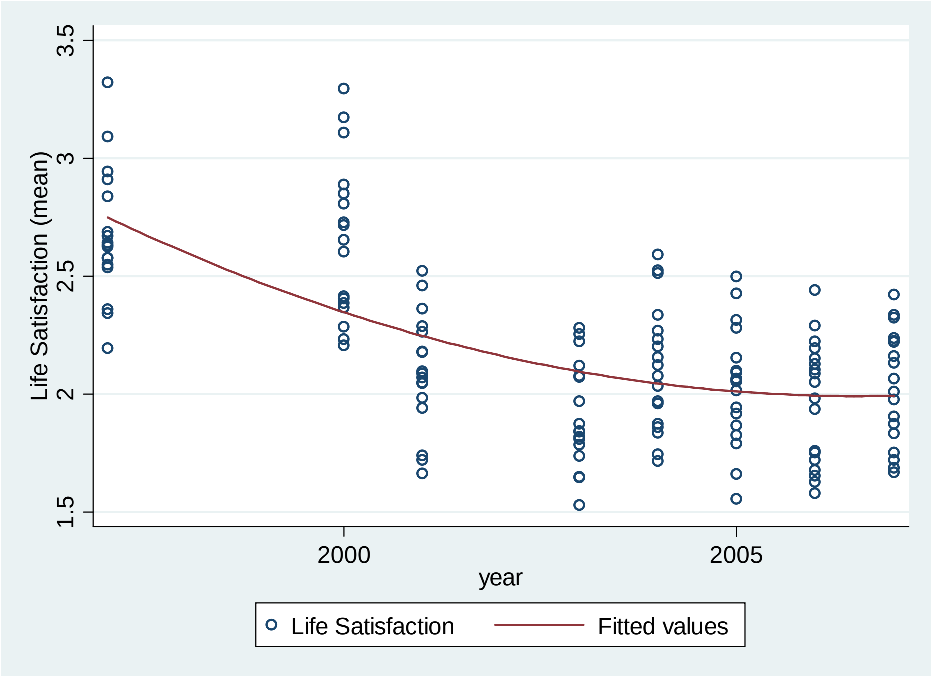
The weather data is from the Tyndall° Centre of Climate Change Research and contains observed weather data for the years 1901 until 2000 and estimated data for the years 2001 until 2100.[4] The data includes: monthly temperature (min and max), precipitation rates, the percentage of cloud covered days and vapor pressure. The macroeconomic variables like GDP per capita are from the World Development Indicators 2008 data CD.

[2] The countries are Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela. As concerning the waves 1999 is missing.

[3] As a matter of comparison we also used the data from the World Values Survey on life satisfaction and happiness.

[4] The observed data depends on the climate change scenario and the model which was applied to estimate the data. We apply the climate change model from the Hadley Centre and the climate change scenario which assumes a moderate GDP growth and a slow application of green technology.

Figure 2 Life Satisfaction over Time in Latin America



Source: Latinobarometro 2009

Figure 2 describes the development of life satisfaction over time in the 18 Latin American countries. There is evidence for a strong rise in average life satisfaction by about 0.75 points on our 1 to 4 points scale from 1997 until 2007.

To describe the effect of climate on life satisfaction we found that higher temperature and precipitation rates have a positive impact on life satisfaction. Only a higher percentage of cloud covered days led to lower levels of life satisfaction.[5] This goes in line with the data of Rehdanz and Maddison (2005) and Frijters and Van Praag (1998), they also find a positive correlation between their measures of SWB and higher temperatures. Nevertheless, in a country which already faces a very hot climate one might expect an inverted u-shape with initially rising SWB with higher temperatures but after passing a certain temperature threshold there might be lower levels of SWB. Therefore, a more in debt analyzes is needed.

3.2 Methodology

To analyze the effect from climate on SWB we follow the approach from Rehdanz and Maddison (2005) and set up the following reduced form regression approach:

[5] See appendix 1, 2 and 3.

$$SWB_{i,t} = \alpha + \beta_1 lnGDP_{i,t} + \beta_2 Age_{i,t} + \beta_3 Age_{i,t}^2 + \beta_4 Married_{i,t} + \beta_5 Employ_{i,t} + \beta_6 TMP\_Max_{i,t} + \beta_7 TMP\_Min_{i,t} + \beta_8 Pre_{i,t} + \beta_9 Cld_{i,t} + \beta_{10} Prog_{i,t} + \mu_{i,t} \quad (1)$$

The SWB variable is life satisfaction, which is to be explained by the dependent variables. We apply GDP per capita to control macroeconomic shocks. Several socio economic variables such as age, being married and having a job control for socio economic impacts. Last but not least several climate variables such as temperature, precipitation rates and the percentage of cloud covered days take the impact of climate on life satisfaction into account. The variable *Prog* is a dummy which takes the value one from the year 2001 on to indicate that the climate data from that year on is based on the predictions of the climate change scenarios.

For comparison we start in table 2 with a ordinary least squares (OLS) regression, which assumes that there is no unobserved heterogeneity across countries and that countries have common slope coefficients β. Since it is very likely that there is unobserved heterogeneity in form of country specific characteristics a_i present, we estimate a random effects (RE) regression. With the Lagrange Multiplier we test for the significance of country specific effects. The outcome of the test yields that there are country specific effects to be considered. The RE model assumes that the country specific effects are not correlated with the independent variables $x_{i,t}$ such as GDP or *Age*. In other words we assume $E(x_{i,t}a_i)=0$. Nevertheless, if the country specific effects are correlated with the independent variables, than the RE coefficients result to be inconsistent and only fixed effects (FE) estimates are consistent. We apply Hausman test, which compares the estimates of the RE and FE regression. The result yields that the RE coefficients are consistent. The RE estimator uses all the variation between the countries and over time. Therewith, it uses more information than the FE estimator, which uses only the variation over time.

There are two further concerns related to the RE estimation results. First, the results could be biased from heteroskedasticity in the error term $\mu_{i,t}$. Therewith, change in the variance of the error terms may lead to inconsistent estimates. And second, there could be serial correlation in terms of a correlation between the error term of one period $\mu_{i,t}$. and the error term of a prior one $\mu_{i,t-1}$. We test for both issues and find that there is autocorrelation when applying the Wooldridge test for autocorrelation in panel data. By applying a feasible generalized squares (FGLS) estimator we can cope with autocorrelation in the error terms. In table 2 the results are listed and the preferred model is the one in column 4.

3.3 Results

Table 2 Results from the Cross Country Panel

	OLS	RE	FE	FGLS	FGLS	FGLS
GDP (pc in log)	-0.295	-0.259	0.068	-0.296	-0.279	-0.02
	(5.12)***	(3.06)***	(0.28)	(7.03)***	(6.65)***	(0.48)
Age	-0.128	-0.193	-0.237	-0.207	-0.187	-0.386
	(1.02)	(1.31)	(1.42)	(2.28)**	(2.00)**	(3.94)***
Age²	0.002	0.002	0.003	0.002	0.002	0.005
	(1.01)	(1.21)	(1.27)	(2.25)**	(1.90)*	(3.93)***
Married	0.01	0.002	0.001	0.009	0.011	0.021
	(1.85)*	(0.56)	(0.25)	(2.84)***	(4.21)***	(5.58)***
Employ	0.008	0.005	0.004	0.009	0.007	0.016
	(2.12)**	(1.32)	(0.93)	(4.07)***	(3.16)***	(6.57)***
Tmp	0	0	0.014			
	(.)	(.)	(0.62)			
Tmp_Max	0.007	0.004	-0.131	0.007		
	(0.42)	(0.17)	(1.96)*	(0.71)		
Tmp_Min	-0.037	-0.038	-0.027	-0.039		
	(1.92)*	(1.51)	(0.28)	(3.46)***		
Pre	0	0	0	0	0	
	(1.69)*	(0.94)	(0.70)	(2.22)**	(3.57)***	
Cld	0.013	0.012	-0.055	0.014	0.014	
	(6.31)***	(3.46)**	(2.05)**	(8.57)***	(8.27)***	
Prog	-0.546	-0.603	-0.555	-0.536	-0.515	-0.349
	(10.51)***	(13.33)***	(8.06)***	(18.49)***	(21.50)***	(6.95)***
Tmp²					-0.001	
					(1.94)	
SD_Tmp_Max						-0.178
						(3.87)***
SD_tmp_Min						-0.056
						(0.74)
SD_Pre						0
						(1.62)
SD_Cld						-0.084
						(4.24)***
Constant	6.465	8.5	14.244	7.968	7.498	8.009
	(2.59)**	(2.82)***	(3.03)***	(4.28)***	(3.87)***	(4.04)***
Obs.	122	122	122	122	122	122
R-squared	0.81	0.84				
Number	18	18	18	18	18	

Source: Authors Estimations. Note: t-statistics are in brackets *, ** and ***denote significance at 10%, 5% and 1% level, respectively.

Considering that the SWB variable life satisfaction is coded on a scale of 1 to 4 coded: 1 Very satisfied, 2 Fairly satisfied, 3 Not very satisfied, 4 Not satisfied at all". In table 2 column 4 we find that rising income leads to increased life satisfaction. The size of the impact is similar to the one *Age* has. Therefore, if income rises on average 1 percent, life satisfaction increases about 0.3 points on our 1 to 4 scale. With higher *Age* life satisfaction tends to rise but with the years it declines again, as the coefficient of *Age²* is indicates (it is positive). Marriage and variable *Employ* seems to have a small negative effect on life satisfaction, which is in contrast to the literature.

The impact of the climate variables is stronger than the one of *Married* and *Employ*. We find that a rise in the temperature of the coldest months would contribute to higher life satisfaction. Rainfall has a significant but diminishingly small coefficient and the percentage of cloud covered days has a negative impact on life satisfaction as one might expect it.

For reasons of multicoliniarity among the climate variables we specified another model in table 2 column 5. And for analyzing the effect of variation in the climate we introduced in table 2 column 6 the standard deviation from the mean of the climate variables. Even though that the results are rather preliminary, the standard deviation of temperature, precipitation and cloudy days plays a role since strong deviations from average temperature such as a strong heat wave affect well being the most. A slight change in temperature over many years is hardly mentioned by humanity and it is possible to adjust. An extreme hot summer with temperatures highly above the usual mean on the other hand can lead to health problems of the elderly.

4 Conclusion

In the first part we pointed out that there is a need to apply not only monetary measures to estimate the gains and losses from climate change. Daily climate is a strong determinant of human well-being. Slow and minor changes might be adapted easily but abrupt and bigger changes are difficult to adapt to and affect well-being. We introduced the concept and two measures of SWB as a non-income based welfare measure and pointed to the advantages and shortcomings in terms of reliability of this measure.

Our empirical analysis applies life satisfaction as a measure of SWB. We control for income, age and family as well as employment status and find a significant positive effect from temperature on life satisfaction. Therefore, life satisfaction would increase with higher temperature in cold months; meanwhile the results on hot months were insignificant. Precipitation rates showed a diminishingly small negative and effect on life satisfaction. A rise in the percentage of cloud covered days leads to a strong negative effect on life satisfaction. Generally our results go in line with Rehdanz and Maddison (2005). Further, we analyzed the effect of the variance of climate on life satisfaction but found so far only preliminary results.

References

Brereton, F.; Clinch, J.P. and Ferreira, S. (2008), “Happiness, Geography and the Environment”, *Ecological Economics* 56, 386-396.

David, P.A. and Reder, M.W. (1974), *Nations and Households in Economic Growth – Essays in Honor of Moses Abramovitz,* Acadamic Press, New York.

Di Tella, R. and MacCulloch, R. (2008), “Gross National Happiness as an Answer to the Easterlin Paradox”, *Journal of Development Economics* 86, 22-42.

Di Tella, R. and MacCulloch, R. (2006), “Some Uses of Happiness Data”, *Journal of Economic Perspectives* 20, 25-46.

Di Tella, R.; MacCulloch, R. and Oswald, A.J. (2003), “The Macroeconomics of Happieness”, *The Review of Economics and Statistics* 85, 809-827.

Dolan, P., T. Peasgood and M. White (2008): Do We really Know What Makes Us Happy? A Review of the Economic Literature on the Factors Associated with Subjective Well-Being”, *Journal of Economic Psychology* 29, 94-122.

Easterlin (1974), “Does Economic Growth Improve the Human a Lot? – Some Empirical Evidence”, in David, P.A. and Reder, M.W. (eds): Nations and Households in Economic Growth – Essays in Honor of Moses Abramovitz, Acadamic Press New York.

Ferrer-i-Carbonell, A. and Gowdy, J.M. (2007), “Environmental Degradation and Happiness”, *Ecological Economics* 60, 509-516.

Ferrer-i-Carbonell, A. and Frijters, P. (2004), “How Important is the Methodology for the Estimates of the Determinants of Happiness”, *The Economic Journal* 114, 641-659.

Frey, B.S. and Stutzer, A. (2002), “What can Economists Learn from Happiness Research?”, *Journal of Economic Literature* 40, 402-435.

Frey, B.S. and Stutzer, A. (2000), “Happiness, Economy and Institutions”, *The Economic Journal* 110, 918-938.

Frijters, P. and van Praag, B.M.S. (1998), “The Effects of Climate on Well-Being and Welfare in Russia”, *Climate Change* 39, 61-8.1

Kapteyn, A., P. Kooreman and R. Willemse (1987), “Some Methodological Issues in the Implementation of Subjective Poverty Definitions”, *Journal of Human Resources* 23, 222-242.

Krueger, A.B. and Schkade, D.A (2008), “The Reliability of Subjective Well-Being measures”, *Journal of Public Economics* 92, 1833-1845.

Mendelsohn, R., A. Dinar and L. Williams (2006), “The Distributional Impact of Climate Change on Rich and Poor countries”, *Environment and Development Economics* 11, 1-20.

Mendelsohn, R. and L. Williams (2004), “Comparing Forecasts of the Global Impacts of Climate Change”, *Mitigation and Adaptation Strategies for Global Change* 9, 315-333.

Pearce, D., W. Cline, A. Achanta, S. Fankhauser, R. Pachauri, R. Tol and P. Vellinga (1996), “The Social Cost of Climate Change: Greenhouse Damage and the Benefits of Control”, in: *Climate Change 1995: Economic and Social Dimensions of Climate Change*, Intergovernmental Panel on Climate Change. Cambridge, UK: Cambridge University Press.

Rehdanz, K. and Maddison, D. (2008), “Local Environmental Quality and Life-Satisfaction in Germany”, *Ecological Economics* 64, 787-797.

Rehdanz, K. and Maddison, D. (2005), “Climate and Happiness”, *Ecological Economics* 52, 111-125.

Rojas, M. (2008), “Relative Income and Well-Being in Latin America”, Universidad Popular Autónoma del Estado de Puebla Mexico.

Smyth, R.; Mishra, V. and Qian, X. et al. (2008), “The Environment and Well-Being in Urban China”, *Ecological Economics* 68, 547-555.

Stern, N. (2006), *The Stern Review Report: The Economics of Climate Change*, London: HM Treasury.

Stevenson, B. and Wolfers, J. (2008) “Economic Growth and Subjective Well-Being – Reassessing the Easterlin Paradox”, *Brookings Papers on Economic Activity* 1.

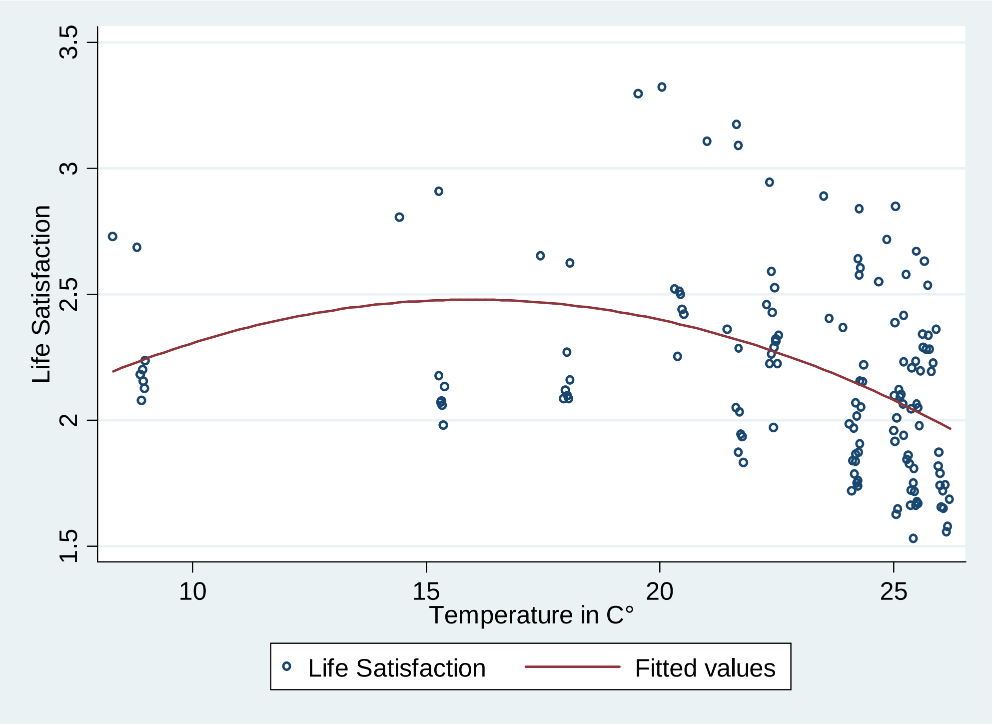
Tol, R. (2002), “Estimates of Damage Costs of Climate Change”, *Environmental and Resource Economics* 21, 47-73.

Welsch, H. (2002), “Preferences over Prosperity and Pollution – Environmental Evaluation Based on Happiness Surveys”, *KYKLOS* 55, 473-494.

Veenhoven, R. (2001): World Database of Happiness, http://worlddatabaseofhappiness.eur.nl/.

Appendix

Appendix 1 Life Satisfaction and Average Temperature



Source: Latinobarometro and Tyndall° Centre of Climate Change Research 2009

Appendix 2 Life Satisfaction and Percentage of Cloud Covered Days

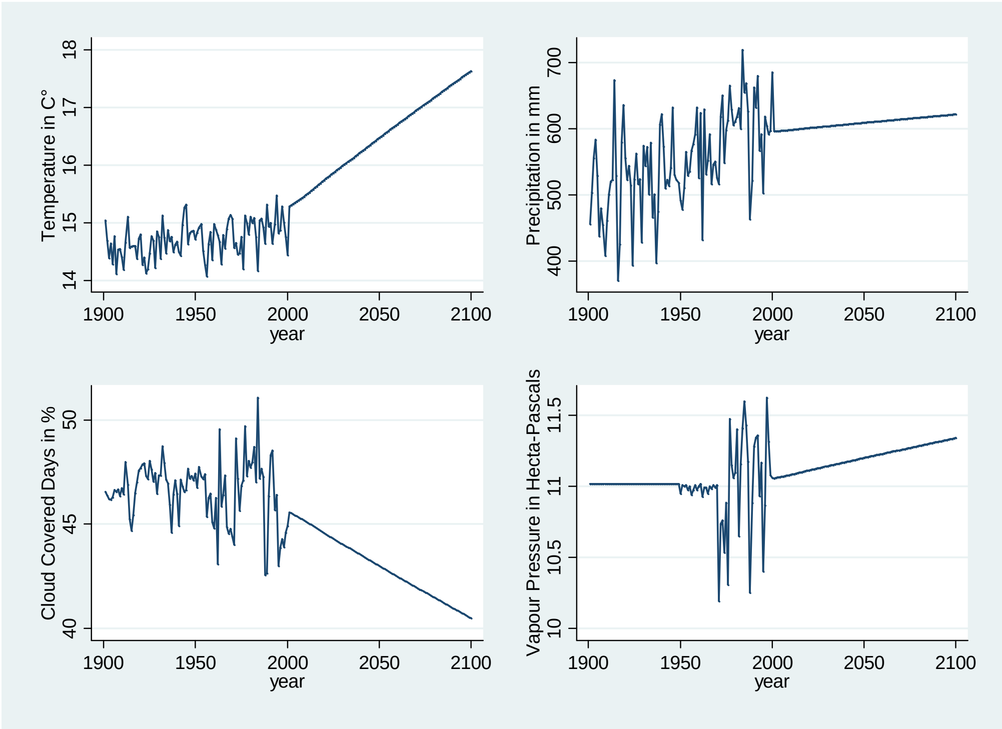
Source: Latinobarometro and Tyndall° Centre of Climate Change Research 2009

Appendix 3 Cross Correlations

	mean_l~s	lngdp_pc	mean_age	mean_p~d	~cemploy	tmp_ann	tmp_an~x	tmp_a~in	pre_ann	cld_ann	vap_ann
mean_life_~s	1										
lngdp_pc	-0.1187	1									
mean_age	0.1326	0.4952	1								
mean_pcmar~d	0.4952	-0.081	0.1382	1							
mean_pcemp~y	0.2298	0.1444	0.0921	-0.3222	1						
tmp_ann	-0.2692	-0.4514	-0.5908	-0.1177	-0.0645	1					
tmp_ann_max	-0.2364	-0.42	-0.6096	-0.0878	-0.0282	0.9808	1				
tmp_ann_min	-0.2904	-0.465	-0.5533	-0.1413	-0.0958	0.9836	0.9296	1			
pre_ann	-0.2727	-0.288	-0.377	-0.0063	-0.2772	0.6661	0.5625	0.739	1		
cld_ann	0.1963	0.1145	-0.1963	0.0131	0.1529	0.2352	0.2491	0.2143	0.3016	1	
vap_ann	-0.2475	-0.4486	-0.5383	-0.0861	-0.1362	0.9495	0.8794	0.9818	0.8292	0.2739	1

Source: Latinobarometro and Tyndall° Centre of Climate Change Research 2009

Appendix 4   Variance in the Climate Data



Source: Tyndall° Centre of Climate Change Research 2009