Do lower greenhouse gas emissions imply lower subjective wellbeing?
- A study of Swedish households

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Abstract

In the contemporary discussion on society's transformation towards long-term climate targets, it is often implicitly assumed that behavioral changes, unlike technological changes, would require sacrifices of individual freedoms and hence cause negative effects on human well-being. In this study we question the foundations for this assumption by analyzing the co-variation between individual households' greenhouse gas (GHG) emissions and subjective well-being (SWB). The aim of the study is to establish a comprehensive picture of the general relationship between SWB and total GHG emissions, as well as to analyze relationships between SWB and emissions from sub-domains including housing, transportation, food, and remaining consumption

Both direct and indirect greenhouse gas emissions are measured in detail. Data on households' energy requirements and private transportation is collected directly from power companies and the Swedish road registry. Indirect emissions from food, aviation and remaining consumption are estimated using a survey questionnaire sent out to 2500 Swedish households with a net response rate of 40 percent. Subjective well-being is measured using single item questions on affective and cognitive well-being. By adding explanatory variables such as socio-economic conditions (total expenditures, income, household size, education, age), value orientation and urban form parameters (e.g. commuting distances) in a multivariate regression analysis, the relationships between individuals' greenhouse gas emissions and their well-being are further analyzed.

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1. Introduction

A successful fulfillment of the two-degree climate target[1] is likely to require significant changes in the lifestyles and consumption patterns of individuals in affluent countries. In the contemporary discussion on society's transformation towards long-term climate targets, it is often implicitly assumed that behavioral changes, unlike technological development, would require sacrifices of individual freedoms and hence cause negative effects on human well-being. The notion that behavioral changes towards GHG emission reductions are seen as trade-offs to "the good life" may in it-self constitute a significant barrier for such efforts to come about. In this study we aim to investigate the relationship between individuals' GHG emissions[*] and their subjective well-being (SWB) in order to shed further light on this issue.

By employing a survey questionnaire combined with register-based data sources we are able to provide estimates on individuals total GHG emissions, together with information on participants SWB and other relevant explanatory variables. Section 1.1 briefly describes the research field and our hypotheses. Section 2 presents the methodology including a description of how the GHG emissions and SWB was measured, and how other variables used in the analysis was collected through the questionnaire. The results are presented in section 3, and in section 4 we discuss our findings.

1.1 Previous research and hypotheses

The small body of research that has analyzed the relationship between quality of life indicators and GHG emissions has for the most part focused on cross-country comparisons (Zidansek, 2007; Abdallah et al 2009). Results suggest a positive but diminishing relationship between GHG emissions of a country's inhabitants and their SWB, which is the most frequently used quality of life indicator. The correlation between these two indicators is likely to be caused mainly by the linkage of each of them to economic activity. The connection between GHG emissions and GDP remains strong, particularly if a consumption-based approach is adopted (Hertwich & Peters, 2009), while the connection between GDP and SWB is strong between low and medium income countries, but diminishes with increasing income (Kahneman *et al* 2006; Inglehart et al, 2008). In this study we measure and analyze the connections between GHG emissions and SWB on individuals within a country. As far as we know no previous study has explored this connection on the individual level, but it seems reasonable to expect that the above relationship is weaker between individuals within an affluent country like Sweden than in a cross-country comparison.

In addition to studying the direct correlations between SWB and GHG-intensive behaviors, we will also attempt to explore ideas saying that the relationship between GHG and SWB could go in the other direction. Previous research that has addressed lifestyles and behaviors which benefit both ecological sustainability and individual well-being has often highlighted ideas related to the concept of downshifting, i.e. a shift away from a harried and material lifestyle to a lifestyle that puts more

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[1] The EU and Sweden have adopted the two-degree target (European Council, 2005), and Meinshausen *et al.* (2006) estimates that in order to have a 75 percent likelihood of reaching this target, global carbon dioxide emissions would need to be halved between the base year of 1990 and 2050, to approach zero emissions at the end of the century. However, between 1990 and 2010 energy-related CO_2 emissions instead continued to grow by 45 % (Olivier et al, 2011). Since reductions in developing countries are likely to take time, it is reasonable to assume that rich countries need to decrease their emissions even more quickly. For the case of Sweden this would imply reductions of 70-85 percentages by 2050 (assuming a contraction and convergence model where per capita emissions are harmonized by 2050, Åkerman et al., 2007 and Rummukainen et al., 2011).

[*] GHG emissions include the three most important greenhouse gases carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) and expressed as carbon dioxide equivalents (CO_2e) based on their respective global warming potential (GWP) over 100 years.

emphasis on for example leisure time and social relations. We use our data to investigate if these theories hold when we analyze them statistically, and will specifically analyze the effect of:

1. Work-life-balance: Jackson (2009) points to the effects of reducing and sharing the work-time in the economy. Paid work provides us with income that is used for consumption which generates GHG emissions, while long working hours is likely to infringe on leisure time with family and friends, factors that has been shown to strongly correlate with increased SWB.

2. Commuting: Individuals who spend a lot of time commuting can for apparent reasons be expected to cause higher GHG emissions through transport. At the same time, this behavior has also been shown to correlate both with health problems (Hansson, 2011) and a low level of subjective well-being (Stutzer & Frey, 2008; Killingsworth & Gilbert, 2010).

3. Material values: Psychologists Brown and Kasser (2005) through their empirical survey conclude that subjects that performed ecologically friendly behaviors were also likely to have higher SWB. The connection between material values and low levels of SWB is also well established in the literature (Richins & Dawson, 1992; Ryan & Dziurawiec 2001, Williams et al. 2000), while the connection between material value dispositions and actual behavior connected to environmental degradation, has received less attention in the academic literature.

2. Method

The following sections describe the postal survey and registry data sources used to estimate the GHG emissions generated by the respondents.

2.1 The Survey

The postal survey was sent out in May 2012, to a random sample of 2500 individuals between 20 and 65 years of age, residing in the region of Västra Götaland in the southwest of Sweden. The net response rate amounted to 40.1 percent, after two mail send-outs, three postcard reminders and a telephone reminder. Although this is a relatively high response rate compared to international levels, the fact that less than half of the sample population chose not to participate in the survey required a non-response rate analysis. We compared characteristics of the sample population to averages for the specified cohort in the Västa Götaland region (obtained by Statistics Sweden) and found some important differences: Women were more likely to answer the survey (55 percent of the respondents), individuals with higher incomes were also overrepresented in the sample; the median income was 6 percent higher than for the total population. We also found an age bias as our respondents were on average four years older than the average citizen. Finally, there is a strong bias towards higher education in the survey sample as 60 percent of the respondents uphold a post-secondary education, compared to 39 percent among the general population. This may be problematic since higher education could imply differences in other relevant factors as well.

2.1.1 The Questionnaire

Respondents were asked to answer a total of 47 questions covering different aspects of their everyday life, including 12 questions posed in order to retrieve information necessary for the estimation of the individuals GHG emissions (as a complement to register-based data) and 15 general questions on background characteristics. The questionnaire also included questions on time-use patters, questions aimed at identifying pro-environmental norms/attitudes/behaviors and so on. A small pilot survey was conducted in 2011 with answers from 87 respondents in order to test translated versions of specific questions, and some corrections were done.

2.2 Measuring Greenhouse gas emissions

The method is summarized in Table 1 below. In all analyses, the GHG emissions are presented per capita (adult). Emissions from residential energy use, private transport and other consumption are attributed to the household as a whole, divided by the number of adults of each household and added to the categories that derive directly from the individuals consumption.

Table 1: Summary of methods used to estimate different categories of GHG emissions*

Category	Data sources and assumptions
Private car transport	The Swedish Road Registry (SRR) stores odometer readings from the two most recent vehicle inspections together with other relevant data such as fuel type, fuel consumption, CO_2 emissions, car brand and model. New cars are not inspected during the first three years. For these vehicles we relied on the respondents' self-stated annual distance from the questionnaire, together with vehicle specific data from SRR. The fuel consumption stated in the SRR is based on the NEDC test-cycle scores where all electric equipment is turned off and where driving conditions are optimal, while CO_2-emissions from real traffic indicate 15-40% increased fuel consumption (Patterson et al., 2011). In our estimates we used a conservative addition by 20%.
Local public transport	Respondents were asked about their weekly commuting choices and distance to work. Estimates of CO_2 emission intensities from public transport provided by the local public transport provider (Västtrafik), amounted to 0.031 kgCO_2/pkm (0.04 kgCO_2/pkm from bus travels and 0.02 kgCO_2/pkm for trams and commuter trains).
Aviation	Respondents were asked about the number of flights to Nordic and European countries during the last 2 years, and for travels to rest of the world during the last 5 years. Average distances were calculated using destination data from the main international airport in the region (Landvetter). GHG emissions estimates of average aircraft emissions per passenger kilometer were collected from the Finish LIPASTO-calculation system (VTT, 2009). We used a factor of 1.7 to include the GWP effect of contrails and induced cloud formation (Azar & Johansson, 2012).
Electricity	For 22% of the respondents we received data on annual electricity consumption directly from their utility company. This information was then used together with explanatory data from the survey to construct a model (R^2=0.61) that was used to estimate electricity consumption from the remaining households in the survey. We used the EU electricity mix of 0.305 kgCO_2e/kWh in the estimates.
Space and water heating	GHG emissions were calculated as the product of five factors (Floor area, Energy performance, Heating system efficiency, Indoor temperature, Emissions factor). For buildings included in the Energy Declarations register these factors could be collected directly from the registry (about 38% of the sample), while data from the questionnaire was used for the remaining households.
Food	The average GHG emissions from food consumption in Sweden has been estimated to 1500 kg CO_2e/cap/y, of which 800 kg originates from meat consumption alone, and the remaining from other foods (Bryngelsson *et al.* (2013). Measuring the emissions from all food products was not feasible given our survey approach and we instead focused on meat consumption, which account for a large share of emissions and much of the variation between individuals. A multi-item question asking the respondent to assess the composition of their diet was used together with GHG emission estimates (Röös, 2012) to calibrate the 800 kg CO_2e per capita. Emissions from other food types where assumed to be 700 kg CO_2e per capita for all individuals in the sample.
Other consumption	By using statistics from the Household Budget Surveys together with emissions data from the Swedish Environmental Accounts, we were able to construct a model (R^2= 0.88) describing the relationship between expenditures on "other consumption" and the resulting GHG emissions. This model was then used together with estimates on each respondent's remaining consumption space derived from our survey data on income, savings, and other large budget posts.

* For a more detailed account of the GHG estimations used, see Nässén *et al.* (2013).

2.3 Subjective well-being

Subjective well-being as defined by Diener et al. (1999) assumes that an individual's "quality of life" can be understood as an aggregate measure that combines an affective and a cognitive evaluation of their own life. In this paper a person's affective mood balance was measured by asking how he/she "feels in general" on a seven-point Likert scale where 1 means "sad" and 7 means "happy". The question designed to answer the cognitive evaluation asks the respondent "how satisfied are you on the whole with the life you live?" where the outer alternatives are "not at all satisfied" and "very satisfied" respectively. This two-item approach is well established in previous research, and has been used in the World Values Survey since 1981 (Inglehart et al, 2008).

2.4 Explanatory variables

As mentioned in the introduction we are interested in describing the relationship between GHG and SWB on an individual level, but we are also interested in assessing research pointing towards the critical theories potential double dividend of change towards a downshifting

2.4.1 Material values

In order to measure the occurrence of *material value dispositions* among the respondents in our sample we used a translated version of the established ”Material Values Scale” (MVS) developed by Richins & Dawson (1992). Because of the space restrictions we used a short-form developed by Richins (2004) that constitutes of 9 statements answered on a 5–point Likert scale. We developed a translated version of the short form and verified it through an online pilot survey. Nevertheless, one of the items lowered the internal consistency of the measure substantially and was dropped in the analysis. Answers were scored 1-5, added and standardized on a 0-10 scale.

2.4.2 Time pressure

Following Larsson (2012) *Time pressure* was measured using two questions in the surevy. The first question asks how frequently the respondent felt he/she "experienced discomfort in trying to keep up with everything that needed to be done", while the second question asked how strong these feelings of discomfort were. The reason for the second question is that stress tolerance varies between individuals and life situation. Parents for example tend to endure a hectic everyday life without experiencing strong feelings of discomfort. The scores on respective answer were then added and standardized on a 0-10 scale.

2.4.3 Other Socio-economic variables included in the model

Through the survey we also asked about other socio-economic conditions that have been shown to influence either GHG or SWB, in order to control for hypothesized results found in the regression analysis. We go through variables that could affect GHG emissions and then variables that have been proven to affect SWB.

Variables that could affect GHG: The variable most likely to affect GHG emissions is a *household's income*, as this sets the limits to consumption and available lifestyles. Nässén (2012) shows that an increase in household income is almost entirely transferred to GHG emissions as a 1 percent increase in income increases the GHG emissions with 0.8 percent. Zelezny *et al.* (2000) finds evidence that women are significantly more active in pro-environmental behavior than men, and respondents' *sex* is hence included in the analysis. Increasing *age* seems to be negatively correlated with environmental concern (Whitehead, 1991), which could be translated into different GHG affecting behaviors. Also *higher education* is thought to have positive impact on attitudes towards climate change, which might be translated into differences in GHG emissions (Tjernström and Tietenberg, 2008).

Variables previously shown to affect SWB: Being *employed* has been proven to greatly affect an individual's well-being, whilst having a disease does not have any clear-cut direct effect on SWB (Argyle, 1999). We constructed a dummy where unemployed/on sick leave=0, and employed/studying/labor market program=1. To be able to uphold *social relations* have an imperative importance to an individuals SWB and we therefore asked respondents to answer how many times per week they socialized with friends and family respectively (Argyle 1999). Research also shows that doing *sports or exercising* increase an individual's SWB, indirectly through the social interaction and directly through effects given by the physical activation (Mutrie & Faulkner, 2004) and this question was also included in the questionnaire.

3. Results

This section provides a short paragraph on descriptive statistics, an analysis of the relationship between SWB and GHG, the GHG/SWB matrix where hypothesized differences in certain parameters are described, and a GHG/SWB-regression.

3.1 Descriptive statistics

Before we turn to the multivariate analysis, let us briefly look at descriptive statistics on the variables included in the analysis. In figure 1 below we see the distribution of GHG emissions per adult in our sample. The average GHG emissions per adult amounts to 8,2 tons per year, which is comparatively low compared to estimates from the Swedish EPA on 10 tons per capita (Naturvårdsverket, 2008) and taken that our estimates include GHG emissions otherwise ascribed to children. The mean SWB of 7.38 is in line with other results on the Swedish population (SOM, 2011).

Figure 1: Distribution of GHG emissions and SWB in the sample population respectively

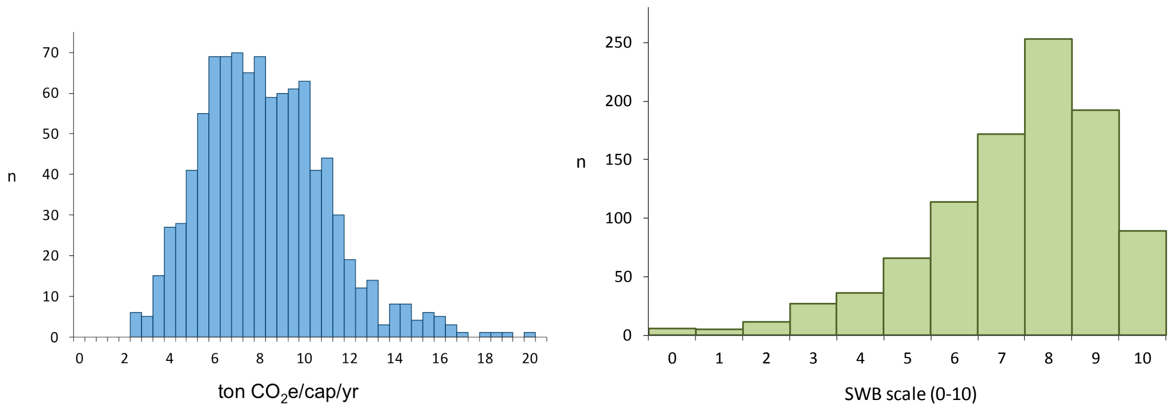


Table 2: Descriptive statistics of the variables used in analysis

	Mean	Std. Dev.	Min	Max	N
Dependent variables					
GHG emissions (per year)	8.22	3.18	1.9	22.8	983
SWB	7.38	1.89	0	10	971
Determinants					
Material values scale (MVS)	2.52	1.84	0	10	958
Time pressure	4.66	2.27	0	10	963
Working hours (per weak)	33.3	17.1	0	95	962
Commuting distance	18.2	25	0	290	822
Background variables					
Education	5	1.78	1	8	975
Sex	0.45	0.5	0	1	979
Age	46	13	20	66	983
Children	0.61	0.49	0	1	980
Variables known to affect SWB					
Working or studying	0.83	0.38	0	1	949
Net income per adult	204	80	946	545	970
Partner	0.77	0.42	0	1	977
Health	5.38	1.31	1	7	975
Time with family (per weak)	3.64	2.11	1	8	954
Time with friends (per weak)	2.67	1.38	1	8	963
Exercising (per weak)	3.58	1.99	1	8	973
GHG intensive activities					
Size of dwelling (m2)	113	54.4	14	380	972
Car use (km/y)	16995	14661	0	82743	975
Flying (flights/y)	1.2	1.28	0	7	983
Red meat (adj. meals/w)	0.18	0.59	0	1	983

3.2 Explaining SWB – does GHG play a role?

In order to analyze the relationship between GHG emissions and SWB, we compare the results in a correlation matrix (see Table 3 below). When compared directly in a bivariate correlation, SWB and total GHG emissions per adult indicate a weak (0.14) but significant positive relationship. This correlation is in turn caused by the GHG emissions from Transportation, Aviation and Other consumption, while GHG emissions from Residential energy or Food consumption does not correlate with SWB. Overall the correlations between SWB and total GHG emissions must be considered to be very weak. The relatively strong relationship between Household CO_2e and Transport CO_2e (0.27) is likely to be due to the increase in GHG emissions by respondents living in separate suburban homes, that increases both household energy use and the need for transport.

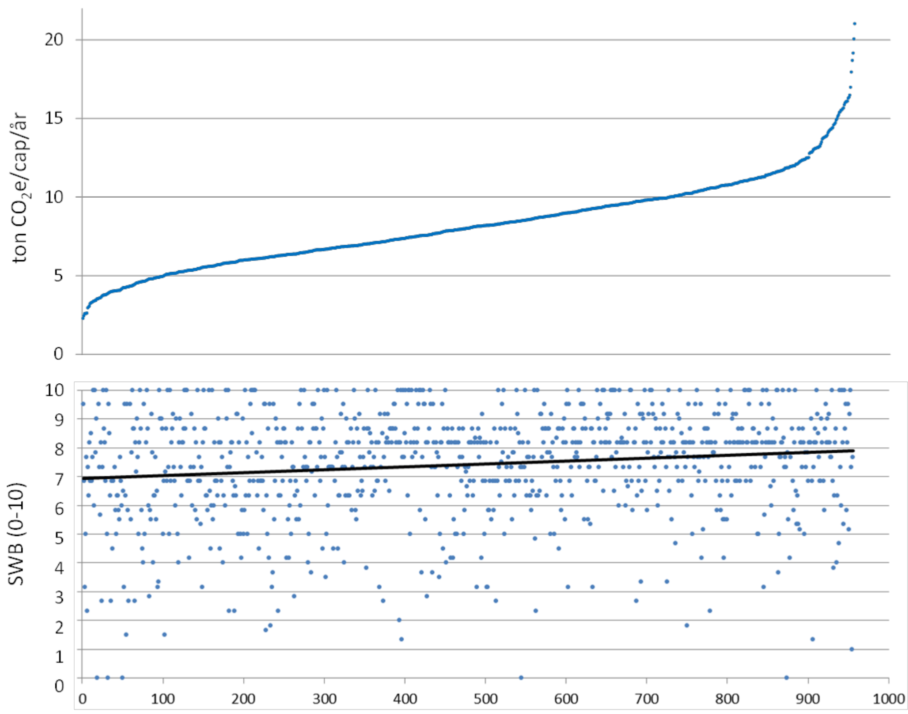
Table 3: Correlation matrix for SWB and different GHG emission sources

	1.	2.	3.	4.	5.	6.	7.	8.
1. SWB Index								
2. Cognitive well-being	.94**							
3. Affective well-being	.94**	.77**						
4. Tot GHG	.14**	.14**	.12**					
5. Residential	-	-	-	.67**				
6. Transport	.11**	.09**	.12**	.66**	27**			
7. Aviation	.13**	.13**	.10**	.45**	-	-		
8. Food	-	.07**	-	.17**	-	.11**	.06*	
9. Other consumption	.14**	.13**	.13**	.42**	.08*	.15**	-	-

Correlation is significant at the *p<0.05; **p<0.01 levels (2-tailed)

Figure 2 provides a visual representation of the relationship the connection between GHG and SWB. The upper box shows respondents sorted according to their GHG emissions, from roughly 2 to 23 tons GHG per adult and year. The lower box presents respondents corresponding SWB value given by their GHG ranking in the upper diagram. Although the average SWB increases from 7 to 8 when respondents are sorted on their GHG emissions, it is fairly evident that there is no strong link between GHG emissions and SWB in the sample population.

Figure 2: Representation of the distribution of GHG emissions and SWB



However, since the potential relationship between GHG and SWB would go through GHG-generating activities and lifestyle factors such as size of dwelling, car use or flying abroad, the effect of these variables on SWB is analyzed. We construct a model (Model 1 in Table 4 below) that includes variables that has previously been shown to be important to determine an individual's SWB, namely: Working/studying (Schwarz & Strack, 1999), Net Household income (Kahneman, 2006), having a Partner (Diener et al., 1999), good Health (Brief, 1993), low Time pressure (Larsson, 2012), Time with Family and friends respectively (Myers, 2004 and Argyle, 1999), sports and exercises (Mutrie and Faulkner, 2004). We also include the background variables: Education, Sex or having Children in order to be able to control for these variables. The presence of children has been shown to either have a negative or no effect on SWB (Diener, 1984). In a second step we add the GHG intensive activities (Model 2) in order to see if they contribute to explaining the variance in SWB.

We use a standard OLS regression analysis. The model has a relatively high explanatory value (adj. R^2 0.393), especially if we take into account the fact that research on the determinants of individuals SWB point towards that genetic predispositions may account for as much as 50% of the variance (Lyubomirsky, 2008). None of the background variables has a significant effect on SWB when controlled for. The variables expected to be important to SWB other hand provided strong and significant effects also in our analysis, except for exercising that had no effect in the regression analysis.

In Model 2, GHG intensive activities are added. All of these variables get a positive sign in the regressions, but none of them is even close to being statistically significant. Also, the explanatory power of Model 2 does not differ particularly from Model 1 (adjusted R^2 increases by 0.002), which further strengthen this conclusion. The only change occurring when we add the new variables is that Net household income becomes non-significant, which is reasonable since they are all related to consumption. These results make it evident that the (material) GHG-intensive activities themselves are clearly subordinate to the non-material aspects in life for explaining variation in SWB.

Table 4: OLS regression models explaining Subjective well-being (Standardized Beta values)

Model		*Model 1*	*Model 2*
		Beta	*Beta*
Control variables	*Education*	-0.008	-0.008
	Sex	-0.041	-0.045
	Age	0.102***	0.10**
	Children	-0.000	-0.011
Variables known to affect SWB	*Working or studying*	0.134***	0.14***
	Net income per adult	0.052	0.032
	Partner	0.158***	0.135***
	Health	0.441***	0.444***
	Time pressure	-0.157***	-0.160***
	Time with family	0.138***	0.139***
	Time with friends	0.150***	0.143***
	Exercising	-0.011	-0.014
GHG intensive activities	*Size of dwelling (m^2)*	-	0.040
	Car use (km/y)	-	0.014
	Flying (flights/y)	-	0.025
	Red meat (meals/w)	-	0.031
N		854	843
R^2 adjusted		0.393	0.395

Correlation is significant at the **p<0.05* ***p*<0.01; ****p*<0.001

3.3 What does matter for the SWB-GHG relationship?

In section 3.2 we learned that the total GHG emissions from households is weakly correlated with SWB, and that if we include GHG intensive activities in a model with do not contribute to explaining the variance in SWB. In this section we instead look at differences between individuals who combine low GHG emissions with high SWB and compare them to individuals with high GHG emissions and low SWB. By comparing these opposite groups it should be possible to identify if there exists any characteristics that separate these groups and that could hence favor a negative relationship between GHG emissions and SWB.

We divide the sample-population into four groups using median splits on SWB and GHG respectively (see figure 2). As mentioned above, differences between sub-sample 1 (high SWB and low GHG) and sub-sample 4 (low SWB and high GHG) is of special interest to our analysis, since previous research has indicated that the difference in Material values could be the biggest between these groups. We are also interested in investigating if the related variables time-pressure, distance to workplace and working hours differ between these two groups. Differences between individuals in sub-sample 2 and 3 could on the other hand indicate variables that tie SWB to GHG emissions, which is also interesting to our analysis.

An ANOVA with a Tukey post-hoc test was conducted in order to compare the sub-samples. Table 5 below displays the mean values for each sub-sample, where the largest significant difference is marked in bold characters (only significance differences larger than $p<0.001$ included).

Reading the table we can see that the hypothesized difference in *material values* between sub-sample 1 and 4 is indeed significant and also makes for the largest difference in the multiple comparisons between groups. The mean value for sub-sample 1 on the Material values scale (MVS) is 2.03, as compared to 2.89 for sub-sample 4. Sub-sample 1 differs significantly (for $p<0.05$) from the group's mean value of 2.52. This indicates that respondents embracing or non-embracing of material values could be a central factor explaining their differences in SWB and/or GHG emissions.

The hypothesized difference in perceived *time-pressure* is also confirmed by the post-hoc analysis, as individuals in sub-sample 4 experiences significantly more time-pressure than group 1. By comparing the background variables included in table 5, this difference could however be due to differences in the amount of average working hours and household composition, as individuals inhabiting sub-sample 4 are more often parents. However the fact that sub-sample 2 (the high GHG high SWB sub-sample) experience less time-pressure than sub-sample 4, although they on average work longer hours and are to an even larger extent parents, indicates that the difference in time-pressure is not entirely determined by these factors. As for the hypothesized differences in *distance to work* and average *working hours* the largest significant differences between the sub-samples are seen between samples 2 and 4. The difference in working hours and household income between sub-sample 3 and 4 makes this comparison a bit complicated.

Figure 3: Schematic figure describing the assumed direction of Material values and Time Pressure

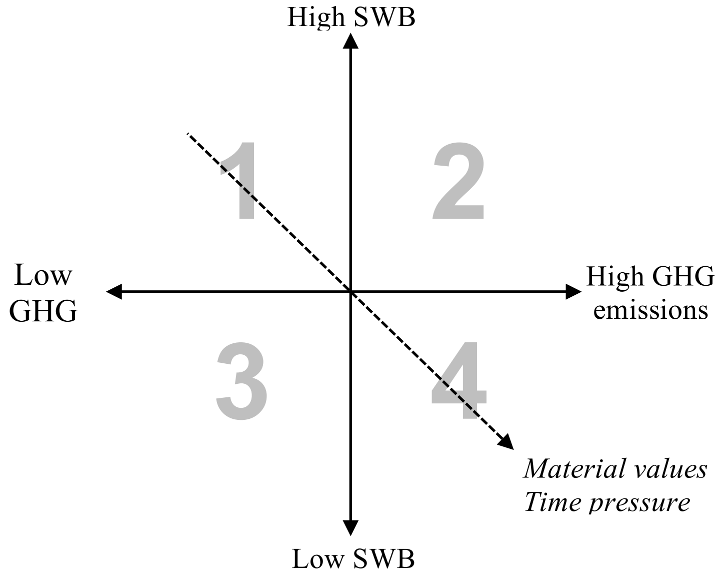


Table 5: ANOVA table on the SWB-GHG matrix

Variables:	1		2		3		4		Average	
	H-SWB/L-GHG		H-SWB/H-GHG		L-SWB/L-GHG		L-SWB/H-GHG		Mean	N.
	Mean	Std.dev.	Mean	Std.dev.	Mean	Std.dev.	Mean	Std.dev.		
Material Values (0-10)	**2.03**	**(1.77)**	2.45	(1.70)	2.66	(1.89)	**2.89**	**(1.87)**	2.52	951
Time pressure (0-10)	**4.05**	**(2.26)**	4.24	(2.21)	4.92	(2.27)	**5.36**	**(2.08)**	4.65	951
Distance to work (km)	14	(17)	**23**	**(30)**	**13**	**(15)**	22	(30)	18	817
Av. working hours (h/week)	32	(18)	**38**	**(14)**	**27**	**(19)**	37	(14)	33	(17)
Net income per adult (t SEK)	177	(64)	**245**	**(77)**	**162**	**(67)**	235	(74)	205	959
Education (1-8)	**4.67**	**(1.84)**	5.30	(1.70)	4.71	(1.83)	**5.33**	**(1.67)**	5.01	964
Children (%)	**0.25**	**(0.44)**	**0.46**	**(0.50)**	0.30	(0.46)	0.42	(0.50)	0.36	971
Female (%)	0.44	(0.50)	0.44	(0.50)	0.44	(0.50)	0.49	(0.50)	0.45	969
Age (20-66)	47	(14)	47	(12)	44	(14)	46	(11)	46	971
Average GHG:	6.0		10.6		5.7		10.7		8.3	

The table depicts results from an ANOVA with a Tukey post-hoc test. Variables marked in bold characters indicate the strongest significant ($p<0.001$) mean difference for that variable (row).

3.4 The SWB/GHG Regression model

The results from the SWB-GHG matrix above are in line with our hypotheses about material values and the interrelated variable time-pressure, while working hours and commuting choices differed more between sub-samples 2 and 3. The absence of large deviations among other relevant variables also indicates that the differences are indeed related to the variables of interest. However, in order to control for effects from other variables we need to confirm above results using regression analysis. In order to do so we construct a new variable where each respondent's SWB is divided by his/her total GHG emissions. This new variable measures the GHG intensity of each individual's SWB, and is somewhat similar to the Happy Planet Index that measures happy life years divided by ecological footprint (NEF, 2012). We use our new SWB/GHG variable as the dependent variable and include the variables used in the above ANOVA analysis in an OLS regression model (Table 6).

The model has an adjusted R^2 (0.257), which is likely caused by the strong effect of income on GHG emissions. The results support the main findings from the SWB-GHG matrix, namely that individuals with higher material values generally fare worse in the SWB/GHG ratio, even when we control for net income per adult, education, children, sex and age.

Distance to work is also significant in the analysis, but as this factor differed the most between low and high GHG households it is reasonable to assume that this result is caused by increases in GHG emissions that has not been countered by increases in SWB. The fact that having children and age also show negative significant results can here be assumed to mean that these variables has a stronger connection to GHG emissions than SWB.

Table 6: Confirmative SWB/GHG regression analysis

	Standardized Beta values
Material values	-0.115***
Time pressure	-0.124***
Distance to work	-0.124***
Av. working hours	-0.011
Net income per adult	-0.403***
Education	-0.011
Children	-0.099**
Sex	0.009
Age	-0.098**
N	775
R^2 adjusted	0.257

Correlation is significant at the *$p<0.05$ **p<0.01; ***p<0.001

4. Conclusions

In this paper we have investigated the relationship between individuals GHG emissions and their subjective well-being. Our results suggest that neither the amount of GHG emissions generated by the individuals' residential energy use, transport, food and other consumption, nor the GHG intensive activities themselves, has any strong link to subjective well-being. Instead, variables related to social activities, relations, stability and health constitute the main factors affecting SWB. These results are in line with previous research.

In a second analysis we turned to investigate how respondents with low GHG emissions and high subjective well-being differed from other respondents. The results show that this group has less material values than all other groups and also experience the lowest level of time pressure. Contrary, individuals with high emissions and low well-being had the highest scores on material values and experienced the highest degree of time pressure. These results provide some empirical support for the idea that a lifestyle with less focus on material aspects and more focus on a balanced use of time could provide a double dividend for lower emissions and higher well-being.

Two limitations to our results should be mentioned, first our results are probably limited to other welfare states and the fact that our sample population differed somewhat from the general population in terms of income and education should also be seen with caution. Secondly, this analysis uses cross-section data, which means that we cannot comment on the effect on SWB if individuals changed their lifestyle towards reduced GHG emissions, as the change itself could affect SWB negatively. But our results do suggest that on a societal level, non-material aspects of life are much more important to our SWB than material ones.

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