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What characterizes persons with high and low GHG emissions? Lifestyles, well-being and values among Swedish households

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CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2014

THESIS FOR THE DEGREE OF LICENTIATE OF PHILOSOPHY

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ABSTRACT

Global greenhouse gas (GHG) emissions need to be reduced to around a third of the current level before 2050 and approach zero at the end of the century if we are likely to reach the two-degree target. Sweden has sometimes been promoted as a model for the transition towards sustainable emission levels, with reductions of 20 percent between 1990 and 2012, but when embedded emissions from imported goods are accounted for (and exports are excluded) the development instead show an increase by at least 15 percent between 1993 and 2010. The efficiency improvements have been more that counterbalanced by increasing consumption levels. Hence a successful fulfillment of the two-degree climate target probably requires action that goes beyond eco-efficiency, by also considering lifestyles and consumption patterns. In this thesis we have combined different theoretical approaches to analyze individuals' conditions, lifestyles, well-being and values with respect to their GHG emissions.

The first paper analyzes which factors are important to determine individuals' GHG emissions. Socio-economic, physical and motivational factors are often considered in separate academic disciplines, and our aim is to provide a better understanding of their absolute and relative importance to households' GHG emissions. We found that net income was the most important variable to explain variance in GHG emissions, followed by the physical variables dwelling type and geographical distances to work and other functions. Motivational factors such as pro-environmental attitudes and norms also affected GHG emissions but to a lesser extent, but some considerations limit the generalizability of these results.

The second paper examines the relationship between individuals' subjective well-being and GHG emissions from consumption. Our results suggest that there is no strong correlation between overall GHG emissions and subjective well-being, and that GHG intensive activities have a low importance for subjective well-being, when compared to social factors such as spending time with friends and family, having a job and being healthy. We also analyze certain behaviors and underlying factors that have been proposed to imply double dividends, and find some tentative confirmation that materialism is related to both lower subjective well-being and higher GHG emissions.

In the third paper we continue the analysis of materialists' consumption related GHG emissions, and their concern for the environment. We find no difference between materialists and others with respect to their concern for the environment, but the materialist group emits about 1 ton more GHG emissions per capita and year than the non-materialist group. Somewhat surprisingly, air travel accounts for around two thirds of this difference. Taken together with other results presented in the paper, it seems materialists' concern for increased status is not specifically expressed through the acquisition of material possessions, and we question the established definition of materialism.

Keywords: Greenhouse gas emissions, sustainable consumption, subjective-wellbeing, materialism

LIST OF PAPERS:

I. **Explaining the variation in greenhouse gas emissions between households: Socio-economic, motivational and physical factors**
Nässén J., Andersson D., Larsson J., Holmberg J.
Submitted to *Journal of Industrial Ecology*

II. **Low-carbon lifestyles and subjective well-being: An analysis of Swedish households**
Andersson D., Nässén J., Larsson J., Holmberg J.
Submitted to *Ecological Economics*

III. **Should environmentalists be concerned about materialism?**
Andersson D., Nässén J.
Working paper to be submitted to *Journal of Environmental Psychology*

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David Andersson

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INTRODUCTION

The European Union has adopted the long-term climate target to limit global warming to two degrees above the pre-industrial level (European Council, 2005). In order to have at least a likely chance of reaching this target, global carbon dioxide emissions would need to be reduced to a third of the current level before 2050, to approach zero emissions at the end of the century (Rogelj et al. 2011, Meinshausen et al. 2009). Since reductions in developing countries are likely to take time, it is reasonable to assume that developed countries will need to decrease their GHG emissions even more quickly.

According to official territorial accounting, Sweden reduced its GHG emissions by 20 percent between 1990 and 2012 (SEPA 2013a) while, in the same period, GDP increased by nearly 60 percent (Statistics Sweden, 2013). Seen from a consumption perspective, however, where emissions embedded in imported goods and services are added and emissions from exports are deducted, GHG emissions have instead increased by at least 15 percent between 1993 and 2010 (SEPA 2013b). Specific consumption trends show that since 1990 GHG emissions from road transport increased by 8 percent (Swedish transport administration, 2013), consumption of red meat increased by 54 percent (Swedish Department of Agriculture, 2013), and the number of passengers on international flights increased by 163 percent (Karyd, 2013). As long as binding GHG emission targets are not in place for developing countries, this "leakage" of production related GHG emissions to developing countries could hardly be seen as sustainable path towards the future.

Above trends indicate that a successful fulfillment of the two-degree climate target requires action that goes beyond eco-efficiency, by also considering lifestyle and consumption patterns. The loosely defined research field of "sustainable consumption" concerns these questions. The research ranges between different academic disciplines (consumer research, environmental psychology, sustainable marketing, environmental economics, environmental planning to name a few) with different objects of analysis. The variety of theoretical perspectives, methodological approaches and identified "key questions" makes this field of research evolving and resourceful, but the lack of consensus and work aimed at synthesizing results is also problematic from a policy perspective.

An important contribution of the papers included in this licentiate thesis is the use of reliable and comprehensive estimates of individuals' GHG emissions. This forms a basis for comparison between different theoretical perspectives to explain households' GHG emissions (paper 1), allows us to examine if and how GHG intensive lifestyles are related to individuals' subjective well-being (paper 2), and provides a means to test different ideas about how materialism may affect consumption and GHG emissions (paper 3).

METHODOLOGICAL APPROACH

The work behind this licentiate thesis started with the design of a postal survey to collect most of the data used in the three different studies. A pilot survey was distributed to around 100 persons to test the distribution of answers on different scales and to receive feedback on the formulation of questions. The main survey was sent out in May 2012, to a random sample of 2500 individuals between 20 and 65 years of age, residing in the Västra Götaland Region in the southwest of Sweden. The net response rate amounted to 40.1%, after two mail send-outs, three postcard reminders and a telephone reminder.

A central aspect of all three papers is the estimation of GHG emissions from the activities and consumption of the individuals and households in our sample. The method this is described below. In addition, the survey also included questions related to explanatory variables for GHG emissions (paper 1), subjective well-being (paper 2) and materialistic values (paper 3). For further descriptions of these variables see the methodology sections of each respective paper.

In order to measure GHG emissions from consumption we needed data on emissions from both direct energy use and from the production and transportation of products and services that the households consume are allocated to the households. Five main categories of GHG emissions were analyzed; residential energy use, car and public transport, aviation, food and other consumption. Emissions intensities for different consumption categories aim to cover upstream activities, that is, from production to the point of purchase. For example, the food category includes emissions from energy use, fertilizers and other intermediate goods in the agriculture as well as industrial food processing and packaging, but not transport of food from store to home which is part of the private transport category, energy for cooking which is part of the residential energy use, or the purchase of kitchen utensils which is part of the "other consumption" category. The impact of waste recovery has not been addressed in this study. Residential energy use consists of household electricity consumption and space and water heating.

Electricity consumption: The preferred source of data was the annual consumption measured by the utility provider, but this data was only collected for 22 percent of the respondents. Instead electricity use was estimated using relevant explanatory data from the survey. An explanatory model was developed from the households with both measured data and questionnaire data ($R^2 = 0.61$). The model included: number of persons in the households to the power of 0.7, floor area per person, dwelling type, type of white goods, self-stated behavior.

Space and water heating: GHG emissions were calculated as the product of the five factors: floor area, energy efficiency of the building, indoor temperature, and emission factor from heating source. This information was collected from the Swedish Energy Declaration registry.

Private and public transport: Information on annual mileage for all vehicles owned by the household was collected from the Swedish Road Registry (SRR). SRR stores odometer indications from the two most recent vehicle inspections together with data on fuel type and fuel efficiency. For new cars, which had not yet undergone vehicle inspection, we had to rely on the self-stated estimates. The self-stated distance was also used for households with access to company cars because these cars are not registered with the household. CO_2 emissions stemming from the use of public transport were estimated using information on travel behaviors from the survey together with estimates of emissions intensities from public transport provided by the local public transport provider 0.03 kgCO_2 per person-km).

Air-travel: GHG emissions from aviation were estimated from questions about the number of non-work related flights conducted to Nordic and European destinations respectively during the last two years and intercontinental flights during the last five years. Average distances were then calculated using data on the number of flights to different destinations from the main international airport in the region. Estimates of average aircraft emissions per passenger kilometer were obtained from the LIPASTO calculation system for air traffic. To account for the additional GWP effect from high altitude emissions we multiplied the direct CO_2 emissions by a factor of 1.7 (Azar and Johansson 2012).

Food: The average GHG emissions generated by Swedish food consumption have been estimated to 1500 kg CO_2e per capita of which 800 kg originates from meat (Bryngelsson et al. 2013). The survey focused on the meat consumption, which accounts for most of the variation between individuals. The respondents were asked how many times during the last week they had eaten dishes with beef, poultry, pork, game, fish or all-vegetarian. Using GHG emission data from a meta-study (Röös 2012), the individuals' GHG-emissions from meat were calculated. Emissions from other food types where assumed to be 700 kg CO_2e per capita for all individuals in the sample.

Other consumption: Measuring specific goods and services are not feasible given by our mail survey setup. These items typically have low GHG intensities (kgCO_2e/SEK), but the aggregated consumption volume is roughly a quarter of the GHG emissions from an average Swedish household (SEPA 2013b). Moreover it is important to try to encompass all types of consumption, as low emissions following small expenditures in one consumption domain may rebound through larger expenditures and higher emissions in other domains (Alfredsson 2004).

A relationship between expenditures and GHG emissions from "other consumption" was established using data from the Swedish household budget survey of around 2000 households (Statistics Sweden 2008a), combined with GHG intensities for 99 categories of products and services (Statistics Sweden 2008b). This resulted in an elasticity of GHG emissions with respect to expenditures on other consumption of 1.07. The total expenditure level is found to be a very strong predictor of GHG emissions from other consumption (R^2=0.88), which is due to the relatively small differences in kgCO_2e/SEK between different types of products. Hence, a household's emissions from other consumption are primarily explained by the total expenditures and not by the composition of consumption.

Our method for calculating emissions from other consumption may exaggerate the link between expenditures and emissions, since high-income households do not only buy more in terms of quantity but also higher quality products. Based on Girod and de Haan (2010), who address this issue, we tested to reduce the expenditure elasticity for GHG emissions from other consumption from 1.07 to 0.72. The effects of this change on the results in paper 1 are a slight reduction of the overall fit of the explanatory model (adjusted R^2 from 0.49 to 0.46) and a reduction of the standardized regression coefficient for Net income from 0.56 to 0.53.

PAPERS:

PAPER I: EXPLAINING THE VARIATION IN GREENHOUSE GAS EMISSIONS BETWEEN HOUSEHOLDS: SOCIO-ECONOMIC, MOTIVATIONAL AND PHYSICAL FACTORS

In the light of the need for radical cuts in emissions it is of interest to study the reasons behind the considerable variance in current emission levels that exists both between countries and between individual households (e.g. Davis and Caldeira 2010; Kerkhof et al. 2009). In paper I we therefore explore the relative importance of different factors on households GHG emissions. Previous research on consumption patterns has shown a strong relationship between *income/expenditures* and energy and/or GHG emissions (Lenzen et al. 2006; Roca and Serrano. 2007; Shammin et al. 2010). This approach captures the environmental effects of consumption in a comprehensive way, while it is often based on data that only contain a relatively narrow set of socio-economic variables. Research on *urban planning* has naturally focused on infrastructural and spatial variables to explain energy use, and this research has found results suggesting that urban form variables had an even larger impact on energy use for transport than socio-economic variables such as income (Næss 1996). Although this structural approach provides information on the risks on lock-in effects and sustainable planning, it cannot tell us anything about the variability of the individual level.

Social and environmental psychology on the other hand, has developed models that form interesting foundations for understanding and explaining human behavior (Aijzen 1991 Schwartz 1992, 2006). This approach examines differences on the individual level, but often fail to measure environmental impact and instead relies on self-stated information about specific pro-environmental behaviors such as recycling, buying environmentally friendly products and other activities, as indicators for environmentally sustainable behaviors (Richins 1994; Brown and Kasser 2005). This implies a range of different error sources if one is primarily interested in drawing policy relevant conclusions about actual environmental effects (this weakness was recently pointed out by Tabi 2013). Hence by measuring GHG emissions on the individual level we hope to be able to better understand the importance these different approaches.

Our results point toward the importance of explanatory variables that have to do with socio-economic or physical circumstances rather than motivations for pro-environmental behaviors. Net income was found to be the most important variable to explain greenhouse gas emissions, followed by the physical variables dwelling type and the geographical Distance Index. The fact that our survey is conducted in a confined geographical area with a certain level of population density, public transport and so on, to some extent limits the generalizability of our results regarding the importance of physical structures to GHG emissions. Also, the comparatively small effect of attitudes on GHG emissions means could be questioned as many individuals may simply not be aware of how different investments or behavioral changes could reduce their GHG emissions. Feedback studies has typically shown medium to large behavioral effects.

Paper II: Low-carbon lifestyles and subjective well-being: An analysis of Swedish households

In paper II we analyzed the relationship between individuals' subjective well-being and GHG emissions from consumption. Previous research that has analyzed the relationship between quality of life indicators and GHG emissions has mainly approached this issue by means of country comparisons (Zidansek 2007; Abdallah et al. 2009; Mazur 2011). Results from these studies suggest a positive but diminishing relationship between the GHG emissions of a country's inhabitants and their subjective well-being (SWB), and this has also been shown on the individual level (Lenzen and Cummins 2013, although with a less reliable data set). We were also interested in examining the relationship between SWB and certain GHG intensive activities such as air-travel, leisure-driving, share of red meat in diet and dwelling size, which could be hypothesized to obstruct environmental regulation in these areas. A third aim of the study was to examine the hypothesis that an embrace of lifestyles and values related to the concept of downshifting would imply a double dividend, these individuals ought to both have higher SWB and lower GHG emissions than others. In order to measure this we looked at materialistic values, commuting and work-life balance (work-hours and temporal well-being).

Our results suggest a weak positive relationship between GHG emissions and SWB in the initial bivariate analysis, but when factors previously shown to affect SWB are included in the analysis this weak connection disappears. Secondly, we analyzed if certain GHG intensive activities and living conditions could explain variations in SWB. Our main result suggests that the relationship between these activities and SWB are generally weak, with the exception of air-travel that could be hypothesized to function as a vehicle for social activities and hence cause increased subjective well-being. A third aim of the study was to investigate potential double-dividends by analyzing individuals with low GHG emissions and high SWB to see how they differed from other respondents. We analyzed if these respondents would differ in work-life-balance, commuting and materialistic values, and our analysis provided tentative support for the idea that materialist dispositions affect SWB negatively while GHG emissions seems to increase.

PAPER III: SHOULD ENVIRONMENTALISTS BE CONCERNED ABOUT MATERIALISM?

The aim of paper III was to examine the importance of materialistic values to the climate issue. Some research suggests that societies around the world have grown increasingly materialistic over the course of the last decades, and other research suggests that materialists care less for the environment (Twenge et al. 2012; Schaefer et al. 2004; Ger and Belk 1996; Podoshen 2010; Kilbourne and Picket 2008; Kasser & Brown, 2005; Schwartz, 1996). This implies that materialism could stand in the way of a transition towards a more sustainable future. However, as discussed above, most of the research measuring pro-environmental behaviors is founded on relatively "soft" indicators, and in this paper we attempt to address this gap by examining if and how materialists differ from others in terms of GHG emissions. Since individuals environmental concern may also be important determinants of environmental policymaking in a country, this issue was also addressed.

We compared more and less materialistic individuals' concern for the environment and their GHG emissions. Contrasting previous research we found no differences in environmental concern between the materialist group and the least materialistic group. GHG emissions on the other hand differed substantially (1 ton) between groups, and differences in air-travel made up two thirds of this difference.

The fact that we found no strong differences in attitudes while we did find differences in certain behaviours is counter to what one might expect, and we believe this finding has implications for the assumptions about materialists hypothesized negative attitude towards the environment and the assumption that materialists principally manifest their status pursuits through acquisition of material possessions.

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Paper I

Explaining the variation in greenhouse gas emissions between households: Socio-economic, motivational and physical factors

Jonas Nässén, David Andersson, Jörgen Larsson, and John Holmberg

Submitted for publication in *Journal of Industrial Ecology*

Summary

Consumption-accounted greenhouse gas emissions vary considerably between households. Research originating from different traditions; consumption research, urban planning and environmental psychology, have explored different types of explanatory variables and provided different insights into this matter. This study explores the explanatory value of variables from different fields of research in the same empirical material, including socio-economic variables (income, household size, sex, and age), motivational variables (pro-environmental attitudes and social norms) and physical variables (the type of dwelling and the distances to work and public/commercial services). A survey was distributed to 2500 Swedish households with a response rate of 40%. Greenhouse gas emissions were estimated for transport, residential energy, food and other consumption, using data from both the survey questionnaire and registers such as odometer readings of cars and electricity consumption from utility providers. The results point toward the importance of explanatory variables that have to do with circumstances rather than motivations for pro-environmental behaviors. Net income was found to be the most important variable to explain greenhouse gas emissions, followed by the physical variables dwelling type and the geographical distance index.

Keywords: Greenhouse gas emissions; Consumer behavior; Energy; Transport; Food.

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Introduction

Emissions scenarios with at least a likely chance of meeting the the long-term EU target of 2 degrees global warming, typically require reductions of global greenhouse gas (GHG) emissions from over 6 tons of carbon dioxide equivalents per capita per year to around 2 tons by 2050 (Rogelj et al. 2011). In the light of this need for radical cuts in emissions it is of interest to study the reasons behind the considerable variance in current emission levels that exists both between countries and between individual households (e.g. Davis and Caldeira 2010; Kerkhof et al. 2009). The aim of this study is to quantify and explain the variance in GHG emissions in a sample of Swedish households. Previous research related to this issue has developed from different theoretical starting points that provide different contributions. The main contribution of this study is the integration of explanatory variables from different fields in the same empirical analysis.

Studies of consumption patterns using nation-wide household budget surveys have shown that the most important explanatory variable is the households' total income or expenditures. Expenditure elasticities of total energy use and emissions have been estimated to as high as 0.57 in the US, 0.64 in Japan, 0.78 in Australia, 0.86 in Denmark and India, 0.91 in Spain and 1.00 in Brazil (Lenzen et al. 2006; Roca and Serrano. 2007; Shammin et al. 2010). This means that an increase in total consumption by 1% can be expected to cause an increase in emission by 0.5-1%. An important strength of these types of studies is their completeness with respect to the description of all types of consumption, as low emissions following small expenditures in one consumption domain may rebound through larger expenditures and higher emissions in other domains (Alfredsson 2004; Nässén and Holmberg 2009). A limitation of these surveys is, however, that they usually contain a relatively narrow set of socio-economic variables.

Research focusing on urban planning has for apparent reasons emphasized the role of infrastructural and spatial variables such as the density of cities and the distance to public and commercial services (shopping centers, public travel, schools etc.) that may lock people into automobile dependency (Newman and Kenworthy 1999; Næss 1996, 2006). In a comparison of Swedish towns, Næss (1996) found that urban form variables had an even larger impact on energy use for transport than socio-economic variables such as income.

In terms of theoretical development, environmental psychology is probably the research field related to this topic that has reached the furthest. The theory of planned behavior (TPB, Ajzen 1991), which predicts behaviors from attitudes, norms, and perceived behavioral control, has been very influential in this research field. TPB and other psychological theories usually focus on specific pro-environmental behaviors such as recycling habits, energy conservation or the purchase of eco-labeled products. It is difficult to transfer these theoretical frameworks directly to the context of this paper that is the total GHG emissions from households, which in turn probably depends on hundreds of different behaviors. There may also be a considerable disconnect between the intentions to reduce environmental impact and the actual effect. Some intentionally pro-environmental behaviors may have real but small effects in relation to the total volume of consumption, whereas other behaviors merely serve as environmental symbols. Behaviors may also be associated with low emissions without being environmentally motivated. Individuals may for example bike to work because it is convenient, healthy or economical. See Peattie (2010) for a thorough review of these matters. Altogether, this means that measuring the impact of motivational factors on GHG emissions will need to rely on more broadly defined pro-environmental attitudes. We also address the role of social norms connected to some particularly GHG intensive activities.

In this study, we use a data set of around 1000 Swedish households to explore the following types of explanatory variables:

- Socio-economic variables: income, household size, sex, age.
- Motivational variables: pro-environmental attitudes and social norms.
- Physical variables: distances to work and public/commercial services, type of dwelling.

Methodology

The analyses of this article are based on data from a survey that is described in the following section. The second section describes how the households' GHG emissions were estimated from behaviors and technology choices in central domains including residential energy use, car and public transport, aviation, food and other consumption. The third section describes the construction of the models and the explanatory variables used in the multivariate regression analyses.

The survey

A 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 Västra Götaland in the southwest of Sweden. The net response rate amounted to 40.1%, after two mail send-outs, three postcard reminders and a telephone reminder. We compared characteristics of the final sample to averages in the region and found some important differences. Women were more likely to answer the survey (55% of the respondents), the median income was 6% higher than for the total population and the average age was four years higher than in the region as a whole (for the specified cohort). Finally, there is a fairly strong bias towards higher education in the survey sample as 60% of the respondents had post-secondary education, compared to 39% among the general population in the region.

To check for a potential self-selection bias of environmentally interested persons we compared the answers to the question "How interested are you in environmental issues in general?" to the results from a survey with a much broader focus on society, opinions and mass media (SOM 2012). The corresponding SOM question is identically formulated, but the answer options from "not at all interested" to "very interested" has a scale from 1-4 compared to 1-7 in our survey. The share of respondents being rather to very interested was 75% in the SOM survey (3-4 on the 1-4 scale) compared to 70% in our survey (5-7 and half of those responding 4 on the 1-7 scale). The share of respondents answering "very interested" was 16% in the SOM survey compared to 10% in our survey. This shows that the environmental focus of the survey does not appear to cause any self-selection bias.

Greenhouse gas emissions

This paper departs from a consumption perspective on GHG emissions. Emissions from both direct energy use and from the production and transportation of products and services that the households consume are allocated to the households. Five main categories of GHG emissions were analyzed; residential energy use, car and public transport, aviation, food and other consumption. Emissions intensities for different consumption categories aim to cover upstream activities, that is from production to the point of purchase. For example, the food category includes emissions from energy use, fertilizers and other intermediate goods in the agriculture as well as industrial food processing and packaging, but not transport of food from store to home which is part of the private transport category, energy for cooking which is part of the residential energy use, or the purchase of kitchen utensils which is part of the "other consumption" category. The impact of waste recovery has not been addressed in this study.

Emissions of the three most important gases carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) are included and expressed as carbon dioxide equivalents (CO_2e) based on their respective global warming potential (GWP) over 100 years. In all analyses, the GHG emissions are presented per capita (adult).

Emissions from residential energy use

For electricity consumption, the preferred source of data was the annual consumption measured by the utility provider. 30% of the respondents authorized that we collected this data, but some could not be collected for other reasons providing electricity data from 215 respondents (22%). For the households where real data could not be gathered, electricity use was estimated using relevant explanatory data from the survey. To improve the fit of these estimates an explanatory model was developed from the households with both measured data and questionnaire data. The best fit to the measured data was found for a model with the following predictors (R^2=0.61):

1. Number of persons in the household to the power of 0.7 (consumption increases less than proportional with the number of persons, due to e.g. collective use of appliances).
2. Floor area per person.
3. Dwelling type: multi-family or single-family house.
4. Type of white goods.
5. Self-stated behavior (use of energy efficient lighting/leave appliances on standby or not).

For space and water heating (also including electric heating), GHG emissions were calculated as the product of the five factors below. The preferred source was the Energy Declarations register which provides data on energy use and heating technologies, but only 375 dwellings with full data availability could be identified from the register (38%). Data from the survey was used for the remaining households.

1. Floor area (m^2).
2. Energy efficiency of the building shell ($kWh_{useful}/m^2/yr$): taken from the Energy Declaration where available or estimated from the year of construction (Swedish Energy Agency 2012).

3. Energy efficiency of the heating system ($kWh_{delivered}/kWh_{useful}$): estimated from heating technology specified in the Energy Declaration or stated in the survey.
4. Indoor temperature: Each centigrade was assumed to affect the demand for space heating by 5%.
5. Emission factor ($kgCO_2e/kWh_{delivered}$): Emission factors for electricity calculated as the average EU mix (0.305 $kgCO_2e/kWh$) and for district heating the average for Sweden (0.101 $kgCO_2e/kWh$).

Emissions from private cars and public transport

Information on annual mileage for all vehicles owned by the household was collected from the Swedish Road Registry (SRR). SRR stores odometer indications from the two most recent vehicle inspections together with data on fuel type and fuel efficiency. For new cars, which had not yet undergone vehicle inspection, we had to rely on the self-stated estimates . The self-stated distance was also used for households with access to company cars because these cars are not registered with the household.

The fuel consumption stated in the SRR is based on ideal test-cycle scores. Real traffic has been shown to cause 15-40% more fuel consumption (Patterson et al. 2011). We used a conservative addition by 20%.

CO_2 emissions stemming from the use of public transport were estimated using information on travel behaviors from the survey together with estimates of emissions intensities from public transport provided by the local public transport provider 0.03 $kgCO_2$ per person-km).

Emissions from aviation

GHG emissions from aviation were estimated from questions about the number of non-work related flights conducted to Nordic and European destinations during the last two years and intercontinental flights during the last five years. Average distances were then calculated using data on the number of flights to different destinations from the main international airport in the region. Estimates of average aircraft emissions per passenger kilometer were obtained from the LIPASTO calculation system for air traffic. To account for the additional GWP effect from high altitude emissions we multiplied the direct CO_2 emissions by a factor of 1.7 (Azar and Johansson 2012).

Emissions from food

The average GHG emissions generated by Swedish food consumption have been estimated to 1500 kg CO_2e per capita of which 800 kg originates from meat (Bryngelsson et al. 2013). The survey focused on the meat consumption which accounts for most of the variation between individuals. The respondents were asked how many times during the last week they had eaten dishes with beef, poultry, pork, game, fish or all-vegetarian. Using GHG emission data from a meta-study (Röös 2012), the individuals' GHG-emissions from meat were calculated. Emissions from other food types where assumed to be 700 kg CO_2e per capita for all individuals in the sample.

Emissions from other consumption

In addition to the main categories of GHG intensive consumption, a significant portion of a household's emissions is caused by "other consumption" that is the multitude of purchased products and services. These items typically have low GHG intensities (kgCO_2e/SEK), but the aggregated consumption volume is large and should not be neglected. Measuring all typed of consumption was, however, not possible in the survey so we had to settle for an approximate approach.

A relationship between expenditures and GHG emissions from "other consumption" was established using data from the Swedish household budget survey of around 2000 households (Statistics Sweden 2008a), combined with GHG intensities for 99 categories of products and services (Statistics Sweden 2008b). This resulted in an elasticity of GHG emissions with respect to expenditures on other consumption of 1.07 as shown by figure 1. The total expenditure level is found to be a very strong predictor of GHG emissions from other consumption (R^2=0.88), which is due to the relatively small differences in kgCO_2e/SEK between different types of products.

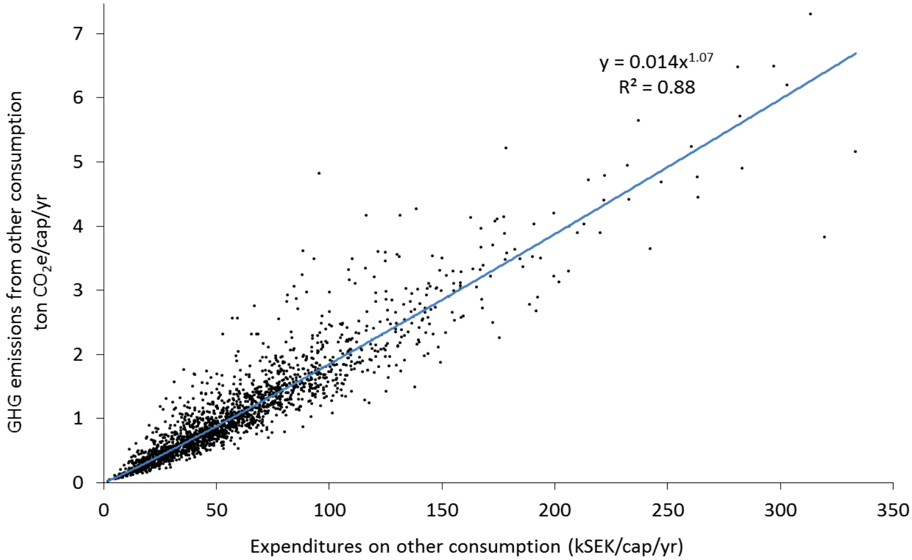


Figure 1 The relationship between expenditures and GHG emissions from "other consumption" that is the sum of non-GHG-intensive products and services. Each dot represents a household.

Hence, a household's emissions from other consumption are primarily explained by the total expenditures and not by the composition of consumption. The survey was constructed to utilize this short-cut and enable the calculation of the households' total annual expenditures on other consumption as the gross income of the household minus taxes, annual household savings, rent, and expenditures in the GHG intensive consumption categories described above. GHG emissions from other consumption were then approximated using the relationship in figure 1.

Explanatory models

Explanatory models for the households' GHG emissions were constructed using three categories of explanatory variables as described in the sub-sections below. These variables were introduced in a step-wise procedure as further described in the results section (Table 3). Linear relationships were used in order to enable direct comparisons of the importance of different types of variables with respect to their impact in terms of ton CO_2e per cap per yr. Models were fitted with ordinary least squares (OLS) and heteroskedasticity robust standard errors using the software STATA.

Socio-economic variables

Income has previously been shown to be the number one variable for explaining GHG emissions. Net Income was calculated from the self-stated salaries of all adults in the household, deducting the taxes according to each adult's income dependent tax rate, and adding child benefits for households with children.

Although both emissions and net income are expressed per capita (adult) we also include the number of adults and the number of children in the analyses. Because of collective goods, that is goods that several individuals can use without affecting the other's usage, and economies of scale, a large household may afford other types of consumption than small households with the same income per capita. Households with two adults are also more likely to own a car than households with one adult.

Age was included as it may have effects in all lifestyle domains. Sex was included because previous research has shown that men travel by car to a larger degree than women and also eat more meat (Räty and Carlsson-Kanyama 2010). This variable was coded 0 for women and 1 for men.

Motivational variables

Pro-environmental Attitudes were measured as the combination of self-stated interest in environmental issues and the concern for the future impacts of climate change (Cronbach's alpha 0.74).

We also attempt to measure Pro-environmental Social Norms (PESNs) for some GHG intensive activities; commuting, long-distance travel, vacations, residential energy use and food (table 1). The questions are formulated as statements which the respondent can agree or disagree with (scale 1-7). These statements can also be divided in two different types of normative influence. The first type (statement 1-3) describes what significant others do, assuming that this in itself may influence the subject's behavior. The second type (statement 4-5) is about what is believed to be expected or considered desirable among significant others. Cialdini et al. (1990) refer to these two types as *descriptive* and *injunctive* norms.

Table 1 Five questions on pro-environmental social norms (PESNs). For questions marked rev., the scale of the variable has been reversed.

	PESN	Valued statement: 'don't agree at all' to 'agree completely'	
1	Car	Most of my close friends take the car to work	(rev.)
2	Vegetarian	None of my close friends are vegetarians	(rev.)
3	Aviation	Most of my acquaintances avoid domestic flights when possible	
4	Vacation	Vacations at remote destinations give status among friends	(rev.)
5	Energy	My acquaintances expect me not to waste energy	

These five norm questions have a low internal consistency (Cronbach's α of 0.30) and also low pair-wise correlations. Hence a combined variable was not constructed.

Physical variables

To explore the role of the proximity to different functions, we establish a Distance Index, calculated as a function of the road distances $d_{i,j}$ from home to the closest coordinate of 10 different types of functions j (work, supermarket, train station, post office, business center, police office, health center, main hospital, governmental authority and cultural institution), based in geographical data. The Distance Index for each household i, is expressed as follows:

$$Distance\ Index_i = \sum_{j=1}^{10} \propto_j \frac{d_{i,j}}{\bar{d}_j}$$

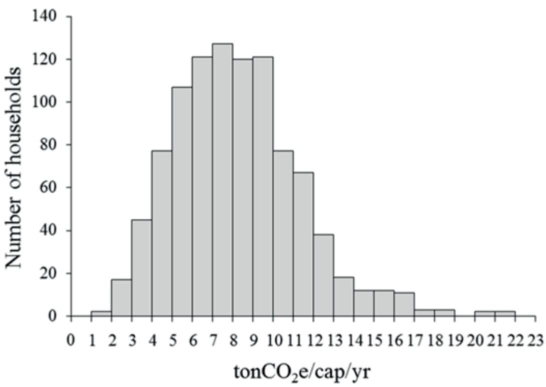
Where $\bar{d}_j$ is the average distance to each function and α_j is the weight of each distance type ($\sum\alpha_j$=1). The Swedish national travel survey shows that commuting constitutes 32% of the total travel distance by car (Trafikanalys 2012) and accordingly α_1 is set to 0.32. No data are available on the exact travel volumes to other functions and hence the other distance types have been given equal weight.

We also include the binary variable Dwelling type, where 0 denotes an apartment in a multi-dwelling building and 1 denotes a detached or semi-detached dwelling.

Results

Figure 2 shows the results of the GHG emission estimates. The mean emissions are found to be 8.2 tons of CO_2e per adult, which is relatively close to previous estimates of Swedish consumption accounted GHG emissions (SEPA, 2008). But it should be noted that the data set is not perfectly representative for the region.

The distribution shown in figure 2 is close to a normal distribution but with a longer tail for higher emissions. The standard deviation is 3.2 tons of CO_2e per adult which gives a coefficient of variation of 0.39. In comparison, a study based on the complete Swedish household budget survey resulted in a coefficient of variation of 0.48 (Nässén 2013). Large variations have also been reported in studies from other countries, for example in the Netherlands (Vringer and Blok 1995) and Canada (Wilson et al. 2013).



	tonCO2e/cap/yr	
	M	S.D.
Total	8.2	3.2
Residential energy	2.2	1.7
Car/public travel	1.8	1.5
Aviation	1.4	1.4
Food	1.5	0.2
Other consumtion	1.3	1.0

Figure 2 Histogram of the total estimated GHG emissions for the 983 households in the sample together with the means (*M*) and standard deviations (S.D.) of emissions from different categories.

Explaining variation in total GHG emissions

The correlations between the variables are shown in table 2. All of the correlations have the expected sign. As expected, all domains of GHG emissions were positively correlated with net income. Pro-environmental Attitudes were negatively correlated with total emissions, and emissions from residential energy, car/public travel and food, but not statistically significant for aviation and other consumption. Both of the physical variables, Distance Index and Dwelling type, were positively correlated with total emissions, emissions from residential energy and emissions from car/public travel.

Table 2 Correlation matrix (Pearson's r) for emission categories and explanatory variables. Omitted numbers are not significant at the 5% level.

	GHG residential	GHG car/public travel	GHG aviation	GHG Food	GHG other consumpt.	Net Income	Pro-env. Attitudes	Distance Index	Dwelling type
GHG total	.67***	.66***	.45***	.17***	.42***	.61***	-.07*	.21***	.37***
GHG residential	1	.27***			.08*	.26***	-.08*	.10**	.44***
GHG car/public travel		1		.11***	.15***	.39***	-.08**	.30***	.28***
GHG aviation			1	.06*		.14***			
GHG food				1		.09**	-.18***		
GHG other cons.					1	.73***			.09**
Net Income						1		.12***	.15***
Pro-env. Attitudes							1		
Distance index								1	.14***
Dwelling type (detached house=1)									1

Significance levels: * = $p < 0.05$; ** = $p < 0.01$; *** = $p < 0.001$ (two-tailed test).

Table 3 shows the results from the regression analysis with total GHG emissions as the dependent variable, adding explanatory variables in a hierarchical procedure. Model 1 contains only socio-economic variables. Again, Net Income was found to be the most important variable and its standardized regression coefficient is almost identical to the bivariate correlation coefficient shown in table 2. The variables Number of Adults, Number of Children and the adults' Age were also positive and statistically significant.

Table 3 Results of OLS regressions explaining total GHG emissions per adult for Swedish households (values are standardized regression coefficients).

	Model 1	Model 2	Model 3	Model 4
Net Income	0.60***	0.60***	0.59***	0.56***
No. of Adults	0.07**	0.07**	0.07*	*n.s.*
No. of Children	0.12***	0.12***	0.12***	0.06*
Sex	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Age	0.09***	0.09***	0.09***	*n.s.*
Pro-environmental Attitudes		-0.07**	-0.07**	-0.06**
Distance Index			0.15***	0.12***
Dwelling type (detached=1)				0.25***
F-value	84.6***	71.5***	63.8***	74.3***
Adj. R^2	0.39	0.40	0.43	0.49
N	970	964	901	898

Significance levels using robust standard errors: * = $p < 0.05$; ** = $p < 0.01$; *** = $p < 0.001$ (two-tailed test).
Multicollinearity test: Highest variance inflation factor found for Dwelling type (VIF=1.25).

In Model 2, the variable Pro-environmental Attitude was added. This gives a statistically significant negative contribution, but increases the fit of the model only marginally. Comparing Model 1 and Model 2 we see that the other regression coefficients are unaffected. In Model 3, Distance Index was added to the regression. This variable improves the fit of the model (R^2_{adj} from 0.40 to 0.43), and does not affect the coefficients of the other variables. Finally, in Model 4, the variable Dwelling type was added, which further improves the fit of the model (R^2_{adj} 0.49). In this model, Age and Number of Adults become insignificant, the coefficient for Number of children was halved, and the coefficient for Net Income also decreased somewhat. This means that Dwelling type appears to be a mediator of both household size, age, and to some extent also for income. This result is expected because large families with high incomes tend to move to detached houses.

From the results in table 3, we can see that the GHG emissions of households can be explained reasonably well with a rather small set of variables; Net Income, Pro-environmental attitudes, Distance Index and Dwelling type explain about half of the variation in GHG emissions (with a small contribution also from the number of children, which is not that interesting in itself). In table 4, we quantify the importance of these four variables in terms of ton CO_2e/cap/yr. The number for the binary variable Dwelling type is the unstandardized regression coefficient, as this gives the difference between an apartment and a detached house. For the other variables, the difference between 'low' and 'high' was defined as the effect of a change from -1 to +1 standard deviations (for a normal distribution, 68% of the sample is found within this range). For Net Income, the standard deviation in the sample is 79000 SEK and the unstandardized regression coefficient with respect to GHG emissions is 0.023 kg of CO_2e per SEK. Hence the difference in GHG emissions between low and high income households was estimated as 2 * 79'000 SEK * 0.023 kg of CO_2e per SEK which is 3.6 tons of CO_2e.

In the same way the physical variables were calculated to account for as much as 2.5 ton CO_2e/cap/yr together. Hence, a high income household living in a detached house in a remote suburb could be expected to cause around 5 ton CO_2e/cap/yr more than a low income household in a central apartment. In comparison, the difference between weak and strong Pro-environmental Attitudes is much smaller (less than one tenth).

Table 4 GHG effects from a change from 'low' to 'high' in each variable. For the first three variables this has been calculated as the effect of a change from -1 to +1 standard deviations (the unstandardized regression coefficient times 2 std.dev.). For dwelling type, which is a binary variable, the value is just the unstandardized regression coefficient.

	Standardized GHG effect tCO_2e/cap/yr	Relative to average emissions %
Net Income	3.6	44
Pro-environmental Attitudes	0.4	5
Distance Index	0.8	9
Dwelling type	1.7	21

The effect of social norms

We also set out to explore the effect of what we term Pro-environmental Social Norms (PESNs). Five types of norm questions were evaluated (table 1). The correlations between these and the different domains of GHG emissions are presented in table 5. All correlations have the expected negative sign and in general the strongest correlations are also found within the expected domains, for example between the PESN for car use and car/public travel emissions (-0.28) and between the PESN for vegetarian food and emissions from food (-0.20). In the methodology description we stressed that the three PESNs to the left in the table are based on a descriptive type of statement, describing what significant other do, compared to the two statements to the right, which describe the normative pressure in a more direct way (injunctive). From the results, we see a clear pattern that the descriptive norm statements give a stronger result. We develop this point further in the discussion section.

Table 5 Correlations (Pearson's r) between emission categories and different pro-environmental social norms (PESNs). Omitted numbers are not significant at the 5% level.

	PESN car	PESN vegetarian	PESN aviation	PESN vacation	PESN Energy
GHG total	$-.23^{***}$	$-.08^{*}$	$-.17^{***}$	$-.08^{*}$	
GHG residential	$-.17^{***}$	$-.06^{*}$	$-.07^{*}$		
GHG car & public travel	$-.28^{***}$	$-.08^{**}$	$-.10^{**}$		
GHG aviation			$-.13^{***}$	$-.15^{***}$	
GHG food	$-.14^{***}$	$-.20^{***}$	$-.15^{***}$		$-.12^{***}$
GHG other consumption			$-.08^{**}$		

Significance levels: * = $p < 0.05$; ** = $p < 0.01$; *** = $p < 0.001$ (two-tailed test).

Explaining variation in emissions from private transport

In a final analysis we focus specifically on GHG emissions from private transport (car and public travel). This is the domain where we have the best quality of the GHG estimate as well as the most relevant set of explanatory variables.

The first column of table 6 shows the results for Model 4 with the same specification as in table 4 but with GHG emissions from private transport as the dependent variable. The same variables are found to be relevant here as for total GHG emissions. The unstandardized regression coefficient for the Distance index was estimated to 0.61 for private transport GHG emissions compared to 0.70 for total GHG emissions. Hence, as expected, this variable primarily affects emissions through transport behavior. We also specify a new Model 5 by adding the PESN variable for car use which was found to have a strong negative bivariate correlation with GHG emissions from private travel (table 5). This result holds also in the multivariate analysis where the PESN variable was found to be the third most important variable after Net Income and Distance Index.

Table 6 Results of OLS regressions explaining GHG emissions from private transport (values are standardized regression coefficients). Model 4 is the same model as the one used for total GHG emissions in table 4.

	Model 4	Model 5
Net Income	0.34^{***}	0.33^{***}
No. of Adults	*n.s.*	*n.s.*
No. of Children	0.08^{*}	*n.s.*
Sex	*n.s.*	*n.s.*
Age	*n.s.*	*n.s.*
Pro-environmental Attitudes	-0.09^{**}	-0.07^{**}
Distance Index	0.22^{***}	0.21^{***}
Dwelling type (detached=1)	0.17^{***}	0.14^{***}
PESN car (friends take car to work)		-0.17^{***}
F-value	40.4^{***}	44.1^{***}
Adj. R^2	0.27	0.29
N	898	895

Significance levels using robust standard errors: * = $p < 0.05$; ** = $p < 0.01$; *** = $p < 0.001$ (two-tailed test).
Multicollinearity test: Highest variance inflation factor found for Dwelling type (VIF=1.28).

Discussion

The aim of this study was to analyze the variance in GHG emissions generated by households, by exploring the influence of different types of explanatory variables. In line with previous research (e.g. Lenzen et al. 2006; Nässén 2014), income was found to be the single most important variable. The mechanisms behind this relationship are well-established; high-income households spend more, which generates more emissions. To some extent, high income households spend relatively more on products and services with lower emissions intensities and they may also invest more in for example energy efficient technologies, but this effect is not strong enough to compensate for the effect of a larger consumption volume.

Our results also confirm the results by Holden (2004) and Vringer et al. (2007), who have shown that pro-environmental attitudes alone have a relatively small impact on the energy use of households. This, however, does not rule out the importance of these factors in a future transition towards a low-carbon society. People may simply not be aware of how their behaviors cause GHG emissions or what changes that are be effective for reducing emissions. Experimental psychological research studies where participants are continually informed about the effects of different actions typically show large reductions (Abrahamse et al. 2005, 2007). Hence by informing, stimulating and in other ways activating pro-environmental attitudes and norms, significant behavioral changes can be achieved. Moreover, research examining the relationship between the environmental attitudes among a country's citizens and the environmental regulations in that country show that attitudes indeed matter for the implementation of ambitious policies (Tjernström and Tietenberg 2008).

Physical structures

According to the results presented in table 4, the difference in GHG emissions between a household living in an apartment in the city center and a household living in a detached house in a suburb is on average around 2.5 tCO_2e/cap/yr. This finding could be interpreted either as an effect of choices by individuals, or as an effect of physical structures that shape behaviors and habits. There is probably some truth in both views, but we argue that it is more useful to view it as a structural effect. First of all, differences in energy use and emissions have been connected to differences in physical variables like urban form also when different cities are compared (Newman and Kenworthy 1999; Næss 1996). In such comparisons, there is no reason to expect the initial preferences to differ between the populations. If preferences would differ between cities, it would be more likely that this would be due to physical differences which in the long run may shape habits and also preferences. Secondly, going back the individual's decisions about where and how to live, these are decisions which may be heavily affected and constrained by other structural factors, such as the availability and prices of different types of dwellings, the labor market, as well as social norms for example about how to live when having children. Decisions like this are also taken maybe only once or twice in a lifetime, again often in conjunction with having children, and then become pre-conditions for other behaviors that eventually become routinized.

Social norms

Because of the low internal consistency of the different evaluated norm statements (table 1) we discarded the idea of any over-arching pro-environmental social norm. Still, the specific pro-environmental social norms were found to have relatively high correlations with the corresponding domains of GHG emissions (table 5). Four out of five statements had a stronger correlation with total emissions than what was the case for pro-environmental attitudes.

An important issue here is, however, what these statements actually capture. As described in conjunction with table 1, we used two different types of statements. The more direct norm statements regarding what is believed to be expected by or desirable among significant others did not give very strong correlations with GHG emissions, which may be due to an unwillingness to admit to be affected by others (Nolan et al 2008). The descriptive statements, formulated as the behaviors of significant others, gave much stronger correlations. According to for example Cialdini et al. (1990), descriptive norms do not motivate through beliefs about what is morally approved, but rather through providing evidence for what is a reasonable and effective behavior.

It is difficult to draw any strong conclusions from these attempts to quantify the effect of social norms on GHG emissions. We see a need for more research in this field, regarding methods for measuring influence from norms, regarding what types of norms that are really important for GHG emissions, as well as how such norms can be changed. Some of the most important social norms in this respect may not even have environmental connotations. Norms concerning issues such as how to live when forming a family or what to consume if one starts to earn a lot of money may also be very important.

Conclusions

In this study we have attempted to improve the understanding of the variance of GHG emissions from households by merging perspectives from different fields. The GHG emissions from around 1000 Swedish households have been surveyed together with sets of explanatory variables borrowed from consumption research, urban planning research and environmental psychology. The results point strongly toward explanations that have to do with circumstances rather than motivations for pro-environmental behaviors. Net income was found to be the most important explanatory variable followed by physical variables that describe what type of dwelling the household occupies and distances to work and public/commercial services. The results also indicate that social norms around GHG intensive activities, that is what significant others do and expect, may have a larger impact on a subject's emission level than his or her attitudes toward the environment as such.

Even though our results show that economic, physical and social structures are all more important than the attitudes of the individual, there is still a large share of the variance that could not be explained by our models. Hence our results should not be used to rule out the importance of individual preferences and habits that may not be coupled to the degree of pro-environmental motivation. It should also be pointed out that these results apply to the emissions generated by the consumption of individuals only and not to the overall transition towards long-term climate targets. Pro-environmental attitudes may be more important regarding support for climate policy than for consumer behavior.

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Paper II

Low-carbon lifestyles and subjective well-being:
An analysis 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 lead to reductions in human well-being. However, this assumption has been questioned by researchers who instead argue that people may live better lives by consuming less and reducing their environmental impact in the process. In this study we explore the relationship between greenhouse gas emissions and subjective well-being, using a sample of 1,000 Swedish respondents.

Our results show that there is no strong link between an individual's emissions and subjective well-being. We also analyze the relationship between specific emission-intensive activities and subjective well-being and find that none of the activities examined correlates with subjective well-being. Finally, we explore a hypothesis put forward in the literature, suggesting that a poor work-life balance, long commute, and materialistic values may decrease subjective well-being and increase greenhouse gas emissions. Our results indicate that materialistic values do correlate with lower levels of well-being and to some extent also with higher greenhouse gas emissions.

Keywords: subjective well-being, household greenhouse gas emissions, double dividends, materialistic values

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1. Introduction

The European Union has adopted a long-term climate target to limit global warming to two degrees Celsius above pre-industrial levels (European Council, 2005). In order to have at least a likely chance of reaching this target, global carbon dioxide emissions would need to be halved between the base year of 1990 and 2050 and approach zero emissions by the end of the century (Rogelj et al. 2011; Meinshausen et al. 2009). Since reductions in developing countries are likely to take time, it is reasonable to assume that developed countries will need to decrease their greenhouse gas (GHG) emissions even more quickly. Assuming a so-called contraction and convergence model, where global per capita emissions are harmonized by 2050, this would imply Swedish reductions of at least 85 percent by 2050 (Åkerman et al. 2007).

According to official territorial accounting, Sweden reduced its GHG emissions by 20 percent between 1990 and 2012 (SEPA 2013a), while GDP increased by nearly 60 percent (Statistics Sweden, 2013). Seen from a consumption perspective, however, where emissions from imports are added and emissions from exports are subtracted, GHG emissions have instead increased by 15 percent between 1993 and 2010 (SEPA 2013b). Specific consumption trends that are not entirely covered in above accounts show that, since 1990, the consumption of red meat have increased by 54 percent (Swedish Department of Agriculture, 2013), and the number of passengers on international flights increased by 163 percent (Karyd, 2013). These trends in consumption indicate that a successful fulfillment of the two-degree climate target may require change that goes beyond eco-efficiency, by also considering lifestyle and consumption patterns. However, policies that enforce behavioral changes are not very popular among citizens (SOM 2012), probably because of perceived negative consequences for personal finances, convenience and, ultimately, quality of life.

The relationship between consumption and quality of life is contested. Fueled by findings in happiness research that show a diminishing returns for happiness with increased income (e.g. Kahneman, et al. 2006; Easterlin 2003; Inglehart et al. 2008), some scholars argue that people may live better lives by consuming less, reducing their environmental impact in the process (Zidansek 2007, see Jackson 2005 for a review of this discussion). This research often highlights ideas related to the concept of downshifting (a.k.a. "slow living,"), i.e., the shift away from a harried and material lifestyle to a lifestyle that puts more emphasis on leisure time and social relations (Schor 1998; Alexander and Ussher 2012). Contemporary consumption research, however, emphasizes that consumption is important to one's identity, for example for maintaining social relations and expressing love (cf. Miller, 1998). In this view, activities and lifestyles with high GHG emissions may be important to us for many different reasons that do not have to relate to crude consumption.

The aim of this study is to analyze the relationship between the individual's subjective well-being and GHG emissions. To our knowledge the only study that has specifically explored individual differences in these domains is Lenzen and Cummins (2013) who, however, base their analysis on data from two different samples. Findings from that study indicate that well-being levels off with increasing GHG emissions. Other previous research analyzing the relationship between quality of life indicators and GHG emissions has mainly approached this issue by means of comparisons across nations (Zidansek 2007; Abdallah et al. 2009; Mazur 2011). Results from these studies also suggest a positive but diminishing relationship between the GHG emissions of the population and their subjective well-being (SWB).

This paper addresses three specific research questions:

1. What is the general relationship between an individual's SWB and GHG emissions?
2. Do GHG-intensive activities and lifestyle choices (e.g., air-travel, leisure-driving — other than for work or commuting, red meat intensive diet, and large residences) affect an individual's SWB?
3. Are there behaviors or underlying factors that imply double dividends, i.e., that correlate with both low GHG emissions and high SWB?

By employing a survey questionnaire combined with registry-based data sources we estimate total GHG emissions for each individual. Through the survey we also collect information on SWB and other relevant explanatory variables. Section 2 includes a description of the mail survey, the variables used in the analysis, and a brief account of how GHG emissions were measured. The results are presented in section 3, and in section 4 we discuss our findings. Section 5 summarizes the main conclusions of our study.

2. Method

This section describes the mail survey and registry data sources used to estimate GHG emissions, SWB, and a set of explanatory variables.

2.1 Survey

The mail survey was sent out in May 2012, to a random sample of 2,500 individuals between 20 and 65 years of age, residing in the region Västra Götaland, in southwest Sweden. The population density of the region is 65 residents per km^2, which is more than twice as high as for Sweden as a whole. Gothenburg, Sweden's second largest city, is the main center, with about one third of the region's 1.5 million residents.

The net response rate amounted to 40.1 percent, after two survey mailings, three postcard reminders, and one 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 in the specified cohort in Västra Götaland and in Sweden as a whole (obtained from Statistics Sweden 2013) and found these 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 mean income was 6 percent higher than the average in Västra Götaland and 4 percent higher than the national average. We also found an age bias as our respondents were on average four years older than the average citizen. Finally, there is a bias towards higher education in the survey sample, as 60 percent of the respondents have post-secondary education, compared to 39 percent of the general population in both Västra Götaland and Sweden as a whole. In most cases, these differences are small and illustrate that our sample is representative for the total population of Västra Götaland as well as Sweden as a whole. The exception is with respect to education, and this may be problematic since higher education could entail differences in other relevant factors as well.

We also controlled for the risk of a self-selection bias given the focus on environmental issues in the survey. The questionnaire included a question on environmental concern, identical to a question included in a broader survey conducted in the same year (SOM, 2012). Luckily, our respondents did not diverge from the general survey on this question.

2.1.1 The Questionnaire

The respondents were asked to answer a total of 47 questions covering different aspects of their everyday lives, including 12 questions meant to retrieve information necessary for the estimation of each individual's GHG emissions (as a complement to registry-based data) and 15 general questions on background characteristics. The questionnaire also included questions on time-use patterns, questions aimed at identifying pro-environmental norms/attitudes/behaviors, and so on. In order to evaluate the questions and scales used in the main survey, a small pilot survey was conducted in 2011, with answers from 87 respondents.

2.2 Measuring Greenhouse gas emissions

The method used to estimate household GHG emissions is summarized in Table 1 below. We include the three most important anthropogenic greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), expressed as carbon dioxide equivalents (CO_2e) based on their respective global warming potential (GWP) over 100 years. Emissions from residential energy use, private transport, and other non-food consumption are attributed to the household as a whole and divided by the number of adults in each household. Remaining emissions that derive directly from the individual's consumption, i.e., public transport, air-travel, and food consumption, are then added to establish the total GHG emissions of the adult respondents. In all analyses, the GHG emissions are presented per adult.

Table 1: Methods used to estimate GHG emissions from different consumption categories

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, CO2 emissions, car make and model. New cars are not inspected during the first three years, and for these vehicles we relied on the respondents' stated annual driving distance in the questionnaire together with vehicle specific data from SRR. The fuel consumption stated in the SRR is based on the NEDC test-cycle scores in which all electric equipment is turned off and driving conditions are optimal. Fuel consumption during regular usage has been estimated to be 15-40% higher than the NEDC scores (Patterson et al. 2011). We increased the SRR values by 20% to take this into account.
Local public transport	Respondents were asked about their weekly commuting choices and distance to work. Estimates of CO2 emission intensities from public transport were provided by the local public transport provider (Västtrafik) and amounted to 0.031 kgCO2/passenger-km (0.04 kgCO2/passenger-km from bus travels and 0.02 kgCO2/passenger-km for trams and commuter trains).
Air travel	Respondents were asked about their air travel: the number of flights (for other than business reasons) to Nordic and European countries respectively in the past 2 years, and the number of inter-continental flights in the past 5 years. Average distances were calculated using the distance and frequency to different destinations from the main international airport in the region (Landvetter Airport). CO2e emissions estimates of average aircraft emissions per passenger-kilometer were collected from the Finish LIPASTO-calculation system (VTT, 2009). A conservative high-altitude factor of 1.7 was used to incorporate the full GWP effect of contrails and induced cloud formation from aviation (Azar and Johansson, 2012).
Electricity	We received data on 200 respondents' annual electricity consumption directly from their utility companies. This information was then used together with explanatory data from the survey on self-stated electricity behavior, types of household appliances, type of residence and size, to construct a model (R2=0.61) to estimate electricity consumption for the remaining households in the survey. We assume a EU electricity mix of 0.305 kgCO_2e per kwh to reflect the conditions given by the EU-ETS cap-and-trade policy scheme where the total emissions are set by the issuing of emission permits at the political level. But from a physical perspective, the actual power system in Sweden is primarily interconnected with the neighboring Nordic countries.
Space and water heating	GHG emissions were calculated as the product of five factors (residential floor surface area; energy performance; heating system efficiency; indoor temperature; emissions factor). For buildings included in the Energy Declarations registry, some of these factors could be collected directly from the registry (38% of the sample), while data from the questionnaire were used for the remaining households.
Food	Measuring the emissions from all food products was not feasible, so we focused on red meat consumption, which accounts for a large share of emissions and much of the variation among individuals. Bryngelsson et al. (2013) estimated the average Swedish emissions from food consumption to 1,500 kg CO2e/cap/y, of which 800 kg originate from meat consumption. A multi-item question asking the respondents to assess the composition of their diets was used together with GHG emission estimates (Röös 2012) to calibrate the 800 kg CO2e per capita. Emissions from other food types were assumed to be 700 kg CO2e per capita for all individuals in the sample.
Other consumption	Other consumption includes clothing, consumer electronics, entertainment, and so on. By using statistics from the Household Budget Surveys together with emissions data from the Swedish Environmental Accounts, we were able to construct a model (R2= 0.88) describing the relationship between expenditures on "other consumption" and the resulting GHG emissions. This model was then used together with estimates of each respondent's remaining consumption space derived from our survey data on income, savings, and other large budget posts.

2.3 Quality of life indicators - Subjective well-being

In this study we have chosen to use subjective well-being (SWB) as an indicator of the respondent's quality of life. However, SWB is just one among several measures designed to capture what we mean by quality of life, including various forms of objective indicators, capabilities, and actualization of human potential. SWB is not the only component of a good life, but it is an important aspect, and it has gained widespread use in both research and applied welfare statistics.

SWB as defined by Diener et al. (1999) is an aggregate measure that combines an affective component (presence of positive or negative mood) and a cognitive component (self-rated life satisfaction). Research has shown that these two components are correlated to some extent (in this study, 0.77^{**}), but it is also possible to be in a positive mood while being simultaneously dissatisfied with one's life and to be satisfied with one's life while being in a negative mood. Hence, the hybrid (aggregated) approach to SWB seems reasonable, as it would be difficult to argue that a person has a high level of well-being while lacking either the affective or cognitive component (Brülde, 2007).

The two-item question used in this study is similar to that used in the World Values Survey (Inglehart et al. 2008). The affective component was measured by asking the respondent how he/she "feels in general" on a seven-point Likert scale, where 1 means "sad" and 7 means "happy." The cognitive evaluation instead asks the respondent "how satisfied are you on the whole with the life you live?" where the outermost alternatives were "not at all satisfied" and "very satisfied," respectively. The SWB indicator is the sum of these components with equal weighting, normalized on a 0-10 scale.

2.4 Explanatory variables

The third aim of the study is to explore behaviors or underlying factors that may imply double dividends, i.e., factors that are positively correlated with SWB and negatively (or at least neutrally) correlated with GHG emissions. As mentioned in the introduction, previous research that has addressed lifestyle changes that would benefit both ecological sustainability and individual well-being has often highlighted ideas related to the concept of downshifting. The survey used in this study was designed to test some of these theories empirically.

2.4.1 Commuting

Individuals who spend a lot of time commuting by car can for obvious reasons be expected to have higher transportation GHG emissions. Irrespective of what mode of transport a person use, commuting also takes time from other social activities that are beneficial for our well-being (Dolan and White 2007) and has also been shown to correlate with health problems (Hansson 2011) and low levels of SWB (Stutzer and Frey 2008; Killingsworth and Gilbert 2010). However, Olsson et al. (2013) found that irrespective of which transport mode subjects used, feelings during commutes are predominantly positive or neutral and speculate that the commuting offers buffer time between work and private spheres of life. Both time and distance is important to the SWB and GHG connections, Commuting was measured in the questionnaire by asking respondents to assess the distance to work and which mode of transport they used.

2.4.2 Work-life balance

As pointed by for example Jackson (2009), reducing and sharing the work-time may imply potential double dividends by both reducing ecological impact and improving the quality of life. Paid work provides us with income that is used for consumption, which in turn generates GHG emissions (Knight et al. 2013; Nässén and Larsson, 2013), while long work hours are likely to infringe on leisure time with family and friends, a factor that has been shown to be an important determinant of an individual's SWB (Argyle 1999).

We asked respondents about their average work hours each week in order to see how this factor affects SWB and GHG. Following Larsson (2012), we also asked respondents two questions assessing their experience of time pressure. We first asked how frequently the respondent felt he/she "experienced discomfort in trying to keep up with everything that needs to be done," and then we asked how strong these feelings of discomfort are. The reason for the second question is that stress tolerance seems to vary among individuals and life situations. Parents, for example, tend to endure a hectic everyday life without experiencing strong feelings of discomfort. Cronbach's alpha for this combined measure was 0.81. The scores on the respective answers were then added and normalized on a 0-10 scale.

2.4.3 Materialistic values

People holding materialistic values, i.e., individuals concerned about the acquisition of material things, have been shown to have lower SWB than others (Ryan and Dziurawiec 2001; Williams et al. 2000). They also engage in relatively fewer environmentally friendly behaviors, like recycling, than others (Richins and Dawson 1992; Brown and Kasser 2005, Hurst et al. 2013), but to our knowledge no previous study has examined the connection between materialistic values and a reliable environmental measure such as GHG emissions.

In order to measure the level of materialistic values among the respondents, we used a translated version of the well-established Material Values Scale (MVS, Richins and Dawson 1992). Because of the space restrictions, we used the short-form that has been shown to have satisfactory psychometric properties (Richins, 2004). The short-form is made up 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.

Two items were dropped from the MVS. The MVS is divided into three dimensions (Success, Centrality, and Happiness), and in our initial data analyses we discovered a significant negative correlation between household income and one of the questions used in the happiness dimension of the MVS form ("It sometimes bothers me quite a bit that I can't afford to buy all the things I'd like" Richins, 2004). It seems reasonable to assume that low-income households are more likely to respond affirmatively on this question for "legitimate" reasons, and this question-item was dropped from the scale. Another item lowered the internal consistency of the measure substantially, probably because of its reverse order formulation and was consequently dropped in the analysis ("I try to keep my life simple, as far as possessions are concerned"). The Cronbach's alpha for the remaining 7 items was 0.83. These answers were then added and normalized on a 0-10 scale.

2.4.4 Other socio-economic variables included in the models

In the survey we also asked respondents questions pertaining to other socio-economic conditions that have been shown to influence either GHG emissions or SWB. These variables are described below.

Variables likely to affect GHG: Household income and hence spending are strong determinants of GHG emissions (e.g., Lenzen et al, 2006; Kerkhof et al, 2009; Nässén 2014). A Swedish study shows that men cause more GHG emissions than women due to differences in travel behavior, and sex is therefore included in the analysis (SIKA 2007). Differences in age may also affect GHG emissions, because of differences in lifestyles, and so on, and we have therefore decided to include age as a control variable. Education has previously been shown to affect environmental attitudes; we therefore assumed that differences in education could spill over into environmentally relevant behaviors (Tjernström and Tietenberg 2008).

Variables likely to affect SWB: Working and studying have both been shown to affect SWB positively; having social relations with friends, family, or a partner also increases our well-being (Argyle 1999). Participating in sports or exercising is partially a social activity, but the physical experience itself also seems to increase SWB (Csikszentmihalyi 1992; Mutrie and Faulkner 2004). Being in good health is probably one of the most important factors influencing how we feel in general (Argyle 1999).

3. Results

This section includes the descriptive statistics, an analysis of the relationship between SWB and GHG, and a GHG/SWB matrix where hypothesized differences in certain parameters are described.

3.1 Descriptive statistics

Average annual GHG emissions per adult are 8.2 tons of CO_2e. As noted above, emissions per adult were estimated as the household's shared GHG emissions from residential energy, private car transport, and other shared (non-food) consumption divided by the number of adults in the household plus individual GHG emissions from public transport, air travel, and food consumption. When children are included in the denominator, the corresponding per capita estimate in our sample is 7.2 tons, which is lower than the 8 tons per capita estimated by the Swedish EPA (SEPA 2008). The difference is probably due to underreporting of own income due to forgotten incomes, which results in reduced emissions from other consumption. The difference is not very large, and for the purpose of our analysis we do not need a totally representative population. The mean SWB of 7.4 is in line with other studies of the Swedish population (Fors and Brülde, 2011).

Table 2: Descriptive statistics for the variables used in the analysis

	Mean	S.D.	Min	Max	N
Dependent variables					
GHG emissions (per year)	8.2	3.18	1.9	22.8	983
SWB	7.4	1.89	0	10	971
Determinants					
Material values scale (MVS)	2.5	1.84	0	10	958
Time pressure	4.7	2.27	0	10	963
Work hours (per week)	33.3	17.1	0	95	962
Commuting distance (kilometers, one way)	18.2	25	0	290	822
Background variables					
Education	5	1.78	1	8	975
Sex (male)	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 (in thousands SEK)	204	80	0	946	970
Has partner	0.77	0.42	0	1	977
Health	5.4	1.31	1	7	975
Family time (hours per week)	3.6	2.11	1	8	954
Social time (hours per week)	2.7	1.38	1	8	963
Exercising (hours per week)	3.6	1.99	1	8	973
GHG intensive activities					
Size of residence (m^2)	113	54.4	14	380	972
Non-work-related driving (km/year)	4756	9951	0	82743	975
Air travel (flights/year)	1.2	1.28	0	7	983
Red meat (share of meals per week)	0.18	0.59	0	1	983

3.2 The relationship between GHG emissions and subjective well-being

The main aim of this study is to learn more about the relationship between GHG emissions and SWB. Figure 1 below provides a visual representation of this relationship in our sample. The upper diagram shows the respondents sorted according to their GHG emissions and grouped into 10 decile groups. The emission level in the highest decile is 3.4 times that of the lowest. The lower diagram presents the corresponding SWB average for each of the ten groups. There is essentially no significant difference between the groups. One possible visual interpretation is that there is a weak positive correlation between GHG and SWB between the groups from 1 to 7, and a weak negative correlation between the groups from 7 to 10. The comparatively low SWB of group 1 stands out, which may partly be traced to the relatively high levels of unemployment and long-term poor health in this group. These, and other factors, are further analyzed in Section 3.3.

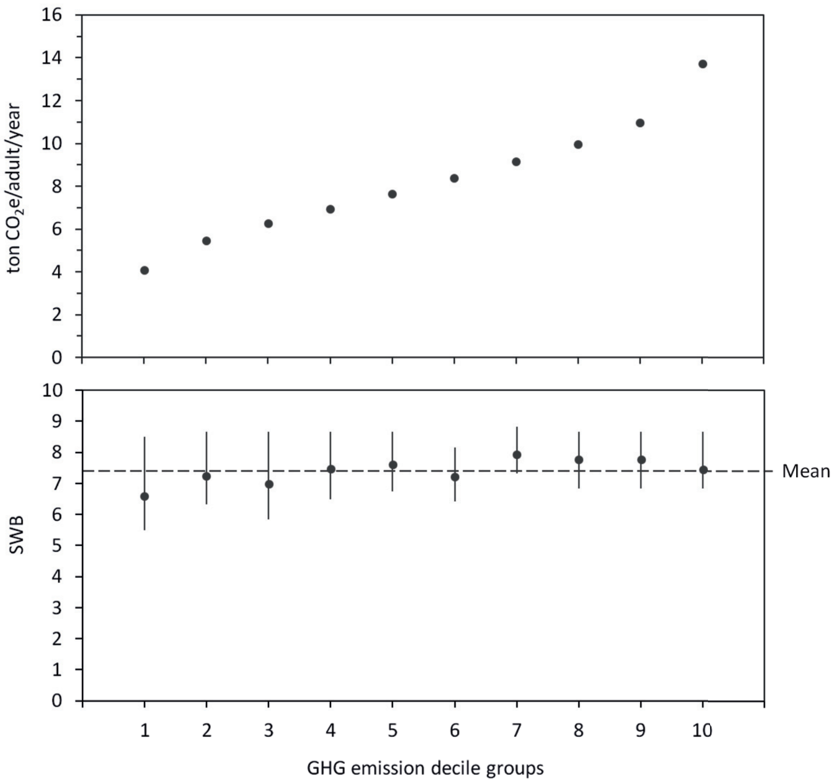

Figure 1: GHG emissions and SWB sorted by GHG emission decile groups.
The points in the upper diagram represent the average emission levels in ten decile groups (each group represents around 100 households). The lower diagram shows the corresponding average levels of subjective well-being in these decile groups. The vertical lines represent the inner quartile ranges.

Table 3 below presents a decomposed view of the respondents SWB and GHG emissions in a correlation matrix. GHG emissions from transportation (private and public), air travel, and other (non-food) consumption are found to have a weak positive correlation with SWB, while no significant correlation is found for residential energy and food consumption. Only small differences are found between the affective and the cognitive components of the SWB index. The three emission categories for which significant correlations with SWB are found are also the three categories with the strongest correlation with income.

When respondents who do not work or study are excluded from the sample, no correlation is found between SWB and GHG, and out of the GHG emission components only air travel is weakly correlated to the level of SWB. Hence the weak correlation between GHG and SWB found in the full sample appear to be associated with the third variable unemployment, which both correlates with low SWB and low consumption levels that in turn lead to low GHG emissions.

Table 3: Correlation matrix for SWB components and GHG emission components (ton CO_2e/adult/year)

	1.	2.	3.	4.	5.	6.	7.	8.	9
1. SWB Index									
2. Cognitive well-being	.94**								
3. Affective well-being	.94**	.77**							
4. Income	.17**	.15**	.16**						
5. Tot GHG	.14**	.14**	.12**	.53**					
6. Residential	-	-	-	.19**	.67**				
7. Transport	.11**	.09**	.12**	.32**	.66**	.27**			
8. Air travel	.13**	.13**	.10**	.24**	.45**	-	-		
9. Food	-	.07**	-	.12**	.17**	-	.11**	.06*	
10. Other consumption	.14**	.13**	.13**	.55**	.42**	.08*	.15**	-	-

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

3.3 Explaining SWB: Do GHG intensive activities play a role?

The second aim of the study is to analyze if there exists specific GHG emission intensive activities that are positively related to SWB. The analysis above suggests that there is no strong overall relationship between GHG emissions and SWB, but since such a relationship would only be an indirect effect of consumption activities, we analyze these activities specifically. A standard OLS regression analysis is used and we construct three models that all include a set of control variables (education, sex, age, and having children) and a combination of variables known to affect SWB (described in section 2.4.4) and GHG emission intensive variables including: size of residence, driving other than for work or commute (total distance minus commuting distance), number of non-work trips by air, and share of red meat in diet. Net income per adult is not included in the analysis as we are primarily interested in the consumption activities and their relation to SWB. In order to test for possible effects of income we ran the models including net income per adult, only to find that this parameter was not significant in any of the models and did not affect the adjusted R^2 relative to the models below.

Model 1 is the proposed "best fit" model; including variables that previous research has demonstrated affect SWB. Model 2 includes only the GHG emission intensive activities, and Model 3 includes both GHG intensive activities and variables known to affect SWB. The reason for providing all three models is that changes in beta values and explained variation (R^2 values) can be of interest to subsequent analysis.

Table 4: OLS regressions describing Subjective well-being (Standardized beta values)

Models		*Model 1*	*Model 2*	*Model 3*
Control variables	*Education*	-0.007	0.040	-0.001
	Sex	-0.026	-0.001	-0.032
	Age	0.118***	0.094**	0.109***
	Has children	0.003	-0.030	-0.005
Variables known to affect SWB	*Working or studying*	0.130***	-	0.128***
	Partner	0.136***	-	0.123***
	Health	0.458***	-	0.455***
	Time pressure	-0.149***	-	-0.152***
	Family time	0.158***	-	0.158***
	Social activities	0.138***	-	0.136***
	Exercising	-0.017	-	-0.019
GHG intensive activities	*Size of residence (m^2)*	-	0.080*	0.039
	Non-work driving (km/y)	-	0.050	0.003
	Air travel (flights/y)	-	0.126***	0.024
	Red meat (meals/w)	-	0.037	0.028
N		894	952	887
R^2 adjusted		0.392	0.036	0.393

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

Model 1 shows that among the control variables, age is positively correlated with SWB, and all of the variables previously known to affect SWB also prove to be significant, except for exercising. The model has a relatively high explanatory value (adjusted R^2 = 0.392), especially since previous research indicates that personality traits determine a large part of a person's subjective well-being (see Steel et al. 2008 for a meta-review). Self-assessed health also explains about half of the variation in SWB in the model.

Model 2 includes only GHG emission intensive activities and control variables in the analysis. In this model, air travel and residence size are significantly correlated with SWB, but the explanatory power of the model is very low (adjusted R^2 = 0.036). This result is in line with some previous research (Brülde and Fors 2013; Nawijin and Peeters 2010).

Model 3 includes both GHG emission intensive activities and variables known to affect SWB and have roughly the same explanatory power as model 1. Here, both air travel and size of residence become insignificant. Hence none of the GHG emission intensive activities analyzed here seem to have a direct relationship to SWB when other relevant variables are included in the analysis.

However, a vacation abroad, for instance, may offer an opportunity for social activities such as spending time with friends and family; air travel may therefore be a vehicle for social activities that in turn increase SWB. In order to test this opportunity, we ran model 1 with air travel as the dependent variable. This analysis shows that individuals who engage more frequently in social activities or have a partner are more likely to travel, while having children greatly limit this propensity.

3.4 Double dividends in the SWB-GHG relationship?

In the previous sections we have showed that the total GHG emissions from households is only weakly connected to SWB and that GHG intensive activities are not related to SWB to any significant extent. However, behind these weak aggregated correlations there may exist factors that affect both GHG and SWB but in opposite directions. In this section we look at more specific values and lifestyle choices that could have a beneficial effect on SWB while reducing GHG emissions.

As discussed in section 2.4.1, previous research has shown that individuals who are relatively high in materialistic values generally fare lower in SWB and are more likely to adhere to a less environmental-friendly lifestyle (Richins and Dawson 1992; Brown and Kasser 2005). Also, individuals who prioritize work over leisure time have been hypothesized to have lower SWB and a higher environmental impact (Jackson 2009). We operationalize this by looking at differences in self-assessed time-pressure and respondents who state that they work overtime separately. We also analyze the effects of commuting, which has been hypothesized to increase GHG emissions and lower SWB.

In order to study the effects on both SWB and GHG emissions, we divide the sample-population into four sub-samples using median splits on SWB and GHG, respectively (see figure 2). In the following, differences between sub-sample 1 and 4 will be of special interest to our analysis, as differences in the variables above between these groups would indicate the existence of double dividends.

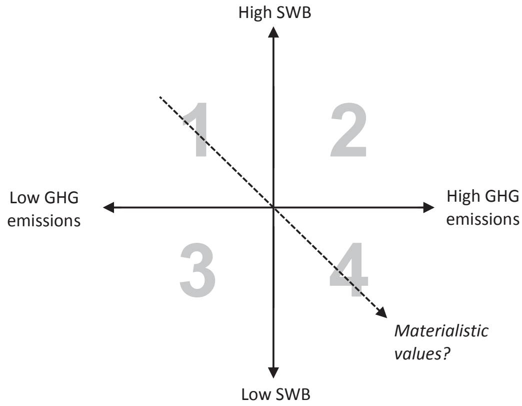

Figure 2: Schematic figure of the GHG/SWB sub-samples
The respondents are divided into four sub-samples using median splits on SWB and GHG respectively. Given the hypothesized effect of materialistic values on SWB and GHG emissions, we would expect the difference between groups 1 and 4 to be the largest.

A one-way ANOVA with a Tukey post-hoc test was conducted in order to compare our four sub-samples. Table 5 below displays the mean values for each sub-sample, where the largest significant difference between the four sub-samples is marked in bold characters.

Table 5: ANOVA table on the SWB-GHG matrix
The table depicts results from an ANOVA with a Tukey post-hoc test. The two variables marked in bold in each row indicate the strongest significant (p<0.001) mean difference for that variable.

Variables:	1 H-SWB/L-GHG		2 H-SWB/H-GHG		3 L-SWB/L-GHG		4 L-SWB/H-GHG		Average	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	N.
Materialistic Values (0-10)	**2.03**	**(1.77)**	2.48	(1.70)	2.54	(1.84)	**2.86**	**(1.83)**	2.49	954
Time pressure (0-10)	**4.05**	**(2.26)**	4.24	(2.21)	4.92	(2.27)	**5.36**	**(2.08)**	4.65	951
Overtime (>40h/week)	.20	(.40)	.28	(.45)	**.17**	**(.37)**	**.32**	**(.47)**	.24	950
Commute by car (1-5 times/week)	4.6	(2)	**5.1**	**(1.6)**	**4.0**	**(2.1)**	5.0	(1.6)	4.7	628
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
Male (%)	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 SWB:	8.9		8.8		6.0		6.3		7.6	
Average GHG:	6.0		10.6		5.7		10.7		8.3	

The results show that the difference in materialistic values between sub-samples 1 and 4 is significant F (3, 950) = 7.51, p = .001. The fact that the difference between sub-samples 1 and 4 is the largest among the groups indicates that materialistic values do indeed affect both SWB and GHG emissions.

For "Time pressure," we also find the largest difference between groups 1 and 4 (F (3, 947) = 16.8, p = .001), which could indicate a double dividend, but it seems more likely that the difference is mainly manifested in the SWB dimension, as sub-samples 1, 2 and 3, 4 form homogenous subsets at p<.05 using the Tukey multiple comparison procedure. The difference in time-pressure can also be explained by the difference in household composition, since "being a parent" is more common in in sub-sample 4 than in sub-sample 1. When comparing the means for "Overtime" in table 5, we see that there is a significant difference in overtime work between sub-samples 3 and 4, as F (3, 946) = 6.82, p = .001. But the Tukey test of homogenous subsets, groups sub-samples 3, 1 and 2, 4, which supports the more general conclusion that overtime work is primarily important to the GHG dimension, while not necessarily so for the SWB dimension. For "Commuting by car," the largest significant difference between the sub-samples is seen between samples 2 and 3, F (3, 624) = 11.86, p = .001; this result does not support the hypothesized double dividend of reduced car commuting.

4. Discussion

The analyses carried out in the previous sections have aimed to develop the understanding of the relationship between an individual's GHG emissions and SWB. The lack of connection between GHG emissions and SWB, both in general and for specific GHG intensive activities, adds further evidence to the view that consumption is not very important to SWB once the individual reaches a certain welfare level. In line with previous research, our analysis shows that health, work, and social relations explained almost 40 percent of the variation in the sample while amount of driving for non-work reasons, size of residence, and share of red meat in diet did not affect respondents SWB at all. Seen in this light, the results of the third analysis should not come as a surprise, as the materialist focus on acquisition and wealth seems wholly misdirected as a means to maximize SWB.

However, our GHG-intensive behaviors are rather rough representations of specific consumer practices with distinct meanings. Therefore, our analysis does not rule out the existence of other specific GHG-intensive consumer practices that may be perceived to be meaningful or in other ways contribute to a better life. As noted in section 3.3, the weak relationship between air travel and SWB could for example be interpreted to mean that some individuals have adopted a lifestyle where air travel fills a social purpose that in turn affects their SWB positively. Although our main results point towards a low importance of GHG-intensive activities for the average individual's SWB, it does not necessarily mean that this lack of connection is a given. A better understanding of how GHG-relevant practices evolve, what drives them, and how they are established may enable policymaking that counteracts some developments and facilitates the emergence of others. Such future research needs to identify specific consumer practices, analyze them in relation to other practices, estimate the related GHG emissions, and follow their evolution among different social-groups over time. This is a challenging task, but we believe it could be equally rewarding.

Three limitations should be kept in mind when considering our results. First, as this analysis is based on cross-sectional data, it is not possible to comment on the actual dynamic effect on SWB of reducing GHG emissions for the average individual. As pointed out by Kahneman (1999), even if actions and behaviors have become habitual and hence hedonically neutral to us, this does not mean that ceasing them would not affect our subjective well-being. However, given the weak correlation between GHG emissions and SWB, a long-term development towards decreased or curbed growth in private consumption in rich countries could be hypothesized not to affect SWB, as long as social relations or unemployment rates are not affected negatively.

Second, the choice of subjective quality of life indicators has implications for the output of our analysis. Unlike objective quality of life indicators, subjective well-being is not a direct consequence of an individual's circumstances, but also depends on aspiration level, adaptation, comparisons with others, personal values, and so on (Wilson 1967). Increases in income and hence consumption and GHG emissions may have a positive effect on objective indicators, while the effect on SWB is more ambiguous. In this study we have chosen to employ SWB since we believe its benefits outweigh its drawbacks for analyses of individuals living in affluent countries. Once primary needs are fulfilled, the importance of values and relational factors to our quality of life increases (Kahneman et al. 2006). The other main advantage of SWB is that it is based on an aggregate of various individual assessments of what is important in life, rather than *a priori* judgments about what should be important (OECD 2013). However, some technical and methodological issues remain to be dealt with (Brief et al 1993; Kahneman et al. 2010; Diener et al. 2009). Another serious risk associated with relying on subjective indicators was pointed out by Swedish sociologist Sten Johansson (1970 pp. 114): "A concept of welfare based on the individual's satisfaction with his or her situation registers the poor's forbearance as well as the rich's discontent."

Third, our results are probably restricted to other affluent welfare states. The comparatively ambitious redistribution systems found in countries in Western Europe probably moderate the importance of income to SWB for low-income individuals and households, compared to other developed countries. Clearly, people in poor countries would benefit from increased levels of consumption. The fact that our sample population differed somewhat from the general population in terms of income and education should also merit some caution as to the generalizability of these results.

5. Conclusions

In this paper we have investigated the link between greenhouse gas (GHG) emissions and subjective well-being (SWB) among individuals in Sweden. To our knowledge this is the first explicit examination of this relationship that analyze individual differences covering GHG emissions from all relevant consumption areas. The initial bivariate analysis indicates a weak positive relationship between GHG emissions and SWB. In a second step we analyzed if certain GHG intensive activities and living conditions, such as size of residence, non-work driving distance, air travel and the fraction of meals that include red meat, could explain variations in SWB. The multivariate analysis shows that when "controlling" for factors such as having good health, a job, a partner and other relations, factors that have previously been shown to affect SWB, the weak relationship found between air travel and SWB disappears. It therefore seems as if a living a low carbon life does not prevent someone from leading a good life. A third aim of the study was to investigate potential double dividends by analyzing individuals with low GHG emissions and high SWB to see how they differ from other respondents. We examined whether these respondents differed in work-life-balance, commuting, or material values, and our analysis provides tentative support for the idea that materialist dispositions affect SWB negatively, while GHG emissions seem to increase, which is also in line with the results above.

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Paper III

Should environmentalists be concerned about materialism?

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Working paper to be submitted to *Journal of Environmental Psychology*

Abstract

Western societies have grown increasingly materialistic in the last four decades, and there are also signs of similar trends in other parts of the world. Materialism is generally understood to be related to status driven pursuits and a more resource intensive lifestyle, and a growing body of research suggests that materialistic values are negatively correlated with caring for the environment and performing pro-environmental behaviors. Taken together, these trends and circumstances indicate that the continuing fostering of materialistic values could undermine efforts aimed at moving society in a more sustainable direction, both through the lack of behavioral changes and by further thwarting necessary policy processes.

However, most of the research measuring pro-environmental behaviors is founded on relatively "soft" indicators, and several studies have addressed the need for more reliable measures of environmental impact. In this study we examine the relationship between materialism and the greenhouse gas (GHG) emissions caused by individuals' travel behavior, residential energy use, food and other consumption. By analyzing the difference between the least and the most materialistic quartile group in a sample of 1000 Swedish residents, we find an increase of around 10 % in their total GHG emissions. Somewhat surprisingly, air travel accounts for around two thirds of this difference. Moreover, no significant difference was found in the degree of environmental concern between the two groups. These two findings form an interesting baseline for a discussion about the concept of materialism.

Keywords: Materialism, Greenhouse gas emissions, Sustainable consumption, Consumption patterns, Air travel.

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1. Introduction

Western societies have grown increasingly materialistic in the last four decades, and there are also signs of similar trends in other parts of the world (Twenge et al. 2012; Twenge and Kasser 2013; Schaefer et al. 2004; Ger and Belk 1996; Podoshen 2011; Rahn and Transue, 1998). A growing body of research suggests that materialistic values are negatively related to caring for the environment and performing pro-environmental behaviors (Kilbourne et al. 2005; Kilbourne and Picket 2008; Kasser & Brown, 2005). Hence, rising materialism could further complicate the necessary transition toward a more sustainable future, both by affecting the behaviors of individuals and by affecting the public support for more ambitious environmental policies.

However, most of the research measuring pro-environmental behaviors is founded on relatively "soft" indicators such as recycling, buying environmentally friendly products and other self-stated activities (Richins 1994; Brown and Kasser 2005). Using pro-environmental behaviors as indicators for environmental outcomes is problematic as they risk overstating the importance of motivational factors over structural ones (Tabi 2013; Nässén et al. 2014b), and several studies have addressed the need to move towards more reliable indicators of environmental impact (Gatersleben et al., 2002; Hurst, 2013). In this paper we attempt to address this gap with the design of a survey that uses a combination of register-based data sources and self-stated behaviors to measure greenhouse gas (GHG) emissions. As far as we know there exist no other study examining both materialism and GHG emissions. The survey is comprised of around 1000 Swedish respondents who answered questions on consumption, materialism, environmental attitudes and a set of socio-economic variables.

1.1 The role of materialism in the climate issue

The scope of this study has been limited to the climate issue. Climate change is probably the most serious environmental threat facing the world today and it is interlinked with many of the other serious environmental problems We assumed that materialism can be related to the climate issue in at least *two* different ways, either directly through individual differences in goals and behaviors affecting GHG emissions, or indirectly through the depreciation of environmental values and related attitudes toward climate policy.

As pointed out by Hurst et al. (2013) the theories focusing on differences in values and attitudes, or goals and behaviors respectively, both aim to explain how materialism relates to environmental *behavior*. Hence, although the primary aim of this study is to entangle the implications of materialism to the climate issue, the results will also contribute to a theoretical discussion concerning the nature of materialism. In the following we give a brief description of the two theoretical approaches, and return to this in the concluding discussion.

The *first* approach hypothesize that materialists are less concerned for the environment and that this leads to differences in behavior. Materialism is here understood as a set of *values* that affect attitudes that in turn inform behaviors, and we hence call this approach *materialism as value* (Ajzen, 1991). The rationale for this negative relationship is generated by the interrelationship between different values. Schwartz (1992, 2006) has shown that some values are more closely related to each other, while others are conflicting, so that individuals with values related to self-enhancement (power, achievement, hedonism) are less likely to hold typically self-transcendent values (universalism, benevolence). This so called "circumplex model" has subsequently been used to analyze how other more specific attitudes and values fit into the model, and the results suggest that environmentalism is closely related to self-transcendence values, while materialism is connected to self-enhancement values (Grouzet et al., 2005). Hence according to the circumplex model materialists are less likely to uphold environmental attitudes and vice versa, simply because they belong to different and repellant value networks.

The *second* approach instead assumes that the negative relationship between materialism and the environment is an indirect consequence of materialists' desire to accumulate wealth and obtain material possessions for the purpose of increased social status, and we will therefore call this approach *materialism as identity* (Brown & Kasser 2005). This is not an established theory but has recently received a more robust foundation by the work of Shrum et al., (2013), and draws on insights from more broadly defined theories in contemporary consumer research and sociology (Shove, 2004; Bauman, 2011). We will consequently.

From a climate change perspective, the amount of GHG emissions caused by individuals is determined by both the *amount* and the *composition* of their consumption. As for the *amount* of consumption, the relationship between households' income/spending and increased energy usage or GHG emissions has been established in the literature, and if materialists typically earn more, work longer hours and so on they could be expected to have higher GHG emissions (Lenzen et al. 2006; Nässén 2014a; Nässén et al. 2014b). It should however be noted that materialists' hypothesized devotion toward the acquisition of material objects does not necessarily imply that the *composition* of their consumption results in larger GHG emissions. Although commodities are typically more GHG intensive than services (emissions per monetary unit), both sectors are on average less GHG intensive than the food, transportation and household energy sectors (see Nässén 2014a). This implies that if materialists typically use a larger share of their disposable income on an expensive car, fashion clothing, designer furniture and other high-end luxury goods, their consumption could actually be *less* GHG intensive than others' depending on what they cut back on.

The above reasoning also begs the question of what materialists actually desire and consume. It seems materialists' supposed focus on *material* goods is largely an *a priori* assumption given by theoretical presumptions of the concept. Materialism have been defined as: "the importance a consumer attaches to worldly possessions" (Belk 1985) or "the importance a person places on possessions and their acquisition as a necessary or desirable form of conduct to reach desired end states" (Richins and Dawson 1992). Although it is often stressed that it is the social role of possessions that are important to people, there nevertheless exist a presumption about the special relationship between materialists and their possessions and this understanding is perpetuated by further research on specific status objects (Dittmar 1992; Richins and Dawson 1994; Kasser 2002; Gatersleben 2011). To our knowledge no study has tried to provide a more comprehensive picture of materialists' overall consumption. We therefore use our rather extensive data on GHG related consumption to provide a rough picture of if and how materialists differ from others in fields such as transportation, residential energy, air travel and other characteristics. As stated above, one would need even more information on budgets and consumption patterns, but we extend our analysis to also cover car ownership and housing costs, to see if and how materialists differ in these consumption areas.

To sum up: In this study we will examine if materialists differ in their *concern for the environment* or their *GHG emissions* and discuss the implications of our findings for *theories on materialism*. Through analyzes of materialists consumption and behavior within the GHG relevant sectors we will also be able to provide a picture of if and how materialists consume differently than others, and more specifically learn to what extent they are indeed *focusing on material status goods*. By this approach we hope to provide some more concrete understanding of the importance of materialism in the climate issue.

2. Method

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. The respondents differed from the total population in that they were more likely women (55%), had higher incomes (median income 6% above average), and was significantly more well-educated (60 percent of the respondents uphold a post-secondary education, compared to 39 percent among the general population). In order to test for potential pro-environmental response bias we also included a question about the respondent's interest in the environment, which was identical to a question used in a larger general survey on the attitudes of Swedish citizens (SOM 2012). Our sample did not differ from the responses on the bigger general survey and we conclude that there is no evident response bias. Below sections provide brief descriptions of how we have measured materialism, environmental concern, GHG emissions and other variables included in the analysis.

2.1 Materialism

There exist several definitions of the concept of materialism and we briefly describe the three most commonly discussed below (see Ahuvia & Wong (2002) for a review). Belk (1985) described materialism as a set of *personality traits* (envy, non-generosity and possessiveness), consequently defining materialism as "the importance the consumer attaches to worldly possessions" (p. 291, 1984). Richins and Dawson (1992) instead defined materialism as a *personal value*, describing it as a "set of centrally held beliefs about the importance of possessions in one's life". A related scale is also Kasser's Aspiration Index that distinguishes between intrinsic and extrinsic goals. Extrinsic goals (e.g., financial success, image, popularity) are seen as means to some other end, while intrinsic goals (e.g., personal growth, affiliation, community feeling) are directed toward intrinsic need satisfaction (see Ryan 1996; Grouzet et al., 2005).

We decided to employ the Material Values Scale (MVS) (Richins & Dawson 1992), which is the most commonly used measure for materialism. The MVS has been shown to have satisfactory psychometric properties and avoid many of the problems of response bias faced by other scales (Mick, 1996). A translated version of the MVS short form originally developed by Richins (2004) was designed, and we tested its reliability in a pilot study. The short-form constitutes of 9 statements answered on a 5–point Likert scale. One of the items lowered the internal consistency among the items substantially, probably because of its reverse order formulation, and was consequently dropped in the analysis (see Wong et al. (2003) for results suggesting this problem). Another item ("It sometimes bothers me quite a bit that I can't afford to buy all the things I'd like") showed a strong negative correlation with household income. Since the question could be hypothesized to pick up on low-income earners' "legitimate" needs. Due to the close relationship between income and GHG emission, it could be expected to cause strange results in the statistical analysis; we decided to drop this item in the analysis. The resulting 7-item scale is provided in the Appendix. The scale had a Cronbach's alpha of 0.824, which is satisfactory and comparable to the English version of the MVS (Richins, 2004). The answers were standardized on a 0-10 scale.

2.2 Environmental concern

The variables used to analyze environmental concern, attitudes and beliefs include: (1) the respondents' self-rated interest in environmental issues, (2) their worry about the future effects of climate change, (3) their preference in favor of a "environment-friendly society even if it would mean low or zero growth rate", and (4) their attitudes toward a proposed increase of the carbon tax already existing in Sweden. In the following, we will use "environmental concern" as an umbrella term for above questions.

2.3 Greenhouse gas emissions

The method used to estimate households' GHG emissions is summarized in Table 1 below. We include the three most important greenhouse gases, carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), expressed as carbon dioxide equivalents (CO_2e) based on their respective global warming potential (GWP) over a 100 year period. 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, and divided by the number of adults in each household. Remaining emissions that derive from the individual's consumption, i.e. public transport, aviation and food consumption are then added to establish the individual's total GHG emissions. In later analysis the GHG emissions from private and public transport is combined into one category named "transport", and households' electricity use and space and water heating is merged into "residential energy". The methods for GHG estimates in the different consumption categories are summarized in Table 1. For a more thorough description of GHG emission measurements see Nässén et al. (2014a).

Through the Swedish Road Registry we had sufficient data to be able to use an online car valuing service (http://www.bilpriser.se) that base their estimates on updated actual sales prices from most car dealers in Sweden and other information. All other background data used in the following analysis were collected from the questionnaire.

Table 1: Methods used to estimate GHG emissions from different consumption categories

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, CO2 emissions, car brand and model. New cars are not inspected during the first three years, and for these vehicles we relied on the respondents' self-stated annual driving 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. Fuel consumption from regular usage has been estimated to be 15-40% higher than the NEDC scores (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 CO2 emission intensities from public transport was provided by the local public transport provider (Västtrafik), and amounted to 0.031 kgCO2/pkm (0.04 kgCO2/pkm from bus travels and 0.02 kgCO2/pkm for trams and commuter trains).
Air travel	Respondents were asked about the number of personal flight travels to Nordic and European countries they had carried out during the past 2 years, and the number of inter-continental flights for the previous 5 year period. Average distances were calculated using the distance and frequency to different destinations from the main international airport in the region (Landvetter airport). CO2e emissions estimates of average aircraft emissions per passenger kilometer were collected from the Finish LIPASTO-calculation system (VTT, 2009). A conservative high altitude factor of 1.7 was used to incorporate the full GWP effect of contrails and induced cloud formation from aviation (Azar and Johansson, 2012).
Electricity	For 215 of the respondents, electricity consumption could be collected from their utility company. This information was then used together with explanatory data from the survey on self-stated electricity behavior, types of white-goods, dwelling type and dwelling size, 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 European union electricity mix of 0.305 kg CO2e/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 some of these factors could be collected directly from the registry (for 38% of the sample), while data from the questionnaire was used for the remaining households.
Food	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. Bryngelsson et al. (2013) estimated Swedish average emissions from food consumption to 1500 kg CO2e/cap/y, of which 800 kg originates from meat consumption alone. 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 CO2e per capita. Emissions from other food types were assumed to be 700 kg CO2e per capita for all individuals in the sample.
Other consumption	Other consumption includes e.g. clothing, consumer electronics, entertainment, and so on. By using statistics from the Household Budget Surveys together with emissions data from the Swedish Environmental Accounts, we were able to construct a model (R2= 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.

2.4 Other variables

In order to provide a better understanding of how materialists differ from others and connect our results to international surveys we have also included some variables that are here treated as background characteristics, but that can hopefully provide additional reliability to our results. As discussed above, materialists are assumed to be more focused on the acquisition of wealth and making tradeoffs accordingly and hence one could assume that they are likely to work longer hours on average and be less satisfied with their economy. We also included political affiliation, as materialist's aim for increased wealth would on a personal level stand against redistributive left wing politics.

We also include questions measuring the respondent's Subjective well-being and perceived purpose in life, since previous research has shown that materialists are less happy with their lives (Borroughs and Rindfleisch, 2002; Ryan and Dziurawiec 2001;). The subjective well-being is well-established in the literature and assumes that well-being includes an affective component (presence of positive and negative mood) and a cognitive component (self-rated life satisfaction) Diener et al. (1999), that are simply weighted together. Resent research has however questioned the reason to aggregate these metrics (Kahneman et al. 2010; Diener et al. 2009), but as the Cronbach in this sample is 0.77 we decided to go on with the combined measure. We also included a Swedish version of a 4 item short form of the Purpose in life test (Crumbaugh 1968; Newcomb and Harlow 1986) with a Cronbach of 0.83. The internal consistency of both measures is above the conventional rules of thumb.

3. Results

In table 2 below we use an ANOVA and split the sample into quartile groups depending on the rate of materialistic predispositions. We use a Tukey post-hoc test to identify differences between the least/most materialistic groups and significant differences are marked in bold in the table. The p-values given by the standard t-test is also included in the table for reference. Using this division of relatively materialist and non-materialist groups we examine how the groups relate to our measures of pro-environmental attitudes, GHG emissions from different sectors, and differences in car and housing expenditures.

Two types of income variables are shown in table; Net household income, which describes the households' total purchase power, and Gross personal income which is the salary of the respondent. But as stated above we also include working hours in order to see if materialists tend to favor work over leisure time in their present working situation, and we included a question on how satisfied the respondent was with his/her household economy. To further describe the preferences of the different groups, the Table also shows a set of consumption-related variables; car ownership, the value of the car, if it is a premium brand, or if it is a "green" car (<120 gCO_2/km), housing expenditure, size and type of dwelling.

The ANOVA shows a big difference in average age for the two groups, with materialists being 12 years younger than the non-materialist group. This result could be due to increasing materialsm with each new generation in Sweden, which is in line with studies from other developed countries (Twenge et al., 2012) but it could also be due to value changes over an individual's life-span, so that once materialistic youths are becoming less materialistic as they grow older.

No significant differences are found for any of the questions relating to environmental concern. The total annual GHG emissions differ by about 1 ton between the upper and lower quartile groups. When we analyze each consumption sector alone only air travel display a significant and large effect of 600 kg GHG between the groups. However the difference in air travel could also be affected by the above-mentioned differences in age between the groups, as younger respondents could be assumed to have adopted a lifestyle where traveling is more frequent, and an analysis taking this into account is described in section 3.2.

We can also see that materialists earn significantly more, work longer hours but are still less satisfied with their economy. This result could be expected based on presumptions regarding a materialistic focus in life. The fact that the relatively older less materialistic group ought to earn more given 12 years of wage increases does not seem to outweigh this effect.

Counter to what we would have expected, we find no significant difference in any of the variables related to respondents' car ownership. However, although statistically non-significant the difference in average total value of cars and most expensive car between the groups is large. But significant differences are found in the other status commodity measured, as materialists seem to spend a lot more on housing costs than non-materialists. Even if we divide the housing cost by the households' net income, materialists spend 5 percent more of their household income on accommodation than the low materialist group.

Finally, we also include the two quality of life indicators Subjective well-being and Purpose in life in Table 2. Although this is not the main focus of this paper, it is relevant to capture this aspect of materialism in relation to previous literature and other data samples. The results are in line with previous research as both of these indicators show clearly that materialists are less content with their lives.

Although the ANOVA gives a "true" picture of how the groups actually differ, the dissimilarity in background variable such as age and income between the groups also undermines some of the results. This is further analyzed in section 3.1 by means of an ANCOVA approach.

Table 2: Relationship between materialistic values and other factors

	Average		Mat-low		Mat-high		Sig.
	Mean	(s.d.)	Mean	(s.d.)	Mean	(s.d.)	
Background characteristics							
Net household income (tSEK/year)	392	(173)	365	(154)	402	(185)	0.049
Gross personal income (tSEK/year)	310	(143)	**284**	**(115)**	**319**	**(148)**	0.021
Gender (share men)	0.45	(0.50)	0.40	(0.49)	0.47	(0.50)	0.101
Education (1-8)	5.0	(1.78)	**4.6**	**(1.88)**	**5.2**	**(1.69)**	0.000
Age (20-65)	46	(13)	**52**	**(11)**	**40**	**(12)**	0.000
Working-hours (hours/week)	34	(17)	**30**	**(18)**	**34**	**(18)**	0.001
Satisfied with own economy (1-7)	4.9	(1.70)	**5.0**	**(1.72)**	**4.5**	**(1.73)**	0.001
Left-right party (Left=1, Right=7)	3.9	(1.69)	**3.5**	**(1.60)**	**4.3**	**(1.70)**	0.000
Purpose in life (0-10)	7.0	(1.93)	**7.2**	**(1.94)**	**6.6**	**(2.00)**	0.002
Subjective well-being (0-10)	7.4	(1.87)	**7.8**	**(1.73)**	**7.0**	**(2.01)**	0.000
Environmental concern							
Interested in Environment (1-7)*	4.7	(1.36)	4.8	(1.40)	4.6	(1.35)	0.414
Worried about climate change (1-7)	4.8	(1.44)	4.8	(1.56)	4.9	(1.44)	0.762
Growth/Environment trade-off (1-7)	4.2	(1.7)	4.4	(1.8)	4.1	(1.6)	0.361
Attitude to increased CO_2-tax (1-7)	3.3	(1.61)	3.4	(1.68)	3.3	(1.60)	0.676
GHG emissions							
GHG emissions per adult (ton/year)	8.3	(3.18)	**7.6**	**(3.07)**	**8.6**	**(3.00)**	0.003
Residential energy	2.2	(1.7)	2.2	(1.6)	2.1	(1.4)	0.219
Transport	1.8	(1.5)	1.7	(1.6)	1.9	(1.5)	0.584
Food	1.5	(0.16)	1.5	(0.15)	1.5	(0.17)	0.257
Air travel	1.5	(1.5)	**1.1**	**(1.3)**	**1.7**	**(1.5)**	0.000
Other consumption	1.3	(1.0)	1.2	(1.0)	1.4	(1.0)	0.119
Status commodities							
Car ownership (share)	0.84	(0.37)	0.86	(0.35)	0.80	(0.40)	0.199
Total value of cars (tSEK)**	67	(75)	62	(66)	80	(94)	0.268
Value of most expensive car (tSEK)**	57	(64)	53	(53)	65	(79)	0.621
Premium brands (share)	0.09	(0.29)	0.12	(0.32)	0.11	(0.31)	0.312
Green car	0.18	(0.38)	0.16	(0.37)	0.15	(0.36)	0.623
Housing cost (tSEK/month)	86	(61)	**73**	**(40)**	**102**	**(92)**	0.000
Size of dwelling	114	(55)	113	(53)	111	(56)	0.671
Private house owner (%)	0.57	(0.50)	0.59	(0.49)	0.52	(0.50)	0.248

Note: Numbers marked in bold indicate a significant (p<.05) difference between the quartile group with the lowest score and the quartile group with the highest scores using Tukey post-hoc tests.
* 1=Do not agree, 7=fully agree.
** This model only included respondents who did not dispose of a company car and where price estimates of the cars could be conducted (N=556).

3.1 The ANCOVA model

In this study our main objective is to examine if materialism is an important enough factor to generate differences in environmental concern or GHG relevant behavioral differences. The ANCOVA represents a robust way of analyzing differences between sub-groups while holding variables at fixed average levels, and use Tukey post-hoc test to detect difference between groups. This method also offers a good opportunity to analyze non-linear inter-group relationships. In order to be able to control for possible underlying or otherwise distorting effects from variables we run a stepwise regression to elicit variables correlating with materialism. We find that age and household income correlates positively with materialism, while the difference in education found in the ANOVA is not significant, probably because older respondents are in general less educated. The effect of household income is problematic as materialists could be hypothesized to work and earn more, which would increase household income, but since the differences between groups is so big we decide to include net household income as a covariate in the model even if it risk causing type 2 errors.

3.1.1 Do materialists care less for the environment than others?

When applying the ANCOVA model (table 3), we find no significant differences for any of the variables used to measure environmental concern. Although the relations go in the hypothesized direction they are very weak, and it seems differences in materialism do not affect environmental attitudes to any larger extent. We will return to these results and their implications in the discussion in section 4.

3.1.2 Do materialists generate more GHG emissions than others?

As stated before, materialism could affect individuals' GHG emissions in two ways, either this group consumes differently, or simply more than others. We use the ANCOVA model on GHG emissions and GHG related variables seen in table 3. The results suggest that when keeping age and household income on the same level in all four groups, the differences in GHG emission between the highest and lowest quartile group's amounts to roughly 900 kg. Again, the only statistically significant difference found using the Tukey post-hoc test is for air travel, quartile 1 (M = 1.1, 95% CI [0.9, 1.3]), 4 (M = 1.7, 95% CI [1.5, 1.9]). This means that air travel accounts for roughly two thirds of the total difference in GHG emissions between groups 1 and 4. If we deduct air travel from the remaining GHG emissions, we find no statistically significant difference between the groups. The fact that air travel is the activity most strongly related to materialism is of course interesting, as it is not an acquisition of a certain high-status commodity, and this finding will be further discussed in section 4.

We proceeded to compare air travelling behavior and found that the difference in GHG emissions between the low and the high materialist groups is caused by increased number of flights to Europe and the rest of the world, while no significant increase could be found for shorter air travels within the Nordic countries. The questionnaire also included a question designed to elicit information about the perceived status attached to travels to remote destinations, and the correlation between this air travel encouraging group norm and materialism was moderate to strong (Pearson's *r* 0.31**). Taken together these two findings indicate that materialists regard air travel as a conspicuous activity that increases status.

Table 3: ANCOVA on the relationship between materialistic values and other factors

	Mat-low		Mat-high		Sig.
	Mean	(S.E)	Mean	(S.E)	
Environmental concern					
Interested in Environment (1-7)	4.7	(0.09)	4.6	(0.09)	0.670
Worried about climate change (1-7)	4.8	(0.10)	4.9	(0.10)	0.384
Environment/growth trade-off (1-7)	4.4	(0.12)	4.1	(0.11)	0.603
Attitude to increased CO_2-tax (1-7)	3.4	(0.11)	3.2	(0.11)	0.405
GHG emissions					
GHG emissions per adult (ton/year)	**7.7**	**(0.19)**	**8.6**	**(0.19)**	**0.007**
Residential energy	2.1	(0.11)	2.2	(0.11)	0.219
Transport	1.8	(0.10)	1.8	(0.09)	0.683
Food	1.5	(0.01)	1.5	(0.01)	0.480
Air travel	**1.1**	**(0.10)**	**1.7**	**(0.09)**	**0.000**
Other consumption	1.3	(0.05)	1.3	(0.05)	0.119
Status commodities					
Car owner (share)	0.86	(0.02)	0.82	(0.02)	0.340
Total value of cars (tSEK)*	82	(6.3)	97	(6.5)	0.339
Value of most expensive car (tSEK)*	70	(5.4)	81	(5.6)	0.576
Premium brands**	0.11	(0.24)	0.12	(0.24)	0.218
Green car	0.19	(0.34)	0.16	(0.34)	0.439
Current housing cost (tSEK/year)	**80**	**(3.6)**	**98**	**(3.6)**	**0.009**
Size of dwelling (m^2)	113	(3.2)	112	(3.1)	0.845
Private house owner (share)	0.58	(0.03)	0.53	(0.03)	0.535

Note: Means adjusted for participants' age (46), household income (393 kSEK), sex (46% male), and whether they had children under 18 living at home (37%). Numbers marked in bold indicate a significant ($p<.05$) difference between the quartile group with the lowest score and the quartile group with the highest scores in a pairwise comparison using Sidak adjustment.
* This model only included respondents who did not dispose of a company car and where price estimates of the cars could be conducted (N=556).
** Premium brands included were: Mercedes, BMW, Porsche, Jaguar, Rolls Royce.

As for the status commodities measured, we find no significant difference in any of the car related variables between groups, but the difference in housing costs remains significant when age and household income is included in the model. Just as with air travel, the materialist groups' focus on accommodation is at odds with the theoretical assumptions about the focus on possessions. Although housing is certainly assumed to be a status good (one of the question items in the material values scale even reads: "I admire people who own expensive homes, cars, and clothes") our analysis indicate that since the difference is not caused by size, the most likely factor making up this difference is the *location* (although we are not able to control for differences in rental/owner apartment). The theoretical implication of this result is further discussed in the next section.

4. Discussion

This study provides several new results that point the theoretical discussion into new directions and suggest new questions to deal with. Although the result that materialists generate more GHG emissions than others through more frequent air travel is perhaps the most policy relevant finding, we will focus on two other results, namely the lack of difference between the non-materialist and materialist group in terms of concern for the environment, and secondly how our broad examination of materialists consumption imply that common assumptions about the nature of materialism may be too simplified.

The result that materialists do not differ significantly from others in their environmental concern, and specifically the finding that materialists' attitudes toward a proposed increase of the Swedish carbon tax do not differ from the low-materialist group, show that materialistic predispositions does not seem to be an important factor affecting individual's attitudes toward environmental policymaking. This result runs counter to results from other international surveys analyzing this relationship (see Kilbourne and Picket, 2008; Hurts et al., 2013 for a meta-analysis), and the difference may be caused by the relatively strong social norms and attitudes surrounding the environmental issue in Sweden (Witherspoon, 1996). One could also argue that the "materialist" group in our sample is in fact not particularly materialistic, as they only represent the most materialistic quartile of a strongly non-materialistic sample population. But the significant differences in satisfaction with one's household economy, frequency of air travelling and housing costs found between groups in the above analysis, suggests that materialistic predispositions are related to behavioral differences relevant to the climate issue. This also has implications for the theoretical discussion on materialism introduced in section 1.1, since the *materialism as identity* approach does not presuppose that materialists hold negative attitudes towards the environment, even though their behavior may cause indirect negative environmental impacts. It therefore seems as if this approach is better suited to encompassing the results of the present study than the *materialism as value* approach.

The main theoretical contribution of this study is probably the picture that emerges when we get an overview of materialists' consumption in different sectors. As mentioned in section 1.1, the focus of materialists on possessions as means to gain social status lies at the heart of the concept. But in this study we have shown that materialists travel more and are willing to spend more money on their housing, while they do not own more expensive cars or live in larger houses. This result indicates that for the relatively younger materialist group, living in an attractive area and traveling to remote destinations might be more important status features than the value or brand of their cars, or the size of their housing. From a broader perspective, these results may also serve to alter (our) stereotype beliefs about which group is most heavily involved in status consumption, as traveling to remote destinations and living in the "right" neighborhood is not something traditionally considered as materialist traits.

These results could be treated as an anomaly or a result only relevant to Sweden, but even if Swedish citizens status pursuits are in fact different from others, the "modern Swede" might very well provide indications of future changes in consumer culture in other Western-European countries (see Inglehart and Welzel 2010). Our results are also substantiated by the recent contribution of Shrum et al., (2012) who propose that materialism is best defined as "the extent to which individuals attempt to engage in the construction and maintenance of the self through the acquisition and use of products, services, experiences, or relationships that are perceived to provide desirable symbolic value" (p. 1180). Given this view, commodities may still largely occupy materialists' endeavors but they are employed as functional status *symbols* given by a specific cultural context (i.e. present consumer society), and other commodities associated with high status lifestyles will also take up the interest of materialists. Future research that explicitly analyzes differences in household budgets and actual goods and services purchased, and relate this data to differences in values, norms and identities could probably act to further inform the theoretical discussion.

So, does this mean that environmentalists should be concerned about materialism? As we have seen, materialists cause more GHG emissions than others, which indicate that the spreading of materialism could generate further difficulties. But although air travel is among the most GHG intensive activities we can engage in, the tendency of materialists to spend a larger share of their household budget on housing should at least on the individual level imply reduced GHG emissions. As noted earlier, the strong relationship between income and GHG emissions and an assumed willingness to earn and spend more money found in our data is perhaps the most important factor affecting GHG emissions. This study has been concerned with individual differences, but if materialism is best described as a broad social phenomenon describing an increasing willingness to accumulate wealth and acquire commodities or experiences that improve their social status, this tendency could be an important driving force in a work-consumerist society. Hence the climate related effects of the increasing materialism in western countries are a complex issue that deserves future interest.

5. Conclusions

In this study we have examined the relationship between materialism and the climate change issue. We have done this by comparing more and less materialistic individuals' concern for the environment and by examining whether they differ with respect to consumption and its related GHG emissions. Contrasting previous research we found no differences in environmental concern between the most and the least materialist groups. GHG emissions, however, differed substantially (1 ton) between these groups. A second intention was to make use of the data collected in the study to provide a more comprehensive picture of materialist's consumption in different domains. This additional enquiry was motivated by what we saw as an *a priori* presumption that materialists hold a special interest in material goods rather than services or other commodities to boost their social status. The results from these examinations was somewhat surprising as we found no significant differences in car related ownership costs, while housing fees differed substantially between the groups. Taken together with the fact that materialists differed substantially in number of air travels to non-Nordic destinations, this suggests that materialist's status seeking behavior is not limited to consumer goods, and that a broadened concept of materialism should be considered.

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Appendix: Material Values Scale

Materialism was measured based on the 9-item version of the Material Values Scale (MVS, Richins 2004) as shown below. Item 4 and 9 were excluded the analysis for reason described in Section 2.1. Answers were provided on a 10–point Likert scale.

1. I admire people who own expensive homes, cars, and clothes.
2. The things I own say a lot about how well I'm doing in life.
3. I like to own things that impress people.
4. I try to keep my life simple, as far as possessions are concerned. (reversed scale)
5. Buying things gives me a lot of pleasure.
6. I like a lot of luxury in my life.
7. My life would be better if I owned certain things I don't have.
8. I'd be happier if I could afford to buy more things.
9. It sometimes bothers me quite a bit that I can't afford to buy all the things I'd like.

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