UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

Reforestation & Marine Permaculture: Does the Method Affect the Willingness To Pay for Carbon Offsetting?

A Randomised Contingent Valuation Study

Elice Fällström & August Schelin

Abstract

Failing to limit global mean surface temperature rise to 1.5°C risks leading to irreversible environmental degradation. One measure to mitigate global warming is carbon offsetting through increasing biotic carbon sequestration. This thesis utilises a randomised contingent valuation study to evaluate the willingness to pay for carbon offsetting as a measurement of the reduction in utility that respondents experience from environmental degradation, based on the microeconomic framework of equivalent variation. Specifically, we look at if the method used for offsetting impacts the willingness to pay for the service by investigating reforestation and marine permaculture. We analyse our data through various regression models, postestimation commands and paired t-tests using Stata. Our regressions gave inconclusive results regarding the effect of the offsetting method used in our main test. Furthermore, our paired t-test results showed significant, albeit small differences in means between willingness to pay for offsetting through the respective method, as well as for the familiarity of the two methods. Both mean values were higher when reforestation was the method considered. The literature review supports the idea that the choice of method is important in terms of co-benefits. Lastly, we found evidence that education affects the willingness to pay for carbon offsetting positively.

Keywords: Carbon offsetting, Reforestation, Marine permaculture, Contingent valuation, Willingness to pay

Bachelor's thesis in Economics, 15 credits
Spring Semester 2020
Advisor: Claes Ek

Department of Economics
School of Business, Economics and Law
University of Gothenburg

Acknowledgements

We want to extend our most heartfelt gratitude to our advisor Claes Ek for his expertise and time spent guiding us through the process of writing this thesis. His support, patience and thoroughness every step of the way has been invaluable. Furthermore, we would like to thank the more than 400 students who took the time to answer our surveys, making this thesis possible. We also want to thank our friends and family who took the time to revise and comment on our work. Lastly, we would like to extend our gratitude to The Student Union at The School of Business, Economics and Law, HHGS, for always greeting us with a smile and allowing us to use their rooms while other areas of society and the school closed down due to Covid-19.

Table of Contents

List of Figures and Tables

Acronyms

BSc	Bachelor of Science Program
CDR	Carbon Dioxide Removal
CVM	Contingent Valuation Method
CSN	Swedish National Board of Student Aid
EV	Equivalent Variation
FAO	Forest and Agriculture Organisation of the United Nation
GHG	Greenhouse Gas
GMST	Global Mean Surface Temperature
IPCC	Intergovernmental Panel on Climate Change
NOAA	National Oceanic & Atmospheric Administration
ppm	Parts per million
SAP	Bachelor of Science Program in Community Analysis
SEK	Swedish Kronor
SMIL	Bachelor of Science Program in Social Environmental Science
UNFCCC	United Nations Framework Convention on Climate Change
WTP	Willingness To Pay

1. Introduction

Scientists around the world are in consensus that human activities have in large induced global warming since the industrial revolution and that the effects of this phenomenon are observable and will get worse (Cook et al., 2016). In order to mitigate the severity of the new conditions, the UNFCCC authored and accepted the Paris Agreement in 2015, stating that nations worldwide must collaborate in order to mitigate global warming. Collaborative measures involve undertaking joint action to reach the set goal of limiting the global mean surface temperature (GMST) rise to 1.5°C above pre-industrial levels, allowing a maximum increase of 2°C by 2050. IPCC (2019) further states that if this goal is to be met, future rates of emissions reductions must increase. As the limits for atmospheric concentrations of greenhouse gases (GHGs) and the GMST rise limitation goal of 1.5°C approach, IPCC explains that the time left to transition away from GHG intensive processes decreases. IPCC also points out that atmospheric concentrations of GHGs will continue to increase as long as GHG emissions remain net positive and will eventually push the Earth past its tipping point, leading to irreversible environmental damages.

In this thesis, we attempt to address the challenges that limiting global warming in time pose by investigating carbon offsetting as a potential part of the solution. Because of the inertia related to changing behaviour, carbon offsetting is now considered as a necessary part of global warming mitigation strategies, according to IPCC (2019). Its importance in such strategies increases the closer the GMST rise gets to the 2°C limit as the time left to transition to more sustainable processes diminishes. Specifically, this thesis studies the willingness to pay (WTP) for carbon offsetting to investigate the demand for such projects from an economic standpoint. We chose to look at carbon offsetting from a WTP-standpoint based on the microeconomic framework of equivalent variation, which is commonly used in environmental economics to quantify the monetary value of preventing degradation in environmental quality.

We further investigate whether the method through which the carbon offsetting is performed affects individuals' WTP for the service, using a combination of a randomised experiment and the contingent valuation method (CVM). Through our experiment, we attempt to answer whether the method impacts WTP by studying two contrasting methods; reforestation – an established and land-based method – and marine permaculture – a novel and ocean-based method. In addition, we will conduct a literature review of the current science to present a more holistic picture. The literature review will include a microeconomic framework, behavioural economics and co-benefits of the two methods, such as areal usage and contributions to ecosystem health. Such aspects should, in addition to WTP, be included in cost-benefit analyses of organisations working with carbon offsetting projects.

The information we hope to attain can be used in a variety of contexts. WTP for carbon offsetting in general, and the respective method used in particular, will give valuable information regarding the legitimacy of projects from a political standpoint as well as a business perspective. As limiting global warming is a global issue and thus politically challenging, it is vital to have public support for proposed actions, and WTP can serve as an indicator of the level of support. For organisations working with carbon offsetting, WTP for the service is an integral part of their external analyses. Furthermore, different methods do not share the same properties in terms of what other values – costs and benefits – are associated with implementing projects. To minimise costs, both monetary and otherwise, as well as to maximise the benefits in terms of carbon sequestration efficiency and co-benefits, it is crucial to know if the method used affects the WTP for carbon offsetting. This applies to policymakers, science funding organisations and organisations working with carbon offsetting.

While this thesis focuses on carbon offsetting, it is vital to note that in order to reach the 1.5°C limitation goal, emissions must also decrease, for example through lifestyle changes and decarbonisation of the energy sector, in addition to removing carbon already emitted to the atmosphere. However, this is outside the scope of this thesis. Due to limited time and funding, we have chosen to limit our study to include students at the School of Business, Economics and Law at University of Gothenburg, Sweden. Thus, the research question laying the ground for this thesis is: Among students at the School of Business, Economics and Law at Gothenburg University, does the willingness to pay for carbon offsetting differ depending on the method used?

2. Background

The following section is intended as an overview of central concepts to this thesis. It is divided into four parts – Carbon Offsetting, Microeconomic Framework, Reforestation, and Marine Permaculture. With the information presented, which was gathered through a literature review of current environmental and economic science, we aim to put our experiment into context.

a. Carbon Offsetting

In this thesis, we will focus on carbon offsetting through photosynthesis; a process in which carbon is biotically sequestered[1] from the atmospheric carbon reservoir and stored in the oceanic or terrestrial carbon reservoir (Selin, 2019). Lal (2007) states that the oceanic and terrestrial carbon reservoirs capture and store 60 percent of the GHGs emitted by humans to the atmosphere through photosynthesis. However, given the 1.5°C limitation goal and the fact that the global anthropogenic emissions are still rising, IPCC (2019) suggests that the amount of sequestered carbon dioxide must increase continuously at the same time as the global GHG emissions decrease. In other words, the annual anthropogenic net emissions[2] must be reduced.

In order to decrease the likelihood of overshooting the global limit of 2°C in GMST rise, IPCC (2015) writes that the carbon dioxide equivalent concentrations in the atmosphere must remain below 450 parts per million (ppm). According to NOAA (2020a), the concentrations are currently at 416.21 ppm, with an annual mean global carbon dioxide growth rate of approximately 2.5 ppm per year (NOAA, 2020b). IPCC (2019) writes that given the current state, the best chance to achieve the 1.5°C limitation goal is through a combination of lifestyle changes and carbon dioxide removal (CDR) strategies. The main reason for why CDR is part of the majority of mitigation strategies, IPCC (2015; 2019) mentions, is due to its cost-effectiveness. One such CDR strategy is to increase biotic carbon sequestration through carbon offsetting activities.

---

[1] Carbon can also be sequestered abiotically through synthetic methods that utilise engineering techniques. Though both biotic and abiotic sequestration have merit, this thesis will solely consider biotic carbon sequestration.

[2] Net emissions is the difference between emitted and sequestered carbon dioxide.

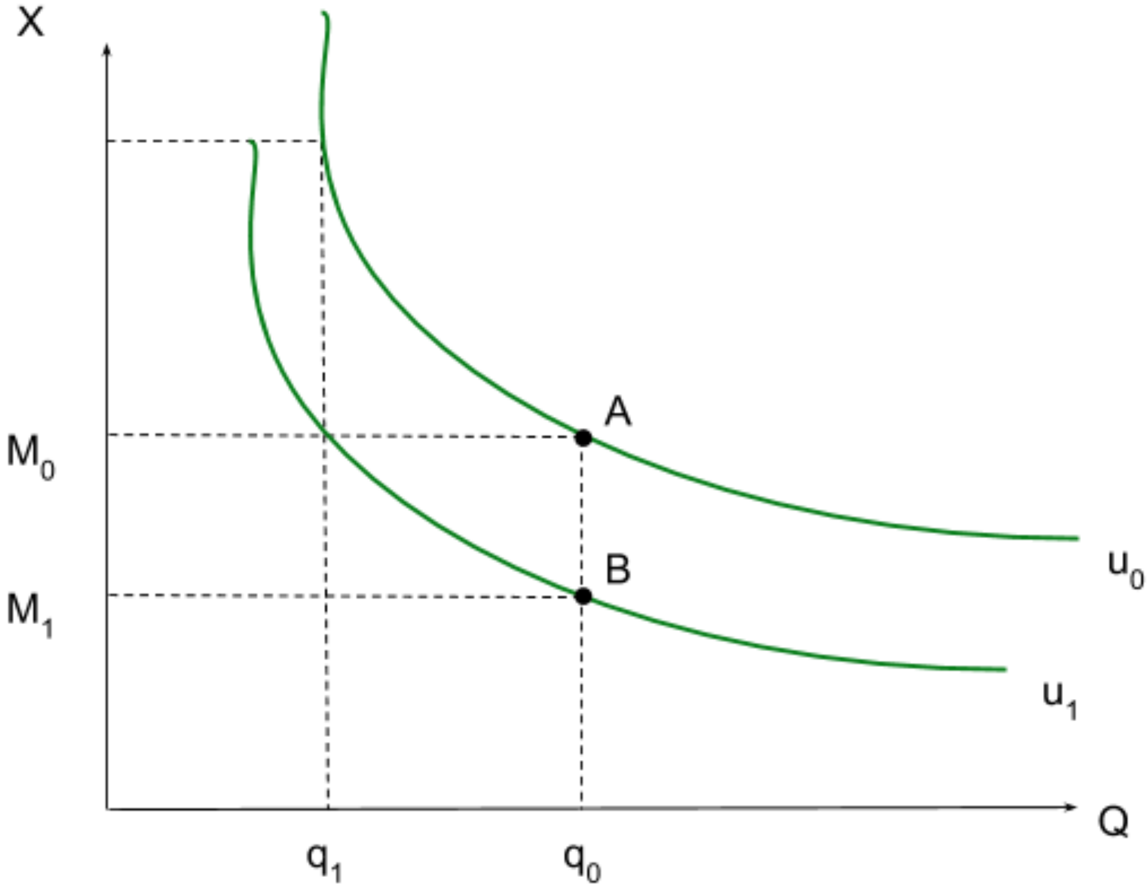
Carbon offsetting is defined as “Principle of an individual, business or organisation compensating for their production of carbon dioxide (or other GHGs) by undertaking, or paying someone else to undertake, actions which will remove carbon from the atmosphere.” (Manley, Foot & Davis, 2019). In recent years, the debate on global warming and the human influence on the phenomenon has become louder, and carbon offsetting has become increasingly familiar as a service (Vidal, 2019, 2 August). It is now offered on the global market as a way to limit individual contribution to global warming. Today, individuals are generally offered to offset their emissions for specific GHG intensive activities, such as flights. This thesis differs from other research regarding offsetting in that it focuses on individuals’ WTP to offset 100 kilograms of emissions from any source, rather than for a specific activity.

b. Microeconomic Framework

In order to understand why WTP for carbon offsetting is interesting to study, it is important to understand the microeconomic theory behind WTP. In contingent valuation studies, Ahlheim and Buchholz (1999) explain that the stated maximum WTP is a measurement of how much, in monetary terms, respondents' are willing to give up in order to prevent a negative change in the provision of a good or service, but that would result in the equivalent reduction in utility as the negative change. They further point out that in microeconomic theory, this is referred to as the equivalent variation (EV). We will illustrate this theory and how an individual’s utility changes using an indifference map (figure 1) applied to our experiment, based on Ahlheim and Buchholz (1999) descriptions.

In figure 1, the quality of the global climate, Q, is expressed on the horizontal axis. The vertical axis expresses other market goods that an individual can purchase, considered as a composite market commodity of quantity X. As Ahlheim and Buchholz (1999) states, environmental quality is a free, public good. Therefore, the individual's budget, M, solely considers the composite market commodity; making his/her budget constraint flat and horizontal. Furthermore, we assume that the individual has convex indifference curves denoting the individual’s level of utility, u, derived from the quality of the global climate and the quantity of the composite market commodity. The higher in the diagram an indifference curve appears, the higher the utility of the individual.

Figure 1: Indifference map



Ahlheim and Buchholz (1999) describe that when the environmental quality decreases, from q_0 to q_1, the individual's utility will decrease as well – from u_0 to u_1. However, instead of considering a reduction in utility through a reduction in quality, they explain that one can consider the equivalent reduction in utility due to a reduction in budget. In figure 1, this is illustrated by the shift from M_0 to M_1, holding the quality constant at q_0. By considering how much money can be taken away from the individual at the initial state to obtain the equivalent reduction in utility, a measurement of the magnitude of that reduction in utility is achieved. The monetary quantification, Ahlheim and Buchholz (1999) state, is the equivalent variation, i.e. the maximum WTP, to prevent a decrease in environmental quality, and is illustrated by the vertical distance from A to B. In this thesis, the respondents' stated maximum WTP for carbon offsets is thus a measurement of the amount of money that can be taken from them, resulting in the equivalent, lower level of utility as a degradation in the quality of the global climate.

However, the theory of equivalent variation is a simplified way of looking at the purchasing process regarding carbon offsets, which does not necessarily capture the entire decision-making process of a consumer. One way of nuancing an individual's decision to purchase offsets is by considering factors such as altruism as well as social norms as part of the explanation. Blasch and Ohndorf (2015) found that altruism, particularly impure altruism, is a driving factor in how much individuals are willing to pay for carbon offsets. That is to say that people may be altruistically motivated to purchase offsets by knowing that they are doing good for the environment or for other people, or, in the case of impure altruism, by the increased level of moral satisfaction they experience while doing so. However, with regards to the likelihood of a person purchasing offsetting services, they found that the utility an individual gains due to social approval, or loses due to social disapproval, is a better explanatory variable. Blasch and Ohndorf further explain that an individual may feel pressure from their peers to offset, and is motivated to do so rather due to that pressure than due to pure altruism. Thus, instead of considering the utility the individual him-/herself gains from prohibiting a decrease in environmental quality, Blasch and Ohndorf explain that he/she considers the utility he/she gains from avoiding disapproval from peers. While our study does not elicit the respondents' motivations behind their WTP, we recognize the benefits of including impure altruism and social approval when investigating consumers' purchasing processes, and encourage future studies to do so.

c. Reforestation

The global forests compose the largest terrestrial carbon reservoir (Bastin et al., 2019) and sequester 470 grams of carbon per square meter and year of terrestrial cropland (Hughes et al., 2012). However, Matthews, Payne, Rohweder and Murray (2000) explain that the flux of carbon from the forests due to natural disturbances (e.g. fires) and anthropogenic activities (e.g. deforestation) causes the forests' net production, i.e. their net contribution to reducing the amount of atmospheric carbon, to be marginal. Furthermore, the anthropogenic activities decrease the net production further through degradation of the existing forest cover (FAO, 2018; FAO, 2016). As a result, the natural forest carbon cycle is altered, which, together with the combustion of fossil fuels is the primary cause of global warming (FAO, 2018).

Bastin et al. (2019) argue that increasing the global tree coverage, and thus the terrestrial biotic sequestration of carbon dioxide, is one of the most effective sequestration strategies available to mitigate climate change, and thereby to limit global warming. Increasing tree coverage can be done through reforestation and afforestation. By definition, reforestation is the act of planting trees in a formerly wooded area in order to restore its forest cover after cutting or fire (UNFCCC, 2002). Afforestation, on the other hand, refers to the act of planting trees on land that has not been covered by forest[3] in the last 50 years (ibid.). This thesis will focus on terrestrial biotic sequestration of carbon dioxide solely through reforestation[4], which is considered an established method for carbon offsetting primarily due to its wide recognition as such in environmental science. Additionally, the method is well-known to the average citizen due to its global implementation, and the fact that forests reduce the amount of carbon in the atmosphere, thus mitigating global warming, can be considered common knowledge. According to Hamrick and Gallant (2017), carbon offsetting projects through afforestation and reforestation sequestered 1.3 million tons of carbon dioxide equivalents in 2016. In the same year, carbon offsets through such projects sold at an average price of USD 8.1 per ton of carbon dioxide equivalents.

d. Marine Permaculture

Permaculture is a concept defined as "Permanent agriculture: a sustainable form of agriculture that is designed to enhance local ecosystems and increase local biodiversity [...] as well as food." (Park & Allaby, 2013). Marine permaculture is an adaptation of permaculture by which macroalgae (kelp) is planted in oceans to create and enhance aquatic ecosystems in a sustainable way. In 2017, kelp was produced at a rate of 12 million tonnes per year, primarily to be used as food for humans (Flannery, 2017).

More recently, the merits of marine permaculture as a means of carbon sequestration, thus enabling the limitation of GMST rise, have begun to be explored. As with terrestrial biotic sequestration, oceanic biotic sequestration of carbon dioxide through macroalgae occurs through photosynthesis. However, the carbon sequestration of macroalgae is much higher than that of trees – at 1600 grams of carbon per square meter and year (Hughes et al., 2012). In fact, according to Morerira and Pires (2016), cultivating 1 kilogram of macroalgae can fix 1.83 kilograms of carbon dioxide. Moreover N'yeurt, Chynoweth, Capron, Stewart, and Hasan, (2012) calculate that covering 9 percent of the world's ocean surface with macroalgae has the potential to replace all fossil fuels used today with biomethane and sequester over 50 billion tonnes of carbon dioxide per year from the atmosphere. A replacement of fossil fuels alone, however, is not a solution to limit global warming as there

[3] In this regard, forests are defined as a land area of at least 0.05 hectares, covered by trees with a potential height of at least two metres and a potential tree crown cover of at least 10 percent.

[4] In existing data and literature, afforestation and reforestation are commonly mentioned together. However, we have as far as possible used sources where data on reforestation is distinguishable.

nevertheless would be a continued flux of carbon to the atmospheric reservoir through the burning of the biomethane.

Gameau, Batzias, Kaplan, Whitwell, and Gameau (2019) describe marine permaculture as a potential solution to limit global warming. The proposed method to develop marine permaculture is to anchor marine permaculture arrays, made from recycled, non-toxic materials, 25 meters below the ocean surface. On these, a species of kelp is planted, and as it grows, the arrays sink deeper to allow it to grow even taller. The arrays are described to be connected to a pump driven by the kinetic energy of the ocean. They state that the purpose of the pump is to bring up cold, nutritious water from deeper parts of the ocean, which fertilises the kelp and stimulates growth. Once growing, the kelp biotically sequesters carbon from the atmospheric reservoir and stores it in the oceanic reservoir. Though kelp plantations have existed for several years in South-East Asia (Flannery, 2017), as of today, the concept of marine permaculture as a means of carbon offsetting has only been tested in pilot facilities in Australia, as mentioned by Gameau et al. (2019). They claim that the kelp planted there can grow at a rate of 50 to 100 centimetres per day, making it the fastest-growing species in the world.

As marine permaculture is a novel method for carbon offsetting that has only been studied in a few pilot projects, we want to recognise the limited amount of publications about marine permaculture as a method for carbon offsetting; the focus of the pilot projects is not solely on carbon offsetting but also co-benefits of marine permaculture. Despite this, we chose to study marine permaculture as it adds a level of contrast to our research. Our choice of methods facilitates the analysis of whether the WTP for carbon offsetting is affected by the method as reforestation is land-based and established, whereas marine permaculture is ocean-based and novel. However, due to this choice, our literature study regarding marine permaculture mostly relied on current science on macroalgae as a carbon offsetter as well as permaculture as a cultivation method. Therefore, our study provides insights into the possibilities of marine permaculture as a carbon offsetter in theory. However, it may not completely represent the effects of marine permaculture in practice today.

3. Method

This thesis is a quantitative study based on a combination of contingent valuation and randomised experiment. The experiment is analysed through several regression models, postestimation and t-tests made to answer the research question "Among students at the School of Business, Economics and Law at Gothenburg University, does the willingness to pay for carbon offsetting differ depending on the method used?". To put the experiment in a relevant context, we conducted a literature study of the current science of carbon offsetting in general, and reforestation and marine permaculture in particular, as presented in section 2.

a. Hypotheses

We hypothesised that the method used would affect WTP for carbon offsetting and that our population would not have the same average WTP for the two methods. We further believed one of the driving factors of our hypothesised difference in WTP between the methods to be prior knowledge of the method in question. Therefore, we hypothesised that our population was not equally familiar with the two methods used. We tested these hypotheses using the following null hypotheses:

1. The method used for carbon offsetting does not affect WTP for the service.
2. The people in our population have the same average WTP for carbon offsetting for both methods used.
3. The people in our population are equally familiar with the methods for carbon offsetting studied – reforestation and marine permaculture.

b. Data Collection and Survey Design

To investigate our research question and test our hypotheses, we used the CVM to design four surveys[5] in order to collect data on our population. We then performed a randomised experiment where these surveys were sent out via email to 2671 student email addresses at the School of Business, Economics and Law at the University of Gothenburg. By opting to use email as our only response collection method, we were able to ascertain that the sample was drawn only from our target population. In order to randomise which survey respondents got to answer, we used the online randomised redirecting tool "allocate monster" which randomly assigned the respondents to one of four surveys.

[5] For an overview of the surveys, see Appendix 1

The surveys were designed to be self-administered using Google Forms in order to reduce selection bias and interviewer bias. Selection bias occurs when the sample population does not accurately represent the population due to certain factors in the survey permitting loss to follow-up (Keil & Edwards, 2019). A loss to follow-up can occur, for example, if the topic of the survey attracts only a certain subset of the population, thus causing false relationships between variables to occur. False relationships can also occur from interviewer bias, where respondents are prone to answer in a certain way, not representing their true preferences, in order to please the interviewer (Scott & Marshall, 2015).

According to FAO (2000), CVM is a commonly used method when studying stated preferences for a change in the quality of environmental goods and services. The method is primarily used when the change considers goods and services with large non-use values and without available data, as is the case when considering mitigation of global warming through carbon offsetting among students. As we wanted to study the stated preferences expressed in WTP among students for the service carbon offsetting, we, therefore, considered CVM to be a good fit. The surveys were finalised after having tested them with a focus group consisting of 15 students from other universities in Sweden, thus resembling our target population well. By conducting a test study with our focus group, we were able to ascertain that our questions were clear and to the point, and verify that our randomisation was working. In order to obtain data on our variable of interest; the method for carbon offsetting, as well as our additional treatment variables; information and order, the surveys all consisted of five main parts:

1. Cheap-talk and oath script
2. Scenario and payment question for [first method]
3. Scenario and payment question for [second method]
4. Respondent behaviour
5. Demographics

The first section was included to reduce hypothetical bias throughout the survey (Cummings & Taylor, 1999). Murphy, Allen, Stevens and Weatherhead (2005) describe hypothetical bias as the difference between the stated value in a hypothetical situation, such as in a survey, and the revealed value when the respondent is asked to make an actual payment. They further argue that the stated values often are higher than the revealed values, although that this difference is possible to reduce through the design of the hypothetical situation. Cummings and Taylor (1999) argue that a cheap-talk script can be added at the beginning of the survey to reduce hypothetical bias. They explain that such a script informs the respondents that, according to research, respondents tend to overestimate their actual WTP in hypothetical scenarios. In the cheap-talk script, the respondents are therefore asked to consider how the WTP they will state would affect their finances had they been asked to make an actual payment. In addition, a cheap-talk script can be combined with an oath script, where the respondents are asked to state a promise to answer truthfully, mimicking the similar act in a courtroom. Jacqumet, Joule, Luchini and Shogren (2012) found that when respondents are asked to take an oath, they are less likely to state a false bid value, and that the variance of the responses is reduced.

Regarding the second and third section, we chose to include the two specific methods for carbon offsetting reforestation and marine permaculture, as motivated in section 2.3 and 2.4, rather than to ask for the respondents' WTP for carbon offsetting in general. We chose to do this to make the scenarios resemble actual market transactions, mimicking the conditions under which the respondents make their usual purchasing decisions, in order to increase the probability of obtaining WTP-statements that better resemble their actual WTP.

The surveys were divided into two sets of two – one non-informative set and one informative set. By adding information about the methods, we attempt to control for and decrease the effect of prior familiarity of the method in question on the stated WTP, thus representing preferences more accurately. All surveys included scenarios for both offsetting methods. We also considered the risk of order-effect bias when designing the surveys. Order-effect bias recognises that a respondent may answer differently depending on the order in which the questions are asked (Perreault, 1976), and is thus intimately connected to anchoring bias. More specifically, the order-effect bias recognises that the respondents may be affected by their answers to previous questions when answering questions asked later in the survey. In order to control for this bias, a split-sample approach can be taken, where respondents are randomly assigned to answer different versions of a survey in which the order of specific questions differ (Bateman & Langford, 1997). We did this by letting one survey in each set present the scenario for reforestation projects first (survey A and survey C) and the other to present the scenario for marine permaculture projects (survey B and survey D) first. The different surveys are illustrated in table 1.

Table 1: Illustration of the Surveys

Set	Survey	**Order** (method presented first)	Information
Non-informative	**A**	Reforestation	No
	B	Marine permaculture	No
Informative	**C**	Reforestation	Yes
	D	Marine permaculture	Yes

In the non-informative set, the second section included a scenario where the respondents were asked to imagine having been given a task to find out more about sustainability, as a part of a course at university. As a result, they came across a website for a non-profit organisation working with carbon offsetting through [first method], where customers could pay to offset a minimum of 100 kilograms of carbon dioxide equivalents per month. The respondents were then informed that the average emissions for the average Swedish person are approximately 800 kilograms of carbon dioxide equivalents per month. However, for the survey, they were only asked to consider purchasing only 100 kilograms in offsets. We chose 100 kilograms as the amount to offset to minimise the risk of respondents being asked to offset more than they emit. In the last part of the scenario, the respondents were informed that the payment was to be made monthly, via an automatic payment service, and that their subscription could be cancelled at any time.

Thereafter, the respondents were asked to state their WTP for this service using the payment card method. We chose a payment card with 23 bids and an exponential response scale, as Rowe, Schulze and Breffle (1996) claim that such a scale reduces centring and range bias[6]. Centring bias describes a respondent's tendency to choose the centred value. Range bias occurs when the range of values presented is larger than is adequate for the particular situation, thereby encouraging the respondent to choose a higher value than they otherwise would have. We calculated the intervals between each value using Rowe, Schulze and Breffles' (1996) suggested formula shown in equation 1:

[6] To reduce the risk of these biases further, we would have wanted to present the bids in columns with a different number of bids in each. However, Google Forms only allows options to be presented in a list format. This may have introduced some bias to the respondents' answers.

$$B_n = (1 + k)^{n-1} \quad (1)$$

In this formula, B_n denotes the bid value and k denotes the percentage increase between the cells and is determined so that $(1 + k)^{21}$equals the upper bound for the selected range. In our payment card, the upper bound, i.e. the 22nd bid, was SEK 250. We also included the 23rd bid “more than SEK 250” to account for respondents with a higher WTP. We chose the lower bound, i.e. the first bid, to be SEK 0 in order to identify respondents who have 0 WTP. This range was chosen based on what we consider to be a Swedish student's regular income, centred around SEK 10 000 (CSN, 2020). SEK 250 can thus be considered to be a reasonable amount to remain after fixed monthly expenses have been paid. We, therefore, considered SEK 250 to be an amount a sufficient percentage of the respondents would be willing to pay. The payment question was followed up by a final question of section two; of whether the respondents were familiar with [first method] as a means of carbon offsetting.

Section three was constructed much in the same way as section two. The only differences were that the respondents initially were asked to disregard the previous section, and that [first method] was exchanged for [second method]. After that, the respondents were asked several behavioural questions in section four; enabling us to control for factors that may have influenced the respondents' stated WTP besides the offsetting method, such as transportation patterns and food habits. Using these questions, we constructed a climate impact index for each respondent to later use as a control variable in our regression. How this was constructed is described in section 3c. Section three of the surveys also included an open-ended, free text question on what made the respondents choose a higher amount for carbon offsetting via reforestation projects, if they chose different amounts for the two methods. The surveys were then ended with demographic questions regarding field of study and income.

The surveys in the informative set were constructed using the same layout as the non-informative set. However, the scenario descriptions (in section two and three of the surveys) in the informative set contained an additional paragraph providing basic information on the particular method. In the regression analysis, this additional paragraph allows us to control for the risk of respondents simply expressing their preference for one of the methods solely due to their additional familiarity with it.

Lastly, we want to recognize that respondents' answers may be influenced by the people around them, i.e. classmates, friends and family, as groups create norms to which its members try to adhere to the best of their ability (Blasch & Farsi, 2013). Due to this fact, and given Blasch and Ohndorfs’ (2015) findings regarding the influence of social approval on an individual’s decision-making process presented in section 2.b, we suspect that the students in the BSc Social Environmental Science (SMIL) program may experience an upwards pressure on WTP as the program has an explicit sustainability focus and caring about the environment is expected. However, while this behaviour can be observed ex-post, it is hard to minimise by the design of the surveys.

c. Climate Impact Index

To model the relationship between respondents’ climate impact and WTP, we asked the respondents to quantify their climate impact by answering questions about how much they travel by airplane and by car, as well as their red meat consumption[7]. These three categories were chosen as they are the most significant sources of GHG emissions from households (Druckman & Jackson, 2016) and would give us a better indication of respondents' emissions than asking respondents to estimate them. The questions were constructed to make answering as easy as possible by presenting options for the number of flights *per year,* car travel distance *per month,* and days of red meat consumption *per week.* As the units of measurement differ, these numbers were converted to tonnes of carbon dioxide equivalents per year before conducting the analysis.

For ease of calculation, we used the average distance to the final destination for Swedes, as presented by Kamb and Larsson (2019); 2700 km one-way (roughly the distance from Stockholm to Madrid) as our distance for the question “number of flights within Europe per year” and twice that distance – 5400 km (roughly Stockholm to New Delhi) – as our distance for the question “number of flights outside Europe per year". This number was then doubled as our questions stipulated round-trips and subsequently multiplied by the average emissions of carbon dioxide equivalents per passenger kilometre, which totals to roughly 170 grams per passenger kilometre (Kamb & Larsson, 2019). For the question regarding distance travelled by car per month, the answer alternatives were given in intervals. These intervals were converted to averages to calculate annual emissions. For example, the option "301 to 500 km" was converted to 400 kilometres in our calculations. This number was then multiplied by 12 to get the annual number and finally multiplied by the average emissions per passenger kilometre of roughly 120 grams of carbon dioxide equivalents (European Commission, 2019).

[7] We chose to ask for the respondents consumption of red meat as we assumed the respondents to have an easier time distinguishing their consumption of red meat, as opposed to meat in general or only the largest polluters.

For the final question on red meat consumption, the answers, which were given in days of consumption weekly, were multiplied by 52 to get an annual figure. The portion size was calculated to 78.53 grams of red meat per day, consisting of 33.67 grams beef, 2.25 grams lamb and 42.63 grams pork, derived from Jordbruksverket's (2020a) data, as well as their presented observations (Jordbruksverket, 2020b). These figures were then multiplied by the emissions from the respective meat source; roughly 60, 24 and 7 grams of carbon dioxide equivalents per gram of meat (Ritchie & Roser, 2020). The products were then summed. The emissions from flights, car travel and red meat consumption were then summed, resulting in a numeric value for total annual emissions. This value ranged from approximately 0.01 tonnes of carbon dioxide equivalent emissions per year if a respondent chose the lowest option on each question, to approximately 18.25 tonnes if a respondent chose the highest option on each question. These numbers were used as a climate impact index to control for behaviour and environmental consciousness in our regression analysis.

d. Data Analysis

When analysing our data, we used Stata to run numerous regressions in order to understand the relationship between WTP and our treatment variables. For ease of explanation, the variables will be explained in the context of our main regression model (model 1).

$$WTP = \beta_0 + \beta_1 Method\_R + \beta_2 No\_Info + \beta_3 Second + \beta_4 Method\_RxNo\_Info + \beta_5 Method\_RxSecond + U \quad (2)$$

The treatment variables in model 1 are the following:

- *Method_R* is our variable of interest and denotes the carbon offsetting method. This is a dummy variable taking the value 1 if the WTP-question concerns reforestation projects, and 0 if the WTP-question regards marine permaculture projects.
- *No_Info* denotes whether the respondent was provided with information about the methods for carbon offsetting or not. This is a dummy variable taking the value 1 if no information was given on the methods, and 0 if information was given.
- *Second* denotes the order of the WTP-questions. This is a dummy variable taking the value 1 if *Method_R* takes on the value 1 and reforestation is the second method presented, or if *Method_R* takes on the value 0 and marine permaculture is the second method presented. Additionally, *Second* takes on the value 0 if *Method_R* takes on the value 1 and reforestation is the first method presented, or vice versa

when *Method_R* takes on the value 0 and marine permaculture is the first method presented.

The interaction terms are of interest to understand how the WTP is affected by a respondent belonging to numerous treatment groups (Wooldridge, 2011), i.e. if more than one of the variables *Method_R, No_Info and Second* take on the value 1.

- The coefficient for *Method_RxNo_Info*, $ß_4$, denotes the additional effect on WTP from both *Method_R* and *No_Info* taking the value 1. That is, if the WTP-question regarded reforestation, and the WTP-questions did not contain information on the methods.
- The coefficient for *Method_RxSecond*, $ß_5$, denotes the additional effect on WTP from both *Method_R* and *Second* taking the value 1. That is, if the WTP-question regarded reforestation, and reforestation was the second method presented.

Lastly, *U* is a residual term denoting any variation in WTP that cannot be explained by the regressors included in the model. When running the regressions, we added the vce(cluster) syntax and clustered by respondent ID as each respondent answered two WTP-questions. By clustering responses in this manner, Stata accounts for the fact that a respondent's two WTP-answers are not independent of each other when calculating the standard errors. Furthermore, adding the vce(cluster) syntax allows us to obtain standard errors that are robust to heteroscedasticity. By applying the model to our surveys, we study how WTP is affected when different treatment variables take on the value 1. These are outlined in table 2.

Table 2: Illustration of how WTP is Affected in Different Scenarios

	Method_R	No_Info	Second	Method_R x No_Info	Method_Rx Second	WTP =
1.	0	0	0	0	0	$ß_0 + U$
2.	1	0	0	0	0	$ß_0 + ß_1 + U$
3.	0	1	0	0	0	$ß_0 + ß_2 + U$
4.	0	0	1	0	0	$ß_0 + ß_3 + U$
5.	1	1	0	1	0	$ß_0 + ß_1 + ß_2 + ß_4 + U$
6.	1	0	1	0	1	$ß_0 + ß_1 + ß_3 + ß_5 + U$
7.	0	1	1	0	0	$ß_0 + ß_2 + ß_3 + U$
8.	1	1	1	1	1	$ß_0 + ß_1 + ß_2 + ß_3 + ß_4 + ß_5 + U$

In order to analyze our regression results further, we compare the WTP between two different scenarios at a time. By comparing the different scenarios, we can discern the effect of method on WTP while controlling for the effects of order and information. In total, we make 12 comparisons, although only one of these will be referred to as our main test. In the main test, we compare the WTP between the following scenarios:

- WTP for the first question among respondents who answered the WTP-question for marine permaculture first and were given additional information about the method, i.e. the scenario given by row 1 in table 2.
- WTP for the first question among respondents who answered the WTP-question for reforestation first and were given additional information about the method, i.e. the scenario given by row 2 in table 2.

The difference in WTP between these scenarios is thus given by - $ß_1$, denoting the effect of the method used for carbon offsetting. In other words, our main test only considers the effect of the method used for carbon offsetting on WTP when respondents are informed about the method in question, and when the WTP-question for the respective method was asked first.

The purpose of our main test is to study the effect of method on WTP in the scenarios where we assume that respondents stated WTP is as close to their true WTP as possible. We argue that this is the case when respondents are informed about the method in question and order-effect bias is minimised. In our main test, order-effect bias is minimised by studying the respondents' answers to the first WTP-question, as the respondent then has not stated a previous bid which may serve as an anchor (Perreault, 1976). As our model is specified, we can conduct our main test directly through the regression, by studying the significance of the coefficient for *Method_R*, $ß_1$. The remaining comparisons are made through using the postestimation command lincom after running the regression on model 1 in Stata.

To increase our understanding of what was driving WTP in our population even further, we created model 2. In addition to the variables included in model 1, described above, model 2 also included the following variables:

- *lINC*, denoting the logarithm of a respondents' income. The logarithm was included to look at how a percentage change would affect WTP, rather than how unit changes would.
- *R_Familiar,* which is a dummy variable taking the value 1 if a respondent claims to be familiar with carbon offsetting through reforestation projects, and 0 otherwise.
- *MP_Familiar,* which is a dummy variable taking the value 1 if a respondent claims to be familiar with carbon offsetting through marine permaculture projects, and 0 otherwise.
- Dummy variables for each field of study; *BSc Economics & Business Administration, BSc Law, BSc Logistics, BSc Social Environmental Science (SMIL), BSc Community Analysis (SAP), Separate Courses*, and *Master's Program*[8]. A given dummy variable takes the value 1 if a student belongs to the respective program, and 0 otherwise.
- *lCO2*, denoting the logarithm of tons of carbon dioxide equivalents emitted per year and will henceforth be referred to as climate impact. The logarithm was included to look at how a percentage change would affect WTP, rather than how unit changes would. This variable was constructed from four separate survey questions in the manner described in section 3c.

In summary, our regression models are structured in the following way:

- Variable of interest: *Method_R.*
- Treatment variables: *Method_R, No_Info* and *Second*
- Control variables: *lINC, R_Familiar, MP_Familiar, BSc Economics & Business Administration, BSc Law, BSc Logistics, BSc Social Environmental Science (SMIL), BSc Community Analysis (SAP), Separate Courses, Master's Program* and *lCO2.*
- Residual: *U*

[8] *Master's Program* only includes students admitted to 300 ECTS in the 2015 or 2016 cohort and who therefore were still included in the email lists we received from Ladok.

To test our second and third null hypotheses, we performed paired t-tests in Stata after checking for correlation, and ran numerous probit regressions. We chose to use paired t-tests as we recognised that the variables in question; WTP for carbon offsetting through reforestation and WTP for carbon offsetting through marine permaculture would be related to one another. A paired t-test makes Stata take the relationship between a respondent's two WTP-answers into account. The probit regressions were run to quantify the relationships between the familiarity of one method and the other, as well as between the respective method and field of study.

4. Results

This section will outline the results obtained from our experiment and accompanying literature review. We use the experiment to answer our hypotheses and attempt to give a more holistic analysis by including relevant literature on co-benefits and ethics of carbon offsetting in general, and reforestation and marine permaculture in particular.

Through our surveys, which were circulated for approximately three weeks, we collected 409 responses out of the 2671 email addresses to which we sent the surveys. This amounts to a response rate of roughly 15.30 percent. While the total number of respondents was larger than expected, it is worth noting that the proportion of respondents differed significantly from program to program. The number of respondents ranged from 5 students from the BSc in Community Analysis to 142 from the BSc in Economics and Business Administration. Table 3, 4, 5a and 5b outline the WTP distribution sorted by field of study, method and survey per method respectively:

Table 3: WTP Distribution By Field of Study

Field of Study	**Mean WTP**	**Std. Dev.**	**Min**	**Max**	**Observations**
BSc Economics & Business Administration	64.20	58.31	0	251	142
BSc Law	57.78	50.30	0	251	88
BSc Logistics	62.65	56.83	0	251	27
BSc Social Environmental Science (SMIL)	79.37	62.40	0	250	60
BSc Community Analysis (SAP)	78.90	33.46	29	137	5
Separate Courses	37.97	26.04	0	113	16
Master's Program	54.35	55.58	0	251	71

Table 4: WTP Distribution By Method					
Method	**Mean WTP**	**Std. Dev.**	**Min**	**Max**	**Observations**
Reforestation	63.97	56.65	0	251	409
Marine Permaculture	60.79	55.68	0	251	409

Table 5a: WTP Distribution For Reforestation By Survey					
	Mean WTP	**Std. Dev.**	**Min**	**Max**	**Observations**
A: Reforestation first, no info	62.92	54.58	0	250	120
B: Marine permaculture first, no info	68.83	67.43	0	251	108
C: Reforestation first, info	56.04	45.08	0	250	90
D: Marine Permaculture first, info	67.44	55.58	0	251	91

Table 5b: WTP Distribution For Marine Permaculture By Survey					
	Mean WTP	**Std. Dev.**	**Min**	**Max**	**Observations**
A: Reforestation first, no info	61.56	56.85	0	250	120
B: Marine permaculture first, no info	63.28	64.16	0	251	108
C: Reforestation first, info	53.90	45.45	0	202	90
D: Marine Permaculture first, info	63.66	52.74	0	251	91

As table 5a and 5b show, our respondents had the highest average WTP for reforestation projects in survey B, where projects using marine permaculture as the method were presented first and no information was given. However, only considering the average WTP divided by survey and method does not reveal driving factors, and as the averages have a fairly small range, from 53.90 to 68.83, limited conclusions can be drawn from this.

Our variables have 818 observations due to each respondent answering two WTP-questions – one for carbon offsetting through reforestation and one for carbon offsetting through marine permaculture. The option “More than 250 SEK” was converted to SEK 251 for statistical analysis in accordance with Rowe, Schulze & Breffle (1996). The distribution of WTP, sorted by method, is outlined in figure 2a and 2b. In order to avoid omitted variable bias, we randomised which survey a respondent got to answer. To check that our randomisation worked, we performed balance tests, which are presented in appendix 2. As the results of our balance tests show, our randomisation was only partially successful. This implies that the results of our regressions may be driven by differences in qualities of our respondents instead of differences in preferences. This occurs as the differences in qualities are correlated with the survey which a certain respondent answered, and our estimates may therefore be subject to omitted variable bias.

Figure 2a: WTP Distribution for Reforestation

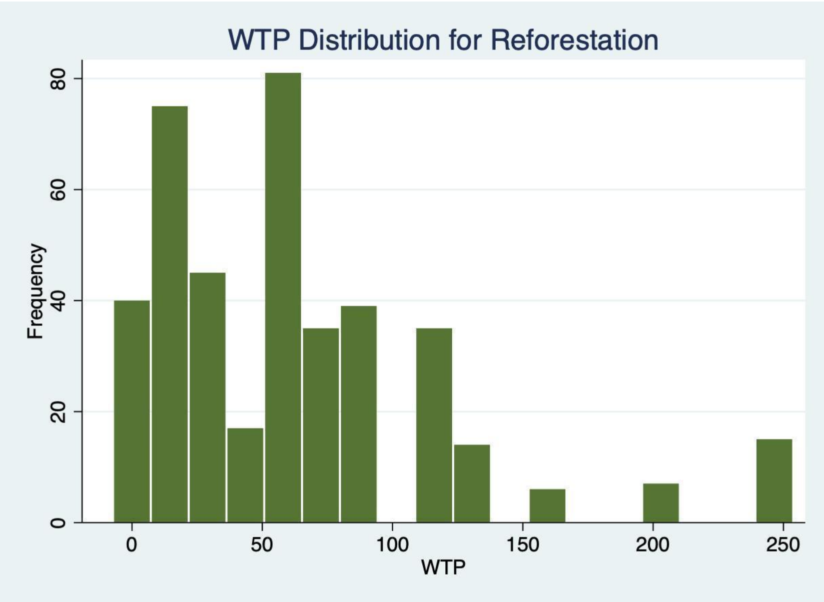
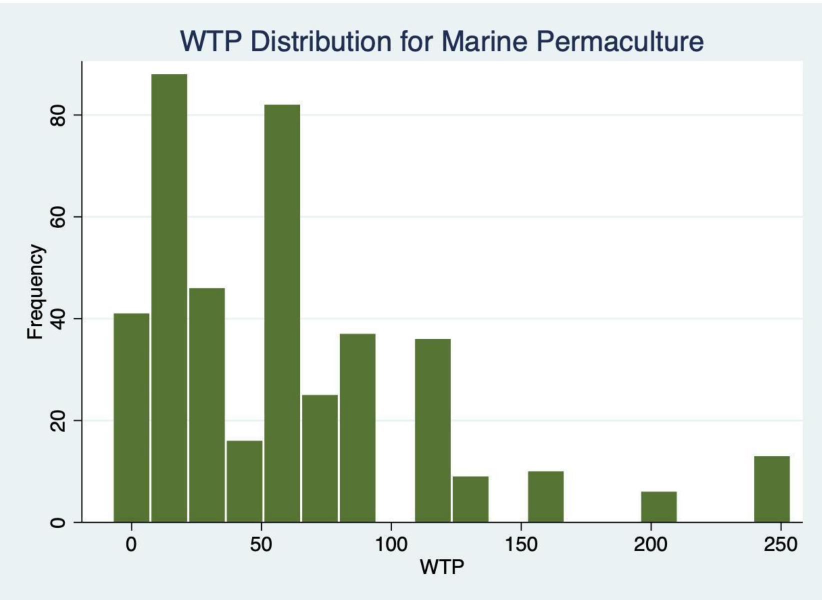


Figure 2b: WTP Distribution for Marine Permaculture



As figures 2a and 2b show, a majority of respondents have a positive WTP regardless of method. The average WTP is slightly higher for reforestation than marine permaculture as table four shows. It is worth noting that the spaces in the higher section of the response spectrum exist due to the exponential scale of possible responses. For example, between 200 and 250 there were no response options, whereas between 0 and 50 there were many response options.

After this initial review of the summary statistics, we began testing our null hypotheses. The first null hypothesis we tested was:

1. The method used for carbon offsetting does not affect WTP for the service.

To test our first null hypothesis[9], we ran regressions on the treatment variables included in our surveys; the carbon offsetting method (*Method_R*), the provision of information (*No_Info*), the order of the WTP-questions (*Second*), and the interaction terms between them (*Method_RxNo_Info* and *Method_RxSecond*), as explained in model 1. By omitting the control variables in our first model, we were able to study the treatment variables in isolation and identify if any of these were affecting WTP, or if unobserved variables, denoted by *U*, drove the effect. As the regression output in table 6 shows, all variables included in model 1 were statistically insignificant at conventional confidence levels. Thus, we could not reject our first null hypothesis.

[9] Note that as each respondent answered two WTP-questions, the number of observations on each variable is 818 instead of 409. It would therefore have been more accurate to perform a random effects test to study the relationship between WTP and method used for carbon offsetting as such a test would acknowledge the definite correlation between each respondent's responses to the WTP-questions. However, this is outside the scope of the econometrics courses given at the School of Business, Economics and Law at a bachelor level.

Table 6: Regression Outputs

	Model 1		Model 2	
	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.
Constant	61.43***	(4.77)	-147.37	(169.90)
Method_R	-3.86	(5.79)	-5.88	(5.78)
No_Info	3.72	(5.43)	3.95	(5.44)
Second	-5.28	(5.54)	-7.30	(5.50)
Method_RxNo_Info	0.47	(2.87)	0.47	(2.88)
Method_RxSecond	13.63	(10.82)	17.68	(10.76)
lINC			42.54	(41.42)
R_Familiar			10.00*	(5.85)
MP_Familiar			10.50*	(6.32)
BSc Economics & Business Administration			29.64***	(8.73)
BSc Law			22.85***	(8.64)
BSc Logistics			25.46**	(12.24)
BSc Social Environmental Science (SMIL)			38.17***	(10.37)
BSc Community Analysis (SAP)			46.69***	(15.39)
Separate Courses			Omitted	
Master's Program			17.96*	(9.44)
lCO2			-6.91	(5.25)
R-Squared	0.01		0.05	
No. Of Observations	818		818	

Standard errors are reported in parentheses and adjusted for 409 clusters in ID

*, **, *** indicates significance at the 90%, 95%, and 99% level, respectively

In order to gain a better understanding of what was driving the effect on WTP, apart from the method used, we ran a regression using model 2. As explained in section 3.d, model 2 included our control variables regarding income, field of study, climate impact and familiarity with the methods for carbon offsetting, as well as the treatment variables and their interactions. As the regression output for model 2 in table 6 shows, the treatment variables all remained statistically insignificant at conventional confidence levels, although several control variables had a statistically significant effect on WTP. At a 90 percent confidence level, all control variables except *IINC* and *ICO2* were statistically significant. *Separate Courses* as field of study was, as the output shows, omitted so as to serve as a reference category. In other words, we were able to better understand what drove WTP when adding our control variables, although the conclusions that can be drawn about those variables are limited as they are in fact control variables. However, it is worth noting that model 2 also has a low r-squared value, implying that the model fits the data poorly. However, as with all research concerning human behaviour, the number of variables that could impact the outcome is simply too large to model.

When analysing our data further, using the postestimation command lincom to compare the differences in WTP between different scenarios, we only found a statistically significant difference at a 90 percent confidence level when comparing row 7 to row 8 in table 2. That is, the difference in WTP was statistically significant only when comparing the following two scenarios:

- The scenario where reforestation was the method used (*Method_R* = 1), the WTP-question for reforestation was asked second (*Second* = 1) and no additional information on the method was given (*No_Info* = 1).
- The scenario where marine permaculture was the method used (*Method_R* = 0), the WTP-question for marine permaculture was asked second (*Second* = 1) and no additional information on the method was given (*No_Info* = 1).

The result, which is presented in full in scenario 3 in appendix 3, we have sufficient evidence to conclude that the sum of the coefficients of *Method_R*, *Method_RxNo_Info* and *Method_RxSecond* does not equal 0, meaning that there is a statistically significant difference between the aforementioned scenarios in our population. The results from the remaining lincom tests can also be found in appendix 3. However, as the coefficient for *Method_R*, $ß_1$, was statistically insignificant when regressing model 1, as shown in table 6, we could not reject the null hypothesis for our main test, and thereby not the first null hypothesis of this thesis. That is, when comparing the difference in WTP between the methods. This implies that, given our data, the method used in carbon offsetting projects cannot be said to have a statistically significant impact on WTP in our population.

The second null hypothesis we tested was:

2. The students in our population have the same average WTP for carbon offsetting for both methods used.

We tested this null hypothesis by performing a paired t-test in Stata as we found a correlation coefficient of 0.87 between the methods. The t-test output is shown in table 7.

Table 7: Paired T-Test of WTP By Method

	Mean WTP	**Std. Dev.**	**Observations**
WTP Reforestation	63.97	2.8	409
WTP Marine Permaculture	60.79	2.75	409
Difference	3.18	1.42	409
H0: mean(diff) =	0		
Pr(|T| > |t|) =	0.03		
Degrees of freedom =	408		
t =	2.23		

The output in table 7 shows that there is a statistically significant difference in means between WTP for reforestation and WTP for marine permaculture. Our second null hypothesis is answered by the t-test null hypothesis that the difference in means is non-zero, which is the only null hypothesis outlined in table 7. The result outlined in table 7 allows us to reject our second null hypothesis at a 95 percent confidence level, meaning that the students in our population do not have the same average WTP for carbon offsetting for both methods used.

Thereafter, we tested our third null hypothesis:

3. The students in our population are equally familiar with the methods for carbon offsetting studied – reforestation and marine permaculture.

Initially, we checked for correlation between the dummy variables *R_Familiar* and *MP_Familiar*. The correlation coefficient we obtained was of 0.19, and we therefore performed a paired t-test. The t-test output is shown in table 8.

Table 8: Paired T-Test of R_Familiar and MP_Familiar

	Mean	**Std. Dev.**	**Observations**
R_Familiar	0.80	0.01	818
MP_Familiar	0.28	0.02	818
Difference	0.52	0.02	818
H0: mean(diff) =	0		
Pr(|T| > |t|) =	0		
Degrees of freedom =	817		
t =	27.47		

The output in table 8 shows that there is a significant difference in means between the familiarity of the methods for carbon offsetting. We can thus reject our third null hypothesis that the students in our population are equally familiar with the methods for carbon offsetting studied. To examine the relationship further, we ran two probit regressions with the two variables (probit 1 and 2). The outputs are shown in table 9, probit 1 and 2.

Table 9: Probit Regressions

	Probit 1: MP_Familiar		Probit 2: R_Familiar		Probit 3: MP_Familiar		Probit 4: R_Familiar	
	dy/dx	Std. Err.	dy/dx	Std. Err.	dy/dx	Std. Err.	dy/dx	Std. Err.
R_Familiar	0.21***	(0.03)						
MP_Familiar			0.16***	(0.02)				
BSc Economics & Business Administration					0.07	(0.09)	0.00	(0.12)
BSc Law					0.02	(0.10)	-0.10	(0.15)
BSc Logistics					0.17	(0.12)	-0.13	(0.17)
BSc Social Environmental Science (SMIL)					0.33***	(0.11)	0.14*	(0.08)
BSc Community Analysis (SAP)					Omitted		Omitted	
Separate Courses					Omitted		Omitted	
Master's Program					0.12	(0.10)	0.05	(0.12)

Probit 1: Relationship between the familiarity of marine permaculture and reforestation as methods for carbon offsetting.

Probit 2: Relationship between the familiarity of reforestation and marine permaculture as methods for carbon offsetting.

Probit 3: Relationship between the familiarity of reforestation as a method for carbon offsetting and field of study.

Probit 4: Relationship between the familiarity of marine permaculture as a method for carbon offsetting and field of study.

All variables in the table are dummies where dy/dx is for discrete change from 0 to 1

*, **, *** indicates significance at the 90%, 95%, and 99% level, respectively

The output in table 9, probit 1 shows that the respondents are 21.27 percentage points more likely to be familiar with marine permaculture as a method for carbon offsetting if they are familiar with reforestation as a method. The output in table 9, probit 2 shows that the respondents are 16.47 percentage points more likely to be familiar with reforestation as a method for carbon offsetting if they are familiar with marine permaculture as a method.

Furthermore, we were interested in how field of study affected familiarity with the methods for carbon offsetting. We, therefore, ran two additional probit regressions to determine the probability of being familiar with the particular method depending on field of study. When running these probit regressions, we found that the only field of study for the relationship to the variables for familiarity was statistically significant and positive was the BSc Social Environmental Science (SMIL). The outputs are shown in table 9, probit 3 and 4.

5. Discussion

As the coefficient on our variable of interest, *Method_R,* was statistically insignificant when running regressions using model 1 and 2, we could not reject our first null hypothesis that the method for carbon offsetting does not affect WTP for the service. The regression results also imply that we were unable to achieve statistically significant results for our main test; comparing the WTP between the methods when the respondent was informed and the method in question is presented first, thereby controlling for order-effect bias. In other words, we did not find evidence that consumers in our population discriminate based on the method used when they are in the market for carbon offsets. The result implies that organisations working with carbon offsetting projects do not need to take what method to use into account as the effect of the method used is uncertain. The fact that we found a significant difference from zero in one out of our 12 lincom tests is not enough to draw firm conclusions about the impact of our subject of interest, namely the impact of method on WTP for carbon offsetting. In other words, our results suggest that more rigorous studies are needed to make firm conclusions about the effect of method on WTP.

Using a paired t-test, we found a statistically significant difference in means between the WTP for the respective method in our population and were thus able to reject our second null hypothesis. Our findings suggest that consumers in our population on average have a higher WTP, and thus a higher preference, for carbon offsetting projects when reforestation is the method used. However, the positive WTP for both methods can be interpreted as a signal of the legitimacy of carbon offsetting and indicates that our, albeit limited, population would accept policies that include carbon offsetting in global warming mitigation strategies.

As the output for our second paired t-test, displayed in table 8, shows, we found a significant difference between the familiarity with reforestation and marine permaculture as methods for carbon offsetting, which lead us to reject our third null hypothesis. As respondents were familiar with reforestation to a higher extent and also had a higher WTP when reforestation was the method used, familiarity with the method can be considered as important to appraise when studying WTP. The relationship between familiarity and willingness to offset has been pointed out in previous research. Lu and Wang (2018) found that knowledge about environmental issues is important in the context of carbon offsetting, and Blasch and Farsi (2013) point out the importance of education for willingness to offset emissions. These findings add credibility to our results regarding our control variables *R_Familiar* and *MP_Familiar* as well as field of study. Even though these variables were only included as control variables, our results in combination with these earlier studies can be useful for organisations working with carbon offsetting as they offer insight into the importance of coupling offsetting projects with education in general, and carbon offsetting measures in particular.

Furthermore, as can be seen in the regression output for model 2 in table 6, belonging to SMIL and SAP – the only programs in our study with an explicit sustainability focus – is associated with a significantly higher WTP for carbon offsetting than the other programs. Given Blasch and Ohndorf (2015) findings, outlined in section 2.b, we recognise that our findings regarding these two fields of study may not be produced by pure altruism, but rather of impure altruism. However, as we did not include any questions to account for impure altruistic behaviour in our surveys, we cannot state whether that is actually the case. Furthermore, the probability of being familiar with marine permaculture and reforestation increases by 33 and 14 percentage points respectively if a respondent pertains to SMIL, as can be seen in table 9, probit 3 and 4. SMIL was also the only program for which the relationships between familiarity with the respective method and field of study were statistically significant. This result reaffirms the importance of education as a means to mitigate global warming.

Hamrick and Gallant (2017) argue that one reason for consumers choosing to offset their emissions through one method as opposed to another is how easy it is to understand. Their research in combination with our findings of higher levels of familiarity and WTP for reforestation than for marine permaculture, as shown in table 8, make it plausible that familiarity with the method in question was, in fact, a driving factor behind the different average WTP. Hamrick and Gallant (2017) also state that some consumers choose what method to offset through based on the co-benefits that a particular method offers. In our research, individuals who are familiar with a method are likely aware of certain co-benefits associated with it; possibly amplifying their WTP for that method. However, as we did not include any information on co-benefits with the methods in our surveys, we could not control for the effect of co-benefits on WTP in our population. Nonetheless, Hamrick and Gallants' (2017) findings emphasize the importance of the method used for carbon offsetting with regards to consumer decisions.

The feasibility of carbon offsetting as part of the solution to global warming depends on various factors, in addition to what potential users are willing to pay for the service. One such factor is the co-benefits associated with a specific offsetting method. For reforestation, Matthews et al. (2000) list co-benefits of healthy forests to include conservation of biodiversity, possibilities for recreation, watershed protection and soil stabilisation. Regarding biodiversity, Matthews et al. state the importance of the global forests for the conservation of both plant and animal biodiversity. They state habitat loss and degradation of forests to be primary causes of forest species extinction, which according to IPCC (2002) reduces the productivity of the ecosystems as well as their resilience to climate change – the effects of global warming. IPCC also mentions that reducing the rate of species extinction impacts other values positively – both the market and non-market recreational, cultural and religious values of the forests. Thus, reforestation has the potential to slow the rate of species extinction down, thereby increasing the forests' resilience to climate change and guaranteeing future biotic carbon sequestration.

Co-benefits with regards to marine permaculture include reducing ocean acidity by increasing pH levels, thereby increasing the potential for growth of species of clams, oysters, crustaceans, and corals (Orr et al., 2005). Furthermore, N'yeurt et al. (2012) estimate that the habitat created if kelp was planted on an area corresponding to nine percent of the global ocean surface area, it would be able to sustain 200 kilograms of fish production per person per year. Lastly, the industry for marine permaculture has the potential to employ a large number of people as the kelp needs to be cultivated and harvested to be used as food, feed or biofuel production. The co-benefits outlined here and in the previous paragraph are examples of values that consumers may consider when deciding on what method to offset through, as noted by Hamrick and Gallant (2017).

Another factor influencing the feasibility of carbon offsetting as part of the solution to global warming is whether the offsetting projects deliver the promised amount of carbon sequestration. Dhanda and Hartman (2011) discuss the conditions under which a carbon offsetting project can be considered valid. They cite the Clean Development Act under the Kyoto Protocol, which states that a project has to provide additionality and be relatively permanent. For a project to provide additionality, the Kyoto protocol stipulates that it is either not required by current regulation, the technologies used are not common practice, or that it faces economic, technological, or investment barriers and, hence, needs offset resources to start up.

Both additionality and permanence are associated with challenges in the context of biotic carbon offsetting. According to Dhanda and Hartman (2011), the lack of regulation in the carbon offsetting marketplace has led to several documented cases of offsetting credits being sold without the offsetting taking place. The insufficient regulation has also led to cases where the same credits for individual projects have been sold to several entities, which are clear examples of the additionality criteria not being met or simply ignored in order to make more substantial profits. IPCC (2019) mentions the lack of permanence as an impediment for efficient global warming mitigation through biotic sequestration. One reason for this is the vulnerability of the terrestrial and oceanic ecosystems to degradation, resulting in the release of carbon back to the atmospheric reservoir. IPCC also acknowledges that when considering natural resources, other interests, such as economic opportunities or resource needs, may conflict with this aim, thus limiting the permanence. Additionality and permanence are issues that need to be addressed in the context of carbon offsetting in general, and reforestation and marine permaculture are no exceptions.

Dhanda and Hartman (2011) also discuss carbon offsetting from an economic equity and a geopolitical perspective. They mention the argument that carbon offsetting creates a pay-to-play system whereby rich countries, organisations and individuals can enjoy "business as usual" and continue to pollute, thus hampering the development of clean technologies. However, they also write that proponents of carbon offsetting argue that the system creates a transfer of capital from developed to developing countries, which would not otherwise exist and thereby serves as an equaliser between nations by providing a source of income to more impoverished regions and people. Regardless of stance on carbon offsetting, there appears to be a consensus about the lack of regulatory standards in the industry. The lack of standards applies despite there being certifying organs in the market to validate projects, such as The Gold Standard. Thus, the market for carbon offsetting as it exists today, as well as the viability of carbon offsetting as a means to reach the 1.5°C limitation goal, is subject for debate.

When comparing the methods examined in this thesis, another aspect to consider is the areal usage as reforestation often stands in direct competition with other forms of land-use, such as agricultural activities. Seventy-one percent of the global landmass is considered habitable land, out of which 37 percent is forest land, and 50 percent is used for agriculture, according to Ritchie and Roser (2019). Out of the agricultural land, they state that livestock currently accounts for 77 percent, despite only producing 18 percent of the global calories. According to Bastin et al. (2019), there are available surfaces that could naturally sustain forests to provide an additional 0.9 billion hectares of tree canopy cover globally. If these areas were forested, they state, an additional 205 gigatonnes of carbon could be stored in the terrestrial carbon sink.

However, as forestable land is also attractive for livestock production, one of the primary reasons for deforestation today is the increasing demand for pastures for livestock and feed production (Matthews et al., 2000). Furthermore, meat consumption per capita is increasing and has been increasing as the world has gotten more affluent, from 23 kilograms per year in 1961 to 43 kilograms per year in 2014 (Ritchie & Roser, 2017). These numbers emphasise the fact that, given the continued trend of increased meat consumption, marine permaculture could ease the burden of land-based animal feed production; particularly as such projects can be carried out in ocean deserts while simultaneously sequestering carbon dioxide.

Moreover, there is an ongoing debate in the literature of whether the qualitative values that ecosystem services provide should be quantified in monetary terms or not. Matthews et al. (2000), among others, argue that recreational and aesthetic values risk being lost if ecosystems were to be quantified in monetary terms. They claim that by monetising ecosystem service values, regards are only taken to utilitarian values, causing existence and intrinsic values to diminish. Conversely, Costanza et al. (1997), among others, claim that placing a monetary value of ecosystem services would help consumers relate to and thereby appreciate the benefits of ecosystem services, thus better understanding the need to protect them.

Assuming economic consumer rationality, a monetary value on ecosystem services would force consumers to consider such services when deciding how to maximise their utility, and also align with the polluter pays principle. In large, this debate gives reason to question if considering carbon offsetting as a service is feasible from an ethical standpoint. Depending on which ethical theory is considered to be true, this question will be answered differently. The willingness among certain actors to justify their polluting actions suggests that parts of society are adopting an impact ethical course of action rather than a deontological one. Regardless, the fact that carbon offsetting has evolved as a service in recent years can be seen as an increase in demand for monetised values on ecosystem services.

Conclusion

We have throughout this thesis emphasised the importance of assuming a holistic perspective on global warming mitigation, of which carbon offsetting can be considered an integral part, based on what has been presented. Through our experiment, we were unable to confirm that the method through which carbon offsetting is done has an impact on the WTP for the service. This result is not in line with our findings through our literature review, particularly when considering factors outside the scope of our experiment, such as co-benefits. Furthermore, our findings suggest that there is a positive relationship between familiarity as well as education, particularly when sustainability-related, and WTP.

Organisations and policymakers can use the results presented in this thesis as an indication for the fact that further research is needed in order to determine the effect of the method used for carbon offsetting on the WTP for the service. These parties should, in their continued work with global warming mitigation, consider that the method used may play a role in a consumer's decision-making process, and that familiarity and education both prove to have a significant effect on WTP. Our population's slightly higher stated preference for reforestation projects, which is more familiar to them, suggest that such projects may receive funding from individuals purchasing carbon offsets. Our findings also present an area of opportunity to increase the propensity to offset emissions through other methods by increasing the familiarity with them. Given this, information campaigns, alongside increased incorporation of sustainability in education can be considered two examples of relevant complementing actions.

In summary, our findings through both our literature review and our experiment suggest that a holistic view of global warming mitigation is required, as it is a global issue and therefore complex to approach with a universal strategy. The ethics and viability of carbon offsetting remain heavily debated topics but are nonetheless essential to include in a broader analysis. Our thesis indicates that when done right, carbon offsetting can be a significant contributor to mitigating global warming. In our population, we found a statistically significant difference in means between the methods considered, as well a significant difference in means between the familiarity of the respective method. However, our findings most importantly suggest that more research is needed to draw firm conclusions about the effects of methods on WTP for carbon offsetting.

References

Ahlheim, M., & Buchholz, W. (1999). *WTP or WTA-Is that the Question? Reflections on the Difference between " Willingness To Pay " and " Willingness to Accept "*. Retrieved from https://www.semanticscholar.org/paper/WTP-or-WTA-Is-that-the-Question-Reflections-on-the-Buchholzb/0915507475f07500154b3325c40dc0bed59d9815

Bastin, J.-F., Finegold, Y., Garcia, C., Mollicone, D., Rezende, M., Routh, D., Zohner, C. M., & Crowther, T. W. (2019). The global tree restoration potential. *Science 365*(6448), 76-79. Retrieved from https://science-sciencemag-org.ezproxy.ub.gu.se/content/365/6448/76

Bateman, I., & Langford, I. (1997). Budget constraint, temporal and ordering effects in contingent valuation studies. *Environment and Planning A, 29*(7). 1215-1228.

Blasch, J., & Farsi, M. (2013). Context effects and heterogeneity in voluntary carbon offsetting – a choice experiment in Switzerland. *Journal of Environmental Economics and Policy, 3*(1), 1–24. Retrieved from https://www-tandfonline-com.ezproxy.ub.gu.se/doi/full/10.1080/21606544.2013.842938

Blasch, J., & Ohndorf, M. (2015). Altruism, moral norms and social approval: Joint determinants of individual offset behavior. *Ecological Economics, 116*, 251-260. Retrieved from https://www-sciencedirect-com.ezproxy.ub.gu.se/science/article/pii/S0921800915002098#s0040

European Commission. (2019). *Average CO2 emissions from new light-duty vehicles registered in Europe increased in 2018, requiring significant future emission reductions to meet upcoming 2020 and 2021 targets.* Retrieved from https://ec.europa.eu/clima/news/average-co2-emissions-new-light-duty-vehicles-registered-europe-increased-2018-requiring_en

Cook, J., Oreskes, N., Doran, P. T., Anderegg, W. R. L., Verheggen, B., Maibach, E. W., Carlton, J. S., Lewandowsky, S., Skuce, A. G., Green, S. A., Nuccitelli, D., Jacobs, P., Richardson, M., Winkler, B., Painting, R., & Rice, K. (2016). Consensus on consensus: a synthesis of consensus estimates on human-caused global warming. *Environmental Research Letters, 11*(4). Retrieved from https://iopscience.iop.org/article/10.1088/1748-9326/11/4/048002/meta

Costanza, R., d'Arge, R., de Groot, R., Farberk, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R. V., Paruelo, J., Raskin, R. G., Sutton, P., & van den Belt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature*, *387*(6630). 253-260.

CSN. (2020, April). Studiemedel – Bidrag och studielån. *CSN*. Retrieved from https://www.csn.se/bidrag-och-lan/studiestod/studiemedel.html

Cummings, R. G., & Taylor, L. O. (1999). Unbiased value estimates for environmental goods: A cheap talk design for the contingent valuation method. *The American Economic Review, 89*(3). 649-665. Retrieved from https://search-proquest-com.ezproxy.ub.gu.se/docview/1474231327?rfr_id=info%3Axri%2Fsid%3Aprimo

Dhanda, K. K., & Hartman, L. P. (2011). The Ethics of Carbon Neutrality: A Critical Examination of Voluntary Carbon Offset Providers. *Journal of Business Ethics*, *100*(1), 119–149. Retrieved from https://link-springer-com.ezproxy.ub.gu.se/article/10.1007/s10551-011-0766-4

Druckman A., & Jackson T. (2016). *Understanding Households as Drivers of Carbon Emissions*. Retrieved from https://link.springer.com/chapter/10.1007/978-3-319-20571-7_9

FAO. (2018). *The State of the World's Forests 2018 - Forest pathways to sustainable development.* Retrieved from http://www.fao.org/3/I9535EN/i9535en.pdf

FAO. (2016). *Global Forest Resources Assessment 2015 – How are the world's forests changing?* (2nd ed.). Retrieved from http://www.fao.org/3/a-i4793e.pdf

FAO. (2000). *Applications of the contingent valuation method in developing countries*. Retrieved from http://www.fao.org/3/X8955E/x8955e00.htm

Flannery, T. (2017, July) How farming giant seaweed can feed fish and fix the climate. *The Conversation.* Retrieved from https://theconversation.com/how-farming-giant-seaweed-can-feed-fish-and-fix-the-climate-81761

Gameau, D. (Writer), Batzias, N. (Producer), Kaplan, A. (Producer), Whitwell, V. (Producer), & Gameau, D. (Director). (2019). *2040* [Documentary]. Australia: Good Thing Productions. Retrieved from https://whatsyour2040.com/

Hamrick, K., & Gallant, M. (2017). *Unlocking Potential State of the Voluntary Carbon Markets 2017*. Washington, DC: Forest Trends' Ecosystem Marketplace. Retrieved from https://www.forest-trends.org/wp-content/uploads/2017/07/doc_5591.pdf

Hughes, A. D., Black, K. D., Campbell, I., Davidson, K., Kelly, M. S., & Stanley, M. S. (2012). Does seaweed offer a solution for bioenergy with biological carbon capture and storage?*. Greenhouse Gases: Science and Technology, 2*(6)*,* 402-407. Retrieved from https://onlinelibrary-wiley-com.ezproxy.ub.gu.se/doi/full/10.1002/ghg.1319

IPCC. (2019). *Special Report: Global warming of 1.5°C*. Retrieved from https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf

IPCC. (2015). *AR5 Synthesis Report: Climate Change 2014*. Retrieved from https://www.ipcc.ch/report/ar5/syr/

IPCC. (2002). *Climate Change and Biodiversity – IPCC Technical Paper V.* Retrieved from https://www.ipcc.ch/site/assets/uploads/2018/03/climate-changes-biodiversity-en.pdf

Jacqumet, N., Joule, R-V., Luchini, S. & Shogren, J. F. (2012). Preference elicitation under oath. *Journal of Environmental Economics and Management 65*(2013), 110-132.

Jordbruksverket. (2020a). *Marknadsbalanser kött, mjölk och ägg - Förbrukning, svensk marknadsandel, diverse*. Retrieved from https://djur.jordbruksverket.se/download/18.35bb416716cd47154dfd6018/1583324749790/F%C3%B6rbrukning_Marknadsandel.xlsx

Jordbruksverket. (2020b). *Konsumtion och förbrukning av kött.* Retrieved from http://www.jordbruksverket.se/amnesomraden/konsument/livsmedelskonsumtionisiffror/kottkonsumtionen.4.465e4964142dbfe44705198.html

Kamb, A., & Larsson, J. (2019). *Climate footprint from Swedish residents' air travel* (Bachelor's Thesis) Gothenburg: Department of Space, Earth and Environment, Chalmers University of Technology. Retrieved from https://research.chalmers.se/publication/508693/file/508693_Fulltext.pdf

Keil, A., & Edwards, J. (2019). Bias in Environmental Epidemiology. In *Encyclopedia of Environmental Health (2nd ed.)*. 288-300. Retrieved from https://www.sciencedirect.com/science/article/pii/B9780124095489106608

Lal, R. (2007). Carbon Sequestration. *Philosophical Transactions Of The Royal Society B, 363*(1492)*,* 815–830. Retrieved from https://royalsocietypublishing-org.ezproxy.ub.gu.se/doi/full/10.1098/rstb.2007.2185#bib87

Lu, J.-L., & Wang, C.-Y. (2018). Investigating the impacts of air travellers' environmental knowledge on attitudes toward carbon offsetting and willingness to mitigate the environmental impacts of aviation. *Transportation Research Part D: Transport and Environment, 59*, 96–107. Retrieved from https://www-sciencedirect-com.ezproxy.ub.gu.se/science/article/pii/S1361920916309543

Manley, W., Foot, K., & Davis, A. (2019). Carbon offsetting. In *A Dictionary of Agriculture and Land Management*. Retrieved from https://www.oxfordreference.com/view/10.1093/acref/9780199654406.001.0001/acref-9780199654406-e-377?rskey=5jwZd9&result=368

Matthews, E., Payne, R., Rohweder, M., & Murray, S. (2000). *Pilot Analysis of Global Ecosystems: Forest Ecosystems*. Retrieved from https://www.wri.org/publication/pilot-analysis-global-ecosystems-forest-ecosystems

Moreira, D., & Pires, J. (2016). Atmospheric CO2 capture by algae: Negative carbon dioxide emission path. *Bioresource Technology, 215,* 371-379. Retrieved from https://www-sciencedirect-com.ezproxy.ub.gu.se/science/article/pii/S0960852416303546

Murphy, J. J., Allen, P. G., Stevens, T. H., & Weatherhead, D. (2005). A Meta-Analysis of

Hypothetical Bias in Stated Preference Valuation. *Environmental and Resource Economics, 30*(3). 313–325. Retrieved from https://link-springer-com.ezproxy.ub.gu.se/article/10.1007/s10640-004-3332-z

NOAA. (2020a). *Trends in Atmospheric Carbon Dioxide - Full Record*. Retrieved from https://www.esrl.noaa.gov/gmd/ccgg/trends/mlo.html

NOAA. (2020b). *Trends in Atmospheric Carbon Dioxide - Growth Rate*. Retrieved from https://www.esrl.noaa.gov/gmd/ccgg/trends/gr.html

N'yeurt, A., Chynoweth, D., Capron, M., Stewart, J., & Hasan, M. (2012). Negative carbon via Ocean Afforestation. *Process Safety and Environmental Protection, 90*(6), 467-474. Retrieved from https://www-sciencedirect-com.ezproxy.ub.gu.se/science/article/pii/S0957582012001206

Orr, J. C., Fabry, V. J., Aumont, O., Bopp, L., Doney, S. C., Feely, R. A., … Yool, A. (2005). Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. *Nature, 437*(7059), 681–686. Retrieved from https://www-nature-com.ezproxy.ub.gu.se/articles/nature04095

Park, C., & Allaby, M. (2013). Permaculture. *A Dictionary of Environment and Conservation.* (2nd ed.) Retrieved from https://www-oxfordreference-com.ezproxy.ub.gu.se/view/10.1093/acref/9780199641666.001.0001/acref-9780199641666-e-5961

Perreault, W. D. Jr. (1976). Controlling Order-Effect Bias. *The Public Opinion Quarterly 39(*4). 544-551. Retrieved from https://www-jstor-org.ezproxy.ub.gu.se/stable/2748507?seq=2#metadata_info_tab_contents

Ritchie, H., & Roser, M. (2020). Environmental impacts of food production. *Our World in Data*. Retrieved from https://ourworldindata.org/environmental-impacts-of-food#you-want-to-reduce-the-carbon-footprint-of-your-food-focus-on-what-you-eat-not-whether-your-food-is-local

Ritchie, H., & Roser, M. (2019). Land Use. *Our World in Data*. Retrieved from https://ourworldindata.org/land-use?fbclid=IwAR1cRw_p89y2aI0jlTLwO-pAyTLnRcQXWKZ-P8oGTmabmnqSbYJDrWigVLM

Ritchie, H., & Roser, M. (2017). Meat and Dairy Production. *Our World in Data*. Retrieved from https://ourworldindata.org/meat-production

Rowe, R., Schulze, W., & Breffle, W. (1996). A Test for Payment Card Biases. *Journal of Environmental Economics and Management, 31*(2), 178-185. Retrieved from https://www-sciencedirect-com.ezproxy.ub.gu.se/science/article/pii/S009506969690039X

Scott, J., & Marshall, G. (2015). Interviewer bias. In *A Dictionary of Sociology (3rd ed.)*.

Retrieved from https://www.oxfordreference.com/view/10.1093/acref/9780199533008.001.0001/acref-9780199533008-e-1168

Selin, N. E. (2019). Carbon sequestration. In *Encyclopædia Britannica*. Retrieved from https://www.britannica.com/technology/carbon-sequestration

UNFCCC. (2002). *Report of the Conference of the Parties on its Seventh Session, held at Marrakesh from 29 October to 10 November 2001: Addendum – Part Two: Action taken by the Conference of the Parties.* Retrieved from https://unfccc.int/sites/default/files/resource/docs/cop7/13a01.pdf

Vidal, J. (2019, 2 August). Offsetting carbon emissions: 'It has proved a minefield'. *The Guardian*. Retrieved from https://www.theguardian.com/travel/2019/aug/02/offsetting-carbon-emissions-how-to-travel-options

Wooldridge, J. (2011). *Difference-in-Differences Estimation* [PowerPoint slides]. Retrieved from http://www.eief.it/files/2011/10/slides_6_diffindiffs.pdf

Appendix

Appendix 1

This appendix presents an overview of the surveys that were used for the data collection for this thesis. To facilitate reading, we present the surveys by section and indicate the differences between the respective sections in **bold letters**. Before each section, we indicate to which survey the different versions belong in *italic letters*, e.g. (*A*). The surveys were carried out using Google Forms. Mandatory questions are marked by an asterisk (*).

Section 1

(A, B, C, D)

In this survey, you will be asked a number of questions about how much you would be willing to pay for carbon offsetting (klimatkompensation). The survey is anonymous, and your answers will be used in our bachelor thesis.

Earlier studies have shown a tendency among survey respondents to overestimate how much they are willing to pay for goods or services in fictional scenarios, like this one. Therefore, we ask that you think about how the amount you choose will affect your actual monthly budget and your ability to purchase other goods and to promise to answer all questions honestly.

I have read the instructions and promise to do my best to answer truthfully.*

Yes

Section 2a

(A, B)

Imagine the following:

As a part of one of your courses at the university, you are tasked with finding out more about sustainability. While searching, you come across a website for a non-profit organisation working with carbon offsetting through *(A, C)* **reforestation** */ (B, D)* ***marine permaculture*** projects. Out of curiosity, you decide to take a break from the university task and find out more about what the organisation can offer you personally.

(C)

The organisation describes the reforestation projects as processes in which various species of young trees are planted in a formerly wooded area, with the goal of renewing the forest cover that was once there. The trees capture carbon dioxide as they grow through photosynthesis and the forest thus works as a carbon offsetter.

/

(D)

The organisation describes the marine permaculture projects as processes in which a species of fast-growing kelp (tång) is planted underneath the ocean surface on rigs made from recycled materials. The rig sinks deeper as the kelp grows, and is connected to a pump which circulates cool, nutrient-rich water from deeper levels, thus enabling the growth of the kelp. The kelp captures carbon dioxide as it grows through photosynthesis and therefore works as a carbon offsetter. The projects can be undertaken anywhere in the world.

(A, B, C, D)

The organisation takes care of the projects themselves, and you can pay to offset a minimum of 100 kg of carbon dioxide equivalents per month. For the average Swedish person, the average emissions are approximately 800 kg of carbon dioxide equivalents per month. For the purpose of this survey, only consider purchasing 100 kg, even though your monthly emissions may be higher than 100 kg. You pay for this service monthly via an automatic payment service (autogiro) and can you cancel your subscription at any time, similar to a Netflix account.

Section 2b

(A, B, C, D)

Which of the amounts below is the highest you would be willing to pay, per month, to offset 100 kg of carbon dioxide equivalents through the *(A, C)* **reforestation** / *(B, D)* **marine permaculture** projects described on the previous page?*

- 0 SEK
- 5 SEK
- 6 SEK
- 7 SEK
- 9 SEK
- 11 SEK
- 13 SEK
- 16 SEK
- 20 SEK
- 24 SEK
- 29 SEK
- 35 SEK
- 43 SEK
- 52 SEK
- 63 SEK
- 79 SEK
- 93 SEK
- 113 SEK
- 137 SEK
- 166 SEK
- 202 SEK
- 250 SEK
- More than 250 SEK

Are you familiar with *(A, C)* **reforestation** / *(B, D)* **marine permaculture** as a means of carbon offsetting?*

- Yes
- No

Section 3a

(A, B, C, D)
While answering this section, please disregard the previous section.

Imagine the following:
As a part of one of your courses at the university, you are tasked with finding out more about sustainability. While searching, you come across a website for a non-profit organisation working with carbon offsetting through *(A, C)* **marine permaculture** / *(B, D)* **reforestation** projects. Out of curiosity, you decide to take a break from the university task and find out more about what the organisation can offer you personally.

(C)
The organisation describes the marine permaculture projects as processes in which a species of fast-growing kelp (tång) is planted underneath the ocean surface on rigs made from recycled materials. The rig sinks deeper as the kelp grows, and is connected to a pump which circulates cool, nutrient-rich water from deeper levels, thus enabling the growth of the kelp. The kelp captures carbon dioxide as it grows through photosynthesis and therefore works as a carbon offsetter. The projects can be undertaken anywhere in the world.
/
(D)
The organisation describes the reforestation projects as processes in which various species of young trees are planted in a formerly wooded area, with the goal of renewing the forest cover that was once there. The trees capture carbon dioxide as they grow through photosynthesis and the forest thus works as a carbon offsetter.

(A, B, C, D)
The organisation takes care of the projects themselves, and you can pay to offset a minimum of 100 kg of carbon dioxide equivalents per month. For the average Swedish person, the average emissions are approximately 800 kg of carbon dioxide equivalents per month. For the purpose of this survey, only consider purchasing 100 kg, even though your monthly emissions may be higher than 100 kg. You pay for this service monthly via an automatic payment service (autogiro) and can you cancel your subscription at any time, similar to a Netflix account.

Section 3b

(A, B, C, D)

Which of the amounts below is the highest you would be willing to pay, per month, to offset 100 kg of carbon dioxide equivalents through the *(A, C)* **marine permaculture** /*(B, D)* **reforestation** projects described on the previous page?*

0 SEK
5 SEK
6 SEK
7 SEK
9 SEK
11 SEK
13 SEK
16 SEK
20 SEK
24 SEK
29 SEK
35 SEK
43 SEK
52 SEK
63 SEK
79 SEK
93 SEK
113 SEK
137 SEK
166 SEK
202 SEK
250 SEK
More than 250 SEK

Are you familiar with *(A, C)* **marine permaculture**/ *(B, D)* **reforestation** as a means of carbon offsetting?*

Yes
No

Section 4

(A, B, C, D)

If you chose different amounts for your willingness to pay depending on the method, what made you choose a higher/lower value for carbon offsetting via the reforestation project?

……………………………………………………………………………

How many times per year do you fly round-trip within Europe?*

- 0
- 1
- 2
- 3
- 4
- 5
- More than 5

How many times per year do you fly round-trip from Europe to somewhere outside of Europe (or vice versa)?*

- 0
- 1
- 2
- 3
- 4
- 5
- More than 5

How many kilometres do you travel by car on a monthly basis?*

- 0 to 10
- 11 to 50
- 51 to 100
- 101 to 300
- 301 to 500
- More than 500

How many days per week do you eat red meat (i.e. beef, lamb, pork) on average?*

0

1

2

3

4

5

6

7

Section 5

(A, B, C, D)

What do you study?*

Bachelor Program in Economics & Business Administration

Bachelor Program in Law

Bachelor Program in Logistics

Bachelor Program in Social Environmental Science (SMIL)

Bachelor Program in Community analysis (SAP)

Separate Courses

Master’s program

What is your net monthly income (i.e. after taxes and interest payments)?*

Less than 10 000 SEK

10 000 - 11 000 SEK (Pick this option if your only income is full-size CSN)

11 001 - 12 000 SEK

12 001 - 13 000 SEK

13 001 - 14 000 SEK

14 001 - 15 000 SEK

More than 15 000 SEK

Appendix 2

The following Stata outputs outline the balance between our surveys and were performed as a test to see if our randomisation worked as intended. We performed the test as an F-test, where we ran three regressions of the surveys B, C and D on all of our control variables; *lCO2, INC, R_Familiar, MP_Familiar* and all fields of study in our population. We also added an “if-statement” to each regression, specifying that data was only to be used from survey A and the respective survey (B, C or D). The null hypotheses we tested was that the differences in qualities and traits of the respondents to survey A and the respective survey (B, C or D) are small. As the p-values for balance test 1 (A2.1) and 2 (A2.2) were larger than α = 0.05, the null hypotheses for these tests were rejected.

A2.1: Balance test 1; Survey B against survey A

```
. reg B lCO2 INC R_Familiar MP_Familiar Smil SPACE JUR PLOG MSc FHS if A==1 | B==1

      Source |       SS           df       MS      Number of obs   =       456
-------------+----------------------------------   F(10, 445)      =      3.76
       Model |  8.85661201        10  .885661201   Prob > F        =    0.0001
    Residual |  104.827599       445  .235567637   R-squared       =    0.0779
-------------+----------------------------------   Adj R-squared   =    0.0572
       Total |  113.684211       455  .249855408   Root MSE        =    .48535

------------------------------------------------------------------------------
           B |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lCO2 |    .028746    .017147     1.68   0.094    -.0049531    .0624452
         INC |   9.76e-06   .0000119     0.82   0.411    -.0000135    .0000331
  R_Familiar |   .1336656   .0599889     2.23   0.026     .0157689    .2515622
 MP_Familiar |   -.222382   .0556783    -3.99   0.000    -.331807    -.112957
        Smil |   .1139748   .2115076     0.54   0.590    -.301703     .5296526
       SPACE |   .2624983   .2031992     1.29   0.197    -.136851     .6618476
         JUR |   .2785509   .2059515     1.35   0.177    -.1262075    .6833094
        PLOG |    .344108    .217985     1.58   0.115      -.0843     .772516
         MSc |   .2286072   .2068634     1.11   0.270    -.1779433    .6351577
         FHS |   .4214557   .2443713     1.72   0.085    -.0588094    .9017208
       _cons |   .0133841   .2693523     0.05   0.960    -.5159765    .5427447
------------------------------------------------------------------------------
```

A2.2: Balance test 2; Survey C against survey A

```
. reg C lCO2 INC R_Familiar MP_Familiar Smil SPACE JUR PLOG MSc FHS if A==1 | C==1
```

Source	SS	df	MS			
				Number of obs	=	420
				F(10, 409)	=	2.39
Model	5.67029026	10	.567029026	Prob > F	=	0.0093
Residual	97.1868526	409	.237620666	R-squared	=	0.0551
				Adj R-squared	=	0.0320
Total	102.857143	419	.245482441	Root MSE	=	.48746

C	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lCO2	.0282992	.0173766	1.63	0.104	-.0058595	.0624578
INC	-.0000113	.000013	-0.87	0.383	-.0000369	.0000142
R_Familiar	.0125001	.0647309	0.19	0.847	-.1147468	.1397469
MP_Familiar	.1077094	.052201	2.06	0.040	.0050937	.2103251
Smil	-.2285027	.1867877	-1.22	0.222	-.5956864	.138681
SPACE	-.0939917	.1795412	-0.52	0.601	-.4469303	.2589469
JUR	-.1686519	.1821863	-0.93	0.355	-.5267902	.1894865
PLOG	-.1959158	.2010353	-0.97	0.330	-.5911071	.1992756
MSc	-.0490732	.1828137	-0.27	0.789	-.4084449	.3102986
FHS	.2304799	.2134577	1.08	0.281	-.1891313	.6500911
_cons	.6010272	.2565948	2.34	0.020	.096618	1.105436

A2.3: Balance test 3; Survey D against survey A

```
. reg D lCO2 INC R_Familiar MP_Familiar Smil SPACE JUR PLOG MSc FHS if A==1 | D==1
```

Source	SS	df	MS			
				Number of obs	=	422
				F(10, 411)	=	1.63
Model	3.95100414	10	.395100414	Prob > F	=	0.0954
Residual	99.5561049	411	.242228966	R-squared	=	0.0382
				Adj R-squared	=	0.0148
Total	103.507109	421	.245860116	Root MSE	=	.49217

D	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lCO2	-.0038781	.0162022	-0.24	0.811	-.0357277	.0279715
INC	-.0000173	.000013	-1.33	0.186	-.0000429	8.34e-06
R_Familiar	.0777615	.0647538	1.20	0.230	-.0495284	.2050515
MP_Familiar	-.1038112	.0563162	-1.84	0.066	-.2145149	.0068925
Smil	.4325854	.2556946	1.69	0.091	-.070047	.9352178
SPACE	.5070538	.2508095	2.02	0.044	.0140244	1.000083
JUR	.4065101	.2534648	1.60	0.110	-.0917389	.9047592
PLOG	.4953051	.26524	1.87	0.063	-.0260911	1.016701
MSc	.4779568	.2539451	1.88	0.061	-.0212365	.9771502
FHS	.683579	.2872655	2.38	0.018	.1188861	1.248272
_cons	.1532187	.3124075	0.49	0.624	-.4608971	.7673345

Appendix 3

In this section we present the Stata-output for further analysis of our regression result when regressing model 1. We conducted this analysis using the postestimation command lincom, through which we compare WTP between different scenarios. As only one of the tests was significant, we chose to confine the output to this section. Furthermore, several of the comparisons result in the same difference, meaning that one output shows the result of several comparisons. For clarity we have added a copy of table 2 to refer back to.

Table 2: Illustration of how WTP is Affected in Different Scenarios

	Method_R	No_Info	Second	Method_R x No_Info	Method_Rx Second	WTP =
1.	0	0	0	0	0	$ß_0 + U$
2.	1	0	0	0	0	$ß_0 + ß_1 + U$
3.	0	1	0	0	0	$ß_0 + ß_2 + U$
4.	0	0	1	0	0	$ß_0 + ß_3 + U$
5.	1	1	0	1	0	$ß_0 + ß_1 + ß_2 + ß_4 + U$
6.	1	0	1	0	1	$ß_0 + ß_1 + ß_3 + ß_5 + U$
7.	0	1	1	0	0	$ß_0 + ß_2 + ß_3 + U$
8.	1	1	1	1	1	$ß_0 + ß_1 + ß_2 + ß_3 + ß_4 + ß_5 + U$

Scenario 1:

- WTP (Reforestation first, No Info)
  = constant + $ß_1$**Method_R* + $ß_2$**No_Info* + $ß_4$**Method_RxNo_Info*
- WTP (Marine Permaculture first, No Info)
  = constant + $ß_2$**No_Info*

  → Difference = $ß_1$**Method_R* + $ß_4$**Method_RxNo_Info*

(1) **Method_R + Method_RXNoInfo = 0**

WTP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
(1)	**-3.386785**	**5.553538**	**-0.61**	**0.542**	**-14.3039**	**7.530334**

Scenario 2:

- WTP (Reforestation Second, Informed)
  = constant + $ß_1$**Method_R* + $ß_3$**Second* + $ß_5$**Method_RxSecond*
- WTP (Marine Permaculture Second, Informed)
  = constant + $ß_3$**Second*

  → Difference = $ß_1$**Method_R* + $ß_5$**Method_RxSecond*

(1) **Method_R + Method_RXSecond = 0**

WTP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
(1)	**9.772246**	**5.931169**	**1.65**	**0.100**	**-1.887218**	**21.43171**

.

Scenario 3:

- WTP (Reforestation Second, No Info)

  = constant + $ß_1$*$Method\_R$ + $ß_2$*No_Info + $ß_3$*$Second$ + $ß_4$*$Method\_RxNo\_Info$ + $ß_5$*$Method\_RxSecond$
- WTP (Marine Permaculture Second, No Info)

  = constant + $ß_2$*No_Info + $ß_3$*$Second$

  → Difference = $ß_1$*$Method\_R$ + $ß_4$*$Method\_RxNo\_Info$ + $ß_5$*$Method\_RxSecond$

```
( 1)  Method_R + Method_RXNoInfo + Method_RXSecond = 0
```

WTP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
(1)	**10.24092**	**5.851095**	**1.75**	**0.081**	**-1.261133**	**21.74298**

Scenario 4:

- WTP (Reforestation First, Informed)

  = constant + $ß_1$*$Method\_R$
- WTP (Reforestation Second, Informed)

  = constant + $ß_1$*$Method\_R$ + $ß_3$*$Second$ + $ß_5$*$Method\_RxSecond$

  → Difference = - $ß_3$*$Second$ - ß5*$Method\_RxSecond$

Scenario 5:

- WTP (Reforestation First, No Info)

  = constant + $ß_1$*$Method\_R$ + $ß_2$*No_Info + $ß_4$*$Method\_RxNo\_Info$
- WTP (Reforestation Second, No Info)

  = constant + $ß_1$*$Method\_R$ + $ß_2$*No_Info + $ß_3$*$Second$ + $ß_4$*$Method\_RxNo\_Info$ + $ß_5$*$Method\_RxSecond$

  → Difference = - $ß_3$*$Second$ - $ß_5$*$Method\_RxSecond$

```
( 1)  - Second - Method_RXSecond = 0
```

WTP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
(1)	-8.344823	5.642509	-1.48	0.140	-19.43684	2.747195

Scenario 6:

- WTP (Marine Permaculture First, Informed)
  = constant
- WTP (Marine Permaculture Second, Informed)
  = constant + $ß_3$**Second*

  → Difference = - $ß_3$**Second*

Scenario 7:

- WTP (Marine Permaculture First, No Info)
  = constant + $ß_2$**No_Info*
- WTP (Marine Permaculture Second, No Info)
  = constant + $ß_2$**No_Info* + $ß_3$**Second*

  → Difference = - $ß_3$**Second*

```
( 1)  - Second = 0
```

WTP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
(1)	5.282885	5.539324	0.95	0.341	-5.606293	16.17206

Scenario 8:

- WTP (Reforestation first, Informed)
  = constant + $ß_1$**Method_R*
- WTP (Reforestation first, No Info)
  = constant + $ß_1$**Method_R* + $ß_2$**No_Info* + $ß_4$**Method_RxNoInfo*

  → Difference = - $ß_2$**No_Info* - $ß_4$**Method_RxNo_Info*

Scenario 9:

- WTP (Reforestation Second, Informed)
  = constant + $ß_1$*Method_R* + $ß_3$*Second* + $ß_5$*Method_RxSecond*
- WTP (Reforestation Second, No Info)
  = constant + $ß_1$*Method_R* + $ß_2$*No_Info* + $ß_3$*Second* + $ß_4$*Method_RxNo_Info* + ß5*Method_RxSecond*

  → Difference = - $ß_2$*NoInfo* - $ß_4$*Method_RxNo_Info*

```
( 1)  - NoInfo - Method_RXNoInfo = 0
```

WTP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
(1)	-4.18847	5.528842	-0.76	0.449	-15.05704	6.680102

Scenario 10

- WTP (Marine Permaculture first, Informed)
  = constant
- WTP (Marine Permaculture first, No Info)
  = constant + $ß_2$*No_Info*

  → Difference = - $ß_2$*No_Info*

Scenario 11

- WTP (Marine Permaculture Second, Informed)
  = constant + $ß_3$*Second*
- WTP (Marine Permaculture Second, No Info)
  = constant + $ß_2$*No_Info* + $ß_3$*Second*

  → Difference = - $ß_2$*No_Info*

```
( 1)  - NoInfo = 0
```

WTP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
(1)	-3.719794	5.428314	-0.69	0.494	-14.39075	6.951161