

Climate Change and Human Choice: Measuring the Nudging

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ABSTRACT: The purpose of this study was to define how climate change is changing in response to positive and negative human behavior. Climate change, in general, refers to changes that take place over a period of tens of thousands of years, involving a particular region or part of the world without human intervention. Climate change takes many forms, depending on the region and the industry in which it operates. The effects of global warming, drinking water shortages, endangered species, and extinction have begun to affect the world's attention and daily lives. And the Nudge effect has become widespread as people's tendency to change their choices has spread. In the last decade, however, climate change has accelerated due to human activities. Since 2008, the effects of the Nudge have had a profound effect on the lives of powerful people. The word nudge means to push lightly or gently stab into the ribs, especially with an elbow. The biggest example is people making smart and healthy choices to reduce greenhouse gas emissions. Choosing the right food can reduce food waste. Greenhouse gas emissions vary from the food we eat and the way we process it. We estimated multiple regression model for CO₂ emissions, GDP growth, energy consumption and factors of human behavior about climate changing data from 1959 to 2018. We found that compared to previous years, greenhouse gas emissions were 4.2 billion square meters less than in previous years. This is a very important result of our research, and shows that the global response to climate change since 1992 has been effective. The use of electric magnes, becoming a vegetarian, riding a bicycle, and becoming a minimalist are the result of Nudge effect. By choosing to be a vegetarian, the level of CO₂ emissions from food is greatly reduced. The fact that greenhouse gas emissions from food waste are equivalent to greenhouse gas emissions from electric vehicles, so the Nudge effect suggests that the results are positive.

KEYWORDS: Nudge theory, CO₂ emission, world warming, make decision

Introduction

In 2020, the world is facing the threat of coronavirus infection, therefore every country is facing major challenge. We have been facing climate change since the middle of the last century. Ritchie and Roser (2019) concluded that global average temperatures have increased by more than 1°C since pre-industrial. With the looming threat of climate change, we need to take action. To combat climate change, the Intergovernmental Panel on Climate Change (2014) recommends decreasing our greenhouse gas emissions, especially our carbon dioxide (CO₂) emissions, through mitigation strategies such as geoengineering, new technologies, and consumption reduction. The amount of monthly greenhouse gas emissions since 1958 has always been higher than in the previous month, but in April 2020, for the first time, it decreased from the previous month and reached the level we had in 2016 (see co2.earth). Numerous scientific studies have shown that human activity plays an important role in greenhouse gas emissions, as evidenced by last month's phenomenon.

It is obvious if the environment we live in becomes worse no matter of development level human kind wouldn't survive. Therefore, it is crucial to fight against global warming and to contribute in slowing it down. The main goal of this research is to investigate the reasons of global warming and to mitigate them. The issues of global warming were brought to the worldwide attention the UN Convention on climate change, which was adopted in 1992 and the Paris Agreement signed in 2016. However, climate change issues were brought up to public attention even before and international treaties such as Kyoto Protocol in 1997, that extends the UN Convention on Climate Change triggers activities on prevention and reduction of onset global warming. Human activities increase greenhouse gas accumulation. Activities such as usage of trees,

destruction of forests, the number of travelers, their usage of transportation and power. The growing number of populations cause increase in food production and consumption. There have been produced various types of video contents that show if people make some changes in their habits it is possible to reduce the impact on the environment and the climate change. Thus, another main objective of this research is to evaluate how effective these contents are and how do they impact people's choices and needs. One of the indicators that witness actions of humans against greenhouse gas accumulation is the growing number of vegetarians and vegans. According the statistics in 2019, 0.1% of the global population is vegetarian, the number has doubled compare to 2007. The increase of vegetarians in the population might be one of the outcomes of previously mentioned video contents to reduce human made greenhouse gas. 50% percent of the vegetarians made this preference due to love of the earth, due to health reasons or by imitating their roles models and celebrities.

According the Classical Economic Theory people's choices are based on keeping the satisfaction level at the highest. However, being a vegetarian is a voluntary choice rather than a rational decision. A nudge theory suggesting consumer behavior can be influenced by small suggestions and positive reinforcements was introduced by a Nobel Memorial in Economic Sciences prize winner Richard Thaler along with his book "NUDGE" launch in 2008. Behavioral economics is one of the emerging sciences and the nudge is one of the key components. Therefore, all these chains of information about what is climate change, what creates greenhouse gas, how to prevent it and how to reduce it, impact human behavior. In 2020 there are 7.7 million vegetarians are around the world (but there are vegetarians who like meat) and 2.8 million people prefer minimalistic approach. The number of eco-friendly consumers, who agree to pay more are increasing. The number of people who use bicycles have reached 1 billion. These are all may be the outcomes of the previously mentioned information flow. These delivered suggestions nudged people to make voluntary choices. Now the objective is to analyze if these nudges were the trigger. Therefore, we will evaluate these global statistics by econometric model. Also, the nudge impact shall be evaluated by macro-economic model, which is a new approach. This scientific analysis shall evaluate the impact on human behavior and therefore contribute in the prevention of climate change. Another one concept related CO₂ emissions is Environmental Kuznets Curve (EKC), that shows relationship between CO₂ emissions and economic growth.

Research background

Scientists have been studying irrational behavioral reactions by nudging experiments. However, our focus is nudging experiments to reduce climate change and greenhouse gas prevention. Szekely, Weinmann vom Brocke (2016) have been nudging people *to pay CO₂ offsets – the effect of anchors in flight booking* experiment, which involved 1350 participants and presented evaluation results of their behavior. They have created flight booking platforms with options low, medium and high amount of carbon emission by one passenger. Also, they placed a donation box for 0-12 Euros. The results showed that exposure to carbon emission amounts impacted the amount of voluntary donations made. Donation amounts were compared to the default flight ticket prices. Therefore, the carbon emission amount was used to nudge people to react against climate change. Waygood and Avineri (2011) researched framing of transport information and how it impacts decision making of travelers. Their nudge influenced more eco-friendly travel mode. The impact was defined by regression analysis. These are some of the instances of micro level behavioral economy surveys. Most of the researches show that transportation and tourism businesses may have the most impact on consumer behavior to prevent climate change. Thus, nudge experiments and surveys are mostly common among transportation and travel service consumers.

Oscar-winning documentary "An Inconvenient Truth" about environment by former U.S. vice president Al Gore issues an urgent warning on what must be done, and done quickly, to save the earth, by research based facts and information. He received Nobel Peace Prize in 2007. After 1 month of the documentary premier Pew Research Center for People & the Press organized a public

survey, it showed that awareness of global warming among Americans increased from 41% to 50%. However, the direct impact of the documentary was not proved. The documentary impact survey was conducted a few times. The survey in the UK showed that this particular documentary has impacted and triggered habit and behavior change. Also, Nolan's (2017) survey showed that the audiences of this documentary, including students became more aware about global warming and power saving. Jacobsen (2011) survey addressed the impact of the documentary after 2 months since the premier. The survey showed that within the 10 miles of the location where the documentary screened consumption against greenhouse gas increased by 50%. Farnsworth and Lichter (2011) concluded that from now on media contents and entertainment contents about climate change shall have more and more impact. Brulle, Carmichael and Jenkins 2002-2010 conducted 74 surveys during the course of 9 years concluded that elite media has stronger influence on creating awareness on climate change, than the actual weather change. Hummel and Maedche (2019) found that only 62% of nudging treatments are statistically significant, by comparing 100 papers with 327 tools of choice architecture. The earliest study related mass media effect was reported by Staats, Wit and Midden in 1996. In this research, during more than two months, the mass media (national television, national newspapers, billboards) were employed intensively to make the public aware of the nature and causes of the greenhouse effect, its consequences and possible ways of dealing with this environmental problems. However macro level researches and nudge experiments on behavioral economic models were not conducted as much.

Nudge, an intervention that gently steers individuals towards a desired action

According the standard economic theory humans always make a rational decision that supports the highest level of benefits. Therefore economic surveys developed based on the rational behavior of an individual or a family. Thus some economic surveys cannot be proved on empiric level. The main part of a human, responsible for decision making is a brain. Behavioral Economics is the combination of psychology and economics that investigates what happens in markets in which some of the agents display human limitations and complications (Sendhil and Thaler 2000). This scientific findings and analysis are accepted worldwide and Nudging impact is the main outcome. This impact was introduced in 2008 and it's been defining daily life routines of people. A nudge theory suggesting consumer behavior can be influenced by small suggestions and positive reinforcements was introduced by a Nobel Memorial in Economic Sciences prize winner Richard Thaler along with his book "NUDGE" launch in 2008. The book divides people in to two groups human and rational and it shows and proves based on series of surveys and experiments, how human can be nudged. Hansen and Jespersen (2013) continued to study concept of nudge suggested by Richard and Sunstein and reported their results. Their framework identified four types of nudges and the result is that may be used to provide a central component for more nuanced normative considerations as well as a basis for policy recommendations. Also they concluded that human behavior is always being influenced by context and international intervention.

The nudge became one of the major findings of behavioral economy. On daily basis we make choices what to buy, what to eat, where to invest, what health, or education services to accept, even among the things we know the best. Also many surveys show that a human being tend to follow the pack. Thus it shows that human behavior is not always rational. So nudging suggests, consumer behavior can be influenced by small suggestions and positive reinforcements Suggestions and positive reinforcements are called architecture. Behavior strongly impacts consumer decision. As there is a shortage of market and information nudges should be used to assist people in making choices and decisions. Climate change might not be an issue on individual level, yet it is one of the main challenges for human kind. People have been provided by proof based information regarding the ways of fighting against global warming through changing behavior and habits since 1992. These information and increasing public awareness is crucial. In the Routledge Handbook of Animal Ethics, Abbate (2019) covered the psychological mechanisms that operate in human-animal relations. One causes of vegan is that thinking about animals. Intended activities such as digital

contents of safe animals or public information about animal rights can influence human decision to become vegan, as like nudging. Lucas, Clayton and Judd (2015) introduced a theory of information nudges that allows for Bayesian updating in a setting of binary choice. Their model highlights that in those settings, the relevant question about the sign and of the treatment affect in whether the information nudge provides “good news” about taking the action to agents at the margin. As previously mentioned people follow the herd. There are plenty of research based proves to it. For instance a student taking an exam follows the crowd and tick the wrong answer even if his answer was the correct one.

During the pandemic people followed each other and bought bags of flour, even though it was not necessary, but because of the rumors of food shortage. It is important to trigger this human behavior correctly. Correlation of the number of animal lovers, vegetarians and minimalists to the previous generations can be evaluated by AR model. The following empirical model examines the impact of the activities of choice architectures on people's choices.

$$\text{AR}(p) \text{ model: } y_t = \alpha + \beta_1 y_{t-1} + \dots + \beta_p y_{t-p} + \varepsilon_t \quad (1)$$

Here, y_t is the number of vegetarians or minimalists during t duration of time. Nudge theory can define if people follow the crowd, by comparing the numbers of vegetarians and minimalists to previous years. Minimalist are increasing because of nudge. Narratives of popular minimalist's lifestyle such as Marie Kondo's video effect on human choice that becoming minimalist (Miriam 2019). Minimalist Academy (2018) defines minimalism on their website as following: “There are plethora of reasons that minimalism has become so popular in recent years. You could say that the popularity of minimalism is a “side effect” of the negative aspects of modern society. Countless people are overworked, underpaid and dissatisfied with their lives. Minimalism offers an escape from the modern problem of working overtime and still not being able to pay the bills. It makes people question whether or not they really need to spend half their life chained to a desk at a job they hate, only so they can buy things they don't need. Another major reason minimalism has taken off is because of increased environmental awareness. In modern times, we're realizing how much damage we've done to the environment as a result of consumerism. Landfills are overflowing, the oceans are polluted, and air quality is declining in major cities across the globe. Choosing to live a minimalist lifestyle allows common people to take a stand against pollution. Many minimalists refuse to buy items with wasteful, useless packaging that does nothing but fill up landfills. They've come to realize that by buying less items, they'll produce less trash. In a time where the future of our environment is at stake, it's no surprise that minimalism has become so popular.”

In the same way the theoretical factors influencing CO₂ emissions, we added factors influencing human decision-making is expressed by the following function. Earliest empirical studies about Environmental Kuznets Curve hypothesis found that relationship between CO₂ emissions and economic growth have shaped “inverted-U” (Gene & Alan 1991; Douglas & Thomas 1992). Therefore economic growth factors first theoretical factors influencing Co₂ emissions, and second factors are energy consumptions, that is one of the main factor of global warming. Another one fact of EKC hypothesis is that energy related CO₂ emissions have reduced in developing countries such as US, the European Union and Japan during 2018-2019 period (see iea.org).

$$F(Y_t) = F(X_t, Z_t, N_t) \quad (2)$$

Here, X_t variables present factors of Environmental Kuznets Curve hypothesis, which are GDP and GDP squared in t period. According to EKC hypothesis, GDP have a quadratic impact on CO₂

emissions, also this shows inaccurate human activities for earth. Z_t variables present factors of energy consumption, which are population, animals, sales of fuel cars and flight in t period. N_t variables present factors related human choice or decision making, which are sales of bicycles, number of vegans, number of minimalism, number of internet users (digital nudging) and global activities of climate change offset in t period. Those results are rises from human activities, they are increasing world GDP and population growth. The size of the human population is the negative impact for climate change. Industrial growth and economic growth have positive relationships. In our study the main role model is the Nudge effect for decision makers. People making the right choice nowadays, like people in N_t . Therefore, N_t describe the people who made appropriate decisions. Attention subsequently turns to the environmental Kuznets curve (EKC) and the unbecoming use of the relationship. To illustrate it is stressed that reducing the intensity of CO₂ in relation to GDP does not necessarily reduce total CO₂ emissions. Some advocates are then made about how the global warming problem might be addressed. Growing the population is benefiting internally. It is possible to improve the skills of personal aid. It is possible to study professionally and it is convenient to make a choice. This economic function shows the entire nudge effect on CO₂ emission worldwide.

Empirical analysis

We use global time series data including world CO₂ emission (CO₂), GDP growth (gGDP), Population (POP), number of animals used for food (ANIMALS), fuel car sales annually (FCAR), number of air passengers (PASS), sales of bicycles (BIKE), number of vegan and minimalist (VEGAN and MINI) and number of internet users (EUSERS) from 1959 to 2018. We estimated the AR(1) model and empirical equation of Environmental Kuznets Curve (EKC) with nudge variables (N_t). In table 1, all result of empirical estimations that shows coefficients and standard errors of all independent variables.

Table 1. Result of Empirical Regression Analysis

<i>Empirical model:</i>	<i>AR(1) model</i>		<i>EKC hypothesis</i>	
<i>Dependent variable:</i>	<i>Vegan</i>	<i>Minimalist</i>	<i>World CO2 emissions</i>	
Constant	0.0273 (0.0254)	0.15* (0.07)	91.48*** (23.6034)	29.61* (16.584)
y_{t-1} : <i>Vegan, Mini</i>	1.048*** (0.07)	0.53** (0.22)	-	-
<i>gGDP</i>	-	-	0.14** (0.0704)	0.17* (0.1006)
$gGDP^2$	-	-	-0.016*** (0.00247)	-0.02** (0.011)
<i>POP</i>	-	-	2.90*** (1.07389)	1.98* (1.1467)
<i>ANIMALS</i>	-	-	0.03 (0.0836)	0.07* (0.0378)
<i>FCAR</i>	-	-	0.12*** (0.0361)	0.044 (0.0559)
<i>PASS</i>	-	-	0.5*** (0.0643)	0.147* (0.0518)

BIKE	-	-	-0.73*** (0.0168)	-
VEGAN	-	-	-0.71*** (0.2264)	-
MINI	-	-	-0.0051 (0.00618)	-
EUSERS	-	-	-	-0.112** (0.0568)
NUDGE	-	-	-	-4.02*** (0.2992)
R²			0.91	0.93

In our estimation results, AR(1) model shows that humans follow the herd and they follow other vegans and minimalists. AR(1) results show that if one person becomes vegan in t period, another 1.048 people will become vegan in $t+1$ period and it is 0.53 for minimalist, similarly. Next results shows that empirical regression model with EKC hypothesis variables including $gGDP$, $gGDP^2$ energy consumption variables including population, animals, sales of fuel cars and passengers and the nudge variables including sales of bicycles, vegans, minimalists, internet users and dummy variable named nudge. Multiple regression analysis indicates $gGDP$ have positive impact and $gGDP^2$ have negative impact on CO_2 emissions, coefficients are 0.14 and -0.016. Our estimation accepted that global Environmental Kuznets Curve is inverted-U shaped. Energy consumptions such as passengers, sales of fuel cars, population and animals in the world has been accelerating global warm process for last decades, otherwise, all of these coefficients are positive and most of them are statistically significant. In both empirical models, we found that energy consumption and economic growth were major causes of climate change. Results of empirical analysis shows that human choice variables such as sales growth of bicycles, vegans and minimalists have negative impact on greenhouse gas emissions and all three coefficients are statistically significant. This result means that we have a chance to stop or slow climate change by influencing human choice. Our dummy variable named nudge is statistically significant and coefficient is -4.02. If there is no climate change policy, 4.02 billion more CO_2 are emitted than in the policy years. We assumed that number of internet users seems to be accelerating the effects of nudging. The assumption is confirmed and digitalization has positive impact on environment. It is nudge effect of all global activities such as provide scientific information and digital contents about global warming to the public and governments agreement for climate changing. We found that it is possible we can change human choice about CO_2 offset as use nudge theory. In additional, by nudging, we can change human choice related energy consumption such as sales of fuel cars, passengers and animals.

Conclusion

In this research we have estimated impact of global activities related climate change offset on human choice by using two economic theories such as Nudge Theory and Environmental Kuznets Curve. First, we evaluate Environmental Kuznets Curve for world data in 1959-2018, the EKC shows relationship between CO_2 emissions and GDP growth. We found that this relationship has “inverted-U” shaped. Second, according to the Nudge Theory, this study explores the possibility of intensifying the human struggle against greenhouse gas emissions. Behavioral economics studies are based on micro-level experiments and questionnaires, but this study has developed the ability to study human choice effects using macro (global) data. The aim is to examine the impact of global environmental efforts on human choice, and to evaluate the variables that reflect the outcome of human choices, such as the number of vegetarians and the number of minimalists, using the AR model. Some of them show that people follow their herds or imitate the actions of others, and the results of the AR model show that the actions of world-famous celebrities have an impact or appeal to others, documentaries and science-based evidence to combat climate change. In addition, our we added indicators related human choice such as sales of bicycles, number of vegans and number of minimalists to the EKC equation. Also dummy variable

named nudge was added this equation, the nudge variables means global activities of climate change offset since 1992. Digitalization can accelerates effects of those activities included mass media, scientific information and international agreements on human responses. In results of AR(1) model, If one person becomes a vegan in t period, then 1.048 people become vegans in $t + 1$ period, otherwise, they follow the person. If one person becomes a minimalist in t period, then 0.53 people become minimalists in $t + 1$ period. Coefficients of vegan and mini are significant and it shows that humans follow the herd. World economic growth has positive impact on CO₂ emissions, but marginal effect (quadratic function) is negative and we have accepted Environmental Kuznets Curve hypothesis in the multiple regression analysis. Energy consumptions such as passengers, sales of fuel cars, population and animals in the world has been accelerating global warm process for last decades, otherwise, all of these coefficients are positive and most of them are statistically significant. In both empirical models, we found that energy consumption and economic growth were major causes of climate change. Results of empirical analysis shows that human choice variables such as sales growth of bicycles, vegans and minimalists have negative impact on greenhouse gas emissions and all three coefficients are statistically significant. This result means that we have a chance to stop or slow climate change by influencing human choice. Our dummy variable named nudge is statistically significant and coefficient is -4.02. If there is no climate change policy, 4.02 billion more CO₂ are emitted than in the policy years. We assumed that number of Internet users seems to be accelerating the effects of nudging. The assumption is confirmed and digitalization has positive impact on environment.

Energy consumption related human choice such as sales growth of fuel cars, animals and passengers increases greenhouse gases. Human choices are changeable. Global activities related climate change have significant impact on CO₂ emissions and digitalization supports effect of these activities. Because humans follow the herd, influencers will help us to stop world warming. Influencers such as governments of high income countries, scientists, politicians and celebrities need to change their behavior by providing people with evidence-based scientific information about greenhouse gases and urging them to do so. This research shows that nudging is effective on world warming.

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