Gender Equality and CO2-Emissions: A Panel Data Study

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Abstract

There is an acute need to combat global warming, of which carbon dioxide (CO2) emissions are the key driver. Climate policy makers so far have assumed that CO2-emissions and gender equality are closely related. However, despite a rapidly growing literature on women and CO2-emissions, no link between gender equality and CO2-emissions has yet been established in economic research. To bridge this gap, this study addresses the question whether gender equality correlates with CO2-emissions and hypothesize that they are negatively correlated. Supported by a theoretical framework based on demand theory, we test the hypothesis by using a two-way fixed effect regression analysis, and panel data for 139 countries over the period of 1995 to 2014. To measure gender equality, the Gender Inequality Index (GII) covering a broader spectrum of gender equality, is used. The results show a significant and negative correlation between gender equality and CO2-emissions, which seems to be driven by developing countries. Our finding supports the belief that gender equality and CO2-emissions are linked and thus contribute to the scientific foundation for climate change policy.

Keywords: Gender Equality, CO2-emissions, Gender Equality Index, Climate Change

List of Abbreviations

CO2 Carbon Dioxide

FDI Foreign Direct Investment

GDP Gross Domestic Product

GDI Gender-related Development Index

GECCO Gender Equality for Climate Change Opportunities

GEM Gender Empowerment Measure

GII Gender Inequality Index

HDR Human Development Reports

IPAT Impact = Population*Affluence*Technology

IPCC Intergovernmental Governmental Panel on Climate Change

UNFCCC United Nations Framework Convention on Climate Change

UNDP United Nations Development Program

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1. Introduction

Decreasing the world's emission of greenhouse gases is among the most pressing issues facing global society today. The emission of greenhouse gases as observed during the last century has caused the average (global) temperature to rise, the consequences of which are already being observed, in rising sea-levels and natural disasters, in floods, monsoons, and droughts, posing an immediate threat to societies worldwide. Among the drivers of global warming, anthropogenic CO2-emissions is the main contributor (IPCC, 2014). It is therefore crucial to study the effects of human activity on CO2-emissions, in order to increase our knowledge and our understanding of ways to decelerate global warming.

Gender equality is increasingly emphasized in policies that aim to combat climate change. The UN program "*Gender Equality for Climate Change Opportunities"* (GECCO) and the recently adopted *"Gender Action Plan"* in the UNFCCC are two of many examples (Global Gender Office, 2018; UNFCCC, 2017). The emphasis on gender equality in policy making is accompanied by an increase in the amount of research available on the subject of gender and climate change. The existing literature focuses on specific aspects of society when examining the effect of gender on CO2-emissions. Studies examining the empowerment of women's political status and CO2-emissions finds a negative correlation between the two (Ergas & York, 2012; Buckingham, 2010). Other research focuses on the inclusion and empowerment of women in the labor force, and finds that it affect both the environmental efficiency and the sustainability reporting of companies (Buckingham et al., 2005; Barako & Brown, 2008). Moreover, research studying gender differences in lifestyle choices finds that women consume less energy than men and, therefore, emit less CO2 in their everyday life (Cohen, 2014; Räty & Carlsson-Kanyama, 2010). The relation between gender in specific aspects of society and CO2-emissions is not sufficient for explaining differences in CO2-emissions; since decision-making that affect CO2-emissions are found in all aspects of society, and all these aspects are interlinked, we argue that there is a need for investigating the relation between gender equality and CO2-emissions. Although the existing literature supports the notion that gender equality and CO2-emissions are linked. There is, to our knowledge, no study within the field of economics that specifically examines the relationship between the two.

The general aim of this study is to examine the relationship between gender equality and CO2-emissions. The main result of this study fits the hypothesis that "Gender Equality and CO2-emissions are negatively correlated". The hypothesis is supported by a theoretical framework, which argues that women are likely to demand higher quantities of CO2-emission reduction than men, due to differences in utility and risk perception. A two-way fixed effect regression model with data for 139 countries over the period 1995-2014 is used to test the hypothesis. In order to quantify the broad and structural concept of gender equality, this study uses a proxy: the Gender Inequality Index (GII). To ensure comparability with previous research on CO2-emissions, GDP, population, the age-dependency ratio, military spending, industry's contribution to GDP, FDI, and, urban population are included as control variables. Furthermore, in line with previous research, the regression analysis is performed when clustering for development status.

The paper starts by introducing a review of the previous research on women's link to CO2-emissions as well as other drivers behind CO2-emissions. This is followed by a section presenting a theoretical framework as well as our hypothesis. Section four describes the data used in the study and section five specifies the econometric approach we use to test the hypothesis. In section six, results from our regression analyses are presented and the following section, seven, discusses the findings in relation to previous research and the theoretical framework. Finally, in section 8 the study ends with a brief conclusion.

2. Literature Review

The first part of this section presents previous research on gender equality and CO2-emissions. Since the economic research on the subject is limited, literature from several disciplines is reviewed. These studies are mainly focused on three areas; empowerment of women, gender differences in lifestyle choices, and women´s effect on sustainability within companies. The second part presents a selection previous research on determinants of CO2-emission and the relevance of these as control variables. The third part defines the gap in previous research that this study is meant to fill

2.1 Studies about Gender Equality and CO2-Emissions

Women's Political Status and CO2-Emissions

Previous research finds that the political empowerment of women have a negative impact on CO2-emissions. In their study, Ergas and York (2012) use an index to measure women's political status and perform a regression analysis to examine whether political status correlates with CO2-emissions. The index is based on: percentage of positions in parliament held by women, number of ministerial posts held by women, and the number of years women have been allowed to vote. The study shows that women's political status is negatively correlated with emission levels per capita, indicating that political empowerment of women is important for policy making aimed at reducing CO2-emissions (Ergas & York, 2012). McKinney and Fulkerson (2015) examines the same relationship, but use a structural equation model. Similarly, they find that the number of parliamentary seats held by women and climate overshoot negatively correlates. In United Nation Development Program`s (UNDP) Human Development Report (HDR) from 2007/2008, 18 of the most developed countries in the world are noted to reduce or stabilize their emissions between 1990 and 2004. Of these 18 countries, 14 had a higher percentage of female elected representatives than the world average (Buckingham, 2010). Although none of the studies presented above prove a causality between women's political status and CO2-emission, they do evoke interest and reason to further explore this correlation.

Table 1. Overview of empirical studies on women's political status and CO2-emissions

Article	**Author**	**Summary**
Women's political status	Ergas & York (2012)	**Question/Focus:** Women's political status effect on CO2 emissions **Main results:** A significant and negative correlation between CO2 emissions and Women's political status
Gender Equality and Climate Justice: A Cross-National Analysis	McKinney & Fulkerson (2015)	**Question/Focus:** Amongst other hypothesis they test if improving women's status reduces climate footprints **Main results:** Countries with greater female representation in governing bodies have lower climate footprints.
Call In the Women	Buckingham (2010)	**Question/Focus:** Women's role in climate policy **Main results:** Women should, to a greater extent, be involved in decision-making regarding climate change.

Women´s Consumption Behaviour and CO2-Emissions

Studies conducted on gender differences in individual decision-making find that women make lifestyle choices that result in less energy consumption than men do. These studies mainly focuses on different consumption categories such as housing, food and transportation. Cohen (2014) and Carlsson-Kanyama et al. (1999) examine gender differences in transportation, where choice of vehicle and length of travel determines the amount of CO2-emissions associated with it. The studies find that men´s mode of transportation generate as much as 53% more CO2-emissions as women´s mode of transportation do, indicating how big the difference in energy consumption can be between the sexes (Carlsson-Kanyama et al., 1999, Cohen, 2014). Another consumption category that displays gender differences is food consumption. Carlsson-Kanyama et al. (2003) finds that men generally consume more food than women, moreover they find that there are differences in food preferences as well. Men consume considerably more meat than women, and due to meat being highly energy intensive, men´s food consumption demand more energy input. In Sweden this difference is illustrated by having an average in meat consumption of 63 kg per year for men and 47 kg per year for women (Carlsson-Kanyama et al., 2003). A final study that examines the gender differences in energy consumption is "*Energy Consumption by Gender"* by Räty and Carlsson-Kanyama (2010). This study looks at Germany, Norway, Greece, and Sweden; where it focuses on all the consumption categories mentioned above and finds that there are significant differences in total energy use in consumption between men and women in both Sweden and Greece (Räty & Carlsson-Kanyama, 2010). Altogether, these studies indicate that men, in general, make lifestyle choices that demand more energy use, and therefore contribute more to CO2-emissions than women do.

Table 2. Overview of empirical studies on women´s consumption behaviour and CO2-emissions

Article	**Author**	**Summary**
Energy Consumption by Gender	Räty & Carlsson-Kanyama (2010)	**Question/Focus:** Examines the gender differences in energy consumption. **Main results:** Significant differences in total energy use were found in two countries, Greece and Sweden. The largest differences found were for travel, eating out, alcohol and tobacco, where men use much more energy than women.
Gendered emissions: counting greenhouse gas emissions by gender and why it matters	Cohen (2014)	**Question/Focus:** Examines gender differences in greenhouse gas emissions. **Main results:** Men work to a greater degree in emission-generating industries. This in combination with their choice of transport vehicles make their CO2-emission rates greater than women's.
Food and life cycle energy inputs: consequences of diet and ways to increase efficiency	Carlsson-Kanyamaa, Pipping Ekström & Shanahan (2003)	**Question/Focus:** Examinest and discuss energy efficient meals and diets **Main results:** The energy inputs for men's food consumption were found to be 14–21% higher than for women, with men's higher meat consumption being partly responsible for this difference.
Insights and applications gender differences in environmental impacts from patterns of transportation - A case study from Sweden	Carlsson-Kanyama, Lindén & Thelander (1999)	**Question/Focus:** Examines gender differences in consumption patterns and their environmental impact **Main results:** The average CO2-emissions from mens' mode of transportation is 53% higher during 1996 compared to the CO2-emissions from womens' mode of transportation during the same year.

Women in the Labor Force and CO2-Emissions

The inclusion and empowerment of women in the labor force affect both the environmental efficiency of companies and to what extent companies take environment responsibility. Buckingham et al. (2005) explores how considering gender in waste-management systems can benefit environmental efficiency. The study examines municipal waste-management in Ireland and the UK, and examine how gender mainstreaming is implemented in the municipalities. The results shows that a higher percentage of female managers results in higher rates of recycling in the area, arguing for the implementation of gender mainstreaming (Buckingham et al., 2005). Further, women have been shown to have an effect on sustainability reporting in companies. Barako and Brown (2008) looks at the Kenyan banking sector and examines how gender diversity in corporate boards influences the reporting of social responsibility. The results show that high levels of women represented leads to greater disclosure and corporate communication of their work on social responsibility and sustainability. The effect of gender diversity within corporate boards is further examined by Prado-Lorenzo and Garcia-Sanchez (2010) in their article *"The Role of the Board of Directors in Disseminating Relevant Information on Greenhouse Gases"*. Even though they find that the general trend of corporate boards is to allocate their focus on creating economic value, it also finds that increasing the amount of women on corporate boards have a positive effect on the sustainability reporting of the company. Thus, the previous research on the empowerment of women in the labor force shows that increasing the percentage of women on corporate boards, or in management positions, will increase sustainability reporting and the company's environmental efficiency

Table 3. Overview of empirical studies on Women in the labor force and CO2-emissions

Article	Author	Summary
Wasting women: The environmental justice of including women in municipal waste management	Buckingham, Reeves & Batchelor (2005)	**Question/Focus:** The effect of women in waste-management **Main results:** Higher percentages of female managers resulted in higher rates of recycling in the area
Corporate social reporting and board representation: evidence from the Kenyan banking sector	Barako & Brown (2008)	**Question/Focus:** The influence of gender on corporate social reporting **Main results:** A significant and negative correlation between CO2 emissions and Women's political status
The Role of the Board of Directors in Disseminating Relevant Information on Greenhouse Gases	Prado-Lorenzo & Garcia-Sanchez (2010)	**Question/Focus:** Highlights the role that companies boards of directors have on practices used to monitor greenhouse gas emissions. **Main results:** An increasing the amount of women in corporate boards have a positive effect on the sustainability reporting.

2.2 Studies about CO2-Emission Drivers

Economic growth

Economic growth is the factor with the biggest and most direct effect on increases in CO2-emissions. This can partly be explained by the increases in consumption, production, and energy usage that follows economic growth (Coondoo & Dinda, 2008; Ergas & York, 2012; York, 2008). Although it lies beyond the scope of this study it is worth mentioning the Environmental Kuznets Curve (EKC), which describes GDP's effect on environmental degradation. It is debated whether or not the EKC can be used to describe the relationship between not only GDP and environmental degradation, but more specifically between GDP and CO2-emissions. Some studies claim it can (Schmalensee et al., 1998; Selden & Song 1994), but many scholars argue for the limitation of the EKC in explaining a relationship between GDP and CO2-emissions (Ravallion et. al, 2000; Iwata et al, 2011; Harbaugh et al, 2002; Moomaw & Unruh, 1997). Therefore, we chose not to further discuss, or take into consideration, the possibility of an inverted "U" shaped relationship between economic growth and CO2-emissions.

Population

To examine the effect of population as a driving force of the principal anthropogenic greenhouse gas, CO2, Dietz and Rosa (1997) use the IPAT framework. Their study shows that population has an important impact on CO2-emissions. Furthermore, they find that the impact of population is roughly proportional to its size, meaning the greater the size of a country's total population, the higher is the level of CO2-emissions (Dietz & Rosa, 1997).

Urbanization and industrialization

York et al. (2003) examines different drivers of environmental impact. Among those drivers are industrialization - the value added to GDP generated by the industrial sector - and urbanization - the percentage of total population living in urban areas. The structure of the economy has a significant impact on CO2-emission levels, where a higher degree of industrialization results in higher emission levels. Similarly, urbanization is shown to have a significant impact CO2-emission levels, contrary to what is expected by many sociological theories. These findings suggest that factors of modernization increase CO2-emission levels and, hence, the associated environmental footprint (York et al, 2003).

Foreign Direct Investments (FDI)

An increasing amount of FDI in developing countries is distributed towards investments in labor-intensive and environmentally inefficient manufacturing, where facilities and power generating techniques used are significantly less eco-efficient than their equivalent used in developed countries (Jorgenson, 2007; Grimes & Kentor, 2003). Both Jorgenson (2007) and Grimes and Kentor (2003) tests FDI and its effect on CO2-emission and finds that they are positively correlated, meaning that increases in FDI will result in higher levels of national CO2-emissions.

Military

Research shows that the degree of militarization in a country is positively correlated with its CO2-emissions. There are several factors that can explain the underlying dynamics of this correlation. Jorgenson and Clark (2009) finds that the military´s large consumption of non-renewable energy in its activities contributes to the emission of CO2. To illustrate, the authors argue that Pentagon possibly is one of the largest consumers of nonrenewable energy in the world; displaying the impact a high degree of militarization can have on emission levels.

The Age Dependency Ratio

Countries with higher ratios of a working population generally have higher consumption and emission rates. York (2008) finds a correlation between the age dependency ratio - the ratio between dependents and working-age population - and CO2-emission. Given that the demographic structure is changing in many countries; he argues that it is of both importance and interest to include this variable when explaining CO2-emissions (York, 2008).

Income Inequality

Ravallion et al. (2000) examines how the distribution of income within and between countries affects their CO2-emission levels. The results show that high levels of inequality correlate with low CO2-emissions. Further, they find a correlation between economic growth and CO2-emissions, indicating that there is a trade-off between climate control and economic growth as well as social equity. However, combining equity with growth will lead to better long term trajectories of CO2-emissions (Ravallion et al., 2000).

2.3 Bridging the Gap

To summarize, the existing literature focus on specific aspects of society when investigating the effects of gender on CO2-emissions, e.g., by addressing the number of parliamentary and/or corporate board seats held by women, or by mapping potential differences in consumption behavior between men and women. When explaining the quantity of CO2-emission, factors such as gender, consumption, and power must be said to be interconnected and thus related to a more complex social concept, that of gender equality. If the number of women in parliament has an overall effect on the number of policies made to decrease CO2-emissions, as argued by Ergas and York (2012), then a more gender-equal society would most likely have a different emission-rate than a society less equal in its parliamentary structure. However, the relation between women's political status and CO2-emissions is not sufficient for explaining differences in CO2-emissions, since policy affecting emission-rates are to be found in many, if not all, aspects of society. Therefore, we argue that the relation between gender equality and CO2-emissions is a necessary explanatory element. To our knowledge, and as illustrated by our literature review, there is no research available on the effect of gender equality on CO2-emissions, a gap that the following study is meant to fill. We also contribute to the literature by using panel data, since most studies on gender and climate change are qualitative in nature, and thereby not utilizing the data here analyzed. The quantitative analyses published on gender and climate change mainly studies specific years. An analysis using data spread over 20 years, and including countries usually not referred to, will be more reliable and contribute to existing research.

3. Gender Equality and Demand for CO2-Emission Reduction.

In this section we introduce our theoretical framework. The economic theories provide an understanding of the foundation on which this paper is built. These theories are then operationalized and a hypothesis is presented, together with an introduction of our proxy for gender equality: the gender inequality index. We conclude this section by discussing the limitation in the theories.

3.1 Demand Theory and Women's Demand for CO2-Emission Reduction

In environmental economics, CO2-emission reduction is recurrently defined as a good. Given this assumption, an individual with higher utility from CO2-emission reduction will, according to demand theory, consume more CO2-emission reduction In economics, the concept of utility is used to illustrate preference relations and help explain decision-making since individuals are assumed to make choices in order to maximize their utility (Böhm & Haller, 2008). The degree of utility gained from CO2-emission reduction depends, partly, on whether an individual experience vulnerability in connection with the effects of climate change. Research on gender and the adverse effects of climate change show that women, to a greater extent than men, are exposed to the consequences of climate change. Women represent a disproportionate share of the poor and due to the poor being the most affected socioeconomic group, studies find that women are disproportionately affected by climate change (Kakota, 2011; Arora-Jonsson, 2011; Cannon, 2002). Further, natural disasters, changes in weather patterns and resource scarcity affect women to a greater extent through higher mortality rates and a greater loss of livelihood opportunities (Singh et al, 2013; Alam & Rahman, 2004; Meyiwa et al, 2014). Since women, to a greater extent, are expected to suffer the consequences of climate change, their utility of avoiding these consequences can reasonably be assumed to be higher than men's. We argue that women acquire more utility from CO2-emission reduction than men, thus they should be likely to demand a higher quantity.

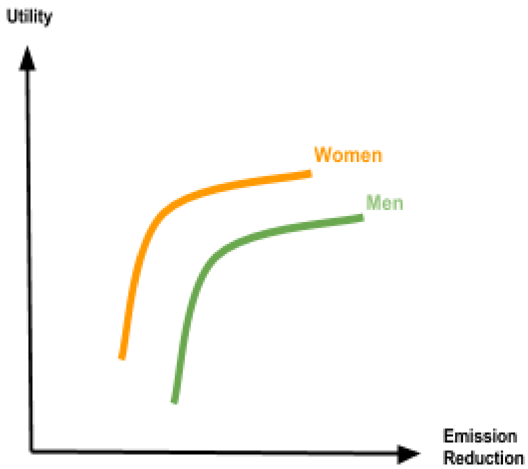

Figure 1. Men and women´s utility curves for CO2-emission reduction. Here women's utility from emission reduction is illustrated in relation to men´s.

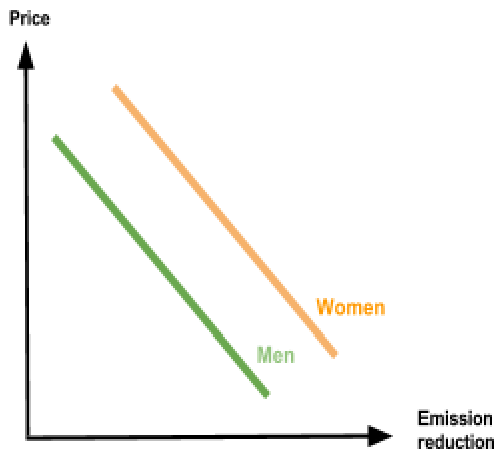

Figure 2. Demand curves for CO2-emission reduction derived from the utility curves in Figure 1. Here women have a higher demand curve for CO2-emission reduction than men, although the slope of the curves are the same.

The utility from consuming a good can be illustrated with utility curves, examples of which can be seen in Figure 1. The marginal utility of a good is equal to the marginal willingness to pay for that good, the price. Therefore, an individual’s demand curve is equal to the derivative of the utility curve. Consequently, higher utility for a good results in a greater demand, which is illustrated in Figure 2. The total demand curve for a good is derived from the sum of all individual demand curves. Building on demand theory and women’s exposure to the consequences of climate change, we expect women to have a higher demand curve for CO2-emission reduction than men.

3.2 Risk Aversion and Women's Demand for CO2-Emission Reduction

Drawing from the theory of risk aversion we expect an individual’s perception of the risk associated with climate change to affect the same individual's attitudes and behavior. In other words, an individual who perceives climate change as a great threat, or has a high level of risk aversion, will strive to minimize the risk associated with it, regardless of whether it concerns choices of consumption, voting pattern, or policy making. This behavior is examined by O´Connor et al. (1999) who finds that risk perception increases people's willingness to act and to take steps towards addressing environmental problems. Moreover, they find that women are more likely to take voluntary action to mitigate climate change, which indicates that women perceive the risk associated with climate change as greater than men do. This is supported by Flynn et al. (1994) who find that white women are more likely than white males to perceive environmental health risks as dangerous.

The notion of women being more risk-averse than men has lead to several studies that examine differences in women's and men's perception of risk and, thus, their level of risk aversion. Jianakoplos and Bernasek (1998) examine financial risk management and finds that women show higher level of risk aversion in financial management. This is further supported by Barke et al. (1997) who finds that, within academic fields, men see substantially less risk from nuclear technology than women, exhibiting the differences in risk perception that exists between the genders.

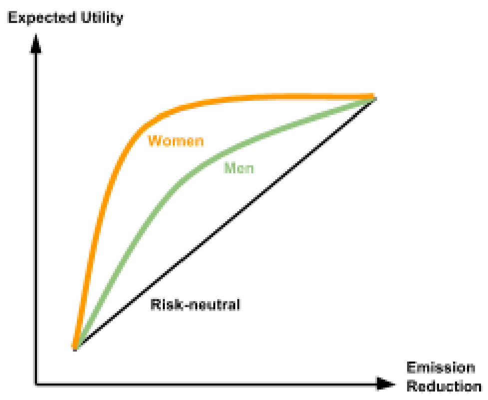

Figure 3. Utility curves for expected utility of CO2-emission reduction. The black line illustrates a risk-neutral individual as well as the expected utility from an uncertain outcome. Here women have a curve more bent than men, illustrating them being more risk-averse.

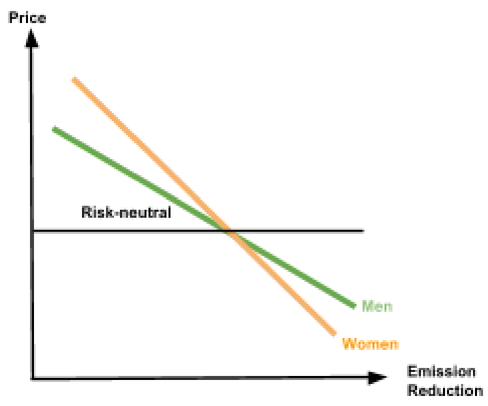

Figure 4. Demand curves for women and men facing the same probability of acquiring a specific utility from CO2-emission reduction. The demand curves are derived from Figure 3. Women being more risk-averse than men results in the steeper slope of the demand curve.

Risk theory builds on the concept of expected utility. Each individual is assumed to have an expected utility based on the future value of a good and the probability of acquiring that value. If an individual prefers a deterministic outcome rather than taking on a risk for the same expected value, she is risk-averse; if an individual is indifferent between the two, she is risk-neutral (Werner, 2008). People's attitudes toward risk are therefore dependent on how risk-averse they are and how they value potential outcomes. People's utility from uncertain outcomes can be illustrated with utility curves, as in Figure 3. A risk-neutral person would have a linear utility curve, equal to the curve of expected utility. A risk-averse person would instead have a waning utility curve, showing a higher utility than the expected utility from acquiring an outcome with certainty. Figure 4 shows how the difference in shape of the utility curves will change the slope of the individual's demand curve, were the more risk-averse individuals will have the steeper demand curve. Given that women seem to perceive climate change as a great risk, and that risk perception affect the slope of demand curves, women are expected to have steeper demand curves for CO2-emission reduction than men.

3.3 Operationalization of the Theories and Hypothesis

The theories presented above suggest that women prefer less CO2-emissions than men and that this difference can be illustrated with women having both a steeper and a higher demand curve for CO_2-emission reduction. In Figure 5 the theories on demand theory and risk-aversion are combined in order to demonstrate how women's demand for CO_2-emission reduction differs from men's.

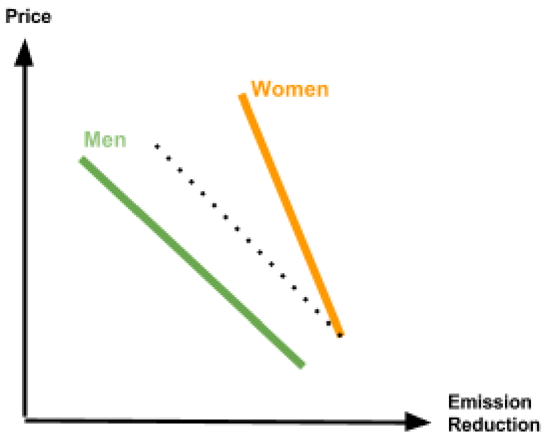

Figure 5. Demand curves for women and men, where women have both have a higher willingness to pay for each quantity of CO_2-emission reduction (derived from a higher utility function) as well as a steeper slope (derived from a more risk-averse utility function).

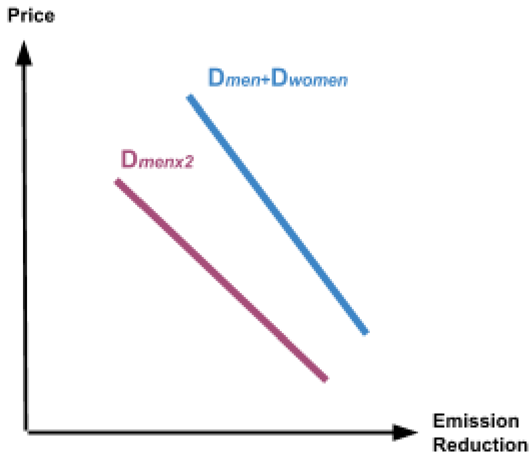

Figure 6. Total demand curves. The purple demand curve illustrates the case where all people are assumed to have the same utility as men ($D_{men} \times 2$) while the blue demand curve represents the case where men and women's differentiated demand curves are summarized to one ($D_{men} + D_{women}$).

Figure 6 shows two different curves, each representing total demand for CO_2-emission reduction. The purple curve illustrates total demand for emission reduction when everyone is assumed to have the same preferences as men. The blue curve illustrates total demand when the differences in preferences between men and women (see Figure 5) are taken into account. Given that women demand a higher quantity of emission reduction, we expect decision-making that includes women´s preferences to have a demand curve for CO_2-emission reduction that resembles the blue curve more than the purple. To summarize, the theoretical framework argues that the inclusion of women's preferences in decision-making should result in a greater total demand for CO_2-emission reduction.

In order to operationalize this argument, the demand for CO_2-emission reduction and the inclusion of women's preferences needs to be translated into quantities. Firstly, given that demand can be translated into the consumed (emitted) quantity, we argue that demand for CO_2-emission reduction can be measured with data on CO_2-emissions over time. Secondly, the extent to which women's preferences are included in decision-making can be seen as analogous to that of a more complex social concept, namely gender equality. By using a proxy for gender equality, the Gender Equality Index (GII), we are able to quantify this variable as well. Building on these assumptions, and our theoretical framework, we argue that gender equality should matter to CO2-emissions and hypothesize that they should be negatively correlated. Thus, we have formulated our hypothesis:

Gender equality and CO2-emissions are negatively correlated.

The hypothesis is primarily tested on a global scale, but, in line with previous research, the effect of development status is taken into consideration as well (Ergas & York, 2012; McKinney & Fulkerson, 2015). Therefore, the hypothesis is tested for developed and developing countries separately. Gender equality is a broad and structural concept, impossible to fully capture or measure in numbers. However, we argue that using the Gender Inequality Index serves as a suitable proxy for our study. The GII was developed by the United Nations in 2010 to improve the measurements and monitoring of gender equality. It is unique due to its focus on critical issues of: economic and political participation, educational attainment, reproductive health issues, and in accounting for overlapping inequalities at the national level. Previous indices, e.g. the Gender-related Development Index (GDI) and the Gender Empowerment Measure (GEM), have been criticized for not providing enough substance for policy making; whereas the former has been criticized for its lack of independency as an indicator of gender gaps and the later for its unclear conceptual basis (Gaye et. al, 2010). The GII addresses the key criticisms of the GDI and the GEM in an effort to satisfy the demand for a more sophisticated and relevant measurement of gender equality. Altogether, with data available for a large number of countries, in combination with its relevance as a proxy, makes the GII the most suitable measurement of gender equality for our study.

3.4 Limitations in the Theories

Theories serve as a great tool when aspiring to explain complex mechanisms. They are, however, simplifications of reality and it is therefore important to question the assumptions on which they are built. This section critically discusses the assumptions inherent to the theories used: that individuals have perfect information, that women care about how other women are affected by climate change, and that there are specific gender characteristics.

There is reason to question whether women have perfect information about their utility from CO2-emission reduction. One of the most recurrent assumptions within economics is that individuals have perfect information about the decision at hand. In this context, everyone is assumed to be aware of their expected utility from reducing CO2-emissions and the risk associated with climate change. As pointed out by Kwerel (1977) this is, of course, not the case. However, assuming perfect information allows economic research to focus on other mechanisms in the economy; in our case the connection between gender equality and CO2-emissions.

Furthermore, the theoretical basis for this study assumes that women act in an altruistic manner towards other women. The women who are affected by climate change do not necessarily constitute the same women who are able to make decisions to mitigate it. Thus, an altruistic side is arguably needed. Women in developing countries are more exposed to the adverse effect of climate change than are women in developed countries (Pearse, 2016). It is therefore reasonable to question if the women who are not personally affected by climate change still obtain a higher degree of utility from CO2-emission reduction than men do. However, this study assumes that they do and that it, to some extent, can be explained by altruism. Altruism means that people are willing to act in order to bring advantages to others, even if it does not bring advantages to oneself. Eswaran (2014) presents several studies showing differences in gender characteristics on altruism, were women show more altruistic behavior than men. Drawing from these studies, womens utility from mitigating CO2-emissions can arguably be influenced by the utility of others due to their altruistic characteristics. Consequently, women acquire a higher utility from CO2-emission reduction, even if not all women are affected by the adverse effects themselves.

Finally, arguing that men and women have different characteristics regarding risk-aversion and altruism can be seen as controversial. Many feminist scholars criticize those who argue that women have certain attributes solely based on their gender (Scott, 1988). The main critique is whether these characteristics really are caused by genetic differences or if they instead could be consequences of social structures (Jensen, 1996). In either case, one can argue that this type of questioning is useful when deconstructing prejudices and relations of power but should not be used to rejecting general claims about women (Heyes, 1997). Taking this into consideration, we are deliberately not drawing any conclusion based on the causes for differences in risk-aversion and altruism. Although, we acknowledge that there seems to be differences between men and women and therefore a basis for investigating its consequences.

4. Data and Descriptive Statistics

This section provides a description of the data, including a discussion regarding; the data sources, handling of the data, the quality of the data, a table summarizing the variables used in the model and descriptive statistics for the data used.

4.1 Data

The data used for this study is gathered from two online databases: The World Bank and The HDR. The HDR, commissioned by the UNDP, provides this study with data of the key independent variable, the GII. In line with previous research the data for our dependent variable CO2-emissions, as well as for the control variables is gathered from the World Bank. Income inequality is not used as a control variable in this study since we had no success in finding data with a sufficient number of observations. A specification of all variables used in the study is presented in Table 4.

Our study covers the time period 1995-2014. We argue that the period provides the study with enough data to perform our regression analysis and captures the effects of the explanatory variables. We are limited to this specific period due to limitations in the data available for our key independent variable, the GII. The HDR only provides data of the index for the years 1995, 2000, 2005, 2010-2014. This means that for the period 1995-2010, our dataset consists of a maximum of four observations for every country. The limited data for the GII is handled by ipolating the data in Stata. Ipolating the GII creates values for the years with missing values, following a linear trend between existing observations. By using a linear interpolation of the GII over time we get data for each year within the time period. We do recognize that by ipolating the key independent variable we lower the quality of the dataset, and by using time to create these new values for the GII, we increase the risk for multicollinearity. However, we argue that the model gets more power and reliability when creating values for the missing years of the GII because it enables us to utilize the large quantity of data existing for the other variables.

Regarding the other variables we were able to obtain data for every consecutive year within the period. Altogether the panel data set we use in the model is strongly balanced, consisting of 2267 observations for 139 countries. A list of the countries analyzed in the study can be found in Appendix 2.

Table 4. Definitions of the variables used in the regression analyses.

Variables	Description	Source
Dependent variables		
logco2	The logarithm of C02-emissions (kt), measured through production based accounting	World Bank
Key Independent variable		
loggiinew	The logarithm of the Gender Inequality Index, with ipolated values.	UNDP
Control variables		
loggdp	The logarithm of the Gross Domestic Product PPP (current international $)	World Bank
logpop	The logarithm of the total population	World Bank
age	The age dependency ratio, ratio of dependents (outside the ages 15-64) to the working-age population (ages 16-64)	World Bank
mili	Military expenditure as percentage of total GDP	World Bank
indu	Industry, value added, as percentage of total GDP	World Bank
fdi	Foreign direct investment as a percentage of total GDP	World Bank
urban	Urban population as percentage of total population	World Bank

4.2 Descriptive Statistics

In Table 5, the number of observations, the mean, minimum and maximum value and the standard deviation for each variable is presented. In order make the results of the variables interpretable, Table 5 display the variables as used in the regression analysis. Here we see that the number of observations varies between the variables. In order to obtain a completely balanced panel, 3140 observations would be needed. The data is limited by the 1133 observation for the GII. Although, when ipolating data for missing values on the GII, and creating *loggiinew*, the number of observations increases to 2778 which makes the data sufficient for the regression analysis. FDI´s maximum value is positive and its minimum value is negative, indicating that our data contains both receivers and donors of foreign direct investments.

Table 5. Description of the data for each variable used in the regression model, including: the number of observations, mean, standard deviation, min and max value, presented separately for developmental status and in total.

	Developing countries					Developed countries					Total				
Variable	**Obs**	**Mean**	**Std.Dev**	**Min**	**Max**	**Obs**	**Mean**	**Std.Dev**	**Min**	**Max**	**Obs**	**Mean**	**Std.Dev**	**Min**	**Max**
logco2	2339	9.172	2.22	3.86	16.15	780	11.26	1.71	7.50	15.57	3119	9.69	2.29	3.86	16.15
loggiinew	2013	-.75	.37	-2.67	-.19	765	-1.79	.54	-3.15	-.46	2778	-1.03	.63	-3.15	-.19
loggii	830	-.81	.41	-2.67	-.19	303	-1.90	.57	-3.15	-.46	1133	-1.10	.66	-3.15	-.19
loggdp	2279	24.42	1.95	19.26	30.54	780	26.13	1.67	22.31	30.49	3059	24.85	2.03	19.26	30.54
logpop	2360	15.91	1.77	11.47	21.03	780	16.11	1.61	12.50	19.58	3140	15.96	1.73	11.47	21.03
age	2360	67.59	19.45	16.45	113.86	780	48.53	4.00	38.45	62.38	3140	62.86	18.87	16.45	113.86
mili	1917	2.33	1.98	.09	16.08	764	1.74	.96	.12	9.20	2681	2.16	1.77	.09	16.08
indu	2062	30.44	14.84	1.88	78.52	763	28.75	6.08	10.72	45.42	2825	29.99	13.08	1.88	78.52
fdi	2277	4.16	6.59	-16.59	89.48	765	7.56	29.27	-58.32	451.72	3042	5.02	15.81	-16.59	451.72
urban	2360	49.44	6.59	7.21	100	780	73.86	11.51	49.70	97.82	3140	55.50	23.30	7.21	100

In order to provide an overview of the dependent variable, CO2, and the key independent variable, the GII, their non-logarithmic values are presented. Figure 7 shows a scatter plot of the GII and time, the trend line illustrates a negative and linear relationship over time. Since ipolated values are created for each year based on a linear relationship between the real observations, the general linear trend can be seen as an argument for ipolating the data. As seen in Figure 8, the variations in the GII over time are quite small, which makes the data suitable to ipolate.

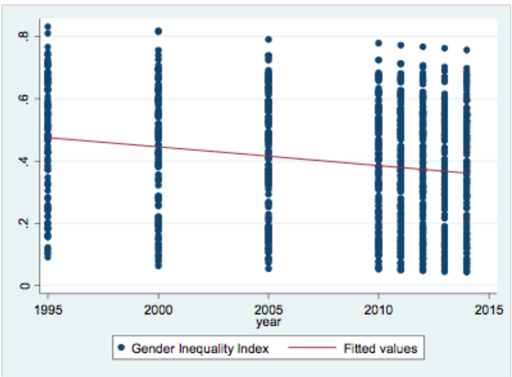

Figure 7. GII observations over time with a linear trend line.

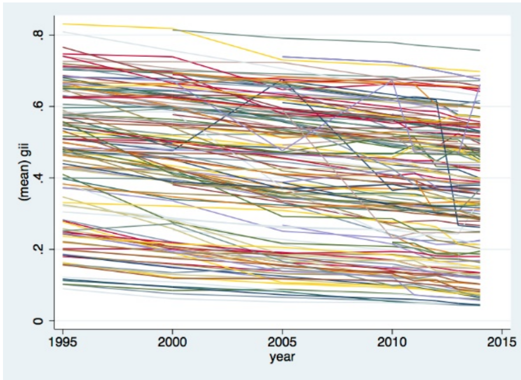

Figure 8. GII observations over time with lines connecting the data points for each country.

In Figure 9 CO2-emission are plotted over time. Two countries have distinctly higher emissions than the others, namely China and the United States. To provide a more comprehensive graph of CO2-emissions over time, Figure 10 show the relationship excluding outliers, where an increasing trend over time is observed for most countries. Since China and the United States have extreme values for CO2-emissions, we perform a robustness test of our model by excluding outliers in CO2-emissions.

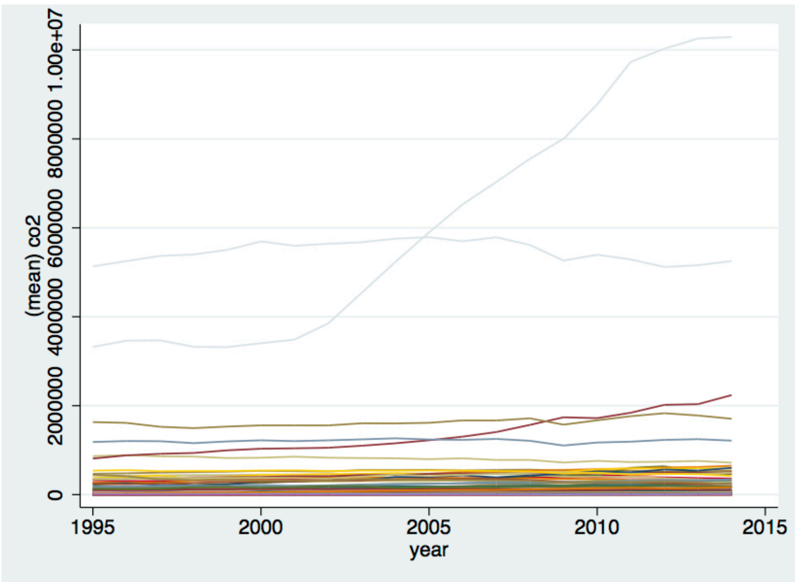

Figure 9. CO2-emissions over time, each line connects the data points for each country.
The two countries with the highest values are China and the US, where China is the one with the increasing trend.

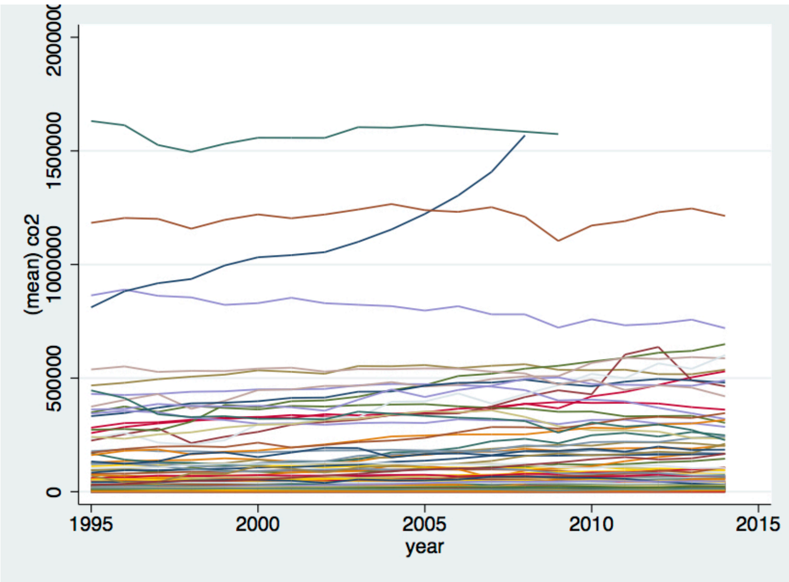

Figure 10. CO2-emissions over time, each line connects the data points for each country with outlier values excluded.

5. Econometric Approach

The section introduce the reader to the models used to test our hypothesis and a brief summary of the alterations and robustness tests performed on the models. This is followed by a econometric discussion where we present and discuss results from several econometric tests. The tests were performed in order to evaluate the quality of the dataset, as well as to decide which regression model to use.

5.1 Econometric Specification

To test the hypothesis that Gender Equality and CO2-emissions are negatively correlated, a two-way fixed effect regression model is used on a panel data set for 139 countries running over 20 years. Our dependent variable is the logarithm of CO2-emissions, *logco2,* and the key independent variable is the logarithm of the GII, *loggii*. The logarithm of CO2-emissions, population, GDP and the GII is used to reduce the skewness of the their distribution and increase the data´s visualizability. Several control variables based on previous research are used in order to isolate the effect of the GII on CO2-emissions (see table 4). Our baseline model is presented below.

Baseline Model:

$$logco2 = \beta_1 + \beta_2 loggii_{i,T} + \beta_3 age_{i,T} + \beta_4 loggdp_{\,i,T} + \beta_5 mili_{\,i,T} + \beta_6 indu_{\,i,T} + \beta_7 logpop_{\,i,T} + \beta_8 urb_{\,i,T}$$
$$\beta_9 fdi\,\mathrm{i} + \beta_{10} yr * + \varepsilon_{i,\,T} \quad i = 1995,\ ....,\ 2014,\ T = 1,\ ....,\ 139$$

Using a two-way fixed effect model is suitable for examining countries over time since it allows for country and time specific effects. This is due to the construction of its error term which consists of: the individual specific effect α_i which is constant over time for each country, a country specific effect γ_T which is the same for each country at a certain point in time, and finally an error term μ_{iT} which ideally should be homoscedastic and not autocorrelated.

Error Component Model:

$$\varepsilon_{i,T} = \alpha_i + \gamma_T + \mu_{iT}$$

In order to test for robustness in the model several alterations are done to our baseline model. Firstly, we eliminate extreme values of *co2* by limiting the regression model to the range +/- 1.5 standard deviations from the median value of *co2*. Secondly, the baseline regression is performed with non-ipolated values of the GII in order to examine the impact of the ipolated values of the GII.

To test the baseline model on developed and developing countries we cluster the data into two categories. The two clusters used in this study are based on the definition for developed and developing countries given by the UN climate change agreement the *Kyoto Protocol*. The protocol divides countries into Annex 1 (developed) and Non-Annex 1 (developing) countries based on their history of contribution to climate change and their current level of industrialization (Kyoto Protocol, 1997). We will in the following refer to these countries as developed (Annex 1) and developing (Non-Annex 1) countries. The two models to test the differences between these clusters are constructed as seen below. The model for developing countries include 100 countries with 1548 observations and the model for developed countries include 39 countries with 719 observations.

Developing Countries Model

$$logco2 = \beta_1 + \beta_2 loggii_{i,T} + \beta_3 age_{i,T} + \beta_4 loggdp_{i,T} + \beta_5 mili_{i,T} + \beta_6 indu_{i,T} + \beta_7 logpop_{i,T} + \beta_8 urb_{i,T}$$
$$\beta_9 fdi\,\mathrm{i} + \beta_{10} yr* + \varepsilon_{i,T,}\ \textit{if developing}\ i = 1995, \ldots\ldots., 2014,\ T = 1, \ldots\ldots., 100$$

Developed Countries Model

$$logco2 = \beta_1 + \beta_2 loggii_{i,T} + \beta_3 age_{i,T} + \beta_4 loggdp_{i,T} + \beta_5 mili_{i,T} + \beta_6 indu_{i,T} + \beta_7 logpop_{i,T} + \beta_8 urb_{i,T}$$
$$\beta_9 fdi\,\mathrm{i} + \beta_{10} yr* + \varepsilon_{i,T,}\ \textit{if developed}\ i = 1995, \ldots\ldots., 2014,\ T = 1, \ldots\ldots., 39$$

5.2 Econometric Discussion

Having a stationary and balanced panel is the foundation for a successful panel data regression analysis. If there is data for each country at each time period in the panel, it is considered balanced. Our data is, according to Stata, considered strongly balanced. Having stationary data means having data that does not change in the shape of the distribution (variance, mean, etc.) when time increases. By performing Dickey-Fuller's unit-root test with several alterations (such as including time trend and first differences) on each variable, we can conclude that our data for GDP and CO2-emissions is time-stationary and the data for all other variables is stationary. Since our data is time stationary a time trend is included in the regression model.

To make sure that our estimates of the parameters in the regression model are efficient, and that the standard errors are consistent, the error terms have to be homoscedastic and should not be autocorrelated. By testing a number of countries with both White's and Breusch-Pagan's tests for homoscedasticity we can conclude that there is no indication that the error terms in our data are heteroscedastic. Through Wooldridge test for autocorrelation in panel data we can confirm that our error terms exhibits autocorrelation. To compensate for the autocorrelation, we use robust standard errors in the regression model. Multicollinearity is a measurement of how much the explanatory variables in the model are a linear combination of the other explanatory variables. Although most models experience some degree of multicollinearity, high levels are to be avoided. This is tested with the Variance Inflation Factor (VIF) test for multicollinearity. If VIF is above 10, it implies that the model contains multicollinearity. Due to our relatively low VIF values (with the highest value of 3.45) we can conclude that our model does not suffer from high degrees of multicollinearity. See Appendix 1 for a correlation matrix.

To decide what regression model to use, Hausman test for random effects is performed. The test compares weather the Fixed or the Random effect model is most efficient. From the test we can conclude that the Fixed effect model is the most efficient regression of the two for our data. To perform a fixed effect regression there has to be some individual specific variation over time in all the explanatory variables, which all our variables have. Based on the results from the econometric tests, the regression model is adjusted in order to control for autocorrelation and stationarity. This is done by introducing robust standard errors as well as using a two-way fixed effect model.

6. Results

In the following section, the results from the panel data regression analyses are presented. Firstly, the result for the key independent variable, the GII, is presented. The results show a significant and negative correlation between gender equality and CO2-emissions in all models but one. Secondly, the results for the control variables are presented.

Table 6. The results from the regression analyses with CO2-emissions as dependent variable. For each regression analysis the number of observations and countries are presented together with the adjusted R^2. For each variable the estimated coefficient, robust standard errors (in parentheses) and the level of significance (*= p<0.1, ** = p<0.05, *** = p < 0.01) is provided.

Variable	Baseline Model	Outliers Excluded	With Non-Ipolated GII	Developing Countries	Developed Countries
constant	-26.6259***	-26.59083***	-27.42829***	-20.04962***	-20.57315***
	(3.747909)	(3.801499)	(3.726246)	(4.454484)	(4.910327)
loggiinew	.194216**	.200478**	.1478593*	.2653084**	-.0591691
	(.0954054)	(.0960252)	(.0822808)	(.1299817)	(.0713129)
loggdp	.7780067***	.7932557***	.8022902***	.8519016***	.4677742***
	(.0951958)	(.1022586)	(.0975522)	(.111697)	(.0861673)
logpop	1.02823***	1.008079***	1.003148***	.4640102**	1.115605***
	(.1916552)	(.1926908)	(.1771274)	(.1931525)	(.2141709)
age	-.0020644	-.0018972	-.0034444	.0031819	.0045086
	(.0023864)	(.0024008)	(.0023566)	(.0029715	(.0059031)
mili	.015727	.0166552	-.0058044	.0164362	-.0248043**
	(.0134243)	(.0134464)	(.0137091)	(.0115195)	(.0107186)
indu	.0057331**	.0055616**	.0049057	.0055173*	.0060882
	(.0026428)	(.0026856)	(.0031919)	(.0028925)	(.0036577)
fdi	.0003561**	.0003557**	.0004697**	.0030588	.0002211**
	(.0001405)	(.0001407)	(0.00022)	(.0019849)	(0.0000829)
urban	.0140428***	.0132387**	.0149334***	.0096525*	.0100879
	(.0049375)	(.0052266)	(.0049869)	(.0057527)	(.0063916)
Adjusted R^2	.6399	.6788	.6834	.6950	.5083
Observations	2267	1257	930	1548	719
Countries	139	90	139	100	39

Table 6 presents the results from the regression analyses. The robust standard errors are shown in the parentheses and the significance level is set from one to three stars, where: *= p<0.1, ** = p<0.05, *** = p < 0.01. The adjusted R^2 indicates the proportion of variance in CO2-emissions explained by the regression model. The R^2 differ for the five models. The baseline model has a R^2 value of 64% and the highest value, 70%, is found in the model for developing countries.

6.1 Results for the GII

The results from the baseline model constitutes the study´s main results; we find that the key independent variable *loggiinew* is significant and positively correlated with CO2-emissions (p = 0.044). A positive correlation between the two variables means that lowering the GII, or increasing gender equality, will decrease CO2-emissions The results for the GII can therefore be interpreted as a negative correlation between gender equality and CO2-emissions, thus supporting the hypothesis of this study. The coefficient of *loggiinew* shows the elasticity between the GII and CO2-emissions, and indicate that a decrease in the GII by one percent will decrease a country's CO2-emissions by approximately 0.19 percent. The size of this elasticity can be compared to the elasticities for GDP and population, which are 0.73 and 1.03 respectively.

We find similar results for the GII when performing the regression on alternated models, supporting the robustness of the model. The coefficient for *loggiinew* in all models, except for developed countries, show a significant and positive correlation. The results from the model excluding outliers is in line with the baseline model; displaying a coefficient of approximately 0.20 with the same level of significance, indicating that CO2-emission outliers do not distort the model. When using the non-ipolated data we still get a significant correlation between the GII and CO2-emissions, although with the lower elasticity of 0.15 and less significance (p = 0.075). The model for developing countries *loggiinew* show a significant and positive correlation (p = 0.044) with a larger coefficient (0.265) than in the baseline model. Hence, the GII has the strongest, with reservation for the variance, correlation in developing countries. In contrast, *loggiinew* is not significant when testing for developed countries.

6.2 Results for the Control Variables

In addition to the results for the correlation between the GII and CO2-emissions, we examine the estimates for a number of control variables. Firstly, the results show that both GDP and population have significant and positive coefficients in all five models. The elasticities of *loggdp* and *logpop* in the baseline model are 0,78 and 1.03 respectively. There are changes in the coefficient between the models. GDP seems to have the strongest correlation with

CO2-emissions in developing countries, whereas population has the strongest correlation in developed countries. Secondly, the correlation between CO2-emissions and the age dependency ratio is insignificant in all five models. Nonetheless, removing *age* from the models decreases the adjusted R^2, which is why it is included in the models. Similarly, military spending has an insignificant coefficient in all models except when testing for developed countries, where it is significant and negative. A negative correlation indicates that increases in military spending will lead to decreases in CO2-emissions. Thirdly, industry´s correlation with CO2-emissions is significantly positive in the baseline model as well as in the model excluding outliers, whereas the model with non-ipolated data for GII shows an insignificant correlation. Similarly, a difference is found between developed and developing countries, where the coefficient for *indu* is significant and positive in developing countries but insignificant in developed countries. Fourthly, the correlation of FDI net inflows as a percentage of GDP is significant and positive in the baseline model, non-ipolated model and the model excluding outliers. Further, the *fdi* display a significant correlation in the model for developed countries but not for developing. The correlation indicates the existence of two possible relationships between FDI and CO2-emissions, either: increases in net FDI inflow leads to higher CO2-emissions or that increases in net FDI outflow lead to lower CO2-emissions. Finally, the percentage of the population living in urban areas is significant and positive in all models except when testing for developing countries.

7. Discussion

The significant and negative correlation between gender equality and CO2-emissions, which fits the hypothesis in this study, is our most important finding. The result supports, and is supported by, the theoretical framework, which argues that the inclusion of women´s preferences in decision-making results in less CO2-emissions. Furthermore, the finding is in line with previous research, which states that: the empowerment of women in politics leads to lower CO2-emissions; the empowerment of women in the labor force improve the environmental efficiency; and that women make lifestyle choices that result in less energy usage (McKinney & Fulkerson, 2015; Ergas & York, 2012; Räty & Carlsson-Kanyama, 2010; Cohen, 2014; Buckingham et al., 2005; Barako & Brown, 2008). Thus, the significantly negative correlation between gender equality and CO2-emissions indicates that increasing gender equality result in women's preferences for CO2-emissions being taking into account, leading to higher total demand for CO2-emission reduction and, consequently, lower levels of CO2-emissions.

The degree of a country's development status seems to affect the correlation between gender equality and CO2-emissions. More specifically, when examining developing countries, the GII is more strongly correlated to CO2-emissions than in our baseline model, indicating that the impact of changes in gender equality is larger in developing countries than in the world as a whole. According to our results the GII does not significantly correlate with CO2-emissions in the developed countries model. This finding indicates that the correlation between gender equality and CO2-emissions found in the baseline model is driven by developing countries. Another possible explanation for the GII not being significantly correlated in the developing countries model is that the model contain less observations and therefore has less power, which can lead to skewed results. Furthermore, this model has the lowest adjusted R^2 value, which indicate that there could be explanatory variables missing in the model for developed countries. Ravallion et al. (2000), for example, discussed how income equality within countries increases the levels of CO2-emissions. Developed countries generally experience high levels of income equality, indicating that it might be influential in the model (Deininger & Squire, 1996). If income equality correlates with the variables included, its absence can affect their estimates. Therefore, performing the regression analysis without income equality as a control variable might influence the results for developed countries to a greater extent than for developing countries. Nevertheless, due to lack of data on income equality we do not include it in any of the regression models.

In addition to the main result, findings regarding the control variables are worth discussing. In line with previous research our study finds that growth in population and GDP are highly correlated with increased CO2-emissions (Coondoo & Dinda, 2008; Ergas & York, 2012; York, 2008; Dietz & Rosa, 1997). Similarly, the positive correlation between CO2-emissions and urbanization as well as industrialization found in previous research by York et al. (2003), is supported by our results. However, the results for age dependency ratio, military spending and FDI differ from previous research. The age dependency ratio show insignificant results in all models, contrary to previous research (York, 2008). Military spending only show a significant correlation in developed countries, where it, by having a negative coefficient, contradicts the results from previous research by Jorgenson and Clark (2009). On the basis of this study, it is therefore possible to question the age dependency ratio´s and military spendings´ relevance when explaining CO2-emissions over time. Finally, the correlation of FDI is insignificant when testing for developing countries. Previous research by Jorgenson (2007) and Grimes and Kentor (2003) finds that FDI is directed towards eco-inefficient industries in developing countries. Thus, one would expect FDI in the developing countries model, if any, to be significant and positive. One possible explanation for this relationship is that the multinationals following FDI flows sometimes bring energy-effective production techniques to the host country. These techniques can be copied by the domestic industry and thus lowering the energy-usage, resulting in a decrease of the country´s CO2-emissions (Mabey & McNally, 1999).

To summarize, our study finds a negative correlation between gender equality and CO2-emissions. Our theoretical framework, as well as the previous research presented, provides an explanation of the relationship between the two. This study does not, however, claim to prove any causality. Neither does this study claim to establish a correlations between gender equality, defined as a structural concept, and CO2-emissions, but limit its findings to establishing a correlation between the GII and CO2-emissions. Moreover, we argue that the GII is a suitable proxy for gender equality, but criticism of the GII questions its usefulness and appropriateness as a global gender equality index, due to limitations in its construction. Permanyer (2013), for example, argues that there is a risk that poor countries are penalized for structural factors that do not relate to gender inequality or the index. Despite its limitations, this study contributes to research by establishing a correlation between the GII and CO2-emissions and thus taking a step towards a better understanding of the relationship between gender equality and climate change.

By establishing a correlation, over time, between gender equality and CO2-emissions, we argue that this study fill a gap in, and, consequently, make a contribution to, existing research. In contrast to previous literature that focuses on CO2-emissions and gender in separate aspects of the society, this study addresses the complex social concept of gender equality, which we argue is necessary when explaining differences in CO2-emissions.

Furthermore, our quantitative approach, unusual for previous research, contributes to research by analyzing new data with a reliable method. In order to further examine the relationship between gender equality and CO2-emissions, we recommend future research to perform similar regressions, e.g. with other measurements of gender equality, other measurements of CO2-emissions, and/or additional control variables such as income inequality. Since this study´s results for the age dependency ratio and military spending contradicts previous research, we suggest future research to examine the effect of these variables on CO2-emissions over time. Finally, investigating the causality between gender equality and CO2-emissions would provide useful knowledge in how to interpret the correlation found in this study, and provide insights into women's role in combating climate change.

8. Concluding Remarks

Global warming is one of the most pressing issues facing the global society today. For this reason, there is an urgent need to expand our understanding of ways to reduce the world's CO2-emissions. One step towards forming policies for mitigating CO2-emissions is to understand what kind of policies that are effective. This study’s contribution to the scientific foundation for such policies, is the finding of a significant and negative correlation between a country's CO2-emissions and the GII’s measurement of gender equality over time. Even though this study does not claim to prove a causal relationship between the two, it indicates that empowering women could prove instrumental for effective climate change mitigation. By providing new findings, we hope to bring research one step further in the quest to decelerate global warming.

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Appendix 1

Correlation Matrix

	logc02	loggii-w	loggdp	logpop	urban	fdi	indu	gini	mili	age	pop
logc02	1.0000										
loggiinew	-0.2879	1.0000									
loggdp	0.9451	-0.3356	1.0000								
logpop	0.7597	0.1914	0.7980	1.0000							
urban	0.4868	-0.5006	0.4856	0.0579	1.0000						
fdi	-0.0684	-0.1213	-0.0868	-0.1975	0.0975	1.0000					
indu	0.2761	0.1585	0.1963	0.2085	0.0734	-0.1387	1.0000				
gini	-0.1397	0.6295	-0.0976	0.1893	-0.0666	-0.1116	0.0873	1.0000			
mili	0.1753	0.2299	0.1200	0.2537	-0.0806	-0.0705	0.1070	-0.0034	1.0000		
age	-0.5113	0.5438	-0.4113	-0.0086	-0.4677	-0.0905	-0.1376	0.4512	-0.0180	1.0000	
pop	0.4650	0.0870	0.4683	0.5715	0.0030	-0.0722	0.0900	0.0958	0.1600	-0.0910	1.0000

Appendix 2

List of countries

Afghanistan	Burundi	Ethiopia	Jamaica	Mauritania	Peru	Sweden*
Albania	Cambodia	Fiji	Japan*	Mauritius	Philippines	Switzerland*
Algeria	Cameroon	Finland*	Jordan	Mexico	Poland*	Tajikistan
Argentina	Canada*	France*	Kazakhstan	Moldova	Portugal*	Tanzania
Armenia	Central African Republic	Gabon	Kenya	Mongolia	Qatar	Thailand
Australia*	Chile	Gambia, The	Korea, Rep.	Montenegro	Romania*	Togo
Austria*	China	Georgia	Kuwait	Morocco	Russian Federation*	Trinidad and Tobago
Azerbaijan	Colombia	Germany*	Kyrgyz Republic	Mozambique	Rwanda	Tunisia
Bahrain	Congo, Dem. Rep.	Ghana	Lao PDR	Myanmar	Saudi Arabia	Turkey*
Bangladesh	Congo, Rep.	Greece*	Latvia*	Namibia	Senegal	Uganda
Belarus*	Cote d'Ivoire	Guatemala	Lebanon	Nepal	Serbia	Ukraine*
Belgium*	Croatia*	Guyana	Lesotho	Netherlands*	Sierra Leone	United Kingdom*
Belize	Cyprus*	Honduras	Liberia	New Zealand*	Singapore	United States*
Benin	Czech Republic*	Hungary*	Libya	Nicaragua	Slovak Republic*	Uruguay
Bolivia	Denmark*	Iceland*	Lithuania*	Norway*	Slovenia*	Venezuela, RB
Bosnia and Herzegovina	Dominican Republic	India	Luxembourg *	Oman	South Africa	Vietnam
Botswana	Ecuador	Indonesia	Malawi	Pakistan	Spain*	Yemen, Rep.
Brazil	Egypt, Arab Rep.	Iran, Islamic Rep.	Malaysia	Panama	Sri Lanka	Zambia
Bulgaria*	El Salvador	Ireland*	Mali	Papua New Guinea	Sudan	Zimbabwe
Burkina Faso	Estonia*	Italy*	Malta*	Paraguay	Swaziland	

** Developed Country (Annex 1)*