INVESTIGATING THE IMPACT OF INFORMATION & COMMUNICATION TECHNOLOGY (ICT) AND INTERNATIONAL PROTOCOLS ON CO_2 EMISSIONS

by

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Ryerson University, 2017

A thesis presented to Ryerson University
in partial fulfillment of the
requirements for the degree of
Master of Science
in the program of
Master of Science in Management
(MScM)

Toronto, Ontario, Canada, 2019

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ABSTRACT

Our life hangs in the delicate balance of the natural environment, on which many of us would agree that human-induced activities are promptly degrading it. Businesses as the engine of an economy play a crucial role in both enhancing and degrading the natural environment. This study aims to investigate the role of international protocols and Information and Communication Technology (ICT) in reducing carbon emissions. For this study, the author has conducted quantitative research in which both micro and macro level approaches were used. The findings indicate that both international treaties and ICT have an inverse impact on the overall model, while they were found to be statistically significant factors in reducing carbon emissions globally. The author has further narrowed down the findings to a micro level to conduct a comparative study between Canada and Norway to evaluate the performance of these two countries on climate mitigation initiatives. This study has further investigated some of the reasons that have caused Canada to perform insufficiently in meeting its climate change targets despite its active role in the negotiations that led to both the Kyoto Protocol and Paris Agreement.

ACKNOWLEDGEMENT

Foremost, I would like to take this opportunity and express my sincerest gratitude to my supervisor Dr. Farid Shirazi for his continuous support, patience, motivation, enthusiasm and immense wisdom. His technical and educational guidance assisted me throughout the research and writing of this thesis. I could not have imagined having a better supervisor and a mentor for my thesis. Thank you for all your support.

Likewise, I would like to express my sincere appreciation to my examining committee members: Dr. Carl, Dr. Keramati, and Dr. Zihayat, for their encouragement, and insightful comments.

Sincere thanks also go to my family for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. I am also grateful to my friends who have supported me along the way. This accomplishment would not have been possible without them. Thank you all.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

CO_2: Carbon dioxide

ICT: Information and Communication Technology

IntLaw: Independent factor which is referring to international protocols

GDPP: The Gross Domestic Products per purchasing power parity

GHG: Greenhouse gas

PRCL2: It refers to the aggregation of PR and CL as independent variables in the statistical model; PR stands for Political rights, and CL stands for civil liberty

Chapter 1

INTRODUCTION

1-1 Introduction

The United Nations' General Assembly in 2015, implemented the 2030 Agenda for Sustainable Development by way of a "plan of action for people, planet and prosperity," that "seeks to strengthen universal peace in larger freedom" (United Nations, 2015, p.1). The United Nations declared 17 Sustainable Development Goals (SDGs) that according to Ban Ki-moon the UN Secretary-General they could be used as a scheme to help all humankind (United Nations, 2015).

Combating climate change and its impacts represent Goal 13 of the United Nations' Sustainable Development Goals (United Nations Global Compact, 2018a). It has also been recognized that organizations worldwide can play a vital role in the advancement of Sustainable Development Agenda through incorporating SDGs in their business strategies and manufacturing processes to come up with new solutions for combating universal sustainable problems (United Nations Global Compact, 2018a). Interestingly, according to Bocken, Short, Rana and Evans (2014); Geissdoerfer, Morioka, de Carvalho and Evans (2018); Morioka, Bolis, Evans and Carvalho, (2017), the demand of providing new solutions to sustainable issues can help organizations to reach new target markets, benefit from collaborating and cooperating with new business partners and ultimately enjoy the opportunity to enhance their productivity levels.

It has been recognized that exponential growth in greenhouse gas (GHG) emissions from human- induced activities on the planet are impacting climate change in a negative way. Certain countries around the world have introduced strategies to limit GHG emissions at different governmental levels. Some of these rules have resulted in the introduction of three groups of carbon-curbing mechanisms to encourage reductions in GHG emissions: the command-and-control system, the cap-and-trade program (which is quantity based) and the carbon tax program (which is price based) (Xu, Xu and He, 2016; Wei, Mi, and Huang, 2014). Through the command-and-control system, the government imposes administrative measures to minimize GHG and carbon emissions. Studies on the command-and-control mechanism have proved that this GHG abatement method is not efficient and therefore is not suggested (Nordhaus, 2006). The other two programs provide economic disincentives to using carbon-intensive fuels by industry and the general public (Carl and Fedor, 2016).

Although a relatively new concept, the use of global carbon-abatement programs have been compared in the literature, and an emerging debate has appeared around which program contributes more to reducing GHG emissions and climate change (Carl and Fedor, 2016; Weitzman, 2017; Xu et al., 2016). In this research the author has focused on the CO_2 as the main contributor to the GHG, since, “each gas that contributes to global warming has a carbon dioxide equivalent, and that weighting factor is used to convert it into a common metric” (Melville, 2010, p.10).

Under the perfect condition, both carbon abatement mechanisms would have identical results, as they both focus on pricing carbon production. Yet, they differ in numerous ways in reality. One of the main differences between these two mechanisms is associated with the method in which the cost of minimizing carbon emissions has been allocated and distributed. For the cap-and-trade, trade permits are provided to consumers for free. This phenomenon is known as “grandfathering." In other words, initially, consumers are not paying for most of their carbon production, thanks to free permits. This method of compliance has been known as a cheaper solution to the reduction of carbon emissions since consumers only pay for the extra permits purchased from industry. Grandfathering approach aids consumers to adapt and control their carbon emissions gradually.

On the contrary, with the carbon tax, consumers are compelled to pay for every unit of carbon production immediately. This is very different from the cap-and-trade system which consumers are given a break during the initial stage. Even though at first, cap-and-trade looks more appealing for the short-term benefits of consumers, but that does not necessarily mean that it is a better approach. Due to grandfathering approach, the government loses huge revenue which could be generated from auctioning off these permits (within the initial stage) in order to use it in other sectors or deducting taxes in other areas.

The other main difference between these two systems is associated with their difference in both cost and benefits of minimizing carbon production under certainty. Under the cap-and-trade mechanism, there is a certain number of permits available which consumers cannot exceed (which is called a cap), but the cost of reducing the carbon emission is not known. Contrarily, the price of doing business and producing every unit of carbon under the carbon tax system is known, but the quantity remains unknown/uncertain.

Either of these two approaches could be preferred, depending on the degree in which the environmental issues are related to the carbon productions. For instance, if a country is more concerned about the degree of carbon productions' impact on environmental issues, then it would be recommended to pursue a cap-and-trade system as the quantity of emission is known. On the contrary, if a country is more concerned about the cost of minimizing the carbon emissions, then it would be recommended to enact and implement the carbon tax mechanism since the cost of every unit of carbon production is known.

The debate in terms of policy-making and the influence of either method on climate change still remains. Even though many economists are in favour of the carbon tax system, some economists are in favour of hybrid carbon abatement system. They argue that through the hybrid system, we can benefit from both systems by putting a cap on the production of carbon (through the help of regulations) while setting a reasonable price floor for carbon production to keep the price of tradable permits within a reasonable price range. Like any other mechanisms, the hybrid system has its problems, but the complexities associated with the hybrid system require a greater contribution of all involved sectors. Regardless of the positions taken by researchers, a common barrier to the generalization of their findings is the recognition that jurisdictionally-specific regulation can be a control factor.

Aside from debates about the "optimal" carbon abetment mechanism, there are other factors impacting firms green decisions by influencing firms' willingness towards investing in more sustainable technologies and practices in order to meet the Sustainable Development Agenda. Examining these factors which could be both external and internal would help different stakeholders who are in charge of planning, investing and policy-making to offer a multi-dimensional solutions to the sustainable issues (Halkos and Skouloudis, 2016; Jensen and Berg, 2012).

According to the literature, the main drivers of environmental advancement and developments are "market pull," "technology push" and "regulatory push-pull" effect (Horbach, Rammer and Rennings, 2012; Rennings and Rammer, 2011).

Similarly, developments of Information and Communication Technologies (ICT) through the entire world are growing inquiries upon the degree to which these developments could be influential in designing greater environmentally friendly patterns in our lives. ICT is expected to reduce the production of carbon dioxide globally through "developing smarter cities, transportation systems, industrial processes and energy saving gains" (Higón, Gholami, and Shirazi, 2017, p.85). Even though climate change could be combated through conventional tactics, but the urgency of the situation urges the need to have a faster and smarter transition towards more sustainable industrial processes and technological advancements. ICT in conjunction with smart technologies can aid to attack issues related to environmental concerns promptly. However, the problem is that unfortunately, not many studies of environmental sustainability have considered ICT as a leading tool to reduce environmental damages.

Chapter 2

RESEARCH OBJECTIVE

The primary objective of this paper is to study and explore both the impact and the magnitude in which ICT and international protocols have in combating climate change through the reduction of carbon emissions. For this purpose, global archival data was used. In this research, quantitative analysis helped the author to understand the relationships between CO_2 emissions and other independent variables of the model, being GDPP, resistance, stability, PRCL2, and education on a global scale. The author has used different statistical methods and advanced analytical tools such as R, Tableau and SPSS in order to investigate the relationships between the variables mentioned earlier with the global warming issues as measured by CO_2 megatons per capita.

The main contributions of this paper could be summarized as follow. According to the empirical results gathered from the decision tree analysis and tableau, for the Canadian government to move towards sustainability and lower their carbon production, the following three factors have to be considered the most, as they have the most robust correlation with the carbon production: ICT, PRCL2 and GDPP. As Canada's carbon production equals to 17.25 megaton per capita, that makes Canada fall under the last bucket of the decision tree analysis, and for countries that fall under that bucket, the factors mentioned above were found to have the strongest correlation with the dependent variable. Similarly, according to the cluster analysis, Canada was found to be in the same cluster as Norway and Austria. Through the comparative analysis between Canada and Norway, law was found to be the weakest link towards sustainability. The overlapping phenomenon in the Canadian Constitution acts has led to incoherent environmental policies.

The author intends to make a modest contribution to the unusually limited literature on this topic. The author also hopes to use the results to inform future energy policy regarding the importance of utilizing ICT and aligning environmental policies at different governmental levels with the national climate emission targets for either carbon-abatement programs in order to reduce greenhouse gas emissions.

2-1 Research Question

The author will answer the following sub-questions before focusing on the principal research questions.

- What is climate change?
- How do we combat climate change?
- How do we reduce carbon emissions?
- What are carbon abatement programs?
- Which program would be better for reducing carbon emissions?
- What are the main drivers of environmental developments?
- What is the impact of ICT on sustainable developments?

The above sub-questions lead us to the principal research questions which this study aims to address:

1. What is the role of ICT in reducing the carbon footprint?
2. What is the role of international treaties in reducing the carbon footprint?
3. How compatible are Canadian environmental policies with Canada's 2030 GHG emission reduction targets?

Chapter 3

LITERATURE REVIEW

What has been hanging in the balance, is the future of our environment and society. Nowadays, environmental problems have caught the attention of different societal and governmental bodies. The questions that are unanimously being addressed by almost all stakeholders are: what are the ways to make the world better? What plans do we need to have to combat sustainable challenges? According to Porter and Kramer (2006), sustainability is a complicated term to define which embraces societal, environmental and economic concerns. Sustainability is a terminology that has been extensively used to refer to the attainment of public/societal objectives in a manner in which commercial, economic and environmental goals could also be achieved simultaneously (Porter and Kramer, 2006).

It has been universally agreed that emissions of carbon dioxide are considered to be the leading cause of global warming. They also can increase the societal costs by harming social welfare. In the recent Paris Agreement COP21, reached in 2015, ninety percent of global carbon dioxide emitters have agreed to declare their mitigation objectives (Weitzman, 2017). However, COP21 is entirely voluntary with no penalties.

In order to reduce carbon pollution, countries are using different carbon abatement mechanisms. The main instruments that are used globally to reduce CO_2 emissions are the cap-and-trade and carbon tax. Governments attempt to maximize social welfare by imposing either of those systems (Xu et al., 2016). Many jurisdictions and regulators have legislated regulations to reduce carbon emissions nationally. Under the cap-and-trade mechanism, firms receive an emission credit (the highest amount is known as a cap) from the government agencies. The permits are tradable on the market. It is therefore known as a system that directly controls the quantity of the overall production of carbon.

Both systems deal with uncertainty. However, there are different types of uncertainty. For the cap-and-trade mechanism, the overall quantities of emissions are acknowledged, but the price/cost is unknown. On the other hand, for the carbon tax system, the price/cost of emissions is known, but the overall emission is unknown (Weitzman, 2017). According to Hoel and Karp (2002), Pizer (1999); Weitzman (1974), the carbon tax program is known to be a better instrument to deal with climate change based on economic models. It has been argued that it is incredibly challenging to resolve global climate change with the cap-and-trade system.

Numerous jurisdictions worldwide have implemented the cap-and-trade as an ideal method to reduce their CO_2 emissions. For instance, the European Union Emissions Trading Scheme (EU- ETS) is the biggest trading pollution permit marketplace in the globe. According to Hintermann (2010), EU-ETS is covering nearly fifty percent of the entire carbon emissions of European countries in the union.

Advocates of the cap and trade program claim that cap-and-trade system is a better mechanism since it has more certainty in limiting the carbon productions because production permits are limited and this may encourage firms and emitters to reduce their carbon emissions (Wittneben, 2009; Keohane, 2009; Stavins, 2007).

On the other hand, under the carbon tax mechanism, firms are charged per unit of producing carbon at a static tax rate (Weitzman, 1974). It has been argued that the carbon tax system is a strategy that helps to change and modify the behaviour of firms (Pizer, 2002).

British Columbia adopted the carbon tax system in 2008, and it was able to lower the GHG emissions of the jurisdiction by 9.9% (Gale, Brown, Saltiel and Center, 2013).

Nordhaus (2007), Metcalf and Weisbach (2009), with many other economists have long been debating over the ideal price and optimal method to tax carbon. There are others who have claimed that both systems are parallel in a sense that they both can be designed to imitate each other (Pezzey, 1992; Farrow, 1995).

3-1 Carbon abatement programs; their impacts, revenues generated & existing reports on GDP

Direct carbon taxing is broadly executed and practiced worldwide for different reasons including combating climate change (Harrison, 2013). For instance, in the United States, improving the administrative prospects of climate regulation is a driving factor behind the increasing interests of regulators for the carbon tax in that jurisdiction (Taylor, 2015; Shultz and Becker, 2013).

Based on dataset gathered within the last few years of pursuing either the carbon tax or the cap- and-trade systems, economists and political analysts are now able to compare the two systems, make decisions and design policies accordingly.

Carl and Fedor (2016) have studied the expenditure of revenues made by both systems. Their study of the revenue generated by the carbon tax system from main universal regions in which it has been practiced shows that the revenue gained from the carbon tax assists policy makers to use it as an incentive to change behaviour patterns of industry. This observation is in contrast to Barthold's (1994), observation. According to Barthold (1994), excising taxes were mainly exercised, as a revenue strategy for governments. Based on Carl and Fedor's findings (2016), the largest share (72%) of the revenue generated (USD$21.7 B) in countries which have chosen carbon tax as a preferable carbon abatement system goes directly towards general government funds. As opposed to the other abatement system that the most substantial portion

(36%) of the revenue generated (USD$6.57 B) goes directly towards taxpayers through tax cuts, direct rebates or refunds.

As it was noted above, the amount of revenue generated by the carbon tax is more than three times of the cap-and-trade program, and it is publicly salient. Chetty, Looney, and Kroft (2009) aided to apply the idea of “consumer salience” to the implications of taxes on procurement. In a case of the carbon tax system, it has been claimed that impacts of carbon tax policy on gasoline in B.C. have been more consumer salient than its parallel change in the price itself. This has resulted in a higher demand for the product (Rivers and Schaufele, 2014). The finding is also consistent with the prior work on this topic by Li, Linn, and Muejlegger (2014).

Similarly, O’Gorman and Jotzo (2014) studied the flexibility of consumers ‘demand in Australia within a couple of years since the introduction of carbon tax in the country. They concluded that the increase in demand for electricity was proportionate to the number of times media mentioned carbon tax. According to Baldwin (2008) and Harrison (2012), the cap-and-trade system can be implemented in regions where public support is not a paramount consideration since it has raised less revenue than the carbon tax. Even though the carbon tax system has generated more revenue, but it also has more transparency in terms of how the revenue is spent and for how much.

While the cap-and-trade system has only been around within the last seven years by producing measurable outcomes, the carbon tax has been practiced since the early 1990s. Scandinavian countries were the only jurisdictions at the time which they exercised carbon tax in the 1990s, and they stayed as the single universal carbon revenue regions for fifteen years. However, during the mid-2000s, carbon tax lost their supporters as the cap-and-trade was considered as a better mechanism and system to practice (“Where Carbon Is Taxed,” 2007).

There are many reasons for the return of the carbon tax since the late 2000s. For instance, British Columbia explicitly chose the carbon tax system over the cap-and-trade due to its ability to generate a substantial amount of revenue to counterweigh existing employment taxes. Iceland and Ireland both chose carbon tax to help shrink deficits due to recession hit. Other countries such as the United Kingdom have chosen carbon tax for its transparency and simplicity (Weitzman, 2017).

As Goulder and Schein (2013) have claimed, decisions of regulators and policy analysts concerning the selection of a particular carbon abatement program over the other have profound impacts on the performance of businesses. As a general rule, the carbon tax mechanism ensures price certainty and subsequently results in revenue certainty that allows authorities to project and budget revenue of upcoming year (Weitzman, 1974). This means that carbon tax can be perceived more like a fiscal device rather than a governmental revenue device. The result is comparable with Kallbeckken and Sælen (2011) finding in which they argue that, as the public trust increases, the government's use of tax revenues also increases.

On the contrary, this is in contrast with the cap-and-trade system that only ensures quantity certainty through quarterly or semi-annually auctions. Both lack of revenue certainty and volatility of price in the cap-and-trade system, explains why many jurisdictions cannot rely on its revenue as a general fund (Nordhaus, 2007). The revenue generated and collected by the carbon tax stays in a country which allows the government to budget and use the revenue within the country for different purposes. As opposed to the revenue generated from the cap-and-trade that gets transferred to other countries to purchase pollution permits. Scholars who focus on the political and legal concerns about carbon abatement programs, they tend to be in favour of the cap-and-trade system, but the majority of researchers who have used "cost-benefit analysis"

(CBA), unanimously chose carbon tax over the cap-and-trade (Wei et al., 2014). Furthermore, it is being argued by Weitzman (2017), that among many other factors, it is also important to consider the low transaction cost of negotiating for a unanimous single price for the carbon tax system as opposed to the transactional cost of negotiating many different quantities for the cap-and-trade program.

Other regulatory strategies could be practiced to reduce CO_2 emissions and accomplish the goal of minimizing carbon pollution, such as mandates. However, the carbon abatement mechanisms have novel features that other alternatives do not have. For instance, both systems not only are unique emission mitigating strategies but also, they are known as new avenues to generate revenue by jurisdictions. As a result, they are known as "dual-purpose" systems (Carl and Fedor, 2016).

3-2 The macro study of carbon abatement programs; impacts on operation management & manufacturing sector

Farinelli et al., (2005), have compared the pros and cons of the two carbon abatement systems to examine the enhancement of energy efficiency under each mechanism. They have found that carbon tax lowers the emission of carbon while adversely impacts the GDP. Harrison and Smith (2009) have argued that the cap-and-trade system is a better option since it is more environmentally and business friendly.

Green, Hayward and Hassett (2007), have considered the main two carbon revenue systems from the viability perspective, and they have concluded that practicing cap-and-trade is exceptionally challenging due to fake emission permits that can be purchased within the marketplace.

Likewise, there are concerns in regard to the misuse of power by government officials through stealing permits in order to sell them for a higher price on the global marketplace

(Weitzman, 2017). Other proponents of the carbon tax claim that it is easier to practice the carbon tax since the cap-and-trade program requires unanimous agreement of all parties involved on a certain target as a baseline for reducing carbon emissions yearly (Avi-Yonah and Uhlmann, 2009). According to Witteneben (2009), the carbon tax is the preferred method as it can lower the carbon emissions faster with less cost.

As Hogue, Johnson, and Kemsley (2014), argue, problems of climate change are mainly due to prompt advancement of the economy. The environmental issues related to climate change have caused various harms and threats to our society and the ecosystem. It is essential to fully comprehend that the threat is real and the challenge requires all of us to play a role in combating climate change (Malhotra, Melville, and Watson 2013).

Among different industry sectors, manufacturing is the most significant sector concerning carbon production, in all developed and developing countries (Fysikopoulos, Pastras, Alexopoulos, and Chryssolouris 2014). Therefore, carbon abatement mechanisms directly impact firms' production decisions.

Nowadays, more and more attention is being given to the "low carbon economy" throughout the world with an aim to change both humans' manufacturing process and lifestyles towards a more sustainable production (Chen and Hao, 2015). The concept of the manufacturing process or the "low carbon manufacturing," is the production of low carbon pollution intensity by effectively and efficiently utilizing the energy resources (Tridech and Cheng, 2011). Many manufacturers globally have initiated to practice the manufacturing process to gain a competitive advantage over their rivals, but a move towards a low carbon manufacturing requires investments in green technologies and substantial changes to the operating systems within firms (Chen, Luo, and Wang, 2016).

According to Chen et al., (2016), the correlation between the "optimal" pricing policies of two competing manufacturers with different efficiency strategies in their production are hugely impacted by their decisions on green investments and innovational technologies, and cost efficiency, under the "balanced power structure." This means, when manufacturers' cost efficiencies for green investments and technologies are comparatively small, the manufacturers' "optimal" price with higher efficiency is high, as opposed to the manufacturers with lower efficiency. The higher efficiency of the manufacturers would lead to fewer carbon emissions (per-unit of production), production, and a greater number of products which results in more investments in sustainable technologies and of course enhancement of profit. Similarly, higher carbon reduction efficiency of the manufacturers would lead them towards the production of more sustainable products through greater investments on green technologies. Mickwitz, Hyvättinen, and Kivimaa (2008), who have studied the impact of administrative tools on environmental friendly innovations, have concluded that both "macro and micro" concerns influence firms' investment decisions on green technologies.

Van Hemel and Cramer (2002) found that internal factors have a great influence on the investment decisions of manufacturers towards greener technologies. Among the internal factors discussed by the authors, new target market, new opportunities associated with investments in innovational technologies and expected increase of products are known to be the most influential internal factors. Investments in green technologies by manufacturers come with a cost, and it is an expensive decision for them to make. Based on Moon, Florkowski, Brückner, and Schonhof (2002), as the demand for more sustainable products increases due to a stronger willingness of consumers to spend more for sustainable products, more manufacturers will become interested in investing on carbon reduction technologies. Therefore, manufacturers will invest in eco-friendly technologies and reduce their carbon emissions, as long as there is either demand or a compulsory requirement that needs to be met (Yang and Chen, 2018; Chitra 2007).

In regards to the impact of carbon abatement programs on the operation management, Jin, Granda-Marulanda, and Down (2014), who have studied the effect of a carbon reduction on a major retailer, have found that high carbon tax rate and a rigorous cap both would force retailers to redesign their supply chain. Benjaafar, Li, and Daskin (2013) studied the impact of either carbon reduction programs on the operational decisions about purchasing, manufacturing and, managing of inventory, and have discovered that by modifying the operations alone, businesses can meet the requirements to reduce carbon emissions. He, Zhang, Xu, and Bian (2015), undertook an Economic Order Quantity model (EOQ) for both the carbon tax and cap-and-trade systems to explore the production problems of carbon-intensive fuels firms. They have found that the difference in the unit production and the model's outcome, are directly proportional to the restrictions and regulations associated with either program.

Drake, Kleindorfer, and Van Wassenhove (2010) have investigated the impacts of the cap-and- trade and the carbon tax on the production and decision-making process. They have found that the cap-and-trade mechanism provides a better result as it not only reduces the overall carbon emission but also it helps firms to gain profit at the same time. Based on another study done by Song and Leng (2011), the authors examined the ideal manufacturing capacities and projected surplus from the production of a single product. They concluded that the cap-and-trade system could help increase the firms' profit while reducing the production of CO_2.

3-3 The impact of government policy decisions, regulations, & country's resistance as an index of regulations on businesses & CO_2 emissions

Based on the Triple bottom line theory which was introduced by Elkington (1999), any organization's outcome should be compared and judged against the interdepended ecological, financial and societal dimensions. “Win-win” hypothesis or Porter’s hypothesis says organizations’ sustainable and financial progress could be improved through the enactment of environmental regulations and policies since these regulations are focused on the innovational enhancement of firms. Since the introduction of the Porter hypothesis, scholars extensively debated over the impacts of fixed and flexible environmental regulations on firms’ innovational advancements (Ambec and Barla, 2006).

According to Majumdar and Marcus (2001), regulations are divided into two main groups of flexible and inflexible. Flexible regulations are “innovation-friendly,” and they would encourage firms to pursue suitable practices, innovations and products in order to meet the regulatory requirements. Flexible regulations would only indicate the required outcome, by leaving some autonomy to firms in choosing their path (how) towards the result. For instance, EU-ETS can be categorized under flexible regulation, since it only has set the cap on the overall quantity of carbon emissions while granting tradable permits to firms (Zhang and Wei, 2010).

On the other hand, inflexible regulation would prescribe certain product or practice for firms to follow in order to meet the required regulation by achieving a certain result. For example, when regulation compels a firm to follow a certain requirement to minimize its carbon pollution in order to produce a particular product/substance, this environmental regulation would ultimately force the firm to invest in the technologies that would reduce and control the carbon emissions rather than enhancing its operational process (Zhang and Wei, 2010).

Shoppers and policy makers can employ constant pressure on businesses to produce products in such a way that would minimize their harmful effect on the ecosystem (Kleindorfer, Singhal, and Wassenhove 2005; Sarkis, Zhu, and Lai 2011; O’Brien, 1999). If companies’ productions and practices are in any way doubtful, not only they would experience fewer demands by consumers, but also fines of not complying with policies and regulations will increase (Klassen and McLaughlin, 1996; Kassinis and Soterious, 2003).

However, it is important to highlight that consumers' non-consumption of a certain product(s) or brands also play a crucial role in moving towards sustainability (Cherrier, Black, and Lee, 2011). According to Stevens (2010) product(s) banning directly impacts the level of firms' investment decisions and innovations and ultimately the sustainability developments. Therefore, governments can both promote and demote sustainable productions and consumptions (Stevens, 2010). Cherrier et al., (2011) argue that the action taken by consumers to not to consume a certain product(s) can be either voluntary or compulsory. In cases where the non-consumption is compulsory, government officials impose a certain penalty through regulations and policies on consumers who consume the forbidden product(s). This is known as an example of a country's resistance towards consuming a certain product(s) through enacting certain laws and regulations. Another example could be seen in some Islamic countries where officials are able to promote or demote people from consumption of certain product(s) through religious regimes by labelling them either "Halal" or "Haram." According to Shirazi (2014), "Halal Internet" which referred to the publicly controlled national Internet, was recently introduced in some Islamic country to limit and restrict the public's access to the Internet to the filtered "Halal Internet." Therefore, citizens are banned from using the "non- Halal Internet."

Moving towards more environmental friendly productions is not always aligned with the "profit- seeking behavior" of the businesses as the cost of doing business may outweigh the benefits of producing green products (Palmer and Oates, 1995; Hoffman and Bazerman, 2005; Pagell and Wu, 2009; Yalabik and Fairchild, 2011).

Market competition can change firms' behaviour beyond compliance (Arora and Gangopadhyay, 1995). It has been recognized that market competition can lead to a more eco-innovative advancement than any other external factor. Competition can reverse the unfavourable impact of emission-intensive businesses, specifically if there are adequate alternatives for consumers to choose from. In other words, it can be concluded that the pressure of regulations and environmentally conscious customers towards eco-friendly innovation is dependent to which industry sector the organization operates (Yalabik and Fairchild, 2011). According to Yalkib and Fairchild (2011), regulatory pressure on organizations with minimal levels of per-unit production tends to force them to respond positively. Conversely, pressure on organizations with high levels of per-unit emissions can only force them to minimally reduce their production than they would otherwise, since the higher the levels of per-unit emissions means more money should be invested to counter the environmental impacts. Likewise, since pressure from both consumers and regulators might remove some of the organization's resources such as losing market and or paying fines, the organization may find it more reasonable to adjust its "market behaviour" through price adjustments rather than investing in green technologies (Yalabik and Fairchild, 2011).

Even though pressure on firms may result in the advanced environmental performance of firms, but stricter environmental regulations may have an adverse impact on the ecosystem (Chen, 2001). Similarly, Bansal and Gangopadhyay (2003) who have considered a dual-stage of the decision-making process for a couple of firms under both uniform and discriminatory tax regimes explored that, under the discriminatory tax policy, consumers' profit (as an element of social welfare) might fade. Under the uniform tax strategy, an identical tax rate is executed on all companies on every unit of production, whereas under the discriminatory tax strategy, companies with less environmental qualities are executed greater tax rate on every unit of production.

Sustainable regulations and policies that are dependent upon investments of firms in green technologies, such as regulations for industries, are very tricky. It is very crucial to understand that enacting direct regulations not only would not motivate and/or force firms to move towards green technologies but also they might have a negative impact on the industry. This would demotivate firms from investing in such innovations. This is true since, huge investments have to be made on controlling and monitoring the carbon production rather than focusing on the operational process (Ford, Steen, and Verreynne, 2014). Conversely, governmental regulations which are more dependent upon investments of governments in firms such as subsidies will help the industry to partially comprehend the regulation itself while leaving firms with enough capital to invest in R&D and green technologies. Thus such regulations would positively impact firms' performance towards more sustainable developments (Lei, Tian, Huang, and He 2017; Das, Alavalapati, Carter, and Tsigas, 2005).

According to "institutional innovation theory," new laws, regulations and policies should focus more on helping firms to invest in green technologies rather than compelling them to obey the regulations through enforcement techniques. Hence, regulations related to both environmental subsidies and tax breaks are necessary to motivate firms towards more sustainable advancements ((Das et al., 2005; Lei et al., 2017).

To understand what forces polluters to respond positively or negatively to a certain voluntary program, it is important to consider the motivations behind the firms/polluter's involvement in that program. This would help policymakers to effectively measure the efficiency and the design of any voluntary program in order to achieve the optimal outcome.

Firm's environmental behaviour can be influenced by a combination of market competition, governmental incentives such as subsidies and eco-friendly legislations, and environmental awareness of consumers which could also be acquired through educational campaigns (Fairchild, 2008). Firms will automatically invest in more green technologies if these three factors are linked together. Likewise, as Köhler et al., (2013); Kiss, Manchón, and Neij (2013), have mentioned, the governmental incentive programs can hugely drive firms towards eco-friendly productions of products. According to Cambra-Fierro, Hart, and Polo-Redondo (2008); and Fraj- Andrés, Martinez-Salinas, and Matute-Vallejo (2009), when firms within industry realize that their compliance has reduced their impacts on the environment, they tend to gain financial benefits through "differentiation." Similarly, Rehfeld, Rennings, and Ziegler (2007) argue that environmental certification is positively impacting the adoption and adaption of eco-friendly technologies.

3-4 Information & communication technology & its impact on CO_2 production

Information technology for environmental sustainability has been studied by scholars such as Melville (2010), who have focused on organizational behaviour of firms in order to improve the firms' environmental performance. Based on his analysis, it was evident that the role of ICT has been greatly underestimated.

Unfortunately, not many studies of environmental sustainability have considered ICT as a tool to reduce environmental damages. However, ICT is expected to reduce the production of carbon dioxide globally through "developing smarter cities, transportation systems, industrial processes and energy saving grids" (Higón et al., 2017, p.85; Ollo-Lopez and Aramendía-Muneta, 2012). As Røpkea, and Christensen (2012), mentioned, ICT has a direct effect on the overall consumption of electricity by building different infrastructure. Based on the studies done by Mingay (2007), ICT has been forecasted to produce around two percent of overall GHG emissions of the entire world. However, it has been claimed by the Global e-Sustainability Initiative report (GeSI, 2008) that ICT will help to combat the global GHG emissions and more specifically CO_2 emissions by fifteen percent.

Developments of ICT through the entire world are growing inquiries upon the degree to which these developments could be influential in designing greater environmentally friendly patterns in our lives. Misuraca and Viscusi (2015) argue that ICT is the main driver of innovation. “Going smart” is a new concept that is promptly shaping and influencing both the academia and the literature related to policymaking. Globally, towns and cities are becoming more and more prompt to rearrange their facilities and service industries, such as transportation services, land usage and services associated to communities and urban infrastructures to become more effective by providing the real-time replies/responses to obstacles, as they happen. This is being done through connecting and incorporating technologies, such as ICT and the IoT (Internet of Things) (Albino, Berardi, and Dangelico, 2015). The intention behind the usage of these technologies is to improve the functionality, distribution, supply and quality of services provided in urban areas in order to minimize expenses, carbon productions and resource usage.

Likewise, adoption and integration of these technologies can also produce longstanding positive impacts on the relationships between the economy, residents and government, since it requires the active involvement of citizens (Komninos, 2013; “Building a Smart Equitable City,” 2015). For instance, by permitting electric cars to park for free in cities or allowing them to pay less annual taxes on roads, consumers will be pushed and encouraged to purchase more electric cars (Bjerkan, Nørbech, and Nordtømme, 2016). This similarly illustrates the significant influence of advancement in technologies on humans ‘choices and lifestyles, by influencing their selections process towards “smart choices.” (Midden, Kaiser, and McCalley, 2007). The concept of “going smart” is more comprehended as the managing of human-made environment intelligently.

Latest innovations in ICT are encouraging the implementation of “smarter” tactics towards the development of sustainable products, which is suggesting a disappearance of conventional methods, or maybe prior, eco-friendly methods supporting developments of environmentally friendly commodities. Gazzola, Del Campo and Onyango (2019) research results propose that the conjunction of “green” and “smart” designs for green advancements could be accomplished if “smart-centric” methods towards both policymaking and planning (strategic decision making) are incorporated in the central vision for developing green urban setting through sustainable tactics. Therefore, this offers a “win-win” answer to sustainable concerns which presents both reliance and the belief in human creativity and technical improvements. This has also been suggested in the Brundtland Report (WCED, 1987): “(…) accumulation of knowledge and the development of technology can enhance the carrying capacity of the resources base (…)“ (p.45); “(…) we have the ingenuity to change (…)” (p.205). Thus, this can be likened to concepts of “ecological modernization” which says technological developments along with the better use of natural resources and change in institutions can help us in moving towards more environmentally friendly movements and growth in the future (Gazzola et al., 2019).

Like many other concepts, the notion of “going smart” has also grown within the last few decades. Originally “going smart” was used to refer to practical efforts towards enhancing the functionality of infrastructures of municipalities and services through the use of innovative technologies. Now, the concept has grown and expanded in a way that encompasses the ideas of “city’s responsibilization” towards citizens and “smart citizens” who are keenly participating and are used to live in smart cities (Vanolo, 2014).

ICT in conjunction with smart technologies can aid to attack issues related to environmental concerns with a focus on both humans and technologies through the usage of “deploy-and- monitor” method. In this method, smart tools/devices are used to enhance social awareness through examining/monitoring both the behaviour of the public and the efficiency of the system. Throughout this process, consumers/public can be persuaded and inspired to adjust and embrace new patterns of behaviours (e.g., use of energy and resources and commuting choices). This would help policy-makers to encourage citizens towards “smart communities” and “smart governance” (Ahvenniemi, Huovila, Pinto-Seppä, and Airaksinen, 2017).

Nevertheless, smart technologies can have unfavourable consequences on nature. To some degree, negative impacts related to different aspects of smart tools/devices such as their lifespan, e- waste management and so forth are unavoidable (Castro and Sanchez, 2003; Hilson, 2002; Williams, 2011).

The constant need to “go green” and “go smart” is justified by considering the significance of nature to human life, the universal economy and the degree in which the environmental concerns and problems are growing. In many areas, technological advancement has been accomplished by the production of smart-eco-friendly technologies which have aided us to minimize environmental problems (those that were caused by humans) and use of resources; yet even best practices are not enough if the advancements degrade the environmental situation.

A modern definition of “going smart” involves resolving difficulties and obstacles associated with urban life by using collections of ICT’s data and internet-connected tools/devices.

Initiatives used for creating smart cities have affirmed their importance in gathering, sharing and or communicating data which can be used in almost unlimited ways. For instance, through the usage of weather sensors, we can establish the speed limits (Haug and Grosanic, 2016). According to Ahvenniemi et al. (2017); Bifulco, Tregua, Amitrano, and D'Auria (2016), smart developments and "going smart" are anticipated to both inspire and help the public to move towards sustainable awareness.

Though, researches propose that people have not yet fully comprehended how "going smart" and sustainable developments can go hand-in-hand (Ahvenniemi et al., 2017; Bibri and Krogstie, 2017). "Going smart" tries to provide accessibility and convenience to the public when using different products and services to react and respond to climate change problems, for instance by building smart infrastructure (Gustavsson and Elander, 2012). It is also important to recognize that numerous ecological harms could be minimized with a shift of humans' behaviours. Equally, we should be considerate about capacities of people for change, by studying different components such as educational level, prosperity, life experiences and so on, relative to the way in which they use the natural resources and the degree in which they are willing to adopt and adapt changes (Steg and Vlek, 2009).

Within the EU 2020 document, it has been highlighted that to achieve a win-win result for a "sustainable, inclusive and smart growth" of European countries, smart strategies should be used to readjust and realign the economy, the environment and climate change (EC, 2010). Building on this, advancement in environmentally friendly technologies are vital since both production and efficiency of resources could be improved, and this will help us in achieving our longstanding goal towards sustainable advancements.

Jensen and Berg (2012), argue that companies that are located in countries with greater innovational and technological advancements in their manufacturing sector, tend to have more resources both in terms of knowledge and manufacturing capabilities. These resources can be further used to encourage and implement eco-friendly managerial instruments such as those that are essential for CSR and SDG reporting. According to Halkos and Skouloudis (2018), R&D is positively correlated to CSR and SDG reporting by companies because to implement environmentally friendly products, the production system is forced to invest in the R&D and new technological machines that reduces their negative ecological impacts on the nature (Bansal, 2005; McWilliams and Siegel, 2001). The result is consistent with prior research in this field. As Jiang, Wang and Li (2018) demonstrated in their study, Chinese manufacturers that have heavily invested in their technological advancements, R&D investments showed to have a direct positive impact on firm's greener innovational performance.

Furthermore, countries that enjoy higher levels of innovational performance are anticipated to be the leaders of the technological competition, which are also expected to have growing shifts towards implementation of more environmental innovations for numerous sectors of their countries (Indicators OECD, 2011). Hence, a collective innovational infrastructure of a country and the intensity of innovation, are both linked to the gradual innovational movements in technologies for a country (Furman, Porter, and Stern, 2002), which would ultimately enhance and increase the adoption of green technologies (Mathur and Berwa, 2017). A country's movements towards greener technological advancement would inspire companies within these countries to commit to production of greener products.

In order to achieve a longstanding goal of enhancing efficiency in energy and reducing carbon productions, ICT should be used to aid us in storing, and analyzing related information, while enabling us to produce reports to policy and decision makers.

3-5 International protocols

The most recent international protocol on climate change, the Paris Agreement, wrapped up the third chapter of the UN climate change framework. The initial round of negotiations about climate change goes back to the period of 1990-1995 when it involved the adoption of the United Nations Framework Convention on Climate Change (UNFCCC). The second phase of these negotiations covered the period of 1995-2004 when the Kyoto Protocol came into existence and force. Yet, the current framework is more holistic in terms of focusing on GHG emissions globally ("Protocol," 1997). The Paris Agreement came into existence as a result of negotiations which took place since 2005, when nations switched their attention to the question of what needs to be done after 2012 (post-Kyoto) when the first round of Kyoto Protocol commitments ends. While developing countries were persisting on the continuation of the Kyoto scheme, Annex I and Annex B countries with specified cap targets were unwilling to do so as they did not find it just, to be bound by emission targets while such targets do not bind major economies such as the United States and China. Instead, they were advocating for a more holistic system (Bodansky, 2016).

The ultimate goal of all these negotiations was to amend the Kyoto Protocol, establish another commitment period and to encourage a long-term collaboration plan under the UNFCCC. The first track of the Kyoto Protocol was launched in 2005 by the parties involved in the agreement, while the second track was scheduled in 2007 in the Bali Action Plan, by the

UNFCCC parties, and finally, the Copenhagen Conference in 2009, meant to conclude all these tracks (UNFCCC, 2008; UNFCCC, 2010; Bodansky, 2016).

Unfortunately, the Copenhagen Conference was loaded by massive expectations which were caused by the Danish government's decision of inviting heads of nations. Yet, since parties only had two years to resolve numerous issues on their plates, the Copenhagen Conference ended with immense frustration, disappointment and failure. Even though heads of major economies and many of the state's leaders accepted and agreed to the Accord, but it was more political rather than legal. It is also important to mention that the Accord was not able to gather acceptance of the entire conference participants (Bodansky, 2010).

Unlike the huge regrets of the Copenhagen Accord, it did help states in moving forward. Despite the Kyoto Protocol which imposed cap targets on nations (top-down structure), Copenhagen Accord introduced a bottom-up structure which allowed countries to outline their emissions targets and the action needed to be taken to achieve those targets. According to the Accord, this information was later recorded and published internationally. Another significant divergence of the Copenhagen Accord from the Kyoto Protocol was that it differentiated between developed and developing countries. Surprisingly, for the first time in the history, India, China and Brazil along with other evolving economies accepted the Accord and provided their national emission targets and pledges (Bodansky, 2010).

The Cancun Agreement in 2010 officially integrated the core elements of the Copenhagen Accord in the UNFCCC framework which also included pledges made by countries to minimize their emissions. However, the Cancun Agreement was not successful in resolving two issues: whether these pledges and commitments should be continued after 2020, and whether Kyoto needed to be extended after 2012 (UNFCCC, 2011a). These issues led to the Durban

Conference ("Durban Platform for Enhanced Action") in 2011 (UNFCCC, 2011b). The negotiations that took place in the Durban Conference ultimately led to the Paris Agreement, and resolved the issues mentioned above. The EU and some of the countries with the Kyoto Protocol's targets accepted to the second round of commitment period. They officially adopted the agreement a year later in Doha. However, India, China, Brazil and South Africa agreed to the mandate in order to negotiate a new platform which would become legally into force from 2020. It is important to highlight that the United States accepted the new mandate as it was not differentiating between developed and developing countries and it applied to all parties involved. The Durban Platform also included the Warsaw decision ("Further Advancing the Durban Platform") in 2013 which meant to articulate the novel hybrid structure of the recent agreement and asked nations to submit their "intended nationally determined contributions (INDCs) before the Paris Conference (UNFCCC , 2011b; Bodansky, 2012). According to the White House press release (2014), China and the United States made a joint announcement to further signal the collaboration between these two major economies and emitters of the world.

After many years of trial and error, countries were eventually able to establish a platform that is known to be the modest approach taken so far. The Paris Agreement intends to build a stronger foundation on combating climate change than heading towards ambitious expectations that the Kyoto Protocol created. Though it is still early to assess the success of the Paris Agreement, some call it as "historic, and the world's greatest diplomatic success" (Warrick, and Mooney 2015; Harvey, 2015). However, if Paris proves it so, the success of the Paris Agreement is not due to its contents but rather to its novel model switch that occurred at the Copenhagen Accord in 2009, where countries terminated the rigid Kyoto platform and agreed on a more relaxed regime to follow. Eight features differentiate the Paris Agreement among the rest.

First of all, it is legally binding (even though it contains non-binding provisions) as opposed to the Copenhagen Accord which was only a political deal rather than legal. Second, it does not differentiate among developed and developing countries (unlike the Kyoto Protocol), and all nations are involved in mitigating and reducing global emissions. Third, it identified and recognized the principal core obligations for all countries. Fourth, it has established a long-term plan to combat climate change, unlike the Copenhagen Accord. Fifth, it has established a durable framework which parties will need to meet every five years to share their accomplishments and introduce their new targets for the years ahead. Sixth, it has set the stage of gradually strengthening mitigating actions over time. Seventh, it has established an improved transparency and accountability framework by recording and announcing states' targets internationally. Eighth, it commands the universe to follow the framework (Bodansky, 2016). The most precious outcome of the Paris Conference was the Paris Agreement which the Copenhagen Accord gave birth to. Even though the Paris Conference was able to give new hope to the global climate change framework, but there is still a lot needed to be done, and a lot could go wrong since states only agreed to the basic structure of the new climate change framework.

3-6 The impact of regional & political stability on an economy & sustainable developments

Countries' stability is directly related to their level of peacefulness. The higher the country's level of stability, the faster the country develops. According to the report of Global Peace Index (2015), "positive peace" factors are independent factors that are significantly associated with "stronger business environments, better performance on well-being measures, gender equality and better performance on ecological measures" of a country (Global Peace Index, 2015, p.83). Positive peace has been defined as "the attitudes, institutions and structures which create and sustain peaceful societies. These same factors also lead to many other positive outcomes that support the optimum environment for human potential to flourish" (Global Peace Index, 2015 p.6).

FIGURE 3-1: The Pillars of Positive Peace
A visual representation of the factors comprising Positive Peace.
Eight factors are highly interconnected and interact in varied and complex ways
(Global Peace Index, 2015)

It has been argued that where the ratio of "positive peace" is greater, societal and economic advancements are more expected to be attained. For instance, Europe has kept its position of being the most peaceful continent in the entire world, and it was also the continent that experienced the greatest environmental, social and economic developments, throughout the eight-year trend of peacefulness (Global Peace Index, 2015).

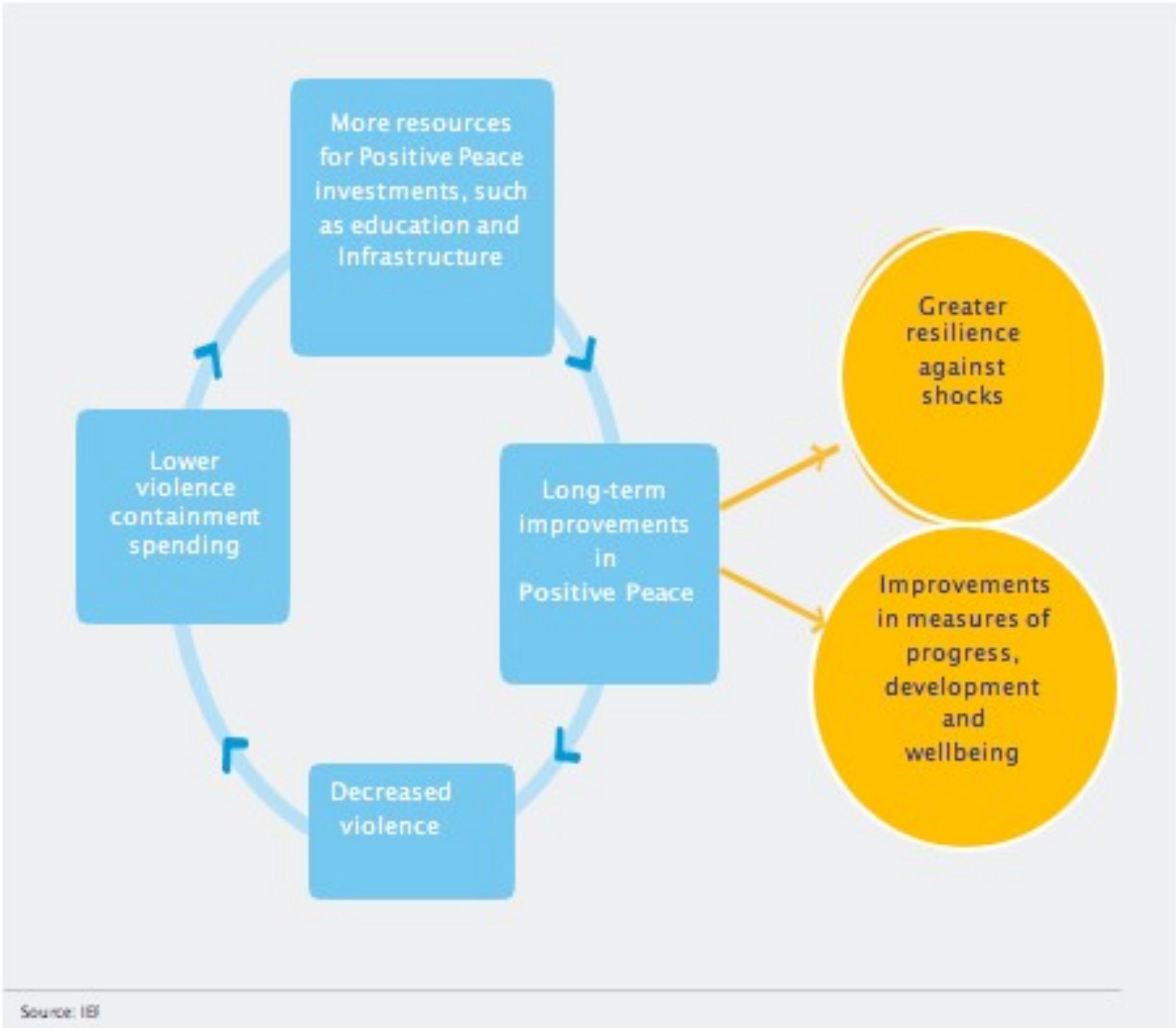


FIGURE 3-2: Positive Peace: Virtuous Cycle of Lowering Violence Containment Spending (Global Peace Index, 2015)

Conversely, countries with weak "Positive Peace" factors tend to use the military to suppress internal conflicts. The violence comes with the cost. According to the Global Peace Index, 2015, direct and indirect cost of violence accounts for 13.4% of the world GDP. This is equal to "the combined economies of Brazil, Canada, France, Germany, Spain and the United Kingdom" (Global Peace Index, 2015 p.5).

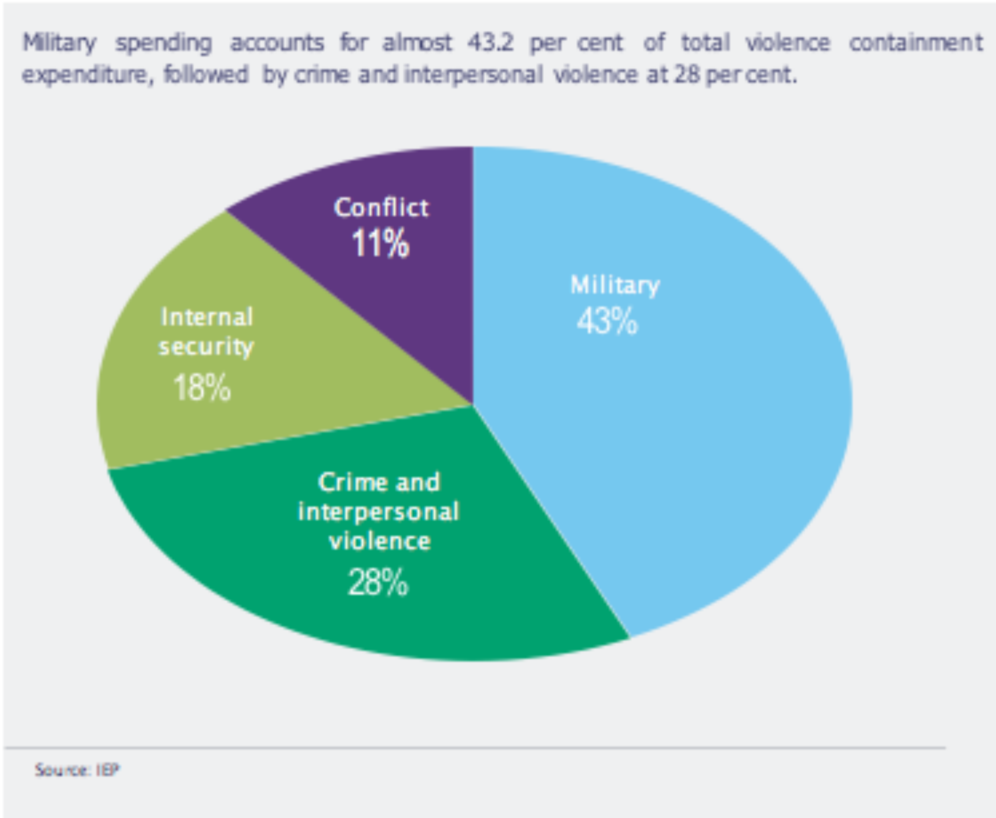


FIGURE 3-: Direct & Indirect Violence Containment by Category2014
(Global Peace Index, 2015)

Aside from the adverse financial impact of militarization, it has been proved that militarization and peacefulness have a negative correlation. "As countries become more militarized they also become less peaceful. They are also more likely to experience negative changes in other domains such as social safety and security and levels of ongoing domestic, national sustainable growth and international conflicts" Global Peace Index, 2015 p.38). The major themes impacting the global peacefulness are: "ongoing domestic and international conflicts; society safety and security; militarization" (Global Peace Index, 2015 p.26). Largely, the factors leading countries towards development are almost the same factors that are needed for societies and countries to be peaceful.

3-7 The impact of educational attainment on corporate social responsibility & sustainability

Studies on CSR, ethics and business ethics have shown that both culture and education can impact mindsets, opinions and expectations of citizens (Dellaportas, 2006; Elias, 2004; Luthar, DiBattista, and Gautschi, 1997; Rosati, Costa, Calabrese, and Pedersen, 2018). De Marchi (2012) also emphasizes the significance of incorporating external stakeholders such as educational and research institutions in creating demands for eco-friendly products. Based on Elias (2004) and Luthar et al., (1997), investments in educating students in business ethics can positively impact their mindsets, awareness and expectancies in terms of CSR and ethics. Prior studies have shown that as the level of education of individuals rises, they show greater concerns in regards to CSR, and in particular, they become very conscious about business ethics (Kelley, Donnelly, and Skinner, 1990; Calabrese et al., 2016; Quazi, 2003). This is also true on the national scale. Hofstede and Minkov, 2010, have defined the national culture on page six of their study as "the collective programming of the mind acquired by growing up in a particular country." The higher levels of education are positively related to both nationwide culture and national sustainability concerns (Park, Russell, and Lee, 2007).

3-8 The impact of political rights & civil liberty on sustainable developments

According to the report of "Freedom in the World" which is generated on a yearly basis, the freedom and democracy in the world has been defined and assessed based on political rights and civil liberties for each state, and the report covers a hundred ninety-five states and fourteen territories ("Methodology Fact Sheet," 2014). Universal Declaration of Human Rights which is also embraced by the United Nations' General Assembly in 1948, drives the methodology of this report. According to the premise of the Universal Declaration of Human Rights, the standards that are used by the report, are applicable to all states and territories, regardless of their geographical, industrial and ethnic differences. It is also important to mention that the report only assesses the enjoyment of rights by individuals, not governments.

According to the "Freedom in the World," the political rights consists of "electoral process, political pluralism and participation, and function of government" ("Methodology Fact Sheet, 2014). Similarly, civil liberties include " freedom of expression and belief, associational and organizational rights, the rule of law, and personal autonomy and individual rights" ("Methodology Fact Sheet," 2014).

Oates (2003) argues that the more public participates in political debates, events and exercise their fundamental political and civil rights, the more involved they become in matters that impact their socio-political lives which also could include sustainable developments such as moving towards smart cities. According to Shirazi, Ngwenyama and, Morawczynski (2010), the level of freedom and democracy are positively related to the level of ICT and sustainable development of a country.

Chapter 4

EXPERIMENTAL ANALYSES

This study aims to examine the relationship between selected external and internal factors on carbon production. The author has used the quantitative approach as the optimal methodology to gather and interpret data in order to answer the following research questions:

1. What is the role of ICT in reducing the carbon footprint?
2. What is the role of international treaties in reducing the carbon footprint?
3. How compatible are Canadian environmental policies with Canada's 2030 GHG emission reduction targets?

The selection of the research approach is very subject dependent. The quantitative approach is mainly used in social sciences, natural sciences and humanities. It is a systematic experimental investigation of observable facts. The quantitative approach provides precise information in regards to a prediction of trends, a creation of extendable results, determination of casual statistical relationships, and so on (Yilmaz, 2013).

Since the author is investigating a social phenomenon (the impact of ICT and international treaties on the carbon footprint), a natural research methodology to pursue was the quantitative approach.

4-1 The Research Model

The empirical analysis to assess the impact of ICT and international treaties on carbon production is based on a linear statistical model which has been presented below:

$$CO_{2it} = C_{it} + (\beta 1 * ICT_{it}) + (\beta 2 * Education_{it}) + (\beta 3 * GDPP_{it}) + (\beta 4 * Stability_{it}) + (\beta 5 * Resistance_{it}) + (\beta 6 * PRCL2_{it}) + (\beta 7 * IntLaw_{it}) + E_{it}$$

Where “C” stands for the constant; “β” stands as the probability of type II error in any hypothesis test; “ICT, education, GDPP, stability, resistance, PRCL2 ” are all independent variables; “E” is known as the statistical error which shows the difference between the retained value and the true value. “CO_2” is the dependent variable. The letter “i” in the index “it” stands for countries and “t” for time (1996-2015).

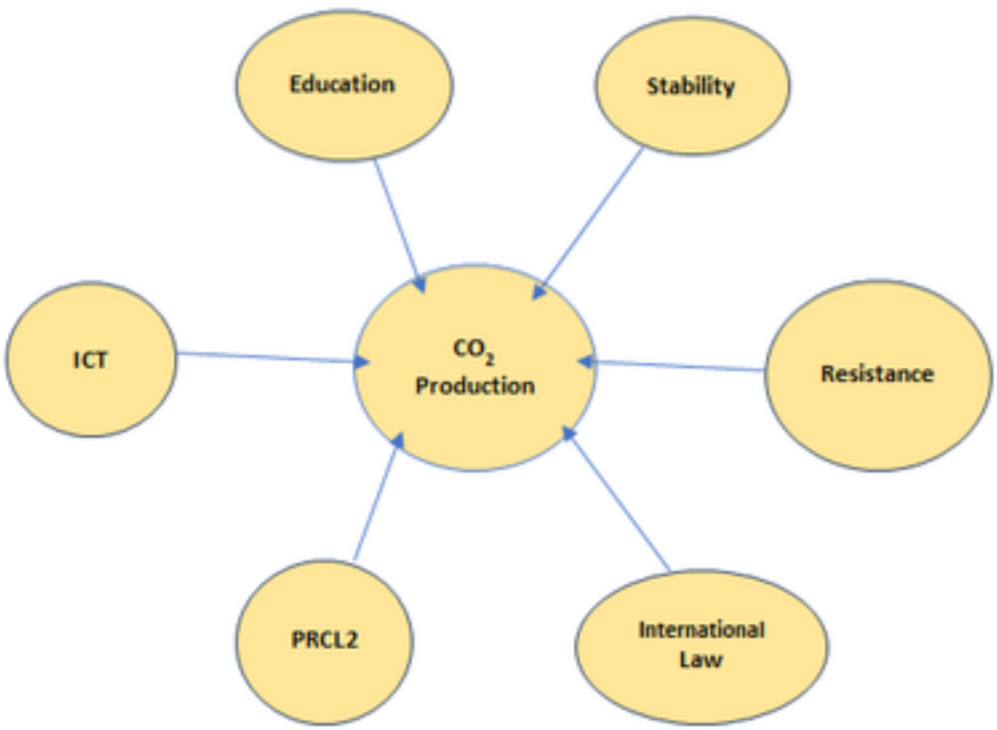


Figure 4-1: The overall research model

4-1-1- Hypotheses

The following hypotheses were proposed:

H_1: It is expected that international climate protocols will have a negative impact on CO_2emissions.

H_2: It is expected that ICT will have a negative impact on carbon production.

H_3: The growth of GDP per capita as a measure of economic growth will increase global CO_2 emissions.

H_4: It is expected that the educational attainment of citizens has an inverse effect on CO_2 emissions.

H_5: It is expected that aggregation of political and civil rights will help societies to reduce their CO_2 emissions.

H_6: It is expected that the political and regional stability of countries impacts their CO_2 production positively.

H_7: It is expected that the countries' resistance either in the form of internal conflicts or lack of regulations, positively impacts their CO_2 emissions

4-2 Data Collection

The main data comes from trusted international organizations such as UN, ITU which is also a subset of UN, and World bank. Academic studies and industry reports were also used for data collection. The author has used a balanced panel data from 1996-2015 for 145 countries with 2919 observations. The author has used various sources to collect the variables for the study. Please see Table 4-1.

Table 4-1
Variables, unit of measurement and dataset sources

Variable	Unit of Measurement	Source
CO_2	Metric tons per capita	World Bank
GDPP	GDP per capita in purchasing power parity terms at 2015 international dollars	World Bank
ICT	The composite of ICT index used in this study combines both stages of ICT development being i) ICT readiness and ii) ICT use and intensity. Indicators measuring ICT readiness in this study include fixed telephone subscribers per 100 people, mobile cellular subscriptions per 100 people, and PC owners per 100 inhabitants. Internet users per 100 people and fixed broadband Internet subscribers per 100 people are used as proxies for ICT use and intensity. To construct the composite index combining both stages of ICT development, we use the average scores of the five indicators.	ITU
Education	To estimate the education index emphasizing the influence of higher education on the use and development of ICT, we estimated: (Education = 1/6 * (primary + 2 * secondary + 3 * tertiary)).	Orbicom & ITU
PRCL2	The level of political rights and civil liberty for each country (zero being the lowest and six being the highest)	Freedom House
Stability	Which an index of regional and political stability impacting each country	Methodology Fact Sheet
Resistance	Which is an index of barriers (lack of regulations or internal resistance)	Governmental laws and regulations impacting sustainable developments

4-3 Data Analyses Methods

For this paper, the author has used different statistical methods and advanced analytical tools. A brief description of each is provided below:

4-3-1 Linear Regression Analysis

According to Seber and Lee (2012), linear regression as a predictive analysis tool is used for two main reasons. Firstly, it is used for forecasting the value of the dependent variable through the help of independent variables. Secondly, it is used to determine which independent variable is the most significant variable in determining the defendant variable's value and in what way (by looking at both magnitude and the sign of the beta). Linear regression helps us to describe the connection between the dependent variable and the independent variable(s). It also specifies whether our statistical model is statistically significant.

Predicting/forecasting trends, defining the strength of independent variables on a dependent variable, and forecasting the consequences of changing independent variable(s) on a dependent variable are the main reasons that linear regression has been widely used (Seber and Lee, 2012).

4-3-2 Univariate Analysis of Variance

According to Flynn (2003), the General Linear Model (GLM) univariate analysis gives both "regression analysis and analysis of variance (ANOVA)" for either one outcome (One-way ANOVA) or more which is called a Two-way ANOVA. Since this study investigates the impact of various independent factors on the dependent variable, the author as conducted a Two-way ANOVA to examine the null hypotheses. The two-way ANOVA measures and evaluates the differences in the "mean" of two or more groups of independent variables which are also known as factors. The main aim of a two way ANOVA is to recognize whether there is a relationship between the groups of independent variables on a dependent variable. This feature of the two-way ANOVA would help a reader to understand whether the weight of one of the factors on the dependent variable is equal for all values of other factors (Norušis, 2006).

4-3-3 Decision Tree/Classification Tree

Decision Tree allows us to find sets, uncover interactions between sets and forecast events. It has been structured in a visual manner by demonstrating "categorical" outcomes. It helps in grouping and classifying models for "segmentation stratification, prediction, data reduction and variable screening" ("IBM SPSS Decision Tree," 2018).

Decision tree analyses are commonly used as they determine which independent variables are strongly correlated with a dependent variable. The goal of decision trees is to show a sequence of events and analyze how it impacts a dependent variable. Decision tree computes probabilities "conditional probabilities" under various settings (Norušis, 2006).

R Script

R is a programming language which offers a great range of statistical and graphical techniques to manipulate data and calculations. R has been widely used in machine learning, running large data and generating complex graphical data (Ihaka, and Gentleman, 1996).

Data Visualization

Data visualization is widely known as a phrase that portrays any attempts in aiding people to comprehend the implication of dataset through embedding the data in a visual setting. Data visualization helps analysts and decision-makers to detect any hidden correlations, trends and patterns that could have gone unnoticed within the text format.

For this study, a data visualization tool called Tableau was used. Tableau is an interactive data visualization platform which helps to transform the raw dataset into the understandable visuals (Ali, Gupta, Nayak, and Lenka, 2016).

4-3-4 Cluster Analysis & K-Means

Another statistical measure that was used in this paper is k-means under cluster analysis of data. According to Fraley and Raftery (1998) cluster analysis which is also known as "segmentation," is mainly used to detect patterns in the dataset in the form of "homogenous" clusters on condition that the new cluster was not found previously. It does not appreciate the difference among dependent and independent variables. K-means cluster analysis (SPSS) is an instrument intended to allocate data to a static number of clusters which their relationships were not recognized hitherto. SPSS provides hierarchical clusters. Nonetheless, the relationships of clusters are constructed on a group of identified variables ("Conduct and Interpret," 2019).

Chapter 5

EMPIRICAL RESULTS

5-1 Research results associated with the Linear Regression Analysis

The Model Summary provides the "R" and "R^2" values. The "R" represents the simple correlation and is 0.697 which indicates a high degree of correlation. The "R^2" value indicates how much of the total variation in the dependent variable which in this case is CO_2 can be explained by independent variables. That means how close the data are to the fitted regression line which in this case is 48.6%. The value of R^2 will be less for the entire population since regression maximizes R^2 for the sample. This phenomenon is known as "shrinkage." The "Adjusted R Square" estimates the population of R square for our model and thus gives a more realistic indication of its predictive power.

Table 5-1: Linear Regression Analysis- Model Summary

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.697[a]	.486	.485	5.128230520	.486	458.551	6	2913	.000

a. Predictors: (Constant), Resistance , ICT, Stability, PRCL2, GDPP, Education

b. Dependent Variable: CO2

The next table is the ANOVA table which reports how well the regression equation predicts the dependent variable. Please see below:

Table 5-2: Linear Regression Analysis- ANOVA table

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	72355.921	6	12059.320	458.551	.000[b]
	Residual	76608.254	2913	26.299		
	Total	148964.175	2919			

a. Dependent Variable: CO2

b. Predictors: (Constant), Resistance , ICT, Stability , PRCL2, GDPP, Education

This table indicates that the regression model predicts the dependent variable significantly well. In other words, it shows the statistical significance of the regression model that was run. In this model, the "p-value" should be less than 0.05. Since the p- value shown above is less than 0.05, it indicates that the regression model statistically significantly predicts the dependent variable.

The next table is the Coefficients table which provides us with the necessary information to predict CO_2 from independent variables. It also helps us to determine whether either of the independent variables statistically significantly contribute to the model by looking at the "Sig." column.

The last column, which is the "Sig." column, shows the significance level of predictors. Statistically, the "B" coefficient or beta coefficient is significant if its p-value is less than 0.05. In this case, all of the "B" coefficients are statistically significant.

Table 5-3: Linear Regression Analysis- Coefficients table

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-4.126	.727		-5.680	.000
	ICT	-.016	.002	-.207	-9.045	.000
	PRCL2	-1.249	.072	-.348	-17.282	.000
	Education	.093	.005	.448	18.252	.000
	GDPP	.000	.000	.455	20.675	.000
	Stability	-.020	.005	-.078	-3.777	.000
	Resistance	.038	.007	.146	5.318	.000

a. Dependent Variable: CO2

Furthermore, we can use the values in the "B" column under the "Unstandardized Coefficients" column to present the regression equation as:

CO_2 = -4.126+ (-0.16)*(ICT) + (0.93)*(Education) + (0.0001)*(GDPP) + (-0.20)*(Stability) + (0.38)*(Resistance) + (-1. 249)*(PRCL2)

The "B" coefficients allow us to compare the relative strengths of our predictors on the dependent variable. It tells us how many units of CO_2 (dependent variable) increases for a single unit increase in each predictor (independent variable). For instance, a 1 point increase in "education" corresponds to 0.93 points increase on the CO_2 production.

Importantly, note that not all "B" coefficients are positive. The positive "B coefficients" indicates that the independent variable and the dependent variable are positively related. Nevertheless, ICT, PRCL2 and stability have an inverse impact on CO_2 production (due to their negative signs). For instance, the more stable a country is, the less CO_2 will be produced based on the statistical model. For the table of Residuals Statistics, Histogram and Normal P chart, please see appendix 1-3.

5-2 Research results associated with the Univariate Analysis

The subject factor (fixed factor) for our Univariate analysis is "region." Under this table, the author was able to narrow down the analysis towards the number of countries in each region.

Table 5-4: Univariate Analysis of Variance- Between Subjects Factors table

Between-Subjects Factors

		N
Region	Africa	840
	Americas	560
	Asia	740
	Europe	720
	Oceana	60

The "Tests of Between-Subjects Effects" tests whether predictors or the interaction between predictors are statistically significant. In order to include the "region" in the regression model, the author decided to use it as a fixed factor. The last column "Sig." shows that "region" has a statistically significant effect on the dependent variable (CO_2) at $p<0.05$.

Table 5-5: Univariate Analysis of Variance- Between Subjects Effects table

Tests of Between-Subjects Effects

Dependent Variable: CO2

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	74150.794[a]	10	7415.079	288.324	.000
Intercept	820.088	1	820.088	31.888	.000
ICT	1994.606	1	1994.606	77.557	.000
PRCL2	3579.583	1	3579.583	139.186	.000
Education	5871.038	1	5871.038	228.286	.000
GDPP	11470.728	1	11470.728	446.021	.000
Stability	664.059	1	664.059	25.821	.000
Resistance	420.839	1	420.839	16.364	.000
Region	1794.873	4	448.718	17.448	.000
Error	74813.381	2909	25.718		
Total	227268.552	2920			
Corrected Total	148964.175	2919			

a. R Squared = .498 (Adjusted R Squared = .496)

5-3 Research results associated with the Decision Tree/Classification Tree Analysis

The summary of the table below includes the method used, the variables included in the model and the variables specified but not included in the model. As it is shown the method used for this analysis is "CHAID." CHAID is a tool that is used to discover the relationship between variables. It builds a predictive tree to determine how variables best merge to explain the outcome of the given dependent variable (Song, and Ying, 2015). Another reason to pursue CHAID specifically for this analysis over other methods was its popularity. Based on the table below, there are thirty-nine nodes and nodes' "maximum tree depth" is three. Interestingly, ICT, GDPP, Education, and PRCL2 are the only independent variables which were included in the result. It can be concluded that these predictive variables/independent variables had the strongest correlation with the dependent variable among the rest.

Table 5-6: Classification Tree Analysis- Model Summary

Model Summary

Specifications	Growing Method	CHAID
	Dependent Variable	CO2
	Independent Variables	PRCL2, Education, GDPP, Stability, Resistance , ICT
	Validation	None
	Maximum Tree Depth	3
	Minimum Cases in Parent Node	100
	Minimum Cases in Child Node	50
Results	Independent Variables Included	ICT, GDPP, Education, PRCL2
	Number of Nodes	39
	Number of Terminal Nodes	27
	Depth	3

The decision tree starts with the root node, which merely shows the distribution of the outcome/dependent variable which in this case is the amount of CO_2 production. The data then split based on statistical significance of the predictor which has the most robust relationship with the outcome. In this case, ICT has the most robust relationship with the dependent variable. Based on the root node, the "mean" of CO_2 emission per capita to the entire world is 5.17 megaton per person. The combination of ICT with the dependent variable would result in the branch with six "buckets" that ICT has been split into (<3.209; 3.209-12.601; 12.60-28.390; 28.39-113.206; 113.206-200.372; and 200.372+). Please see Appendix 4 parts 1-3.

Even though it might be appealing to consider the "mean" values that are lower than the average CO_2 emissions (e.g., indicated on the first node) to conclude that the countries which are located under those nodes, are moving more towards sustainable developments through low carbon production but the problem is that, countries that fall under those buckets are usually developing countries with almost no infrastructure, industrial processes, transportation systems and very low GDPP. It is crucial to understand that when the economy is not running, not much carbon dioxide will be produced. As a result, the production of carbon dioxide is low in those countries. In order to make sustainable decisions, we cannot mimic those countries due to the reason mentioned above. Therefore, we have to focus on countries that their average CO_2 emissions are close to the "mean" CO_2 emissions shown in the root node.

As the tree continues branching down, it is evident that the next most important variable for the countries in the bucket with less than 3.23 up to 12.60, is GDPP which then switches to education for countries in the bucket of 12.60-28.39. This trend continues till it shifts back to GDPP until the very last node which is PRCL2.

The "Risk" table is a measure of the tree's predictive accuracy. For categorical dependent variables, the risk estimate is the proportion of cases which were incorrectly classified after adjustment, for prior probabilities and misclassification' costs. For scale dependent variables, the risk estimate is within node variance.

Table 5-7: Classification Tree Analysis- Risk table

Risk

Estimate	Std. Error
26.100	2.866

Growing Method: CHAID
Dependent Variable: CO2

5-4 Research results associated with the Linear Regression Analysis

In order to expand the analysis of this research and include the "Intlaw" as one of the independent variables to assess its impact on the dependent variable, the author has gathered data for following international agreements and accords: the Kyoto Protocol, the Copenhagen Accord, and the Paris Agreement. The author has explicitly chose the international protocols mentioned above, since those agreements and conferences were the main international treaties that established an actionable framework and initiative for all countries to follow and they are acknowledged on a global scale.

These three agreements are columned as "Intlaw" in the analysis. Accordingly, countries that both entered and remained in all of these three agreements were coded as "1", as opposed to the countries that either did not enter or later withdrew from either one or more of the above-mentioned agreements and accords, were given zero. The author has undertaken another Linear Regression analysis to assess the significance of the recently added variable. The tables below summarize the findings.

Table 5-8: Linear Regression Analysis- Model Summary

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.700[a]	.491	.489	5.105152893	.491	400.519	7	2912	.000

a. Predictors: (Constant), IntLaw, Resistance , ICT, Stability, PRCL2, GDPP, Education

b. Dependent Variable: CO2

Table 5-9: Linear Regression Analysis- ANOVA table

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	73069.924	7	10438.561	400.519	.000[b]
	Residual	75894.251	2912	26.063		
	Total	148964.175	2919			

a. Dependent Variable: CO2

b. Predictors: (Constant), IntLaw, Resistance , ICT, Stability, PRCL2, GDPP, Education

According to the coefficients table shown below, the recently added independent factor is also statistically significant. The negative value of "B" recognizes that the "IntLaw" has an inverse impact on the overall model and the dependent variable.

Table 5-10 Linear Regression Analysis- Coefficients table

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1.609	.869		-1.853	.064
	ICT	-.016	.002	-.203	-8.906	.000
	PRCL2	-1.216	.072	-.339	-16.834	.000
	Education	.087	.005	.421	16.873	.000
	GDPP	.000	.000	.453	20.661	.000
	Stability	-.024	.005	-.091	-4.391	.000
	Resistance	.039	.007	.151	5.503	.000
	IntLaw	-1.944	.371	-.072	-5.234	.000

a. Dependent Variable: CO2

The author has used the cluster analysis and K-means in order to identify which cluster/group of countries Canada belongs to among oil-producing nations. Since there are three main oil-producing regions, namely Asia, America, and Europe, the author has chosen the number three as the number of clusters. Please see table 5-11 and appendix 5. Based on the results gathered from the K-means cluster analysis, Canada, Austria, and Norway were identified as homogenous.

Table 5-11: The Cluster Analysis- K-means results

Case Number	Countries	Cluster	Distance
1029	Austria	3	9520.713
1175	Austria	3	4903.752
1321	Austria	3	3279.875
1467	Austria	3	1062.998
1613	Austria	3	5063.482
1905	Austria	3	6060.357
2051	Austria	3	5010.141
2197	Austria	3	9444.968
2343	Austria	3	6690.707
2489	Austria	3	9024.598
2781	Austria	3	2020.975
1191	Canada	3	9582.619
1337	Canada	3	5396.887
1483	Canada	3	1294.222
1629	Canada	3	2713.518
1775	Canada	3	4747.068
1921	Canada	3	866.785
2067	Canada	3	5808.93
2651	Canada	3	8680.273
2797	Canada	3	2461.589
102	Norway	3	4208.31
248	Norway	3	4925.909
394	Norway	3	6768.173
540	Norway	3	5154.535
686	Norway	3	3347.46
832	Norway	3	2948.697
978	Norway	3	1582.068
1124	Norway	3	8666.226

According to the data gathered from the U.S. Energy Information Administration (2017), Canada was ranked fourth in terms of the number of the barrel of oil production per year, and per capita, Norway was ranked fourteenth, and Austria was ranked seventy-fifth ("U.S. Energy Information Administration," 2017). Since Canada and Norway produced more barrels of oil and were ranked closer to each other compared to Austria, further analysis has been held over the performance of these two countries on climate mitigation initiatives in the discussion section.

The results show that international climate protocols, ICT, stability and PRCL2 have a negative impact on CO_2 emissions across the globe while being statistically significant factors for carbon reduction (p-value <0.05 and negative beta coefficient' signs).

The hypotheses acceptance or rejection table (shown below) has been used to summarize this section by indicating which hypotheses were accepted or rejected. Please see below:

Table 5-12: Hypotheses acceptance or rejection table

HYPOTHESIS NAME	HYPOTHESES	P-VALUE	BETA	ACCEPT/ REJECT
H_1	It is expected that international climate protocols will have a negative impact on CO_2 emissions.	0.000	-1.944	ACCEPT
H_2	It is expected that ICT will have a negative impact on carbon production.	0.000	-0.016	ACCEPT
H_3	The growth of GDP per capita as a measure of economic growth will increase the global CO_2 emissions.	0.000	0.000	ACCEPT
H_4	It is expected that educational attainment of citizens has an inverse effect on CO_2 emissions.	0.000	0.093	ACCEPT
H_5	It is expected that aggregation of political and civil rights will help societies to reduce their CO_2 emissions.	0.000	-1.249	ACCEPT
H_6	It is expected that political and regional stability of countries impact their CO_2 production positively.	0.000	-0.020	ACCEPT
H_7	It is expected that the countries' resistance either in the form of internal conflicts or lack of regulations, positively impacts their CO_2 emissions	0.000	0.038	ACCEPT

Chapter 6

DISCUSSION

As it was discussed earlier, under the "Linear regression-coefficients table," among all independent variables, three of them which were "PRCL2", "stability" and "ICT" were negatively correlated with the dependent variable. This means an increase in the value of one would result in a decrease of value in the other variable. Even though the outcome is statistically significant, but what matters more is the interpretation of the quantitative analysis into real life explanations.

6-1 The impact of PRCL2, Stability, and ICT on sustainable developments

Various developing countries along with the Persian Gulf countries are ranked among the top twenty-five largest emitters of CO_2 (way beyond the world's mean CO_2 emissions) (Boden, Marland, and Andres, 2009). Please see appendix 5. Since many of these countries have massive oil reserves which count for almost forty percent of the world's confirmed reserves and twenty-three percent of world's gas reserves (Reiche, 2010), it is expected that these countries would have enacted comprehensive environmental policies, advanced green technologies, and built green societal culture in place. Yet, as it was mentioned above, the amount of CO_2 emitted from these countries proves it wrong. Studies have shown that low level of political freedom and civil liberty which includes but are not limited to, "freedom of expression, associational and organizational rights, the rule of law and personal autonomy," significantly impact the level of countries' environmental sustainability (Saddam, 2012). In many of these countries and in particular, in the Persian Gulf region countries, citizens lack the fundamental human rights. For instance, by strictly limiting or completely banning citizens to have access to the Internet, governments infringe citizens' civil right- the right to broadband/ freedom to connect. The right to broadband comes from the notion that all humans must be able to have access to the internet in order to both enjoy and exercise their fundamental human rights such as freedom of expression and opinion.

Such governmental infringements can be explained in fear of citizens getting around the control of government by educating and enhancing their social, environmental, political, legal, information security, and public awareness. It has been argued by many scholars such as Drezner and Farrell (2004) and Snellen (2001) that ICT plays an essential role in providing access to information and involvement of citizens in their socio-political lives. According to Norris (1999) and Shirazi et al., (2010), ICT in the form of technology advancements, aid in the prompt collection and distribution of information through interactions, collaborations and communication of groups. These technologies help the public to participate in political debates and events to get them more involved in matters that impact their socio-political lives (Oates, 2003). According to Weare (2002), having access to ICT technologies is directly proportional to the citizens' political involvements and the political progression of countries. Based on the claim of Dahlgren (2005), ICT and the Internet not only extend the interactions and representations of citizens, but also it pluralizes the structure of the public scope by enriching their political dialogue, enhancing the collaborations of the public with governmental institutions and the collaboration of constitutes themselves. Katz (1997) argues that the emergence of ICT technologies has created a novel political actor- "digital citizen." Having access to information is the crucial factor for fostering democracy and exercising political rights such as freedom of expression (Balkin, 2004). It has also been argued by Mudhai (2003) that ICT initiatives have been recognized to help to create and lead the "third wave" of democratization. Online communication tools and more specifically social media are known as the main channels for change. Such changes could be seen by looking back a few years ago at Tunisia and Egypt. No one can underestimate the significant role that communication tools played in both revolutions.

Along with the influential impact of ICT and democracy on PRCL2, Rosati and Faria (2018), argue that the percentage of companies that report their SDGs are much higher in countries where concerns about sustainable development, climate change, CSR, labour protection, political and human rights and investments in tertiary education are at their paramount level. Therefore the social development of the country greatly impacts its sustainable development which includes both environmental and economic developments. Within this context, Salim, 2015, has focused on two dimensions of the social development which are "human development and civic engagement." According to Sims, Gong and Ruppel, (2012), a growth of an economy, participation of women's in labour market and low level of corruption are positively correlated to the human development. As it was also mentioned in the Human Development Report (2016, p. 5), " the human development approach and the 2030 Agenda can be mutually reinforcing by contributing to the narrative of each other, by exploring how human development and Sustainable Development Goal indicators can complement each other and by being a forceful advocacy platform for each other."

In light of the above evidence, it is no wonder why the countries mentioned above are ranked among the top twenty-five largest emitters of CO_2. Governments in many of these countries are not concerned about infringing fundamental rights of their citizens, let alone investing in green technologies to protect the world through reducing their CO_2 emissions.

Along with the recognition of environmental advancements, it became apparent that environmental problems are not going to be resolved without the help of the public and of course without considering the public's lifestyles. In order to prepare an optimal plan to tackle environmental issues, it is essential to understand the public's ethical position/standing related to environmental problems because the planning is about and for the people (Gazzola et al., 2019).

Consequently, it is not surprising to consider the public as one of the main stakeholders of current environmental issues. Likewise, as it was discussed by some scholars (Goldberger, 2011; Grant, Trautner, and Jones 2004; Shutkin, 2003), civic engagement not only has proved to be correlated to the sustainable development, but it also has been recognized to play a vital role when it comes to sustainability (Portney, 2005). This is consistent with the prior studies by Halkos and Skouloudis, (2016), which have found that civic engagement is a significant contributing factor to inspire and influence the CSR penetration at the country level. Based on Deakin and Al Waer (2011), citizens' participation and involvement through community engagement can enhance the communal intelligence of a city's associations/foundations/societies by working through "e- governance" in terms of co-designing and participating. This would ultimately result in increasing adaptability and flexibility of the citizens to effectively and promptly respond to changes and enhance the intelligence of the city by meeting the demands of the market. Therefore, the author is claiming that civic engagement can also impact the reporting of SDG.

Jensen and Berg, 2012; De Geer, Borglund, and Frostenson (2009), argue that the density of trade unions within a country is positively related to the level of involvement of employees in decision making and the overall socio-political progress of the country. They also claim that the involvement of employees and the socio-political progress may be correlated to a higher sensitivity of companies to the CSR and ultimately SDG reporting.

It was also argued that countries' stability is directly related to their level of peacefulness. The higher the country's level of stability, the faster the country develops. Based on the Global Peace Index (2015, p.83), "Positive peace" factors are independent factors that are significantly associated with "stronger business environments, better performance on well-being measures, gender equality and better performance on ecological measures" of a country. Contrariwise, countries with weak "Positive Peace" factors tend to use the military to suppress internal conflicts. "As countries become more militarised they also become less peaceful. They are also more likely to experience negative changes in other domains such as social safety and security and levels of ongoing domestic, national sustainable growth and international conflicts" Global Peace Index, 2015 p.38). Essentially, the factors leading countries towards development are almost the same factors that are needed for societies and countries to be peaceful based on the Global Peace Index (2015). Please see below.

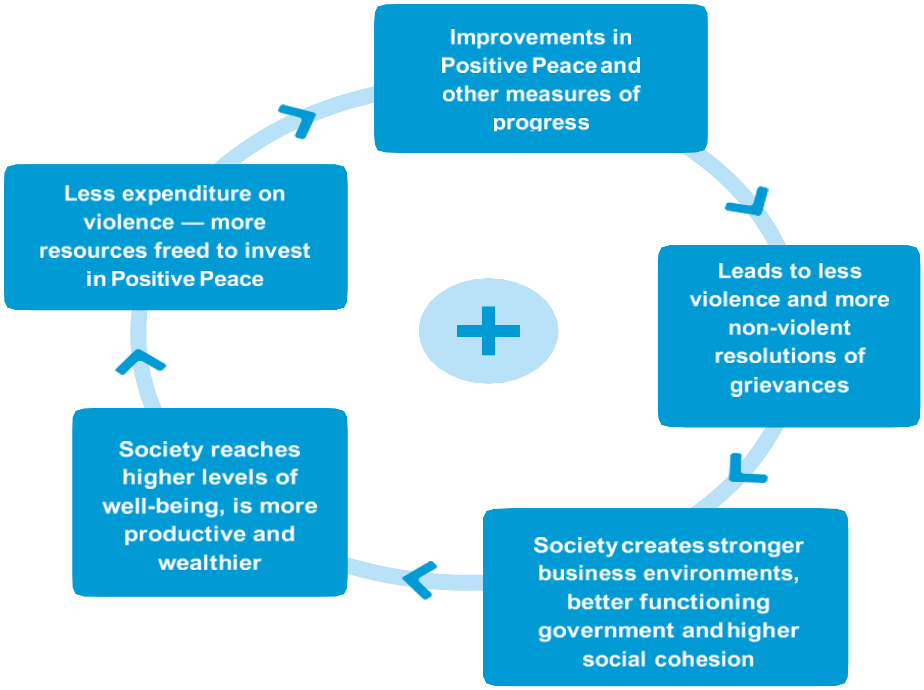


FIGURE 6-1: Vicious Cycle of Positive Peace
Example of positive feedback loop and transition to violence
(Global Peace Index, 2015)

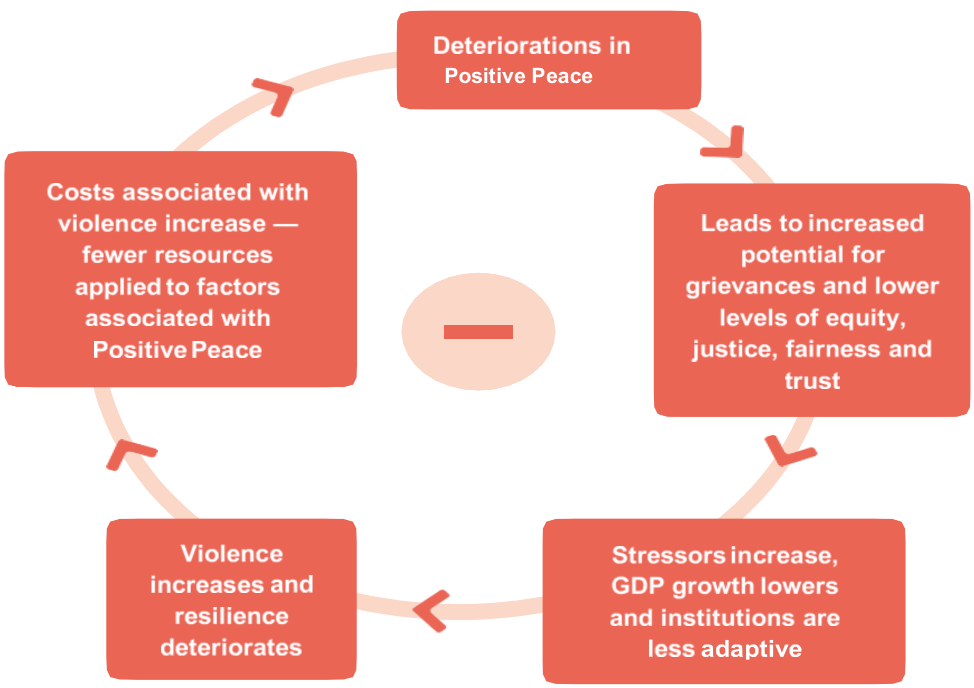


FIGURE 6-2: Vicious Cycle of Positive Peace
Example of negative feedback loop and transition to violence
(Global Peace Index, 2015)

Based on evidence above, political rights along with civil liberties, and stability all help countries to move towards social, environmental and economic developments to reduce the carbon footprint. Yet, the delicacy of the topic urges the need to achieve a faster transition towards more sustainable developments. Latest innovations in ICT are encouraging the implementation of “smarter” methods towards the development of sustainable products. ICT can play a major role in enhancing environmental advancements through building smart(er) cities, commuting systems, electrical grids and industrial and operational processes (Higón et al., 2017). ICT in aggregation with smart technologies can aid to attack issues related to environmental concerns through the usage of “deploy-and-monitor” method. Based on this technique, smart devices are used to enrich social awareness through monitoring the behaviour of users and the efficiency of the system. Throughout this process, we can ultimately persuade and inspire consumers to adjust and embrace new patterns of behaviours by utilizing social media channels and media. This would help us to encourage citizens towards “smart choices.”

6-2 Comparative Study

As it was discussed earlier, countries involvement in international protocols and negotiations proved to be a statistically significant factor in reducing their GHG and carbon emission levels. The study’s empirical results made the author wonder what makes Canada to be ranked among the top ten largest emitters of GHG emissions worldwide (“Global greenhouse emissions,” 2018) unlike some European countries with similar but not identical socio-ecological systems such as, Norway. Contrasting to Canada, Norway has been ranked among the top ten countries that have performed well in mitigating climate change despite the fact that it is a significant supplier of oil and gas in Europe (“Exports of Norwegian oil and gas,” 2019). According to the report of Climate Change Performance Index (CCPI) (Burck, Marten, Bals, and

Höhne, 2018), Norway was ranked seventh as opposed to Canada which was ranked fifty-first among fifty-six countries that are jointly accountable for more than ninety percent of GHG productions of the entire planet. The ranking scores of the CCPI are defined by a country's collected enactment around fourteen indicators in the four groups of: "GHG emissions, renewable energy, energy use and climate policy" (Burck et al., 2018, p.6).

Through the use of Tableau, the author was able to find the "mean" carbon production of both countries from 1996-2015. Please see below.

Table 6-1: Canada vs Norway CO_2 emissions

Countries	Canada	Norway
Average CO_2 emissions/capita	17.256	9.482

According to the table, Canada's carbon emissions are almost as twice as Norway's average carbon production. The average carbon emission of 17.256 means that Canada falls under the last branch of the decision tree with the mean CO_2 emissions of roughly eighteen. The branch shows that the two strongest independent factors for countries that fall under the bucket 18 are ICT and PRCL2 and which remarkably correlates to the results of the linear regression coefficients table. Based on the values of the coefficients table, PRCL2 and ICT were among the covariates that had negative impacts on the overall model. This means for Canadians to improve their environmental and sustainability issues, ICT in conjunction with PRCL2 can aid them to achieve their goals.

Norway and Canada have a robust trade and investment bond which has been built on matching resource capabilities, comparable levels of socio-political growth, and mutual economic and environmental interests, standards and values (Brother, 2017). They also tend to be very similar in regards to citizen's educational attainment level, ICT improvements, and economic developments and most importantly, they both have substantial oil reserves ("Norway vs. Canada," 2013).

Based on the evidence above, the natural question is: what caused Canada to perform insufficiently in meeting its climate change targets and social efficiency with the natural environment? To answer this question, it is vital to examine the Canadian Environmental Policy and Institutions.

To achieve social efficiency, there are many factors involved. Although it is beyond the objective and the scope of this paper to address all of these contributory elements, the author focuses on the foundations of Canadian Constitution and its impacts on environmental policies.

6-2-1 The Case of Canada

The type of Canadian government is Federal Parliamentary Democracy and Constitutional Monarchy which has three levels of governments: federal, provincial and municipal. ("Government", 2017). Canadian Constitution Act (1867) establishes the distributions of federal and provincial powers. Federal powers are covered under section 91 while most of the provincial legislative powers are covered under section 92. For instance, under section 91, the federal government holds power over lands, waters, fisheries, and entrance in international agreements. One of the most important provisions which is a preamble toward the section 91 and gives the federal government the power to regulate legislation is the provision of "Peace, Order, and Good Government (POGG). This section is the foundation of various environmental legislation such as the "Canadian Environmental Protection Act" (Field and Olewiler, 2011). The federal government also holds power over both interprovincial and international trade and tax levies.

On the other hand, under section 92, the provincial government holds power (within the provinces) over property and civil rights, local and private disputes, lands and resources ("Consolidated Federal Laws of Canada," 2019). Along with the section 91, the section 92A of the Constitution Act (1982) further empowers the legislative power of provinces over the natural resources which includes "development, conservation and management of non-renewable resources" Field and Olewiler, 2011, p.3). This means provinces are allowed to enact environmental regulatory rules.

In order to regulate environmental issues, usually, both governmental levels are involved as legislative powers overlap. The Canadian Constitution Act does not prohibit this phenomenon. The overlapping powers are sometimes complementary, but they also could be contradictory which would result in incoherent policies.

Along with different legislative powers, Canada has an astonishing wealth of energy resources and profile which are not equally distributed across the country (Fertel, Bahn, Vaillancourt and Waaub, 2013). The disparity between unequal resources distributions means that different climate policies are needed for different jurisdictions as the supply and demand are different. The energy and environmental policies are regularly connected. For example, policies in regard to the greater use of fossil fuels refute policies meant to reduce carbon production. To further complicate matters, overlapping legislative powers of Canadian governments enhance these contradictions. As it was mentioned earlier, provinces are in charge of development, conservation and management of their resources. However, the federal government is also in charge and responsible for economic and industrial advancements of energy sector while has the authority to provide financial incentives and support/finance activities (Fertel et al., 2013). Therefore, the federal government can interfere in decisions where mutual powers exist.

Generally, Canadian Environmental policies are more command-and-control based rather than incentive based. Policies are more framed as guidelines rather than specific standards (as opposed to technology standards which are widely used). Canadian environmental legislations are not mandatory and are mainly enabling, and neither governments have clear jurisdiction over the environmental issues (Field and Olewiler, 2011).

In late 2016, the federal government introduced the "Pan-Canadian Framework on Clean Growth and Climate Change" to meet the Paris target to minimize the GHG emissions by thirty percent lower than the 2005 levels. The Pan-Canadian Framework is an agreement between different governmental levels which focuses on four pillars of "pricing carbon pollution; complementary measures to further reduce emissions across the economy; measures to adapt to the impacts of climate change and build resilience; and actions to accelerate innovation, support clean technology, and create jobs ("Introduction," 2017). The framework recognizes the existing carbon pricing programs by different provinces (for instance, Ontario and Quebec introduced the cap-and-trade program in 2013, and B.C. introduced the carbon tax in 2008 and so on) while enforcing jurisdictions without the carbon pricing system in place to the federal carbon price from the January 1, 2019 ("Next Steps in Pricing Carbon Pollution," 2017).

However, oppositions have targeted both the provincial and federal programs/frameworks. At the provincial level, the election of Ontario's new Progressive Conservative government has given a kiss of death to the Ontario's climate mitigation program as he has introduced legislation to kill the cap-and-trade. Similarly, Ontario, Manitoba and Saskatchewan have challenged the constitutionality of the federal government's ability to impose a carbon tax policy on provinces through the Pan-Canadian framework.

As it was mentioned earlier, lack of consistency in federal climate strategies due to noncooperation of provincial governments and overlapping jurisdictional powers over natural resources along with the absence of organization for exchanging energy between provinces have caused Canada to perform insufficiently in meeting its global climate targets and it can be concluded that Canadian Environmental Policies are not compatible with its 2030 emissions reduction targets (Fertel et al., 2013). At this point, it is not easy to answer whether Canada is able to meet its 2030 target to lower its GHG emissions by thirty percent lower than the 2005 levels. Please see below for the Canadian's summary of pledges and the country's developments.

CANADA	Summary of pledges and targets	
PARIS AGREEMENT	Ratified	Yes
	2030 unconditional target(s)	30% below 2005 by 2030 [15% below 1990 by 2030 excl. LULUCF] [26% below 2010 by 2030 excl. LULUCF]
	Coverage	Economy wide, incl. LULUCF
	LULUCF	Currently examining its approach for LULUCF accounting
COPENHAGEN ACCORD	2020 target(s)	17% below 2005 by 2020 [19% above 1990 by 2020 excl. LULUCF] [4% above 2010 by 2020 excl. LULUCF]
	Condition(s)	None
KYOTO PROTOCOL (KP)	Member of KP CP1 (2008–2012)	Withdrawn
	Member of KP CP2 (2013–2020)	No
	KP CP1 target (below base year)	6% below 1990
	KP CP2 target (below base year)	None
LONG-TERM GOAL(S)	Long-term goal(s)	80% net emission reductions below 2005 levels by 2050

Figure 6-3: Canada Summary of Pledges & Targets ("Canada pledges and targets", 2018)

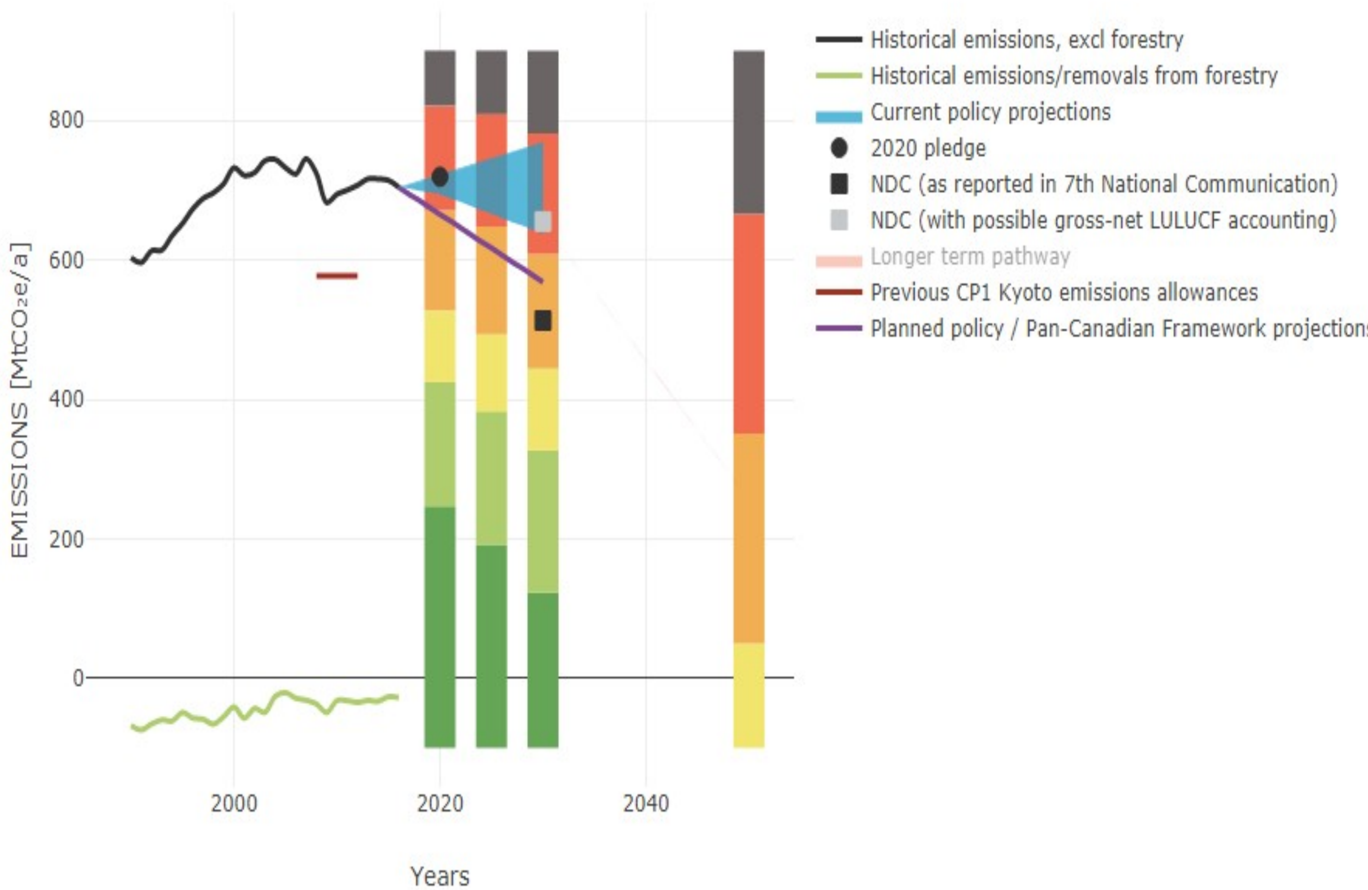


Figure 6-4: Canada- Country Summary ("Canada Country Summary," 2018)

6-2-2 The Case of Norway

Unlike Canada, Norway has implemented carbon tax since 1991 (which has been used later as the primary climate mitigating instrument), and it is known as one of the priciest carbon tax programs globally (measured per ton of carbon dioxide) (Bruvoll and Larsen, 2004). Norway carbon tax has increased the prices of fossil fuels which has impacted the carbon production of the industry both directly (i.e., energy efficiency) and indirectly (i.e., market competition).

According to the Norwegian carbon tax, gasoline has the highest tax rates of "USD$51/ tonne of CO_2." Average Norway's carbon tax is almost four times higher than the majority of the shared approximated quota price in the Kyoto Protocol (Bruvoll and Larsen, 2004). Comparably, local plans such as NGOs from the local designated reps and nationwide governmental plans have played a significant part in laying climate policy on the local schema in Norway (Aall, Groven, and Lindseth, 2007). For instance, the green NGO "Future in Our Hands" (FIVH) and the "youth organization of Friends of the Earth Norway" (NU) were the only reps to present local climate initiatives in Norway (Kyrre, Lundli, and Aall, 1999). According to the Sustainable Governance Indicators (Stiftung, 2018), Norwegian environmental policies are considered to be among the best policies in the world. The country has enacted a well-rounded monitoring program in place, and its rate of renewable-resource use is between the highest in the world (Stiftung, 2018).

Norwegian citizens are very environmentally conscious. The government frequently encourages worldwide collaboration on ecological problems. The government has also enacted a variety of laws, regulations and specific policies on building regulations, vehicles, and so forth. In 2013, the proportions of electric vehicles in Norway were much higher than any other countries, thanks to specific tax exemptions, many driving privileges and free parking spots (Holtsmark and Skonhoft, 2014). Norway keeps the world-wide record share in electric cars and "it is expected that by the end of 2018 every second new car sold in Norway is electric" ("Norway Country Summary," 2018). Unlike the Canadian government, the Norwegian government supports green initiatives through different subsidy programs. Please see below for the Norwegian summary of pledges and country's developments.

NORWAY	Summary of pledges and targets	
PARIS AGREEMENT	Ratified	Yes
	2030 unconditional target(s)	40% below 1990 by 2030 [44% below 2010 by 2030]
	2030 conditional target(s)	Carbon neutrality
	Condition(s)	As part of an ambitious global climate agreement where other developed nations also undertake ambitious commitments, Norway will adopt a binding goal of carbon neutrality no later than in 2030
COPENHAGEN ACCORD	2020 target(s)	30–40% below 1990 by 2020
	Condition(s)	Global and comprehensive agreement after 2012, with major emitting Parties agreeing on reductions in line with achieving the 2 degrees Celsius target
KYOTO PROTOCOL (KP)	Member of KP CP1 (2008–2012)	Yes
	Member of KP CP2 (2013–2020)	Yes
	KP CP1 target (below base year)	1% above 1990
	KP CP2 target (below base year)	16% below 1990
LONG-TERM GOAL(S)	Long-term goal(s)	Low carbon society by 2050 Reduction in GHG emissions by 80–95% from 1990 reference

Figure 6-5: Norway Summary of Pledges & Targets (“Norway pledges & targets,” 2018)

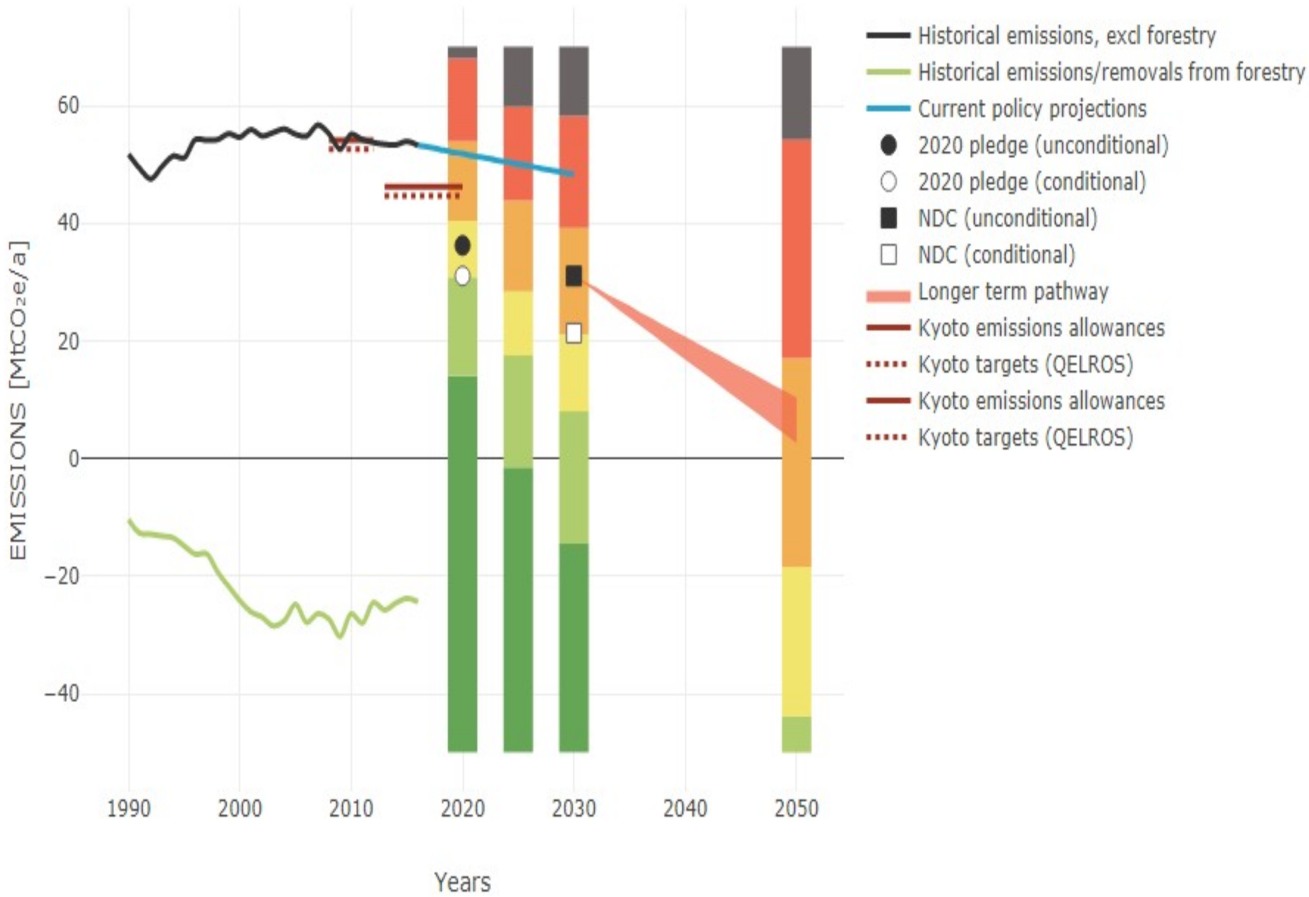


Figure 6-6: Norway Country Summary ("Norway Country Summary," 2018)

Even though Norway has not yet expected to accomplish its goal of 2030, to reduce its GHG emission levels by frothy percent lower than 1990, an increased budget allocation has complemented the novel climate law which aims to achieve "carbon neutrality" by 2050 to the "Ministry of Climate and Environment of $USD 1.22 billion since 2017" ("Norway Country Summary", 2018).

Chapter 7

CONCLUSION

Human-induced activities have exponentially grown GHG emissions worldwide. The United Nations' General Assembly has established the 2030 Agenda which has defined seventeen SDGs and among them, combating climate change represents the goal thirteenth of this agenda.

In this study, the author has focused on the CO_2 as the main contributory gas that contributes to global warming. There are three main instruments to reduce carbon emissions which are command-and-control, cap-and-trade, and carbon tax. Among these three, the cap-and-trade and carbon tax have proved to be better mechanisms to reduce the GHG and carbon emissions. The debate remains in its early stage; nevertheless, it has policy significance for large emitting countries that are still considering the appropriate carbon-abatement programs. Regardless of the positions taken by researchers, a common barrier to the generalization of their findings is the recognition that jurisdictionally specific regulation can be a control factor.

Along with carbon abatement programs, other factors also impact firms' decisions to employ and invest in green technologies. According to the literature, the main drivers of environmental advancement and developments are "market pull," "technology push" and "regulatory push-pull" effect (Horbach et al., 2012).

This study has examined the impact of the ICT, GDPP, PRCL2, resistance, education, stability and international protocols on CO_2 production. The model and all independent variables were proven to be statistically significant. Yet, among them, ICT, PRCL2, stability and international treaties were found to have an inverse impact on the model.

The author has further clustered the dataset through the use of cluster analysis to identify which cluster Canada belongs to among the oil-producing countries. Norway, Canada and Austria were found to be grouped in the same cluster. Consequently, a comparative analysis between Canada and Norway has been undertaken to find out what has caused Canada to perform insufficiently in meeting its climate change targets and social efficiency with the natural environment in comparison with Norway?

According to the literature, lack of consistency in federal climate strategies due to noncooperation of provincial governments and overlapping jurisdictional powers over natural resources along with the absence of organization for exchanging energy between provinces have caused Canada to perform insufficiently in meeting its global climate targets (Fertel et al., 2013). The future of Canadian pledges and targets is still not clear as the new Ontario's government has introduced new legislation to kill the cap-and-trade program while a few Canadian provinces have challenged the constitutionality of the "Pan-Canadian framework" which was designed to help Canada to meet its 2030 emission target.

Chapter 8

LIMITATIONS & FUTURE STUDIES

Despite the significant contribution of this study, it also has some methodological limitations- first, the age of data. The data covers the period from 1996-2015 and lacks current data. Second, the measure used to gather data and to remove outliers. In order to maintain the balance of the panel data, the author has only incorporated observations (independent factors) which were covered in the literature and data were available for all countries. For instance, literature has touched on the impact of deforestation and water pollution on carbon production, but the data for those variables are not available for all countries. In cases which the data were available, the process of gathering data from multiple different sources made it a time consuming option to consider. In regards to measures used to remove outliers, the author has used tableau as a graphical representation of outliers. If the distance between the decision point and the overall average of variables was huge, then that point/variable could potentially impact the model negatively. Even though outliers could not impact this research' results, since the dataset was huge, but the author intended to keep the data clean. Therefore, only small nations and islands such as Lichtenstein were removed from the dataset in order to enhance the accuracy of the results and keep it noise free. The third limitation was time. Due to time constraint, the author has only examined the Canadian Constitution Act and its impact on environmental policies. Other socio-political contributory factors were left untouched. To better assess the main cause of Canada's insufficient performance in terms of meeting its climate targets it would be useful to examine other factors as well.

For future studies, the findings of this study could be verified through the use of qualitative research by conducting both semi-interviews with market stakeholders and a survey among consumers to measure the response rate to outcomes currently being experienced. Also, future studies could focus on green production of countries that are heavily dependent on the oil and gas production for their industries since oil and gas are the main contributors of regional and global CO_2 emissions.

APPENDICES

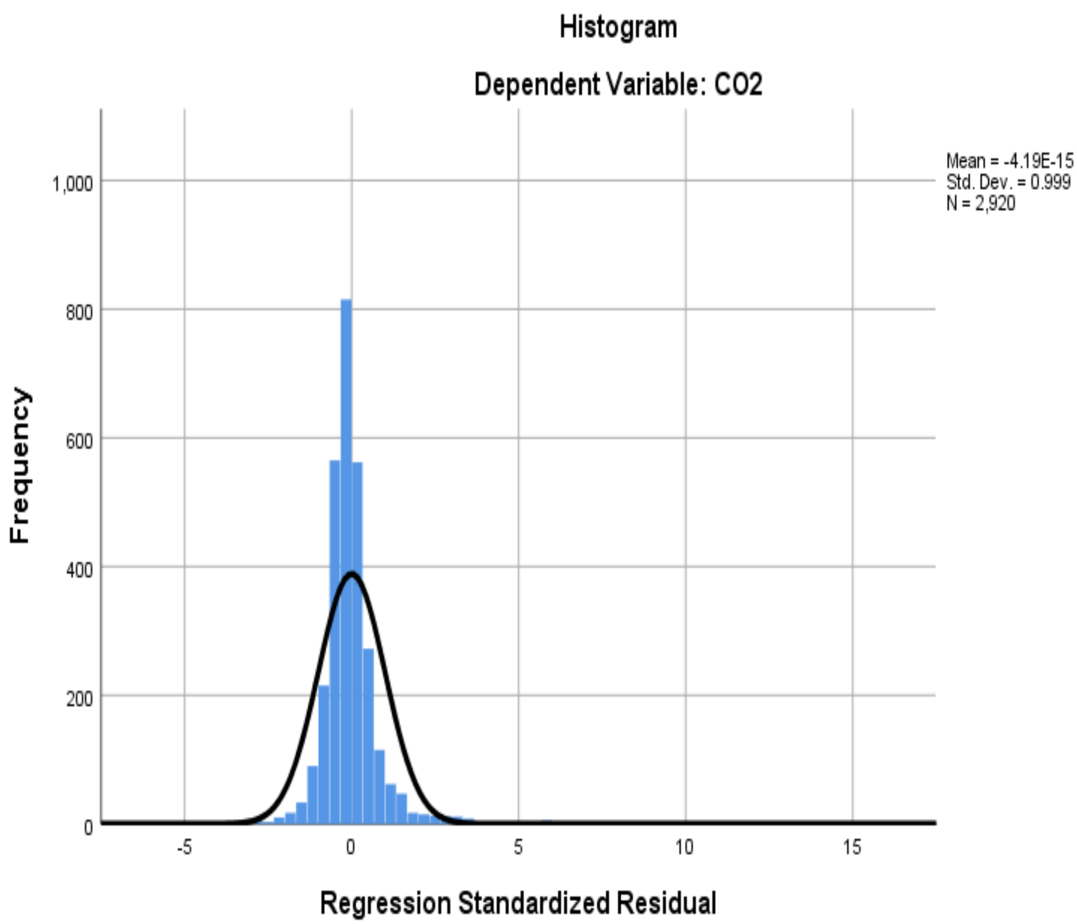
APPENDIX 1- LINEAR REGRESSION- RESIDUAL STATISTICS TABLE

Residuals Statistics[a]

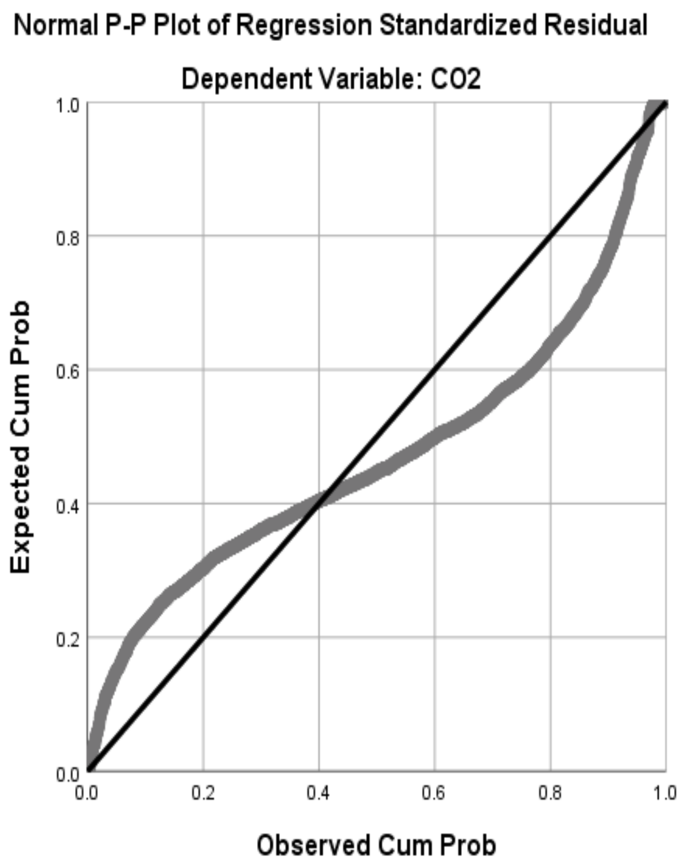
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	-5.49565077	27.18770790	5.178471545	4.978746235	2920
Residual	-16.1452904	55.45813751	.0000000000	5.122957274	2920
Std. Predicted Value	-2.144	4.421	.000	1.000	2920
Std. Residual	-3.148	10.814	.000	.999	2920

a. Dependent Variable: CO2

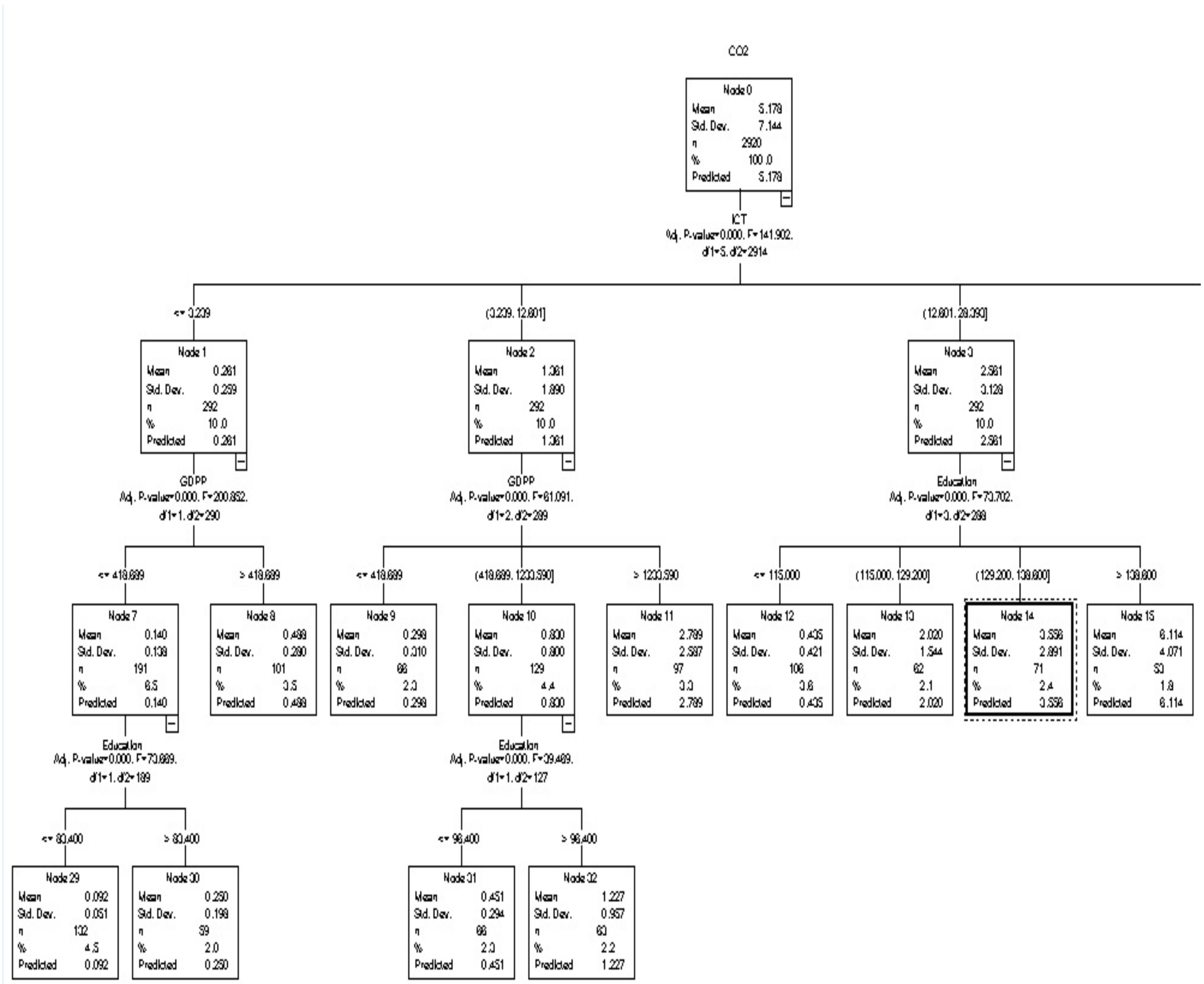
APPENDIX 2-LINEAR REGRESSION-HISTOGRAM CHART



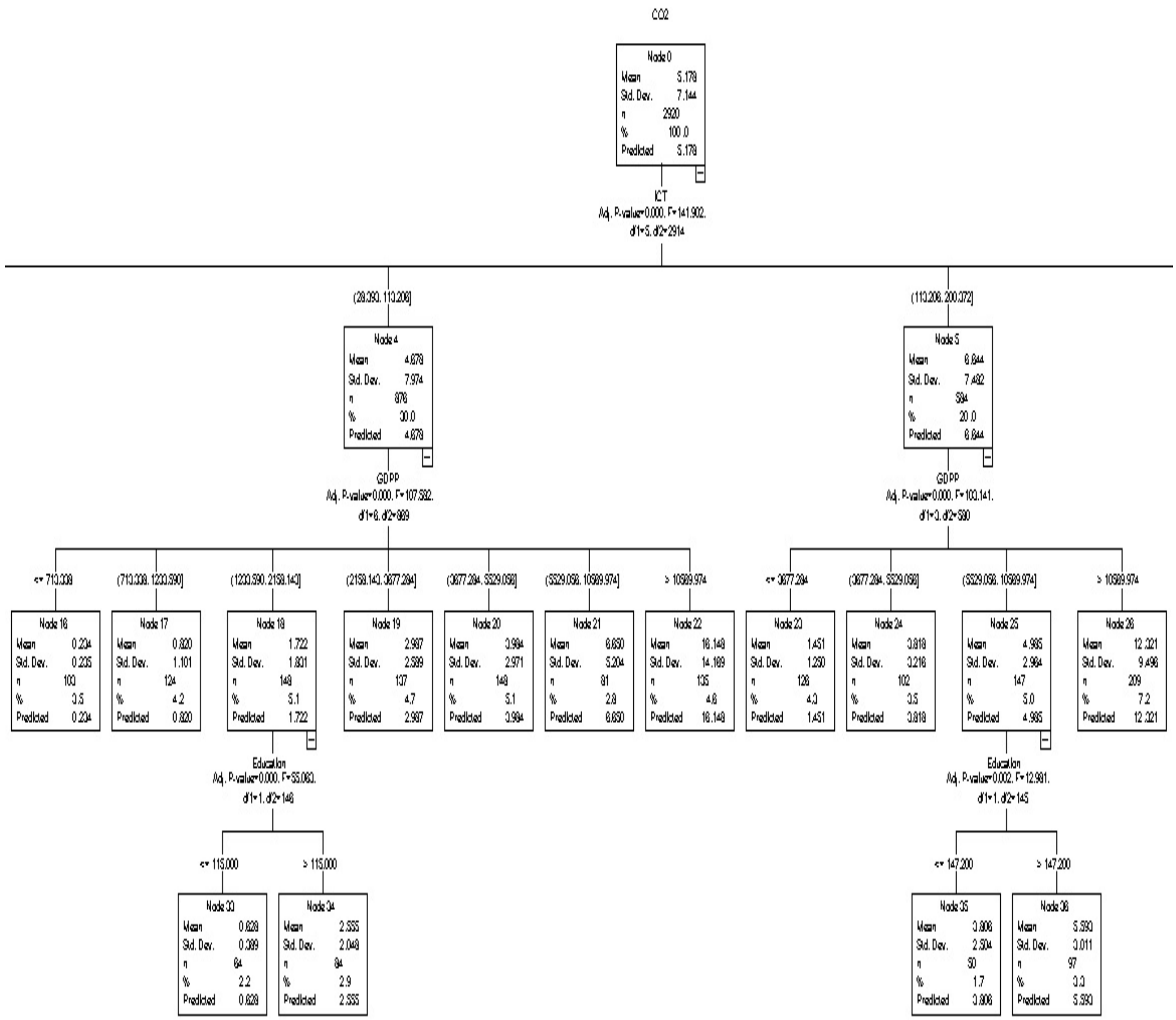
APPENDIX 3- LINEAR REGRESSION- NORMAL P-PLOT CHART



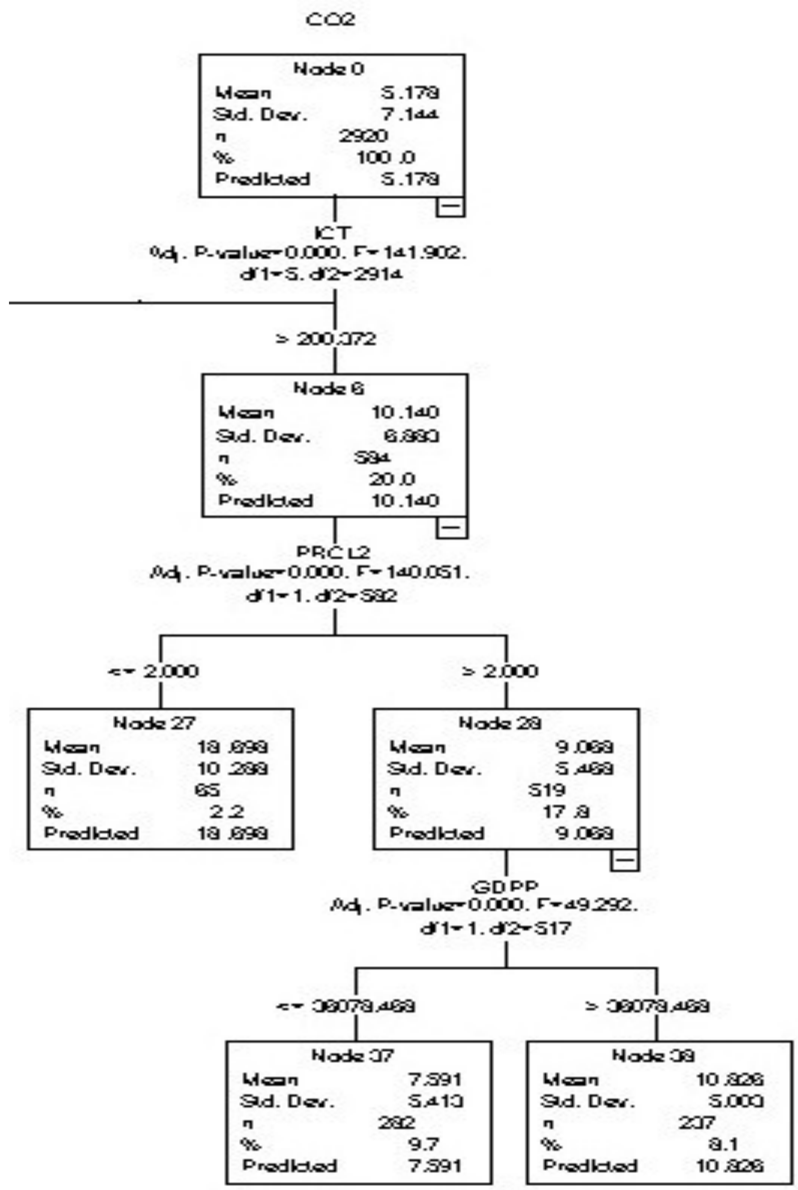
APPENDIX 4- CLASSIFICATION TREE- TREE CHART- PART 1



APPENDIX 4- CLASSIFICATION TREE- TREE CHART- PART 2

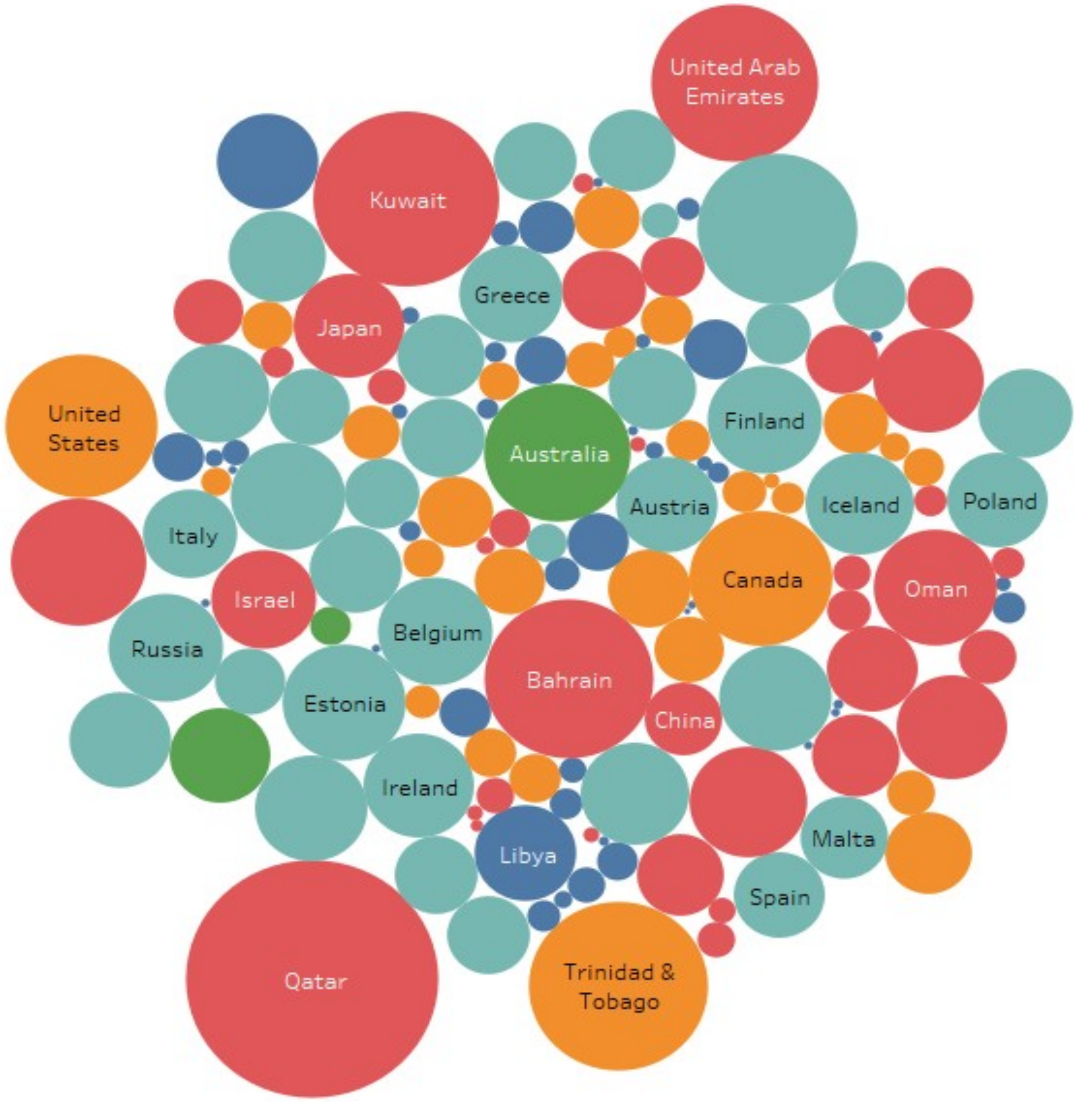


APPENDIX 4- CLASSIFICATION TREE- TREE CHART- PART 3



APPENDIX 5- TABLEAU BUBBLE MAP

Sheet 5

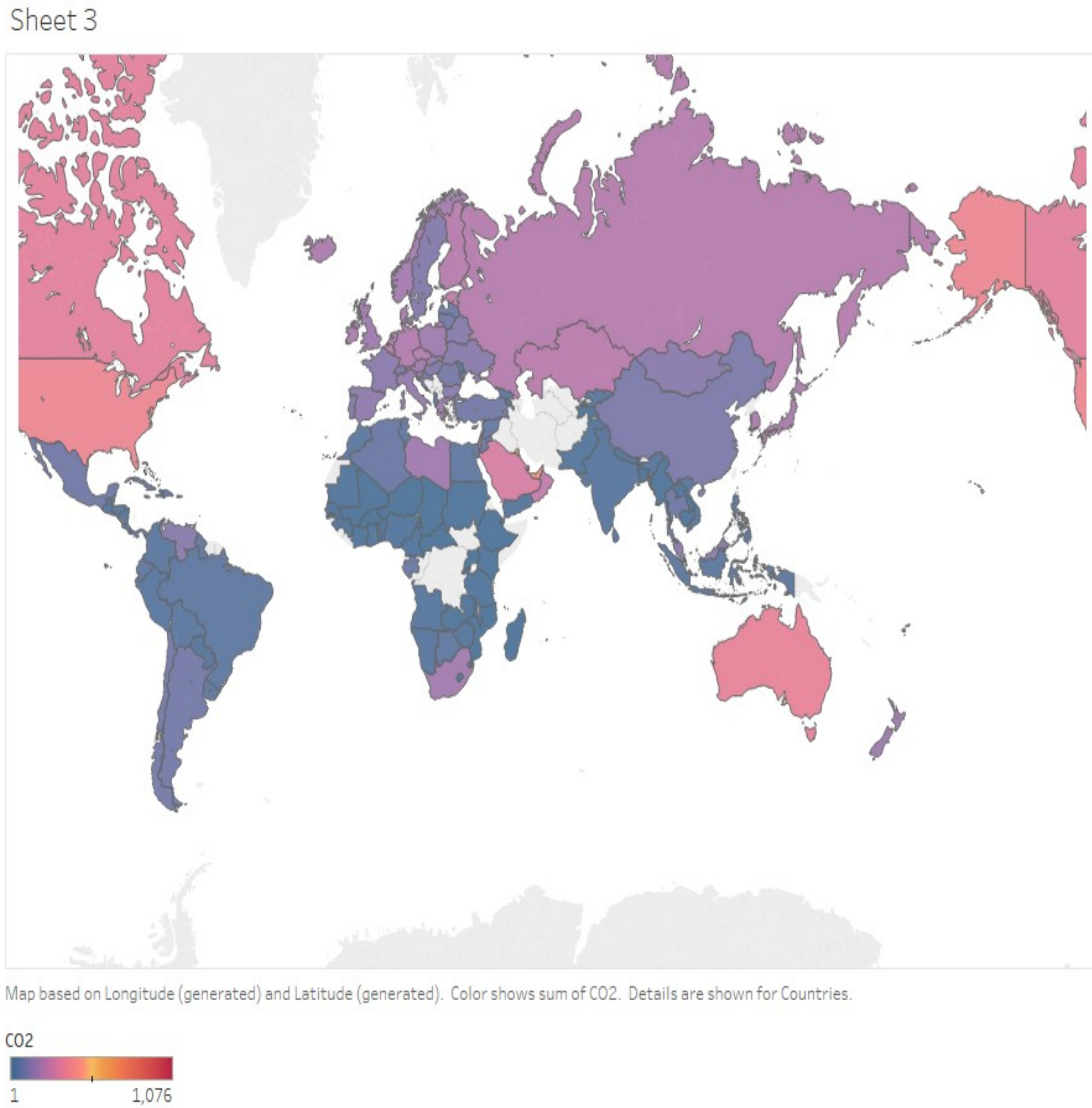


Countries. Color shows details about Region. Size shows average of CO2. The marks are labeled by Countries.

Region

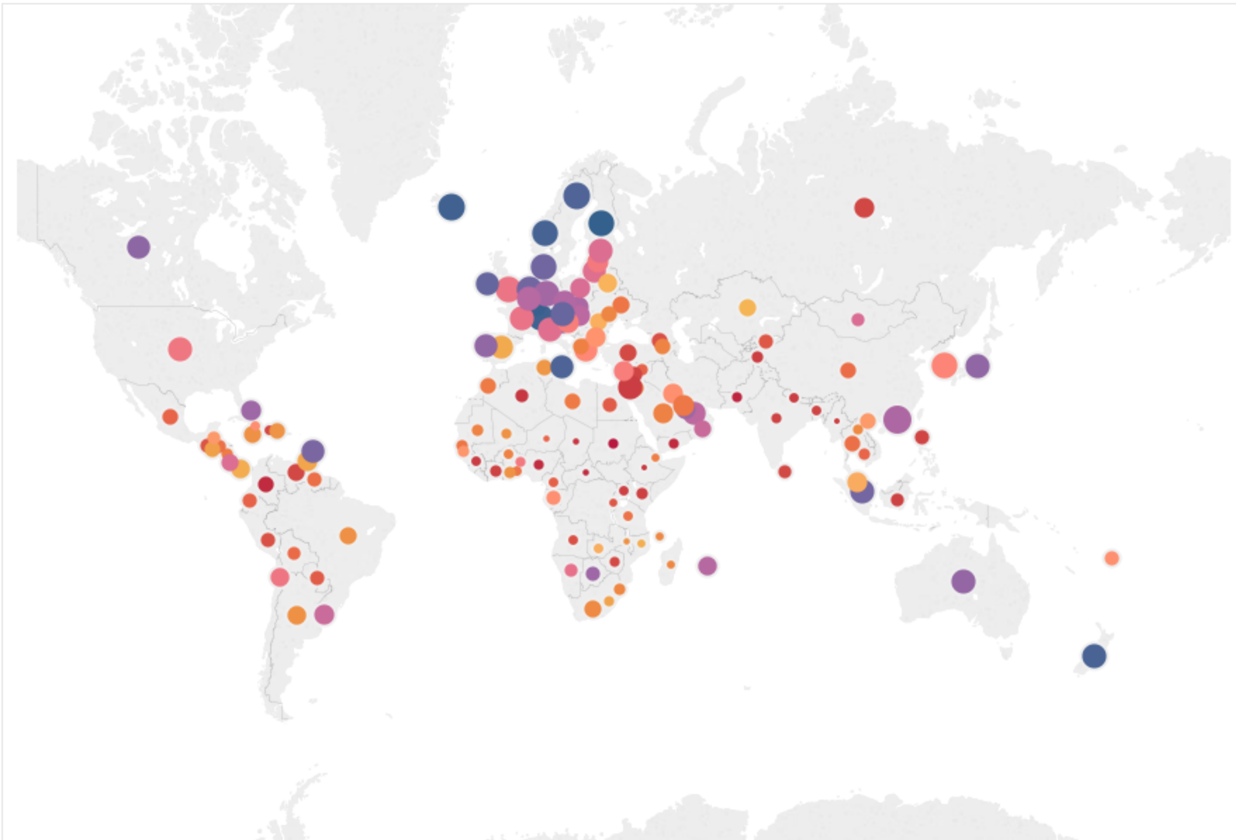
- Africa
- Americas
- Asia
- Europe
- Oceana

APPENDIX 6- TABLEAU MAP



APPENDIX 7- TABLEAU SYMBOL MAP (ICT & STABILITY-COUNTRY BASED)

Sheet 2

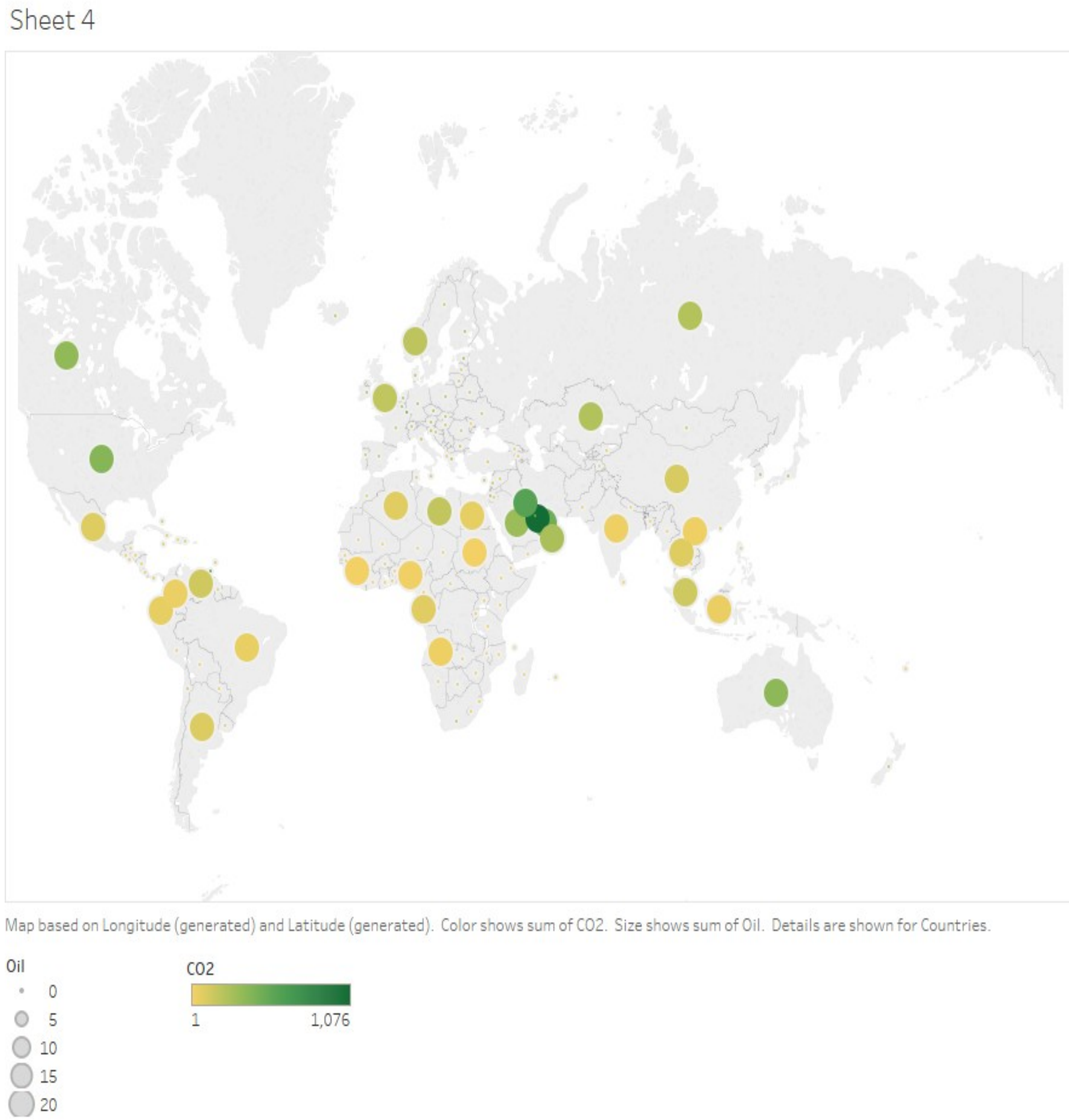


Map based on Longitude (generated) and Latitude (generated). Color shows sum of Stability. Size shows sum of ICT. Details are shown for Countries.

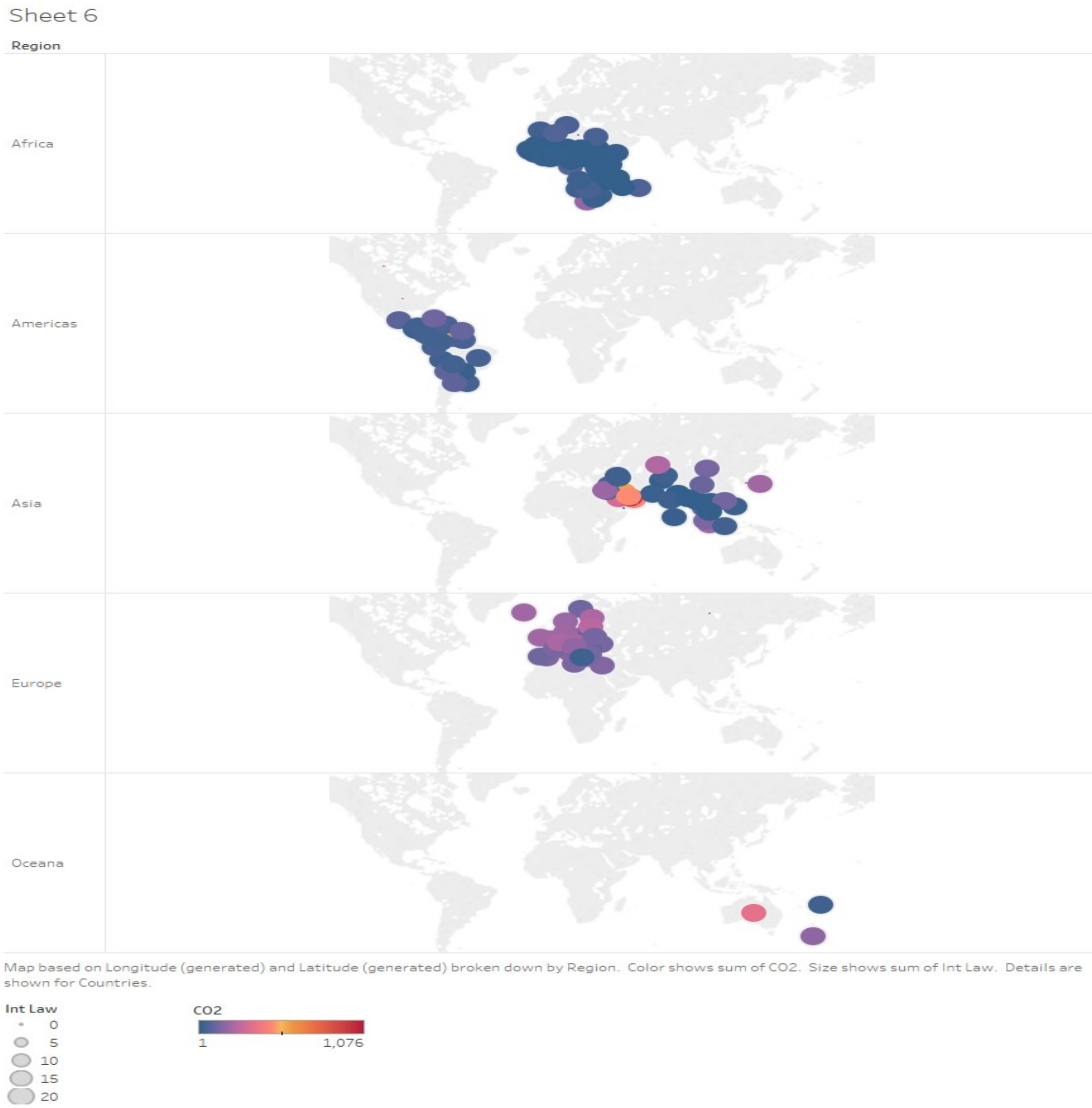
ICT
205
1,000
2,000
3,000
4,000
5,354

Stability
42 1,949

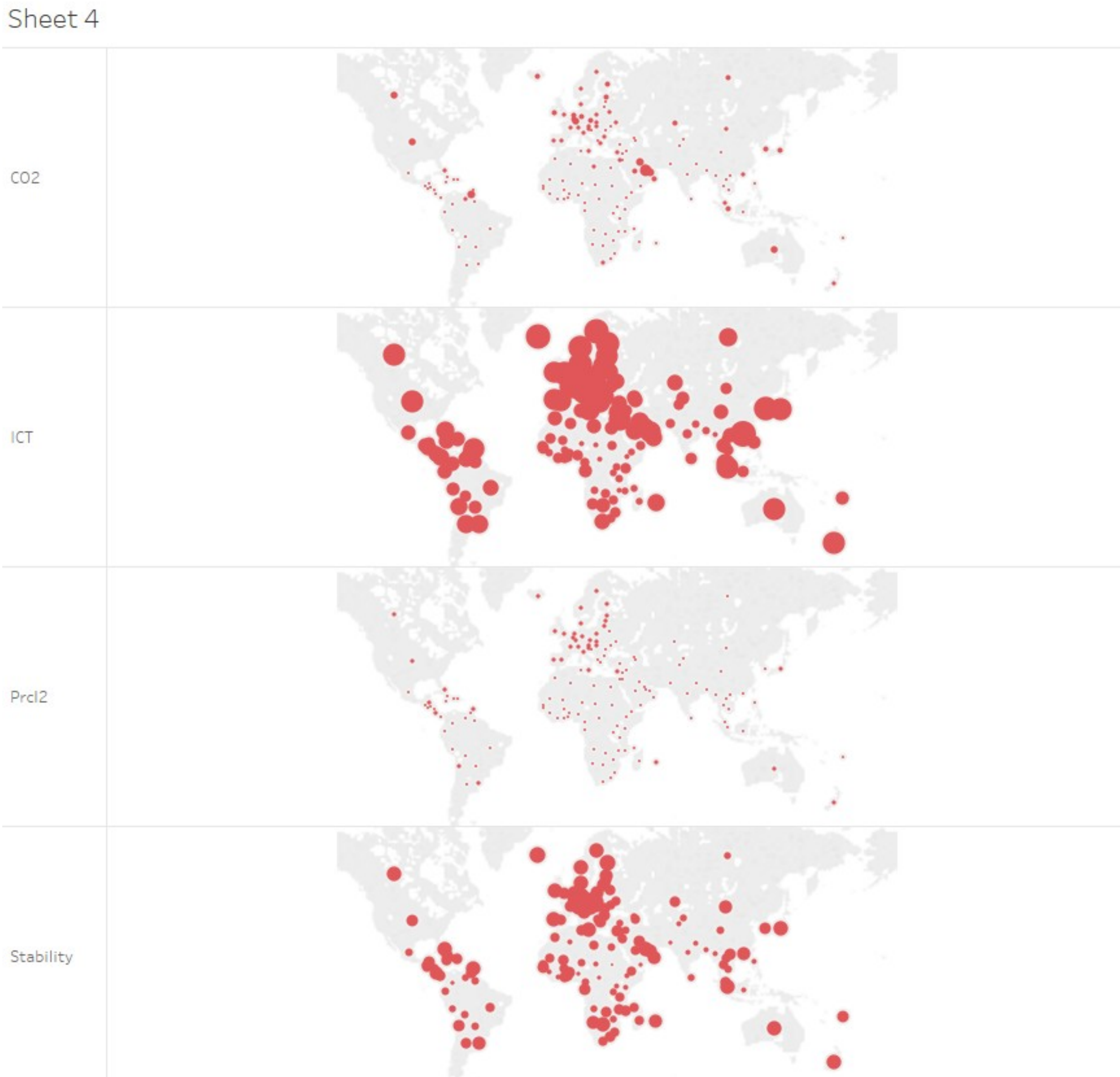
APPENDIX 8- TABLEAU SYMBOL MAP (CO_2 & OIL-COUNTRY BASED)



APPENDIX 9- TABLEAU SYMBOL MAP (CO_2 & INTERNATIONAL TREATIES- REGION BASED)



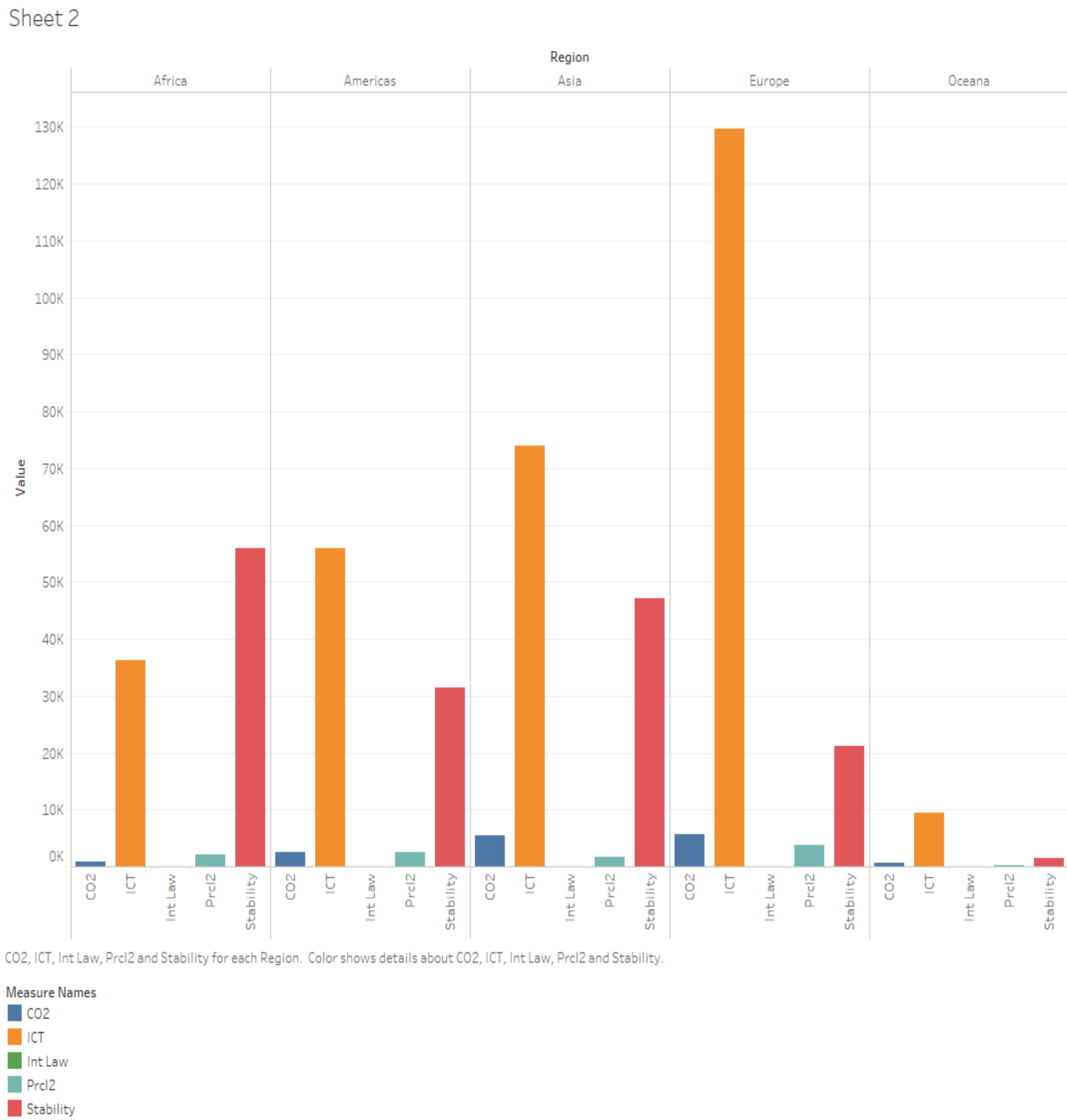
APPENDIX 10- TABLEAU MAP (CO2, ICT, STABILITY, PRCL2- COUNTRY BASED)



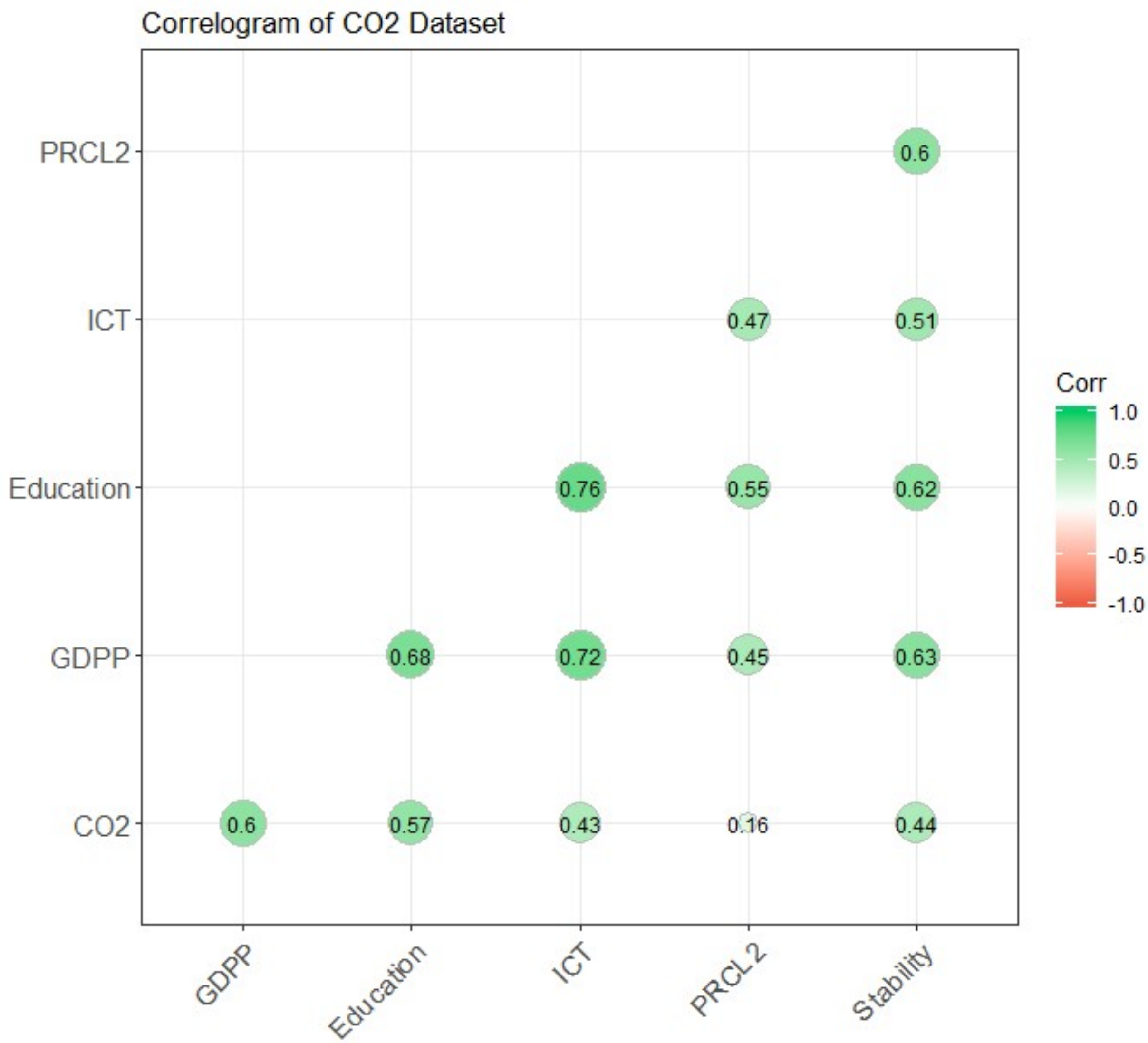
Map based on Longitude (generated) and Latitude (generated) broken down by CO2, ICT, Prcl2 and Stability. Size shows CO2, ICT, Prcl2 and Stability. Details are shown for Countries.

Measure Values
0
1,000
2,000
3,000
4,000
5,354

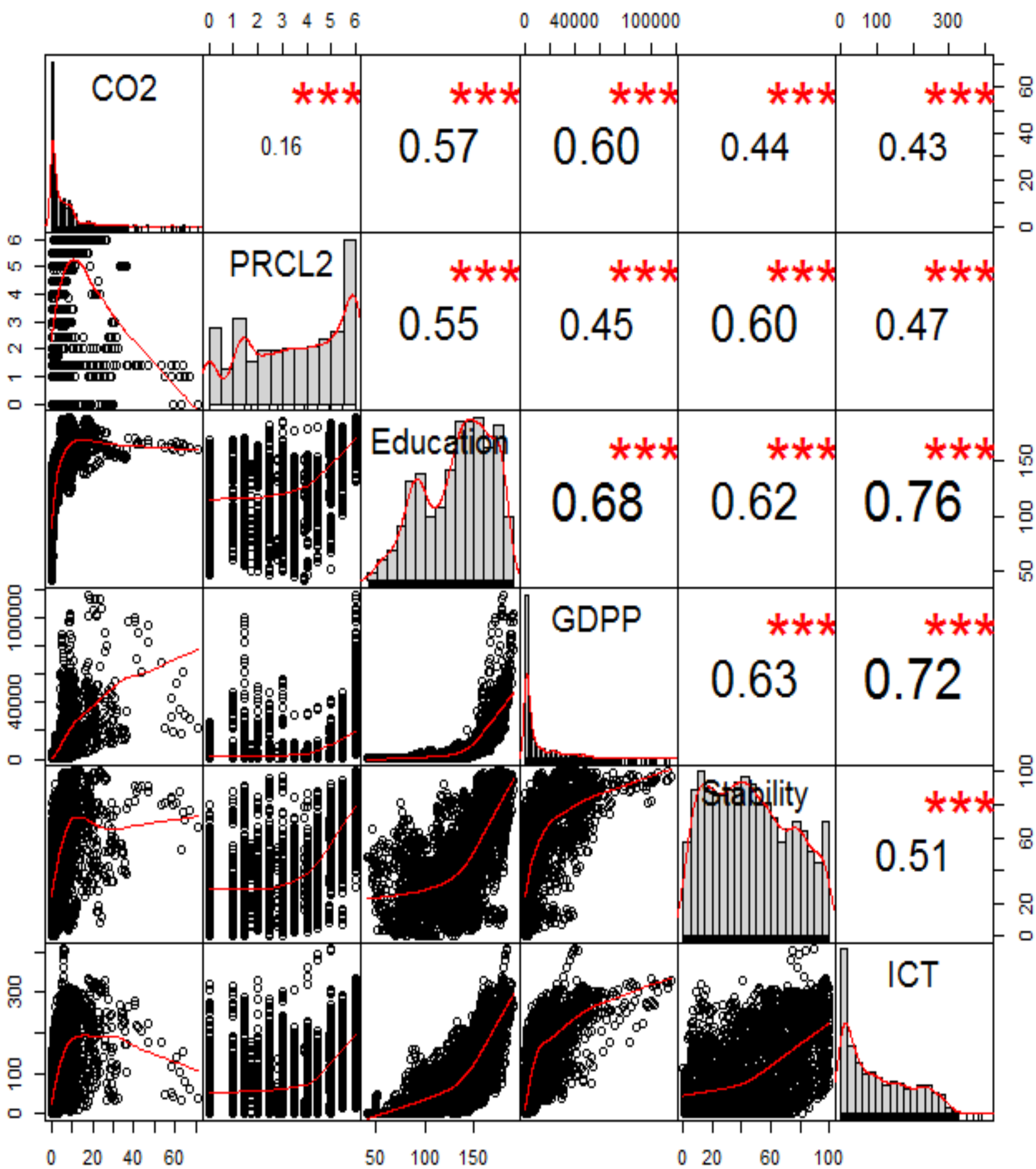
APPENDIX 11- TABLEAU SIDE-BY-SIDE CHART



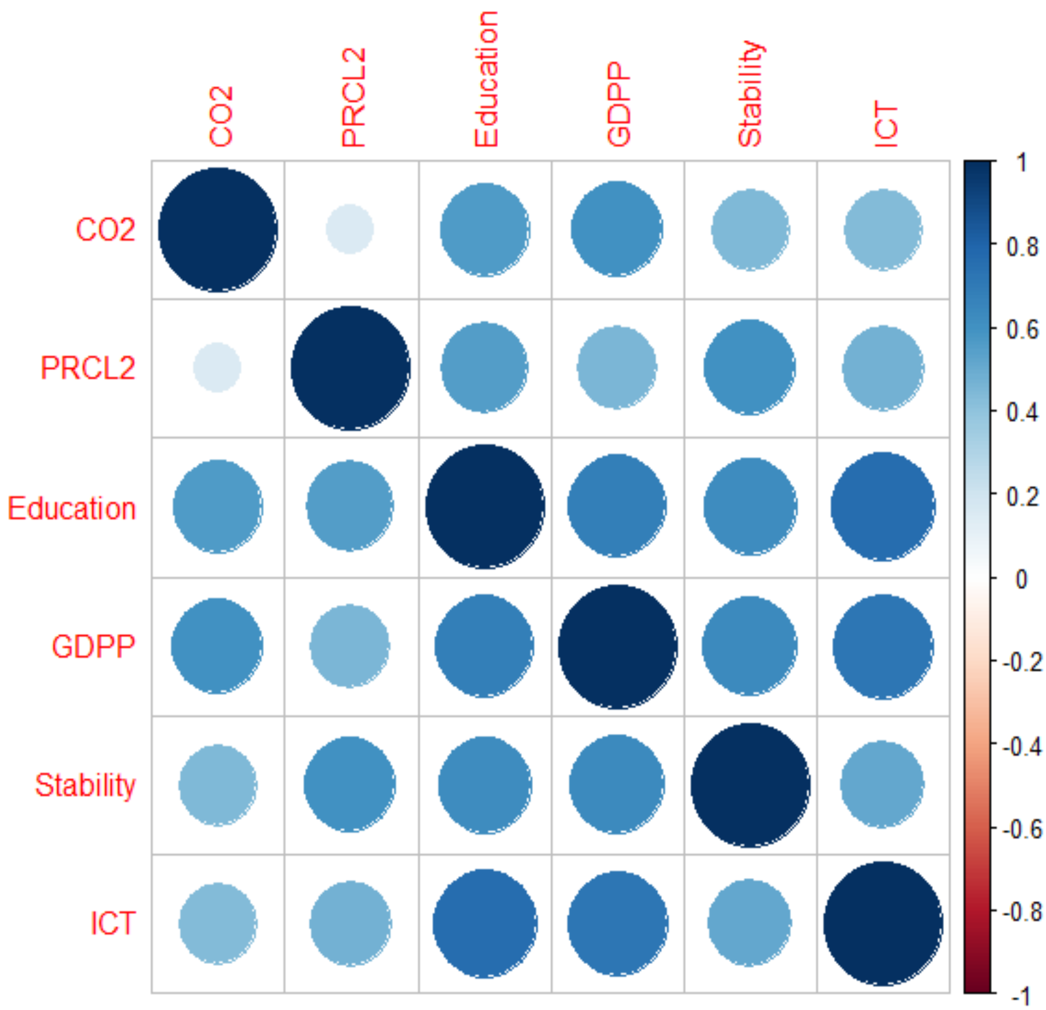
APPENDIX 12- R CORRELATION PLOT



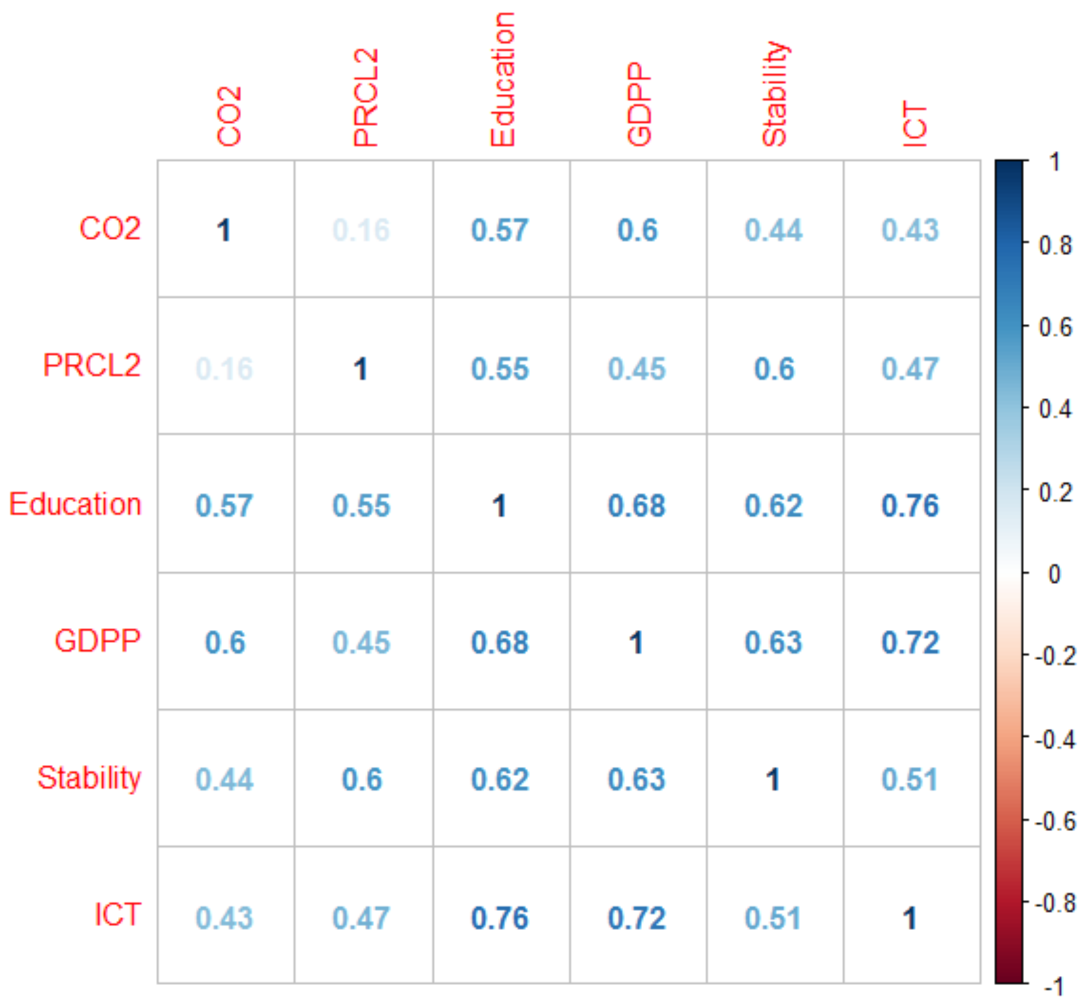
APPENDIX 13- R CORRELATION MATRIX (SCATTER PLOT, CHART & HISTOGRAM)



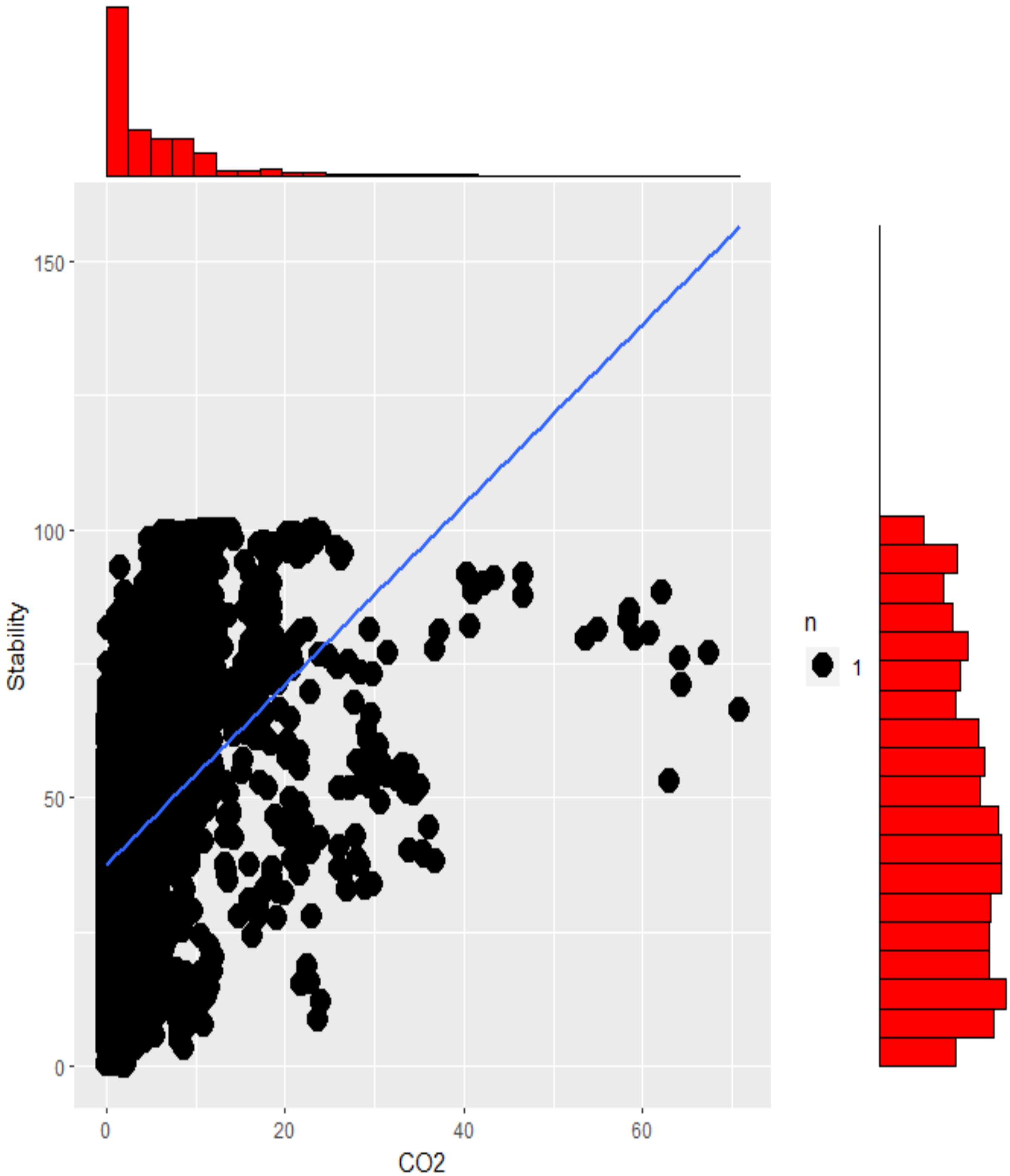
APPENDIX 14- R CORRELATION PLOT



APPENDIX 15- R CORRELATION NUMBER MATRIX



APPENDIX 16- R CORRELATION TRENDLINE PLOT MATRIX (STABILITY & CO_2)



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