Mapping Controversies

Mitigation through Valuation

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Executive summary

Thirty-five euros. That is what you approximately pay in Finland for the emission of one metric ton of CO2. However, metric tons of CO2 may become cheaper depending on your location. In Ireland for instance emitting one metric ton of CO2 only costs fifteen euros. But aren’t the externalities caused by CO2 emissions equal around the world? Why, then, does the value given to a metric ton of carbon differ from one place to another? And why are we giving a monetary value to carbon emissions? In fact, with the scientific proof that climate change is happening, addressing it has become a major environmental, as well as social and economic issue. Governments, companies, and civil society are trying to find appropriate responses to mitigate it. However, in order to do so, we must first understand climate change. We must figure out what the long term effects of climate change are and how to measure these effects. Hence, there needs to be a common language and methodology that can determine the real impact on our planet. Therefore, our objective is to analyze if the creation of such a common framework is possible and how would it be conceptualized.

Carbon valuation has become the predominant discourse among experts and policymakers in the last decades as the most effective way to mitigate climate change. The challenge lies in how such an issue, involving so many opposed stakeholders, can be tackled through an objective lense. It is also crucial to determine who the experts are and where their legitimacy comes from to build such a discourse. As prevalently spread, the idea that numbers are neutral is the backbone of the measurement methodology dominance. But can we really put a price on the pollution created by our economic system? And should we?

Our research starts by deconstructing the process that has led to pricing carbon. The objective is to understand how scientific discoveries regarding climate change became framed by the economic interpretation as an urgent and global issue. We first examine the expertise that put the quantification of carbon damages at the heart of policymaking. After having questioned the objectivity of quantification methods, we review how these methods have shifted from a scientific point of view to an economic-oriented analysis of carbon impacts, notably thanks to the work of economists such as William Nordhaus and Nicholas Stern. This is mainly explained by the market relationship of Man as a “rational actor” to Nature as a “Common Pool Resource” system. As these resources are limited, putting a price on the overconsumption of them (over-polluting for instance) seems to be the preferred political approach to tackle the issue.

Our second chapter presents precisely how carbon has been priced by governments and scientific experts. The aim is to understand the different methods that have been developed of carbon valuation. We focus on the methodology, the actors using them, their limits and criticisms. Carbon taxes were the first mechanism implemented as a tool for climate change mitigation. However, they are not the most commonly utilized tool. Instead, cap-and-trade systems, based on a “market” for carbon emissions, are the prevalent method. Nevertheless, even if these two methods are widely used by governments, the debate on which one is better for mitigation purposes is not closed. Their effectiveness on emissions reductions and their inability to include the many dimensions of climate change, such as the effects on agriculture, health or coastal areas, have been highly criticized. That is why we have decided
to dig into the Social Cost of Carbon (SCC) which is a more accurate and comprehensive measurement of the “real” cost of carbon.

After having explored the different possibilities that are offered to policymakers for mitigating climate change, we explain some of the reasons why the controversy we try to address is still relevant. First, the political struggle to price carbon is ongoing and can limit the use of the pricing method. Also, there are heterogeneous stakeholders with diverging interests. In that sense, one method could be supported and benefit one actor but be rejected by another, which impedes the coherence of solutions. Because of the lack of an intelligible framework, private actors have started to develop their own methods of carbon pricing. From individually led initiatives to companies developing shadow prices or internal taxes, these parallel methods are gaining importance. However, other stakeholders have brought up the need to address the disparity of solutions and to come to a certain consensus. The possibilities of such a consensus enable us to open up the discussion at the end of our research.
# Table of contents

**EXECUTIVE SUMMARY** ........................................................................................................................... 3

**TABLE OF CONTENTS** ............................................................................................................................ 5

**INTRODUCTION** ....................................................................................................................................... 7
  Method ......................................................................................................................................................... 8
  Outline of paper ......................................................................................................................................... 10

**CHAPTER 1. THE FOUNDATIONS FOR CARBON ECONOMICS** .......................................................... 11
  1. Government and Numbers: Literature Review .................................................................................... 12
     1.1. From Knowledge to Expertise: the Role of Experts in Public Policy ........................................... 12
     1.2. Economic Analysis in Decision Making ...................................................................................... 13
     1.3. Generating Authority and Consensus with Numbers ..................................................................... 15
  2. History of Economics of Climate Change ............................................................................................ 17
     2.1. The Science Behind the Discovery of Climate Change ................................................................. 17
     2.2. The economic community joins the debate ..................................................................................... 20
     2.3. Consensus on Climate Change Marred by Measuring Uncertainty in Economics ....................... 22
  3. Who Prices Carbon and How ................................................................................................................ 23
     3.1. Dr. Economics, or How I Learned to Stop Worrying and Love Nature ....................................... 23
     3.2. Macro and Micro Implications of Ecological Market Failures .................................................. 25
     3.3. Market Makers, Societal Pillars: Presentation of Climate Change Actors .................................... 26

**CHAPTER 2. MAPPING EXISTING PRICING REGIMES** ....................................................................... 29
  1. The First Attempt to Price Carbon .......................................................................................................... 31
     1.2. How it works .................................................................................................................................... 31
     1.3. Implementation: Advantages and Critiques ...................................................................................... 32
  2. The Dominant Pricing Method: ETS ....................................................................................................... 37
     2.1. How does an ETS work, who created it and why ........................................................................... 37
     2.2. First Design - EU ETS ................................................................................................................... 40
     2.3. ETS Improvement Based on Lessons Learned ............................................................................. 43
  3. Social Cost of Carbon, the “real” cost of carbon emissions ................................................................. 46
     3.1. Why and how is the Social Cost of Carbon calculated? ................................................................. 46
     3.2. Implementation and Criticism ........................................................................................................ 49
CHAPTER 3. TOWARDS A NEW CONSENSUS? .................................................. 54

1. The political economy of carbon pricing .............................................. 54
  1.1. Expectations vs Reality: Political challenges of carbon pricing .............. 55
  1.2. Carbon pricing until interests do us part ........................................... 57
  1.3. New players and new rules in the carbon pricing game ....................... 59

2. The emergence of parallel pricing mechanisms ..................................... 61
  2.1. From a leadership void to personalized solutions: what’s driving pricing? .... 61
  2.2. Tailor-made pricing methods ............................................................. 62
  2.3. Losing the target? Limitations of the “do-it-yourself” carbon pricing mechanisms .... 68

3. Towards an international carbon price? The emergence of public/private collaboration .... 69
  3.1. Shifting the carbon pricing framework towards enhanced collaboration ....... 69
  3.2. Setting up a global carbon pricing culture ......................................... 73
  3.3. The implications of an international carbon price: no global solution ahead? .......... 76

CONCLUSION ........................................................................................................ 80

TABLES AND FIGURES ......................................................................................... 83

BIBLIOGRAPHY ....................................................................................................... 85
1. Fieldwork and personal communications ...................................................... 85
2. Analytical bibliography ................................................................................... 85
3. References analyzed ...................................................................................... 86
Introduction

Look down at the iPhone in your hand. Apple estimates that the life cycle of an iPhone 6 amounts to 95 kg CO2 emissions, which includes its production, transport, use, and recycling (Apple, 2014). One rarely considers this large carbon footprint that is generated when making the purchase for an iPhone. Armed with this information, should you now as a “responsible” citizen refuse to buy the phone or throw it away if you already own one?

Of course as a global, environmentally conscious citizen, you should be aware of your carbon footprint, and should, ideally, be held accountable for it. If a third of Paris’ 2.2 million inhabitants (intra-muros) owned an iPhone 6, that would represent 69,666 tons of CO2 emitted - all throughout Apple’s long supply chain, spanning numerous countries across three continents based on their original valuation (Apple, 2016). Pollution, then, seems to be more of a collective action problem. How can one feel individually responsible for something that is created and bared collectively, given that the effects of individual action are so diffused. Furthermore, the implications of climate change are not likely to affect you or your peers anytime soon. Even with our forecasting tools, it is difficult to predict its course. Realistically, it is hard to wrap one’s head around the causal link between buying a phone today and a tsunami hitting a small island in ten years. Indeed, the future generations will be the ones most strongly impacted. Why, then, should we, the present generation, sacrifice our present consumption and leisure, knowing it is not us who will be able to reap the benefits of such sacrifices? Assuming we do take up this responsibility, how should we value this sacrifice and its future benefits?

Today, climate change is one of the most important concerns on the political, economic and environmental agenda. Climate change is happening, and it is happening now. Finally, we are approaching consensus over the necessity to act upon our anthropogenic involvement in environmental degradation and its direct impact on climate change. The accumulation of evidence gathered by environmental scientists and economists has been key in backing the legitimacy of this shift in conceptualizing the problem. While the experts behind climate change are slowly shifting out of public scrutiny, we are still nowhere close to an internationally accepted, standardized regime for mitigating environmental damage. An emerging proposition to lead this fight is to attribute a monetary value to each ton of carbon emitted.Attributing a price to carbon emitting activities could create a lingua franca for climate change, translating atmospheric pollution into a “commodity” easily understandable and usable by all, organizations and individuals alike. Such a framework is thought to enable accrued mitigation (reducing greenhouse gas emissions) by incentivizing it, through a monetary estimation of the impact of emissions. This concept has evolved to take various forms through initiatives led by governments, companies, and the scientific community. While increasing amounts of public and private entities have started to attribute a monetary value to their carbon emissions, assessing and valuing the impacts of any greenhouse gas emissions in social and economic terms remains a controversial endeavor.

Coming back to our iPhone example, the 95 kg CO2 emissions can theoretically be assigned a range of different prices depending on the method used to estimate its value. The price could be imposed through a national carbon tax, that Apple will pay and which
may trickle down to the buyer in the form of an increased in the price of the phone. The price attributed to the 95 kg CO2 may be drastically different if it was computed by using the Social Cost of Carbon, or if it was determined by the supply and demand of what can be called a “carbon market” through an Emissions Trading Scheme, for example. These valuation methods and enforcement tools, which will be presented and analyzed in depth throughout this paper, are at the heart of the many debates that constitute a major current controversy. It is indeed hard to decide whether Apple should be the one creating and shouldering that burden of cost, or if the governments of each of the countries involved in the supply chain should intervene, jointly or independently. The consumers may also have to share the costs or have a say in the valuation of these CO2 emissions. The existence of widely differing prices for a same amount of pollution raises the question of the fairness of the prices and their justification. Ultimately, the very objective of each pricing method and the possibility of converging towards a unified and globally standardized price for carbon are at stake. It is within these interrogations that the carbon pricing controversy lies.

There is, to date, no international consensus on the ways to price carbon, nor on the actual effects of such prices, and these controversies are as perceptible at the local level as the global one. The concept of actually influencing mitigation through pricing is even less straightforward, as no clear causal relationship has been established between carbon pricing and mitigation. The very need for a price is thus not consensual either, and the actors involved in the controversy have diverging agendas defending differing interests. In fact, the one consensus that has emerged among the international community is that it seems impossible to implement an appropriate framework to wholly reverse existing environmental damages as well as halt them for the future. Yet, in the wake of a new era of international negotiations, shifting of power relations and a growing emergency to reach an effective agreement, it seems more imperative than ever that solutions to these obstacles are found.

Method

When modelling the effects of climate change it seems essential to account for all of the human, environmental, economic and ethical interdependent variables at play. This should be done in order to derive a socially, economically and politically justifiable monetary estimate of the damage done by carbon emissions. However, a model is by essence a simplification of reality as it turns complex facts into broad indicators; any simplification requires choices, sacrifices, specific assumptions, and particular variables. This means that it may be impossible to create a model reflective of reality with all its dynamic and infinite variabilities. Precisely measuring the impact of climate change thus cannot be done through the lens of one single discipline or model. Those that tackle the issue therefore do so with varying degrees of comprehensiveness, with some models attempting to factor in more variables than others.

Our starting point for this analysis was with one such model, the Social Cost of Carbon (SCC). While it is not the oldest methodology for carbon pricing, it aims to approach climate change and carbon emission in a rather extensive way, accounting for many of the social and political consequences of carbon emissions. It also offers a complex point of entry into the subject because it is widely cited and there is much debate about its
parameters. This complexity is further highlighted by the existence of various models within the SCC framework and contention among experts on the model and parameters that best predicts the future price of current carbon emissions.

This led us to question what other models existed and why the primary focus was on carbon. Interestingly, by broadening our focus, we learned that the controversy is not so much about the choice of carbon as opposed to another compound, but is rather centered around the choice of pricing. Extensive research revealed that while carbon dioxide may not be the only factor contributing to climate change, it is in fact the primary greenhouse gas emitted by human activities. Further, it has been subject to much scrutiny over the years due to the fact that it is relatively easier to control, monitor and create a market for compared to other pollutants such as methane or other GHGs.

In order to refine our understanding of prices, we then examined the history of climate change sciences, from denial to the inclusion of the most strategic economic and human stakes. Aggregating and synthesizing the scientific findings with the economic analysis becomes extremely challenging, whilst trying to maintain a balance in perspectives of fields and contradicting theories regarding climate change modeling. Though there is some consensus, much of the discoveries and models have shaken the scholarly world.

After having understood how one type of price can be generated through economic modelling, we looked at other tools that aim to mitigate climate change through carbon pricing. Through a series of reports, interviews, in-depth research, and patchwork analysis we derived an overview of the dominant methods of carbon pricing and the controversy behind their inconsistency.

In our analysis, we distinguished between two types of approaches. The first approach is economic research oriented targeting regulators and political authorities with the aim of finding a number to put at the heart of top-down policy design. The second is more market oriented, with businesses and some economists privileging market-based approaches, where the price of polluting would be more or less determined by a law of supply and demand. Hence, the principles of free market subsequently influencing the actors' choices.

Such an overview of the diverse and often diverging mindsets behind different approaches regarding climate change risks mitigation led us to question the prevalence of economics in the analysis. Our paper will therefore bring other points of view to the table: non-governmental, legal, individual, and philosophical. This last point is imperative in understanding the stakes behind adopting a universalistic and global, or, tailored and regional posture regarding carbon.
Outline of paper

The paper is divided into three Chapters. Chapter 1 explores the foundations of carbon pricing through a literature review of policy tools and economic analysis, a historical summary of the economics of climate change and an analysis of the key actors in the debate and their approaches as well as interests. Chapter 2 conducts an in-depth analysis of the two prevailing methods of carbon pricing: Carbon Tax and Emissions Trading Schemes (ETS) as well as a discussion about the most recent addition to the carbon pricing arena – the Social Cost of Carbon. Chapter 3 will finally give life to these tools by analyzing the dynamics of the interactions between stakeholders in the carbon pricing controversy. It will observe the way in which this debate has evolved through international negotiations as well as through the inclusion of new actors and their parallel pricing mechanisms. This will ultimately lead us to describe the shift of the conversation towards the need to act in common and the will to create global standards. Finally, a synthesis of the analysis is proposed and concluded with various avenues of future development and insight into the future of the carbon pricing culture.
1. The Foundations for Carbon Economics

This chapter aims at understanding the politicization of climate change as a global issue, a process whose latest step seems to be carbon pricing. After decades of denial and unlimited resource extraction in a limited resource system, it appears that ecological risks are becoming a problem of the highest importance and emergency. The reason behind this is the realization of the catastrophic multiplier effect that an environmental change could have on all levels of social life and human survival. This revolutionary mindset shift overthrew the idea that polluting behaviors are an individual choice with a limited impact on the surroundings of the polluting entity. Putting climate change on the political agenda was therefore a cornerstone of world politics. However, two analytical prisms seem to be predominant: the global level of analysis, and the economic framework. The choice of such standpoints have a determinant effect on the tools and strategies to mitigate the effect of climate change. Behind the construction of this analytical frame lie the reasons explaining why we are putting a price on carbon today. Deconstructing this framework will be the objective of this chapter.

To do so, our analysis will follow three steps. First, we will analyze the role of “experts” in public policy-making. By understanding the way this expertise is produced, we will deconstruct the centrality of numbers in social sciences which will lead us to reconsider the way governments quantify intangible social issues. Hence, in the second section, we will go through what has been produced so far throughout the scholarly research: this will allow us to understand the main analytical trends that have shaped the idea and practice of carbon pricing. To understand the debate that has greatly shaped climate change policy guidelines these last decades this analysis of the history of economics of climate change will have two pillars: the work of William Nordhaus and that of Nicholas Stern. Finally, we will unravel the assumptions and motivations behind the choice of economic quantification as the main way to understand nature. Understanding this “Homo Economicus” reasoning is key to discerning the mechanisms behind the price tag on a clean atmosphere.
1. Government and Numbers: Literature Review

In the famous Milgram experiment, the expertise and assurance conveyed by the white lab coats made the participants willing to inflict electric shocks at levels that would have killed the cooperating actor in the adjacent room if the shocks were really administered. While this serves as an extreme example, we see how the authority of science and the power of acting in the name of research can be taken as a literal justification for (sometimes extreme) decisions. Science is seen as needed to convince the public of ideas which are often beyond their knowledge.

In this section we will briefly discuss the literature that lay the foundations for understanding who the experts are for the question of carbon pricing and how these initial tools of measurements were established in social discourse and government policy. To do this, we will examine the role of expertise in public policy, then discuss how economic analysis, in particular cost-benefit analysis (CBA), became the dominant tool for policymakers and the decision process. This will bring us to unveil how and why it is no longer just a question of who has the expertise but also how it is presented: the power of numerical presentation of data.

1.1. From Knowledge to Expertise: the Role of Experts in Public Policy

The problem of climate change is a complex one. It mobilizes very diverse disciplines; biology, physics, ecology, but also politics, economics, anthropology and history. The complexity of the concepts and issues at stake creates a need to find experts. In effect, Western societies have built legitimacy of policy and decision-making around facts and expertise.

Expertise allows to find a common language in order to efficiently discuss complex issues such as climate change. According to Latour (1999) policy-making in so-called « modern societies » is based on evidence: if we can prove something, then a solution can be proposed. Moreover, expertise is not only needed at the policy-maker level; the public outside governments closed doors also demands information. Linking the roots of policies in what appears undeniable facts and strong expertise can therefore be used in order to create legitimacy for implemented solutions.

From that perspective, science is a cultural enterprise, as well as a structural source of authority. In each one of the cultural enterprises there is a socio-cultural repertoire made up of a range of political norms, institutions, or behaviors that affect and determine the common practices (Ezrahi, 1990). Experts are representatives of such cultural enterprises.

Furthermore, in The Descent of Icarus, Ezrahi (1990) examines the relations between science, technology and politics in modern liberal-democratic societies. The author argues that science and technology are instrumentalized by politics in modern liberal democracies. On the ecological crisis, there is a need for those democracies to transcribe all the problems linked to the Earth into understandable and usable data. The science that is created therefore serves a political role as it upholds instrumental paradigms of public action in the modern liberal-democratic state.
This profound attachment to science and expertise has limits. By placing expertise above everything else and letting it shape reality, it can end up generating violence and tyranny (Visvanathan, 1997). This is why in democracies transparent processes are set up when policy-makers call on the intervention of experts. In France for instance, hearings of experts conducted by an Assembly commission are made public.

The limits of expertise also lie in the concept itself. The term is misleading as it tends to imply that somehow any expert will have expertise on any topic or discipline. The immense amount of knowledge accumulated by humanity and, in the specific issue of climate change, the number of disciplines involved show how compartmentalized knowledge is. Though this tendency is established, many tend to offer legitimacy to experts whose opinions are presented as valuable on any topics. Here, it is worth noting that expertise and influence should not be confounded; expertise can bring legitimacy to influence decision-making, but influence does not necessarily imply expertise.

Evidently, climate change issues require strong expertise. Understanding the impacts of every type of human activities or reframing our understanding of nature demands that expert join forces with policy-makers. There is a need to define nature, to take its pulse and to understand it in order to reverse the situation.

While definitely needed, the role of experts in this case needs to be balanced. Echoing to what was said earlier on the present role of expertise, Latour (1999) explains that modern scientific promotes concepts that are “immutable, presentable, readable and combinable with one another”. However, Latour adds that for something to be categorized as modern science it must serve or have a purpose. In the context of climate change, the purpose of scientific expertise would therefore be to produce exploitable data on carbon emissions impacts to accompany and justify decision-making over how to reduce them. In other words, science generates power; it helps actors to impose their will (Latour, 1999). Expertise not only produces legitimacy; it also creates debates and conflicts.

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Experts and their knowledge play a key-role in decision-making at the political scale. The balance of power between stakeholders is determined by both the expertise achieved by each actor and their ability to use this expertise in order to influence others. The carbon pricing debate is no exception. Every stakeholder leans on specific knowledge and presents it as expertise in order to push forward its own interest in the reaching of a global carbon price. Expertise is a condition for policy-making, a generator of debate and a subjective use of knowledge.

1.2. Economic Analysis in Decision Making

The carbon pricing task is a role for scientists, economists and engineers, but COP21 showed that there is also a political process. The process did not end with a consensus, but rather has been thrown back to each field for implementation of the policy. In this section, we specifically examine the birth of economic analysis and its influence on this political process.
The proliferation of economic analysis for policy tools can be historically traced from the use of CBA in US bureaucracy (Porter, 1995). It was first seen in the case of U.S. Army Corp of Engineers for a quantitative evaluation of public water infrastructure projects such as dams, levees and other large-scale construction in the 1900s through a federally uniform quantification scheme. It became formalized over time to “almost universal validity” by the 1960’s. As such, CBA became the ratio of quantification of benefits versus costs and allowed for simple categorization itemization. A value of above one meant that the project had a significant number of benefits that outweighed the costs, and should be further pursued. Contrastingly, a ratio value of less than one required significant external political justification for funding. Accordingly, cost-benefit analysts in the US Corps became increasingly sophisticated in their methods as demand for their expertise gained traction.

However, Porter’s work was not without criticism for the approach, as well as its shaky history of adoption. Based on the recordings of Congressional hearings, Porter recognizes CBA as a method to encompass a broad width of perspectives from divergent stakeholders, but concurrently created a dependence of authority from the engineers of the US Corps. In their model, the officers overestimated in the benefits and underestimated the costs, highlighting the unreliability of their results. It was also not without disputes of challenging their expertise from electric utilities, railroads, the Department of Agriculture and the Bureau of Reclamation. Furthermore, while the modality produced uniformity and institutionalization, it was these very characteristics that faced heavy public distrust. CBA tools still notably remained susceptible to political pressures and tides, but were purportedly marketed as a neutral and objective analysis of projects, particularly because it was backed by numbers and figures.

To further elaborate on this point of authority of analysis, in the case of US Corps their work was never questioned and gained an automatic trust because it was backed by an ‘elite body of experts’ and served as an economic ideal of mechanical objectivity. Congress simply did not have the expertise to assess their method of analysis and waived off any further judgement because it was considered an apolitical methodology. Hence, the trust that stemmed from the organization of the US Corps was transferred to their method of analysis. CBA was no longer just employed for water infrastructure. Projects of transportation, military, other government programs, and health served as sectors of expansion for its applicability. Though its use was constrained to projects where the benefits could be quantifiably measured and also required the availability of ’experts’ or technical proponents that had the capacity to conduct said analysis. This in and of itself was an excluding measure, yet Porter’s work goes beyond to show that when applied CBA actually led to changes in the very nature of envisioned projects.

Interestingly, the scope of CBA was further propelled into the environmental sphere by a case in 2008 where the Ninth Circuit flagged the Department of Transportation’s (DOT) Corporate Average Fuel Economy (CAFE) standard for light trucks because the cost-benefit analysis performed by DOT failed to account for the standard’s beneficial effects for climate change (Masur and Posner 2011). A small number of environmental groups, amongst the petitioners, tried to persuade the court that the DOT should not have used cost-benefit analysis, which they believed was impermissible under the statute. Ultimately, this argument was rejected by the court. However the court noted that if the DOT used CBA, then it could not arbitrarily include some benefits such as reduction in automobile noise and congestion, while excluding others, such as reducing greenhouse gas emissions.
Thus in response to this ruling, the DOT monetized the climate benefits, and hence CBA was initiated in federal regulation of climate change.

The stakes of the CBA within the economic framework are that they guide public policies and projects. Yet ultimately, political/bureaucratic conflicts of interests between stakeholders and agencies are the underlying drivers of the selection criteria favoring a particular project or policy. CBA aims at resolving decision-making dilemmas based on complex, presumably ‘apolitical’ calculations. It started as a way to "limit the play of politics in public investment decisions", and evolved to become a method “grounded in economic principles”, and to be “applied to almost every category of public action.” In its best form CBA can be deemed politically neutral as it draws from widely shared intuition regarding human well being, yet it will always for short for political questions on contested normative issues (Masur and Posner 2011).

This is intrinsically linked to the work of Foucault who uses a sociological framework to examine how we attribute monetary value to intangible things and derive economic value. He claims that economic valuation of nature should solve three questions: why, how and what. “Why” requires deriving an economic monetary value, “how” is techniques and arguments used by laymen and experts that provokes the behavior as well as monetary transactions, and “what” is the feedback loop from monetary values to the common social practices and the depictions in society. Furthermore, when monetizing and performing an analysis of nature’s value, it is directly linked to a form of power because it enables acts of classification, control, and discipline (Foucault, 1997; Kologlugil, 2010). The assertion of this power into social discourse is invariably a form of bias in the expertise based on the literature. Drawing from Foucault’s work we see that while CBA endeavors to be an apolitical methodology, it still is an act of power assertion.

To summarize, through the work of Porter we see the birth and expansion of CBA as a tool to ascertain values for projects and justify their efficacy; though not without serious shortcomings. This is highlighted in the case of DOT’s failure to account for climate change in its analysis, leading to the inclusion of CBA in the federal regulation on climate change. Foucault asserts that this monetization and measurement of nature is an act of power. Tying this all together we understand that while CBA was created as an objective tool, it became propagated through an assertion of power. This method of measurement became the dominant tool of economists, who are featured throughout the discourse on environmental issues. As this study tackles the question and controversy behind the price for carbon, it is imperative to link the growth of economic analysis as part of decision-making tools to the development of economic expertise in pricing carbon.

1.3. Generating Authority and Consensus with Numbers

Monetization and measurement rely on a central tool: numbers. Throughout the history of the social sciences and policy making, numbers have gained a tremendous weight. Credibility, comparison, falsifiability: statistical and numerical analysis are praised as they are perceived to ground abstraction into reality. A socially constructed belief has allowed numbers to become a universal authority generator.

A number is perceived to have two essential characteristics:
A figure is easily “transportable” and can circulate among actors;
but it is also seen as more “powerful” than many others forms of evidence.

As Bruno Latour (1990) puts it, these two properties came with the birth of European modern science, which emphasized the inscription of scientific claims in “hard facts” that were: mobile, immutable, flat, scale modifiable, reproducible, recombinable, superimposable, and can be part of a written text. This is why numbers have appeared to be the ideal way to erect “objectivity” in opposition to simple relativism.

Still, “You cannot establish objectivity without being a relativist” declares Latour during an interview in 2013. According to the scholar, it is only by taking into consideration as many different standpoints as possible that one can try and get close to producing objective knowledge. In that sense he is distinguishing “objective knowledge” from truth and normative statements. “Knowledge is about objectivity, not about truth. Knowledge is one form of objectivity.” Therefore, the findings that result from a scientific methodology based on numbers should be interpreted with regards to what they are: a relativist and constructed outcome, not a dogmatic ground rule.

Yet, expertise that relies on “hard science” and quantifying methods has somehow gained the aura of dogmatic ground rules over time. Why? Statistical objectifications “have contributed to the institutional and cognitive consolidation of the social sciences” (Desrosières, 1991). Because quantification imposes rigid, algorithmic rules that everyone must follow, it creates a type of mechanical objectivity that has a great power: this is at the heart of consensus building. The idea behind this Durkheimian vision is that in order to be consolidated, social sciences need their “social facts” to be treated as “things which hold together”.

Here, consolidation is the process through which an information or a statement gains the ability to be transmitted through time and space without suffering deformation - or what Durkheim (1900) qualifies as “treating social facts as things.”. This is what renders scientific work experienceable and comparable. Statistical objectifications succeed in transcending “individual and conjectural contingencies”: this is what makes it possible for scientists in general and social scientists in particular to construct generalizations. Statistics and numerical analysis suit this process of consolidation which makes them the ideal “tool of governance and proof” (Desrosières, 1991).

This is the first epistemological step to the attribution of a monetary value to intangible things such as life and nature. The main challenge of this new relationship to things and concepts is to transform “different qualities into a common metric” (Espeland and Sauder, 2007.) Each disaster might be unique, each natural landscape might have particular properties; however, the aim of monetary commensuration is to create a homogeneous grid that can sum these different elements into one flat unit. The creation of this grid is part of

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1 “Bruno Latour - The Relativist” - Interview given to The University of Bergen, 2013.
the consolidation process. To see climate change as the amount of additional degrees of atmospheric temperature, or the number of species extinct, is a result of this process. Here, the role of statistics and Durkheimian approaches to social facts is predominant in climate change policymaking.

Based on Latour and Desrosières work, the fundamental difficulty of bringing together “objectivity” (in regards to personal beliefs), “relativism” (in regards to more excluded standpoints) and “credibility” (in regards to authority beholders) translates into years of debates and ramping negotiations. The example of the Kyoto Protocol is an illustration of the struggle to define which climate policy to adopt: a global gradual “policy ramp” or a national radical policy with immediate measures. This history of economic policy of climate change will be tackled in the next section.

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In sum, this section enumerates on the role of experts in government policy, the prevalence of CBA analysis within an economic framework in decision making, and the power of numbers to create a consensus.

2. History of Economics of Climate Change

As we have now discussed the extensive literature and debate to provide context on the role of expertise and economic analysis in the climate change narrative, it is also important to understand the history of its discovery as well as the origins of present day discourse and framing. This section will provide an overview of the historical landmarks in climate change discoveries as well briefly discuss the dominance of the economic framework in the political and academic spheres from a historical perspective. It will discuss the main economic models and policy tools and establish how these tools came to price carbon. It will then offer a critique of the Stern Review and one of the main challenges of uncertainty that the economic framework faces.

2.1. The Science Behind the Discovery of Climate Change

i. Industrial revolution and a frenzy for global economic activity

The birth of climate change and its intrinsic link with the economy started with industrialization. In the early 1800’s as coal was discovered and the first industrial revolution occurred, we started releasing carbon emissions. This demand was created from the rise in trade and economic activity. Which thus created a loop between carbon emissions and economic interactions. The fact that the “world economic activity is a cause of climate change and climate change impacts economic activity,” makes it a cyclic activity (Stern et al, 2014). Furthermore, climate change is regarded as “the biggest externality the world has ever seen” since it is an international issue that creates a shared burden (Stern Review, 2006). From an economic point of view, externalities are considered positive or
negative impacts of an activity A on another activity B, that are not accounted for by the market. This link then created a response from businesses, governments, and international actors to establish mechanisms for mitigation.

**ii. Scientific literature: discovery of man-made climate change**

The scientific literature, though without consensus, started to recognize patterns and evidence of what would be called later climate change. In the early 19th century there was a development of research that scientifically established the effect of greenhouse gases and particularly carbon emissions with the works of Fourier (1827), Tyndall (1861) and others (Held and Soden, 2000). One of the most influential studies was done by Manabe and Wetherald in 1967 which demonstrated tremendous foresight into our current predicament by recognizing a doubling of CO2 content in the atmosphere has the effect of raising the temperature by 2°C. The scientific consensus was then clearly articulated in the reports of the Intergovernmental Panel on Climate Change (IPCC), which were created in 1998 to evaluate the state of climate science as a basis for informed policy action. Thus within the scientific community it is vital to recognize that there is robust consensus that anthropogenic global climate change is occurring (Oreskes, 2004). The disaccord now lies in how best to measure it and how to tackle the issue.

**iii. The rising Keeling curve**

The Keeling curve served as the major discovery paving the way for consensus of the rise in carbon levels affected by manmade activities. By the 1950’s, Charles David Keeling began tracking the CO2 levels in the Earth’s atmosphere from two of the world’s last wildernesses - the South Pole and the summit of the Mauna Loa volcano in Hawaii (BBC, 2007). According to Professor Andrew Watkinson, director of the Tyndall Centre for Climate Change Research at the University of East Anglia (UEA), “it wasn’t until Keeling came along and started measuring CO2 that we got the evidence that CO2 was increasing from human activities.” This was the first real indication in the scientific community that captured a clear and consistent rise in carbon levels as depicted in the chart below. In 1958, when Keeling took the first measurement, carbon levels were at 315 ppmv, by 2005 they had reached 378 ppmv. Hence began the debate over climate change and the interaction of the human contribution to this in the scientific community.
**Figure 1.** A picture of Keeling with the original maps of carbon emissions.

**Figure 2.** Carbon levels rising from 1960 to 2010 based on the Keeling Curve (NOAA): Mauna Loa Observatory, Hawaii Monthly Average Atmospheric Carbon Dioxide Concentration.

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6 Ibid.
2.2. The economic community joins the debate

The economic community joins the narrative by establishing models to measure a cost and/or price of the negative externalities of carbon. As the growth in the scientific literature expanded and climate change rapidly gained international traction, policies and approaches needed to be adopted to address the growing concerns. Economists joined the narrative during the first wave of oil shocks in 1973-74 to create a relatively new field of environmental economics and studies on energy (American Institute of Physics, 2016). The work of Coase (1960) really shaped the economic turn towards the very liberal view that markets and carbon pricing was the best approach. He states “property rights is a necessary condition for actors to be able to remediate externalities (pollution) by negotiating directly between them in a decentralized manner (no intervention/very limited intervention of the State),” which is directly applicable to carbon emissions.

Future scenarios and projections were developed in 1983 in an effort to disentangle the effects of gas emissions and climate change. By 1979 the World Climate Research Programme was launched to coordinate international research. Subsequently, in 1988, the creation of the IPCC at the Toronto conference called for strict, specific limits on greenhouse gas emissions. These organizations relied heavily upon economic forecasts and degree scenarios as the standard for international guidelines. That same year, UK Prime Minister Thatcher was the first major leader to call for action on the issue. On an international scale, the Kyoto Protocol was adopted on December 11th, 1997 and entered into force on February 16th, 2005. This engaged the international community to create an agreement to set binding emission reduction targets linked to the United Nations Framework Convention on Climate Change.

Following this, the European Commission first broached the idea of a European Trading scheme, subsequently a detailed discussion of a tradable permit system began. In March 2000, the Commission issued the Green Paper on GHG Emissions Trading, setting into motion the debate about the possibility and the feasibility of such a scheme, and thus laying the foundations for the EU emissions trading system (EU-ETS) (Carbon Tax Policy Paper, 2013). This will be expounded on more later in the paper. The key takeaway for this is that policy instruments were being developed from the economic models to establish limitations on carbon emissions by governments.

i. Economic models on climate change

Economic models became popular tools of measurement and were widely adopted by the international community as a method of establishing necessary actions. In economic terms climate change is considered to be the classic open access resource problem, similar to the tragedy of the commons. Therefore a value needs to be placed in order to recognize the benefits of a good environment and the costs of negative externalities imposed through emissions. The Kuznets curve and the decomposition approach using the Kaya identity are the most standard methods to decompose environmental issues. Climate change literature is derived and borrowed from broader environmental economic literature such as that of externalities and pollution. These models were then utilized in policy reports and mechanisms to establish international norms and theory. The Kuznets curve, for example,
was featured in a report published by the World Bank in 1992 during the Rio de Janeiro Earth Summit and proposed that concentrations or per capita emissions of various pollutants, particularly carbon emissions, rise and then fall as GDP per capita increases (Stern et al, 2014). Thus economic models began proliferating policy reports and international forums.

ii. Why we came to price carbon - the social cost

In recent years, there have been attempts to find a cost for the damages that goes beyond the field of economics to incorporate social values and priorities, while still establishing a monetary price. The Social Cost of Carbon (SCC) is a heavily discussed method in the carbon literature. Traditionally, the policy debate has focused on the costs of mitigation, but there is an increasing interest in the economic costs (social costs) of climate change due to the extensive literature and data. The SCC is an estimate of monetized damages—human and physical—of carbon dioxide emissions in a year which will be further elaborated upon in Chapter II, along with other methods.

To create the SCC, climate scientists make predictions about the effects of greenhouse gases on the Earth. SCC is usually estimated as the net present value of climate change impacts over the next 100 years (or longer) of one additional tonne of carbon emitted to the atmosphere today. It is the marginal global damage costs of carbon emissions. In 1994, the U.S. Federal government created an interagency working group (IWG) to standardize SCC values for when they create their Regulatory Impact Analyses. The group consists primarily of economists, who came up with tools for predictions by creating integrated assessment models (IAMs), which try to measure and approximate the potential costs and benefits of carbon dioxide emissions. The SCC, along with other methods, are not met without criticism, as we will elaborate upon further in the paper.

iii. A Deeper Analysis of Economic Literature - the Stern Review

Economic literature recommends policy measures by governments, such as a tax, to limit global catastrophes caused by climate change from carbon emissions (Barker 2008, Dietz et al 2007, Aldy et al 2008, Tol 2009, Helm 2010). One of the most quoted pieces in economic literature is the Stern Review from 2006. In his analysis Stern states that climate change is a market failure that takes the form of a negative externality with many free riders (countries). It is highly dependent on the evolution of stocks (of CO2 accumulated so far in the atmosphere), its consequences are uncertain, and requires constant investments - particularly in research and development (R&D). Therefore, as a policy response, the government should take measures such as including environmental taxes, the allocation of 1% of global GDP per annum to mitigate the global potential catastrophes linked to climate change. In sum, Stern aims at demonstrating that the benefits of acting early, strongly and globally are far greater than the cost of inaction. In fact, the review even predicts that inaction would lead to at least 5% decrease of global GDP in the “real possibility” of a 5-6 degrees temperature increase.
The Stern Review mainly targets public policy makers as they seem to enjoy the biggest structural advantages to spur change: taxation ability, monopoly of authority. Thus from an economist’s perspective, climate change is no longer solely a matter of biology or natural science. This is why economists develop new studies to answer an anthropogenic issue with anthropogenic tools, which then become the foundations for policy instruments and political discourse. However, risk, uncertainty and extreme events are inherently absent from Stern's model as they are not included in the time series that use only recorded data of past events. This is an issue that arises consistently throughout the economic literature on climate change and carbon pricing.

2.3. Consensus on Climate Change Marred by Measuring Uncertainty in Economics

Uncertainty is a key flaw to economic models and analysis. Ultimately, while the scientific community was able to establish the foundation for the economic community to reach a consensus on the existence of climate change, there is still much debate about the models and hence about the appropriate policy instruments to tackle the issue. One of the main issues economists face is measuring uncertainty (Heal & Millner, 2013).

In fact, one of the main critiques of the IAMs is the fact that almost no study has given an estimate of the level of uncertainty linked to the damage expected (whether in the climate system or the economic system) (Van den Bergh & Botzen, 2015). This is due to the narrow empirical basis used in IAMs. Furthermore, the studies in environmental economics are generally conducted by a small number of scientists that collaborate to some extent, which makes the available literature not as independent as it should be. Additionally, excluding the most extreme scenarios in the models seems to be the worst way to get rid of uncertainty in models: it severely underestimates the SCC, leading to a nonsensically weak policy.

This issue holds true for other economic models and tools as well. A central problem with carbon tax has to do with the uncertainty about the effects of climate change and the costs of abatement (Metcalf and Weisbach, 2009). This is further exacerbated by the fact that tax policies often go through another layer of interaction with other mechanisms such as the EU ETS System: cap-and-trade program applicable to EU emissions from the energy industry and energy intensive industries, its origins mentioned earlier in the paper.

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To briefly summarize, Keeling established a rise in carbon levels that created a growing consensus in the scientific community regarding the potential threat of climate change. The economic actors joined the debate in the 1970’s through the birth of environmental science and the urgency of oil shocks in the markets. International institutions and nations entered into discussions on policy instruments to tackle the issue of climate change through organizations such as the United Nations. Economic models and theories were used as the basis for their engagement and to facilitate action on agreements. As the social cost of carbon was developed among other methodologies to price carbon, the economic community faced challenges with their models and internal debate on the best approach.
One of the biggest critiques to the current measures of pricing carbon is there is no way to measure uncertainty. This is further underlined as a key critique in principal works such as the Stern Review, which does not account several of these factors in the model presented. Hence, it is important to consider how we price carbon and who are the key actors in determining these prices. This will be further elaborated on in the next section.

3. Who Prices Carbon and How

A price implies that there is a demander and a supplier who agreed to engage in a transaction at this very price. This market relationship has regulated many exchanges of goods and services throughout human History. Today, it seems like it is also structuring our relationship to nature. The previous sections focused on the way economics and science came together to produce knowledge regarding carbon pollution. This section aims at understanding how we came to use the economic rationale of market externalities to think of carbon pollution as a behavior to be priced - and therefore demanded and supplied.

3.1. Dr. Economics, or How I Learned to Stop Worrying and Love Nature

i. Man and Nature: quantifying for the better

To understand why economics has become the predominant analytical prism for the study of climate change, we must understand how the relationship between society and Nature has evolved. Bruno Latour, in his book Politics of Nature: How to Bring the Sciences into Democracy (2004), argues that we applied a tradition of separating facts from values to our link with Nature: such a dangerous distinction has led us to “ignore Nature's socially constructed status” and normalize our materialistic tie to it.

It appears that throughout History, we have come to see Nature as a capital stock, our use of natural resources as capital flows, and our cohabitation in Nature as a rivalrous and non-excludable behavior: in other terms, we de facto labeled Nature as a “common pool resource”. This means that the act of using or consuming the resource of the common pool (catching a fish for instance) is an act of “appropriation” that withdraws it from the “resource system”, made of “resource units”. In this unregulated “open-access” resource system, each appropriator (fish consumer for example) has the incentive to make the rational “short-term cost-benefit analysis” where he perceives himself in competition with the other appropriators.

Such an economic quantification implies that we also accept the corollary assumptions that go with it: (1) Nature’s benefits are limited to the consumption/use of extractable products or services, (2) Resources might be depletable (limited capital stock) and therefore this leads to a race to get the maximum of it while each of us still can, (3) Common Pool Resource framework confines management of Nature to traditional property law doctrines, in an anthropocentric mindset, (4) and accounts for “transboundary impacts” and externalities.
ii. Climate change: the “greatest market failure”

This race for the maximization of utility linked to natural resources appropriation seems to be doomed to ruin (Hardin, 1968) if nothing is done to regulate it. This is why climate change is mainly described as a ‘Tragedy of the Commons’, both resulting from and nurturing “free rider” types of behavior.

As mentioned previously, British economist Lord Nicholas Stern explains: “Climate change is a result of the greatest market failure that the world has seen.” Indeed, actors internalize the benefit of natural appropriation while externalizing the detriment and negative effects of such an appropriation. Therefore, the way we have behaved in the market of Nature has been so far fundamentally characterized by the existence of unmanaged negative, as well as transactions in which prices do not reflect the full costs of producing a product or service. The price of energy does not reflect the climate change related costs of producing it.

Producing electricity, cutting down trees, driving cars: all these are activities that are at the roots of a balance shift between inputs of CO2 in the atmosphere, and their elimination in the biosphere as transformed chemical outputs. Everyday higher concentrations of carbon worsen global warming, and widen the range of potential effects on social, economic, and ecological life. This means one thing: with our current political framework regarding climate, as time goes by, temperature gets higher, the number, nature and intensity of consequences gets bigger. Catastrophic outcomes are no longer part of an unrealistically apocalyptic scenario.

iii. The fertile rationale for pricing carbon

Hence, emitters of greenhouse gases behave in a way that is costly for all. But this cost is not as high for them as it is for non-heavy polluters: indeed, the only way they can become accountable for the consequences of their individual actions is in the case of a policy intervention. A policy designed in order to make polluting behaviors more costly will make alternative ways of production more attractive, therefore discouraging demand for pollution. The idea of imposing a cost on greenhouse gases is also an incentive to invest in R&D to find less expensive or CO2-intensive ways of production. This is the case for pricing carbon through tailored policy measures.

In other terms: to an economic problem, an economic solution. It seems like the demand for the “right” to pollute is going up, and according to the law of the market, its price should also go up. This is where the rationale for methodically pricing carbon takes place: this price needs to be high enough to disincentivize actors from emitting Greenhouse Gases, but low enough not to hurt international and inter-sectoral competitiveness and activity.

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3.2. Macro and Micro Implications of Ecological Market Failures

i. The challenge of thinking “glocally”

Numbers might seem the most objective and neutral element; yet, they hide a tremendous work of assumptions, selection, and negotiation to get to this numerical result. The eternal question is “what is a price the reflect of?” The costs? Of opportunity, production, or both? The reflect of demand and supply? Of whom, where and when? These questions are complex to answer when it comes to the price of a car or a house, but when it comes to the price of polluting our air, a number becomes the least consensus-based and objective of all elements. Starting with the central debate: should we apply the same calculus method and therefore same price to all?

On the one hand, in the context of a “recognized failure of international negotiations” for climate cooperation, the abandon of the “universalistic paradigm of action”, and the obvious lack of international enforcement system, we observe that action at the national level (especially in developing countries) implemented by individual jurisdictions as well as bottom-up dynamics are increasingly privileged. We will see in more details how each country or firm follows the carbon pricing method it perceives to be the best fit.

On the other hand, economists (Joseph Stiglitz, 2001; William Nordhaus, 1994; The World Bank) seem to agree on the fact that “the way to put an end to carbon leakage and climate free-riding is to establish a global carbon price signal” (Stéphane Dion, 2005). The relationship between anthropogenic greenhouse gases and climate change are global and non-linear. This crucial idea means that a ton of CO2 produced today will have increasing marginal impacts no matter where pollution comes from - be it a Nike sweatshop in Indonesia or a small hammam in Istanbul. In other terms, the costs of carbon are split overall of us, and not simply borne by the emitting country.

In political terms, such a statement requires the creation of a uniform global pricing method of CO2. This challenges the basis of international cooperation in an era of fragmented global policy and perceived unfair international institutions. Imposing the same price of carbon worldwide might be the greatest collective action challenge of our time. But beyond its mere implementation, the management of its consequences on societal structures will be difficult to assess, among which include a new pattern of distribution of income.

ii. From carbon pricing to wage fluctuation

Indeed, pricing carbon may have a game-changing impact on industries and trade, and in turn on wages, employment and societal structures – both at national and global levels. Porter and Van der Linde (1995) propose the hypothesis that there should be a

8 http://carbon-price.com/experts/
9 http://carbon-price.com/experts/
10 Declaration of S. Dion, former Canadian Environment Minister during the U.N. Climate Summit in 2005
harmonization of environmental regulation between neighboring countries to avoid an unfair situation where non-regulated countries would benefit more from trade. In that sense, well-designed regulation would not be the bane of entrepreneurs but would rather enhance competitiveness and reduce the damages of unilateral unbalanced policies.

This is particularly aimed at businesses and firms, more and more encouraged to take initiatives to price carbon internally. Through a UN initiative for Business Leadership regarding climate change, firms are invited to materially shift their investment decisions to cleaner options.

3.3. Market Makers, Societal Pillars: Presentation of Climate Change Actors

Mapping out actors involved in climate change mitigation requires an understanding of market as well political transactions, at the center of which reigns the individual. Let us see specifically how.

We might state that there exists a consensus that climate change is real, and that action must be taken against it. However, the debate remains unsettled regarding the best strategy to tackle climate change, the assumptions on which to build this strategy, and the results it should generate (immediate and radical, or gradual and reformist). Several actors of different natures shape this ongoing discussion, whose outcomes are of strategic importance. We might be tempted to oppose the public and private sectors in a binary classification of their preferences and goals. But it seems like the range of stakeholders and their different stances follow a more complex pattern of distribution.

Under the traditional situation that governments seek to maximize social welfare and firms profit, individuals are at the same time distanced from and at the heart of climate change policy, as they directly and indirectly impact decision making at higher levels. Indeed, whether as consumers or as citizens, individuals enjoy a great negotiation power when collectively gather for a shared cause. Such a position shifts top-down mindsets of governments and firms, since it entitles them to an accountability tightly linked to the success and durability of their activity. The challenge is to try and find an equilibrium where all interests are equally represented by a single price of carbon, where the damages to all parties are reflected.
But as game theory helps us predict, there is no natural will to try to participate to global welfare if that implies significantly minimizing one's own welfare. In other terms, these three stakeholders (individuals, firms, and governments) might be more likely to think of greenhouse gas emissions reductions from a selfish point of view. In that sense, to engage in drastic measures that have a high, direct opportunity cost for them and their country is not mandatory, as the damage caused by pollution is globally diffused, and will be borne by the entire planet. This is where expertise comes to play a strategic role: it is in the hands of the “experts” to propose a model convincing enough for each actor to let go of their immediate rational calculation and think in broader terms.
In this chapter, we have mapped the literature used to tackle the question of pricing carbon. We have seen that policy and market decisions rely increasingly on experts from various fields (economics, engineering, and social sciences). Normative knowledge and frameworks have therefore gained decisive power in decision-making. Through Porter’s work we see the birth of CBA as the central method of evaluation. This contributed to the emergence of the use of economic analysis to back up, compare, and choose among different policies.

We have thus provided an overview of the historical discovery of climate change and the economic framework used to analyze it. With Keeling establishing the rise in carbon levels in the 1950’s, there was a growing consensus in the scientific community of human impacts on carbon emission levels. As the economic actors joined the debate there was a new field of environmental science that emerged and rapidly gained traction. Economic models and theories were adopted by the international community as a way to facilitate action and come to consensus on the impacts. Methodologies such as SCC which featured complex models including IAMs were implemented into government policies. However, the issues were not without contention since the economic community faced internal debate on the best methodologies and pricing. One of the biggest critiques at play was there is no way to measure uncertainty in these models. Thus leading us to the important question of how carbon pricing came about and who are the key actors.

To probe further at these questions we then use Bruno Latour’s work, which establishes the consistent commodification of nature in social discourse. Hence, linking the cost-benefit analysis with the economic valuation of how we interact and ultimately ‘consume’ nature. Climate change is seen from the economist’s perspective as a market failure, essentially it is the tragedy of failing to regulate a ‘common good.’ Thus creating a space and demand for regulatory methods and policy tools in the field of economics. As governments seek to maximize social welfare and firms profits, individuals are at the same time at the bottom and at the heart of climate change policy, as they directly and indirectly impact decision making at higher levels. This establishes the hierarchy of actors. Ultimately, it is through the large social forces and actors creating policy instruments that then shape the decisions of our ‘global’ carbon consumption through an economic framework.

Given this dominant economic framework, it is now important to consider how these tools are developed. More specifically, now that we have established the need to price carbon, we must consider how do we actually obtain the price. In the next chapter we will examine the ways of pricing carbon through various taxation methods and further expound on the SCC methodology.
2. Mapping Existing Pricing Regimes

As established in Chapter I, the correlation between greenhouse gas emissions (GHG) and climate change is widely accepted. Even though, the multi-stakeholder involvement in this issue has been built throughout the years since the “Earth Summit” in Rio in 1992, it was COP21 and the Paris Agreement that finally managed to bring together scientists, policy makers, private sector and social society to develop concrete actions together to reduce greenhouse gases below 2°C. There is a clear message, the world has to transition to a low-carbon economy. Nevertheless, climate change mitigation and adaptation actions require a funding of around 100 billion USD per year which is not currently available. Facing this funding challenge, public and private stakeholders seem to agree on the need to price carbon. The creation of a global carbon price plays a crucial role in the creation of effective and comparable GHG emissions reduction policies. However, pricing carbon continues to encounter the same debacle since it was first proposed: there are multiple and often competing ways for setting a carbon price, and also different means to implement it. Through this chapter, we provide a detailed insight into the dominant carbon pricing methods that exist in the world today.

As a response to the need to reduce GHG emissions, several governments started implementing market based solutions. Two of these methods are widespread: carbon tax and cap-and-trade initiatives. The core idea behind these government initiatives (1) is to monetize CO2 emissions to discourage the use of fossil fuels and (2) to make carbon-intensive goods more expensive, and (3) to encourage industries as well as consumers to transition to low-carbon production and consumption.

In the first section, we delve into the very first method used to price carbon; Carbon Tax. It was the also first market based mechanism to be implemented at the national level in 1990. It has been largely determined by policymakers through estimates given by economists and climate scientists to be imposed on polluters.

In the second section we highlight the next carbon pricing system to emerge in the global arena; the Emissions Trading Scheme or the ETS. During the Kyoto protocol negotiations, ratified in 1997, various European governments started to support market mechanisms as the most efficient and effective way to price carbon. This gave birth to a second solution, an ETS, globally known as a cap-and-trade system.

However, despite their successful implementation, carbon taxes and the ETS have been criticized for not being comprehensive enough. This includes their inability to address climate change from a multidimensional perspective. The effects on agriculture, development, jobs, or even on human health still have not been accounted for. As a response, a new tool, mentioned earlier in the paper, to estimate carbon pricing has been proposed called the Social Cost of Carbon. This approach seeks to rectify these shortfalls of the existing carbon pricing methods. We discuss the process and implementation of the SCC in the last section.
The objective of this Chapter is to present the different initiatives that have been developed to price carbon in order to illustrate the current debate in the construction of a global carbon price in this chapter. In order to give a general picture of the status quo, we illustrate the current world trends of carbon pricing (see Figure 3). So far, 46 countries have started implementing either a carbon tax, a cap-and-trade system, SCC or a combination.

Figure 4. Global Carbon Pricing Trends. Courtesy of World Bank 2015 (State of Carbon Pricing)
1. The First Attempt to Price Carbon

Carbon tax was the first method to be used by a country in order to limit carbon emissions. Since the creation of the first carbon tax in Finland in 1990, more than fifteen national carbon tax policies have been implemented. In the following section, we will explain how carbon taxes work. First, we will discuss in detail on the definition and history of carbon tax policies then explain elements of design and key aspects of implementation. We will end by examining a case study to illustrate how a successful carbon tax policy works.

1.2. How it works

i. Definition of Carbon Tax

A carbon tax is a fiscal policy implemented by governments and policymakers with the goal of reducing greenhouse gas emissions generally at the local or national scale (World Resources Institute, 2015). Today, many carbon taxes are created by taking the SCC (see discussion on SCC in section III) into account but originally the tax rate was simply based on the carbon content of fuel and a price was chosen to encourage behavioral change. In this way, a carbon tax can be understood as a form of pollution tax. The tax rate depends on the carbon content of fossil fuels involved in the production and distribution of goods and services (World Resources Institute, 2015). This means the more fossil fuels a company burns in the production and distribution of their goods, the more the higher the tax. Some programs run on an annual basis which means that certain entities have to report their GHG emissions to the government once a year and pay an annual fee. In this way, entities are encouraged to change their production and distribution methods to be more environmentally friendly and less carbon-intensive (Sumner, Bird, and Smith, 2009). Other programs tax specific fuels and collect the tax when the fuel is purchased, placing the burden on consumers to change their behaviors.

ii. Background

Recent research suggests the original idea of pollution taxes may have come from the Massachusetts Institute of Technology professor David G. Wilson (Berdik, 2014). In 1973, Wilson pioneered the idea of taxing fossil fuels but did not gain much attention from the US government nor the international community (Berdik, 2014). After much concern throughout the 1960s and 1970s, a global approach was finally arranged. In 1979, the First World Climate Conference (FWCC) was held in Geneva where climate change emerged as a major global concern (World Meteorological Organization, 2016). Since then, many individual countries have adopted methods to mitigate the effects of climate change. One such country was Finland. Finland first introduced a carbon tax in 1990 and they continue to utilize it today. Other Scandinavian countries implemented carbon taxes soon after. They also implemented various environmental taxes: energy taxes on CO2 emissions, pollution

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taxes on CO2 emissions, transport taxes, and resource taxes (National Statistical Offices, 2003). All of the environmental taxes were created to generate revenue for the state except for the CO2 tax which was created explicitly to reduce CO2 emissions and reduce global climate change (National Statistical Offices, 2003). Since the first carbon tax programs in Scandinavia, other countries as well as cities and regions have developed similar policies for climate change mitigation.

iii. Where it is implemented

Today, about 15 countries or subnational jurisdictions have carbon taxes in place and many more are considering creating such taxes. A full list is included in Figure 4 below. Carbon taxes are currently implemented at the national, state, and regional level. Below is a table illustrating the implementation of carbon tax since 1990:

<table>
<thead>
<tr>
<th>Country/Jurisdiction</th>
<th>Start Date</th>
<th>Tax Rate ($/USD unless noted otherwise)</th>
<th>Annual Revenue</th>
<th>Revenue Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finland</td>
<td>1990</td>
<td>$30/metric ton CO2 (€23)</td>
<td>$750 million (€590 million)</td>
<td>Government budget; accompanied by independent cuts in income taxes</td>
</tr>
<tr>
<td>Netherlands</td>
<td>1990</td>
<td>Less than $20/metric ton CO2 in 1996</td>
<td>$4,119 billion (€3.213 billion)</td>
<td>Reduction in other taxes; climate mitigation programs</td>
</tr>
<tr>
<td>Norway</td>
<td>1991</td>
<td>$15.90 to $61.76/metric ton CO2 (NOK 89 to NOK 345)</td>
<td>$900 million (1994 estimate)</td>
<td>Government budget</td>
</tr>
<tr>
<td>Sweden</td>
<td>1991</td>
<td>Standard rate: $104.81/metric ton CO2 (SEK)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry rate less than €14/metric ton CO2 (2013 SEK)</td>
<td>$5,645 billion (1994 estimate)</td>
<td>Government budget</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>1992</td>
<td>$16.41/metric ton CO2 (DKK18)</td>
<td>$965 million</td>
<td>Environmental subsidies and returned to industry</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>2001</td>
<td>$0.0198/Portable for electricity; $0.0027/kWh for natural gas provided by gas utility; $0.0177/kg for liquefied petroleum gas or other gaseous hydrocarbons supplied in a liquid state; and $0.0027/kg for solid fuel</td>
<td>$1,919 billion (€77.4 million)</td>
<td>Reductions in other taxes</td>
</tr>
<tr>
<td>Boulder, CO</td>
<td>2007</td>
<td>$12.93/metric ton CO2</td>
<td>$846,685</td>
<td>Climate mitigation programs</td>
</tr>
<tr>
<td>Quebec</td>
<td>2007</td>
<td>$3.20/metric ton of CO2 (C$4.50)</td>
<td>$159 million (C$202 million)</td>
<td>Climate mitigation programs</td>
</tr>
<tr>
<td>BAAQMD, California</td>
<td>2008</td>
<td>$0.0100/metric ton of CO2</td>
<td>$1.1 million (expected)</td>
<td>Climate mitigation programs</td>
</tr>
</tbody>
</table>

**Figure 5. Implementation of Carbon Taxes since 1990 (Carbon Taxes: A Review of Experience and Policy Design Considerations)**

1.2. Carbon Tax Policy Design

There are various considerations policymakers must take into account when designing an effective carbon tax. The most crucial elements to consider are the tax base, the tax rate, and the revenue distribution. While various options can be effective, each decision must coordinate with the others to be highly effective in reducing GHG emissions. Other characteristics such as social acceptance are also key elements, though they will not be addressed here.
i. Tax Base

First, governments decide the tax base of the program they are implementing. This means they must agree in which fuels and sources to impose the fee on. Governments can allow certain industries to be exempt from the tax in order to allow the economy to remain strong while some changes are made while moving to a less carbon-intensive economy. Governments must also decide if the tax will be applied upstream or downstream (Sumner, Bird, and Smith, 2009). “Upstream” means the point at which fuel is extracted or imported or where carbon carbon enters the economy. “Downstream” means the point at which carbon dioxide is emitted, usually being quite close to the consumer. In a downstream carbon tax, more entities need to be regulated and taxed while in an upstream approach, fewer entities are involved (World Resources Institute, 2015). It is important to recognize the potential effects of taxing upstream versus downstream sources when designing a carbon tax because consumers, industry, and the economy will be affected in different ways.

ii. Tax Rate

Next, governments need to determine a tax rate. Since a carbon tax does not set a specific limit of emissions, it is imperative for governments to choose a tax rate that corresponds to their policy goals. This is the reason why carbon tax rates vary from country to country and from sector to sector. The higher the tax rate, the more consumers and companies are pushed to change their behavior and dependence on carbon (Sumner, Bird, and Smith, 2009). Low tax rates may result in very little or no changes in behavior which means they are not effective mitigation methods. Some of the highest carbon tax rates are seen in Europe while some of the lowest rates occur in North America. In Northern California, the Bay Area Air Quality Management District (BAAQMD) rate is $0.045 per metric ton CO2 while Sweden’s standard tax rate is the equivalent of $105 per metric ton of CO2 (Sumner, Bird, and Smith, 2009). Clearly the tax rates vary greatly due to the objectives and use of revenues of the carbon tax policy.

iii. Revenue Distribution

The last major decision to be made when designing a carbon tax is the allocation of revenues. Again, depending on the objectives of the carbon tax, the distribution and use of revenues can widely vary. The main options include using carbon tax revenues to (World Resources Institute, 2015):

- Cut distortionary taxes
- Return money to households or electricity consumers
- Reduce national deficit and/or supplement government budgets
- Direct revenues to carbon mitigation programs
- Fund infrastructure for climate change adaptation
- Provide transitional assistance for affected sectors and/or regions
- Encourage innovation in low-carbon technologies.
While all of these are viable options, they are non-exclusive and thus may be combined and chosen as desired by policymakers when designing a carbon tax (World Resources Institute, 2015).

One of these options is using revenues to cut distortionary taxes. This is a particularly popular allocation strategy in the US since many politicians are skeptical of global climate change. By using carbon tax revenues to cut other taxes such taxes on labor, investment and capital, skeptics may support a carbon tax since taxes on “productive” activities are not popular. This is also called a “revenue-neutral tax swap” and similarly popular with consumers and citizens who are living under a carbon tax since their tax rates will not go up (World Resources Institute, 2015). Currently the United Kingdom and British Columbia use this method; they have reduced income taxes and other taxes while implementing their carbon tax (Sumner, Bird, and Smith, 2009).

Alternatively, policymakers may choose to return the carbon tax revenue to households or electricity consumers. This is also called a “fee-and-dividend” approach and allows low-income households to be treated more fairly as they would receive what they spend on the tax. This is an equitable and simple approach but does not increase incentives to work or invest (World Resources Institute, 2015).

Other carbon taxes were created to raise revenue for governments. Sweden and Norway both chose this approach because it is a simple, straightforward way to utilize revenues (Sumner, Bird, and Smith, 2009). In a similar line of reasoning, governments can use carbon tax revenues to reduce deficits (World Resources Institute, 2015). Countries that have large national debts which affect growth and investment, can choose to use revenues to reduce these deficits. While this would help the economy of a single country, it is not a particularly common use of revenues.

Some state and local governments direct their carbon tax revenues to fund carbon reduction programs. One such example is in Quebec, Canada. The region uses their revenues to support a “green fund” which invests in better public transportation, pushes for reduction of GHG emissions, and supports innovative research in the green technology and alternative energy field (Sumner, Bird, and Smith, 2009).

The last three options for use of carbon tax revenues are to use them to fund infrastructure for climate change adaptation, provide transitional assistance for affected sectors and/or regions, and encourage innovation in low-carbon technologies (World Resources Institute, 2015). These are not specifically employed uses of revenues at the moment, but they represent an option for governments to consider. The advantage of funding infrastructure for climate change adaptation is that many countries are not properly prepared for the effects of extreme weather events and are not allocating resources to preventative measures. In addition, different regions and sectors are disparately affected by a carbon tax, due to their differing dependence on carbon. For example, if the US were to apply a national carbon tax, the western states would be less affected by the tax than the eastern and southern states since the generation of fuel and dependence on carbon varies by region (World Resources Institute, 2015). The final option is to use carbon tax revenues to encourage innovation in low-carbon technologies. This is a good opportunity to fund green initiatives but is not as popular or attractive to the public as other options.
1.3. Implementation: Advantages and Critiques

i. Why countries implement Carbon Taxes

Carbon taxes are an attractive method for mitigation due to their simplicity in implementation. Unlike cap-and-trade systems, they do not require emissions allowances auctions or monitoring (World Resources Institute, 2015). This means that they can be more swiftly implemented. Another reason for countries to prefer carbon taxes over cap-and-trade systems is that they lead to a certain price pathway (World Resources Institute, 2015). Under a cap-and-trade system, the number of emissions is capped, not the price of carbon, which can lead to highly volatile prices. While carbon tax policies have certain advantages, they are far from perfect and are frequently debated.

ii. Criticisms of Carbon Taxes

Carbon taxes are not always met with enthusiasm. There are several controversies not only debated regarding their effectiveness in comparison with other mitigation methods but also within the carbon tax policy. Here we will highlight the most frequent and relevant criticisms to carbon taxes:

Benefit Uncertainty. There is no guarantee that a carbon tax will achieve a certain decrease on GHG emissions (Avi-Yonah and Uhlmann, 2009). While a cap-and-trade system has a specific cap, a carbon tax seeks to encourage changes in industries and new behaviors in consumers and thus does not provide a set limit of allowed emissions. This may make it seem like a risky endeavour for mitigation but it has been proven that in the long term a carbon tax has the same impact on emissions reductions as a cap-and-trade system. Also there is uncertainty in the accuracy of emissions reportings by those who must pay the tax which may make the tax less effective overall if many entities falsify their level of emissions (World Resources Institute, 2015).

Tax Exemptions. Carbon tax programs will not affect every industry in the same way. Thus industries with more dependence on carbon are taxed much more (Sumner, Bird, and Smith, 2009). Because of this variance between industries, governments may allow tax exemptions or reductions to the most affected industries. Some critics oppose the notion of tax exemptions because it reduces the impact of the tax overall as less adaptations are made and carbon dependence may remain.

Calculation Method. Carbon tax is often calculated using the social cost of carbon. The discussion around an optimal carbon tax usually revolves around the SCC, which reflects the estimated damages of the climate change on Earth. Also, SCC is a highly malleable concept that is driven by an analyst’s often arbitrary initial assumptions (Murphy, Michaels and Knappenberger, 2015). We will examine this further in our section on SCC.

Carbon Leakage. Carbon leakage refers to businesses moving production overseas when climate mitigation methods make production too expensive (European Commission, 2016). Carbon taxes may result in higher costs for certain sectors such as mining and manufacturing and thus they may seek to evade by moving to a country without a carbon tax. This is a major issue for all mitigation methods of GHG emissions, especially for ETS.
and carbon taxes. Governments can try to prepare for this possibility and avoid it happening by slowly phasing in mitigation programs.

**Political Resistance.** In many countries the idea of adding on another tax is highly unappealing. It is difficult to get support for the addition of another tax onto the existing tax structure, be it at the national or regional level. Thus there exists some political resistance to the implementation of carbon taxes as they lack mass appeal as well as strong opposition from certain interest groups. This will be discussed at greater length in Chapter III.

### iii. Case Study - British Columbia, Canada

Now we will use a case study to examine the effectiveness of one experience in implementing a carbon tax. British Columbia, Canada is said to have one of the most advanced and transparent carbon tax programs in the world.

The program of British Columbia scheduled tax increases over time to allow citizens and businesses time to reduce GHG emissions (BC Ministry of Finance, 2014). Initially the tax started at CAD$10 per ton and rose by CAD$5 per year until 2012 when it hit CAD$30\(^{13}\). All carbon tax revenues are returned to taxpayers through various tax cuts, making it a revenue-neutral program. Now British Columbia’s personal income tax is the lowest in all of Canada and they also have one of the lowest corporate tax rates in North America (P.F., 2014). The program works by taxing the purchase or use of fuels within British Columbia (BC Ministry of Finance, 2014). The amount added on as a tax depends on the carbon content of the fuel and since each fuel has a different carbon content, each fuel is taxed differently. Table 1 below demonstrates the different pricing of the taxed fuels in the program from 2012.

This program can be considered to be effective due to British Columbia’s 12.9% drop in GHG emissions since implementation of the carbon tax (BC Ministry of Finance, 2014). Also, there has been a decrease in fuel consumption (a 15.1% decrease, British Columbia’s GDP has remained unaffected (same as rest of Canada), and there has been no net increase in taxes since carbon taxes are returned to taxpayers (P.F., 2014).

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Units for tax</th>
<th>Tax rate July 1, 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline</td>
<td>cent/litre</td>
<td>6.67</td>
</tr>
<tr>
<td>Diesel</td>
<td>cent/litre</td>
<td>7.67</td>
</tr>
<tr>
<td>Jet Fuel</td>
<td>cent/litre</td>
<td>7.83</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>cent/cubic metre</td>
<td>5.7</td>
</tr>
<tr>
<td>Propane</td>
<td>cent/litre</td>
<td>4.62</td>
</tr>
<tr>
<td>Coal - High heat value</td>
<td>$/tonne</td>
<td>62.31</td>
</tr>
<tr>
<td>Coal - Low heat value</td>
<td>$/tonne</td>
<td>53.31</td>
</tr>
</tbody>
</table>

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While British Columbia’s carbon tax has been effective, it is not the only way to implement a successful carbon tax nor distribute revenues. They designed a carbon tax that best suited their economy and region and while it may not be perfectly replicable, it is a model program that demonstrates the efficient and effectiveness of this mitigation method.

Carbon taxes have existed in implementation since 1990 and have grown in use over time. Today about fifteen countries or regions have implemented carbon tax policies. The design of such a policy is complex and therefore each design decision must be weighed. But when designed with careful consideration from policymakers, carbon tax policies can be an effective method for climate change mitigation. Sometimes, they are met with valid criticisms which must be examined in order to improve upon the policies or challenge their efficacy. While the carbon tax was the first mitigation method that was developed, it is not the most common method of mitigation. Emissions trading systems have become the most prevalent method. We will examine them in the next section.

2. The Dominant Pricing Method: ETS

2.1. How does an ETS work, who created it and why

The emissions trading system or cap-and-trade is a market-based initiative to monetize GHG emissions created to discourage the use of fossil fuels and mitigate climate change. The main difference of cap-and-trade from carbon tax can be found in its economic model in which the price of carbon is established indirectly by setting a cap (the maximum level of emissions that can be released into the atmosphere) and letting the market set the price based on supply and demand (Goulder and Schein, 2013). The cap-and-trade approach is supposed to solve this failure and to reduce to reduce GHG emissions there were it is most cost-effective.

i. History

The idea of an emissions trading system, or cap-and-trade, became strong in the international arena through the Kyoto Protocol in 1997, with the assignment of emission reduction targets and the creation of 'flexible mechanisms'. The objective of these was to help participating countries attain their emission reduction objectives in the most economically efficient way. The Kyoto Protocol transformed the GHG emissions in commodities for exchange. The long debate among the countries - particularly the European Union, USA, Japan, Canada and Russia, in conjunction with the publication of the Green Paper on GHG Emissions Trading by the European Union - for the construction of the Protocol text marks the emergence of the market based initiatives as a core element of the international climate change policies (Convery and Redmond, 2007).
The strong support to cap and carbon market solutions is the result of a long history of environmental regulation reforms and 'environment economisation'. If we look at the different instruments used by the state in terms of environmental policies since the 1960s, we can find three main alternatives: regulation, taxes, and negotiable permits. The latest one was proposed for the first time by Nobel Prize in Economics, Ronald Coase in 1960. His thesis was that in an ideal state without transaction costs, the economic actors have the capacity to negotiate among them in order to find the way to minimize the most the global externality costs. Therefore, the solution lies in the decentralized action of the economic actors, mediated by the market (Aykut et Dahan, 2014).

Nevertheless, Coase's thesis assumes the existence of a perfect negotiation, which is not the case in climate negotiations. Setting an emissions cap requires a political decision. This is why Thomas Crocket in 1966 proposed the idea, later systematized by Harkness Dales in 1968\textsuperscript{14}, of creating a system based on cap-and-trade. During the 1970s, economists and jurists of the 'property rights school' radically critiqued the inefficiency of the state regulation known as 'command and control' and proposed the paradigm shift towards the indirect regulation by the market. These critiques started in the US and later migrated to Europe.

Aykut and Dahan (2014) state that during the 1980s, there were different national and international organizations that started defending the market based instruments. These include the US Environmental Protection Agency (EPA) with the publication of the Emissions Trading Policy Statement in 1982 and the OECD with the publication of the Economic Instruments for Environmental Protection report in 1989. The evolution of the debate illustrates the progression towards an indirect intervention of the state and the growing role of the market as mediator in environmental politics. 'Environment economisation' places the market as the solution and not the cause of climate change.

The strong leadership of the European Union during the negotiations of the Kyoto Protocol allowed the existence of the Protocol and the adoption of the 'flexible mechanisms' by many countries even though the US did not ratify the Protocol. The EU has played a crucial role in pushing forward innovative solutions to climate change by creating one of the biggest carbon market in the world, the European Union Emissions Trading System in 2005. With this initiative, the EU became the leader in the implementation of market instruments for environmental policies and has encouraged several countries around the world to follow the same path.

\textbf{ii. ETS economic model and design}

The emissions trading system is a system that mixes quantity objectives or 'command and control' instruments with price or economic instruments. It consists of setting a cap - a maximum GHG emissions limit that can be liberated into the atmosphere - for all the polluting activities undertaken by the industries that participate in the system. A certificate equivalent to each ton of GHG emission is issued and the general idea is that each company or firm receives a limited right to pollute.

Economically speaking, cap-and-trade is about permits or licenses to control the externalities caused by the anthropogenic activities that pollute the environment. This means that each externality has to hold a permit. Permits are issued up to an optimal amount equivalent to a ‘cap’ which is set by a central authority - usually a government body - that holds GHG stocks databases. The central authority issuing the permits becomes the ‘regulator’ that sets the aggregate emissions possible in the system and assigns each system participant - mostly firms - with an emissions right to discharge specific quantities of a specific pollutant per time period (European Commission, 2016).

As the involved firms are required to hold the number of permits equal to the pollution they produce, they are left with three options once they enter a cap-and-trade system (Traeger, 2009):

1) to reduce their emissions to equal the amount of permits they were given,

2) to reduce their emissions to an amount even lower to the permits they were given and sell the permits overload in the market,

3) to reduce their emissions but not enough to equal the permits they were given, so they have to buy permits from the market.

Cap-and-trade falls in the economic logic of the law of supply and demand. The higher demand for a good, the lower its supply and the more scarce this good becomes. In this sense, creating a cap generates scarcity of the possibility to pollute. The price of emitting an additional ton of CO2 will be equal to the demand and supply of ‘polluting permits’. From a polluter’s perspective, there is a point at which emitting one more unit of CO2 is no longer as profitable as it used to be: this point is where he maximizes his profit. At this point, the price of the permit is equal to the marginal abatement cost - in other terms: the cost of reducing additional emissions. Since companies have different marginal abatement costs, a company with high abatement costs might prefer to have permits to cover its emissions rather than paying the high marginal abatement costs. Therefore it will prefer to trade ‘polluting permits’ with a company with low marginal abatement costs.

As trading permits brings together the demand of companies with high abatement costs and the supply of companies with a lower abatement cost, this market system ultimately ensures the equalization of marginal abatement costs among firms. Therefore emissions reduction will occur where they are most cost-effective, thanks to the law of supply and demand. Too many allowances compared to demand will result in a low carbon price, and reduced emission marginal abatement costs. Too few allowances will result in too high a carbon price and high marginal abatement costs (European Commission, 2016).

Figure 6 illustrates cap-and-trade between two firms with different marginal abatement costs. The intersection between the low and high marginal abatement costs is the profit maximization and the space below (C, G, K) is the total cost of achieving the efficient emissions level (e*). The cap set by the central agency is the vertical line in the middle. Trading between the two firms will occur in the areas D and F, and the price will be set based on the economic efficiency.
2.2. First Design - EU ETS

i. Design and Positive Outcomes

The European Union Emissions Trading System (EU ETS) has been presented as the ‘flagship’ of European climate change policy. It was created in 2005 as the main instrument with which the European Union was going to attain its Kyoto Protocol commitments. It is currently the largest cap-and-trade system in the world covering more than 11,500 entities, representing 45 percent of the total GHG emissions from all the EU Member States, Iceland, Norway, and Liechtenstein (ICAP, 2015). The overall goal of this system is to maintain a carbon market that would incentivize the investment in low-carbon and green technologies (Sewalk, 2014).

When EU ETS was first created, the European Commission knew that it was a learning process. This is the reason why it structured its implementation into phases:

**Phase I** - From 2005 to 2007. The cap was set in a decentralized manner based on the National Allocation Plan of each Member State of the system, but it had to be approved by the European Commission. Almost all countries used ‘grandfathering’ or free allocation of allowances. Only a few used allowances allocation or benchmarking. The sectors and thresholds covered were the power sector (>20 MW annual thermal capacity per installation) and industries such as oil refineries coke ovens, iron and steel plants and production of cement, glass, lime, bricks, ceramics, pulp, paper and board (ICAP, 2015).

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15 The National Allocation Plan is equivalent to its UNFCCC defined carbon emissions reduction target. The European Commission oversees if the NAP fulfills the Emissions Trading Directive (EU Directive 2003/87/EC). The first and foremost criterion is that the proposed total quantity is in line with a Member State’s Kyoto target (European Commission EU ETS Handbook)
Phase II - From 2008 to 2012. The cap was set the same way as it was set in Phase I. Free allocation of allowances, only around 3 percent of the allowances were auctioned in eight Member States. Commercial aviation was added to the sectors and thresholds covered (ICAP, 2015).

Phase III - From 2013 to 2020. A centralized EU-wide cap for stationary sources was adopted: 2,040 MtCO2e in 2013, reduced by 1.74% annually. Aviation sector cap: 210 MtCO2e / year for 2013–2020 (not decreasing). Carbon Capture and Storage (CCS) installations were added as well as production involving N2O. 40 percent of total allowances were auctioned, with different allocation rules for the electricity sector, manufacturing and aviation16 (ICAP, 2015).

Phase IV - From 2021 to 2028. The European Commissions is proposing a 2.2 percent annual reduction of EU-wide stationary cap. Process of allowances auction of Phase III will continue (ICAP, 2015).

The EU ETS now covers all the emissions of carbon dioxide, nitrous oxide and perfluorocarbons done by the power sector and energy-intensive industries. The aviation sector has been included since 2012. The idea at the beginning was that the EU ETS will include all domestic and international flights from and to the EU, however the European Commission suspended the requirements for flights operating from and to non-EU countries in April 2013. The flights operating within the European Economic Area continue to be included in the system and the European Commission is working with the International Civil Aviation Organization (ICAO) to develop a global market mechanism to address international aviation emissions by 2020 (Egenhofer, 2014; ICAP, 2015)

In 2006, fifteen European Member States had adopted the EU ETS, 12,000 entities were participating in the system and more than 260 million tons of CO2 were traded. The price allowances reach the ‘peak carbon price’ equal to €30 per ton of CO2.

ii. Critiques and Limitations

The EU ETS has rapidly become as the preferred market based solution for climate change. However, its implementation has proven to have several limitations. Due to the lessons learned of the EU ETS, the cap-and-trade system encounters the following critiques:

The allowance over-allocation creates price volatility - After the 2006 ‘peak carbon price’, the system experienced a significant allowance surplus when several EU countries stated that their actual emissions were less than the number of total allowances that had been allocated in the system. The problem was that the Member States had inflated their NAPs projections and this led to an over-allocation of almost 5 percent of the total annual allowances (Egenhofer, 2014). Allowance over-allocation meant that there was no scarcity

16 Electricity sector: 100% auctioning with optional derogation for the electricity sector in new Member States. Member States with a GDP per capita below 60% of the EU average may also continue giving free allowances to the energy sector up to 2030. Manufacturing sector: Free allocation is based on benchmarks. Sub-sectors deemed not at risk of carbon leakage will have free allocation phased out gradually from 80% of the benchmarks in 2013 to 30% by 2020. Sub-sectors deemed at risk of carbon leakage will receive free allocations at 100% of the pre-determined benchmarks (ICAP, 2015:29)
and caused a price fluctuation and an eventual price collapse of 54 percent. By 2007, the price per permit was almost zero and firms had no incentive to reduce GHG emissions. This situation was worsened by the global economic crisis of 2008 (Sewalk, 2014). Over-allocation has mainly been pointed out as the result of the free allocation process followed by the EU ETS during Phase I and II (Egenhofer, 2014).

**ETS is inefficient in reducing GHG emissions** - The literature on this subject is scarce from the 2005-2008 period and missing after 2009 (Branger et al., 2015). The available results obtained show that the emissions reductions as a result of the EU ETS are only between 2 to 4 percent of the total amount of covered emissions (Ellerman et al., 2010). Nevertheless, the debate around this topic is that EU ETS casualty in GHG reductions is difficult to attribute to one action because other policies and determinants may have affected firms’ decisions. Previous studies do not allow for the accurate quantification of the abatement cost-CO2 price relationship (Egenhofer et al., 2011).

**Free allocation of allowances generates windfall profits** - During phase I, all sectors and industries participating in the EU ETS benefited from ETS related rents. Today, free allocations of allowances generated ‘windfall profits’ estimated as much as €13 billion annually (Egenhofer, 2015). Reason why the EU ETS has been criticized for passing the pollution externalities cost to the consumers as they experience a rise on energy prices while the power industry benefited with windfall profits (Sewalk, 2014). As a response to this, the European Commission decided to benchmark free allocations\(^\text{17}\) and auction 40 percent of the allowances during Phase III and it is analyzing the possibility of auctioning all the allowances of the power sector (Egenhofer et al., 2011).

**The implementation of an ETS or cap-and-trade requires a complex and lengthy process** - A cap-and-trade system involves an extensive data collection for the establishment of ‘caps’. It also requires monitoring, reporting and verification (MRV) systems to manage the allowances which can make the process become really complex (Sewalk, 2014). In the case of the EU ETS, each Member State has to develop its own rules for cap allocation and monitoring which represent a high level of complexity, administrative burdens, transaction costs, and transparency issues. Furthermore, the industry’s lobby has managed to influence the role of the central authority and manipulate the quantity of allowances available (Egenhofer, 2015).

**It creates “carbon leakage”** - One of the biggest critiques of implementing environmental regulations is that these will only apply to domestic producers and not imports. This could potentially lead to carbon leakage - emissions-dependent industries will relocate to countries with no environmental restrictions. Economists and environmentalists state that in order to avoid carbon leakage in cap-and-trade systems, a border tax adjustment - taxing the imports from countries without climate change regulations - has to be adopted (Sewalk, 2014).

**It has failed to incentivize investment in low-carbon/green technologies** - According to Egenhofer et al (2011) it is difficult to project that cap-and-trade mechanisms will drive green

\(^{17}\) Firms receive free allowances only up to a benchmark that is calculated on the basis of the ‘10% most efficient’ installations (Egenhofer et al., 2011).
technologies on their own. The decision to whether or not invest low-carbon technologies depends on a global political signal as is the case of the Paris Agreement of 2015.

*It gives the wrong message, ‘the right to pollute’.* This is more of a philosophical critique to the cap-and-trade as some analysts believe that allowances represent the right to pollute of the industry instead of following the ‘polluters pay’ principle of the carbon tax, which can encourage polluters to continue emitting (Sewalk, 2014).

### 2.3. ETS Improvement Based on Lessons Learned

#### i. Solving cap-and-trade price volatility - Market Stability Reserve vs. price collars

Many carbon pricing specialists believe that the above mentioned failures of the EU ETS prevent it from becoming the most effective alternative to price carbon and to reduce GHG emissions. Above all, price volatility in EU ETS has been the major critique against the effectiveness of the system. It is true that cap-and-trade could allow an ‘environmental benefit certainty’ as the cap and total number of allowances is set based on GHG emissions reduction targets committed in the Kyoto Protocol and now the Paris Agreement to stay below the 2°C increase (Sewalk, 2014). Nevertheless, price volatility does not create a confident investment panorama for the development of new and innovative green and low-carbon technologies. In fact, it is believed that the spillovers generated by EU ETS have prevented the investment in green or low-emissions technologies (Branger et al. 2015, Egenhofer et al., 2011, ICAP, 2015).

The above arguments have made many analysts start preferring carbon tax schemes as they allow price certainty and stability. Nevertheless, a recent report from the World Resources Institute Report (2015), a non-governmental global research organization, states that the price volatility issue of cap-and-trade can be solved in the design of the system by implementing a cost-containment mechanism. Branger et al. (2014) and Egenhofer et al (2011) also support the argument stating that the only way to ‘rescue’ cap-and-trade is to introduce price floors and ceilings, also known as ‘price collars’, during the auctioning and trading of the allowances as a price ceiling limits how fast allowance prices can rise, and a price floor limits how low they can fall (WRI, 2015).

However, the implementation of a ‘price collar’ has not been supported by the European Commission so far, because it raises complicated institutional and ideological issues. According to Egenhofer et al. (2011) a price floor or ceiling would require an independent central bank to be implemented. Current alternatives include the auctioning of allowances at a minimum price; for example at $30 per ton of CO2, which would give a clear and confidence signal to investors that the price per ton of CO2 will be fixed around that price in the future. This requires less institutional coordination, but its efficiency still must be tested. Larsson and Lonnroth (2010) proposed to stabilize the allowance price along a predetermined trajectory, though this approach has been criticized for making the system become a type of carbon tax as it allows price predictability (Egenhofer et al., 2011).

In the meantime, the European Commission continues to place an ETS as the instrument to achieve 40 percent of the GHG emissions reduction target. To improve the previous implemented phases, it has opted to create a Market Stability Reserve to be introduced in 2021, for Phase IV. MSR is a rule-based mechanism that will allow the management of the
number of allowances in the market in order to control price volatility – it will withdraw allowances when there is surplus and release when there is scarcity (ICAP, 2015). Nevertheless, analysts think MSR is insufficient to solve the problem. Moreover, there is currently no indication that a majority of Member States would favor this reform and there is actually a current debate between the European Commission and Germany as the later proposes to implement the process in 2017 (Branger et al. 2015, ICAP, 2015).

It important to mention that whatever alternative proposed, there is a consensus in the fact that cap-and-trade needs a cost-containment mechanism in order to solve price volatility. Likewise, analysts agree that cap-and-trade systems are not able to correct market failures on their own as they are unable to address all sources of GHG emissions. This is the reason why governments have to acknowledge the importance of implementing complementary environmental policies such as energy efficiency labels and standards, offset programs, investment and incentives for R&D of low-carbon technologies.

ii. Cap-and-trade around the world and the future projects

As of 2016, there are 17 emissions trading systems (ETS) in operation around the world and 15 in potential operation, among them the China National Emissions Trading System announced in September 2015. The most dynamic region in the world with regards to ETS is Asia with 8 ETS launched in 3 years. All these cap-and-trade systems work on the same economic basis, but its design from system to system which have adopted improvements based on the lessons learned by the EU ETS.

New cap-and-trade systems implemented by other countries or cities have had the opportunity to improve and test modifications to the original design. Such is the case of the California and Quebec cap-and-trade system which decided to include a price floor equal to $10 USD per ton in 2012 with a 5 percent increase per year plus inflation adjustment. Three of the Chinese ETS pilots are testing the results of setting aside an allowances reserve to manage price fluctuation (Branger et al., 2015). The Regional Greenhouse Gas Initiative is the first mandatory cap-and-trade system in the US, conformed by nine states. The RGGI first compliance period was in 2009 and it was the first in the world to auction allowances and reinvest the auction proceeds in energy efficiency and renewable energy (ICAP, 2015).

Furthermore, New Zealand has declared that the implementation of a cap-and-trade system has enabled the country to meet its Kyoto Protocol emission reduction targets, and place them in a good track to attain the Paris Agreement Commitments. New Zealand’s cap-and-trade, implemented in 2008, covers all sectors of the economy, but has a strong role in the forestry sector. The national cap-and-trade system launched by South Korea in January 2015 also includes cost-containment measures such as a allowances reserves that can additionally allocate allowances, up to 25 per cent; and a retention of allowances limit of minimum 70 per cent and maximum 150 percent per compliance year and the temporary set-up of a price collar (ICAP, 2015).
Cap-and-trade systems supporters such as the International Carbon Partnership have the goal to create a global cap-and-trade system that links all the different cap-and-trades in the world. The first experience of linking two cap-and-trade systems is the California-Quebec with fully fungible carbon units. These two systems shared some commonalities, but were different in several parts of their design. The factors that enable the linkage were that both systems belong to the Western Climate Initiative and that they created a special negotiation group that work for almost two years in the establishment of the common grounds. They decided which things were going to be identical such as the auction and trade of allowances; provisions that had to give the same outcome, but did not need to be identical such as monitoring, reporting and verification processes, and provisions that could be different such as offset voluntary programs before the linkage. Both systems are formally linked in January 2014 and there continues to be an ongoing process of coordination and exchange.

Many analysts project the expansion of cap-and-trade systems such as the conversion into a national scheme in Japan after the good experience with the Tokyo cap-and-trade and the creation of the China’s national system after the seven pilot programs currently in operation. The European Commission has declared its interest to create the global carbon market and the first steps toward that would be to link with other compatible cap-and-trade systems that would not undermine its environmental integrity, such as the Swiss ETS, the OECD countries and later emerging economies (European Commission, 2009). Nevertheless, there are still many doubts in how the conversion into national schemes will be done as there are many technical, political, and harmonization difficulties.

Perdan and Azapagic (2011) state that there several cap-and-trade design features may generate barriers to linking, such as differences of ambition embodied in the caps, treatment of offsets, price management policies, rules on banking and borrowing, different allocation methodologies, etc. That emissions trading specialists estimate that a global carbon market would take around 40 years to be built and that in other to do so there needs to be clear government regulatory and policy signals that incentivize the ‘ecologization of the economy.’
Even though the cap-and-trade seems to be the prefered instrument by governments around the world to tackle climate change - 17 existing ETS and the potential of 15 more - the debate around the best way to price carbon in order to reduce GHG emissions continues. The failures of EU ETS such as price volatility and debatable capacity to reduce GHG emissions, have incentivized the creation of new carbon pricing instruments that take into account social and environmental externalities such as the Social Cost of Carbon.

3. **Social Cost of Carbon, the “real” cost of carbon emissions**

In this section, we explore the SCC, or the “real” cost of carbon. By using integrated assessment models, experts attempt to estimate the cost of damages that emitting one more ton of carbon in the atmosphere now will have in the future. This includes damages arising from climate change such as decreased agricultural yield, property damage due to sea level rise and human health costs among others. The first subsection explains why estimating the SCC is important and examines the components that current models use to estimate it. The second subsection presents implementation cases and the criticism that SCC receives. First, we see how policymakers adopt SCC values and employ the SCC to inform policy decisions. Second, we look at the issues that exist with the calculation of the SCC which make the current estimates arbitrary and arguably unusable.

3.1. **Why and how is the Social Cost of Carbon calculated?**

i. **Why a Social Cost of Carbon**

In 2013, we emitted 34.5 billion billion tonnes of carbon dioxide into the atmosphere tons as a result of human activities and our yearly emissions of carbon have been steadily increasing over the past decades (Olivier et al., 2013). These CO2 emissions have a social cost because they contribute to climate change. The effects of global climate change are diverse and potentially very large and could cause damages to society through sea level rise, droughts, floods, storms, ecosystem change, impact on biodiversity, etc... According to the promoters of SCC, it is therefore important to know the cost society will bear for each ton of CO2 emitted. SCC reflects the need for a normative value of carbon. A normative value is a value fixed at the discretion of an authority based on the range of values computed by different stakeholders.

Knowing this “social cost” makes it possible to compare the costs of emission reductions known as mitigation with the benefits of avoided damages due to these emissions reductions. In order to make this cost-benefit-analysis, economists set out to estimate the SCC, which is defined as the “net present value of climate change impacts over the next 100 years (or longer) of one additional tonne of carbon emitted to the atmosphere today. It is the marginal global damage costs of carbon emissions” (Watkiss et al., 2005). According to the U.S. Environmental Protection Agency, the SCC is “an estimate of the economic damages associated with a small increase in carbon dioxide (CO2) emissions,
conventionally one metric ton, in a given year. This dollar figure also represents the value of damages avoided for a small emission reduction (i.e. the benefit of a CO2 reduction).”

In its simplest terms, the SCC is a figure that tries to place a value on the damage done or damage avoided by emitting a discrete amount of carbon dioxide.

As mentioned in Chapter 1, the SCC is estimated through IAMs. Through IAMs, economists attempt to model the interaction between CO2 emissions and damage to society to obtain a monetized value for the social cost of releasing an extra ton of CO2 in the air on a given year. SCC is a useful tool for governments to be able to create effective environmental laws and to understand the potential damages of greenhouse gases. SCC can be thought of as the benefits of taking action to reduce future climate change damages (Greenstone et al, 2013).

According to the report “A Third Wave in the Economics of Climate Change,” IAMs are now used in the influential reports produced by the IPCC and by several governments in the economic assessment of climate change policies around the world (Farmer et al, 2015). IAMs have come under increasing criticism because they aggregate all physical and social effects of climate change into monetary value and have been ascribed as close to useless by some. By the 1990s the number of IAMs exploded, and by 2009 models proliferated to such an extent that there was a need to adopt common standards. In an attempt for standardization only certain models were included, hence reducing the spectrum of analysis and the robustness of other models as will be further discussed.

**ii. Inputs**

To calculate the SCC, economists integrate a global climate model with a global economic model creating Integrated Assessment Models, or IAMs. To do this, economists base IAMs on a series of emissions scenarios. For each scenario, resulting temperature changes are derived; this is the climate model. The models then use a damage function, which informs what economic impacts the temperature changes. The three most-cited IAMs today are William Nordhaus’ DICE model from Yale University, the PAGE model by Chris Hope of Cambridge University and the FUND model by Richard Tol of Sussex University.18 Although some differences exist between the models, all IAMs use six essential elements, whether determined endogenously (by the model) or exogenously, to derive the SCC. The six elements are listed below (Pindyck, 2013).

1. Projections of future emissions of a CO2 equivalent under business as usual and one or several abatement scenarios. This may be determined by the projected GDP growth and the carbon intensity of the economy.
2. Projections of future atmospheric CO2 equivalent concentrations resulting from past, present and future CO2 equivalent emissions.
3. Projection of average global or regional temperature changes and in some cases measures such as rainfall variability, hurricane frequency, and sea level increase that is likely to happen from higher CO2 equivalent emissions.

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18 Costofcarbon.org, 2014
4. Projection of the economic impact, usually in the form of lost GDP and consumption, resulting from higher temperatures. This includes direct economic impacts and any other adverse effects of climate change, such as social, political and medical impacts, all monetized and integrated to the loss of GDP.

5. Estimates of the cost of abating GHG emissions by various amounts, both now and throughout the future. This in turn requires projections of technological change that might reduce future abatement costs.

6. Assumptions about social utility and the rate of time preference, so we can value future economic and social cost in the present.

To understand how IAMs work in practice, Bonen et al (2014) provide the following visualisation of the models used to monetize the damages from man made climate change.

![Visualisation of Economic Damages as the Social Cost of Carbon in IAMs as seen in Bonen et al (2014).](image)

Today, IAMs have their own journal, *The Integrated Assessment Journal* and policy makers rely on these models to adopt one or several SCC values to use in cost benefit analysis for policy appraisal. Even though they take the same six elements into account to calculate SCC, results vary widely, which is cause for concern as the policies that will emerge from using one value over another will be drastically different. Next, we shall see how the SCC is implemented and why its implementation can be criticized.
3.2. Implementation and Criticism

This subsection explores how governments on both sides of the Atlantic have used the SCC. We will see that the United States have adopted a relatively low SCC while the United Kingdom has adopted a higher SCC. So policy makers can decide what models and parameter values to use to estimate the SCC and arrive to conclusions that suit their agenda. As we have seen, the Social Cost of Carbon exists to manifest in the present a cost that will occur in the future, when most of us may have long passed. Therefore, governments will need long term vision and strong leadership to embark society on the venture of reducing carbon emissions significantly through the use of high SCC values. For now, it seems the values used by governments are low enough to create little change.

i. Which countries implement it and why? - Different countries have different estimates

The two main countries that have adopted a Social Cost of Carbon in policy appraisal are the United States and the United Kingdom.

In the United States, federal agencies are required by law to assess the costs and benefits of a proposed regulation and to regulate “only upon a reasoned determination that the benefits of the intended regulation justify its costs.” In 2010 and 2013, President Obama gathered an Interagency Working Group (IWG) on the Social Cost of Carbon to harmonize the SCC used in policy making. The IWG used the DICE, FUND, and PAGE models to obtain four values of the SCC using different discount rates. The United States estimates the social cost of carbon pollution emitted in 2015 to be $57, $37 and $11 using the discount rates of 2.5 percent, 3 percent, and 5 percent, respectively of which the central value is $37. The IWG also retained a fourth estimate of $109 as an attempt to capture damages linked with extreme climatic outcomes. It is one thing to adopt an SCC estimate but does this endeavour have any effect in the policy making of the country?

Hahn and Ritz (2014) evaluate the inclusion of SCC in American regulatory decisions and find that putting a value on carbon emission “does not generally affect the ranking of the preferred policy with the status quo”. As we can see in the table below, including the benefits of reducing carbon emissions does not always lead to increased benefits, as happens for Standards of Performance and Emission Guidelines for Waste Incinerators, passed in 2011 by the EPA. In fact, by comparing cost-benefit analyses with and without inclusion of SCC, Hahn and Ritz find that for most analyses the cost of carbon represents only between 10 and 20 percent of total net benefits and that the inclusion of the SCC in the cost-benefit analysis may only affect the ranking of policy options in about 1 of 8 cases.

TABLE 2. RULES PUBLISHED BY U.S. AGENCIES THAT INCLUDE THE SCC.

Our second example is the United Kingdom's adoption of a Social Cost of Carbon of £70 per ton for internal use, meaning decisions to create policies that reduce carbon emissions will be subject to a cost benefit analysis where £70 is the monetary benefit or reducing one ton of carbon emissions (Pearce, 2003). The United Kingdom has now moved away from SCC use for policy but while it was used, the SCC was applied by several government departments in a range of policy decisions as the following table shows.

<table>
<thead>
<tr>
<th>Agency / Year</th>
<th>Rule ID Number</th>
<th>Subject</th>
<th>Net Benefits including CO₂ (Billions 2011$)</th>
<th>Net Benefits not including CO₂ (Billions 2011$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOE / 2013</td>
<td>1904-AC04</td>
<td>ECS for Distribution Transformers</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>EPA / 2013</td>
<td>2066-AR13</td>
<td>NEISHAP for Boilers and Process Heaters</td>
<td>47</td>
<td>47</td>
</tr>
<tr>
<td>EPA / 2012</td>
<td>2066-AQ54</td>
<td>GHG Emissions Standards for Light-Duty Vehicles</td>
<td>460</td>
<td>410</td>
</tr>
<tr>
<td>DOT / 2012</td>
<td>2127-AK79</td>
<td>CAFE Standards for Light-Duty Vehicles</td>
<td>490</td>
<td>440</td>
</tr>
<tr>
<td>EPA / 2012</td>
<td>2066-AN72</td>
<td>Standards of Performance for Petroleum Refineries</td>
<td>0.55</td>
<td>0.50</td>
</tr>
<tr>
<td>DOE / 2012</td>
<td>1904-AH90</td>
<td>ECS for Residential Clothes Washers</td>
<td>35</td>
<td>32</td>
</tr>
<tr>
<td>DOE / 2012</td>
<td>1904-AC64</td>
<td>ECS for Residential Dishwashers</td>
<td>0.56</td>
<td>0.47</td>
</tr>
<tr>
<td>EPA / 2012</td>
<td>2066-AP52;</td>
<td>NEISHAP for Steam Generating Units</td>
<td>57</td>
<td>57</td>
</tr>
<tr>
<td>DOE / 2011</td>
<td>1904-AB50</td>
<td>ECS for Fluorescent Lamp Ballasts</td>
<td>19</td>
<td>18</td>
</tr>
<tr>
<td>DOE / 2011</td>
<td>1904-AB79</td>
<td>ECS for Residential Refrigeration Products</td>
<td>43</td>
<td>34</td>
</tr>
<tr>
<td>EPA, DOT /</td>
<td>2066-AP11;</td>
<td>GHG and Fuel Efficiency Standards for Medium- and Heavy-Duty Vehicles</td>
<td>51</td>
<td>45</td>
</tr>
<tr>
<td>2011</td>
<td>3127-AK74</td>
<td>Intercity Transport of Particulate Matter and Ozone</td>
<td>210</td>
<td>210</td>
</tr>
<tr>
<td>DOE / 2011</td>
<td>1904-A906</td>
<td>Standards for Standby/Off Mode for Residential Furnaces, A/C, and Heat Pumps</td>
<td>1.5</td>
<td>1.2</td>
</tr>
<tr>
<td>DOE / 2011</td>
<td>1904-AC99</td>
<td>ECS for Residential Clothes Dryers</td>
<td>3.7</td>
<td>3.2</td>
</tr>
<tr>
<td>DOE / 2011</td>
<td>1904-A909</td>
<td>ECS for Residential A/C</td>
<td>1.9</td>
<td>1.5</td>
</tr>
<tr>
<td>EPA / 2011</td>
<td>2066-AO12</td>
<td>Standards of Performance and Emission Guidelines for Waste Incinerators</td>
<td>0.32</td>
<td>0.32</td>
</tr>
<tr>
<td>EPA / 2011</td>
<td>2066-AO25</td>
<td>NEISHAP for Major Sources</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>EPA / 2011</td>
<td>2066-AM44</td>
<td>NEISHAP for Area Sources*</td>
<td>-0.13</td>
<td>-0.13</td>
</tr>
</tbody>
</table>

TABLE 3. EXAMPLE OF THE USE OF SCC IN THE UK (WATKISS, 2005)
The social cost of carbon has been used by governments to carry out cost benefit analyses in which they measure the monetary benefit of regulation that reduce carbon emissions against the cost of the regulation. It can also be implemented as a tax to rectify the market failure in which polluters do not pay for the damages of their pollution. Finally, it can be used by companies as an internal carbon “shadow price” which enable them to make investment choices that pollute less and therefore anticipate regulation and improve their image.

ii. Critiques and Limitations

One of the first IAMs that attempted at calculating the Social Cost of Carbon was the DICE model, developed by William Nordhaus over 20 years ago. He found an SCC of $20 or less, and a very low optimal abatement of GHG emissions. On the other hand, Stern concludes from his model that the SCC is higher than $200 and recommends immediate and radical emission reductions consistent with his value of SCC. According to critic, the exact parameter values inserted into the models depend solely on what the modeler sees as reasonable, explaining that this gives enormous freedom to the modeler who can decide of the resulting SCC by manipulating the parameter values. Based on the work by Pindyck (2013), we will show that modelers chose their discount rate, climate sensitivity and the nature of their damage function. This entails making assumptions that they are not qualified to make.

First, the SCC varies according to the rate of time preference, a parameter that has no correct value because its determination is based on our ethical perspective of the importance of the wellbeing of future generations. The lower the rate of time preference, the higher the SCC will become as future damages will be discounted in the present. Some modelers use the rate of time preferences that emerges from consumer and investor behavior which ranges from 2 to 5 percent but nothing points that its use is valid in this context. Others use a rate closer to zero, estimating it unethical to discount the damages done to the livelihoods of future generations. Commenters point out that what is today being “buried in models as inscrutable parameters” are in fact a “social and ethical judgments” and should be a matter for democratic discussion20.

Second, climate sensitivity also affects the value of the SCC. Climate sensitivity is defined as the temperature increase that would eventually result from an anthropomorphic doubling of CO2 equivalent emissions. The greater climate sensitivity, the greater the SCC as it means that one ton of CO2 equivalent will have a greater climatic impact. Unfortunately, climate sensitivity depends on important feedback loops that we cannot predict today and modelers are constrained to use parameter values that even the International Panel on Climate Change are unsure of. Modelers are not in a position to use climate sensitivity in their models legitimately, climate sensitivity is “unknowable” (Allen and Frame, 2007).

Third, the damage function used in the model determines the final value of SCC. We know virtually nothing about the damage that temperature increases will cause to GDP. Some models calculate damage according to the sectors of the economy and some do it regionally. Some studies evaluate the effect of small temperature changes over short periods of time but we have no scientific studies that we can use to predict what would happen to the economy after decades of temperature increases. Therefore, the equations used to determine the damage to society are made up by modelers and are not supported by any theories. Once again, modelers are not in a position to legitimately evaluate damage to the economy resulting from climate change. Yet the integrated assessment models are used by policy makers to inform decisions.

Finally, the SCC value is future dependent because one ton of CO2 equivalent emitted now has less impact if we assume strong emission reductions in the coming decades than if we assume business as usual. If we assume that there will be strong emission cuts, the SCC will be lower and its application to policy will incidentally lead to weaker action on climate mitigation. But the size of emission cuts depends on decision makers with varying degrees of impact, ranging from investors to consumers and is largely influenced by the strategy of companies and governments, something that is difficult if not impossible to predict.

The SCC, then, is largely model dependent as many aspects of the models are arbitrarily chosen and determined by the modeler. But the advantage of trying to calculate the SCC is that most economists today have understood that there is a Social Cost of Carbon, meaning that when we emit CO2, society pays a price. There is virtual consensus among economists that this social cost must be internalized in the prices paid by consumers and firms. Therefore, converging around the Social Cost of Carbon is positive because it will help the public and politicians understand that there is a cost to emitting carbon, and that even though we do not know its exact value, it is important to take it into account and get used to the idea that we need to start paying for it now to avoid future damages.

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While ETS and carbon tax install a price for emitting CO2 paid by the emitters, the SCC is a concept in order to determine the damage done to the society as a whole by carbon emission without seeking to explicitly put a price on actual emissions. As shown in the examples of the U.S. and UK governments, the SCC chosen by policy makers is used to include the benefits derived from the reduction of CO2 emissions in cost benefit analysis for policies that affect CO2 emissions. SCC is also used by various policymakers in order to calculate the carbon tax itself so that the result is all encompassing and attempts to also integrate the costs to society at large in the production costs.

While the two former approaches aim at largely reducing emissions through carbon pricing, nowhere do they take into account the cost imposed on society as a result of these emissions. Thus, in that sense, SCC seems to be a more holistic approach although it has been subject to various criticisms itself. According to Pindyck (2013) the SCC is actually incalculable with the current state of climate science. The catastrophic possibilities of climate change are unknowable and there is no method to derive the damages that these catastrophes would entail. Therefore, some academics along with civilian activists argue that the SCC used by governments in too low and does not reflect the real risks of climate change. They argue that we need a higher SCC to have policies that curb CO2 emissions more rapidly. Therefore the debate surrounding SCC is concerning its real value, some believe it should be high while others believe it should be low. All agree that CO2
emissions have a social cost and we should take into account today to correct market failure.


It has been over twenty years since the Kyoto Protocol and even longer since the first carbon tax initiatives were developed. Nonetheless, whether the price of carbon is imposed as a tax on polluters, determined by the market economy by a cap-and-trade system or calculated on its social costs remains a controversial issue. No single method seems to gather enough consensus from all the public and private stakeholders to position itself as the best choice to price carbon. In addition, there are several countries, such as Mexico and China, that are considering a GHG emissions reduction system based on a combination of these approaches.

Carbon pricing implementation is complex and it involves a spectrum of possibilities. Countries are choosing the most suitable choice to price carbon based on their national social, economic, and institutional contexts. The current panorama makes ‘one-size-fits-all’ model seem unrealistic. Nonetheless, SCC represents the alternative that takes into account the social, economic, and environmental aspects behind GHG emissions and represents an innovative tool to create more accurate estimations of carbon price to be used in the form of carbon taxes or other climate change policies.

The urgency to find a solution to the lack of funding for climate change adaptation and mitigation actions, as well as the potential economic impacts of climate change, has inspired alternative stakeholders to join the carbon pricing debate.
3. Towards a New Consensus?

Up until now, we have described how we have come to price carbon and the different methods that have been proposed by different experts and stakeholders. Our purpose for this last chapter will be to depict the dynamics behind these processes. We will try to analyze the interactions between stakeholders in the carbon pricing controversy and see how this debate has evolved for mitigation purposes, through international negotiations, the inclusion of new actors and mechanisms, and the shift towards the need to act together.

During the COP21, pricing carbon became central to the debate and to the proposals for action. We can see this through the example of the Carbon Pricing Leadership (CPL) Coalition, which sought to gather all the stakeholders. Initiated by the World Bank director general Jim Yong Kim and the IMF governor, Christine Lagarde, the CPL Coalition is composed of governments, businesses and civil society organizations in charge of studying and proposing successful carbon pricing policies.

This last chapter will allow us to study in depth the political economy of carbon pricing, digging into each stakeholder interests and their evolution in order to understand the global picture of carbon pricing today. We will then focus on new initiatives that have emerged in response to the political difficulties to harmonize carbon pricing policies. Finally, we will explain recent evolutions of the controversy and how there has been a shift in the debate with these new stakeholders and initiatives entering the game, and willing to reach a consensus.

The main goal of our last section will be to provide a framework to understand and analyse the new developments of our controversy.

1. The political economy of carbon pricing

We have seen that, today, governments use different methods to try to put a price on carbon in order to mitigate climate change. However, these tools are not easy to implement. In the following section we will study the political economy of carbon pricing with a focus on the players at the international level in order to analyze the current global situation. We will try to explain why some methods have become more popular than others from the political point of view. We will first dig into the political challenges of pricing carbon; then focus on a geopolitical analysis of the methods utilized and end with a discussion on new players and developments on carbon pricing at the international level.
1.1. Expectations vs Reality: Political challenges of carbon pricing

i. Stakeholder analysis: who wants what in carbon pricing?

In order to understand the political economy of carbon pricing and the future development of climate change mitigation policies, there is a need to analyze the actors around the table and their agendas. For most countries the political economy of policy reform is central in determining the extent to which a society overcomes the challenge of reducing emissions while taking full advantage of its associated opportunities. Part of the challenge lies in choosing appropriate policies. But perhaps the greater part lies in implementing them, and this requires a willing acceptance by all the principal actors – government, businesses, employees, consumers, and the public at large. For climate change policy this is at least as complex and difficult as in other areas of structural policy reform.

If we dig into the main stakeholders and their agendas, following Jenkins (2014) analysis, we can first identify individuals that can be considered both as citizens and consumers. Citizens' seek to achieve general interest by maximizing public welfare, and thus, they tend to push for action against climate change without focusing on the method. Individuals as consumers prefer lesser prices which imply that they usually give less support to a policy impacting directly their daily costs (heating, electricity, transport etc.) The second group of actors are NGOs and other para-public actors such as UN agencies. They have a specific role in representing "civil society" welfare. In that sense, they support mitigation policies and methods that have real impact on reducing emissions. Finally, we have companies, which are increasingly concerned about the effects of climate change but don’t want their profits to be affected by aggressive mitigation policies. From the 1990’s, the IMF’s neoliberal ideology became dominant assessing that power was defined by the capacity to win the economic and business wars: cheaper exports, disappearance of trade barriers, etc. Businesses became the major stakeholder as source of economic prosperity, employment and international political power. This situation has been for a long time an obstacle to a high price on carbon as businesses were opposed to it. We will see later that this balance is changing with companies starting to become conscious that it is in fact, in every agent’s interest to mitigate climate change.

On the other side of the stakeholders spectrum, we have policy makers that need to both respond to other stakeholders claims and allocate their resources efficiently. In the context of financial crisis and budgetary constraints, governments need to efficiently allocate their resources. Therefore, they cannot afford to highly subsidize carbon so the optimal policy would be to make private polluters pay. However, politically speaking making national private actors pay for carbon hasn’t been an easy thing to deal with. In the context of fierce international competition and economic crisis businesses have become central stakeholders in economic policy making. This can vary from country to country but evidence from the US and Europe provides a “real-world” example of this phenomenon.
ii. The political difficulties to implement carbon pricing policies

Even if today there is a consensus on putting a price on carbon, it is not an easy policy to implement because of the varying interests of each stakeholder, as we have stated before. It is actually extremely difficult to achieve from a political perspective, if compared to subsidies or regulations. Even if the cost of non-pricing measures often exceeds the costs of putting a price on carbon (OECD, 2011), they are easily agreed upon since regulations and subsidies are less visible to the wider public. This implies that the steps towards arriving at a carbon price are delicate, different and are under constant threat of being blocked by powerful stakeholders. The implementation of carbon pricing policies can be difficult for two main reasons:

First, there are rising concerns over the distribution of costs and benefits of pricing instruments among countries, individuals and even generations. Who will pay if businesses are taxed for their emissions? Won’t it have an effect on prices? Poor households having an important part of their revenue used for heating or energy intensive practices will be the losers in this kind of policy. Wealthier households that can afford the increase in prices or that consume “sustainable” products won’t see their welfare decrease. This is a classic controversy in the public debate: Who should pay? Developed countries that based their economic development on highly polluting industries during the second half of the XXth century? Developing countries that have become the largest emitters today? Energy intensive businesses? Citizens using one of the most emitting sources such as private transport? Moreover, given the distant and diffuse nature of benefits, identifying and mobilising the winners in favor of carbon pricing is far more difficult. As mentioned before, the free-riding problem arises in that context. Some polluters won’t be forced to pay for their emissions. In that sense, collective action would be difficult to achieve. As Olson (1965) explains in The Logic of Collective Action, if some actors can profit from others’ actions without any effort, payers will be incentivized to leave the action or politically push for withdrawal of the regulation.

Second, there are also concerns about leakage and competitiveness of energy intensive companies. If carbon is priced in one country and not in another, leakage effects can be considerable. However according to an OECD report (2011): “if the EU were to cut emissions unilaterally by 50% by 2050 (relative to 2005), just under 12% of this abatement would be ‘wasted’ through leakage.” In fact, this is more a political than an economic problem. Concerning competitiveness, rising costs relating to higher carbon prices can be an obstacle for one country’s firms international positioning. Fears of being disadvantaged are stronger in the most polluting, internationally tradeable and energy-intensive sectors. With many of these sectors likely to be politically powerful, and highly motivated in their efforts to maintain the status quo, policymakers will need to pay particular attention to them.

However, ever since climate change began to appear as a central concern in international public debate and negotiations, carbon pricing has been highlighted as the central way to effectively mitigate climate change. Governments have started implementing emission targets (even if not binding), together with other policies and regulations. We will now study the political balance between different pricing methods and how and for what they are used today.
1.2. Carbon pricing until interests do us part

As we have seen, the political economy of carbon pricing makes it tricky to implement an adequate policy responding to each stakeholder’s interests. We now try to explain how this political battle can be illustrated through international experiences with pricing carbon. We will analyze the success and failures in practice of each of the methods studied in Chapter II of the paper. The objective is thus to project future developments on the international use of each of them.

i. SCC: do we really care about future generations?

One of the important objectives of the Social cost of carbon is to take into account future generations’ well-being in terms of consumption through the choice of a discount rate. Indeed, the importance we give to future generations is defined by the discount rate taken into account for the calculations. The logic says that, the more we care about future generations well-being, the more we should pay today to reduce emissions. That’s why SCC rates can go from $5 to 141$, it depends on moral, cultural and political considerations and the importance we give to future well-being.

What we can see today is that, even if SCC is used sometimes, implying that social and environmental impacts are taken into account when defining pricing rates, it is often set at a very low rate. That might be because key actors’ agendas are short term rather than long-term, which explains the difficulty to use high levels of SCC when implementing mitigation policies. Governments want to get elected; businesses want to make profit and distribute dividends to their shareholders and consumers want to consume as cheap as possible. In fact, as Jesse Jenkins (2014) underlines, while estimates of the full social cost of carbon range from $15 to $150 per ton of CO2 in 2012 dollars, households in the United States may be willing to pay as little as $2 to $8 per ton to combat climate change”, according to a range of public values and willingness-to-pay research.

Social, political and cultural factors would thus need to be considered when explaining why a high social cost of carbon is not frequently used when implementing carbon pricing policies. However, many experts and governments are thinking of designing a progressive carbon price as it may be easier to implement politically in the short term. Increasing the rate would be subject to less opposition once different actors are used to it and have integrated it in their economic and political decisions. Nevertheless, this can only be made through a carbon tax and not through a cap and trade system, where prices are determined by supply and demand. It is thus interesting to see the carbon pricing policies that are commonly used around the world and try to analyze the future for a carbon tax using progressive SCC rates.

ii. Cap-and-trade and carbon taxes: the tug of war in the international arena

Because of political difficulties, carbon taxes haven’t been hugely successful. Either cap and trade systems are preferred or carbon taxes are set at a very low rate.
As we have seen before, energy intensive businesses have more to lose with a carbon tax than they do with a cap and trade system for various reasons. One is that cap-and-trade is more flexible, and so some companies can even make profits on allowances if they emit less than expected. Another reason is that carbon price with cap-and-trade depends on other variables, such as commodity prices. Another reason is of political culture. Actually, European countries, which have a political tradition of taxing and of an interventionary State in the economy, were in favor of a carbon tax before Kyoto. However, in order to ratify the protocol, the support of the United States was needed and a carbon tax was unimaginable for US politicians and businesses. American political culture willing to keep the State away of the market mechanisms reinforced this opposition. That’s why even if the US didn’t ratify the protocol at the end, the option of a cap-and-trade system was kept also in European countries. Another example is that during the 2008 U.S. presidential election, both candidates supported a cap-and-trade system over a carbon tax since adding a new tax to the political agenda was political suicide (Avi-Yonah and Uhlmann, 2009). There is also resistance to a carbon tax from certain interest groups when they can profit from a cap-and-trade system by cheaply adapting their company and auctioning off excess allowances (Avi-Yonah and Uhlmann, 2009). Other criticize that carbon taxes are another way for governments to get revenue and make little headway in environmental terms (Sumner, Bird and Smith, 2009). One way to combat this notion is to use the revenues from the program to support environmental measures or mitigation programs (Sumner, Bird and Smith, 2009). Another example of this opposition to carbon taxes is the 2014 decision of Australian senate to repeal the carbon tax implemented by the government in 2012. This repeal is just the latest and most glaring example of the extremely up-hill political battle facing any effort to put a hefty price on carbon.

Indeed, cap-and-trade systems are the most commonly used mechanism by countries implementing carbon-pricing policies. Taking into account the difficulties to implement carbon pricing policies, cap-and-trade systems might be the best way for governments to start introducing a price on carbon, as it is also the preferred instrument by strategic businesses. In fact, according to the European Commission’s Stakeholder consultation analysis on Emission Trading System (ETS), 98% of industry stakeholders support measures meant to protect EU industry and strongly believe (88%) free allocation to be an adequate instrument in this sense.

However, cap-and-trade systems are not the perfect solution and face many problems as The Economist states in its article “ETS, RIP?” 21. Cap-and-trade systems have faced a host of problems like price shocks in the European ETS in 2007 due to excessive supply. More recently in the US, the cap-and-trade system has a contentious topic after the successful implementation then quick reversal of US Acid Rain Program (Kennedy, Obeiter, and Kaufman, 2015). We can also wonder, for instance, what will be the consequences of the drop in oil prices? Could a price shock due to falling oil prices drive cap-and-trade prices down and let an open pace to the development of a carbon tax? Also, carbon taxes have rising support from citizens. Citizens are becoming especially concerned about the consequences of climate change that are beginning to be felt at the individual level. Big mobilizations before, during and after the Paris agreements around the world might show that individuals are giving the priority to their citizen interest (public welfare) than to their interests as consumers (lower prices). We can wonder to what extent citizens, as voters,

21 The Economist, April 2013, “ETS, RIP?”
could thus change the balance between the two instruments, in countries where the regime allows it.

The balance in carbon pricing methods is delicate. On the one hand, even if SCC methodology might be used, rates are often very low because of the possibility to use high discount rates. On the other hand, the use of ETS and carbon taxes are inherently depend on political context. If today ETS is widely used, it is because it is seen as more flexible for companies (which have long been the definitive stakeholders). Carbon tax may become the new rule, as it is more supported by politically engaged citizens. Further it may also be necessary discourse if the drop in oil prices keep the ETS prices too low. Indeed, the balance of power is changing...

1.3. New players and new rules in the carbon pricing game

New players are entering the carbon pricing game, disrupting the traditional equilibrium of industrial powers. On the one hand, emerging economies which are getting industrialized and which are demographically relevant, have become essential actors for climate change mitigations. Nothing can be done without China or India playing the game. On the other hand, the multiplication of international conferences (COP: conferences of parties), with multiple agreements but little action taken, highly contribute to the general confusion on the future of carbon pricing.

i. Emerging economies entering the ring: the example of China

In 2009, the Chinese government pledged to reduce its CO2 emissions per unit of GDP by 40 to 45 percent compared to the level of 2005. In its 12th Five-Year Plan (2011-2015), the Chinese government announced its will to gradually set up a national carbon market. The introduction of an ETS is seen as a key contribution for achieving China’s climate goals. Indeed, mitigating climate change has become a must for the survival of the political system, because air pollution is causing both frustration and health problems to Chinese population.

As mentioned in Chapter II, in September 2014, China announced the plan to launch a national ETS in 2016, which will be based on the experience of the seven pilots ETS currently in operation. Nevertheless, there are worries that the true impact of China's increasing number of coal-fired power stations is being masked by the cooling effects of these plants' sulphur emissions. As a major player in world trade and the world's largest emitter of GHGs, China's introduction of an ETS sends an important policy message about the need to mitigate climate change, the need to establish a carbon price and support for carbon markets as an effective tool to do so. Critiques to carbon markets include, as mentioned previously, concerns about competitiveness, free-riding and carbon-leakage. A national ETS in China has the potential to reduce these concerns as it would help level the international climate policy playing field. China’s decision to implement ETS pushes this instrument to the forefront of policy options and other actors, competing with Chinese industries, will probably bring cap and trade systems to the forefront particularly vis-à-vis other pricing methods.
ii. Are we getting lost in the game? From Copenhagen to Paris

Some climate change activists, like John Sauven, executive director of Greenpeace UK\(^\text{22}\), describe the international agreements on climate change as a lot of discussion, dialogue and debate but with few outcomes.

During the 2009 Copenhagen international conference on climate change, developed countries and the biggest developing countries agreed – for the first time – to limit their greenhouse gas emissions. This was landmark, as it meant the world’s biggest emitters were united towards a single goal. Although the emissions reductions agreed on were still not enough to meet scientific advice, the conference was a major development in reducing emissions compared with “business as usual”.

However, a well articulated and legally binding agreement was still not signed. The Copenhagen agreement was not fully adopted by the UN in 2009 because of last-minute chaos at the conference. For this reason, it was seen as a failure by environmentalist groups. US blamed China for this failure. In a press conference, President Obama condemned the insistence of some countries to look back to previous environmental agreements as a basis to not move forward in the future. He said developing countries should be "getting out of that mindset, and moving towards the position where everybody recognises that we all need to move together"\(^{23}\).

Nevertheless, the Paris conference of 2015 concluded with the engagement of governments, civil society and businesses towards the transition to low-carbon economy. World leaders embraced carbon pricing through the emergence of the Carbon Pricing Leadership Coalition. The Coalition includes governments, intergovernmental agencies, businesses and nonprofits, who all agree the world needs to be pricing carbon fairly, effectively and efficiently, as soon as possible. Actually, companies around the world have highlighted their need for a framework to price carbon internationally by connecting cross-border permit trading schemes. However, if there is not a clear and predictable carbon price nor a binding agreement this might be difficult to implement in practice.

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Up to now, we have seen the difficulties in building a political consensus on carbon pricing policies in the presence of a number of important stakeholders with opposing interests. Carbon pricing is not an easy measure as it leads to an increase in costs, especially in an era where cost efficiency and price competitiveness are key. Even, when the implementation of such policy leads to a consensus, the way it is done can be very problematic and make us wonder what the real objectives behind pricing carbon are. Is mitigation the main goal? In the international arena, the balance of power is shifting. Even if the fight against climate change has been acknowledged by international actors for (mainly strategic) reasons, the ways to lead this fight are not homogeneous, given that the interests of each actor are not clear either. The difficulties in establishing a comprehensive price or method has created a

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23 Remarks by the President of the United States during press availability in Copenhagen (December 18, 2009, Copenhagen, Denmark) Link: https://www.whitehouse.gov/the-press-office/remarks-president-during-press-availability-copenhagen
leadership void that has led different actors to define and establish their own carbon prices. We will now try to understand the emergence of these parallel mechanisms.

2. The emergence of parallel pricing mechanisms

The economic pressures seem to be taking over the political inability of the global community to provide a rapid and effective solution. The regulatory void created by this lack of consensus has driven individuals and organizations to adopt mechanisms that suit their needs. Interestingly, stakeholders who are at the core of the carbon pricing issue do not implement the expected traditional carbon tax or ETS, but rather use varying models of carbon valuation. While these mechanisms may be less precisely defined and unified, they are perhaps more readily tangible and usable by the organizations who need them. Why such alternative mechanisms arose, how they function and whether they are a viable path to follow to achieve the goals set by the various stakeholders are the issues we set out to unravel in this section.

2.1. From a leadership void to personalized solutions: what's driving pricing?

Attributing a monetary value to carbon emissions internally and disclosing it publicly is a growing trend for both private and public entities, at the level of the individual or the organization (any kind of collective structure). Between 2014 and 2015, the number of companies openly stating their use of a pricing mechanism through the CDP (formerly Carbon Disclosure Project) has tripled, with 435 companies now disclosing carbon pricing and 583 anticipating to do so in the coming years (CDP Report 2015). Disclosing refers to the voluntary self-reporting of climate-change related data, strategies, and objectives of organizations in order for it to be accessible to the public. The CDP is a London-based international non-for-profit organization that was founded in 2000. It provides a platform through which companies can disclose their natural capital use which are then published yearly in publicly available reports. It thereby aims to bring together major stakeholders (companies, investors, governments) in order to better and more transparently manage global environmental risks.

The use of carbon pricing can mainly be thought of as a strategic tool. Incorporating a price on their actual or avoided carbon emissions is a way for organizations to anticipate an eventual carbon tax or another form of regulation soon to be imposed externally, at the national or regional, or international level. By preparing for and being ready to adapt to a foreseeable regulation, organizations aim at minimizing their potential losses. This price on carbon emissions is thus becoming key in organizations’ investment decisions: by incentivizing investments in clean energy and energy efficient projects, companies acknowledge that acting now may save them expenses in the long run as they anticipate the risks of extreme climate events on productivity and growth.
Pricing and disclosing also involve corporate social and environmental responsibility objectives, and may polish an organization’s image in the eyes of investors and clients. Showing its commitment to emissions reduction targets, and its responsible risks assessment, the organization can thus targets customers sensitive to this topic and investors more keen to engage with an environmentally risk-conscious entity. As such, carbon pricing is also driven by the need to face the accountability to both upstream (investors) and downstream (consumers) stakeholders.

Another key aspect of carbon pricing mechanisms, which is perhaps less of a driver than it is a claimed target, is the aim to mitigate GHG emissions and to create behavioral changes within and around the organization, in order to positively impact climate change. Behavioral change is sought to resort to more virtuous economic activities at the individual level, and to invest in such activities at the decision-making level.

Therefore, even in the absence of imposed regulations, internal carbon valuation is thus increasingly being used by all sorts of organizations in a voluntary and customized manner, either driven by market strategic incentives or by a commitment to mitigating climate change.

2.2. Tailor-made pricing methods

i. Trading carbon emissions at the consumer level

A first way to translate carbon emissions into monetary value at the consumer level is what can be called a “carbon savings system”. This mechanism seeks to reward individual behaviors and actions that favor low carbon emission. The organization implementing such a system can make the rewards tangible through an accumulation of points, discounts, vouchers, etc. for consumers who follow “greener” behaviors. These behaviors can be for example reducing car use, using ecologically responsible product in agriculture, or investing in energy-efficient housing infrastructure. In these savings mechanisms, tons of CO2 avoided are monetized to positively incentivize consumers to change their behaviors. The rewards can also be earmarked to orient investments towards socially and environmentally responsible goods and services.

An example of such a savings system is the French Société 450’s incentive project. The Bretagne-based project rewards companies and households that reduce their emissions, with “kg of Kyoto CO2 credits” proportional to their reduction achievements. This “climate money” can then be converted into a monetary value and used to buy environmentally responsible goods and services from partner organizations (such as electric bikes, train tickets, etc.). The price used by Société 450 is almost 10 times higher than the one fixed by the EU carbon market. 450 uses the price fixed by GIEC economic experts: €52.64/tCO2 in 2014, with a 4% yearly increase to reach €100/tCO2 in 2030.24

Another consumer-level initiative example is the CitéGreen platform. This application launched in 2012 in France also used “green nudges” to encourage citizens to use cleaner transportation methods. CitéGreen would calculate the distances walked or biked by its

24 Novethic, 2016, “Compte Epargne CO2 pour lutter contre le réchauffement climatique”
users and convert them into discount points to be used in its partner companies in the culture and sports sectors. It closed in 2015 because of its inability to become economically sustainable despite its sponsors' financing, thus questioning the viability of similar tools.

Carbon savings systems are used in a variety of sectors such as agriculture, housing, transports, waste or forestry.

We can therefore note that bottom-up mechanisms can come from and be geared toward citizens-consumers themselves, eager to play a role in the societal shift towards increased emissions mitigation.

However, the major drivers of parallel pricing mechanisms are the larger scale organizations, public or private, that use a variety of methods which can be gathered under the umbrella term “internal carbon pricing”. These mechanisms enable organizations to track actual or avoided carbon emissions within their structure, and give them a value in order to account for them in their budgets and decisions.

ii. From shadow pricing to internal tax: pricing from within

There is a broad diversity of personalized and voluntary internal carbon pricing mechanisms. Those are not always as transparently disclosed or as meticulously calculated as the methods we have evoked in Chapter II. The lack of imposed regulations also enables organizations to avoid accountability in terms of the rationale behind the final value per ton of emitted CO2 chosen, thus distancing themselves from the debates questioning the legitimacy of the experts behind carbon prices. Internal pricing is used across the board by public and private entities, in sectors ranging from airlines, technology, and telecommunication services to financials, healthcare or consumer staples companies, on all five continents (CDP Report 2015).

Although producing a strict and exhaustive classification of internal pricing methods is quite complicated, the two main trends that can be mapped in internal pricing mechanisms are the use of a shadow price (fictive amount not actually disbursed) and the use of an internal contribution with real financial flows.

**Shadow pricing** consists of adding a budget line for carbon emissions and taking these sums into account for investment decisions, while not actually pairing them with tangible monetary flows. This anticipatory mechanism, formerly used by the UK government (Paul Watkiss Associates, 2005), and now widely used by companies across many sectors (CDP, 2015), leads to a better acknowledgement of the expected value of projects that reduce GHG emissions and the future costs of investments that increase GHG emissions. Shell, for example, takes into account a cost of US$40 per anticipated ton of CO2 emitted in order to decide on the comparative attractiveness of its projects. While the extra cost will influence the investment decision, it will not be disbursed by the company at any time.26

In the words of Adele Morris, senior fellow and policy director for the Climate and Energy Economics Project (CEEP):27

> “Shadow pricing is a method of investment or decision analysis that adds a hypothetical surcharge to market prices for goods or services that involve significant carbon emissions in their supply chain. For example, if a firm is analyzing acquisitions of new energy-using equipment, it would use expected energy costs of expected market prices plus a charge associated with the carbon dioxide that would be released when the fuel is combusted.” (“Why the federal government should shadow price carbon”, Adele Morris, Brookings 2015)

**Internal contributions**, on the other hand, enable the organization to collect money through an internal taxation system. Their scope can either encompass only certain internal activities (such as airline travels or particular departments within the structure), or

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27 The CEEP was developed by the Economic Studies program at Brookings and aims to develop and promote solutions to anthropogenic impact on climate by focusing on robust and efficient economic and environmental sources and tools. About the Climate and Energy Economics Project. (n.d.). Retrieved April 24, 2016, from http://www.brookings.edu/about/projects/climate-energy-economics/about
can be collected for all GHG emitting activities, according to actual emissions or estimated amounts of avoided emissions. The money collected is usually centralized in an investment fund that can be managed internally by the organization, or externally by a tier structure. These funds, called compensation funds, enable the organizations to offset their emissions by investing in activities, within their structure or outside, that could “compensate” for the CO2 produced. These can be energetic efficiency initiatives, activities supporting local ecosystems, carbon offset projects, or could take the form of carbon credits sold to companies in the carbon market. The organization can decide to invest enough to offset all of its emissions, or only part of them, depending on its total annual emissions and the reduction objectives it is trying to reach (e.g. carbon neutrality, or only a given percentage reduction).

An example of such internal contribution paired with a compensation fund is the one used by Société Générale.

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Case Study

Société Générale

An example of an internal tax combined with mitigation fund based on incentives for internal redistribution.

A carbon tax is collected internally from each department, according to its carbon emissions. The money thus collected is then redistributed internally to departments proposing initiatives allaying economic and environmental efficiency. The aim is therefore to incentivize departments to reduce their carbon emissions as well as to stimulate clean initiatives internally, for which subsidies can be received. As an example, in 2014, 35 projects were selected and shared the €3.2 million collected internally. The 2014 carbon price was set at 15€/tCO2.


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Box 1. Case Study – Société Générale
The actual prices used for shadow pricing or internal contributions are extremely varied, and are chosen by the organization. For example, Exxon Mobile’s shadow price is based on the political-economical current context and thus fluctuates accordingly. Other organizations base their prices on an existing baseline value. The South African Harmony Gold Mining Co., for example, relies on the estimated upcoming national tax rate, while Portuguese Galp Energia SGPS uses the EU-ETS value, and American Covanta Energy Corporation bases its price on the US Government’s SCC (CDP 2015). The price can also be calculated according to the organization’s carbon reduction commitment and offset goals, such as done by Microsoft. According to the CDP 2015 disclosure report (CDP 2015), corporate carbon prices for that year ranged from US$0.95 to US$357 per metric ton of CO2 emitted (prices used by the South African industrial Group Five and the Japanese company NGK Spark Plug respectively).

**Figure 10. Examples of disclosed company carbon prices in CDP 2014 Report**

**World Bank Report 2015**

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**Case Study**

**Brazilian ETS for the private sector**

_An alternative internal pricing mechanism_

“One Brazilian business group that CLG [Prince of Wales’s Corporate Leaders Group’s] has been partnering with is taking a novel approach. Empresas Pelo Clima (EPC) implemented an ETS Simulation using live corporate data to engage Brazilian companies in discussions around what a robust cap and trade market might entail and how it could be designed and implemented. The ETS Simulation is delivered in partnership between the Rio de Janeiro Green Stock Exchange (BVRio – Bolsa Verde do Rio de Janeiro) and EPC through the Center for Sustainability Studies of the Business Management School at the Getulio Vargas Foundation (FGV-EASP).

Twenty companies, including local and regional companies, along with global corporates voluntarily participated in the first round of the cap and trade ETS Simulation. The Simulation included aspects of two carbon market systems, including auctioning and bonds markets and assessment of company emission submissions, as well as fines for non-compliance. […]

The project is providing the space to unlock and facilitate conversations between companies and the government around how a carbon market in Brazil could potentially work. It is helping to build capacity within the companies so they can begin to embed carbon reduction activities into their core business strategy. It is also creating momentum within the country in terms of carbon pricing, hopefully speeding the whole process up.”

Nicolette Bartlett - World Bank Blog - 2014

*Source: Bartlett, “Testing Carbon Pricing in Brazil.”*
Parallel pricing mechanisms are therefore a means for citizens and organizations to quantify the value of carbon emissions in order to include it, formally or implicitly, into cost-benefit analyses for daily activities such as biking to work or more large-scale decision-making such as investment choices.

2.3. Losing the target? Limitations of the "do-it-yourself" carbon pricing mechanisms

While this succinct classification of parallel mechanisms enables a clearer understanding of the ways organizations price carbon, the diversity of internal pricing mechanisms shows that the sources of carbon price and their use within organizations defy most categorizations. Even the variability in terminology used, ranging from “internal carbon price”, to “shadow price”, “carbon cost”, “carbon adder” or “internal carbon fee”, underlines the lack of formal and transparent classifications. How, then, can we know if the overall target of mitigation is being reached, and to what extent these parallel mechanisms are viable?

Whether it targets the consumer or the inner structure of organizations, a main objective put forth by pricing actors is the prospective mitigation achievable through carbon valuation. But when the price per ton of emission is not regulated, the reduction objectives not imposed, and the very pricing process and its disclosure totally voluntary, it seems reasonable to doubt about the actual impacts on climate change achieved. Shadow pricing can be particularly limiting in terms of impact on climate change, since the price remains theoretical and the monetary disbursement is therefore not a threat to the organization. Yet, actually disbursing the internal price to a compensation fund is also a matter of contention: lack of monitoring and evaluation of the internal taxes allegedly paid to such funds to compensated emissions opens the door to imbalances between claims and facts. There thus remains uncertainties as to the extent to which compensation is achieved. In both internal taxes and shadow pricing, the price of carbon is not necessarily taken into account for all of the organization’s decisions, which can further limit its mitigating potential.

Moreover, as we have seen, internal prices are usually influenced by the political-economic context and the probability of a carbon tax implementation rather than being an objective monetization of the impacts of emissions. The social cost of carbon is therefore not likely to be reflected in such voluntary pricing mechanisms. This leads to prices usually too low to have a real impact on investment decisions (CDP, 2015). For example, if a company simply divides the amount it is ready to invest in carbon offsetting by its targeted reduction levels, this may lead to a very low carbon value, which is not necessarily based on any kind of tangible calculations of the impacts of these emissions. Yet this would still be registered as “duly achieved” reduction objectives for the company’s Environmental Responsibility. Should this be considered effective mitigation? One can wonder for example about the effectiveness of Microsoft’s carbon fee invested in a carbon neutral fund, when its price - around $4/ tCO2 in 2014 (CDP, 2015) - is obtained by
dividing offset costs by total carbon emissions. The impacts of internal pricing are therefore likely to be centered around disclosure and CSR polishing rather than actual environmental efficiency. As an example, Société Générale’s model achieved a 0.7% reduction in emissions between 2013 and 2014 (Société Générale, 2014).

Furthermore, when the social impact of climate change is (at least partially) taken into account in the pricing, in some consumer-level initiatives for example, the resulting prices are usually very high. Recall Société 450’s price of €52.64/tCO2 increasing at a 4% annual rate. This can have dire effects on the efficacy of the mechanisms, especially in the absence of a broader regulatory framework imposed uniformly by governments. The failure of the CitéGreen platform three years after its creation illustrates this risk regarding the viability of voluntary pricing.

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While the actual impacts of parallel pricing mechanisms on climate change mitigation remain unproven, and their viability seems unsure, an objective that seems more readily verifiable and positively impacted by internal pricing is the behavioral changes it can induce. Bringing the issue of valuing carbon emissions on the table, in a structure’s decision process or in consumers’ individual choices, does seem to lead to a responsibilization of workers at all levels, and to a conversation about alternative, cleaner activities and methods. The appropriation of pricing mechanisms by new actors therefore seems to play a part in creating a climate change culture which is gaining momentum as we speak.

3. Towards an international carbon price? The emergence of public/private collaboration

3.1. Shifting the carbon pricing framework towards enhanced collaboration

As shown in previous arguments, carbon pricing is no longer the exclusive prerogative of States or supranational organizations such as the EU. Civil society is now participating in the conception of carbon pricing methods and instruments. The traditional definition of civil society frames it as a social sphere distinct from both the market and the State (Bernauer, 2013). On one hand, it is composed of civil society organizations (CSOs) that are voluntarily formed by people and conform a wide range or networks, associations, movements and groups that can act through collective actions. On another hand, CSOs’ interactions are also part of civil society. Companies can also be included within the civil society framework.

29 Novethic, 2016, “Compte Epargne CO2 pour lutter contre le réchauffement climatique”
The involvement of civil society contributes to designing a new framework for discussion and action, in which all stakeholders have a say and States are confronted to new requests.

i. Companies: adding steam to the carbon pricing machine

Innovative mechanisms for carbon pricing such as carbon savings, shadow pricing and internal carbon tax were created and supported mainly by companies. This fact underlines that while they form one of the bloc of actors that would be most affected by a carbon price, companies are now advocating for carbon pricing. This is due to two key facts. One is that impacts of climate change on businesses are now clearly identified, both as a threat and an opportunity. The other is that carbon pricing debates create uncertainty, while by nature, companies prefer institutional and regulatory stability.

The issue of climate change adaptation and greenhouse gas mitigation has an increasing impact on many aspects on companies’ strategies. Framing the carbon pricing debate is therefore quite difficult, as tendencies are quite contradictory. On one hand, many companies benefit from climate change business opportunities, thanks to innovation and opening of new markets, for example through new technologies. On the other hand, companies now have to design long-term strategies in a very uncertain context regarding carbon pricing regulation. The following diagram illustrates how climate change affects companies. It also underlines how carbon pricing regulation is now part of the risks faced by businesses.
To deepen the analysis and to authorize dialogue between actors, it is essential to overcome the classic opposition between the public and private sector. As shown in the diagram above, one of the major difficulties faced by companies is uncertainty. As States fight against each other and within their own territory to establish a consensus on carbon price (or not to), companies are waiting for a decision to be able to design their own strategies according to the winning scheme. The intensification of the carbon pricing debate may suggest that there is little chance that one of the methods will be implemented soon. But it also shows that carbon pricing is becoming more credible in the eyes of all stakeholders. Therefore, companies are not facing the uncertainty around the question “Will there be a carbon price?” The true question has become “What is the price of carbon going to be?” This is the reason why the private sector with multinationals and energy companies leading the movement, is now adding its voice to the debate, with multinationals and energy companies leading the movement.

Companies’ CEOs and major actors have come forward, mainly in the business and general press, to ask governments for an explicit carbon pricing. Through the observation of major international summits or events and of press articles, it appears that the energy industry may be more mentally and technologically prepared to decarbonize the economy than many of the other stakeholders in the debate. This is the opinion of Peter Bryin, member of Citizen’s Climate Lobby, a US-based organization advocating for a carbon tax.
Invited to participate to the CERAWeek, the “Super Bowl of energy policies conferences”, he wrote that “When leaders like BP, Shell, and ExxonMobil are calling for a carbon price, they’re doing so not just because it’s good for society, but because predictability is good for business.” Clearly, an explicit framework is a necessity for companies, who would rather advocate for a carbon tax than be left in the dark. As ExxonMobil CEO Rex Tillerson said in a speech before the Woodrow Wilson International Center for Scholars in Washington in January 2009: “A carbon tax is also the most efficient means of reflecting the cost of carbon in all economic decisions – from investments made by companies to fuel their requirements to the product choices made by consumers.”

To balance the call from companies to governments regarding carbon pricing, we should note that this course of action is clearly linked to the fact that companies have less stakeholders to respond to. They have more flexibility and can therefore adopt more of a solution-oriented focus. In fact, carbon pricing mechanisms are not the only contribution of the private sector to the climate change mitigation debate. The example of energy companies is highly relevant. Among many other initiatives, major investments are made in carbon-and-storage technology. Major companies were already shifting their strategies towards less carbon-intensive resources such as natural gas and nuclear power before the carbon pricing debate was put in the spotlight. Smaller companies in other industries are also taking action. Networks of initiatives to at least understand the emissions induced by a company’s processes are flourishing worldwide. The most famous one is of course the Climate Disclosure Project (CDP). Companies are the most represented stakeholders in the CDP documentation compared to public authorities for instance, though local governments are also very active.

Surprisingly, while the environmental movement began with strong anti-capitalist roots, companies are now fueling mitigation activities. Obviously energy companies, mainly those concerned with fossil fuel exploitation, have interests which are greatly incompatible with high carbon prices. However, they still value long term strategy design over short term profit. This is why they are now adding their voices to the debate, and offering solution-oriented tactics. Nevertheless, the private sector is not the only non-public actor claiming its role in the carbon pricing debate. It is part of the wider, and even more heterogeneous civil society which is composed of infinitely diverse organizations.

ii. Civil society coming up at governments: no turning back

Even though there is no consensus on carbon pricing within civil society (which includes companies as seen above) as a group, it has become the most dynamic actor in pushing for carbon pricing. Civil society has managed to enter or open new spaces of debate both at the domestic and international scale. By bringing together even diverging forces, civil society is framing Government’s’ responsibility to act. As we have already discussed companies’ participation, the focus will now be put on other actors composing civil society.

Civil society has become more interested in carbon pricing. Since the 1990s, civil society actors worked towards gaining technical expertise on climate change issues and perceived the shift towards the hegemony of economics as explained in Chapter I of this paper. Getting involved in carbon pricing appeared as an evidence for organizations or individuals who believed traditional action was not enough to force governments to act against climate change. In other words, the carbon pricing debate opened a new space for discussion within the climate change debate, and civil society decided to be part of it too. Some civil society organizations were even created with a specific carbon pricing purpose. This is the case of Citizen’s Climate Lobby in the United States.

International events got to be the display of this commitment, culminating in the COP21 in Paris. Outside of the “blue zone” where parties’ representatives were negotiating, the civil society was highly active. Alliances, new platforms for debates or initiatives were launched or concluded in Paris. One example is the Carbon Pricing Leadership initiative mentioned above.

All of these actions operate a shift in terms of expertise from States and international organizations towards civil society. By consolidating their own visions and expertise, members of the civil society become major stakeholder in the carbon pricing framework. This tendency might increase the difficulty of trying to achieve consensus on carbon pricing. In fact, there is no reason to believe that civil society actors would reach an agreement among themselves more easily than States. From another, more relevant perspective, its level of knowledge and expertise improves civil society's ability to negotiate with other stakeholders. Therefore, States are now required to implement more transparent negotiations, present clearer and more ambitious objectives and achieve concrete results. In other words, civil society’s implication in the carbon pricing debate is complying with its role of preserving the interests of a symbolic “global citizen”, pushing States towards concrete action even if no consensus is reached.

A global, although very diverse, civil society has emerged and taken the lead on the questions of carbon pricing. Companies have joined the movement, asking governments to take decisions on the short term. Civil society has therefore become the motor of negotiations, creating high expectations for States in terms of results and accountability. Carbon pricing has been put under the spotlight in the climate change mitigation debate. To some extent, it has even eclipsed the adaptation debate. Clearly, all of these initiatives, actions and propositions still haven’t led to an agreement. Yet, they have not been in vain.

### 3.2. Setting up a global carbon pricing culture

Mapping actors, positions and debates under the prism of who is advocating for what method enables us to see the existing contradictions and oppositions between them. However, the carbon pricing controversy is even more interesting when we change our perspective. In fact, while there is no consensus on carbon pricing, the numerous debates and initiatives taken allow to set up a carbon pricing culture worldwide. Thereby, new solutions that could not have been contemplated before are now put forward.
i. Setting the scene for a real show: the World needs to get to know carbon pricing

In order to price carbon, every method or tool has pre-requisites. Although immediate action is required to mitigate climate change, stakeholders (States, civil society, experts etc.) need to create and share a common knowledge and culture before they can accurately and efficiently implement any carbon pricing method or tool. This step is happening now and is in fact quite advanced.

When we think of carbon pricing, the focus immediately goes to methods and mechanisms to set a precise price. This reasoning is legitimate as it points to what seems to be the major difficulty. However, carbon pricing is not only about agreeing on a specific and justifiable number. As this white paper shows, carbon pricing is the outcome of a change in mindset. It is the result of a lasting process that turned science into economics, economics into politics, and politics into ethics. It is therefore possible to argue that carbon pricing is the symbol of a relatively new “culture”.

Although science argues that the World needs mitigation, partly through carbon pricing, as fast as possible if not right now, implementing a new international culture cannot be done one day to next. Maybe this is the reason why the international community has not been able to reach a consensus on carbon pricing. The culture needs time to be framed and shared. What is meant by a carbon pricing culture are the following the conditions necessary before even being able to start discussing about carbon pricing. The first condition is the ability of different actors with various views and backgrounds to design methods to price carbon. The methods that were developed somehow represent how each stakeholder translated their own sets of interests and agendas into a valuation method. The second condition is the ability of different actors to implement those methods. Among others, implementing methods means having or developing the authority to do so, the capacity to explain how to use it, to develop relevant partnerships, etc. It also means that specific elements are already available, such as relevant data, and that you have access to them. The third condition relates to the ability to monitor and review your own model, and to solicit another party to do the same, meaning other actors such as consulting firms also need to master this kind of expertise.

Developing and spreading an international economic of climate change culture has progressively shifted the attention towards carbon pricing, making it possible for all of the experts to come up with solutions. It has not to lead to a single path towards consensus on a method of pricing carbon. However, this culture opened the door to a similar way of reasoning, evaluating and assessing the quality of methods. This has an essential step in the debate that was taken collectively and worldwide: it must not be underestimated.

ii. The emergence of standards rather than solutions

From this new perspective, it looks like a precise target “one-size-fits-all” carbon pricing method might not achievable. Maybe it is not even desirable. Nevertheless, this common culture and understanding of issues at stake is leading stakeholders to homogeneity rather than consensus on carbon pricing, mainly through the emergence of standards. Therefore, the controversy already has positive outcomes.
One illustration of how a carbon pricing culture is spreading worldwide and shaping the discussion is the case of cities and local authorities. Before even considering the implementation of a carbon tax (for instance), cities need to acknowledge and understand their CO$_2$ emissions. Carbon inventories, or carbon footprints, can therefore be seen as the first steps towards valuation and mitigation. However, as for carbon pricing, many methodologies were developed to create such inventories. Examples are: Bilan Carbone (ADEME), Baseline Emissions Inventory (The Covenant of Mayors Initiative), International Standard for Determining Greenhouse Gas Emissions (UNEP) etc. Every method has its own scope, target audience (region), mechanisms etc. There is, however, no consistency between these. But the question is: how can we expect to build consensus valuing emissions when there is no consensus on quantifying them? To overcome this difficulty, it is possible to learn from the reaction of the carbon inventory “community”. Instead of continuously debating on which method is the “best” one, some networks and organizations came together to create the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories. Those were the C40 Climate Leadership Group, the World Resources Institute and ICLEI. Instead of designing a new method again, they chose to capitalize on those that already exist. They invited experts from every organization that had designed a carbon inventory method, meaning every actor that had acquired a carbon inventory culture. Together they designed the GPC method. It was not intended as a superior methodology, and it did not replace the pre-existing ones. However the process allowed to underline common standards that methods shared, therefore formalizing this shared culture. The same process is ongoing in carbon pricing with projects such as PESETA and PESETA II. Driven by the Joint Research Center of the European Commission, their objective is to make a consistent multi-sectoral assessment of the impacts of climate change in Europe at a 2100 horizon.

Tentatively looking away from the outcome could allow actors to translate the current cooperation between them into a concrete working process with results. This process is actually very similar to the one that is ongoing with companies. They too are formalizing their shared culture, for instance through standardized reporting (CDP) or by reaching out towards consulting firm to assess and value their carbon emissions.

We have displaced the focus from the carbon price to the necessary steps to be taken before discussing it. Although there has been an incredibly fast movement in the past decade towards carbon pricing and the economics of climate change culture, it has not yet reached maturity. Stakeholders recognize the importance of reaching a global solution and are building up the bases of the solution. Quoting Rex Tillerson again: “Given the global nature of the challenge, and the fact that the economic growth in developing economies will account for a significant portion of future greenhouse-gas emission increases, policy options must encourage and support global engagement.” Even though all agree on the importance of achieving a global standard, it still seems improbable that some would accept a compromise. Therefore the conditions are not yet favorable enough to reaching and even less to implement a global carbon price.

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32 Juan-Carlos Ciscar, personal communication (April 13th, 2016)
3.3. The implications of an international carbon price: no global solution ahead?

Listing and analysing the requirements of an international carbon price put in evidence the “costs” and difficulties that would emerge even if a solution was to be found. This is due to the nature of the existing methods and mechanisms, as discussed in chapter 2 of this white paper.

i. The hidden costs behind carbon pricing: limits and implications

The consensus approach to carbon pricing necessarily brings many difficulties and obstacles that can be counter-productive. Negative consequences may last even after a solution is found. Existing methods and mechanisms for carbon pricing are not mature enough when it comes to implementation and addressing all the diverse effects they might have on different stakeholders.

Desperately trying to achieve a consensus might not be desirable, although of course setting a universal price and system appears to be the best imaginable scenario. In fact, the range of prices existing now definitely show that there is too many different interests between actors, regions and time scales. The challenge is that if the price is set too high, some actors may back off negotiations and just refuse to implement the international regulation (if this terms can be used) within their sovereign territory. But if the price is too low, it will have no impact on climate change mitigation, which has to be remembered as the top objective. The feasibility of such a process is difficult to conceive. Apart from the UNFCCC, there is nowhere to discuss such a matter. As illustrated before, new areas of discussion are conceived by stakeholders. However those do not have an official and concrete locality to take place. Even within the UNFCCC framework, all of the parties do not have the same voice, as civil society is only part of working groups with only a consultative voice in negotiations, for example through the YOUNGO group for youth. Meanwhile, from the same perspective, groups as a companies tend to organize parallel events such as the Business & Climate Summit (2015) or the Sustainable Innovation Forum. While there is a reinforced common culture and cooperation in carbon pricing, there still is a lack of coordination between actors. In fact, there is a huge contradiction between the reinforcement of the role of the civil society on one side and its extremely limited role in the only official negotiation arena in the other side. The form of the dialogue is not adapted to the plebiscited “consensus approach”, so obviously its content will not reach consensus either. A legitimate process to reach an agreement on carbon pricing would need to guarantee that the outcome is not the “winner’s price”. However, given the differences between stakeholders, obtaining such a consensus or even a democratic process might be an unachievable dream that might freeze the controversy rather than taking it forward.

The governance scheme and structures required for carbon pricing are not the only limits. It is crucial to understand that the methods and tools studied represent entirely new frameworks. In other words, they have often not been tested, or only in a few and limited contexts. This means that it is impossible to know yet what are possible limitations and fragilities. On the 2nd of May 2016, the first trial of “CO2 traffickers” began in Paris. In
this case of carbon emissions credits trafficking at the European scale, the French State estimates it has lost around 1.6 billion euros\textsuperscript{33}. The trafficking system began shortly after the implementation of the European ETS; showing how major flaws need to be tackle before carbon pricing can be efficient and effective.

![Figure 13. Illustration from Colcanopa on carbon quotas traffic\textsuperscript{34}](image)

The question of the guarantees of the legitimacy of a universal carbon price raises the question of who would be the guarantor of the process. It cannot even be considered that the international market would regulate it as it obviously would not represent equally every stakeholder, beginning with those that reject the market pricing methods. So who is to be taking this role? Who can enforce the outcome of a universal treaty on carbon pricing? Would it be possible to act without putting anybody in charge?

\textit{ii. Is the World ready for a global carbon price?}

In a scenario where a global carbon price would be defined, it is uncertain if the international framework would be capable of making it work.

Every method mentioned in this paper requires that someone or something looks over its implementation. Instinctively, the example would be governments for a carbon tax or the invisible market hand for ETS. But even if it is in some cases possible to identify which actor would be in charge of implementation, methods of enforcement are never clear. High risks flow from a poor quality of implementation, regulation and reviewing of any of the


\textsuperscript{34} Ibid.
methods. Some may advocate for the creation of an international body in charge of carbon regulation. This body would have authority on the private sector mainly, in some ways bypassing the States in that matter. However, influential voices rise against optimism in governance issues. T. Boone Pickens, an American businessman in the energy sector said: “I don’t believe in a price on carbon, because the government is going to control it and they’re going to fail.”

It thus can be considered that the international community is not ready to implement a universal solution. As Penny Mealy, University of Oxford stated: “existing efforts to apply these models to such a question are still in their infancy - so, while I’m personally hopeful and optimistic, it remains to be seen!” However many solutions are still possible that one can consider. One would be to set an international mechanism, in other words to recognise one of the cited method as the universally recognised one, but to set different level of prices based on industry sectors, groups of actors etc. However, those disparities would create a very unequal world and discourage the cooperation spirit that has seem to arise in the past decade. Moreover, it could also incentivize divergent disruptive behaviors, with the setting up of a black markets for emissions, or faking of carbon inventories etc. Another option could be to develop optional methods more. This approach would bet on the capacity of such method to promote a less emitting development of industry in developing countries and to drive innovation in others. Inspired by the case of carbon quantification methods, it could be decided that instead of targeting a single method and price, nothing more than guidelines could be proposed to every country. The objective would be to push each country to develop its own method, but to comply with a list of standards. The scale of this option can be discussed: local authorities might be more efficient if they are in charge of implementing those standards.

36 Penny Mealy, personal communication (April 15th, 2016)
The case of shadow pricing illustrates how actors are reacting to the absence of a formal and the officially recognized superiority of one carbon pricing method. Implementing solutions-oriented schemes such as shadow pricing is a form of benefit caused by the very blurred situation of carbon pricing worldwide. This method allows actors to do better than others even by doing the strict minimum. In fact, we have seen that shadow pricing is easy to implement but its real impact on climate change is not transparent and certainly not linear as it can be adapted to the actor’s will.

Shadow pricing underlines the relative autonomy of actors. While no solution enforced, an international culture forged around climate change economics has spread worldwide. More and more actors realize how carbon pricing represent both risks and opportunities for them. Now that they cannot ignore the possibility of international or domestic regulation, they cannot however have visibility on when and how it will happen. So the implementation of mechanisms such as shadow carbon pricing also points out to the reaction of some stakeholders that do not want or cannot wait for governments, academics or other traditional experts to agree on a universal and legitimate price for carbon. For companies, regulation is needed so that they can plan for the future. For citizens and other civil society organizations, the clock is ticking for some populations and for future generations. The civil society, which includes companies, has accumulated expertise and is now looking to have its many voices heard in the debate. This emergence of an autonomous civil society is adding to the complexity of the debate, even more because disagreements exist within it. Yet it is also changing and shaping the carbon pricing debate framework. By contributing to shift the focus on collaborating and creating coherent standards rather than to desperately wait for the perfect and universal solutions, the civil society recognizes the flows of the international system and deals with them.

Many actors have divergent interests, and every model might fit an actor and be rejected by another one. This ongoing competition and endless debate tends to overshadow the main objective of carbon pricing which is mitigation. It is in fact very difficult to assess how any of the carbon pricing method being tested around the world have had a concrete impact on mitigation.
Conclusion

Do you have to pay fifteen or thirty-five euros to offset your carbon footprint? The amount that you will pay for a ton of CO2 will vary according to the country, firm or voluntary initiative you are part of. Throughout this paper we have deconstructed the carbon pricing debate to illustrate the complexity of the topic. Even though the world has not been able to agree on a global carbon price, carbon pricing does indeed represent the main strategy used by the majority of stakeholders to tackle climate change.

The question of climate change was really transformed into the debate of carbon pricing by environmental economics, due to the need to quantify and theoretically consolidate the issue. Climate change skepticism is no longer a major threat as the scientific community came to a consensus that propelled the world to realize the catastrophic multiplier effect that climate change will have on human life and nature. This mobilized the political community into action. Basically, the scientific expertise enabled the creation of a common language across the different political, economic, and social sectors to act against climate change.

It is important to remember the role of the expansion of CBA in US climate change federal regulations. It was first used by the US Army Corp of Engineers to create a quantitative evaluation of and justify the efficacy of public water infrastructure projects such as dams. It soon became a method 'grounded in economic principles' and applied in almost every public sector issue (Masur and Posner, 2011). Transportation, government, and health programs started frequently applying CBA with assertive validation. Statistics and numbers are perceived as a neutral and objective tool in these analysis. Yet, as demonstrated by the literature, they are indeed still built and calculated with subjectivity.

Statistical and numerical analyses allowed for credibility, comparison, and refutability to be applied to reality. The establishment of CBA as the ‘tool for policy decision-making’ represented the use of power and the construction of a social belief that placed statistics and numbers as the ‘tool of governance and proof’ (Desrosières, 1991) and eventually led to the monetization and valuation of nature.

As aforementioned, scientists played an essential role in this consolidation process. The Keeling Curve proved the direct causality of CO2 concentration in the atmosphere with global climate change. After that, meteorologists and environmental scientists continued to look for data to justify climate change as a potential global threat caused by human activity. Economists joined this debate in the 1970s by giving birth to environmental economics, mainly as a response to the oil crisis.

The issue with climate change is that it represents a perfect ‘tragedy of the commons’. This, in economists’ words, is the biggest market failure. Their perspective is that in order to solve this market failure, the value of climate change had to be quantified, to numerically account for its potential benefits and negative externalities due to economic and productive activities. Faced with the inefficiency of command-and-control methods to reduce GHG emissions, economists transformed CO2 into a commodity and with it, the way man relates to nature.
Countries started experimenting with different economic models to make CO2 emissions more expensive and therefore incentivize the transition to low-carbon technologies, setting the basis of what is now known as carbon pricing. The first ones to apply market-based solutions as mitigation action for climate change were the Nordic countries with the implementation of carbon taxes in the 1990s.

The different critiques and failures of carbon tax policies and ETS such as the failure to create investment in green technology and price volatility respectively, pushed scientists and economists to develop a more encompassing model: the SCC. The SCC represents a more holistic approach that takes into account the overall cost of GHG emissions for society. It has been used to assess environmental policies and to calculate carbon taxes. Nevertheless, none of these tools have managed to measure uncertainty when calculating carbon price. As time passes, choosing which instrument to use has become an increasingly complex debate. Building a ‘one-size-fits-all’ carbon price seems like an unreachable objective as stakeholders with opposing interests are actively participating in the process. Companies, individuals and civil society organizations have joined governments and institutions in the creation of carbon pricing tools. The bottom line is that all of these stakeholders are realizing that carbon pricing represents both a risk and an opportunity for them. And in the absence of consensus to establish a ‘global carbon price’, organizations and individual stakeholders are adopting action-oriented tools such as internal carbon taxes and internal pricing mechanisms.

The growing number of stakeholders that stopped relying on experts and policy-makers to take action could be perceived as a perpetuation of the carbon pricing controversy. From this perspective, additional tools and methods imply additional actors with even more diverging agendas. However, this paper proposes a new framing of the controversy by arguing that this phenomenon contributes to creating a carbon pricing culture. The creativity of present contributions to carbon pricing allows for a global language based on shared knowledge. It also produces data, generates innovative governance schemes and establishes legitimacy to the need for carbon pricing. In other words, it is filling in the gaps. While science and economics allowed us to reach consensus on the need for global action on climate change mitigation, carbon pricing culture goes one step further as it allows stakeholders to agree on the necessary processes to be implemented before reaching a global carbon price. Those elements are prerequisites that stakeholders need to master before they can discuss how to overcome the carbon pricing controversy. Nowadays, this process has already resulted in diffusing global standards that may be able to mould together carbon prices with similar standards rather than coming at one single global price.

On the other hand, the setting up of a carbon pricing culture is also questioning the role of experts, on which this paper based its approach. In fact, this process allows many actors to become experts, as each stakeholder producing a new tool establishes its own models and criteria. The limits of the carbon pricing controversy may lie just in this issue. In societies that have awarded full legitimacy to expertise and experts behind it, carbon pricing requires new experts to evaluate the quality and efficiency of carbon pricing tools. Specialized consulting firms have taken on this role by proposing their services in carbon pricing evaluation. These consultants are rapidly expanding their knowledge on complex methods and tools, by centralizing global expertise. Though as highlighted in this paper very little is known about their methods, and transparency is left up to their own discretion. In order to understand the real impact of carbon valuation on mitigation, and based on the leading
role that societies give to experts, it would be interesting to focus future researches on the role and findings of consulting firms on carbon pricing. Shedding light on this area could indicate that we are moving closer to a global consensus or that there may be more to the story behind the lack of transparency.
Tables and figures

Figure 1. A picture of Keeling with the original maps of carbon emissions......19
Figure 2. Carbon levels rising from 1960 to 2010 .............................................19
Figure 3. Actors and stakeholders of carbon pricing.............................................27
Figure 4. Global Carbon Pricing Trends. Courtesy of World Bank 2015.............30
Figure 5. Implementation of Carbon Taxes since 1990 ........................................32
Table 1. Selected carbon tax rates by fuel, Courtesy of Ministry of Finance of British Columbia (2012) ........................................................................................................37
Figure 6. Cap-and-trade economic model between two firms with different marginal abatement costs (Haab and Whitehead, 2005) .........................40
Figure 7. Visualisation of Economic Damages as the Social Cost of Carbon in IAMs as seen in Bonen et al (2014) .................................................................48
Table 2. Rules published by U.S. Agencies that include the SCC .....................50
Table 3. Example of the use of SCC in the UK (Watkiss, 2005) .........................50
Figure 8. The CitéGreen Initiative ........................................................................63
Box 1. Case Study – Societe Generale ..................................................................65
Figure 9. Environmental and Social Responsibility (Société Général Report, 2014) ..........................................................................................................................66
Figure 10. Examples of disclosed company carbon prices ..................................67
Box 2. Case Study – Brazilian ETS .......................................................................68
Figure 11. Representation of the civil society definition .......................................70
Figure 12. Drives, risks and opportunities of climate change for businesses ....71
Figure 13. Illustration from Colcanopa on carbon quotas traffic ......................77
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