A SOLUTION FOR AN EXTERNALITY, GREENHOUSE GASES: CARBON MARKET

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Summary

Greater awareness to increased greenhouse gas concentration has prompted governments to craft different policies to reduce emissions, including the creation of carbon markets. There are two types of systems of tradable emission certificates: i) the EU Emissions Trading System (EU ETS), based on the cap and trade principle, which works on the basis of trading permits; and ii) certificates based on the deployment of projects created with a focus on emissions reductions (such as the Clean Development Mechanism). These systems, as opposed to taxation policies (Pigouvian taxes), are attempts to solve environmental problems through the use of a market instrument. Based on the New Institutional Economics, Coase presents arguments that government intervention is not a solution to the problem of externalities as preached by Pigou. According to Coase, the state should create conditions, through the definition of property rights, for economic agents to freely negotiate so-called "environmental goods", such as the reduction of air pollution. In this sense, carbon trading in essence follows the logic advocated by Coase. There are several markets immersed in various institutional structures, with specific rules and specific organizations, but which follow some assumptions common to all. Since the markets are influenced by many factors, some have grown more than others. Given that market solutions are relatively innovative, this paper presents the dynamics of the evolution of carbon markets, examining the different structures of existing markets, their performance, and their barriers to growth.

Key words: Clean Development Mechanism, Kyoto Protocol, emissions reduction, carbon market, carbon certificates, flexibility mechanisms, EU ETS, Institutional Economics, transaction costs.

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Introduction

Climate change is one of the most pressing environmental concerns facing humanity. Research in the area offers increasing evidence that human activities are largely responsible for the higher concentration of greenhouse gases (GHG) in the atmosphere, which causes global warming, the main cause of climate change (IPCC, 2008).

Greater awareness of the consequences of the increasing concentration of greenhouse gases has triggered some policies to reduce emissions, including the creation of carbon markets. In this context, there are two types of systems of tradable emissions certificates: the EU European Trade Scheme (ETS) following the cap-and-trade principle, which works on the basis of negotiations for permits, and certificates based on deployment projects created with a focus on emissions reductions (such as the Clean Development Mechanism). These systems are attempts to solve environmental problems through the use of a market-based tool as opposed to tax policies.

Given that these solutions, which are based on the New Institutional Economics, are relatively innovative, the main objective of this paper is to present the dynamic evolution of carbon markets, examining the different structures of existing markets, their performance, and their barriers to growth. To achieve these purposes, the article initially presents the global consensus about global warming, then presents the economic rationality of measures to reduce this phenomenon; next, it presents an introductory approach to theories on tradable emissions certificates, followed by the world's carbon markets; and, finally, it presents the dynamics of these markets, covering their construction and evolution over time.

1. The global consensus on global warming

Studies on climate change have intensified in recent decades, with a huge advancement in the research of climate science in the area of observation, in the field of modeling, and in the treatment of uncertainty. A major responsibility for consolidating these studies lies with the Intergovernmental Panel of Climate Changes (IPCC), established in 1988 by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO), with the aim of providing information in order that governments can develop policies related to climate change.

The first report released by the Panel was published in 1990, the second in 1995, the next in 2001, and the fourth in 2007. The IPCC is composed of researchers from member countries of the United Nations, and critically examines the international scientific and technical literature that addresses this problem. From these studies, reports are prepared with the most relevant information on aspects of climate change. These reports are periodically reviewed by experts and subject to the approval of the representatives of all governments involved (Oliveira, 2008; IPCC, 2008).

Based on the initial report, the General Assembly of the United Nations established the Intergovernmental Negotiating Committee, responsible for drafting the United Nations Framework Convention on Climate Change (UNFCCC). The document of this Convention was signed in 1992, during the United Nations Conference on Environment and Development (UNCED), also known as Rio-92. During the UNFCCC it was agreed that member countries of the Organization for Economic Cooperation and Development (OECD), and economies in transition (the Russian Federation and other countries of Central and Eastern Europe) would agree to adopt national policies and measures aimed at reversing the level of their greenhouse gas emissions to 1990 levels by the year 2000. They were also to submit periodic reports known as "National Communications", detailing their policies and programs for reducing GHG emissions, featuring the annual so-called Emissions Inventories.

After the initial commitments regarding the reduction of greenhouse gases were agreed in the UNFCCC, a permanent, periodic discussion process was established, based on the exchange of information on scientific development, technological progress, and the political willingness of countries to adhere to the new agreements. The development of this process required the creation of the Conference of the Parties (COP), the supreme body of the

Convention, the highest decision-making authority, whose meetings have occurred annually from 1995 to the present day. The 3rd Conference was held between 1 and 12 December 1997 in Kyoto, Japan, giving rise to the Kyoto Protocol (Ribeiro, 2003; Rocha, 2003; UNFCCC, 2005b).

Environmental problems are part of a complex field, tied to a mesh of different, often conflicting, interests. Attaining the goal of reducing emissions requires international cooperation, and hence political, ethical, and economic factors must be taken into account. Countries may have different interests and positions both in relation to understanding and in how to combat climate change, so the actions to be taken may differ between them. Moreover, the issue of global warming also raises many questions due to the prevailing uncertainty regarding measurement of its effects on the planet and the real harm they can do to society.

Due to both the complexity of the matter and the lack of consensus on the understanding of the causes and consequences of climate change, some scholars within the global scientific community - albeit a minority - deny the existence of global warming. Others reject the thesis that warming is being caused primarily by human activities and not by natural factors, and many still have a wide range of arguments contrary to the IPCC reports (Grossman, 2001; Lindzen, 2005 cited by Veiga, 2007).

Despite these disagreements within the scientific community, the thesis that prevails, especially in international forums, is the precautionary principle, which recommends that although there is no complete certainty with regard to a particular phenomenon, the world must take steps to guard against the possible harm that may be caused. Thus, one should avoid the effects of air pollution as a precaution against the possible negative effects on climate (Veiga, 2007). The decision about which are the most appropriate measures to minimize the effects of climate change is another controversial issue, one hardly agreed on by the parties involved.

2. The economic rationale for measures to reduce global warming

The background to the discussion about measures to address climate change is the debate over the most efficient solution to the market failure inherent in the degradation of natural resources, labeled a negative externality. An externality is defined as a cost or benefit that is

imposed on individuals by the actions of others, but which is not taken into account in the market price (Varian, 1994). According to Baumol and Oates (1993), externalities are present whenever a utility or the production of an agent "X" includes real variables (non-monetary) in quantities determined by others who do not care about the welfare of "X", and do not compensate "X" for the effects of their activities.

When externalities exist, the unrestricted market mechanism leads to inefficiency, because it cannot pass on all the information about the costs and benefits contained in this good. The deviation from the economy of perfect resource allocation generates suboptimal performance of the social welfare function, a condition which would, from the perspective of classical economists, justify regulation through measures of command and control and taxation.

Traditional economics admits that economic externalities, in diverting the economy from efficient allocation, are a typical case for government intervention. The emission of greenhouse gases is an example of a negative externality, as it causes harm to others, even if they are not responsible for the emissions. Pigou (1920) presents as a solution to negative externalities the creation of taxes (Pigouvian taxes) in an amount equivalent to the cost (benefit) of the externality generated. Such a solution - the principle of the paying polluter - has been adopted by the Organization for Economic Cooperation and Development (OECD), and suggests the economic valuation of the degradation and the imposition of taxation. In other words, one must adopt a tax on each unit of pollution emitted that is equal to the marginal social cost of this pollution, which would represent the optimal level of emission.

In the 60s, Nobel Prize-winner Ronald Coase proposed a new way to analyze this problem, through the critique of the Theory of Welfare contained in his article "The problem of Social Cost" (Coase, 1960). Contrary to Pigou's view, Coase posited that government intervention is not a solution to the problem of externalities due to two important considerations. First, he argued that the public authority is not without its flaws (corporate interests, lack of information, and political pressure), and contrasts the approach of market failures with government failures. Coase, as well as the members of the Chicago School—divergently from the predictions of the models of classical theory—consider the effects of economic regulation more as a reflection of political and distributional objectives than of efficiency. Furthermore, they claim that private solutions generally involve lower costs,

because if there are no transaction costs,[1] the results would not be affected by state action; however, there would be costs involved in adopting the policy.

This logic gave birth to a theoretical line called New Institutional Economics, whose proposal is that the state should create conditions, through the definition of property rights, for economic agents to freely negotiate so-called "environmental goods", such as the reduction of air pollution. Carbon trading has at its core the logic advocated by Coase,[2] insofar as it enables a tool aimed at the ownership of a free asset,[3] based on transactions of emissions permits or carbon emissions reduction certificates. Property rights are intended to internalize externalities when the gains of internalization outweigh its costs. A market of emissions reduction certificates for greenhouse gases (GHG), through a clear determination of property rights, proposes the internalization of this externality (Mueller, 2002).

It is worth noting that environmental services are characterized as public goods because they are non-exclusive and non-rival. Therefore the prevailing proposals embody the idea of markets associated with instruments of command and control based on governmental imposition of behaviors specific to companies or individuals. For example, a pollution control policy can include emissions permits, of which a limited number are ascribed to a specific group (or groups) within a sector (or sectors). Therefore, those who can reduce their emissions to a level below that of their shares can sell their surplus, while those who cannot restrict their emissions can buy permits. The system dispenses with the regulatory authority in charge of defining the appropriate levels of emissions to be applied across companies and industries, or to determine the most appropriate technology to be used. By incorporating the tools of command and control, the markets for environmental services make it possible to change the characteristics of non-rivalry and non-exclusivity of these products, which allows for trading a good which otherwise could not be easily negotiated (Nusdeo, 2008).

Based on emissions reduction instruments, the question is how the carbon markets are formed and structured, in order to evaluate the different constructions and scope of these instruments.

[2] See, e.g., FARBER, Daniel A. The Case Against Brilliance. Minnesota Law Review, v. 70, April 1986, p. 919.
[3] A free asset is one whose supply is unlimited, and whose consumption is costless; for this reason it is not susceptible to private appropriation.

3. An introductory approach to emissions reductions trading

According to the economic logic presented in the previous section, the different carbon markets were formatted following basic guidelines common to all, inherited from theoretical concepts thought of long before the creation of the Kyoto Protocol.

Thus, the creation of a market for certified reductions of GHG emissions stems from the concept of tradable emissions permits (cap and trade), initially formulated by Dales in 1968 and later developed by Montgomery (1972), Tietenberg (1985), and Baumol and Oates (1988), among others. The fact that the air is a public good, common to all, raises the following questions: who has rights over it, and who is responsible (who must pay) for air pollution? Thus, when a market of certificates is established, certain reduction targets are set; or, in a trade based on the cap and trade principle, the rules determine a limit on emissions, which participants must obey (Conejero, 2003; Montgomery, 1972 ; Tietenberg, 2003).

The academic literature presents three basic types of systems of tradable emissions certificates: the ambient permit system (focused on the exposure to emissions at the reception point), the emissions permit system (focused on emissions sources), and the pollution offset system (combining features of the previous two). With respect to regulating the sale of certificates, four programs stand out: offset policy, bubble policy, netting policy, and emission banking.

The offset policy, created by the Environment Protection Agency (EPA)[4] in the 1980s, is a new program that allows polluting plants to settle in regions where air quality does not meet appropriate environmental standards. However, this is possible only if the new emissions are offset by a reduction in existing sources of pollution in other regions. Rather than impose a rigid zoning law barring expansion of activities in the area, the entry of new firms is permitted, provided that local environmental quality is not undermined.

The bubble policy, also created by the EPA in the 1980's, is a mechanism that treats multiple emission points of existing polluting plants in a given area as if encased in a bubble. The total gas emitted in a particular region is controlled, and as long as values remain below this allowed total companies can still pollute. Participants can negotiate emissions reductions among themselves, depending on whether or not they have attained the set level of reduction.

[4] The EPA is a US government agency that aims to provide environmental education and research, besides creating and helping to implement regulations to reduce environmental pollution in the USA (EPA, 2005, online).

The netting or net emissions policy sets a determined limit, and a maximum of certificates that participants can acquire to achieve their goals. From these boundaries, companies are free to increase or decrease their emissions as long as the net growth of emissions does not exceed the pre-determined ceiling. Emissions banking, in turn, enables companies to store or sell reduction certificates or permits for use in reductions in the offset, bubble, and netting policies (Almeida, 1998, May, 2003; Pindyck and Rubinfeld, 1994).

Next we present the main characteristics of the major global carbon markets created from the logic of the emission permits market, and that of emissions reduction based on projects.

4. Global carbon markets

There is no carbon market defined by a single commodity, by a single contract. What is commonly called ”carbon market” is a collection of various transactions through which volumes of GHG emissions reductions are traded, and which differ with respect to size, shape, and regulations. These transactions can also be separated into Kyoto compliance and non-Kyoto-compliance: that is, whether the carbon credits meet the parameters set by the Kyoto Protocol or not. Although there are standardized markets, in general information about transactions is limited and difficult to measure. Besides, there is no obligation to publish prices and negotiations, and there is no central emissions clearinghouse for all transactions.

4.1 The Kyoto Protocol and the Clean Development Mechanism

One of the most relevant carbon markets today stems from the establishment of the Kyoto Protocol, which introduced economic tools needed to help meet the objectives and principles established by the UNFCCC. This treaty stipulates that countries belonging to Annex I (developed countries and economies in transition) should reduce their combined emissions of greenhouse gases by an average of 5.2% of 1990 levels over the period between 2008 and 2012.[5]

To facilitate compliance with these reduction targets, the Protocol established commercial instruments called Flexibility Mechanisms, by which an Annex I country can exceed its limit

[5] During the last annual meeting, COP 17, a political compromise was agreed, with the following assumptions: the establishment of a formal provision for a second commitment period of the Kyoto Protocol; the launch of the Green Climate Fund to expand long-term financing to developing countries; and the establishment of a formal clause for an action plan that results in a global agreement on climate change (Durban Platform for Enhanced Action), to be defined in 2015 and entered into force in 2020. However, Japan and the Russian Federation stated that they would not participate in the next period of Kyoto.

of emissions without increasing global net emissions, provided that there is an equivalent reduction in another country.

With the entry into force of these ceilings on GHG in the atmosphere, greenhouse gas emissions start to have a cost. An Annex I country has two alternatives for achieving the targets and using them according to its cost-benefit analysis: invest in more efficient technologies in terms of GHG emissions in their own companies, or use the flexibility mechanisms, leveraging the lower costs of deploying projects in other countries.

The flexible mechanisms provided for in the Protocol are three: Joint Implementation (JI), Emissions Trading (ET), and the Clean Development Mechanism (CDM). These three instruments result in the conception of a carbon market. Joint Implementation allows industrialized countries to offset their emissions and sinks by participating in projects in other Annex I countries.[6] The Emissions Trading policy delineates transactions relating to GHG emissions among Annex I Parties, by addressing the adoption of policies based on markets for tradable allowances. This mechanism allows developed countries to negotiate among themselves the emissions quotas agreed in Kyoto, whereby countries with emissions greater than their quotas can buy permits to cover these excesses. Finally, and directly affecting developing countries, is the Clean Development Mechanism (CDM), through which industrialized countries can meet their reduction commitments by investing in projects which avoid greenhouse gas emissions in developing countries. According to the Protocol, Annex I countries should finance and facilitate the transfer of knowledge, technology, know-how, and environmentally sound practices and processes related to climate change to developing countries (UNFCCC, 1997). The extent to which these assumptions must be obeyed is not determined by the Protocol, nor is it clear what it means to promote sustainable development, since there is no global rule, so it depends on the definition given by each particular nation.

[6] Sinks are defined as any process, mechanism, or activity, including the biomass and in particular forests and oceans, which have the property of removing greenhouse gases, aerosols, or GHG precursors from the atmosphere. They may be also other terrestrial, coastal and marine ecosystems (UNFCCC, 2004).

4.2 *European Emission Trade Scheme - EU ETS*

The first large emissions trading market, the UK Emissions Trading Scheme (UK ETS) was developed in 2002, through an auction of 4.028 MtCO2e. In 2007 this program ceased its activities, but it led to the creation of the EU Emission Trade Scheme (EU ETS), which began operating in January 2005. The first phase of compliance with reductions lasted from 2005 to 2007; the second from 2008 to 2012, coinciding with the first phase of the Kyoto Protocol; and the third will span from 2013 to 2020 (DECC, 2012, online; Defra, 2005; ETS, 2005, UK, 2005).

The European market initially emerged to help countries meet the targets set by the Kyoto Protocol. The EU ETS Commission created a Linking Directive, which functions as a regulatory regime that determines the relationship between the Kyoto Protocol and the EU ETS. The Linking Directive allows institutions included in the EU ETS to use Clean Development Mechanisms (CDM) certificates to meet their commitments (Ieta, 2005; Point Carbon, 2005c; World Bank, 2005b).

Each member country of the EU ETS develops a National Allocation Plan (NAP) that establishes the amount of GHG emissions "permits" to be distributed to their industries and power plants. It is up to each company to adjust its polluting profile to remain within the established quota; if it exceeds this limit, it can buy permits, and if it is below, it can sell its allowances. Covering about 12,000 facilities in the first phase, the scheme included the energy, metal and steel, pulp and paper, cement, and ceramics and glass sectors. At this stage, only carbon dioxide (CO2) emissions were regulated.

Many changes are expected for the EU ETS by 2013, when its third phase will come into force. There are discussions about the inclusion of other sectors (such as aviation) and other countries from outside the EU, such as Norway, Switzerland, Iceland, and Liechtenstein. The emissions limit for the bloc will fall by 1.74% per annum until 2020, and there will be a substantial increase in the number of permits auctioned (from below 4% thus far to over 50%). Other gases and sources will also become part of the EU ETS, such as CO2 from petrochemicals, ammonia, and aluminum; N2O from adipic, nitric, and glycolic acids; perfluorocarbons from the aluminum sector; and the capture, transport, and geological storage

of CO2. Based on these possible changes, and others still pending, an increase is expected in the price of carbon certificates as well as growth in this market (Defra, 2012; ETS, 2012).

4.3 Other world markets

Developed by the Dutch government, the Certified Emission Reduction Unit Procurement Tender (CERUPT) results from this government's interest in investing in CDM projects through the purchase of Certified Emission Reduction units (CERs). They also created the Emission Reduction Unit Procurement Tender (ERUPT), similar to the CERUPT program, but directed the Joint Implementation Projects (CERUPT, 2005, online).

In 2011, new initiatives for regional and domestic carbon markets gained strength in both developed and developing countries. Three new cap-and-trade schemes were approved in national laws and two in state laws. China is also moving forward in its regional initiatives and is expected to come up with a program to reduce national emissions by 2015.

New Zealand was the first country outside the EU to approve and implement its own emissions trading scheme, active since 2010, and is a rapidly growing market, whose carbon value has tripled to US$351 million.

In 2011, the cap-and-trade regulation in California was adopted by the California Air Resources Board (CARB). It shall come into force in 2013 and, with a coverage expansion scheduled for 2015, will cover 85% of annual emissions. In late 2011 the Australian Parliament passed its Clean Energy Act, establishing a national cap-and-trade system in 2015. The program should cover about 60% of the 600 million tons of CO2e emitted annually in the country. Quebec, accounting for 12% of GHG emitted annually in Canada, approved its own cap and trade plan, and aims to link it to the California plan in the context of the Western Climate Initiative as of 2013. In addition, Mexico, Brazil, and the Republic of Korea passed bills on climate change with broad coverage in April 2012.

The large number of programs around the world demonstrates that there is a worldwide mobilization to use the market as a tool for solving the problem of GHG emissions. Many reduction schemes have more aggressive targets than Kyoto's, but they follow precepts

defined in this Protocol, aiming not only to meet the targets set out in this Treaty, but to also extrapolate its goals.

4.4. Carbon market brokering

Some organizations - and different reduction programs - have emerged to support carbon transactions, establishing the rules necessary for the market to develop, acting as lenders or intermediaries.

World Bank

The World Bank actively participates in the carbon market, through fundraising and financing emissions reduction projects. Its main carbon market-related funds are: The Prototype Carbon Fund (PCF), the Netherlands CDM Facility, the Italian Carbon Fund, the Community Development Carbon Fund, the Bio Carbon Fund, and the Danish Carbon Fund. These funds, guaranteed by the World Bank, can be public or public/private, have a differentiated focus, and basically purchase emissions reductions from projects in developing countries and economies in transition (World Bank, 2012).

Stock markets for carbon credit

- *Brazil's BM&F Bovespa*

Aimed at the development of this market, BM&F Bovespa (formerly BM&F), in partnership with Brazil's Ministry of Development, Industry and Foreign Trade, organized the Brazilian Market for Emissions Reduction (MBRE) by creating a grant fund for carbon projects. Its role is to provide a set of rules and regulations, project registry system, and a trading center to stimulate the development of CDM projects, thereby providing greater transparency to the carbon market. The BM&F created a bank of CDM projects, available on the Internet since late 2005, which functions as an electronic system to record information related to CDM projects that have already been validated or that are still in design phase. In addition, investors pre-selected by the fund may disclose their intentions to purchase or sell the certificates resulting from CDMs (BM&F Bovespa, 2012, online). The BM&F is the first stock exchange in the world to conduct a public auction of credits, from the Brazilian CDM project generated by the Bandeirantes landfill.

Despite this development effort, in July 2012 there were only five projects registered and six with purchase intent. The institution has developed a project database and mediates credit auctions, but nevertheless there is no Brazilian stock exchange that offers the trading of carbon credits along with the other financial instruments traded in the country and the world. It is likely that one of the reasons why there is no such exchange trading is the lack of univocal legal definition regarding carbon certificates. In other words, there is no consensus about whether carbon credits are a commodity, a contract, or other type of negotiable paper.

World Stock Exchanges

Although it has not ratified the Kyoto Protocol, in December 2003 the United States became the first country to create a stock exchange for carbon credits, the Chicago Climate Exchange (CCX). Its goal was to promote electronic commerce negotiations on the reduction of GHG emissions. From its inception until 2010, the CCX operated as a cap-and-trade program, and in 2011 it launched the Offsets Registry Program for voluntary emissions reductions (VERs) based on different protocols.

The CCX was the result of its members' (over 100) interest in reducing GHG emissions through a voluntary agreement among them, with basic rules for reduction and specific behavioral patterns. It was created as a self-regulating platform, managed by its members, which set the rules of this market, for example defining baselines and the eligibility of projects and sectors involved, while monitoring reductions and developing auctions. Participants voluntarily assumed the commitment to reduce emissions, which began to be controlled through a legal agreement. Those reducing emissions to below their targets acquired emissions allowances and could sell them to those who did not reach their goals, or bank them. Some standards established by CCX followed the standards proposed by the Kyoto Protocol, but in general, compliance goals were less stringent.

Between 2003 and 2011, 745 MtCO2e were traded, but by the end of 2011 negotiations were considerably reduced, and the major participating companies abandoned the CCX. The lack of interest in carbon trade is a reflection of the global economic crisis, and especially of the lack of government support in the form of clear targets on emissions reductions, beyond changes in EPA's Acid Rain Program.

Another stock exchange that traded carbon credits was the Chicago Climate Futures Exchange (CCFE), launched in 2004, which also ended its activities in early 2012. Nevertheless, according to experts, the end of a stock exchange does not affect the market, since operations can be moved to another exchange, as occurred with the CCX, which in 2011 was acquired by the Intercontinental Exchange (ICE). Moreover, in this case the participants of the Chicago exchange actually decreased their operations (CCX, 2012; CES 2012; Theice, 2012).

Along the lines of the CCX, the European Climate Exchange (ECE) was launched by the Chicago Climate Exchange in 2005, and incorporated by Climate Exchange PLC, a company listed on the London Stock Exchange. Other stock exchanges available to negotiate carbon credit are: Montreal Climate Exchange; Chicago Climate Future Exchange (CCFE), later merged into ICE Futures; NordPoll in Norway; Energy Exchange Austria; New Values/Climex in Germany; Vertis Environmental Finance in Budapest; and Multi-Commodity Exchange in India. Others have plans regarding the negotiation of carbon credits, including the Hong Kong Exchange and the European Energy Exchange in Leipzig (CCX, 2012; CES 2012; Theice, 2012, World Bank, 2012).

5. Dynamics of the global carbon market

The 1990-2009 inventory of CO2 emissions from Annex I countries showed a decrease of 17.61% in total emissions, from 17.673 MtCO2e[7] to 14.560, including the Land Use, Land Use Change and Forestry (LULUCF) sector[8]. Even without considering LULUCF, emissions fell from 19,042 MtCO2e in 1990 to 16,844 MtCO2e in 2009, an 11.5% drop. The largest reductions were observed in Eastern European countries, probably influenced by the modernization of their formerly obsolete and inefficient industrial plant, but also by the poor performance of world economies in recent years. Despite the overall drop, many countries showed a significant increase in emissions, such as Turkey, Canada, Australia, and Spain

[7] Greenhouse gases must be converted to the CO2 standard , thus the acronym MtCO2e means million tonnes of CO2 equivalent (UNFCCC, 1997).

[8] LULUCF—Land Use, Land Use Change and Forestry—covers projects related to carbon sequestration by forests, including afforestation and reforestation.

(including LULUCF). Countries showing the highest reductions were: Russian Federation, UK, Poland, and Germany (Table 1). What can be concluded is that global emissions were reduced overall, but mainly due to the economic crisis of recent years, despite increased emissions in some countries.

País	Emissões CO_2e (com LULUCF)			Emissões CO_2e (sem LULUCF)		
	1990	2009	% Redução	1990	2009	% Redução
Estados Unidos	5.320.257	5.618.165	5,6	6.166.812	6.608.227	7,16
União Européia	5.244.184	4.182.394	-20,25	5.588.798	4.614.526	-17,43
Federação Russa	3.449.581	1.477.756	-57,16	3.369.295	2.127.354	-36,86
Japão	1.196.976	1.137.690	-4,95	1.266.553	1.209.213	-4,53
Alemanha	1.216.727	937.262	-22,97	1.247.901	919.698	-26,3
Canada	523.777	679.734	29,78	591.262	691.834	17,01
Austrália	461.618	599.829	29,94	418.470	545.858	30,44
Reino Unido	783.308	565.987	-27,74	779.387	570.066	-26,86
França	526.288	458.483	-12,88	565.987	522.403	-7,7
Italia	457.362	396.449	-13,32	519.157	491.120	-5,4
Ucrania	863.316	354.875	-58,89	933.283	374.120	-59,91
Polonia	553.856	346.049	-37,52	564.517	383.225	-32,11
Espanha	264.110	338.920	28,33	283.168	367.548	29,8
Turquia	142.159	287.120	101,97	187.029	369.648	97,64
Holanda	214.544	201.347	-6,15	211.852	198.872	-6,13

Country	CO_2eEmission (with LULUCF)			CO_2e Emission (without LULUCF)		
	1990	2009	% Reduction	1990	2009	% Reduction
EUA	5.320.257	5.618.165	5,6	6.166.812	6.608.227	7,16
EU	5.244.184	4.182.394	-20,25	5.588.798	4.614.526	-17,43
Russian Federation	3.449.581	1.477.756	-57,16	3.369.295	2.127.354	-36,86
Japan	1.196.976	1.137.690	-4,95	1.266.553	1.209.213	-4,53
Germany	1.216.727	937.262	-22,97	1.247.901	919.698	-26,3
Canada	523.777	679.734	29,78	591.262	691.834	17,01
Australia	461.618	599.829	29,94	418.470	545.858	30,44
UK	783.308	565.987	-27,74	779.387	570.066	-26,86
France	526.288	458.483	-12,88	565.987	522.403	-7,7
Italy	457.362	396.449	-13,32	519.157	491.120	-5,4
Ukraine	863.316	354.875	-58,89	933.283	374.120	-59,91
Poland	553.856	346.049	-37,52	564.517	383.225	-32,11
Spain	264.110	338.920	28,33	283.168	367.548	29,8
Turkey	142.159	287.120	101,97	187.029	369.648	97,64
Holand	214.544	201.347	-6,15	211.852	198.872	-6,13

Source: Data based on UNFCCC (2012 a).

Table 1. Countries with higher emissions and reduced effective CO2e emissions reductions in Mt (thousand of metric tonnes)

5.1 Performance of the main carbon markets, EU ETS and CDM

Buyers of carbon credits can basically be divided into four categories: i. multilateral institutions; ii. funds from governments, as in the case of Austria, Belgium, and Denmark; iii. development banks, such as those in Japan and Germany; and iv. other commercial enterprises. Some of the major buyers of carbon credits are investment funds, such as the ones financed by the World Bank and the Government of the Netherlands.

The negotiations of certificates occur through private agreements using contracts and prices which are often confidential, without public records, and transactions are traded over the counter (OTC), i.e. without standardized regulations, which makes it difficult to obtain information. The prices differ greatly, in relation to market, project, risk, country, and other specifics.

Reflecting the global crisis and the uncertainty over the future of measures to reduce emissions, certificate prices have fallen in recent years, especially in 2011 and 2012 (Table 2). The drop in prices of carbon credits resulting from CDM projects was higher than that observed on the EU ETS market, especially by virtue of the lower risk its allowances operations pose to investors (World Bank, 2012).

The estimated average price of certified emissions reductions (CERs)[9] fell from US$11.8 (€ 9.1 / t) in 2010 to US$10.9 (€ 7.9 / t) in 2011. Also, the difference between the prices of certificates in the EU ETS and CDM became greater, mainly due to the lack of assurance of acceptance of CDM certificates after 2012 (Table 2).

Year	2005	2006	2007	2008	2009	2010	2011	2012
Price	3-7	6-24	12-25	25	17	16	8.5	4

Source: CCX (2012); WORLD BANK (2005, 2007, 2010, 2012)

Table 2. Average price of carbon credits (US$ / tCO2e)

China is in the top rank of countries that have purchased CERs (87% of the primary market), whereas Latin America, which in 2005 owned 20% of primary CER contracts,

[9] CERs(certified emission reduction) - Nomenclature used for carbon certificates resulting from CDM projects.

represented only 2% of the market in 2011 (the same portion as in 2010). African countries stood out in 2011. There was an increase in participation from this continent which accounted for 21% of issued CERs, mainly influenced by a higher interest in certificates by buyers from less developed countries. Organizations in the UK (followed by Switzerland) dominated the market for primary CERs in 2011, with 26% of transactions (World Bank, 2008, World Bank, 2012).

Another result of both the uncertainties of carbon markets and the global economic crisis is falling demand for certificates, resulting in oversupply. Even in this context, there was an increase of 17% compared to the total volume of certificates traded (Table 3). This can be justified when it is understood that a considerable part of the negotiations of the carbon credits was motivated by hedging, portfolio adjustments, and earnings prospects taking advantage of the low price of certificates.

Carbon Market	2010		2011	
	Volume (MTCO2e)	Value (M$US)	Volume (MTCO2e)	Value (M$US)
Emission Permit				
EU ETS	6.789	133.598	7.853	147.848
Other	373	1.336	228	1.033
Total	***7.162***	***134.935***	***8.081***	***148.881***
Emission reduction carbon market				
Secundary CDM	1.260	20.453	1.734	22.333
Other	16	184	88	917
Total	***1.276***	***20.637***	***1.822***	***23.250***
Primary CDM	224	2.675	264	2.980
Voluntary market	69	414	87	569
Other primary market	41	530	28	339
Total	***334***	***3.619***	***379***	***3.888***
TOTAL	**8.772**	**159.191**	**10.282**	**176.019**

Source: World Bank (2012).

Table 3: Volume and value traded on Global Carbon Markets

The European scheme remains the main actor in the global carbon market, reaching a volume of US$148 billion in permits traded in 2011, which represents an 11% increase since 2010. In terms of the volume of certificates traded, the increase was 27% (Table 3). The lower growth in value can be explained by the sharp fall in prices. Importantly, the countries' total reduction target, both within the EU ETS and Kyoto, has already been affected. This result, as already observed, is to a large extent due to the very weak global economic performance rather than reduction measures adopted by countries (Table 4). The fact that the overall goals have already been achieved shows the need for increased global reduction targets, likely to be agreed in the next determinations outlined by the European Community (EUETS, 2012; UNFCCC, 2012, World Bank, 2012).

Country	Effective emission reduction (A)	Emission reduction target (B)	(A - B)
EU	(974.272,00)	(341.241)	(633.031)
Russia	(1.241.941,00)	(172.818)	(1.069.123)
Japan	(57.340,00)	(75.680)	18.340
Germany	(328.203,00)	(258.810)	(69.393)
Canada	100.572,00	(35.640)	136.212
UK	(209.321,00)	(97.488)	(111.833)
Australia	127.388,00	(28.480)	155.868
France	(43.584,00)	(29.324)	(14.260)
Italy	(28.037,00)	(33.595)	5.558
Poland	(181.292,00)	(33.807)	(147.485)
Ukraine	(559.163,00)	(47.884)	(511.279)
Spain	84.380,00	(15.068)	99.448
Holland	(12.980,00)	(12.782)	(198)

Source: UNFCCC (2012). Data processed by the author.

Table 4: Countries with greater reductions; reductions in actual emissions; and reduction targets under the Kyoto Protocol

Despite the growth in the number of CDM projects (Table 5), reflecting the increase in the volume of traded carbon credit (Table 3), there are many difficulties in implementing a project. Studies (World Bank, 2012; Point Carbon, 2012) indicate that the clauses in existing

contracts for the purchase of carbon credit hinder market growth. As a result of the oversupply of carbon certificates, the interests of credit buyers prevail through the imposition of restrictive covenants on sellers, shifting most of the responsibility of project risks to the seller. Added to this barrier is a shortage of buyers of certificates in the initial stages of the CDM cycle, mainly influenced by the fact that many governments are gradually migrating to the secondary market for carbon credits. This change is occurring because the risks of the carbon credit are smaller in this market, besides the fact that the process of buying and selling is more simplified than in primary markets.

Year	Total	Annual Var
2004	1	
2005	62	6100%
2006	409	560%
2007	427	4%
2008	430	1%
2009	685	59%
2010	809	18%
2011	1.107	37%
Jan-Jul 2012	365	-67%
Total	4.295	

Source: UNFCCC (2012)

Table 5. Number of registered CDM projects worldwide, per year and annual variation

Other barriers related to markets pointed out by holders of CDM projects are failures of the calculations required to determine the emission reductions, projected difficulties in drafting contracts, problems of poor choice or poor definition of the methodology employed in the project, and excessive requirements to be met to implement a CDM. Besides these problems, which are not directly financial, spending on charges related to the CDM cycle (registration fees, payment audit etc) are further transaction costs that negatively influence the decision to implement a CDM (Godoy, 2011).

In an attempt to reduce the problems of transaction costs in the adoption of an CDM, while simplifying the deployment process, the UNFCCC has created a mechanism called programmatic CDM, or Program Activity (PoA). Through this program, it is possible that different projects come with only one contract, a request for registration with the Executive Committee, provided that they have some common features (like similar activities, region, project type). Despite the progress reflected in the number of ongoing projects (269 PoAs are being approved in 2011), the mechanism is still incipient (UNFCCC, 2012, WORLD BANK, 2012).[10]

Conclusion

The discussions relating to global warming assume a broad dimension: environmental, economic, political, and social. In seeking solutions to the problems of climate change there is a growing number of interests involved, most often conflicting. Despite the different approaches that exist, the thesis that prevails on this topic considers global warming a problem to be faced. It is also assumed as a consensus that the main cause is the increase in greenhouse gases in the atmosphere resulting from anthropogenic activities observed in recent decades. As a way to deal with this problem, carbon markets have arisen as an attempt to define property rights on emissions of greenhouse gases. The creation of these carbon trade provides flexibility in meeting the goal of reducing emissions by associating environmental improvement anchored by resources acquired through the sale of certificates, either in primary or secondary markets.

The available information on carbon trades is typically presented in technical language, often based on an understanding of international law, and existing studies generally incorporate the ideas and concepts in a non-consolidated basis, which complicates their understanding and applicability. However, carbon trade have several points in common through institutions, rules, and requirements. The structures arise from the bases of emissions certificates negotiations, defined beginning in the 1970's, and refer to the economic logic inherited from Institutional Economics, the need for defining property rights in the existence of externalities. Definitions of objective rules that underpin organizations dictate the

[10] One of the projects highlighted by the World Bank is a Brazilian initiative entitled "Carbon finance and integrated management of solid waste", which seeks to support Brazil's National Policy on Solid Waste, coordinated by the Caixa Economica Federal. This project has potential to generate reduction of 30 million tons of CO2e distributed over the next 15 years.

development of markets. In addition to the formal, regulated, rules, other factors can affect the efficiency of these markets: greater government participation to actively promote and encourage an environment where transactions occur; the specificities of each region involved; and the habits and culture of the people who reflect the absorption of formal rules, i.e. reducing transaction costs so that the direct property can be better defined. All these factors, which affect the social behavior of a society, interfere in good market development.

Since markets are influenced by many factors, and despite having basic assumptions common to all, some grow more than others. The carbon market resulting from the Clean Development Mechanism appears more timid than the EU ETS. However, Kyoto has created unique tools for achieving its goals, the flexibility mechanisms that enable the joint participation of various stakeholders whether they have emissions reduction targets or not. In the case of the CDM, there is incentive for international cooperation, since it promotes increased investment in developing countries. Although there are criticisms of the Protocol, it is worth remembering that an important feature of Kyoto is that before any decision is made or any rule is changed there must be consensus among all signatory countries, so the targets and other reduction rules proposals are set in the agreement, something quite complicated given the large number of participating countries.

Initiatives to attract the competitive participation of the private sector are essential for the identification and implementation of lower-cost solutions aimed at mitigating and adapting to climate change. Market mechanisms are economic instruments that allow private participation, with particular interest in reducing emissions. Alternatively, the financial interest of participants increases, since profit may accompany the environmental benefits. However, the participation of private capital in the deployment of low-carbon technologies has been hampered by low certificate prices in the short term and the absence of projected future price increases. Uncertainties about the carbon market and global economic difficulties lead interested parties to opt for investments and lower-risk markets. The adoption of more ambitious targets by many countries, improving on the rules on carbon markets such as the CDM and the EU ETS, would bring greater interest in participating. The emergence of a growing number of local emission reduction measures result in a new paradigm, the need for standardization of various markets for transaction of reduction certificates and permits. Given awareness of this dilemma, several standardized markets should be sought with the intent of

increasing transparency, reducing information asymmetry, and thereby reducing transaction costs. The challenge will be to define a path for continued development of such individual initiatives by binding and restructuring global carbon.

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