POST KYOTO: DOES CARBON EMISSIONS TRADING HAVE A FUTURE?

Martine van der Vlugt
Studentnummer 186180

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Doctoraalscriptie, Erasmus Universiteit Rotterdam
Scriptiebegeleider H.R.J. Vollebergh

Contents

Preface

The Kyoto Protocol, the allowance and credit trading schemes based on it and the question as to whether or not it should be continued after 2012, is a polarizing issue. One is either for it or against it, or so it seems, and that is then all too easily equated with being for or against "the environment". Also, the reasons cited for one's standpoint are often remarkably unbalanced: thus for example, one may find arguments "for" (post-) Kyoto such as 'although not perfect, it's the best we have' (without any further explanation), or arguments "against" (post-)Kyoto like 'as long as China and India do not participate, any mandatory cap is worthless'.

The views on the success of the carbon emissions trading scheme introduced by the European Union are equally opposing. One the one hand, one can hear or read very enthusiastic accounts of the hundreds of millions metric tonnes of CO_2e traded, on the other hand one hears professional traders of financial assets and commodities explaining that the "carbon market" is not interesting at all because the liquidity is far too low.

Especially the latter dichotomy has led to the subject of this essay. It tries to answer the question "does carbon emissions trading have a future" by assessing the merits of both the Kyoto Protocol and the European Emissions Trading Scheme on the basis of criteria generally used to judge the efficiency of financial and commodities markets. Because if the efficient trading of emissions (permits/allowances or credits) is viable, even if only in theory as yet, a strong case can be made for the continuation of the market-based model of the Kyoto Protocol. If, however, it turns out that the model of emissions trading has inherent obstacles which make efficient trading an unattainable ideal, then one should seriously question any continuation of the Kyoto Protocol.

The realization of this paper has been quite a long and difficult process, mostly because of the perennial scarcity of time. As it is with these things, however, one is fortunately never all alone, and I wish to express my gratitude to all those that have contributed to the realization of this paper. These are first of all my mother and my daughter, who each in her way provided me with all those precious bits of time (an hour here, a morning there) that I could string together to produce this paper. Then there are those, named in chapter one, that made their time available for the interviews. And those that provided the introductions for the abovementioned interviews, which are Mr. Van den Burgh (who provided the introduction to Ms. Van Klaveren), Ms. Feldbrugge and Mr. Wind (who jointly provided the introduction to Mr. Koutstaal), Mr. Van Heijst (who provided the introduction to Mr. De Haan), Ms. Evertsz (who provided the introduction to Mr. Douwes and Ms. Hsu) and Ms. Steen-Luijten (who provided the introduction to Mr. Boonman). And my colleagues at Optiver, most notably Mr. Van Heijst, who provided me with important information on the practical aspects of trading. And last but not least, Mr. Vollebergh of the Erasmus University in Rotterdam who provided me with much information on the subject and with his guidance on this paper.

Chapter one
Introduction

Purpose of this paper

This paper will investigate whether one of the basic economic models underlying the Kyoto Protocol – the trading of carbon emission permits- is viable in practice. While in theory the model is often considered to be the most efficient means to achieve a reduction in the concentration of carbon dioxide in the atmosphere, in practice the results so far have been doubtful. This may be due to practical difficulties that can be overcome in the future, or it may be due to fundamental obstacles that probably cannot be overcome in the (near) future. Of course, a combination of the two types of difficulties may also be possible. It is the aim of this paper therefore to investigate the difficulties that have been experienced with carbon emissions trading to date, to evaluate the nature of these difficulties (are they of a passing or fundamental nature) and, on the basis thereof, to make some predictions as to the viability of carbon emissions trading in the future.

While the goal of this paper is therefore to investigate the practical functioning of the trading model in general, a large part of the investigation will consist of the evaluation of the EU ETS, the largest carbon emission trading scheme implemented to date.

This paper will not contain a description of the phenomenon of global warming itself, and its possible present and future effects. It will be taken as a given that the rising levels of carbon dioxide in the atmosphere are posing threats to mankind and live on earth in general, and are therefore undesirable. Also, this paper will not compare the efficiency and/or optimality[1] of carbon emissions trading with that of other instruments available such as taxes or prescriptive regulation. It will be described why the trading model, when functioning properly, is an efficient means to limit carbon emissions and it will then be investigated whether this model is viable in practice. The question whether, and for what reasons, the trading model should or should not be chosen over one or more of the other instruments will not be discussed.[2]

At this point it should be noted that if a trading model does not function efficiently this does not mean that the environmental objectives – the desired reduction of carbon emissions – cannot be met. This ultimately only depends on whether compliance with the cap, which quantifies the desired reduction, is enforceable. A trading model that does not function properly does however entail that the costs of the reduction are higher than anticipated, which may be an important factor in considering whether or not the trading model should indeed be the preferred instrument to achieve the desired carbon emission

[1] Following Perman (2003), optimality is related to the maximization of the overall objective of a society, given any relevant constraints that may be operating. The optimality of the trading model will not be discussed, other than when the interaction between the trading model and the other two mechanisms of the Kyoto Protocol (JI and CDM) is described.

[2] Doing so would require a similar investigation of each of the other instruments in addition to a discussion of all the political considerations and would therefore fall outside the scope and purpose of this paper as a "doctoraal scriptie".

reductions.

This paper is written from a trader's perspective. It stands, as it were, with its feet on the trading floor[3] and looks at carbon emissions trading with a trader's view, asking only one question: can I make money by trading carbon emissions rights? Translated into more scholarly and probably more acceptable language: Can the trading of carbon emission rights "work" in practice, can it indeed become an efficient way to curb carbon emissions? Because although often forgotten by those that are concerned with the curbing of carbon emissions and/or the implementation of carbon emissions regulation, including by those implementing regulation to foster the trading of carbon emission rights, trading is ultimately only done for one purpose by those engaged in it: to be better off as a result of the trading, either because they profit from the trading itself (buying low, selling high) or because they profit from the end result (they had the asset and they prefer the cash they received for it, or vice versa). The idea being then, of course, that all these individual entities or persons pursuing their own interest will, collectively, further the public interest as efficiently as possible. To quote Adam Smith (1776, Book IV, Ch.2., p.447)[4]:

"But it is only for the sake of profit that any man employs a capital in the support of industry; and he will always, therefore, endeavour to employ it in the support of that industry of which the produce is likely to be of greatest value, or to exchange for the greatest quantity, either of money or of other goods.
As every individual, therefore, endeavours as much as he can both to employ his capital in the support of domestic industry (…) (h)e generally, indeed, neither intends to promote the public interest, nor knows how much he is promoting it (…) he is, in this as in many other cases, led by an invisible hand to promote an end which was no part of his intention (…) By pursuing his own interest he frequently promotes that of society more effectively than when he really intends to promote it."

<u>Structure of this paper.</u>

The structure of this paper is as follows:

Chapter two will describe the economic rationale behind carbon emissions trading as a means to achieve – through the pursuit of personal profit – a public goal. In other words, it will describe a modern day version of Adam Smith's "invisible hand". It will contain a description of the challenge to internalize the costs of a global public "good", or rather "bad", such as the rising levels of carbon dioxide in the atmosphere and it will describe the theoretical model underlying carbon emissions trading.

In *chapter three* a basic set of criteria will be identified, the fulfillment of which is considered a necessary condition for a trading model to be viable in practice. These criteria will as much as possible be specified in practical terms. Thus, the criterion

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[3] Or rather, in the dealing room, as floor trading has disappeared almost everywhere and is certainly non-existent for carbon emissions trading.
[4] As quoted in Perman (2003, p. 5).

“efficient markets”, always cited as a “conditio sine qua non” for the success of any market model, including the market for carbon emissions and usually assumed to be fulfilled, will be critically assessed in real life terms: what could these markets be in the present and near future, what are the criteria by which they can be judged as efficient, could these criteria potentially be met in practice with respect to carbon emissions trading?

Chapter four will assess the Kyoto Protocol on the basis of the criteria developed in chapter three. After a brief description of the most salient aspects of the Protocol, the three market-based instruments of the Protocol will be considered. Subsequently it will be assessed if, and to what extent, the Kyoto Protocol meets the criteria identified in chapter three. Due to the rather general and abstract nature of the Protocol, this assessment is necessarily very limited.

Chapter five will look at the European Emissions Trading Scheme (EU ETS). After a short description of this scheme this chapter will proceed with an evaluation of on the basis of the criteria identified in chapter three. It will be considered whether the relative success or failure of the scheme can be linked to the extent to which the criteria identified in chapter three as necessary conditions for the viability of the trading model have been met.

Chapter six will consider the future of carbon emissions trading. It will discuss the achievability of the criteria developed in chapter three, the extent to which current plans for the “Post-Kyoto phase” meet these criteria and the difficulties still to be overcome.

The Conclusion will summarize whether and to what extent the flaws (or failure to meet the criteria) in the current trading schemes are either of a fundamental nature or of a passing nature, whether and to what extent these flaws are addressed in the current plans for the “Post-Kyoto phase”, whether and to what extent these flaws can be amended in theory and, ultimately, whether or not carbon emissions trading does have a future.

Sources for this paper

Apart from the literature as listed in the Bibliography, this paper is also based on the information obtained in interviews with Ms. Van Klaveren of the Netherlands Ministry of Economic Affairs[5], with Mr. Koutstaal, formerly inspector of the Netherlands Ministry of Finance and currently program leader regulation (programmaleider regulering) with the Netherlands Central Planning Agency (Centraal Plan Bureau)[6], with Mr. Dobber[7], with Mr. De Haan, commercial director of the European Climate Exchange[8], with Mr. Douwes of the Capital Markets group and Ms. Jiefan Hsu of the Structured & Project Finance

[5] The interview took place on March 7, 2007.
[6] The interview took place on May 10, 2007, when Mr. Koutstaal was still at the Ministry of Finance.
[7] The interview took place on May 24, 2007.
[8] The interview took place on May 25, 2007.

group of Deloitte Financial Advisory Services B.V.[9] (on June 1, 2007) and with Mr. Boonman, head of environmental markets origination at Fortis Bank.[10] In addition, the author has drawn extensively on the knowledge of trading and of financial markets present at her employer Optiver, a proprietary arbitrage trading company.

[9] The interview took place on June 1, 2007.
[10] The interview took place on June 14, 2007.

Chapter two
The theory of carbon emissions trading

Adam Smith (1723-1790) was the first to recognise the importance of markets for the efficient allocation of scarce resources. His is the famous statement of the role of the "invisible hand" which is cited in chapter one. The resources that Adam Smith had in mind, however, were essentially all "private" resources such as labour and money. That is to say, there was generally no question as to who owned the private property rights to those resources. Because of this, those resources were automatically tradeable on the various markets.

The theory of Adam Smith does however not work readily with respect to those resources for which no private property rights exist by nature or by convention[11]: the so-called "public goods". The defining characteristics of public goods are rivalry (is one agent's consumption at the expense of another's consumption?) and excludability (can agents be prevented from consuming?). Only goods that are both non-rivalrous and non-excludable qualify as "pure" public goods, while only goods that are rivalrous and excludable qualify as "pure" private goods. There are many intermediate types of goods, which are either rivalrous but non-excludable, or vice versa, but which do share the characteristic with pure public goods that no private property rights exist *a priori* with respect to these goods. Many natural resources qualify as public goods, either pure (e.g. the air we breathe) or intermediate (e.g. the fish in the ocean). A concept closely related to public goods is that of externalities. An externality is an unintended and uncompensated effect of one agent's action on the utility or profit of another agent. A clear example of an externality is air pollution caused by industry. Although an externality can in principle occur both in respect of private goods and in respect of public goods, it is usually in respect of public goods that externalities are most problematic. This is because the absence of private property rights with respect to the public goods that are affected makes it difficult to assign liability and impose the obligation to compensate for the negative effects of the externality.[12] Nonetheless, it has long been – and often still is - a popular rule of thumb that the "cost" of externalities should be borne by those causing the externality. In short, "the polluter pays"[13].

It was Coase (1960) who was the first to recognise that the maxim of "the polluter pays" as a means to address the "social cost" of externalities was fundamentally flawed. It was also Coase who was the first to recognise that, although public goods may in principle not fit Adam Smith's solution, market transactions may still be a very important means to achieve optimal allocation of social cost. However, as Coase also pointed out, because of the "non-private" nature of public goods, the market-based solution will only work if

[11] This is not to say that private property rights cannot be assigned to such goods. Indeed, this is considered an important remedy against harmful externalities, as set out further in this chapter. However, such private property rights do not come "naturally" and are always assigned purposefully by active government regulation.

[12] It is of note that externalities may also be beneficial. In this case, the problem is the lack of compensation by those positively affected by the externality to the generator of the externality.

[13] Although simple in concept, this rule of thumb is rather more difficult in practice: because no one "owns" the affected public goods, to whom should the compensatory payment be made?

private property rights are assigned to these public goods. Because of the importance of Coase's ideas for the carbon emissions trading model, his ideas will be discussed here in more detail.

In his article, Coase criticizes the idea, generally held until then[14] and specifically advocated by Pigou (as referred to in the article of Coase)[15], that it is always "the polluter (who) should pay". In Coase's words (p. 1), *"The conclusions to which this kind of analysis seems to have led most economists is that it would be desirable to make the owner of the factory liable for the damage caused to those injured by the smoke, or alternatively, to place a tax on the factory owner varying with the amount of smoke produced and equivalent in money terms to the damage it would cause, or finally, to exclude the factory from residential districts (and presumably from other areas in which the emission of smoke would have harmful effects on others)."*

As Coase makes clear, this type of reasoning is fundamentally flawed, as it fails to take into effect the benefits that the factory may bring to society. Thus, in deciding which party should pay to which other party (the factory paying those hindered by the smoke, or those hindered by the smoke "paying" the factory by having to accept the smoke of the factory without compensatory payments), the overall costs to society (whereby "costs" include the "social costs" usually not expressed in monetary terms, such as pollution) should be weighted against the overall benefits to society (whereby "benefits" include the "social benefits" such as a higher rate of employment is the area)[16]. While the measuring of such overall costs and overall benefits obviously is not very easy, fortunately there is a rather easy way to determine who should be paying to whom, and how much: market transactions. By means of various practical examples, Coase demonstrates that – *provided market transactions are costless* – market transactions ensure that the costs and resources will always be allocated such that the overall effect for society is optimal. For this result to be obtained, however, an important preliminary condition has to be fulfilled: the assignment of legal liability on either of the parties concerned. This is not because the decision which party is to be held liable is relevant for the ultimate result, as this result will be the same (an optimal allocation of resources) regardless of which party is held liable. But this is because without the assignment of legal liability the market transactions that are necessary to obtain the optimal result may never occur. In Coase's words (p. 8): *"It is necessary to know whether the damaging business is liable or not for damage caused since without the establishment of this initial delimitation of rights there can be no market transactions to transfer and recombine them. But the ultimate result (which maximizes the value of production) is independent of the legal position if the pricing system is assumed to work without cost."*

[14] This idea is still surprisingly popular today.
[15] A.C. Pigou, The Economics of Welfare 183 (4th ed. 1932)
[16] In fact, Coase is aware that the cost-benefit analysis should ultimately encompass all types of monetary and non-monetary, material and non-material costs and benefits, as he states (p. 43): "But it is, of course, desirable that the choice between different social arrangements for the solution of economic problems should be carried out in broader terms than this and that the total effect of these arrangements in all spheres of life should be taken into account".

Coase however realizes that the assumption that there are no costs involved in carrying out market transactions is very unrealistic. Market transactions do involve costs; costs of information, costs of negotiation, costs of contract, costs of inspection (are the terms of the contract honored?) etc. As a result of these costs, many transactions necessary for the optimal allocation of resources may never take place. Coase proposes two possible solutions for this dilemma. One is to bring the economic activity that is increasing the value of production on the one hand, but is causing the harm on the other hand, within the confines of a firm, thus presumably lessening the transaction costs. This idea is only very briefly treated in the article[17] and will not be discussed further here. Another possible solution is direct government regulation[18]. Coase (p. 18) is however very critical of this latter possibility: *"Furthermore there is no reason to suppose that the restrictive (...) regulations made by a fallible administration subject to political pressures and operating without any competitive check, will necessarily always be those which increase the efficiency with which the economic system operates."* Later on in his article, Coase discusses a special type of government regulation: taxation. Coase considers that only one type of taxation may lead to potentially optimal results, and that is a tax which is based (p.41) "(…) on the fall in the value of production (in its widest sense)" resulting from the damage-causing factor. But he views this as an unattainable ideal, since *"(...) to do so would require a detailed knowledge of individual preferences and I am unable to imagine how the data needed for such a taxation system could be assembled."* Finally of course there is the option to do nothing at all. In which case the importance of the courts delimiting the legal rights and obligations of each party become all the more important. As Coase puts it (p. 27*) "In a world in which there are costs of rearranging the rights established by the legal system, the courts, in cases relating to nuisance, are, in effect, making a decision on the economic problem and determining how resources are to be employed."*

Coase explicitly states that his article is merely meant to make the relevant decision makers (most notably lawmakers and judges) aware of the fact that "the polluter pays" dogma frequently upheld is wrong and that regard should be had to the total social effect when deciding upon legal liability. He discusses the limitations of the various solutions he proposes to obtain the optimal social result and clearly states that the mechanism of market transactions will only work if there are no transaction costs, which he considers an unrealistic scenario. Nonetheless, from the article it transpires that Coase's preference is clearly with the pricing mechanism inherent in market transactions, as he states (p. 40): *"The main advantage of a pricing mechanism is that it leads to the employment of factors in places where the value of the product yielded is greatest and does so at less cost than alternative systems."*

Finally, Coase makes a very important observation regarding the nature of the "production factors" usually considered when making the cost-benefit analysis. Thus he states (p. 43, 44):

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[17] But more extensively in another writing of Coase, to which he refers, which is "The Nature of the Firm", 4 Economica, New Series, 386 (1937).
[18] As Coase states (p. 17): "The government is, in a sense, a super-firm (but of a very special kind) since it is able to influence the use of factors of production by administrative decision."

"A final reason for the failure to develop a theory adequate to handle the problem of harmful effects stems from a faulty concept of a factor of production. This is usually thought of as a physical entity which the businessman acquires and uses (an acre of land, a ton of fertilizer) instead of as a right to perform certain (physical) actions. (…) If factors of production are thought of as rights, it becomes easier to understand that the right to do something which has a harmful effect (such as the creation of smoke, noise, smells, etc.) is also a factor of production. (…) The cost of exercising a right (of using a factor of production) is always the loss which is suffered elsewhere in consequence of the exercise of that right – the inability to cross land, to park a car, to build a house, to enjoy a view, to have piece and quit or to breathe clean air."

As this paper is about carbon emissions trading, a more specific description of the nature of carbon emissions as an externality is warranted, as this will have consequences for the possibilities and design of a market-based approach to address this externality.[19] Before narrowing down to carbon emissions, however, a few general observations in respect of Coase's theory should be made. First, it should be observed that Coase himself clearly recognizes that the theorem named after him – namely that given an assignment of property rights, private bargaining between individuals can correct externality problems and lead to efficient outcomes and that this holds regardless of whether these property rights are assigned to the generator of the externality or the affected party – only works in the absence of transaction costs. This is very relevant because the absence of transaction costs is an unrealistic scenario, as Coase also recognized. Given the reality of transaction costs, either one, or more likely both, parts of the Coase theorem (private bargaining will correct externality problems *and* it is in principle not relevant to which party the property rights are assigned) will no longer hold. Therefore, the issue of the allocation of the property rights is very important. This issue will be discussed more fully below in relation to carbon emissions rights. Second, it should be noted that even if the Coase theorem holds, the decision as to which party the property rights are assigned – the generator or the affected party – does affect the wealth of either of the parties. Generally speaking, the property rights represent a value that can be quantified in monetary terms and therefore the (relative) wealth of the party to which these rights are assigned increases with the value of these rights whereas the (relative) wealth of the party to which these rights are not assigned decreases. In other words, it is important to note that efficiency is not the same as equity and that efficient outcomes can still be very inequitable.

The distinction between efficiency and equity is very well captured in the two fundamental theorems that Perman (2003, p. 123) considers "(…) the formal foundations for modern welfare economics and its application to policy analysis in market economies". According to the first theorem, a (any) competitive market equilibrium is an efficient allocation. According to the second theorem, to every efficient allocation there corresponds a competitive market equilibrium, which is based on a particular distribution

[19] As Tietenberg (2007) observes (p. 64) "At the most general level, the major conclusion of this review is that context does matter. The various resources being controlled by tradeable permits have different characteristics, and those characteristics affect program evaluation, design, and effectiveness."

of initial endowments. Thus, a competitive market equilibrium can be made more equitable – or rather, can be replaced by another more equitable market equilibrium - by changing the distribution of initial endowments. Lump-sum taxes and transfers may achieve this. What governments should not do, however, is intervene in markets directly to pursue equity objectives. Efficiency, in other words, is to be left to the markets and to the markets alone. Governments should be concerned with equity alone. Any inequities in the outcome of the functioning of the market mechanism should be corrected through redistributive taxes and transfers *outside of and apart from* the market mechanism.

It is now time to narrow down the theoretical considerations to the subject of this paper: carbon emissions[20]. What are the characteristics of carbon emissions and what consequences do these characteristics have for the design and functioning of a (market) mechanism aimed at controlling or curbing these emissions? First, carbon dioxide is a stock pollutant (as opposed to a flow pollutant). That is to say, the damages caused by carbon dioxide depend only on the accumulated level, or stock, of the pollutant in the environment. The flow of the pollution, that is to say the rate at which the pollutant is being discharged in the environment, is irrelevant[21], except of course for the fact that the rate of the flow (the intensity of the emissions) determines the rate of increase of the stock. In addition, the emissions of carbon dioxide are uniformly mixing. By this it is meant that the emissions quickly become so dispersed in the atmosphere that the concentration rates do not vary from place to place. Thus, the location of the emissions source, or in other words the spatial dimension of emissions control, is irrelevant. The temporal dimension of emissions control, however, is highly relevant. This is because it is the accumulated stock of the pollutant over time that is determining the level of damages *and* because carbon emissions have only a very slow rate of decay. To represent this algebraically, if M denotes the level of carbon emissions, A represents the emissions stock size, and the parameter α indicates the rate of decay, then the rate of change of the carbon emissions stock over time can be written as

$$dA/dt = M_t - \alpha A_t$$

whereby $0<\alpha< 1$ (and in the case of carbon emissions, rather closer to 0).

What are the policy implications of the above characteristics? First, although it is ultimately the stock of the pollutant that matters, the only way to control this is through a control over the emissions. So it is the flow that gets controlled. Second, because of the uniformly mixing character of carbon emissions, the location or locations at which the control takes place is/are irrelevant. So how then is it determined where the control takes place, and in what manner? Various criteria are conceivable, based on equity, efficiency or a combination of the two. One of the criteria most often used, in any event by economists designing the theoretical framework of a control mechanism, is that this control mechanism be cost-effective. By this it is meant that the chosen control

[20] The correct term is of course “carbon dioxide emissions”, but in this paper the shorthand version “carbon emissions” will also be used.
[21] To understand the concept of pure flow pollutants, think of loud noise or intense light: the moment the emissions flow stops, the damage will immediately drop to zero.

mechanism, among all possible control mechanisms, achieves the pollution control at the lowest cost. A necessary condition for this is that the marginal cost of pollution control (also called "abatement") be equalized over all controlled entities (also called "abaters"). This is known as the "least-cost theorem of pollution control" (Perman, 2003, p. 204).

Now let's consider the various possible control mechanisms and see how they fare under the cost-effectiveness constraint. Broadly speaking, the possible mechanisms can be classified in either of two classes (Perman, 2003, ch. 7). The first class consists of the so-called "command and control" instruments, such as technology requirements and non-transferable output quotas. These instruments impose mandatory obligations or restrictions on the behaviour of firms and individuals. The second class consists of incentive-based instruments, that is to say instruments that create incentives for firms and individuals to voluntarily change their polluting behaviour. This class can be further divided into three subclasses: taxes, subsidies and marketable permits. To see how these mechanisms fare under the cost-effectiveness constraint, it is best to represent this algebraically. The following algebraic representations are from Perman (2003, Appendix 7.1).

The least-cost theorem can be written as:

(1) $$\text{Min} \sum_{i=1}^{N} C_i \text{ subject to } M^* = \sum_{i=1}^{N} M^*_i$$

whereby
M^* = predetermined total emission target
M^*_i= the (optimized) emissions limit for the firm
and
C_i = firm i's abatement costs.

Abatement costs are a function of the severity of the emissions limit the firm faces. If it assumed that the abatement cost function is quadratic, then this function may be represented as:

(2) $$C_i = (\alpha_i - \beta_i M^*_i + \delta_i M^{*2}_i)$$

To solve the problem of the least-cost theorem, a mathematical technique called the Lagrangian (L) can be used. This technique is very useful to solve a problem whereby a function is to be minimized or maximized, subject to certain constraints. The Langrangian consists of two components. The first is the function to be minimized or maximized, while the second component contains the constraint function or functions, each constraint function preceded by a separate Lagrange multiplier variable. These Lagrange multiplier variables may be interpreted as the "shadow prices" of the constraints.
In the case of the least-cost theorem, there is a function to be minimized (the cost function C) subject to one constraint, which is that the predetermined total emission target M^* be met. Thus, the Lagrangian for the least-cost theorem may be written as:

(3) $L = \sum_{i=1}^{N} C_i + \mu (M^* - \sum_{i=1}^{N} M^*_i)$ =>

$$L = \sum_{i=1}^{N} (\alpha_i - \beta_i M^*_i + \delta_i M^{*2}_i) + \mu (M^* - \sum_{i=1}^{N} M^*_i)$$

The necessary first-order conditions to obtain the required minimum (least-cost solution) are:

(4) $\delta L / \delta M^* = - \beta_i + 2\,\delta_i M^*_i + \mu^* = 0, \; i = 1,2, \ldots, N$ and

(5) $\delta L / \delta \mu = - M^* + \sum_{i=1}^{N} M^*_i = 0$

Solving equations (4) and (5) would give each firm's – optimized - emission limit M^*_i and the – optimized – shadow price of the pollution constraint (the Lagrange multiplier) μ^*. Note that μ^* is constant and the same for each firm.

In the case of command and control instruments, non-transferable and specific restrictions are imposed on each firm. As follows from the above equations, especially (4) and (5), in order for those restrictions to lead to M^*, M^*_i needs to be known for each firm. And to derive M^*_i each firm's specific cost function C_i needs to be known by the regulator imposing the restrictions. Given the lack of incentive for a firm to disclose its specific cost function to the regulator, the likelihood that command and control instruments may lead to the total emissions target at least cost is very small.

For taxes and subsidies, an important characteristic is that the rate – the amount of tax levied per unit of emissions or the amount of subsidy paid per unit of emissions reduction – needs to be the same for each firm. Then as follows from the above equations, in order for the total emissions limit M^* to be reached, the tax or subsidy rate needs to equal μ^*, the optimized shadow price of the pollution constraint. And the only way to derive μ^* is that the emissions limit for each firm, M^*_i be known. For which, again, it is necessary for the regulator imposing the restrictions to know each firm's specific cost function C_i. So for taxes and subsidies the same problem exists as for command and control instruments: Given the lack of incentive for a firm to disclose its specific cost function to the regulator, the likelihood for these pollution control instruments to be cost-effective is very small.

Now let's look at marketable permits. In order to reach the predetermined total emissions target M^*, the regulator will set the total supply of permits (for one unit of emission per permit) equal to M^*. Represented algebraically:

(6) $M^* = \sum_{i=1}^{N} L^0_i$

whereby
L^0_i = quantity of (units of) emissions originally issued to the *i*th firm.

The cost-function of each firm is now the sum of abatement costs and the costs of trade-acquired permits:

(7) $\mathrm{CL_i} = C_i + P(L_i - L^0_i)$ =>

$\mathrm{CL_i} = \alpha_i - \beta_i M^*_i + \delta_i M^{*2}_i + P(L_i - L^0_i)$

whereby
L_i = quantity of (units of) emissions the firm will produce after trade; and
P = market price of one emission permit

Since the quantity of (units of) emissions the firm will produce after trade L_i is equal to the (optimized) emissions limit for the firm M^*_i, equation (7) may also be written as:

(8) $\mathrm{CL_i} = \alpha_i - \beta_i L_i + \delta_i L_i^2 + P(L_i - L^0_i)$

In addition, since the total supply of permits is equal to M^*, the constraint that the total emissions target be equal to the sum of the emissions limit for each firm is automatically met (albeit that for this constraint to be met, M^*_i does not necessarily need to be the optimized emissions limit of the firm).

This time therefore, the necessary condition for minimization is:

(9) $\delta \mathrm{CL_i} / \delta L_i = - \beta_i + 2\, \delta_i L_i + P = 0, \; i = 1,2, \ldots, N$

Comparing equation (9) with equation (4) shows that P, the market price of one emission permit is equal to μ^*, the optimized shadow price of the pollution constraint (and note that after this condition has also been met, M^*_i is the optimized emission limit of the firm). So by letting the market set the price P of an emission permit, the requirements of the least-cost theorem can be met and the emissions target can be realized at least cost. Moreover, this target may be reached regardless of the initial distribution of permits and without the regulator having to know each firm’s abatement cost function. Which confirms the Coase-theorem.

As follows from the above, then, the guiding principle for the selection of marketable permits as the optimal pollution control mechanism is cost-effectiveness, while the determining factor has been the minimization of the information imbalance between the polluters on the one hand and the regulator on the other hand.

It is interesting to note that this ultimate determining factor is what is also at the core of "mechanism design theory", a theory[22] which focusses on the problems associated with incentives and private information and which, as The Economist (20 October 2007) puts it "(…) goes to the heart of one of the biggest challenges in economics: how to arrange our economic interactions so that, when everyone behaves in a self-interested manner, the result is something we all like." Which sounds like a modern-day version of Adam Smith's words and which is also reflected in Coase's intuitive struggle to determine whether "the problem of social cost" should be solved by the markets, within a firm or under another institutional arrangement (such as by government intervention).

Another thing that is of note with respect to the above mathematical analysis is that while the market mechanism does appear to neutralise the information imbalance between the polluters and the regulator, it only does so with respect to the price-setting problem. It does not solve the problem, also based on an information imbalance, of how to determine the total emission limit in order to reach a certain emission reduction, at least not if this reduction is set as a relative goal, such as a percentage of current pollution. It is of note that a distinction should be made here between the total limit of, let's say, a country and a "micro" limit of let's say a paper mill. On the aggregate level, countries usually have a pretty good idea of their total emissions and are able to monitor these. The problem however is how these total emissions should then be broken down into emission levels per polluting entity. This is especially relevant if an emissions trading system is set up which will only cover part of the emitting sources.[23] In such case, the aggregate cap will have to be broken down in two "sub-caps", one to cover the entities or sectors subject to the cap and one to cover the other entities and sectors. If the emissions trading system also provides for the grandfathering of permits and the government wants to act as equitable as possible, the sub-cap effectively has to be broken down into micro caps per polluting entity. The market mechanism does not provide a solution for this. In other words, it does not answer the questions as to who are the polluters and how much they emit without emission constraints. It also does not solve the problem, once a permit system is there, of how to determine whether a firm indeed only emits as much as is covered by its permits.

The latter problem is a problem of monitoring and control, or compliance. A further study of this problem would fall outside the scope of this paper, but suffice it to note that this problem is a consequence of the nature of carbon emissions as a uniformly mixing pollutant and that this problem exists with all of the incentive-based mechanisms (taxes, subsidies and marketable permits) described above. The only sort of instrument that would allow this problem to be solved in a relatively easy manner are specific types of command and control instruments that either control the input used by a polluting firm or impose technoligical requirements on the production methods. The former problem (how

[22] For which its most important proponents, Leonid Hurwicz, Erik Maskin and Toger Myerson, have won the Nobel Prize in economics in 2007.

[23] And in fact an emissions trading system will probably always cover only part of the emitting sources, as it will be very difficult to have all individuals (that are driving cars, cooking dinner etc and thus are all emitting sources) participate in an emissions trading system.

many marketable permits should there be and how should they be distributed initially) is the problem of allocation, to which we shall turn now.

As mentioned before, Coase was one of the first to recognise that the way the private property rights created to correct the externality (in this case, the carbon emission permits) are allocated is of great importance. Firstly, this is because of equity considerations; even if ideal market circumstances exist and therefore the initial distribution is not relevant for the ultimate, efficient, outcome, the initial distribution does determine the relative wealth of the participants in that market. However, the initial allocation may also be important because of efficiency considerations; given that ideal market circumstances most likely do *not* exist, trading may not or not always take place, and therefore the initial allocation will to a larger or smaller extent determine the ultimate "equilibrium" allocation.

There are two principal manners in which tradeable permits may be allocated initially: through auctioning and through so called "grandfathering". The principal advantage of auctioning is that this allows the information imbalance between the polluters and the regulator to be minimalised; since polluters have to pay for their permits, they have every incentive to be truthful about the amount of permits they think they need for the time-span covered by the permits. Of course, since the cap and therefore the amount of permits that are auctioned is established in advance, auctioning in itself does not solve the risk of over allocation, i.e. the risk that in aggregate too many permits are made available. An auction will however signal the price that polluting entities are willing to pay and will therefore be an indication of the relative stringency of the cap. Thus, frequent repetition of auctions will give the regulator a good indication of a realistic sub-cap that may be imposed and will minimalize the risk of over-allocation.[24] Finally, as also the initial permits come at a price, the polluters have every incentive to include in their projection all economically feasible emission reductions, either through the decrease of production or through technological innovation, during the time-span covered by the permits.[25] For the regulator (the government), the auction will produce income that may be redistributed for example through alleviation of taxes, the subsidization of research on emission reduction techniques etc. A very important disadvantage of auctioning however is that this negatively affects the competitiveness of the participating companies and industries. Though this effect may be mitigated through the aforementioned redistribution of the financial results of the auction, the fact that the auction imposes extra costs on the participants while their competitors in other countries may not have these costs is an important obstacle for the political acceptability of auctioning.[26] Another drawback of auctioning is that this may induce companies to relocate to countries where they are not subject to emission restrictions ("carbon leakage").

[24] Although from the perspective of certainty – very important for investment decisions – too frequent auctions and too frequent amendments of the (sub-)cap are undesirable.
[25] It is of note that this implies an effective monitoring and enforcement (compliance) mechanism.
[26] A solution to this problem would be the introduction of a carbon tax on imports from emission-friendly countries. Such a tax however does not seem to be very acceptable politically, perhaps because it is easily considered as, or confused with, protectionism.

In the case of grandfathering, the permits are handed out for free by the regulator to the polluters, based on an estimation of the amount of permits necessary to cover the emissions during the time-span covered by the permits. To make this estimation, the regulator is dependent on the information provided by the polluters. Needless to say, the possible exploitation of the information imbalance between the polluters and the regulator is the principal drawback of this system. The polluters have every incentive not to be truthfull about their projected emissions, and over-allocation to some polluters at the expense of others is a real risk. If the estimation is based on present emissions, this system may induce strategic behaviour by the pollutants, i.e. the increase of emissions to ensure the allocation of as many permits as possible. The polluters do not have an incentive to reduce their emissions through the decrease of production, especially not if the amount of permits is updated from time to time.[27] In the case of grandfathering, the pollutants potentially gain a windfall profit because any surplus permit may be sold in the market, while the costs of the regulator (implementation and maintenance of the tradeable permit system, monitoring and compliance) remain uncovered. The big advantage of grandfathering is of course that the competitiveness of the participating companies and industries is not affected, which makes this system much more politically acceptable. However, as Volleberg (1997) has observed, the risk of carbon leakage is not entirely eliminated, as companies may be tempted to firstly sell off their permits and then relocate to more emission-friendly countries.[28]

Fortunately, a black-and-white choice between pure auctioning and pure grandfathering is not necessary. As Vollebergh (1997) argues, a hybrid system in which only part of the permits are handed out for free alleviates the burden on the participants while maintaining the incentive to be truthful about the projected emissions, at least above the level covered by the grandfathered permits, and to reduce the emissions above that same level[29]. The regulator may given each polluter permits covering a certain percentage of expected emissions for free, or it may vary the percentage of grandfathered permits per section of industry, depending for example on the competitive exposure of such industry. Also Aalbers (2007) is of the opinion that a mixture of auctioning and updating is to be preferred above either pure grandfathering or pure auctioning.

Apart from the choice whether to opt for grandfathering, auctioning or a mixture of both, the regulator has to decide which companies/sectors/industries to include in the permit program. Theoretically, all emitters of carbon dioxide should be included, but from a practical point of view this is not feasible, as this would mean all households, in fact all individuals in a society should obtain carbon emission permits, based on a projection of their emissions during a certain future time-span. In practice, therefore, it is the industries that will be the subject of the permit requirement. Indirectly, however, households and individuals may also be included, for example because the electrical power plants using

[27] In fact, updating is inevitable in a system in which the regulator hands out permits for free.
[28] A solution proposed by Vollebergh is to hand out non-tradeable permits, wholly or partially.
[29] A reduction below the level covered by the permits handed out for free may allow the polluter to make a profit by selling the excess permits in the market, but it might jeopardize the future allowance in the case of updating. Note that this also holds for reductions above the level of the grandfathered permits, in case the grandfathered permits to be received through updating are based on a percentage of total emissions in the period leading to the updating moment.

fossil fuels – and therefore subject to the permit program – will include their costs of the permits into the price they charge their customers (including households and individuals). This leaves the direct consumption of fossil fuels by individuals (gasoline for cars, gas for heating) uncovered, but this might be solved by requiring the suppliers of these consumption fuels to obtain permits covering the projected emissions as a result of the use of those fuels; whereby the costs of those permits would then again be included in the price of the fuel (as also Vollebergh 1997 and Aalbers 2007 suggest). Thus individuals and households, while not directly participating in the permit program, do get the incentive to reduce emissions through the higher price charged to them for the use of power and/or fossil fuels.[30]

Another important choice that the regulator has to make is whether the emissions trading should occur within a "credit", also know as "project-based" program or within a "cap-and-trade" program. In a cap-and-trade program there is one overall emissions cap, against which actual emissions are measured. Total emissions by all countries (and entities and individuals within those countries) should not exceed the cap.[31] In a project-based program, by contrast, actual emissions are measured against a so-called "baseline", which is the level of emissions that would have occurred in the absence of the project. The baseline needs to be determined for each individual project in order to ensure that the emission reduction effected through the project is additional to the emission reductions that would have occurred anyway (this is called the "additionality requirement"). The difference, measured in emission units, between that baseline and the emissions that occur after the implementation of the project then constitute the credits that can be used by a party or country subject to a cap to offset its excess emissions. As Fischer (2005) clearly describes, project-based programs have a number of practical drawbacks. Establishing a baseline for each individual project, such that the additionality requirement is met, is a cumbersome task, involving costly administrative and information-gathering activities. Apart from general uncertainty, there is the problem of asymmetric information between the certifying authority and the participants. Various approaches can be chosen to establish the baseline: historical emissions, expected emissions (in the absence of the project) and average emissions within the same industry in the same social, economic, environmental and technological circumstances. This leaves plenty of room for error and interpretation, while the "historical" and "expected emissions" approaches can even be an incentive for entities potentially to be involved in a project to increase emissions before joining a project. As a result of all this, the baseline can easily be established too high or too low.

Apart from these practical objections to the project-based programs, however, there is a more fundamental objection, as Koutstaal (2003) has showed: the baseline functions as a subsidy on production. Why this is so can best be illustrated with the following diagrams, copied from Koutstaal (2003).

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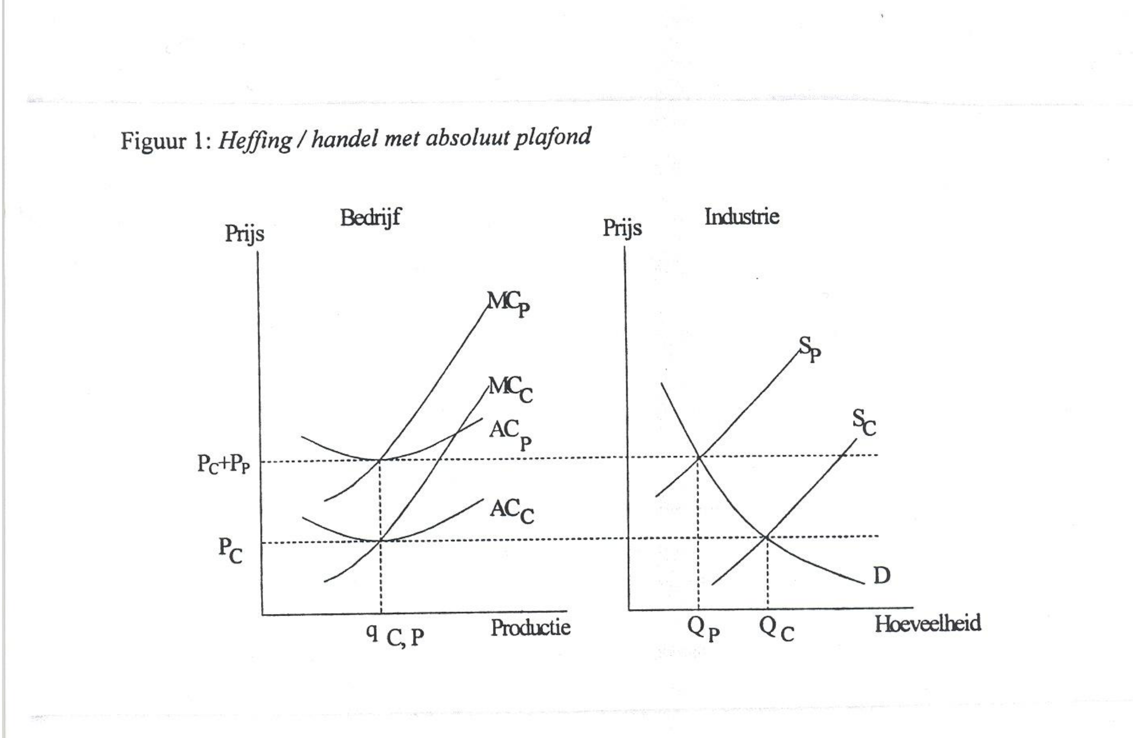
[30] In such a system, care should be taken to avoid double charging, for instance of power plants that use fossil fuels as input.

[31] In practice of course such an overall cap is then broken down into "sub caps" for each of the countries, and then broken down even further to individual caps for each emitting entity. This is clearly illustrated by the European Trading System, which will be described in chapter five.

Figure 2.1



Source: Koutstaal (2003, p. 203)

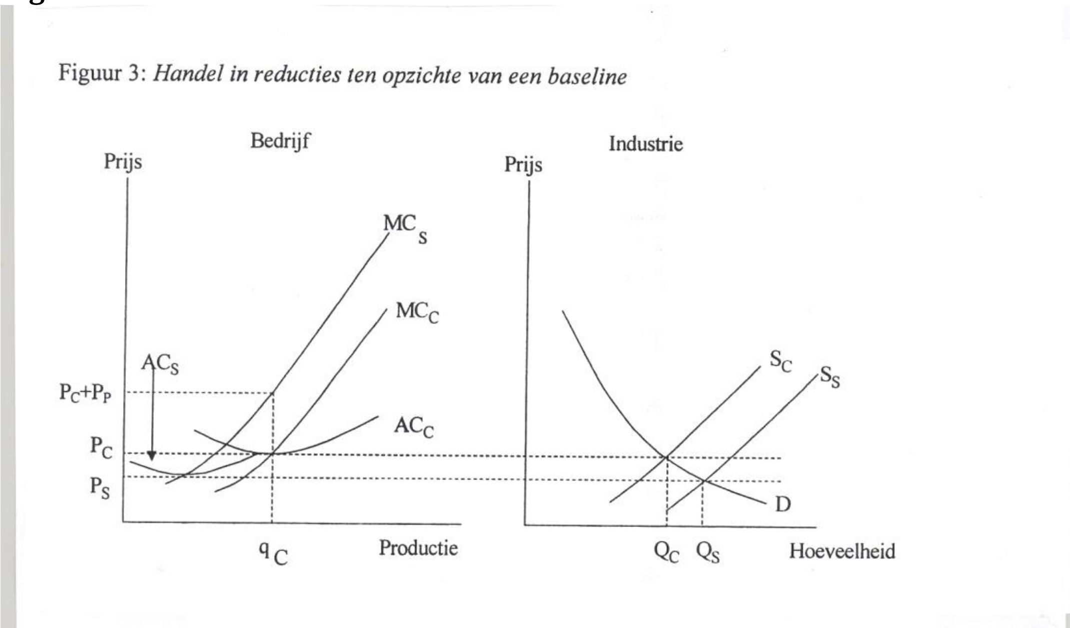
As follows from Figure 2.1, the introduction of emissions trading with an absolute cap causes the marginal cost curve and the average cost curve to move upwards, the distance between the original curves and the new curves being equal to the price of the emission trading rights. As a result, the long-term supply curve moves to the left and demand (and therefore quantity produced) decreases.

As follows from Figure 2.2, the introduction of baseline-and-credit trading causes the marginal cost curve to move upwards, the distance between the original curve and the new curve being equal to the price of the emission credits. This is because the company is willing to increase its marginal reduction costs up to the point where these costs are equal to the price it can obtain for the emission credits. This effect is therefore the same as with the emissions trading model. What is different, however, is the effect on the average costs. Because the baseline does not have any opportunity costs (credits can only be created if the company produces) the baseline has the effect of a subsidy on production. The value of the credits decreases the average production costs.[32] As a result, the average

[32] Note that this can only be the case if it is assumed that the decrease of the average cost because of the value of the credits is larger than the increase of the average costs because of the abatement effort. This assumption seems realistic since otherwise the company will not be enticed to make the abatement effort. Also, the abatement effort is likely to be in the form of a one-off investment, whereas the value of the credits increases with the increase of production. In this scenario, then, the higher the production, the lower the average cost increase because of the abatement effort and the higher the average cost decrease because of the value of the credits. In such a scenario, the company has every incentive to increase its production.

costs will decrease, the long-term supply curve moves to the right and demand (and therefore quantity produced) increases. And because quantity produced increases, emission of greenhouse gases increases, even though the quantity of emission per unit of output decreases. Whether the total/overall emission increases relative to the original situation or not is uncertain, but it is clear that the baseline-and-credit trading mechanism is less efficient than the cap-and-trade mechanism in effecting an overall emission reduction.[33]

Figure 2.2



Source: Koutstaal (2003, p. 205)

A final decision that the regulator needs to take regarding the design of the emissions trading program concerns the time-span covered by the permits. This is a very important dimension of the permit system. In theory, this time-span should be indefinite. This is because, as has been discussed, the damages caused by carbon dioxide depend only on the accumulated level, or stock, of the pollutant in the environment. The time at which, or during which, the pollutant has been emitted into the atmosphere is irrelevant. Thus, by allowing the permits to be used whenever, now or in the future, the polluters see fit allows optimal allocation not only across users (i.e. space) but also across time, thereby achieving optimal efficiency. In practice, however, infinitely valid permits would not work very well. The most important objection is that, since there is no end-date at which the polluters have to submit sufficient permits to cover their emissions, polluters might postpone emission reduction and/or the purchase of sufficient permits indefinitely. It will also be very difficult if not impossible for the polluters to estimate their emissions and therefore their permit requirement over an infinite period of time, because they can neither oversee the development of their company nor the technological advances in the field of abatement techniques. In addition, as Aalbers (2007) observes, the value of

[33] Koutstaal calls this the "allocative inefficiency" of baseline-and-credit trading.

infinitely valid permits would be very high, which might cause financial problems for the polluters or which might have a negative impact on the trading of the permits. It is therefore advisable to make the period during which the polluters have to cover their emissions by sufficient permits finite, for instance five years. This means that by the end of such time period the polluters would have to demonstrate that they have enough permits to cover their emissions during that period. It is important that this period not be too short, because the polluters will only make investments in abatement technology if they know they have a chance of such investment paying off. It is also important that this period not be too long, because that will make it more difficult for the polluters to make an estimate of their emissions. It is of note that the period during which the polluters have to cover their emissions by sufficient permits (let's call this the "compliance period") does not need to coincide with the period during which the "rules of the game" (i.e. how are the permits allocated, which polluters are subject to the abatement regime etc.) remain unchanged (let's call this the "regulated period").[34] Thus, having a relatively long regulated period, divided into shorter compliance periods, thereby allowing the polluters to "save" unused permits for later compliance periods would allow a more optimal allocation of the abatement efforts (either through production reduction or through technological advances) through time, while still imposing a certain compliance discipline. Whether the opposite – "borrowing" permits from future periods – should be allowed is debatable, as this could tempt companies to continuously borrow from future compliance periods until the end of the regulated period, only to find out then that they are being "squeezed" in the permit market. Which might lead to heavy fines on companies for non-compliance, or to corporate bankruptcies, both of which are undesirable from an economical and environmental point of view.

This theoretical overview would not be complete without some attention being paid to the international dimension of carbon emissions trading. Thus, so far this paper has mentioned "the regulator". In practice, however, this concept encompasses a multitude of regulators, ideally covering all countries in the world. Again because of the nature of carbon emissions as a uniformly mixing pollutant, pollution in one location will affect the entire world and so it is with abatement of pollution. To make a permit system acceptable and effective, therefore, such system should theoretically encompass all countries in the world. In practice, this has so far proved impossible. As a result, the "free rider problem" is a major problem, i.e. emission friendly countries benefitting from other countries' abatement efforts without paying any price for it. Lengthy and repeated negotiations and the application of game theory play important roles in addressing this problem. We shall however not expand any further on this aspect of emissions trading – which could easily cover a doctoral thesis – and now turn to the focus of this paper: the actual trading of carbon emissions permits. In the next chapter we shall firstly consider the theoretical requirements for an efficient market in emissions permits.

[34] Aalbers (2007, p. 76) makes a similar, but slightly different distinction. He distinguishes between an "allocation period", which is a period during which the polluters may keep their permits and a "planning period", which is a period during which the rules either do not change or change as determined previously. The disadvantage of his definition of "allocation period" is that it does not make clear that the important factor is not whether the polluters may keep their permits, but that there is a certain "deadline" by which the polluters will have to demonstrate compliance with the permit requirement. In fact, polluters might have excess permits that they might "save" for the next period.

Chapter three
Efficient markets in theory

The concept of efficient markets is a difficult one, and numerous attempts have been undertaken to define such markets and to list the criteria to which they should conform. These lists tend to be relatively long and may differ from author to author. In this paper, the list is based on the experience of the author and has been made as short as possible. Three main criteria have to be met in order for markets to be, or have the potential to become, efficient: tradeable assets, scarcity and efficient markets.

1. Tradeable assets

Clearly, there can only be a market if there are tradeable assets. Thus, there should be "assets" and those assets should be "tradeable". What does this mean with respect to carbon emissions trading?

In the case of carbon emissions trading, the "asset" is not so much the pollutant – carbon dioxide – or the resource – clean air - . Instead, the asset is the right to emit a certain quantity of carbon dioxide into the atmosphere. Thus, as Tietenberg (2007, p. 78) has observed, the tradeable permit[35] approach doesn't really privatize the resource (in the case of carbon emissions trading, air) itself. What it really does is to privatize the right to access the resource to a certain degree. Tietenberg calls this a "somewhat uneasy compromise" between the wish of the environmental community that air, water etc. belong to the people and should not become private property and the wish of economists that tradeable permits be treated as secure property rights so as to ensure the right (environmental) investments in the resource.

It is of note that while carbon emission permits do not have any intrinsic value, they do have an opportunity value[36]. That is to say, once an emissions trading scheme is established and entities have obtained carbon emission rights/permits, be it through auctioning or through grandfathering, these permits may be sold to other entities and therefore have an opportunity value. It is however very important to realize that this opportunity value is entirely dependent on the international treaties and the national laws that created the concept of carbon emission permits, on the supranational bodies and national governments that implemented and maintain a system of tradeable permits and on the willingness of national governments to commit themselves to credible emissions targets and a credible continuation of the system of tradeable permits in a sufficiently distant future. "Sufficiently distant" in the sense that it is believed worthwhile, in

[35] In this paper, the word "permit" shall be used to denote any possible right to emit carbon emissions. The word "allowance" shall be used to denote the carbon emissions right pursuant to the EU ETS.
[36] More properly stated, the value of carbon emission permits is their opportunity cost.

economic terms[37], by companies and consumers to invest in emissions reducing technologies and lifestyles. The more certainty with respect to the future value of carbon emission permits, the higher the current opportunity value of such permits. Fortunately, there is one characteristic of opportunity value that works in favor of the future of carbon emission permits: it tends to maintain itself. Thus, as Mr. Koutstaal pointed out[38], once economic entities (governments, companies)[39] have obtained carbon emission permits[40] that have a value – the opportunity value – that can be converted into real life cash, they will not be inclined to let this go; so they will lobby their governments and the supranational bodies to continue the system that created this value for them.

Apart from the permits themselves, "derived" assets – derivatives - may be created, such as options and futures on permits. Derivatives in general are very useful instruments that allow certain risks (mostly concerning adverse changes in the price of the underlying asset) to be allocated to those parties that most want to bear them. With respect to carbon emissions permits, derivatives are particularly useful because, as set out below, emitters subject to a permit program really only need the permits at one particular moment in time, which is at the end of a compliance period, when they have to demonstrate that the have enough permits to cover their emissions during the compliance period.

2. Scarcity

This is an obvious, yet fundamental criterion. The laws of demand and supply will only work if there is scarcity. And this entails that there is an initial situation in which certain parties have a certain asset which they may be willing to sell (depending on the price they can get for it), while others parties do not have the asset but may want it (again depending on the price). In other words, there is a potential demand and a potential supply. If the parties representing this demand and supply are able to meet and trade, in an efficient marketplace (see below), an optimal situation will ultimately be arrived at with an optimal price and an optimal allocation of the asset such that no party can be made better off without making another party worse off: in other words, pareto efficiency. This is the theory that also underlies the carbon emissions trading model. So in theory there is an initial allocation stage, then a trading stage and then an optimal final stage. In practice, however, pareto efficiency is not a permanent state. Because individual parties' demands and supplies change continuously, in any split second all of the aforementioned three stages are present: initial stage, trading stage and final, efficient stage[41]. Which explains why trading is a continuous process. It also explains why it is generally held that at any

[37] Sadly perhaps, but realistically speaking the strongest incentive for mankind in aggregate has always been the prospect of improving its economic status. This is in fact the basis of Adam's Smith's theory and of carbon emission trading. See chapter two.
[38] Interview on May 10, 2007.
[39] In theory this enumeration should include individuals, but in practice they are not economic entities with respect to carbon emissions trading yet.
[40] Or the potential to create credits, through the Kyoto project based mechanisms.
[41] It is doubtful whether a pareto-efficient situation can ever be attained, since this requires optimal market conditions (absence of transaction costs in the broadest sense) that are probably unattainable in practice.

moment, the market price[42] of an asset reflects all the information available in the market about that asset. This is because this price is the result of the aggregate of all individual demands and all individual supplies, each of which demands and supplies is based on the information available to the individual making the demand or supply.

For carbon emissions trading, this mechanism should in principle work the same. In practice, however, this may be different, for three reasons. Firstly, the above-described theoretical stages presuppose that in the initial situation the asset is (i) scarce and (ii) allocated in a non-optimal manner. These presuppositions do not necessarily have to be true, at least not entirely true, with respect to carbon emissions permits, especially not if permits are grandfathered by a regulatory authority that tries to give every party subject to the program sufficient permits to cover its emissions, whereby in addition it is acting as equitable as possible. Secondly, the opportunity value of the carbon emissions permits – and this is their only value as they do not have any intrinsic value – may be limited in time since they may loose their validity at the end of a regulated period. Thirdly, while the supply of permits may be continuous (as parties decide they have excess permits that they want to sell in the market), there is really only one moment in time that there is an immediate demand and that is when, at the end of a compliance period, parties have to demonstrate that they have sufficient permits to cover their (past) emissions during such period.

It is important to realize that the question whether there is really a demand depends on the question whether and to what extent the verification process is (i) likely to happen and (ii) credible. As Paul Betts (2008) puts it: "In the case of this new market, the all-important responsibility of verifying the carbon quota and credit entitlements will rest with political organizations – either national governments or the United Nations. (…) The question is, have governments allocated sufficient resources for this crucial monitoring role? (…) Of course, it is sensible to put a price on carbon and force companies to address the environmental challenge. But no one should be under the illusion that just because this is a worthy enterprise, and one designed to protect the planet for future generations, the actors will all behave responsibly". Credible and enforceable compliance, therefore, is a prerequisite for scarcity in the carbon emissions market.

In order to analyze the drivers of demand and supply in any market, it is useful to distinguish between different types of participants on a market. Generally speaking, parties that engage in trading on a market may be classified as either "order flow providers" or "liquidity providers". The order flow providers are the parties that want to buy or sell assets either from a "speculative" perspective (essentially wanting to buy the asset when it is considered relatively inexpensive, hold it while its value increases and then sell it with a profit) or from a "usage" perspective (that is to say they are "end-users" of the asset). With respect to carbon emissions trading the latter category is composed of the parties that have to demonstrate compliance in a carbon emissions trading scheme (for this reason, they will from now on be called the "compliance parties"). Clearly, the two types (speculative and compliance) can overlap, as those who ultimately need the

[42] In practice, there is rarely one "market price". Rather, there is a bid price and an ask price, and the difference between the two prices – the "spread" - may be narrower or wider.

asset may still well participate in the market for speculative purposes. The trading desks of large energy companies (power, oil) are clear examples of this.[43] For purposes of analyzing the demand and supply, however, the distinction may be useful. Another distinction that can be made within the group of order-flow providers is between the individuals or small players (the "retail segment") on the one hand and the large institutions (the "wholesale segment") on the other hand. In practice, the flow of the retail segment is mostly channeled through brokers that are the exchange members, while parties in the wholesale segment may be exchange members themselves.

The liquidity providers are the parties that act on the market from a trader's perspective. They want to buy and sell assets to make a profit on the transaction itself (difference between purchase and sale price). One could argue that this is also what the speculative order flow providers want, but the difference is that the speculative order flow providers typically hold the assets for a certain (relatively long) time while the liquidity providers want to buy and sell as quickly as possible, preferring to hold the asset as shortly as possible. Thus, the speculative order flow providers are interested in the difference in the value of an asset *over time*, for reasons relevant to the asset and its characteristics, while the liquidity providers are interested in the difference in the price of an asset *at a certain point in time*, for instance because there is a minimal price difference between the same asset traded in more than one market, or simply because of the difference between the sale price (the "bid") and the purchase price (the "offer") of an asset. Typically, the speculative order flow provider is very knowledgeable about the assets it trades (financial analysis), the drivers of the specific demand and supply etc. while the liquidity provider is hardly interested in the assets it trades, knows very little about them and simply searches the markets for assets that exhibit small price differentials which can be exploited (arbitrage trading). Liquidity providers quote bid and offer prices more or less continuously. Frequently, these parties act as so-called "market makers" which means that they take upon themselves the obligation (at the request of the exchange and against certain privileges such as lower transaction fees) to always be willing to quote a price to buy or sell securities so that a party wishing to sell or buy will always find a counterparty on the market. This and the fact that their trading volume tends to be very high (the minimal price differentials can only be exploited in a commercially meaningful way if the number of assets traded is very high) is the reason that these parties are called "liquidity providers".

From the above description it becomes clear that the liquidity providers do not by themselves create any demand or supply. Rather, they will enhance existing demand and supply, making the market more "liquid". As explained below, however, they will only appear on stage once there is already a substantial demand and supply to begin with. In an analysis of demand and supply, therefore, the focus should not be on the liquidity providers and their motivations. To a somewhat weaker extent, the same argument can be made for the speculative order flow providers. Although they will step in earlier than the liquidity providers, they will still only come if there is a market in the asset to start with, i.e. if there are parties willing to buy the asset simply because they need the asset and

[43] In the commodities markets and in the markets for carbon emissions, the parties that engage in the trading for speculative purposes only are often called the "financial parties".

parties willing to sell the asset to them. So for an analysis of the fundamental drivers of demand and supply, one has to look at the parties that need the asset, which for carbon emission allowances are the compliance parties.

3. Efficient markets

The concept of "efficient market" is the subject and focus of the "Efficient Market Hypothesis", a theory that has been in existence for about forty years now and of which Fama (1970)[44] is the most well known proponent. In essence the theory states as a hypothesis that the market price of an asset contains, at any given moment, all relevant information with respect to that asset. A market therefore ensures that there is "informational efficiency". This informational efficiency, in turn, creates "allocational efficiency", because all market participants have access to the same – complete [45]– information about the asset and will therefore, in aggregate, allocate the financial means available in an optimal manner, creating a state of Pareto efficiency (see above under the heading 'scarcity'). Informational efficiency also leads to "operational efficiency", which means that the costs involved with the transactions –and these involve all types of costs, including the costs involved with information gathering – are as minimal as possible.

As has been discussed in chapter two, this last notion – costless trading – is at the heart of most theories concerning the merits of a market model. Coase's theory is based on it, but Coase himself readily acknowledged that this ideal was not attainable in practice. The Efficient Market Hypothesis makes a somewhat weaker assumption, when it states that the costs are minimal. In practice, then, the ideal of efficient markets, in the sense of all information being available at no cost to all market participants and trading itself also being costless, is unattainable. As any ideal, a fully efficient market may not be reachable but it may be approximated as closely as possible. So let's consider the conditions for an efficient market, whereby it is understood that 'efficient" is to be understood in practical terms, i.e. as close an approximation to the ideal as possible.

A first condition is that the way the trading takes place ensures the most optimal[46] access to information for the trading participant. In other words, the degree of "informational efficiency" – more commonly denoted as "transparency" by traders - should be as high as possible. Traditionally, trading could be done in either of two ways: on a regulated exchange or "over the counter". The latter way of trading, abbreviated as "OTC", means that two parties agree on a trade and then execute, clear and – if necessary - settle such a

[44] Fama, E.F., 1970, Efficient Capital Markets: A Review of Theory and Empirical Work, *Journal of Finance*, 25, 383 – 417, as discussed in Aalst, P.C. van, Van den Bergh, W.M. et al. (1997).
[45] There are different interpretations as to what is considered as "complete", however. Thus, according to the 'weak' version of the Efficient Market Hypothesis ("EMH"), the hypothesis is that the market price reflects all historical information with respect to the asset. According to the 'semi-strong' version of the EMH, the hypothesis is that the market price reflects all publicly know information, whereas the hypothesis of the 'strong' version is that the market price reflects all information, public and private.
[46] As fully as possible against as low costs as possible.

trade between them[47], without the involvement of any exchange, clearing facility or settlement facility.[48] Each side of an OTC transaction runs a counterparty risk on the other side of the transaction.[49] The former way of trading, on a regulated exchange, means that parties generally do not choose the party they trade with (because trading on an exchange is almost always anonymous); that the trade is executed on the exchange, that a clearing institute will take care of the clearing of the trade and, if necessary, that the trade will be settled into a settlement facility such as a central securities depository. The clearing institute often also assumes the counterparty risk by interposing itself as a "central counterparty" between the two sides of a transaction. Another very important difference between the regulated exchange market and the OTC market is that on a regulated exchange market the assets that are traded, and the way they are traded (in other words, the "contracts" between buyers and sellers) are fully standardized in terms of size, maturity, manner of delivery etc. On the OTC market, by contrast, each contract can be different and designed to fit the precise wishes of the parties.

From a viewpoint of "informational efficiency", trading on a regulated exchange is – in principle, see below - clearly favored over OTC trading, as on a regulated exchange all information from all market participants is reflected in the bid and offer prices (the central order book), whereas with OTC trading parties have to gather this information by calling up potential counterparties one at the time. However, there may be many reasons why parties may still choose to trade OTC. One of those reasons may be, as mentioned above, that the wishes of the parties with respect to the characteristics of the contract do not fit the moulds of the standardized exchange contracts. Another reason may be that the size of a transaction that a party wishes to execute cannot influence the price at which that transaction is executed. In the regulated market, and the more so the less liquid the market, a large order will be executed in many smaller transactions during a certain (longer or shorter) time span, each transaction driving the price in a direction unfavorable to the party that entered the order. OTC trading however has a number of drawbacks, two of which have already been mentioned: less informational efficiency and counterparty risk with respect to the clearing and settlement of a transaction. A third drawback is the fact that OTC trading is not anonymous (the counterparties know each other) whereas exchange trading almost always is. But in practice, these drawbacks can be circumvented to a large extent by using the services of a broker – who acts as an intermediary in which all information from all potential counterparties that trade through that broker is centralized and who also obviates the need for the counterparties to make themselves

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[47] Typically, a trade concerning the asset itself is cleared ("processed") and settled (which is the actual transfer of the asset from the seller to the buyer and the simultaneous transfer of the cash paid for the asset from the buyer to the seller), while a trade concerning a derivative of an asset is only cleared. Thus with respect to carbon emissions trading, if the asset is the permit itself, a transaction concerning such permit needs to be cleared ("processed") and settled. If the asset is a derivative of a permit (a future or option), such asset needs only to be cleared, since the asset traded is not the permit itself, but a certain right with respect to such permit.

[48] However, a broker is often involved. For this reason, Point Carbon (2007) makes a further distinction between "brokered" OTC transactions on the one hand and OTC transactions without the involvement of a broker, called "bilateral" transactions, on the other hand.

[49] "Counterparty risk" is the risk that the counterparty to a transaction does not perform its obligations following from the transaction, most notably either the transfer of the asset or the payment for the asset.

known to each other – and by making use of the services offered by many exchanges to report an OTC trade, once done, to the exchange which will subsequently ensure that the clearing and possibly settlement take place in the same manner as exchange trades, i.e. through a central counterparty which reduces the counterparty risk to almost zero.

In practice, there are often also more practical or sometimes "irrational" reasons why parties choose to trade through a broker rather than directly on an exchange. Thus, parties may feel uncomfortable with a new market or a new asset and may prefer to rely on the information gathered by seasoned brokers. Another reason, relevant for derivatives trading, is the fact that parties are required to post margin when trading on exchange whereas this is not the case when trading OTC. This may be seen as a practical advantage of OTC trading over exchange trading, but it is ultimately irrational as the margin on exchange is also required from the counterparty one trades with and will decrease the counterparty risk substantially. A less irrational but very practical reason for choosing OTC over exchange trading may be the fact that a lively OTC market exists while there is much less activity on the regulated market for the same asset. This may not be the case because all those parties trading OTC have an objective reason to do so, but more so because there is so little activity on the exchange that it fails to have the "informational efficiency" one would expect. After all, the "informational efficiency" only works if sufficient and sufficiently diverse parties post their bid and offer prices in the order book. Another way of saying this is that the degree of "informational efficiency" of a market depends on the liquidity of a market, i.e. the number and diversity of buyers and sellers and the frequency of their transactions. And this, liquidity, is very much a "chicken and egg" story. From the perspective of an order flow provider, a regulated exchange may be unattractive because there is no liquidity. But this is a self-reinforcing process: because the order flow providers stay away from the regulated exchange, that exchange remains illiquid. A liquidity provider that is willing to quote continuous prices on the exchange may reverse this process. But the liquidity provider will only do so if the potential liquidity, i.e. the amount of order flow that may be lured away from the OTC market, is large enough.

It is of note that apart from the information that is contained in the bid and offer prices which are displayed in the central order book, regulated exchanges endeavor to further enhance the "informational efficiency" by strict regulation concerning the timely publication of price sensitive information, prohibition of so called "insider trading" etc., all with the aim to ensure that there is equal information on the assets traded for all market participants.[50]

Although there are exceptions, then, in general it can safely be stated that from the perspective of "informational efficiency" exchange trading is preferred over OTC trading and the degree to which trading in a certain asset is conducted on exchange is a sign of the degree of the (informational) efficiency of the market in that asset.

[50] One caveat however is that quite a few exchanges do charge for what is called "data feed", i.e. all types of real time and historical price information, to parties that are not members of those exchanges.

A second condition for an efficient market is that the costs of trading are as low as possible. In other words, that the degree of "operational efficiency" is as high as possible. "Informational efficiency" and "operational efficiency" partly overlap, as the latter type of efficiency also comprises the costs of information gathering, which is the focus of the former type. Leaving the costs of information gathering aside, however, there are many other costs that can stand in the way of efficient trading: costs of intermediaries like brokers, software providers and clearing banks, exchange costs (membership, connectivity, trade execution), clearing and settlement costs etc. Probably[51] the best way to ensure that these costs and the fees that are charged to trading participants to cover these costs, are kept as low as possible is to foster competition on all levels involved in the trading, clearing and settlement chain. This has in fact been the core of a piece of European Legislation that has recently[52] been implemented across the EU and which has had a huge impact on the trading landscape even well before its actual implementation: the Markets in Financial Instruments Directive[53], or "MiFID" for short. Before MiFID, the fees that were charged especially by established exchanges and clearing and settlement houses went far beyond what was necessary to cover their costs. They were able to charge these fees because competition between exchanges, between clearing houses and between settlement institutions within the EU was in practice impossible. The reason for this were a myriad of national rules in each of the EU countries which, although naturally not aimed at obstructing competition, did have this effect in practice. The rules of MiFID, aimed at breaking these "national monopolies", have caused a huge increase in competition among exchanges and have encouraged the creation of alternative trading platforms[54] and internal execution platforms of financial institutions[55]. Thus tellingly, one such recently created alternative trading platform, Chi-X, boasts in a publication celebrating its first anniversary[56], "significant savings – more than 2 basis points of average price improvement compared to trading on the underlying exchanges" and "low cost execution – execution costs of just 0.05bps (based on passive/aggressive ratio of 50:50); clearing and settlement cheaper too". Although MiFID is not applicable to the trading in carbon emission allowances itself, it is applicable to the derivatives of such allowances.[57]

A third condition for an efficient market is that the financial means available can be allocated to the asset as optimally as possible, in other words that the degree of

[51] Although competition is usually heralded as the only way to ensure as low costs as possible, there are other ways to control costs. Thus for example, the Norwegian government closely monitors the net income of the Norwegian energy exchange Nordpool: if this income becomes too high, the government instructs the exchange to lower its fees. Also, in the "old days" (until about a decade ago) exchanges and the pertaining clearing houses were usually "mutual", meaning that the parties trading on those exchanges owned them. Such ownership was usually a condition for a party to become a member of the exchange. As a result, the exchanges and clearing houses were seen as service providers, not as profit centers and the fees charged were primarily meant to cover the costs. With the "demutualization" of the last decade (exchanges going public) this has changed dramatically.

[52] As of 1 November 2007.

[53] Directive 2004/39/EC (2004).

[54] So called "multilateral trading facilities".

[55] So called "systematic internalizers".

[56] Disseminated by e-mail on April 9, 2008.

[57] Annex I, Section C, paragraph 10.

“allocational efficiency” is as high as possible. Although “allocational efficiency” may probably be considered the result of the other two types of efficiency, there are some aspects of trading which may specifically be considered in this category: The possibility to combine the trading in the instruments itself with that of the trading in derivatives of those instruments such as options and futures and the diversity of the market participants. We will now consider these two aspects in somewhat more detail.

The importance of the possibility to combine the trading in the instruments itself with that of the trading in derivatives of those instruments such as options and futures is manifold. Traditionally, derivatives markets have sprung up on the back of flourishing spot markets. Spot markets come into existence as places (whether real or virtual) where supply and demand of a certain asset meet and the asset is traded “on the spot”. As such markets and the parties trading on them become more sophisticated, the need to lock in future price movements, or at least the option to protect oneself from such movements deemed excessive, arises. The possibility to do this allows the parties to take more risks on the spot market, which will enhance the trading and liquidity of such market. Derivatives also allow parties to achieve optimal allocation through time. Another advantage of derivatives is that they offer a cheap opportunity to speculate on price movements of the asset; instead of having to buy the asset, the speculating party only needs to pay the margin (and in the case of options, also the premium) in advance. Upon expiration, such derivatives trades will be settled on the spot market[58], which will contribute to the liquidity of the spot market. Finally, the most liquid derivatives markets will attract liquidity providers on that market[59] which will want to hedge their positions on the spot market, thus contributing to the liquidity of the spot market. Interestingly enough, while it could perhaps originally be stated that derivatives markets developed on the back of successful spot markets and that therefore the information for the derivatives trades was mostly derived from the spot markets, there are now assets for which it can be said that the derivatives markets are the most liquid and where the derivatives markets are therefore the prime source of information for the spot market. As we shall see in chapter five, this is certainly the case with respect to carbon emissions trading.

Finally, the diversity of market participants, in terms of their ultimate need for (in the case of compliance parties) or desire for (in the case of speculative parties and liquidity providers) the asset traded, will ensure that there is a large diversity in demand and supply, which will translate into a large number of transactions and a large number of assets traded.[60] Not only will this ensure the most optimal allocation possible in the sense that there is the highest chance that each specific demand will meet each specific supply and vice versa, but it will also ensure that the “bid-offer spread”[61] is as narrow as possible, since all these bids and offers compete to make the closest “match”. And the narrower the bid-offer spread, the lower the transaction costs and, again, the more

[58] Unless the derivatives contract specifies a “financial settlement”, in which case the financial value of the contract – if any – is paid to the party entitled thereto.
[59] Liquidity providers on derivatives markets are called “market makers”.
[60] Theoretically, the two aspects of volume – a large number of transactions and a large number of assets traded – need not go hand in hand, as many transactions can be done concerning just a few assets at the time or vice versa. In practice however the two usually do go together.
[61] See footnote 41.

efficient the market. This is because the bid-offer spread also represents a trading cost, since the difference between the (higher) price at which an asset can be bought and the (lower) price at which that asset can then be sold represents a loss. Traders therefore call the spreads in a market the "implicit costs" of such market.

If an exchange, together with other institutions such as clearing houses and securities depositories, is able to offer relatively low cost and (technically) efficient trading and if the scarcity of the asset and the nature of the asset is such that a sufficiently large and diverse number of market participants flock to the market, then volumes, both in terms of number of transactions and in terms of the number of assets traded will be high and the market can be called "liquid". Market liquidity may be defined as the ease with which an asset traded on the market can be bought and sold without losing its value.[62] Although this – market liquidity - may appear as the logical end result of the fulfillment of the aforementioned criteria, it should be kept in mind that with respect to each separate market[63] it is rather more circular, a fluid state continuously dependent on the willingness of parties to trade on that market, which willingness is again dependent on the liquidity of that market. Thus, order-flow providers will come to a market if that market has a sufficient degree of liquidity. Liquidity providers can help achieve that. However, since the liquidity providers live off the small profits they make on each individual transaction, they need to be able to trade on a sufficiently large scale to cover their expenses. In addition, they need to have a certain degree of comfort that they will not be left with a large long position[64] or a large short position[65] that they cannot trade out of[66]. And for that there needs to be enough (potential) order flow.

As the above makes clear, liquidity is key: the more liquid a market, the higher the volume[67] traded, therefore the narrower the bid-ask spread and the more efficient the market. Liquidity, in other words, is seen as the closest proxy parameter of efficiency. But although everyone in the financial markets seems to agree on this, precisely what liquidity is and how it can be measured is rather unclear. As described in The Economist of April 28th, 2007 (p.84), the Bank of England has – in its six-monthly "Financial Stability Report" – attempted to quantify liquidity by combining three measures into a composite ratio: (i) the bid-offer spread, (ii) the ratio of price movements to trading volumes and (iii) the spread between corporate bonds and government securities. Measure (i) is evident: the smaller the spread, the more liquid the markets. Measure (ii) captures the effect of trades on asset prices: the less this effect, the more liquid the markets. Measure (iii) is based on the assumption that the premium investors demand for

[62] Definition from The Economist of April 28th, 2007 (p.84).
[63] Assuming parties have a choice of market, which is almost always the case. In addition, parties have the choice to trade OTC or cleared OTC instead of on exchange.
[64] I.e. a position in which the liquidity provider owns or will own (once cleared and/or settled) the assets because it quoted a bid price or prices at which another party or parties sold the assets to it.
[65] This is the reverse of a long position, i.e. it is a position in which the liquidity provider sold the assets because it quoted an offer price or prices at which another party or parties bought the assets from it.
[66] A liquidity provider is on the market to make money from the frequent buying and selling of assets, i.e. from trading itself. It is not interested in the assets itself, and does not want to have large positions in the asset, at least not in the long run, because these positions are risky and need to be hedged.
[67] Both in terms of number of transactions as in terms of assets traded.

corporate bonds is not only caused by the higher chance of default, but also by the lower degree of liquidity of corporate bonds. Thus, the smaller this premium, the smaller the "liquidity gap" between government securities and corporate bonds and hence the more liquid the markets.

With respect to carbon emissions trading, measure (iii) is not relevant but measures (i) and (ii) are. Unfortunately, however, the data for measure (i) are only available for the last few days[68], while the use of measure (ii) would fall outside the scope of this paper, as this would require extensive data research and analysis. Fortunately however we were able to obtain data regarding some other proxies of liquidity that are often looked at, which are volumes of the asset traded and open interest (the number of derivatives contracts that have not been closed/sold or expired yet). These data will be considered in chapter five.

With all this it should be kept in mind that liquidity is a relative measure and then only so within the same asset class. Thus, one could say that the market in carbon emissions permits has become more or less liquid through time, or that a certain exchange in carbon emissions is more or less liquid than another market in that same asset. But one cannot say with certainty that a market is liquid or illiquid[69], nor can one probably say that a market in one asset is more or less liquid than a market in another asset[70]. That is probably also not relevant, in any case not for order flow providers, since they are interested in a particular asset and do not care how the market or markets in that asset compare, in terms of liquidity, with the market or markets in other assets.[71] Ultimately, the question that this paper tries to answer is whether the market in carbon emission permits is efficient and if not, whether it can be made efficient. As is the case with its close equivalent parameter liquidity, efficiency is a relative concept that can essentially only be measured through time, not across markets for different assets. Thus, all that can be done is to consider whether and to what extent the criteria that have been identified in this chapter as conducive towards an efficient market have been met or can potentially be met with respect to carbon emissions trading. In addition, historical data may be considered to try and assess whether the market in carbon emissions has become more liquid over time. This is what this paper will do in chapter five.

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[68] This will give a "snapshot" of the actual situation, but gives no information on the relative increase or decrease of liquidity over time.

[69] Although in practice this is what happens; traders speak of a "liquid" or "illiquid" market, despite the facts that no one exactly knows where the boundary between liquid and illiquid lies and that judgments with respect to what is or is not liquid may differ from person to person.

[70] Unless such assets would be highly similar.

[71] This may be different for liquidity providers, who are not so much interested in the asset or assets they trade but rather in the possibility to arbitrage on price differentials with respect to that asset in different markets. But for the purposes of this paper, the motives of liquidity providers are not that relevant.

Chapter four
The Kyoto Protocol in theory and in practice

The Kyoto Protocol in theory

The Kyoto Protocol, adopted on 11 December 1997 and ratified on 16 February 2005 is the first binding international agreement to limit greenhouse gas emissions.[72] Under the Kyoto Protocol, the developed countries listed in Annex B to the Protocol agree that their greenhouse gas emissions shall not exceed the amount assigned to each country (which amounts are also listed in Annex B). In addition, the countries listed in Annex I to the UNFCCC (the so called "Annex I countries"[73]) commit to reduce *"(...) their overall emissions of such gases by at least 5 percent below 1990 levels in the commitment period 2008 to 2012"*[74]. The Kyoto Protocol is a protocol to the UNFCCC, the United Nations Framework Convention on Climate Change, which was adopted in May 1992 and came into force in March 1994.

It is usually held that the Kyoto Protocol envisages three market-based, "flexible" mechanisms to achieve the desired emission reduction: emissions trading, Joint Implementation and the Clean Development Mechanism. When one actually reads the text of the Kyoto Protocol however, it becomes clear that this simplistic and generally held impression should be qualified in a number of ways:

1. The obligations of the Annex I countries with respect to the emission limitations are set against a background of sustainable development and the assistance of developing country parties. To say that the Kyoto Protocol pursues a multiple goal not only of emission limitations but also of sustainable development and the assistance to developing counties would go too far, yet it is clear that the way in which the emission limitations are to be achieved is limited by the boundary conditions of sustainable development and assistance to developing countries. The ways in which these boundary conditions are to be met are prescribed in a relatively detailed manner.

2. The Kyoto Protocol only explicitly provides for emissions trading between the countries listed in Annex B to the Protocol. It does not provide for emissions trading between entities or individuals within one country, or between entities or individuals located in different countries. This is not to say of course that such trading is not possible.

[72] For more extensive information on the Kyoto Protocol see http://unfccc.int
[73] With a few exceptions, the countries listed in Annex I to the UNFCCC are the same as the countries listed in Annex B of the Kyoto Protocol. In practice, therefore, the denotations "Annex I country" and "Annex B country" are often used interchangeably.
[74] Article 3 paragraph 1 of the Protocol.

3. As opposed to the articles providing for the project-based mechanisms, the article in the Protocol that provides for emissions trading (article 17) is very short: only three sentences. The concept of emissions trading is not elaborated upon. The only guidance that the Protocol gives is that *"The Conference of the Parties shall define the relevant principles, modalities, rules and guidelines, in particular for verification, reporting and accountability for emissions trading"* and that *"Any such trading* (between the Annex B parties, MV) *shall be supplemental to domestic actions for the purpose of meeting quantified emission limitations and reduction commitments under that Article* (3 of the Protocol, MV)".

4. That same principle, namely that the flexible mechanism be supplemental to domestic actions, is prescribed for the "Joint Implementation" mechanism (article 6, paragraph 1 under d of the Protocol).

5. Another similarity between the provision for emissions trading and that for the Joint Implementation mechanism is that the transfers of reduction units resulting from Joint Implementation projects are only envisaged between Annex I parties. The transfer of reduction units between entities or individuals located in those Annex I countries is not provided for. This is not to say of course that such transfer is not possible.

6. By contrast, the provision for the "Clean Development Mechanism" (article 12 of the Protocol) does not require that this mechanism be supplemental to domestic actions. The Marrakech Accords (see below), however, make it clear that the principle of supplementarity also holds for the CDM mechanism. In addition, the participation of "private and/or public entities" is explicitly provided for. Finally, it is of note that the "Clean Development Mechanism" is intended to become effective even before the first commitment period (from 2008 to 2012), since article 12 paragraph 10 of the Protocol provides that *"Certified emission reductions obtained during the period from the year 2000 up to the beginning of the first commitment period can be used to assist in achieving compliance in the first commitment period".*

7. Finally, as could be expected both the "Joint Implementation" mechanism as the "Clean Development Mechanism" require the emissions reductions achieved through the projects to be "additional" to the reduction that would have otherwise occurred.

When reading through the Kyoto Protocol, then, a picture emerges of a large international agreement between developed and developing countries with the aim to limit/reduce the emission of greenhouse gas emissions globally. An important secondary goal of the agreement is to foster the development of the developing countries. Consequently, there is a sharp distinction between the roles of developed and developing countries, the developed countries committing themselves to certain limitations/reductions and the developing countries being potential beneficiaries of (i) knowledge transfer regarding reduction and sustainable development and (ii) reduction projects under the Clean Development Mechanism. The three flexible, market-based mechanisms that are proposed to effect the emission limitation/reduction are described in a rather general, succinct and non-detailed manner and are left to be worked out at a later stage. Two of the three mechanisms (emissions trading and Joint Implementation) are aimed only at the developed countries themselves, that is to say the governments of such countries and are prescribed to be supplemental to domestic actions within those countries. Only the third mechanism, the Clean Development Mechanism, allows for the participation of non-governmental entities and persons and, by aiming at projects in developing countries, for the participation of developing countries. The secondary goal of the Kyoto Protocol, namely to foster the development of developing countries, specifically in the field of emissions reduction and limitation, transpires very clearly from the Clean Development Mechanism.

While it can therefore be said that the focus on the market-based instruments in the Kyoto Protocol is more limited in scope than is usually assumed, there are some references in the Protocol that make it clear that these instruments are considered to be very important by the parties to the Protocol. Thus, article 1 paragraph 1 under (a) (v) of the Protocol provides that each Annex I country shall:

"(a) Implement and/or further elaborate policies and measures in accordance with its national circumstances, such as:
(…)
(v) Progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors that run counter to the objective of the Convention and application of market instruments;"

In addition and very importantly, the Kyoto Protocol (article 3 paragraph 13) allows for "banking": the "saving" of unused assigned amount units for use in future commitment periods. Thus, the Protocol allows for efficient allocation of abatement efforts not only geographically – which is what the market-based mechanisms aim to achieve – but also through time.[75]

The Kyoto Protocol in practice

1. Tradeable assets

It is clearly the intention that credits from the project-based mechanisms and parts of the amounts assigned to the Annex B countries should be tradeable, but how this should be achieved in practice is left entirely open. The Marrakech Accords of 2001 however provide further guidance. Thus, the credits from the project-based mechanisms (ERUs and CERs) and the units from the assigned amounts (AAUs) are clearly described. The

[75] Although it should be observed that, strictly theoretically speaking, to allow for perfect efficiency through time would also require "shortening" of assigned amount units during a certain commitment period, that is to say "borrowing" from future periods.

conditions that need to be fulfilled in order to obtain credits from the project-based mechanisms are extensively described, especially with respect to the CDM, in which case the Marrakech Accords contain specific instructions for the registry in which the credits derived from CDM are to be held. The same holds for the trading in AAUs. Thus, on the basis of the descriptions in the Marrakech Accords one could say that the criterion ‘tradeable asset’ is more or less met, although some detail should still be worked out.

2. Scarcity

As regards the criterion ‘scarcity’, one could say that this is met already in the Kyoto Protocol with respect to the Annex I countries, as these committed to a 5% decrease in emissions relative to the 1990 level. The other aspect of scarcity, compliance, is quite extensively dealt with in the Marrakech Accords as it provides rather detailed guidelines with respect to the conditions that the “Parties” (the participating countries) have to meet in order to be eligible for receiving the credits from the project-based mechanisms and/or for participating in the transfer of AAUs. The recent[76] suspension of Greece[77] shows that compliance is indeed enforced.

3. Efficient markets

The Kyoto Protocol does not contain any indication as to how the criterion ‘efficient markets’ should be met. So how is this functioning in practice? Is there any trading, or rather transfer, of CERs, ERUs or AAUs taking place? Note that the trading in EU allowances under the EU ETS strictly speaking does not fall under the trading envisaged in the Kyoto Protocol, as the Protocol only provides for trading of the first mentioned instruments between participating countries.

To start with, up to the date of this paper there has not been a single trade neither in an AAU nor in a secondary (see below) ERU.[78] This is probably caused by the fact that ERU’s were not accepted as credits in the first EU ETS period (since they could not be used pre-Kyoto), while AAU’s may not be used by private entities in the EU ETS.[79] Trading in CERs, however, has been rather substantial although at the same time this has been beset by difficulties. From the start, investment banks, hedge funds and specialist venture capital groups have jumped at the occasion and invested hugely in CDM projects. The procedural difficulties and the risks however turned out to be considerable. With respect to the procedural difficulties one could say, as Capoor, K. and Ambrosi, Ph. (2008), p. 21 do, that “(t)he project-based market became, in some ways, a victim of its own success (…)”. As they observe (p. 4), “(p)rocedural inefficiencies and regulatory bottlenecks have strained the capacity of the CDM infrastructure to deliver CERs on schedule, as too many projects await registration and issuance (…)”. With respect to the

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[76] April 2008.
[77] The enforcement branch of the U.N. Climate Change Secretariat declared Greece to be in non-compliance with the Kyoto Protocol because it had failed to maintain a proper national system for recording greenhouse gas emissions. Because of this suspension, Greece (and presumably Greek companies) is not eligible for using CERs. Source: Reuters, 22 April 2008.
[78] Point Carbon (2008).
[79] The New Zealand ETS is the only ETS so far where AAUs may be used as credits by private entities.

risks, these are various and of a nature that many financial parties are not used to. There is the risk whether or not the project will be approved by the "CDM Executive Board", a body of the UN that ensures that credits are only obtained from projects that comply with the requirements as laid out in the Kyoto Protocol, the Marrakech Accords and ensuing documents. Then there is the risk that the project may not be completed as anticipated, due to adverse actions of host governments.[80] And if the project is completed, it may be that it generates less credits than anticipated, simply because the emission reductions, as measured against the baseline, are not as high as anticipated. Then there is the uncertainty with respect to the admissibility of CDM credits (CERs) in markets such as the ETS, where the European Commission is tightening its standards with respect to the admissibility of CERs and ERUs.[81] And finally, there are the technical difficulties such as the fact that the International Transaction Log (ITL) in which ownership and transfers of CERs have to be registered, only came into being in 2007 and is still not connected to the transaction log of the EU (called Community Independent Transaction Log or CITL). Probably because of these procedural difficulties and risks, the number of new projects entering the "pipeline" (public comment period of the validation stage in the CDM project cycle) has decreased sharply since mid 2007.[82]

In addition and if the above were not enough, the international community is posing some serious questions as regards the desirability of the CDM mechanism. The CDM mechanism (like the JI mechanism) is a so-called "project-based" mechanism. As discussed in chapter two, the principal drawback of project-based mechanisms is that they function as a subsidy on the polluting production. This production subsidy inherent to the CDM mechanism is clearly illustrated by looking at the example of China. China is by far the largest beneficiary of CDM projects. In 2006, 70% of the total volume of CDM projects went to China.[83] Although this inched down to 62% in 2007[84], China is still the biggest supplier of CDM credits. The Chinese government, quick to realize the moneymaking potential of this, has imposed a tax of 65% on emission-reduction credits. Partly because of this, European companies are paying many times the actual cost of reducing emissions. Since that price is passed on to European consumers, it is they who are ultimately contributing billions of euros to the Chinese government.[85] Meanwhile, two 500MW coals-fired power plants are starting up in China every week, and each year the country's coal-fired power-generating capacity increases by the equivalent of the entire British grid.[86] Creating in turn tremendous opportunities for yet more CDM projects. In fact, as the Economist (17 May 2008) observes, the Chinese government, keen on improving the air quality anyway, might hesitate to issue regulations to that effect for fear of jeopardizing the "additionality" of potential CDM projects and so losing

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[80] Zurich, a large insurance company, is already offering protection against this type of "political risk" involved with carbon credit projects.
[81] Under the proposals of the EU Commission of 23 January 2008, CERs (and ERUs) could only be used if they proceed from projects in countries that have ratified a new agreement on climate change.
[82] From the maximum of 176 by July 2007 to around 100-120 in May 2008, according to Capoor, K. and Ambrosi, Ph. (2008), p. 19.
[83] Point Carbon 2007, p. 18. The Economist, June 2nd, *Trading thin air*, states that this percentage is 53%.
[84] Point Carbon 2008, p.18. According to Capoor, K. and Ambrosi, Ph. (2008), this percentage is 73%.
[85] The Economist, 2 June 2007 , *Trading thin air*.
[86] The Economist, 2 June 2007, *Dirty king coal.*

out on valuable credits. Emissions from China and India (for which a similar story may be told) have almost doubled since 1990.[87]

Back in the Annex-B countries (most notably Europe) the CDM mechanism has some other unwanted effects. Through the CDM mechanism, the aggregate cap of the Annex B countries is actually extended to cover the entire globe. In principle this is fitting, since the environmental damage of carbon emissions, as a uniformly mixing flow pollutant, is not tied to any location or area. In practice, however, this means that companies in Annex B countries as well as the governments of such countries may buy permits rather than cut their own emissions.[88] Subject, of course, to the principle of "supplementarity". How this is to be interpreted in practice however, i.e. up to what level entities and countries may comply with their abatement obligations through the purchase of credits, is completely open. That polluting entities are likely to purchase credits is clear, as around 40% of respondents to the survey conducted by Point Carbon in 2006[89] said that they considered the CDM and JI market the most cost-efficient way to reduce emissions (which given the almost non-existence of the JI market means that these respondents really indicated CDM credits), while about 25% of respondents considered trading CDM/JI credits their primary carbon compliance strategy.[90,91] Governments are also not adverse to the purchasing of Kyoto project credits. From a trader's perspective the picture is more mixed. On the one hand, the flow of CDM credits may bring more liquidity to the markets.[92] On the other hand, however, this may bring about additional market uncertainty, since the demand for carbon emission permits may not only be influenced by fundamentals such as the relative price of natural resources, the weather, the technological progress of the entities subject to the cap, the stringency of the cap etc (see chapter five), but also by the amount of credits expected to flow from CDM projects, not to mention the uncertainty relating to the extent to which these credits may actually be used because of practical difficulties such as those experienced with the connection of the International Transaction Log (where CDM credits are registered) to the Community Independent Transaction Log of the EU.[93,94]
With all this, it has to be kept in mind that when mention is made of CER trading, what is meant is the trading in credits derived from projects that have been completed. To avoid confusion with those CER transactions that are really investments in CER generating projects, the trading in CERs is usually referred to as the "secondary CER market" (as opposed to the "primary" market in which CERs are generated). The secondary CER

[87] The Economist, 2 June 2007, *Struggling to save the planet.*
[88] Thus, the European Commission observes (CEC 2008) that "(…) there is a risk that too generous a use of CDMs can dilute the effectiveness of the ETS by increasing the supply of credits and thereby cutting demand for allowances, and reducing the incentive for governments and companies to promote emissions reductions at home."
[89] Point Carbon 2007, p. 22.
[90] Point Carbon 2007, p. 15.
[91] Interestingly, however, CDM credits were not used at all by entities during the first ETS period, see chapter five. JI credits were not yet allowed during this period.
[92] Especially since CER futures have been introduced on the exchanges. See chapter five.
[93] See further in chapter five.
[94] In the ETS, this uncertainty is limited since the amount of credits from CDM-projects that may be used is limited. In addition, it is possible to make an educated guess about the amount of future credits flowing from CDM projects by looking at the UNFCCC website.

market really only took off in 2007, when it increased to in total 350 Mt, up from 40 Mt in 2006.[95] Exchange trading only started mid 2007 with the Nordpool exchange introducing the first CER products, and a few other European exchanges followed in March 2008. The ITL was not functioning until mid 2007, making spot trading in CERs practically impossible. As of the date of this paper, it is in fact still impossible in the EU and between the EU and parties outside the EU, as the link between the ITL and the CITL has not been completed. Outside the EU, exchanges are taking initiatives with respect to CER trading, such as the Indian exchange NCDEX, which launched futures trading on carbon credits in April 2008. It may thus be that efficient markets will eventually develop for CER (and perhaps ERU and AAU) trading.

Evaluation of the Kyoto Protocol in practice

The Kyoto Protocol does not contain any guidance as to how efficient markets in the tradeable assets identified by the Protocol (ERUs, CERs and AAUs) should take effect. The Kyoto period has just started. As only CERs could be traded per-Kyoto, it are only these that have been traded in what could perhaps in the future become efficient markets. Whether that will really happen will probably mostly depend on the future of CDM and the Kyoto Protocol itself. As regards the other two types of asset identified by the Kyoto Protocol, ERUs and AAUs, one could say that until now they did not have a chance yet, given that the period in which they are valid has only just started. Whether they will become tradeable in efficient markets will, again, depend on the future of the Kyoto Protocol.

[95] Point Carbon (2008), p. 19.

Chapter five
The European Emissions Trading Scheme (EU ETS) in theory and practice.

The EU ETS in theory

Through Council Decision 2002/358/EC of 25 April 2002, the Kyoto Protocol was approved by the European Community. This meant that, once the Kyoto Protocol entered into force, the European Community and the Member States were committed to reducing their aggregate emissions of greenhouse gases by 8% compared to the 1990 levels in the period between 2008 and 2012. In addition, the so-called "Burden Sharing Agreement" (BSA) of 19 June 1998[96] was reaffirmed. In the BSA, the Member States agree how the 8% reduction target is to be redistributed among them. On 25 October 2003, Directive 2003/87/EC (the "Emissions Trading Directive") entered into force. The aim of the Directive is stated as "(…) to contribute to fulfilling the commitments of the European Community and its Member States more effectively, through an efficient European market in greenhouse gas emission allowances, with the least possible diminution of economic developments and employment." Through this Directive then, a scheme for greenhouse gas emission allowance trading within the European Union was established, the European Union Emissions Trading Scheme (EU ETS). Two periods (hereinafter to be referred to as "ETS periods") are distinguished: from 1 January 2005 through 31 December 2007 (the "first ETS period") and from 1 January 2008 through 31 December 2012 (the "second ETS period")[97]. The second ETS period coincides with the commitment period of the Kyoto Protocol. For each ETS period, each Member State is allocated a certain total of CO_2 equivalent (CO_2e)[98]. Each Member State is allowed to achieve part of this total through participation in the Kyoto project based mechanisms, either by the State itself and/or by the installations in that State.[99]

In the first ETS period, at least 95% of the allowances[100], up to the cap which consists of the total CO_2e for a Member State, must be allocated free of charge by such Member State. In the second ETS period, this percentage is 90%. The allowances are allocated to installations undertaking activities that are listed in Annex I to Directive 2003/87/EG. These installations are generally referred to as falling into five categories: Public Power and Heat; Pulp and Paper; Oil and Gas; Cement, Lime, Glass; and Metals. Within four months following the end of a calendar year falling within an ETS period (therefore by 30 April at the latest), the installations covered by the EU ETS have to submit allowances equal to the total emissions of the installation during that calendar year. These allowances are subsequently cancelled. Allowances may be transferred between persons within the

[96] Doc. 9702/98 of 19 June 1998 of the Council of the European Union reflecting the outcome of proceedings of the Environment Council of 16-17 June 1998, Annex I.
[97] The first and second ETS period are sometimes also referred to in the paper as "phase I" and "phase II".
[98] This is the measuring unit of the admitted offsets for carbon emissions. Thus, one allowance represents one tonne of carbon dioxide equivalent.
[99] Thus, Kyoto based credits are allowed either for both the State itself and the installations in that State, or for the installations only. It is not allowed for a State to use up all or almost all of the allowed Kyoto based credits.
[100] See footnote 1 in chapter three.

EU (whereby “person” is defined as any natural or legal person) or between persons within the EU and persons in third countries (listed in Annex B to the Kyoto Protocol) that also have greenhouse gas emissions trading schemes and which have concluded agreements with the EU providing for the mutual recognition of allowances. Allowances are only valid for the ETS period for which they were issued, although the Directive leaves Member States the option to “issue allowances to persons for the current period to replace any allowances held by them which are cancelled in accordance with the first subparagraph”.[101] Each Member State has to provide for a register in which issuance, holdings, transfers and cancellations of allowances are registered. The Commission undertakes to ensure that the registries are standardized. In the first ETS period, excess emissions carry a penalty of EUR 40 per tonne, while in the second ETS period this amount is increased to EUR 100 per tonne.

Finally, Member States have to develop “National allocation plans” (“NAP”s) for each ETS period, “(…) stating the total quantity of allowances that it intends to allocate for that period and how it proposes to allocate them”.[102] Such NAPs then have to be approved by the European Commission.

Directive 2004/101/EC (the “Linking Directive”) entered into force on 13 November 2004. The purpose of this Directive is to link the project-based Kyoto mechanisms, CDM and JI, with the EU ETS. CERs (credits from CDM-projects) may be used during both ETS periods, while ERUs (credits from JI-projects) may be used in the second ETS period. In order to ensure that the use of CERs and ERUs will be supplemental to domestic action, each Member State shall specify in its NAP the percentage of the allocation of allowances to each installation that constitutes the maximum for which CERs and/or ERUs may be used. The Member States also have to state such a percentages for themselves.

Directive 2004/101/EC dutifully reflects the secondary goal of the Kyoto Protocol, which is the furtherance of the development of the non-Annex I countries. But Directive 2004/101/EC also has a more practical goal in mind, when it states that “As a result, this (the opportunity to use CERs and ERUs, MV) will increase the diversity of low-cost compliance options within the Community scheme leading to a reduction of the overall costs of compliance with the Kyoto Protocol while improving the liquidity of the Community market in greenhouse gas emission allowances.”

The Monitoring and Reporting Guidelines[103], finally, contain detailed prescriptions for the monitoring, reporting and verification of emissions for entities subject to the EU ETS.

[101] Article 13 of Directive 2003/87/EC
[102] Article 9 of Directive 2003/87/EC
[103] Commission Decision 2004/156/EC of 29 January 2004 establishing guidelines for the monitoring etc, O.J. L 59/1 EN 26.2.2004

The EU ETS in practice

1. Tradeable assets

In the Emissions Trading Directive[104], an allowance is defined as "an allowance to emit one tonne of carbon dioxide equivalent during a specified period, which shall be valid only for the purpose of meeting the requirements of this Directive and shall be transferable in accordance with the provisions of this Directive." Although the legal nature of the allowances is not identical in all Member States (in some Member States they are considered as financial instruments, while other Member States consider them to be normal commodities)[105] it is clear that the allowances represent an (opportunity) value in each of the Member States[106] and thus qualify as "assets". It is also clear that the allowances are tradeable and meant to be tradeable. A transaction in an allowance itself is completed with a registration in the national transaction log of a Member State.[107] The national transaction logs of the EU Member States are connected through the "community independent transaction log" (CITL). Allowances are tradeable in the ETS market, but not outside that market, as no other countries with similar schemes have been approved yet pursuant to the Emission Trading Directive.

As could be expected, derivatives of allowances have readily been created either by the exchanges at which the allowances can be traded or by the parties themselves (when trading OTC)[108]. The most common forms are futures and options and these, especially the futures, are in fact more heavily traded than the underlying allowances themselves (see below).

In addition to the allowances, there are the credits derived from the CDM and JI mechanisms. For the first ETS period, these would be only the credits derived from the CDM, called CERs (Certified Emission Reduction units), since the credits from JI projects, called ERUs (Emission Reduction Units) could only be issued after the start of the second ETS period, which coincides with the first commitment period of the Kyoto Protocol. In any event, until now only the derivatives of the credits could be traded because the physical link between the CITL and the International Transaction Log ("ITL") operated by the United Nations has not yet been established.[109]

[104] Article 3 of Directive 2003/87/EC
[105] EEA (2007)
[106] During the period of their validity, that is.
[107] But note that such registration is not required for the derivatives.
[108] For a description of the term "Real OTC" as used in this paper see Chapter three.
[109] Two spot trading platforms have recently announced however that they will merge to create "Climex", on which CERs and ERUs may be traded. Climex will make use of the Swiss carbon registry, which is connected to the ITL. Reuters (www.reuters.com), Thu Feb 14, 2008 3:34am EST. The merging platforms are New Values and euets.com. Another new climate exchange, "Bluenext", also expressed an interest in such a "Swiss solution" (www.carbon-financeonline.com, Jan 23, 2008).

2. Scarcity

In essence, the scarcity in allowances should be created by the cap on total emissions (the total of CO_2e available to a Member State) that may be offset either by credits from the Kyoto based projects (CDM and JI) or by allowances. Thus, the NAP of each Member State for each ETS period, as approved by the European Commission, states (i) the total volume of CO_2e available to it, (ii) how many of this may be offset by Kyoto based credits (typically between 10% to 15%), (iii) therefore how many allowances are available to the installations, (iv) which installations are subject to the program[110] and (iv) how the available allowances are distributed among those installations. To determine the number of allowances allocated to each installation in its realm, a Member State relied partly on historical data provided by the installations themselves and partly on information collected by itself. For each ETS period, the total of allowances thus available for that period are distributed to each installation in equal portions for each of the years of that period.[111] Allowances issued during the first ETS period were valid only for that first period[112], while allowances issued during the second ETS period remain valid also beyond that period. There are no explicit provisions for borrowing, but limited borrowing is possible in practice as the allowances for the new year are to be issued by 28 February of such year[113] while the allowances to cover the emissions in the previous calendar year only have to be submitted by 30 April. Although in theory each country could auction 5% of the allowances in the first ETS period, in practice in almost all countries 100% of the allowances were grandfathered.[114] For the second ETS period there is likely to be some more auctioning, although more than 15 Member States (including those representing a big share in allowances) do not plan auctions[115] whereas for those that do the percentage will in any event not be more than 10% and rather closer to 5%. Verified emissions reports covering the previous calendar year (each calendar year being a compliance period) have to be submitted to the competent authority before 1 April of the following year, while sufficient allowances and/or credits have to be submitted before 1 May.

So what has the experience with the EU ETS so far showed us with respect to scarcity and what have been the main drivers of demand and supply? To start with the latter, it is clear that the initial supply during the first ETS period was created entirely by the governments, i.e. the allowances were fully grandfathered. Further supply during the course of the first ETS period came from installations that estimated that they were

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[110] Such installations hereinafter referred to as “the installations”.
[111] Thus, for the first ETS period one third of the allowances available for an installation were distributed at the beginning of 2005, one third at the beginning of 2006 and one third at the beginning of 2007. For the second ETS period, there were five equal portions.
[112] The exceptions are France and Poland, where allowances issued during the first ETS period remained valid for the second ETS period. However, the number of allowances from the first ETS period that thus kept their validity was subtracted from the number of allowances that would in principle have been available to that Member State during the second ETS period.
[113] Article 11.4 of the Emissions Trading Directive. In practice however, allowances are not always handed out in time, as is the case now with the distribution for the first year of the second ETS period.
[114] The exceptions are Denmark, Hungary and Ireland.
[115] Capoor, K. and Ambrosi, Ph. (2008), p. 11.

allocated more allowances than they would use. Supply could in theory also have come from CERs. Interestingly enough, there was a substantial volume of CO_2e available from CDM projects during the first ETS period (Point Carbon 2007), but in practice none of this was used (EEA, 2007).[116] This is probably because the market was fundamentally long during the first ETS period (see below) and CDM credits could be banked into the second ETS period and beyond, so it did not make sense economically to use them during the first ETS period. Demand was determined first and foremost by the caps as set out in the NAPs, which were translated into the number of allowances allocated to each of the installations. Thus, in practice demand came from installations that estimated that the initial allocation to them was insufficient.[117] For the second ETS period that has just started, the picture is more or less the same, although the national caps have been set lower and some (between 5% and 10%) of the allowances will be auctioned (see above). The supply of CERs will probably increase while this is the first time ERUs may be used. Because of the much tighter allocation in this period, it is likely that this time the credits will actually be used, in other words that there will be a real demand for these credits. At the same time, however, this demand will be limited by the cap (of about 12% on average) on total credit usage allowed. In addition, the condition posed in the current EU proposal for the admissibility of additional Kyoto credits in the third EU ETS period, namely that a satisfactory international agreement be reached (see chapter six), has the effect that many parties will consider the current cap on total credit usage to be covering both the second and the third EU ETS periods. Also, it is still uncertain at what moments these credits may in effect be used, as the ITL is still not connected to the CITL.

As regards the verification process (remember that for carbon emissions trading, credible and enforceable compliance is a prerequisite for scarcity), in brief this consists of the following steps. Firstly, the installations have to report their emissions themselves. Secondly, the emissions thus reported have to be verified by an independent verifier. The first and second steps have to be completed before the 1st of April of the year subsequent to the reporting year. Thirdly, the installations have to submit sufficient allowances to cover their verified emissions in the reporting year, which has to happen before the 1st of May of the next year. Although a lengthy description of the pros and cons of this method and the practical difficulties that may be encountered would fall outside the scope of this paper, it appears that overall the verification process itself did not present any major difficulties, nor significant deviations or misleading statements.[118] Of course, this may also be due to the fact that the market was fundamentally long during the first ETS period, so that there would probably not have been many incentives for incorrect reporting.

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[116] Although these credits were not tradeable yet during the first ETS period, they could have been obtained directly by a party subject to the ETS by participating in a CDM project.

[117] The word "estimate" is used here because there is really only one moment per year that the participants actually *need* the allowances and that is when they have to submit the allowances matching their verified emission reports to the authorities.

[118] EEA (2007) compared the reported verified emissions for 2005 in the EU with the Member States' greenhouse gas inventories for 2005. They state (p. 47) that "In general, the analysis of the year 2005 does not indicate any serious problems with consistency of CO_2 emission data reported under the EU ETS and GHG inventories".

What is it that makes participants estimate their demand or supply of carbon emission allowances? Many have posed this question, as knowing the drivers of demand and supply obviously is a way to make a nice trading profit. Especially for the "end-users", the fundamental drivers are weather and fuel (coals, gas) prices. Weather determines the demand for power used for heating or cooling. The higher the demand for power, the higher the production of carbon dioxide (all other things being equal). Weather also determines the relative demand for the fuels used directly for heating (cooling is mostly through power), which in turn influences the relative price of those fuels, which in turn influences the decision of companies having a choice of fuels to prefer one fuel over another, which in turn has an impact on the production of carbon dioxide (all other things being equal), since some fuels are cleaner than others. The precipitation on which the hydropower production depends is also determined by the weather, and such precipitation in turn determines the amount of "clean" power available and thus the amount of "dirty" power (generating carbon emissions) required (all other things being equal). In the preceding sentences, the expression "all other things being equal" was used often, to indicate that ultimately the interplay between weather, fuel prices and the production of carbon dioxide – and thus the demand for allowances – is a very complicated one. Nonetheless, Point Carbon (2007) has estimated that the overall correlation between the allowance price and the combined effect of fuel and weather was 0.92 in 2005 and 0.41 in 2006[119]. The lower correlation in 2006 is not due to the waning influence of fuel and/or weather during that year, but to the enormous impact of that other driver of demand and supply, the regulatory/political factor. This factor encompasses a multitude of regulatory and/or political issues surrounding the ETS and carbon emissions trading in general, such as uncertainty over the future regulatory environment, the date at which the ITL will become connected to the CITL and the percentage of CERs and ERUs allowed, the question whether or not, and if so to what extent, allowances will be auctioned in the future, the political publication of the NAPs, of the verified emissions data etc. It was this last mentioned issue, the publication of the verified emissions data in April 2006, that caused an enormous price crash in the EU carbon emissions market as it became clear that the market overall was long the allowances and not short, as had been expected until the publication. Another example of a regulatory/political issue is the fact that for the first ETS period the allowances were only valid for that period. This meant that those allowances lost all "time value", i.e. potential for future value because of future demand, towards the end of the first ETS period.

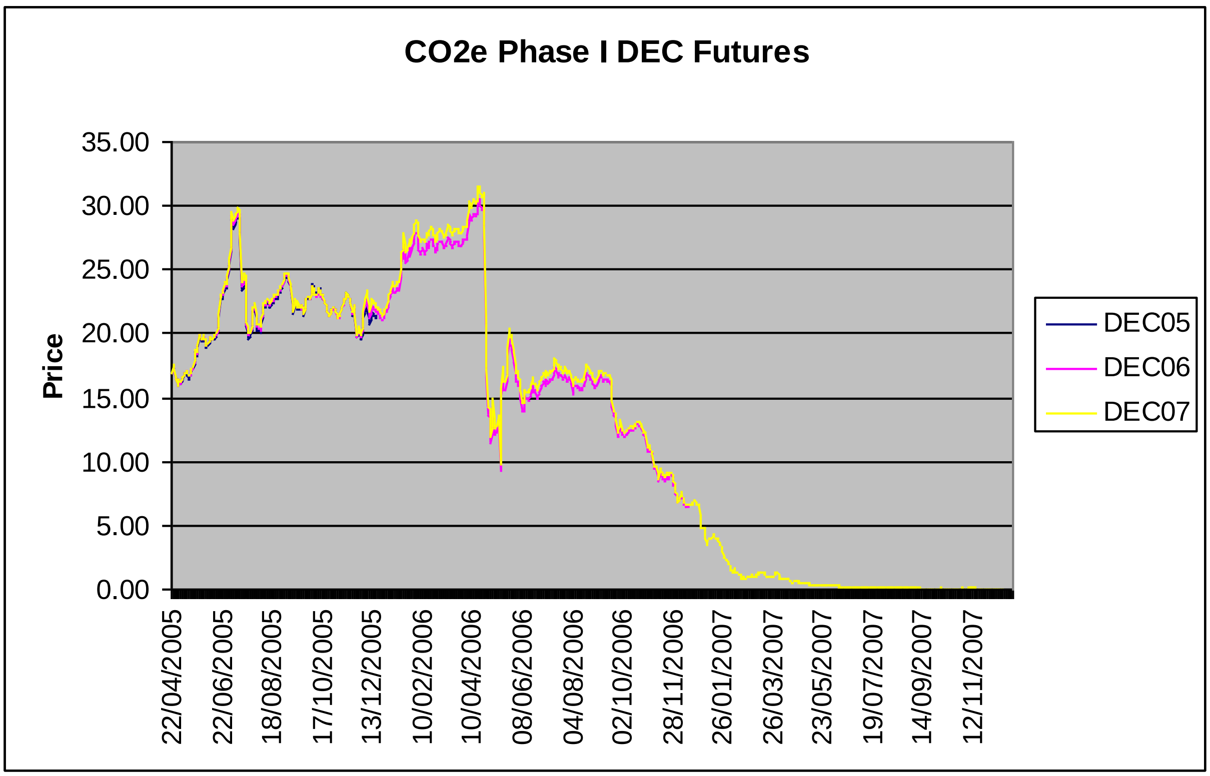
So what do the prices during the first ETS period reveal about the above? As can be seen in Figure 5.1, which sets out the price of the December expiration future contract through the time of the first ETS period, prices went up in the beginning, reaching a peak at EUR 31.8 on April 20, 2006. This is probably due to the combined influence of fuel and weather, i.e. trading on the fundamentals. As mentioned Point Carbon (2007) estimates that the overall correlation between the allowance price and the combined effect of fuel and weather was 0.92 in 2005 and 0.41 in 2006. The correlation from June to December 2006 however was 0.98 and from January to mid-April it was 0.57. Clearly, the correlation broke down in April/May, which coincides with the publication of the verified emissions reports for the first year (2005) of the first ETS period. The reports showed that

[119] Data for 2007 were not available.

the market was fundamentally long the allowances and not short, as had been expected by the market until then. This information caused a huge price crash, as can be seen clearly in the graph. After that, the market recovered somewhat, as there were one and a half more years to go in the first ETS period and participants probably still held back with selling allowances as they were not completely certain yet of future demand. Towards the end of the first ETS period, however, all those with excess allowances tried to sell them on the market, while demand was almost completely absent because the market was still long the allowances.[120] Since the allowances would loose their value after the first ETS period, the price dropped to zero towards the end of that period.

It is of note that Figure 5.1 shows the futures prices, not the spot prices, of the allowances during the first ETS period. This is because volumes in futures were much higher than those in the spot market and therefore the price fluctuations of the future more accurately reflect market demand and supply over time. In addition, futures trading was largely concentrated on one exchange (the European Climate Exchange, "ECX") while spot trading was more fragmented, making it more difficult to find aggregate data.

Figure 5.1



(Source: Bloomberg, ECX)

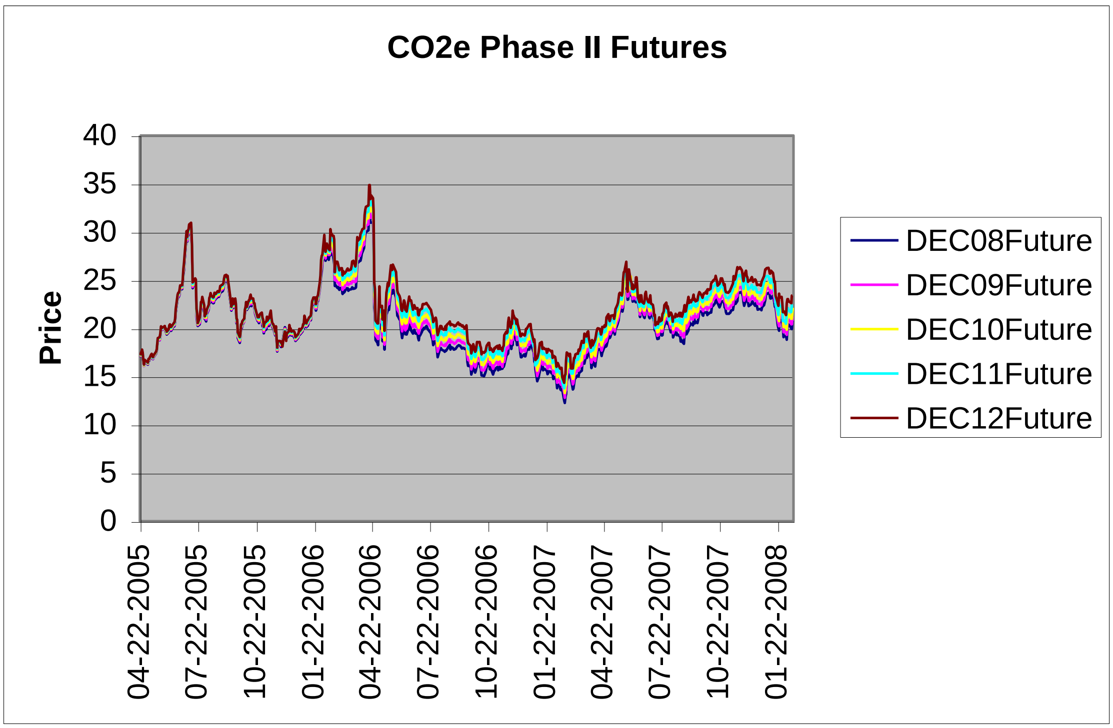
The price crash of April/May 2006 revealed two important imperfections of the nascent ETS market during the first ETS period: one, that the market had been fundamentally

[120] Interpretation as in Fortis (2007).

long, so that hardly any scarcity existed and two, that while the hypothesis that at any moment the price of an asset in a market reveals all the information available in that market may still be true, the information available with respect to carbon emissions allowances had certainly not been very comprehensive. As it turned out, it was the information that had been scarce, not the asset.

As regards the second ETS period, a different picture emerges. It should firstly be mentioned that this period has just started (as of January 2008) and that almost none of the allowances for 2008 have been handed out yet[121], so that spot prices are not yet available. What can be done though is look at the futures prices for each of the years of the second ETS period. The most important and heavily traded are the future contracts which expire in December, since the expiration time coincides with the end of the calendar year, which is the time period that needs to be covered with allowances each year. In Figure 5.2, the prices of the ECX Dec08, Dec09, Dec10, Dec11 and Dec12 futures are presented.

Figure 5.2



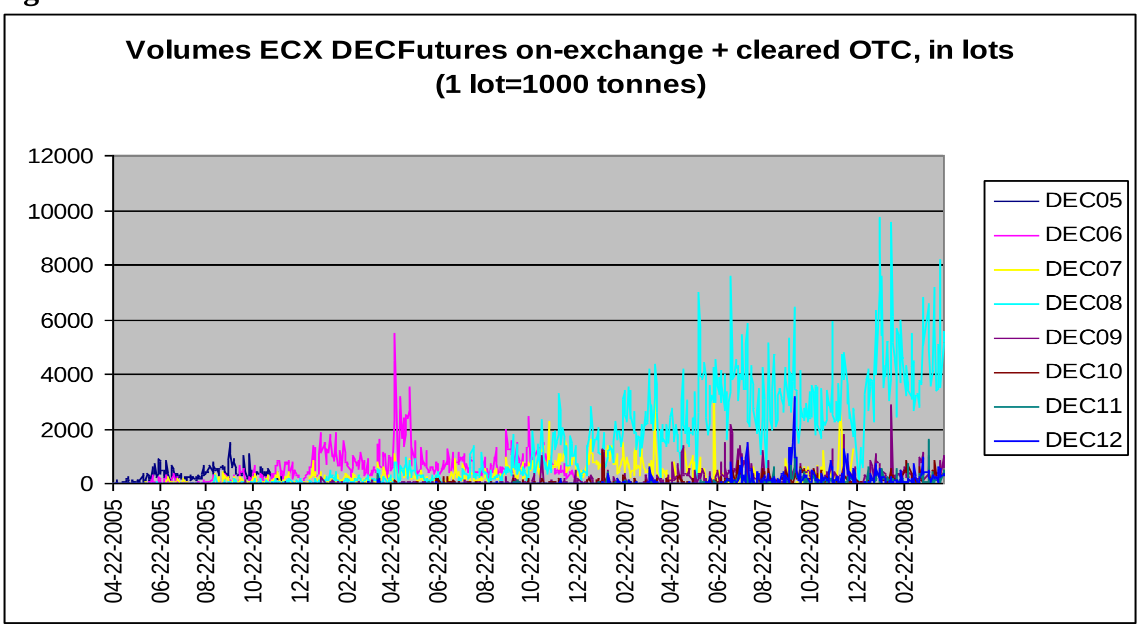
(Source: Bloomberg, ECX)

It is evident that the prices of the futures are well above zero. Clearly, market participants expect the market to be fundamentally short during the second EU ETS period, which is in line with the policy of the EU Commission to ensure such shortage through the implementation of more stringent national caps.

[121] As of the moment of finalizing this paper, at the end of May 2008, only six countries had enabled their registry for issuance of allowances for the year 2008.

Interestingly, the prices of the various December futures are largely convergent, the differences probably being attributable to interest (the later the expiration date, the more expensive the future as the interest is locked in the price) effects. Thus, the data may be interpreted as indicating that the parties trading only seem to have a vision with respect to the aggregate shortage of allowances in the second ETS period, not with respect to each of the individual years. For if that were the case, it could be argued, the prices of the various futures would be expected to move asynchronically. Such argumentation however does not take into account the fact that the allowances may be banked.[122] Thus, if one bought a DEC08 future that expires and it results that one does not need all the allowances resulting from such expiration to cover one's emissions over the year 2008, the remainder of the allowances may be used to cover the emissions in one of the following years. For practical purposes, then, an end-user (compliance party) only needs to have a vision for the current year, because a surplus of allowances may be banked into the future but a shortage of allowances may not be covered by borrowing "from the future". A speculative party does not need to have any vision for any specific year, since the asset (the allowance) keeps its opportunity value throughout the entire second EU ETS period (and in fact, most likely, during the third EU ETS period as well). All in all, then, although the parties trading may well have different visions with respect to the individual years of the second (and third) EU ETS period, they do not need to express such visions through their trading. An alternative explanation closely linked to the foregoing may be that the parties trading really only have a vision with respect to the nearest future, that is to say the year 2008 and that they "peg" the prices of the other futures on this one. As Figure 5.3 shows, the DEC08 future is in fact by far the most heavily traded.

Figure 5.3



(Source: ECX)

[122] The author thanks her colleague Jan-Jaap van Heijst for pointing this out.

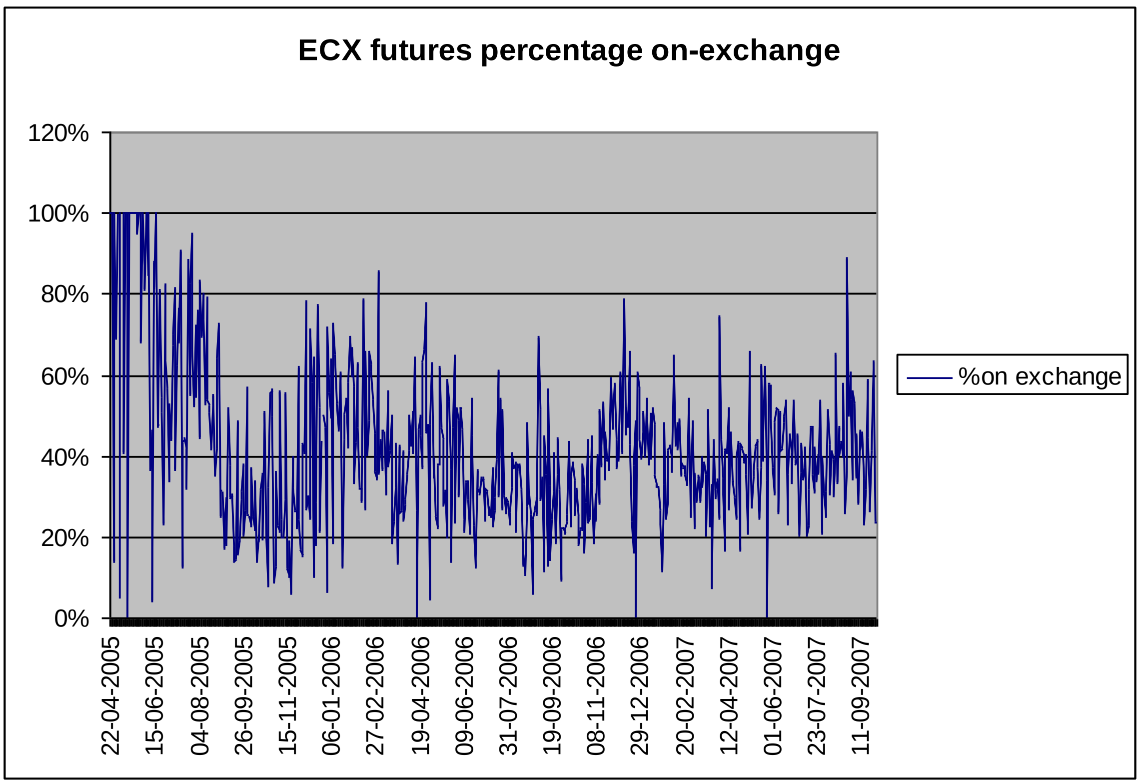
3. Efficient markets

In the following, the criteria for efficient markets that were developed and described in chapter three will be measured as far as practically possible.

a. Exchange versus OTC

Point Carbon (2006, 2007 and 2008) estimates that the total volumes for the EU ETS market were 362 Mt CO_2e in 2005, 1017 Mt in 2006 and 1600 Mt in 2007[123]. Of these volumes, 21% was on-exchange in 2005, 28.6% in 2006 and 30% in 2007. Although there seems to be some development towards a larger percentage of on-exchange trading, then, it can safely be stated that the carbon emissions market is still largely an OTC market. This same picture emerges when the futures executed on the ECX are measured as a percentage of the total futures and forwards[124] cleared and settled through the ECX (which total includes the cleared OTC trades), as visualized in Figure 5.4.

Figure 5.4



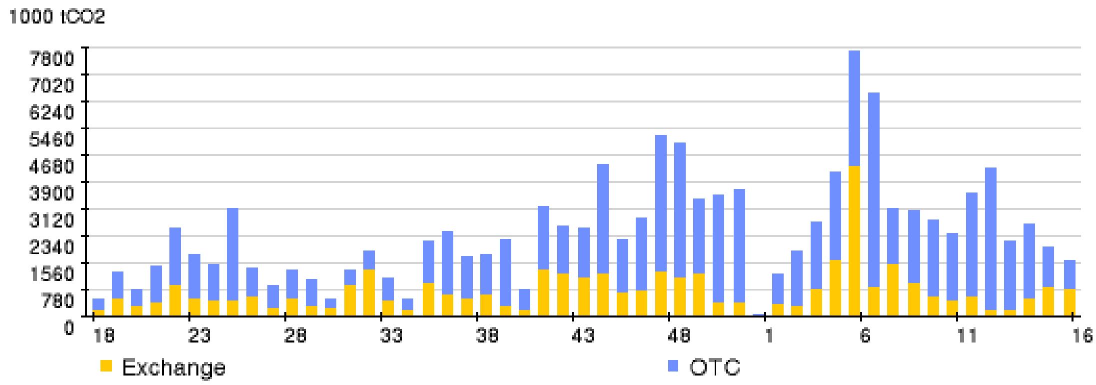
(source: ECX)

[123] Note that although the period of trading described in the Point Carbon reports coincides with the first ETS period, these volumes also encompass some trading (futures and forwards) with respect to the second ETS period, as can be seen in Figure 5.3.

[124] The common trading terminology is to call the on-exchange derivative a "future" while its off-exchange (OTC) equivalent is called a "forward". When an OTC forward is submitted to ECX for clearing, it is automatically converted into a future, but only for the purposes of clearing. These types of "converted" futures are called "Exchange-for-Physical (EFP)".

A similar picture emerges when one considers the distribution between spot and cleared OTC contracts[125] on Nordpool of the last year (in weekly volumes):

Figure 5.5



source: Nordpool.

b. Competition among exchanges

There are five European exchanges where carbon emissions products may be traded: the European Climate Exchange (ECX), Nordpool, Bluenext, the European Energy Exchange (EEX) and the Energy Exchange Austria (EXAA). Three of the exchanges (Nordpool, EEX and EXAA) are energy (power and gas) exchanges that added emissions products to their offering, while the other two exchanges (ECX and Bluenext) are special emissions exchanges.[126] As follows from Figure 5.6, ECX is by far the largest exchange in terms on tonnes of CO_2e traded.[127]

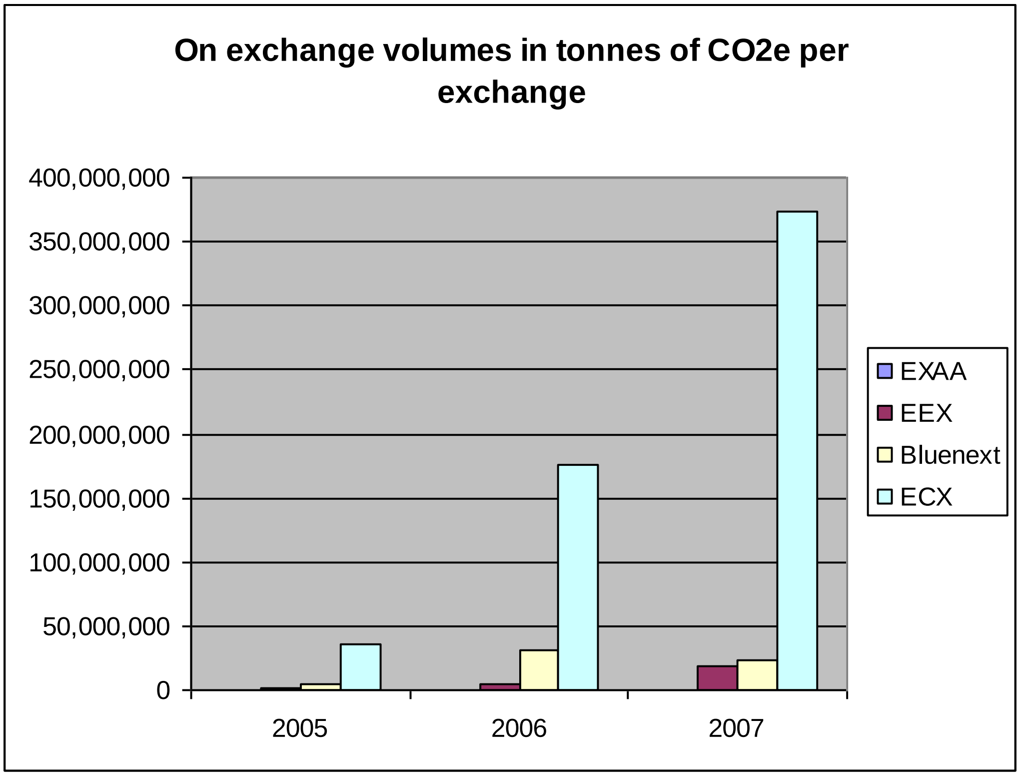
For each of the exchanges, membership is in principle open to all parties interested and each exchange offers good clearing and settlement facilities, so that there are no obstacles to competition from that perspective. Not all products may be traded on all exchanges, however, as Table 5.1 shows.

Nonetheless, with respect to each of the most important products (spot, EUA future and CER future) there are at least three choices for a party wishing to trade, so that proper competition should be ensured. As Figures 5.7 and 5.8 show, however, both for spot trading and for EUA futures trading[128] market participants showed a clear preference for

[125] It is not clear from the website whether these are volumes of spot, futures or both. Given the volumes it is probably either forwards or both.
[126] But note that Bleunext was only formed on 21 December 2007. It took over the EUA spot trading from the energy exchange Powernext.
[127] According to Point Carbon (2007), more than 75% of exchange trades were conducted on the ECX in 2007, whereas according to Wills and Szabo (2008) this is 85% in April 2008.
[128] Due to the very recent introduction of the CER future on ECX and EEX, meaningful data are not yet available. Data from Nordpool are not available at all.

Bluenext (or rather Powernext, as the data concern a period when Bluenext had not started yet, see below) and ECX.[129]

Figure 5.6



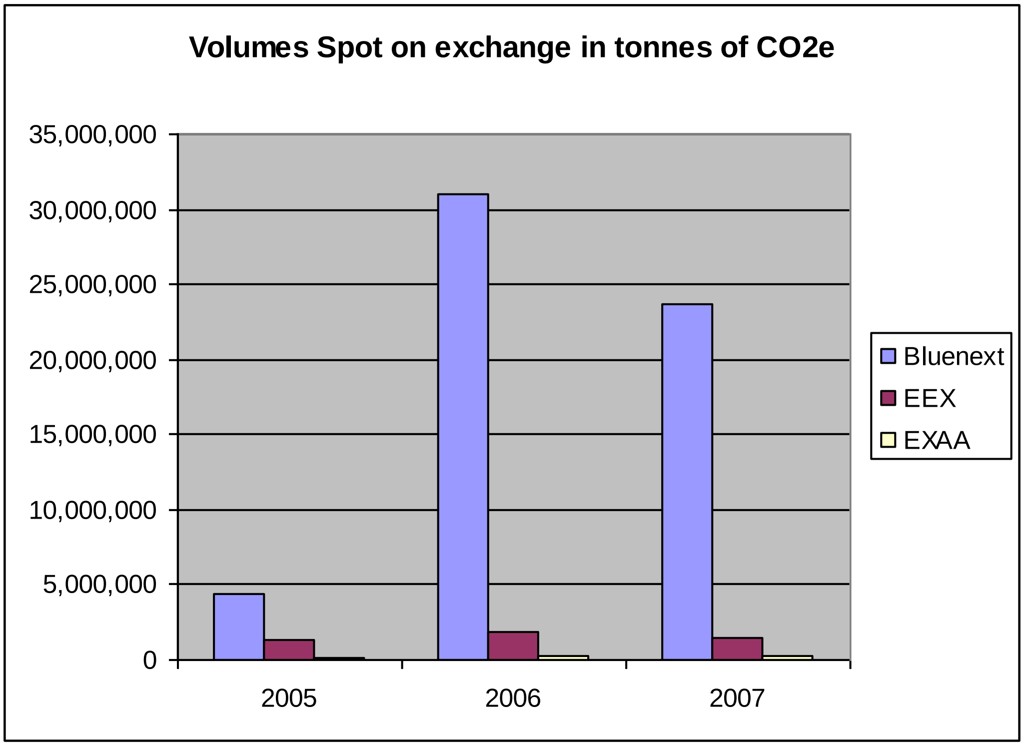
sources: EXAA, EEX, Bluenext, ECX (data Nordpool not available)

Table 5.1
First introduction of products

	Spot	Futures	CER futures	Other
ECX	-	Apr-05	Mar-08	Oct-06
Nordpool	Oct-05	Feb-05	Jun-07	-
Bluenext	Jun-05	Apr-08	-	-
EEX	Mar-05	Oct-05	Mar-08	Apr-08
EXAA	Jun-05	-	-	-

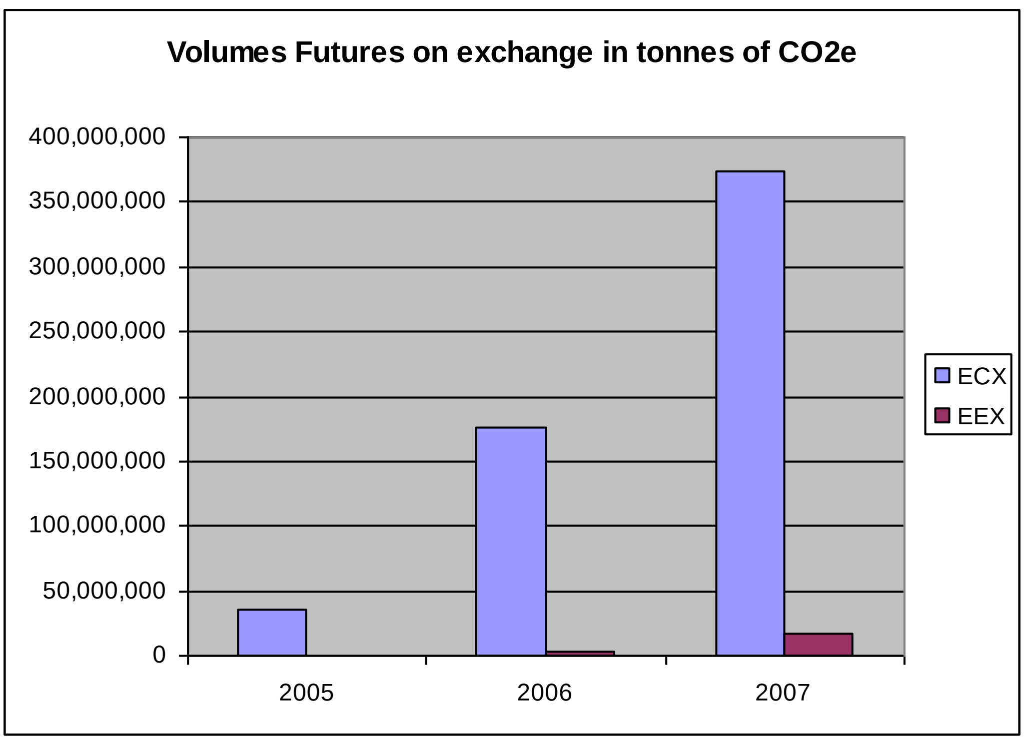
[129] It is tempting to conclude that market participants show a clear preference for "emissions only" exchanges. Note however that this may only be said with respect to the futures trading, since Bluenext as an "emissions only" exchange was formed on 21 December 2007.

Figure 5.7



sources: Bluenext, EEX, EXAA

Figure 5.8



sources: ECX, EEX

c. Diversity of products traded (spot and derivatives)

The ECX[130] is a derivatives exchange, on which only futures and options may be traded. There were EUA futures with expiration dates for every month for the first EU ETS period. For the second period, the EUA futures can only expire in December. With respect to EUA options, apart from two other months all EUA options expire in December of the various years of the second ETS period. Also traded on ECX are EUA "calendar spreads", products that allow traders to speculate on price differences in the underlying EUAs between two specific dates. Since March 14, 2008, CER futures can be traded, while CER options are expected to be launched shortly.
Nordpool[131] offers trading in EUA futures[132], CER futures and spot EUA contracts. The futures have March and December deliveries.
Bluenext[133] was formed on 21 December 2007. It took over the spot carbon trading business of Powernext, which trading was launched in June 2005. At the moment of writing this paper, Bluenext offers spot EUA contracts and EUA futures (since 21 April 2008). The futures have December expiries. Bluenext plans to launch spot CER contracts once the ITL will have been connected to the CITL. It also plans to launch CER futures in the second quarter of 2008.
The EEX [134] offers trading in EUA spot and futures contracts, options on EUA futures and CER futures. The futures have December deliveries, the options on the futures expire three exchange days before the final trading day of the underlying EUA futures.
The EXAA [135] is a spot market that offers spot EUA contracts. Trading takes place via an auction system. Thus, orders placed by market participants are collected in a closed order book and none of the trading participants are able to view the bids of the others. Once per week the orders are auctioned, whereby two market makers ensure that the liquidity is sufficient and fair market prices are determined.

d. Diversity of market participants

ECX: The Members List of ECX shows 92 "trading members" (parties that can execute trades but that need the services of a third party clearing bank to clear their trades with the exchange clearing) and 30 "clearing members" (parties that can both execute trades and clear those trades with the exchange clearing, either for themselves or for third parties). The trading members are large energy companies (power, gas, oil), large banks (UBS, Fortis etc), brokers, a few companies apparently specializing in carbon and even two market makers/liquidity providers (Fortis and Jane Street Capital).
Nordpool: The Members List of Nordpool shows 416 parties, 126 of which are both trading and clearing members. The names are mostly those of large energy companies,

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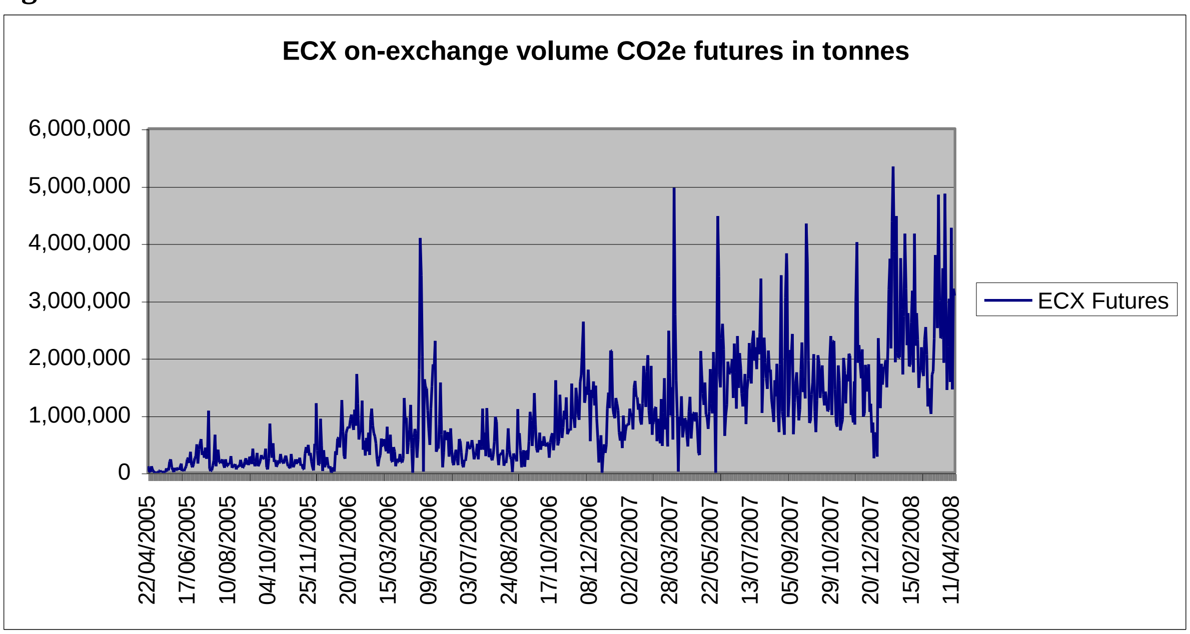
[130] Information from www.europeanclimateexchange.com
[131] Information from www.nordpool.com
[132] Confusingly called "forwards".
[133] Information from www.bluenext.eu
[134] Information from www.eex.com
[135] information from www.exaa.at

some of large banks. The names are predominantly Scandinavian. Since membership of Nordpool is for the entire exchange (thus including the power and gas segment, which is the core business of the exchange), it is not possible to deduct from the Members List which parties are active in the carbon emissions segment.
Bluenext: The Members List of Bluenext shows 73 trading members of the spot market (there is no information on clearing members), of which only 7 are also members of the futures market. The vast majority of the members come from Powernext, the energy exchange of which Bluenext took over the carbon trading in December 2007. The fact that there are so few members of the futures market should not be surprising since trading in this product is only offered as of April 2008. The list shows the familiar large energy companies, banks and brokers, plus quite a few companies apparently specializing in carbon emissions.
EEX: Since this is a huge energy exchange, the Members List shows hundreds of names. Unfortunately however no distinction is made between market segments so that it is not possible to see which parties are active in the carbon emissions segment.
EXAA: The Members List for the CO_2e spot market shows 21 names, almost all from Germany and Austria. Interestingly, there are no names of big banks or brokers, but there are quite a few that suggest companies specializing in carbon trading. The remainder consists mostly of energy companies and glass and ceramics companies.

e. Trading volumes

In terms of volumes, the EUA futures contract is by far the most actively traded and ECX is the exchange where most volume is traded (see above). As Figure 5.9 shows, volumes in terms of tonnes of CO_2e (in this case of ECX futures, as mentioned the most liquid CO_2e product) have increased substantially since the beginning of CO_2e trading.

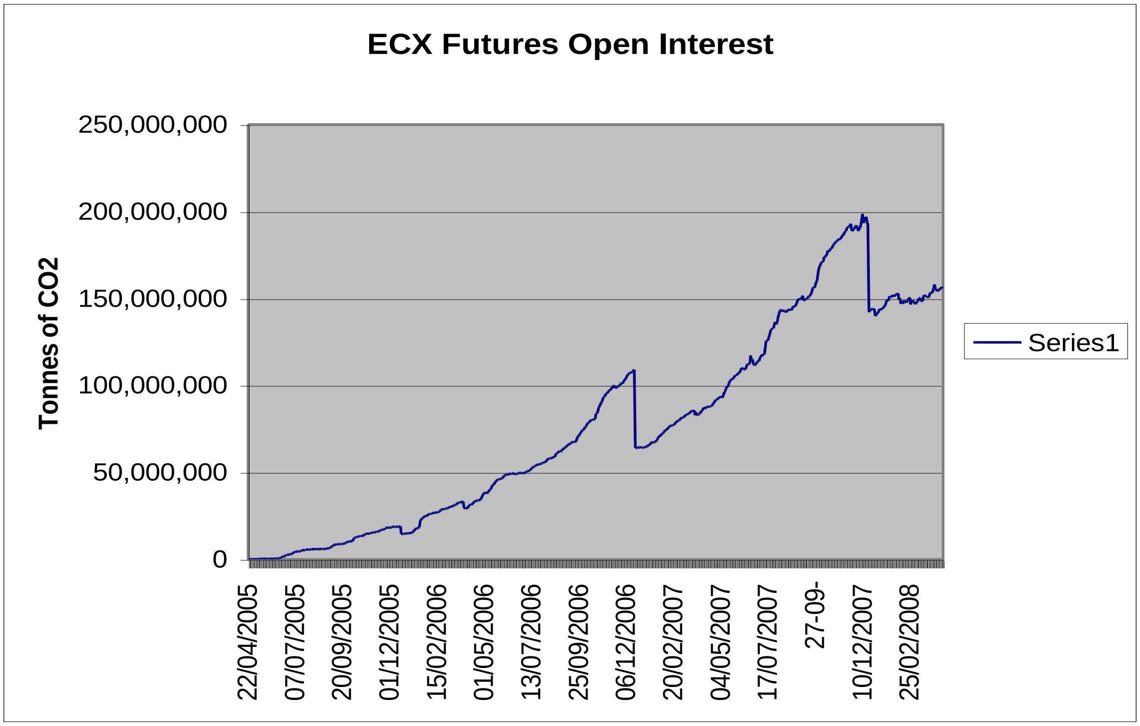
Figure 5.9



Source: ECX

Also the open interest shows a substantial increase since the beginning of CO_2e trading, as follows from Figure 5.10. Open interest is the total number of options and/or futures contracts that are not closed (sold) or delivered (expired) on a particular day. It is a well-known measurement used by traders to measure the interest of market participants in the asset traded.

Figure 5.10

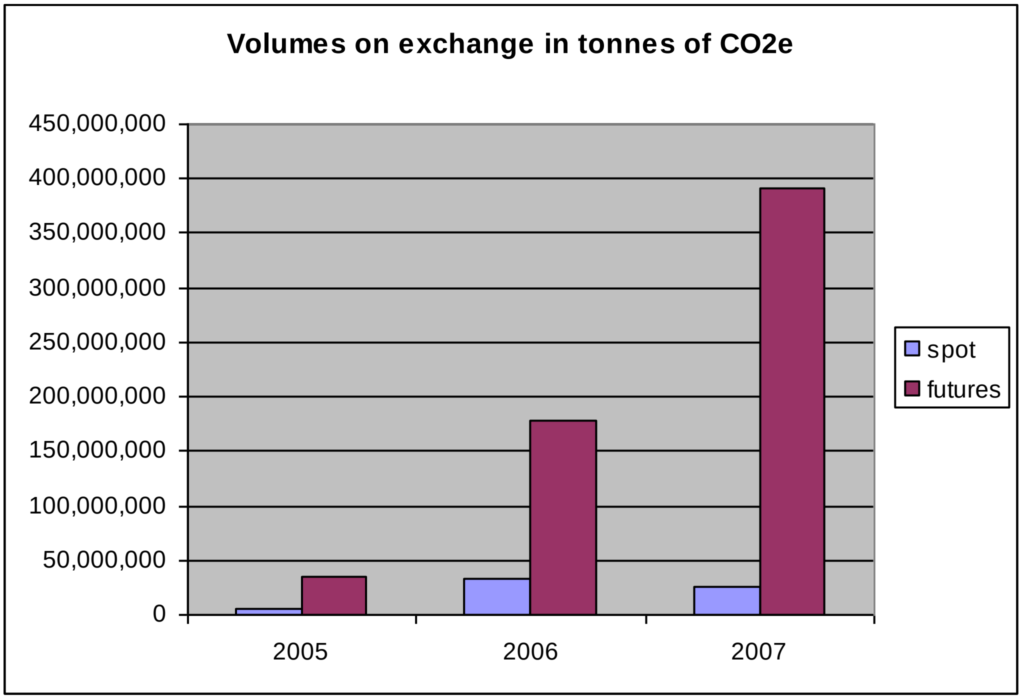


Source:ECX

With respect to the spot EUA trading it should firstly be observed that the volumes are very small compared to those in the futures market and that these volumes are fragmented between the exchanges Nordpool, EEX, Bluenext and EXAA. Figure 5.11 shows the total volumes (in tonnes of CO_2e) in spot trading on Bluenext, EEX and EXAA (data for Nordpool were not available), contrasted with the total volumes in futures trading on ECX and EEX (data for Nordpool were not available).

Interestingly, although trading in futures is clearly increasing, this cannot be said of the trading in spot. This information is however probably misleading. This is because the spot trading could only concern the first EU ETS period (allowances for the second EU ETS period were not handed out yet), while the futures trading could (and did, see Figure 5.3) also concern futures with expiration in the second EU ETS period. Since the value of the EU allowances for the first EU ETS period quickly declined to zero in 2007, the trading in these products declined as well.

Figure 5.11



sources: EEX, EXAA, Bluenext, ECX

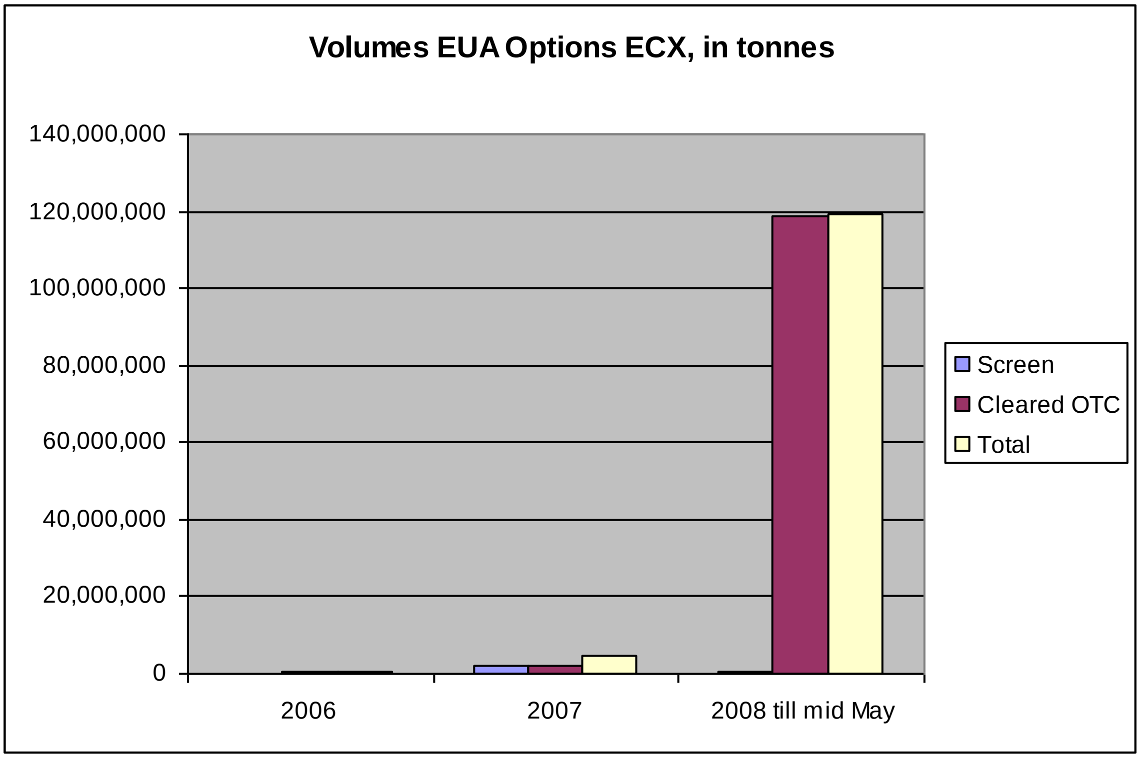
One area that we have not touched upon so far is the trading in options on EUAs, a product only offered by ECX. Until very recently, trading volumes were limited, but as of January 2008 trading in this product increased substantially, as Figure 5.12 shows. Point Carbon (2008) suggests that this may be due to the fact that options are increasingly used as a hedge both by CER project developers and aggregators, by ETS participants (compliance parties) and by speculative order flow providers (financial parties) alike. Mr. De Haan, commercial director of ECX[136] adds to this that especially compliance parties now feel much more the need to hedge their possible future demand because the cap is much more stringent in the second phase of the EU ETS. In addition according to Mr. De Haan, liquidity providers have now discovered the carbon futures market while quite a few U.S. parties are using the ECX to get accustomed to carbon trading in anticipation of the U.S. carbon market or markets.

Finally, there is hardly any information with respect to CER trading yet, as the CER futures have only been introduced very recently.[137] The information that is available however shows a substantial interest from the market for this product: total volume traded, in tonnes of CO_2e, on the ECX between 14 March 2008 (the launch date) and 22 April 2008 was 20,440,000 tonnes (of which roughly 25% was on exchange and 75%

[136] Telephonic enquiry by the author on 22 May 2008.
[137] With the exception of the CER future on Nordpool which was introduced mid 2007. Data from Nordpool are however not available on their website, other than anecdotal information in press releases.

cleared OTC). Nordpool, in a press release of 13 August 2007, notes a volume of in total 1,746,000 tonnes CO_2e (of which about 65% was on exchange).

Figure 5.12



Source: ECX

So what are the expectations for the second ETS period with respect to trading volumes? For 2008, Point Carbon (2008) expects an increase, for a variety of reasons. Firstly, the tighter allocation would lead to higher volumes simply because more parties will be short allowances and will have to trade in order to obtain them. Secondly, the tighter allocation would lead to increased volatility because prices would become more sensitive to changes in fundamentals, which increased volatility would in turn lead to higher trading volumes. Thirdly[138], there will be more auctions in the second ETS period, which would prompt more trading. And finally, the increase in the option trading would cause increased trading in the underlying (or rather the future thereof) as well. When it comes to the years after 2008, Point Carbon (2008) is less certain. Because allowances handed out in the second ETS period may be banked into the third (post-Kyoto) period between 2013 and 2020, expected supply and demand in that third period will have a direct influence on the scarcity (and hence price and trading volume) in the second ETS period. Uncertainty with respect to expected scarcity in the third period therefore means uncertainty in the second period as well. Naturally, future scarcity is always uncertain because it is very difficult to predict the fundamentals (weather, fuel etc), but with respect to the third period there are important regulatory uncertainties as well. Thus, the EU

[138] Point Carbon (2008), p. 26 lists a third reason that in our opinion is the same as the second reason stated by them. This third reason named by Point Carbon is therefore not repeated here.

Commission in its review of 23 January 2008 has stated that Kyoto credits will only be admissible in the third period if a satisfactory international agreement for this period is concluded.[139] At the same time, such satisfactory international agreement may lead the EU to increase the overall reduction target from 20% up to 30%. In all, the degree of success of the follow-up of the Bali conference will have an ongoing influence on the ETS market in the second ETS period.

Evaluation of the ECX in practice

So how has trading under the EU ETS fared so far? Clearly, lack of scarcity has been the big problem during the first EU ETS period, hampering the proper functioning of the market in terms of informational and allocational efficiency. Because there was no scarcity, the dynamics of demand and supply failed and the market did not convey the right information. It is likely that mostly speculative order flow providers were active on the market, who had to rely on "circumstantial" information concerning scarcity such as analysis of fundamentals (weather, relative price of fuel etc) and regulatory developments, but who could not rely on that primary source of information, the prices in the market.[140] This problem was exacerbated by a number of factors, some of which are probably of a passing nature but some of which are of a more structural nature. Firstly, volumes were still relatively low in the first two years, especially on the spot market. And precisely the spot market is still the most effective market when it comes to transmitting information on demand and supply, since it transmits information on actual shortage rather than expected shortage on some future moment. Secondly, while volumes are certainly picking up, the difference in volumes between the spot market and the futures market remains striking. This is probably a more structural characteristic of carbon emissions trading, attributable to the fact that there is really only one moment of actual demand per year, which is on the 30th of April when allowances have to be surrendered to cover the emissions of the past year. Thirdly, a large part of the traded volume is still OTC, hampering once again the transmission of information through the price forming mechanism of the exchange. The fact that most exchanges offer OTC clearing means that one of the most important drivers for parties to choose exchange trading, the minimalization of counterparty risk, is neutralized. This probably explains why there is no clear tendency for trading to move on-exchange. Perhaps this will change with the further professionalization of carbon trading, as more parties realize that on-exchange trading is ultimately preferable in terms of efficiency. Given the "chicken-and-egg" nature of liquidity however (see chapter three), that process may still take quite some time. Finally, carbon emissions trading does do well in terms of the other criteria established in chapter three, which are competition between exchanges, diversity of market participants and diversity of products traded. Given the notable differences in volumes between exchanges consolidation is likely, with the ECX and Bluenext, the two "carbon only" exchanges, probably emerging as the winners for the futures respectively

[139] See further chapter six.
[140] Research by Hintermann (2008) suggests that the allowance price in the first EU ETS period was indeed at least partially driven by a speculative bubble, both before and after the 2006 crash.

the spot market.[141] Finally, there is clearly a market interest in the trading of CER products, but the introduction of these credits in the EU ETS is seriously hampered by the failure, so far, to link the ITL to the CITL.

[141] Of course, such consolidation runs counter to the condition that there be competition between exchanges. However as has been shown with the financial exchanges, competition tends to lead to consolidation, creating semi-monopolies that are then again challenged by new trading platforms formed by parties dissatisfied with the hefty fees levied by the incumbent exchanges.

Chapter six
The future of carbon emissions trading

What does the future of carbon emissions trading look like, when assessed on the basis of the three criteria for efficient markets?

1. Tradeable assets

As we have seen, neither the fact that an EU allowance is an asset nor the fact that it is tradeable causes any problems within the EU ETS. The future also looks bright, as the European Commission is clearly committed to a further strengthening of the EU ETS and has in fact already defined a third EU ETS period to run "post-Kyoto", i.e. from 2013 until 2020.[142] As the Commission has also ruled that allowances obtained during the second EU ETS period may be "banked" into the third EU ETS period, there is in fact regulatory certainty with respect to the validity of the allowances from 2008 until 2020. This is a very important fact since, as was discussed in chapter three, carbon emission permits do not have any intrinsic value. They only have an opportunity value, which is entirely dependent on the regulatory environment. This regulatory environment, then, is quite stable with respect to EU allowances, in any case for the current investment-planning period. For the credits derived from the Kyoto project-based mechanisms however, this is a different story. As was shown in chapter four, it are actually only the secondary CERs that so far may be considered as tradeable assets. Perhaps secondary ERUs and secondary AAUs will follow, but active trading in these credits is currently non-existing. As for CERs, as was discussed the creation and supply thereof is a risky and lengthy process and the number of new projects entering the "pipeline" (public comment period of the validation stage in the CDM project cycle) has decreased sharply since mid 2007. In addition, the extent to which CERs will continue to be acceptable as offsets is uncertain. The principle of supplementarity as laid down in qualitative, not quantitative, terms in the Kyoto Protocol is subject to different interpretation by different governments and supranational entities at different moments. Thus the EU Commission has stated that additional credits, that is to say more credits than those allowed in the second EU ETS period, will only be allowed in the third EU ETS period if a satisfactory international agreement for the post-Kyoto period is signed. It may be that future ETS's in other countries such as the U.S. will allow Kyoto credits, but if and to what extent that will be the case is unclear. Another obstacle to the tradability of the Kyoto credits has been the difficulties experienced with the ITL (which only became operational in 2007) and its connection to the CITL. Finally, it is in fact even uncertain whether there will exist "Kyoto credits" after 2012, as a successor to the Kyoto Protocol is still far from being reached. At the UNFCCC meeting in Bali mid December 2007, the members agreed on a mandate to engage in a process to produce a new climate deal over the next two years. Whether such a deal will be reached and what shape it will have is far from clear. The negotiations in Bali were very difficult and agreement was not reached until the last minute. Positions diverged widely on issues such as whether quantified emissions targets should be included and to what extent developing countries should take on commitments. That emissions trading is the preferred way forward for the large industries

[142] CEC (2008)

in the world is clear: in a two-page advertisement in the Financial Times of 30 November 2007, business leaders of over 150 global companies made "(a) call to world leaders for a comprehensive, legally-binding United Nations agreement to tackle climate change." This "Bali Communiqué on Climate Change" stated among other things: "We believe that an enhanced and extended carbon market (…) offers the necessary flexibility, allows for a cost-effective transition and provides financial support to developing countries". Meanwhile, large first world countries such as the U.S., Canada, Australia, Japan and New Zealand do not want to wait for the outcome of the UN negotiations and have started setting up national ETSs. Of these, the initiatives in the U.S. attract the most attention. If there were to be established a nationwide U.S. ETS, this would be huge. There are various proposals for such a federal cap-and-trade system. The one considered to have the highest chance of success, the U.S. Senate's Lieberman-Warner Climate Security Act, proposes a cap of 5.2 to 5.7 Gt. This would dwarf the size of the EU ETS that has an aggregate cap of 2.1 Gt. While the proposal for a federal ETS is being held up by the presidential elections, several regional trading schemes are being set up by various U.S. States, of which the RGGI, the Regional Greenhouse Gas Initiative is the most well known.

While these U.S. initiatives, and ETS initiatives in other countries, will undoubtedly ensure tradability of the permits within their own system, the challenge will be to link these various ETSs such that the assets will be tradeable across the various systems and therefore countries or groups of countries. This "linking issue" is becoming more and more important as the UN negotiations are difficult and ETSs are being organized around the globe. This importance is recognized and a special organization, the International Carbon Action Partnership or ICAP, was set up in October 2007. ICAP has as its goal "the establishment of a well-functioning global cap and trade carbon market." Through sharing of knowledge and best practices, ICAP "will enhance the design of other schemes by ensuring that design compatibility issues are recognized at an early stage. As a result, ICAP will make possible future linking of trading programs." ICAP is open to "public authorities and governments that have established or are actively pursuing carbon markets through mandatory cap and trade systems with absolute caps."[143] Current members are the European Commission, nine European countries, five U.S. States that participate in the RGGI, seven U.S. States that participate in the Western Climate Initiative (WCI), New Zealand, Norway and Australia. So what are the design issues that may stand in the way of effective linking? The OECD (2002) lists seven categories, which are (1) allocation modes: auctioning, grandfathering, updating; (2) upstream and downstream allocations; (3) accounting for direct or indirect emissions; (4) coverage; (5) absolute or relative targets; (6) timing of allocation, banking and borrowing; (7) incentives, stringency and penalties[144]. While a detailed discussion of these categories would fall outside the scope of this paper, it is important to note that only a few of the above categories cause real problems in the case of linking systems with different solutions. Thus, the co-existence of different allocation modes could create competitive distortions, but these would exist whether or not the systems would be linked. In fact,

[143] www.icap-carbonaction.com

[144] The OECD paper distinguishes an eight category, which is the integration of project-based mechanisms. This paper however does not consider that to be a linking issue.

sources under both systems would benefit from the linking as they would have access to more abatement options than if they were limited to their own system. Upstream and downstream designs are compatible provided a common unit of measurement is used (e.g. tonnes CO_2e) and fuels are not used interchangeably between both systems. A practical solution to avoid double counting in case fuels are used between both systems is to exempt exports of fuels from the upstream system to another system (whether upstream or downstream). Linking direct and indirect systems can also lead to double counting. In this case however there is no simple practical solution and cumbersome arrangements will have to be made to ensure that all emissions are accounted for in the combined regime. Linking systems with different coverage (activities and gases) can lead to fragmented markets, but this problem may be solved in practice by creating fungible units which are not specific with respect to activities and gases, such as the AAUs under the Kyoto Protocol. The co-existence of systems with relative and absolute targets may create competitive distortions, but these would exist whether or not the systems would be linked. Linking systems with different provisions for banking and borrowing could be problematic if unlimited banking is allowed in one system and not in the other. The system allowing unlimited banking would attract permits from the more restricted system, creating an artificial shortage in the latter system. Finally, linking systems with different incentives for compliance could obviously lead to movement of sources to the less stringent system, thus undermining the environmental integrity of the linked system as a whole. In all, most but not all linking issues can be solved. Close cooperation between regulators of different (potential) ETSs, such as proposed by ICAP, is of the utmost importance.

2. Scarcity

As discussed in theory in chapter three, trading of marketable permits as an emissions control mechanism is the preferred mechanism from a cost-effectiveness perspective, primarily because this method minimizes the information imbalance between the polluters on the one hand and the regulator on the other hand. Thus, as different from other mechanisms such as command and control instruments, taxes and subsidies, the regulator need not know the specific cost function of each firm. However, this minimization of the information imbalance only holds with respect to the setting of the optimal shadow price of the pollution constraint. It does not hold with respect to the initial allocation process of the permits. For this, the market mechanism in itself does not give any answers.

As the review of the EU ETS in practice has shown, precisely this information imbalance between the polluters on the one hand and the regulator on the other hand with respect to the initial allocation was the main obstacle to a proper functioning of the emissions trading in practice during the first EU ETS period. The lack of incentives for polluters - and the governments of those polluters – to be truthful about their current and projected emissions led to an over allocation of allowances such that there was no aggregate scarcity at all. Weary of falling in the same trap again the EU Commission slashed the NAP proposals for the second EU ETS period, thus probably ensuring that the “conditio sine qua non” for trading, scarcity, would be fulfilled for the second EU ETS period.

In addition, the EU Commission has announced[145] that it will gradually increase the proportion of allowances that will be auctioned rather than grandfathered. Thus, the power sector (not subject to international competition) would be subject to full auctioning as of 2013, while for the other sectors the proportion of auctioning would increase gradually as of 2013 until full auctioning would be reached by 2020. It is of note that auctioning rather than grandfathering the permits will not in itself reduce the risk of over allocation. As Woerdman (2008) correctly observes, it is the height of the aggregate cap that determines the degree of scarcity, not the choice for auctioning over grandfathering. However, as discussed in chapter two, auctioning does give information about the relative stringency of the cap and repeated auctioning may therefore be an important instrument to fine-tune this cap. In addition, the choice for auctioning over grandfathering does solve quite a few other problems that stand in the way of an efficient EU carbon emissions reduction program, as Bovenberg and Vollebergh (2008) argue. Thus for example, grandfathering on the basis of current capacity functions as a subsidy on the extension of this capacity (more capacity means more valuable permits), not as an incentive to reduce this (polluting) capacity. Nor does it provide an incentive to invest in pollution reducing techniques, for although this may lead to some spare permits in the current regulated period, it will lead to a reduction in the permits allocated for the next regulated period. Grandfathering may also lead to “rent seeking behavior”, as Aalbers (2007) describes: because grandfathering is usually based on the current and projected emission levels of the polluters and because the regulators lack the capacity to objectively establish these levels, polluters will be incentivised to overstate these levels in order to ensure a higher allocation.[146] The solution to this problem is evident: the permits should be auctioned rather than grandfathered, as this will ensure that the polluters have every incentive to keep their future emissions as low as possible (either through reducing their production or through investing in new emission reducing techniques) ánd to be truthful about their current and projected emissions.[147]

Another advantage of auctioning is that it conveys truthful information about the expected demand of compliance parties (i.e. those parties that ultimately need the permits to comply with the regulatory requirements) to other market participants such as speculative order flow providers[148]. As was shown in chapter five, in addition to lack of scarcity, lack of information about market demand and supply has so far been one of the more fundamental problems of the EU ETS.

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[145] CEC (2008)

[146] For more examples and an extensive discussion on these distorting aspects of the initial allocation process in the EU see Bovenberg and Vollebergh (2008) and Aalbers (2007).

[147] If they are not, they themselves bear the cost either by paying too much in the auction because they purchase more permits than necessary, thereby driving up demand and price, which permits they may have to sell at a lower price later on in the compliance period because demand results to be lower than it seemed in the auction, or vice versa by paying too much later on in the compliance period when they have to purchase additional permits at a price higher than in the initial auction because demand results to be higher than it seemed in the auction.

[148] See chapter three.

Of course, auctioning does pose quite a few problems, the most important of which is the competitive disadvantage for companies subject to a cap vis-à-vis companies established in countries that either do not have a cap, or that have a less stringent cap or in which permits are partially or wholly grandfathered.[149] This competitive disadvantage could even lead certain companies to migrate to more carbon friendly countries, as a result of which worldwide carbon emissions do not decrease at all. This phenomenon is usually referred to as "carbon leakage". To counter both competitive disadvantages and carbon leakage, a "border tax" on carbon intensive products from more permissive countries is often proposed. This could take the form of a fee levied per product, or the obligation to buy emission permits that would cover the supposed "carbon content" of the product. Either way, the implementation of such a system would be immensely difficult as Allan Beattie (2008) points out, firstly because it is difficult to measure the "carbon content" of a product anyway and secondly because the components of such a product may proceed from a multitude of countries, some of which may have a form of carbon taxes (and then probably not all to the same degree) whereas others may not. In addition, such a border tax is likely to provoke litigation (under the World Trade Organization) and retaliation from affected countries such as China or India. Bovenberg and Vollebergh (2008) therefore propose instead to subsidize those industries that are mostly affected by international competition.

As mentioned, auctioning would not only reduce the information imbalance between the polluting sources (compliance parties) and the regulator, it would also enhance the transparency of the carbon market. In other words, it would reduce the information imbalance between each individual compliance party (that knows its own degree of scarcity) on the one hand and the other parties (other compliance parties, financial parties, liquidity providers) active on the carbon market on the other hand. As became apparent in chapter five, lack of information about demand and supply, has been another problem in the EU ETS to date. The price crash of 2006 not only revealed a lack of scarcity of allowances, but also a lack of information with respect to this scarcity. The same lack of information on the relative scarcity transpires from the fact that the prices of the different futures for the second ETS period move almost perfectly synchronically. This lack of information can be attributed to the fact that there is no active spot market in carbon emissions[150], which in turn is caused by the fact that there is really only one moment per year when there is an actual "spot" demand, which is when the allowances to cover the emissions of the previous year have to be surrendered (on April 30th). In addition to auctioning, therefore, quarterly reporting instead of yearly reporting has been suggested[151] as a means to enhance the transparency of the carbon market. This would naturally entail higher administrative costs, but the benefit would be that there would be four moments per year at which reliable information about demand and supply in the carbon market would be available. Another possibility would be to install continuous

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[149] Although recent research, as discussed in The Economist (2008) of June 21st, indicates that the competitive disadvantage would probably be much less than usually maintained by those in favour of a border tax and/or against a price on carbon emissions.
[150] As discussed in chapter three, an active futures market could take over this role, but then the futures would have to have various expiration dates. The futures in the carbon market all have December expiries (with a few exceptions).
[151] By Mr. Boonman during the interview.

emissions monitoring devices at the polluting sources covered by the ETS, as was done in the U.S. sulfur allowance program[152] and then require very frequent (say monthly) reporting and surrender of allowances. Also this solution would naturally entail higher administrative costs.

3. Efficient markets

With respect to the last criterion for efficient markets, the markets themselves, we can be short. If the review of trading under the Kyoto Protocol (chapter four) and the EU ETS (chapter five) has shown anything, it is that efficient markets will readily be created once the other two conditions – tradeable assets and scarcity – have been met. It is clear that parties in all countries want to trade and will do so when possible. Multiple derivative products will be created and different types of market players (compliance order flow providers, financial order flow providers, liquidity providers) will flock to the market to try and make a profit. Those problems that the markets have experienced so far (lack of scarcity, lack of transparency) have their causes outside the markets. Once dealt with, the markets will pick up, as the recent increases in volumes on the European markets – following the creation of real scarcity - have shown. In this respect, again, the future of the markets for EU allowances looks rather good. Scarcity has been created for the second and third ETS period. Transparency will be increased through the increased auctioning of allowances. Regulation seems fairly stable until 2020 and the number of parties subject to the EU ETS will be increased with the inclusion of ever more sectors. At the same time, however, the more fundamental problem underlying lack of transparency so far – the absence of a spot market because of the absence of continuous or at least frequent demand from compliance parties – has not yet been dealt with. In addition, there are quite a few administrative and technical hurdles that have still to be taken, such as the streamlining of the NAP approval process, the synchronizing and improving of the yearly issuance of new allowances and the connecting of the ITL to the CITL. Outside the EU ETS, in the broader realm of the Kyoto Protocol, markets in credits are emerging. Whether these will have a future will depend on the question whether or not a credible and workable successor to the Kyoto Protocol will take effect. As regards other ETSs, finally, the same picture holds: given the fulfillment of the conditions of tradeable assets and scarcity, the markets will take care of themselves.

[152] Tietenberg (2007).

Conclusion

The title of this paper contains a question: does carbon emissions trading have a future? As the research reflected in this paper indicates, the answer is a resounding "yes". Governments and private parties alike are counting on a future with carbon emissions trading and the alternative abatement strategies (command-and-control mechanisms, taxes, subsidies) are less and less considered as realistic alternatives. The main argument mentioned in favor of carbon emissions trading is efficiency: trading would be the most cost-effective means to achieve the desired reduction in carbon emissions. This presupposes that an efficient market in tradeable carbon emission permits is feasible. It is this presupposition that has been the subject of this paper. On the basis of three criteria – tradeable assets, scarcity and efficient markets – it has been investigated whether the difficulties that have been encountered with carbon emissions trading to date are of a passing nature or of a more fundamental nature. The investigation has centered on two emissions trading markets operating in practice, the market based directly on the Kyoto Protocol and the EU ETS market. As the experience with the Kyoto market has shown, emissions trading based on credits from project-based mechanisms has many practical and ethical drawbacks. The future of this type of trading is therefore doubtful at best and developing countries would do well to reconsider their insistence on the CDM and the refusal of a binding cap, especially since equity considerations may also be reflected in the relative height of the cap. As opposed to trading in credits under project-based mechanisms, emissions trading in allowances under a cap-and-trade system is very viable. The experience with the EU ETS has shown that most obstacles encountered so far may be classified as "growing pains" that can and will be overcome. There is however one characteristic of carbon emissions trading that poses more fundamental problems, which may still be overcome, but much less easily. This is the fact that in the case of carbon emissions trading both the tradeable asset and the scarcity are created through regulation only. The tradeable asset does not have any intrinsic value, nor is there any natural demand for carbon reductions. As Capoor and Ambrosi (2008, p. 47) put it, *"Long-term expectations of future policy and regulation are the primary source of the carbon market's* demand *and action by regulators determine much of the available* supply *in terms of allocation of sufficient allowances as well as the issuance of carbon credits. Policymakers and regulators bear the biggest responsibility for the continuation of carbon market momentum by setting expectations for their role in long-term climate mitigation."* As it is, it is precisely these expectations or rather the lack thereof that is plaguing the Kyoto market. Because of this, it may be that this market is already doomed before it has even properly started. Fortunately, that is not to say that carbon emissions trading may disappear. Far from it, as initiatives for national or supra-national ETSs are being undertaken around the globe. The most significant of these to date, the EU ETS, has every prospect of a successful continuation in the future as policymakers have created a large degree of regulatory certainty until 2020. However, also the EU ETS has come across problems stemming from the regulatory nature of the asset and the scarcity. The exploitation of the information imbalance between polluting entities and the regulator, by the former, led to an over-allocation of allowances and therefore a lack of scarcity in the first ETS period. This lack of scarcity, in turn, meant that the market as a transmitter of information through the price forming mechanism did not function properly. This problem has been overcome in the second period, or so it seems, because the EU Commission has set the national caps in such manner that scarcity is ensured. However, lack of scarcity was not the only problem standing in the way of transparency and a proper functioning of the market. The fact that allowances covering past emissions have to be surrendered to the regulator only once a year means that actual, or “spot” demand by compliance parties does also only exist once a year. As a result, there is no active spot market in allowances and information on scarcity (for compliance parties and financial parties alike) is only available through the futures market. The futures, in turn, tend to have only one expiration moment per year (for the same reason), so that the information available through the futures market concerns the expected scarcity over the time-span of a whole year. It is this lack of transparency that forms the most serious obstacle to the proper functioning of the carbon emissions market. Perhaps the recent surge of trading in the carbon emissions options market offers a solution, although also these options tend to have the same yearly expiration date. Auctioning, preferably on a recurrent basis, would provide more information but the most structural solution would be more frequent reporting, perhaps based on continuous emissions monitoring at the site of the polluting entity. In any event, carbon emissions markets are likely to be around for a long time to come, whether in the form of a global Kyoto-like market or, perhaps more likely, in the form of various linked ETSs. Hopefully, these markets will be as efficient as possible, thus justifying the almost universal choice for this type of abatement mechanism over the other types. The parties participating on the carbon markets, however, may have somewhat less laudable motives for their enthusiasm for trading: through the markets they are able to trade their assets (carbon emission permits or credits) and thereby realize the opportunity value of these assets. In other words, they may very well be there to pursue their own profit, the public interest leaving them cold. But as Adam Smith already observed, there is nothing wrong with that.

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