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Is Sweden comparatively advantageous in trading emission allowances under the EU Emission Trading Scheme?

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Trade and compliance

Master thesis
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Foreword

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Abstract

This thesis has sought to answer the question if Sweden is comparatively advantageous in the trade with emission allowances in the EU Emission Trading Scheme (EU ETS) in 2005-2008.

By analyzing the emission levels in the Swedish greenhouse gas abundant sectors and the compliance to the EU ETS, it was shown that Swedish production outperformed the emission targets every year studied, leaving a large amount of emission allowances to be sold. This is to a large extent due to the use of renewable sources of energy in the electricity and heating sectors which have also been especially targeted by government policies. It has also been shown that most Swedish industry sectors are competitively advantageous when the EU ETS is taken into account. These measurements imply that Sweden has successfully managed to become efficient in the use of greenhouse gases i.e. comparatively advantageous in trading emission allowances. However, when analyzing Nord Pool trade data there is a contradictory relationship showing that Sweden not only has a negative net trade flow; it has gone from being a net exporter to a net importer of emission allowances. The reason for the discrepancy in this thesis is thought to be that Swedish firms emit more greenhouse gases abroad than at home. This is due to a measurement mismatch in the definition of Sweden.

This thesis could therefore not conclusively answer whether Sweden is comparatively advantageous or not.

Key words: European Union Emission Trading Scheme, EU ETS, cap and trade, comparative advantage, negative externality, Sweden, Kyoto protocol, trade, international economics, econometrics

Abbreviations

CDM -	Clean Development Mechanism
CER -	Certified Emission Reduction
CO_2 -	Carbon Dioxide
ECX -	European Climate Exchange
EEA -	European Environmental Agency
EEX -	European Energy Exchange
EPA -	Environmental Protection Agency
ERU -	Emission Reduction Unit
EU -	European Union
EUA -	European Union Allowance
EU ETS -	European Union Emissions Trading Scheme
EXAA -	Energy Exchange Austria
G8 -	Group of Eight
GDP -	Gross Domestic Product
GHG -	Greenhouse Gas
JI -	Joint Implementation
LULUCF -	Land Use, Land Use Change and Forestry
MBI -	Market Based Initiative
NAP -	National Allocation Plan
OTC -	Over the Counter
UNFCCC -	United Nations Framework Convention on Climate Change

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1 Introduction

In 1997 a majority of the countries in the world signed the international treaty to be known as the Kyoto protocol. This was the start of a new era in international environmental politics to fight the growing problem of global warming. The intent of the protocol is to limit and reduce the amount of atmospheric greenhouse gases (GHG) in a period of 20 years based on the amount of emissions in 1990. During this time period the emissions of green house gases would be cut with a total of five per cents. The protocol, which mainly targets carbon dioxide, also states by which methods this can be achieved where market based initiatives (MBI) is a central theme.

There have been a variety of approaches to the inclusion of the negative externality of GHGs during the years where the most commonly used tool has been a carbon dioxide (CO_2) tax. This is still a common instrument, but during the last decades the fairly new cap and trade system has been more frequently favoured. This system, which was first suggested in 1966 by the economist T D Crocker, is designed to put the market at the centre of attention. It was first implemented on a larger scale when the acid rain program in USA was launched. By capping the total amount of acid rain inducing components allowed and letting the market by trading allowances decide where these were most efficiently reduced, the phenomenon of acid rain effectively decreased. A similar system is now used on an even larger scale in the EU in order to reduce the amount of GHGs emitted and to meet the Kyoto emission targets.

The EU cap and trade system is called the EU Emissions trading scheme (EU ETS). It covers a total of 30 countries and almost 2000 million tonne of GHGs. This system has successfully managed to collect the members under a united environmental policy for the European community, by implementing a common regulatory framework for all to comply. With a single market for emissions of GHGs differences between countries in production, technology and development therefore becomes increasingly clear and interesting to study. This thesis takes on one part of studying such differences. It takes on the case of Sweden.

1.1 Problem and hypothesis

The purpose of this thesis is to analyze if Sweden is a comparatively advantageous country in trading emission allowances. In order to determine this, a number of variables will be taken into account. First off, the division of emissions by sector and the total Swedish compliance will be analyzed. Further on, the competitiveness of Swedish firms within the scheme and the policy implications of the allocation of allowances by Swedish authorities will also be analyzed. These measurements will present if such a prerequisite exists. Lastly, trade data will be processed to ascertain if Swedish trade reflects such an assumption. More explicitly the question is.

- Is Sweden comparatively advantageous in trading emission allowances in the EU ETS?

The hypothesis is that Sweden has a comparative advantage. This would mean that Swedish installations emit less GHGs than allowed thus leaving an excess of emission allowances unused. These are most likely sold in order to gain profit i.e. appearing as positive net trade in trade data.

1.2 Delimitations

The main limitation of the study is the analysis of Sweden in the EU ETS. The trading mechanisms of the Kyoto protocol will not explicitly be included, though they are hard to completely exclude since the systems are intertwined in many ways. It is mainly the tradable allowances issued by the Kyoto protocol that overlap the European scheme that become troublesome, but the other compliance variables are easier to isolate.

This thesis will not make any attempt to discuss the legality of the EU cap and trade system. Some efficiency measures of the scheme, mainly the pricing of allowances, will be discussed but the intent is not to further question the mechanisms of the EU ETS. Also, the existence of the greenhouse effect will not be questioned.

1.3 Disposition

The thesis is divided into six main chapters. These are outlined to make it as easy as possible for the reader to follow. This introduction, chapter one, is followed by a background to the study. This chapter will present the Kyoto protocol, the cap and trade system which is the basis for the system and of course the EU ETS system itself. It also includes a presentation of what previous research has been concentrated on. The third chapter will give a brief theoretical discussion about the externalities of environmental costs and comparative advantages. The analysis of the empirical material will be presented in the fourth chapter. This will be introduced by an in depth review of the hypothesis followed by the methodology that will explain how the material is processed. This is followed by the variables needed to answer the question. The fifth chapter will discuss the empirical analysis in contrast to the question and the hypothesis leading up to the sixth chapter which concludes the thesis. Abbreviations and a list of exhibits are presented separately and references are found in chapter seven.

2 Background

This chapter will present the background to this thesis by explaining the Kyoto protocol, the cap and trade system and the European Union emissions trading scheme. This chapter will give the reader an understanding of the mechanisms of the EU ETS.

2.1 The Kyoto protocol

The well known Kyoto protocol was the result of the 1997 international climate change summit in Kyoto, Japan. This protocol became an extension of the United Nations framework convention on climate change (UNFCCC), the difference being that the UNFCCC is a voluntary agreement, while the Kyoto protocol is a binding commitment to agreed levels of emissions reduction. The intentions of the two entities are however the same; to 'stabilize atmospheric concentration of greenhouse gases (GHGs) at a level that will prevent dangerous interference with the climate system' (Kyoto protocol reference manual: sid. 12, 2008).

The Kyoto protocols main intention is to reduce GHG emissions to the 1992 levels. Due to differences in countries absolute and relative levels of emissions, the maximum level allowed differs between countries. Worth mentioning is that, even though a majority of the world's countries has signed the treaty not all are included in the limitations. Excluded are first and foremost developing and newly industrialized countries (Kyoto protocol reference manual, 2008:13). There are about 40 countries that are limited in emissions by the treaty called the annex 1 countries. These are divided into eight subgroups depending on the percentage amount of reduction or allowed increase. These groups vary in levels ranging from – 8 % to + 10 %.

Moreover this, there are a variety of other limitations in the agreement. One of these is the Land use, land use change and forestry (LULUCF) which regulates the human induced alterations in the usage of land causing changes in a country's GHG inventory (unfccc.int, 2009). Since GHGs, mainly carbon dioxide, isn't just about the emissions but also the absorption. The natural cycle in the exchange of oxygen and carbon dioxide with plants is well known, thus the lack of CO_2 absorption is becomes a vital part of the greenhouse effect. The LULUCF article in the Kyoto protocol mainly focuses on forestry issues such as human induced afforestation, deforestation and reforestation, but also crop management and other kinds of commercial land use. Forestation must be accounted for by the annex 1 countries when reporting to the UNFCCC (Kyoto protocol reference manual, 2008: 14-15). If there are changes in a country's amount of forestation this will be reflected in the emission targets reported (ibid.).

That what makes the Kyoto protocol especially interesting is in what way emission reductions can be achieved. This protocol namely introduced trade mechanisms as a tool to reduce GHG emissions. The system itself is not that different from the EU ETS albeit positioned on a global scale. Allowances are issued to countries that engage in GHG reducing technology in another country. These allowances can be used to reach the Kyoto targets or they can be sold at market prices (Kyoto protocol reference manual, 2008: 16). The main difference between the EU ETS system and the Kyoto protocol is that the first mentioned covers basically all commercial GHG emissions which is not the case with the Kyoto protocol. Further on, a country cannot only buy units to cover excess GHG emissions without themselves introducing GHG reducing actions; this is a prerequisite. These units are therefore more of a complement by which obtaining the goals are made possible for parties that otherwise wouldn't.

The Kyoto units are also valid within the EU ETS system and are tradable in the same way as the EU ETS units. Even though the protocol does not address any regional trading system specifically it works like an umbrella under which the mechanisms can be connected. It is therefore possible to establish a regional trading scheme with the commitments to the Kyoto protocol (Kyoto protocol reference manual, 2008:16).

There are two kinds of Kyoto unit's traded, Joint Implementation (JI) and the Clean Development Mechanism (CDM). They can be traded in the same way but are awarded by different requirements. The first kind of unit programme, Joint Implementation, is based on the internationalization between countries. This is rewarded if an annex 1 country invests in GHG reducing activities in another annex 1 country; such units are called Emission

Reduction Units (ERU) (Kyoto protocol reference manual, 2008:17). This kind of unit is basically just a transfer of emission reductions between annex 1 countries since they don't reduce the total amount of emissions within the annex 1 countries. For this reason ERUs are not viable in the EU ETS. The second Kyoto unit programme, Clean Development Mechanism, works just like the JI units but with one difference. Like JI units an annex 1 country can obtain these by investing in GHG reducing activities in a second country (Kyoto protocol reference manual, 2008:17). The difference is that these are awarded when such activities are implemented in a non annex 1 country (ibid.). This also means that the total amount of emissions within the annex 1 countries is allowed to increase while the total amount of emissions worldwide stays the same. When traded, these units are called Certified Emission Reductions (CER) (ibid.). CERs are allowed to be used within the EU ETS and are worth the same amount of emissions as EU ETS units, one tonne of GHG per allowance.

2.2 Cap and trade

The cap and trade system is the main MBI tool used to combat global climate change. By implementing a cap on the total amount of emissions allowed, the market is free to trade the right to emit GHGs in between each other. The fundamental theory is that the market itself is the best regulator in the dispersion of the economic impact.

Before these market based initiatives were introduced the more commonly used regulation was command and control. This phrase includes a variety of tools to regulate environmentally negative externalities such as taxation, quotas or legal control. Though causing a similar effect on the environmental impact, it has been shown that these methods are far from economically efficient because of the fixed design (Stavins, 2007). Command and control measures instead tend to cause firms to take on similar shares of the pollution though these aren't uniform in size, technology or performance (ibid.). This means that the economic impact differs between firms.

The MBI presents itself as an alternative that uses the market as the base of the system. This was a different approach by which environmental goals could be achieved by untraditional methods (Burtraw and Evans, 2009). The cap and trade is as an incentive-based market orientated system where individual firms have a greater control over their emissions and environmental goals. It is well suited for markets where firms are differentiated in production, size, technological progress and location (ibid.)

The system is carried out by introducing a ceiling in the amount of emissions allowed during a certain time. This is possible by creating a limited amount of rights to emit GHGs. These rights, or allowances, are then either given or auctioned out to firms that use GHGs in their production. The firms are then free to trade the allowances in between each other as they see fit. However, the firms always have to hold as many allowances as is needed to cover their emissions. If these firms own more allowances than they need they can sell them at market price, but if they have too few they need to buy a corresponding amount of allowances to cover all of their emissions. If a firm possesses fewer allowances than emitted GHGs they will be fined for the transgressed amount of emissions. In this way the allowances are allocated socio-economically cost efficient and the regulator does not need to take into account every firms cost functions or their level of technology, because the individual firm will find the best production option that minimizes their costs (Burtraw and Evans, 2009). By extension their new cost function will represent one part of the total socio-economic cost function set by the cap (ibid.).

More over this, the system also presents an incentive to reduce emissions. By investing in emission reducing technology, firms can effectively lower their costs. It gives firms the control of their own externalities.

2.2.1 Allocation principles in the cap and trade system

An important part of the Cap and trade system is in what way the allowances are distributed. There are two main policies in this matter, handout or auction. The choice between the two has been a source of a great deal of discussions within economic literature. The handout model is also called grandfathering and means that the initial distribution of the emission allowances are allocated for free. There are mainly two reasons for doing so, to ease firms into the cap and trade system and to avoid additional restraint on consumer prices. However, it also causes some difficulties in the distribution of the allowances. Since all firms would like as many allowances as possible, the allocation can become rather problematic. Even if this process is based on objective measurements like previous emissions, expected future emissions, benchmark models or even politics, it has been shown that rent seeking behavior plays a certain role in such allocation (Burtraw and Evans, 2009). Other distorting effects are the uneven allocation to new entrants based on benchmark models and windfall profits. The reason for windfall profits to arise is the tendency shown in some markets where firms pass on the fictitious cost of allowances to the consumer. This causes consumer prices to rise while companies make more profit even though the allowances were given for free (Sepibus, 2007). In order to minimize the effects of rent seeking behavior and windfall profits, the cap and the allocation of allowances must be set in an efficient manner.

The second approach to the distribution of emission allowances is the auctioning system. This kind of allocation is a lot simpler in design and is also favored in economic literature. Without any preparatory work in allocation plans, all allowances are auctioned out to firms at market price. This minimizes the risk of rent seeking behavior and windfall profits but causes consumer prices to rise as production marginal costs increase. There is also a difference in the incentives. In a hand out distribution there is the possibility of making profit if environmentally sound technological changes are made, although an auction conveys a message that these changes are necessary to maintain a competitive edge in the marketplace through the threat of increasing costs.

2.3 The European Emissions Trading Scheme

The 13th October 2003 was the day the European parliament agreed to adopt the EU council directive 2003/87/EG which included a new approach to the ratification of the Kyoto protocol. This directive introduced a cap and trade system to reduce the amount of greenhouse gases emitted within the EU. The intention was to comply with the Kyoto protocol in a cost effective and economically viable way. It was calculated by the EU Commission that the system would lower the public cost by 35 percent as opposed to letting member states individually reduce GHG-emissions (naturvardsverket.se, 2007). In addition to carbon dioxide the directive also included the GHGs methane, nitrous oxide, hafnium carbide, perfluorocarbons and sulphur hexafluorides (European Parliament, 2003).

The system mainly targets the industries using greenhouse gases intensively as by-products in production. Individuals and households are completely exempted along with some industries such as transportation and aviation. Other exemptions are plants or parts of plants used for research and development and facilities used for testing new products and processes (ibid). However, the intent is to include more sectors as the system progresses.

The EU ETS works just as described in the cap and trade part above. The EU commission sets the cap on the total amount emissions allowed within the scheme and issues the corresponding amount of allowances. The distribution of allowances is carried out by a handout process, also described above, where the appropriate authorities in every country allocate the allowances according to guidelines set out by the commission. The Swedish agency in charge of the distribution process is the Environment Protection Agency (EPA) Naturvårdsverket. The intent is to use the grandfathering system during the first two phases and then swap the allocation approach to an auctioning system in 2013.

Within the system, one allowance equals one tonne of GHG emissions. In order to assure compliance to the system, companies and other institutions covered are obliged to report the amount emitted once a year to the respective member state agency in charge of the emission rights distribution. If an installation exceeds their held amount of allowances in emissions at this time their infringement is to be set in an effective, proportional and deterring manner. The penalty in the second phase is €100 per excess tonne plus the cost of allowances needed (Daskalakis and Markellos, 2008). If installations were to emit less GHGs than allowances held these can, in addition to be sold, be banked for future periods (ibid.).

There are two kinds of emission rights possible to use in the trading scheme, the EU allowance (EUA) and Certified emission reductions (CER). The first mentioned is the kind of allowance that is specific for the EU ETS, which can only be used within the system. The other kind, CERs, is used in the same as a EUA but is directly issued through the mechanisms in the Kyoto protocol, as previously mentioned. Every allowance has an expiration date depending on when they were issued. An allowance can be used in the year of the issuance or in years to come depending on this expiration. They can actually also be used for previous periods. If an installation exceeds their limitations of emissions one year they can cover these with allowances allocated in the following period (Stauffer, 2008). This way, the system remains flexible and limits the possibility to speculate in the markets.

There are today five larger scale European market places for trading emission allowances. The London based European Climate Exchange (ECX), Nord Pool, which is particular large in the Nordic countries, the European Energy Exchange (EEX), the New York stock exchanges environmental branch Bluenext and the energy exchange of Austria (EXAA). These all offer trade with both EUAs and CERs. However, over the counter (OTC) trade is also a common trading route. OTC means that firms trade directly with each other without intermediaries (IETA report, 2007). When comparing the climate exchanges in size the ECX is the largest followed in falling order by Nord Pool, EEX, Bluenext and EXAA.

The introduction of a common environmental policy in emissions was especially pushed onto the agenda by the northern European countries, including Sweden (Nello, 2005: 264). The reason for this was the existing differences in compliance cost to GHG polluting industries. After the implementations of the 'single market program' such differences in fiscal governing became incentives for reallocation of industries. Since the northern members of the EU had higher environmental compliance cost these feared they would be undermined in a race-to-the-bottom (ibid.). With a joint environmental program such fears would be uncalled for.

2.3.1 EU ETS since 2005

The EU ETS is currently in the second phase which will last until 2012. The first phase was initialized in January 2005 and ended in December 2007. The scheme currently includes 27 countries. The introduction of the system ran smoothly and the price levels increased steadily from just over € 7 to over € 25 in the following 15 months (Nord Pool price index, 2005-2007). However, in the end of April 2006 the price collapsed and halved in just a few days after it became clear that a majority of countries had over allocated allowances in the initial distribution (Entec, 2007); this caused the price to plummet rapidly. By the fall of 2006 one allowance could be bought for less than 10 € and in February they had fallen to just one cent (Nord Pool price index 2005-2007). This caused many to publicly criticize the EU ETS as being an ineffective tool in combating climate change.

Preceding the second phase the system was made more stringent and more inclusive. There were three new countries included, Norway, Iceland and Lichtenstein (eubusiness.com, 2007). This was an intentional effort of the EU commission to expand the scheme outside the union with the intent to globalize the cap and trade system (ibid.). The industries included at this point were first and foremost installations that previously had been exempted due to production differentiations.

The second phase also introduced the possibility of expansions to include other industry sectors, mainly the aviation, maritime and forestry sectors (Dimas, 2005). The aviation industry alone is responsible for three percent of the EU total carbon dioxide emissions and has yet to invest in carbon dioxide efficient technology. This is also an expanding industry which makes it all the more important to include (ibid.) as with maritime transportation. Because of deforestation resulting in a lower natural absorption of atmospheric carbon dioxide the forestry sector was also considered a valued sector to include. These changes are expected to be implemented in 2012. There is also an intention of including the transportation sector in the third phase though there are problems with how to restrict what to include and exclude.

Despite the fact that the new entrants of countries and sectors enlarged the scheme, these were rather small additions. The more pressing issue in entering the second phase was determining how to set the new cap.

When entering the second phase of the scheme the EU commission showed an increased constraint on the cap of allowances issued. The main reason was that the first phase resulted in a 1.8 percent increase in emissions (European Union, 2008). Even though the EU GDP growth was 2.8 percent in 2007 alone, this was not an impressive result. The main constraint in entering the second phase was the reductions of allowances issued. The allocations in the first phase didn't apply such constraints, instead confiding in the member states allocation plans to present a correct evaluation of emissions over the three years (ibid.).

When assessing the allocation plans for the second phase the EU commission used a more stringent starting point. This comprised three main points that needed to be fulfilled. The first was that the allocation plans had to be consistent to the EU total and individual countries Kyoto commitments. The second was the consistency with actual emissions in the annual progress reports and the third was the consistency with the technological potential for emission reductions (European Union, 2007).

2.4 Previous research

Even though the EU ETS is rather young, combined with the fairly untested use of the cap and trade system, the scheme has already come to be well documented. There are some different approaches to the subject in the previous research. One of these is the studies of the allocation principles and the implications on competitiveness between industry sectors and countries. In the article, “The European emission trading scheme put to the test of state aid rules” de Sepibus (2007) discusses the compatibility of the allocation of allowances to the state aid rules implying competitive distortions in the electricity sector. In, “Strategic partitioning of emission allowances” Böhringer and Rosendahl (2008) analyzes the effects of strategic partitioning by the inclusion and exclusion of sectors to the scheme in compliance cost and emission prices. Further on, there has been some other research done in competitiveness effects to the system where the authors Sonja Peterson and Gernot Klepper (2008) have been especially active. These articles discuss differences in competitive advantage between sectors and regions when the EU ETS is taken into account. A number of studies have also been published on the price mechanisms in the spot markets (Benz and Trück, 2008) and what factors affect the pricing of EUAs (Aggeryd and Strömqvist, 2008). There are also some studies that have been made in the use of the cap and trade where the efficiency of such a system is analyzed by including the EU ETS, and in what manner the allocation of allowances is conducted (Burtraw and Evans, 2009). In the case of Sweden as a member country in the EU ETS the few articles that are published mostly deals with emission reduction possibilities in specific industries or installations. One report however investigates how the Swedish economy will be affected by the climate goals in the Kyoto protocol but only indirectly includes the EU ETS (Hill and Kriström, 2005).

Although being a well studied area the aspect of the actual trade in emission allowances is not as well documented. The reason for this most likely lies in the secrecy when it comes to the amounts traded by specific actors. There have been unsuccessful attempts by news journalists (Hermansson, 2009), but none were found in scientific articles.

3 Theoretical discussion

This chapter will present a brief discussion on the theoretical framework to the question of this thesis. The intent is to offer the reader an understanding about the economic mechanisms surrounding the externality of pollution and choice of comparative advantage as a measurement.

3.1 Negative externalities

The phenomenon of global warming caused by the greenhouse effect is in economic theory a case of negative externalities. This means that there is a mismatch between private and social cost, specifically when a third party pays an excess cost not included in the production. It is this excess cost that is called a negative externality. By exemplifying this, if a firm produces a good with air pollutants as a by-product, such as GHGs, the private cost is the direct cost of producing that good. However, the social cost that presents itself as the negative effect on the surroundings, such as global warming, is not included in the production cost. In this way the firm does not carry the full cost of their production, leaving a negative external cost. The implication of this is that externalities cause the allocation of recourses to be inefficient. Since the market price does not reflect the total cost, neither producer nor consumer will pay full price for the product (Nicholson, 2005: 588). It is instead a third party that pays for the additional cost. In an unregulated market the assumption is that such additional cost will not be included in the price since both the producer and consumer (assumed rational) strive to minimize their cost leaving the market inefficient (fundamentalfinance.com, 2009). But, since society as a whole both benefits (lower cost) and loses from pollution, there is an optimal level where the marginal benefit and marginal cost intersects (Krugman and Wells, 2005: 458).

The most common solution to offset market inefficiencies is to place a market regulation. The optimal regulation would impose just the right amount of coercion to subdue dead weight welfare loss from arising (fundamentalfinance.com, 2009). A traditional way of regulating such markets is to impose a tax specifically known as a Pigovian tax. The intent of such a tax is to (as the effect of all taxes) lower the produced amount of goods to a level where nature can absorb the byproducts without harm (Nicholson, 2005: 593-594). Another way to regulate the market is the now well known creation of tradable pollution rights though the important notion to understand is that these both result in the same equilibrium (ibid.). Whether a firm pays a tax or a royalty in order to pollute does not matter, the output reducing effect will still be the same.

How to distribute such pollution rights has come to be a source of great discussion. As previously written, there have been a number of discussions as to how this allocation is to be made, though it has been shown that the initial distribution is irrelevant to the market. If the rights are well defined and do not include any transfer costs, the trade will end up in the most effective equilibrium (ibid.). The reason for this is bargaining. Even though a firm would gain from being allocated as many rights as possible initially, there is an incentive that these will be set to use where they are the most valued. Even if one firm would be given all rights, using the excess rights would effectively increase cost (ibid.); the firm would therefore gain more from selling the rights not needed instead of using them. The incentive to a firm which has not been given any rights is quite simply that without them they would not be able to pollute at all i.e. stop production. There is thus a gain for both producers to coexist. This is referred to as the *Coase theorem*.

The theory of negative externalities is at the center the global warming dilemma. As shown above, there is a need for regulation to effectively include social cost. It is the choice of regulation that has been the greatest source of discussions. Also, the Coase theorem plays a certain role in the determination of allocation principles, which will be analyzed further on.

3.2 Comparative advantage

Comparative advantage is one of the fundamental reasons to why nations engage in international trade. The fact that there are differences in prerequisites between countries opens up the possibility of specialization i.e. efficiency in production. As the name states, this is a relative measurement where at least two countries enjoys different advantages in productions when compared. Trade arises between the two when one country can produce a good more effectively i.e. to a lower cost than the other. Such differences can be constituted by different variables; the most common in economic literature being differences in land, labor and capital. The first model that dealt with comparative advantage, by David Ricardo, used only the division of labor (Costinot, 2009: 255). This pointed out that even though a country has a higher output capacity over another country in, at least, two traded goods, they can still reap profit from trade due to differences in labor productivity. The theory of comparative advantage evolved further when Heckscher-Ohlin introduced the possibility of multiple production factors. This theory explored the advantages in abundance of such production factors as land and capital. If a country is relatively abundant in land it will be more productive in the production of land-intensive goods (Krugman and Wells, 2005: 412).

The Ricardian and Heckscher-Ohlin models are the classic theories that constitute the base of the concept. The modern international economic research though has taken into account other factors when assessing comparative advantages. One of these is the disparities in technological progress (Costinot, 2009: 255). This means that the technological progress also plays a certain role as a determinant of specialization. The higher the technological progress a country inhabits, the higher the complexity in production is observed. A similar role is played by institutional quality and level of human capital. Some theories even claim that technological specialization is dependant on the character of the market. A liberal market economy (such as the US) is specialized as radical innovation while a coordinated market economy (such as Germany) is focused on incremental innovation (Akkermans et al, 2009: 181). For environmental economic theory another variable that has been shown to act as a comparative advantage is regulation of pollution. It has been shown that countries can specialize in lowering environmental compliance cost to specifically attract polluting industries thus holding a comparative advantage in such production (Das, 2009: 470). Countries that engage in such race-to-the-bottom policy implementation are known as pollution havens.

Even though some of the modern takes on the theory of comparative advantage have been very well discussed and criticized the fact that new factors have been taken into account implies that the case of comparative advantage is far more complex in its determinants than previously thought. Whenever there are differences in factors that have implications to production there is the possibility of comparative advantages in trade, given that other factors are held constant. The question of this thesis is unorthodox in the way that the comparative advantage in trading emission allowances arises by being efficient in pollution intensive production leaving allowances to spare, and not in the production of allowances itself. This is therefore really a study in the abundance of pollution reducing industries that causes a comparative advantage in trade.

4 Empirical analysis

This chapter is the center of study. It will present the chosen measurements and results needed to give a comprehensive answer to the question. Firstly the hypothesis will be revisited to offer an understanding to the chosen measurements followed by a brief review of the methodology used. After this, the empirical measurements and results will be analyzed.

4.1 Returning to the Hypothesis

It is the hypothesis of this thesis that Sweden is a comparatively advantageous country in trading emission allowances. Since allowances are not produced per se the measurement of comparative advantage is a country where emission reductions in GHG abundant production industries are efficient.

The hypothesis is based on the notion that Sweden is a country that is well known for its environmentally sound policies and technological progressive climate in green markets. For example, a well known fact is that fossil fuelled energy sources such as coal based energy production are basically non-existent in Sweden. The main sources for energy are instead nuclear-, hydro- and wind generated. Also, in the heating of houses Sweden has in a large extent switched from electric to locally produced heating by using forestry- and household waste products. Public transportation is another sector that in many parts of Sweden has been switched from gasoline to other more environmentally friendly substitutes such as biogas, ethanol and other alternatives (Kaemer, 2008). It is therefore thought that Swedish industries to a larger extent have switched to green technology thus being more emission efficient in GHG abundant productions. This would imply that Sweden is comparatively advantageous.

4.2 Methodology

In order to determine if Sweden has a comparative advantage in trading emission allowances a number of variables will be analyzed. It is first of all necessary to establish if the prerequisites for such an assumption exist. This is done by analyzing Swedish emissions compared to the allocation and allocation principles of the allowances. Furthermore, the future competitiveness of sectors is also analyzed to give a comprehensive picture as to whether this is case or not. These factors will then be used in context to actual trade flows to establish if an advantage exists.

The main choice of methodology is the quantification of the problem. Since the question is characterized by a large statistical population, where both trade and emission are of the quantitative sort, there is a need for this method. The main material measured in this thesis is the trade data collected from the Nord Pool exchange and analyzed first hand. The other measurements of the question are more diverse since there are many aspects to the dilemma. The quantified data used to analyze this part is however not processed first hand but is mainly relied on statistical compilations by the European Environmental Agency (EEA), previous articles and the Swedish EPA.

However, to say that this thesis is solely based on quantifiable measures would be incorrect. The measurements of the question are mainly quantitative but the analysis of how these relate to each other and the evaluation of the results are qualitative. More over this, some qualitative measures are used to present a comprehensive result.

4.3 Emissions and targets in Sweden

As previously stated, Sweden has for a long time been internationally known as an environmentally friendly country. This can also be shown in the statistics. Within the European Union only two countries emit less greenhouse gases per capita (2007), Romania and Latvia. In total emissions Sweden is ranked the 19^{th} biggest emitter (EEA Pivot application, 2009).

Carbon dioxide constitutes the largest amount of GHGs, over 98 percent of the total emissions (Naturvårdsverket, 2008). The largest sector for emitting CO_2 in Sweden is transportation. In 2007 this sector alone emitted 20642.37 thousand tonnes of CO_2 which roughly accounts for 40 percent of the fuel combustion activities. Within this group, road transportation accounts for the largest amount. Though being the largest emitting sector in Sweden, and a big contributor in other EU countries as well, the transportation sector is not a part of the EU ETS yet. Following the transportation sector in size are the energy sectors (electricity and heat) and manufacturing industries including construction (ibid.). These account for about 20200 thousand tonnes of CO_2 and are the main sectors for the allocation of allowances in the EU ETS compliance. Because of the reporting date of the statistics presented here being in December the following year, the 2007 statistics are the latest available, but these numbers give a fair overall view from where Swedish emissions originate.

When compared to other industrialized countries the difference in Sweden is quite clear. Since Sweden use coal and oil generated energy to a small extent there is a big difference with other countries. Combining all industrialized countries, carbon dioxide originating from energy production totals closer to 40 per cent (worldbank.org, 2009) compared to Swedish production that adds up to roughly 20 per cent (Naturvårdsverket, 2008). Further on, transportation amounts to 20 percent and manufacturing and construction to just over 12 percent (worldbank.org, 2009). When comparing the latter, in Sweden this amounts to about 20 percent of the total emissions (Naturvårdsverket, 2008). The main productions in the industry sector where carbon dioxide is a bi-product is constituted by steel production, chemical and the pulp and paper industries (ibid.). The reason for the industry sector being relatively larger in Sweden than in other industrialized countries is mainly that it is a relative measurement. The exclusion of energy and heat production leaves the industrial sector at just under 20 percent in the other industrialized countries as well, but it is also a fact that the main Swedish industrial productions are fairly intensive in carbon dioxide emissions.

Sweden has been a part of the EU ETS system since the beginning in 2005. During this time Swedish companies have been allocated allowances for the emissions they are projected to release. It is important to understand that these allowances are allocated to a specific installation which means that they are not allocated to a particular company as much as it is allocated to a specific country. This means that a company that resides in country A but emits greenhouse gases by operating an installation in country B receives allowances from country B. This is an important notion that is needed to bear in mind further on.

Presented below is a diagram showing the Swedish compliance to the EU ETS (EEA pivot application, 2009-10-06). The four sets of bars indicate the four years 2005 – 2008. Each set includes three measurements that together paint a good picture of the compliance to the EU ETS. The left light blue bar represents the amount of allocated allowances. The brown bar in the middle gives the amount of surrendered allowances. This is the bar that needs to cover the annual total amount of emissions represented by the darker blue bar on the right.

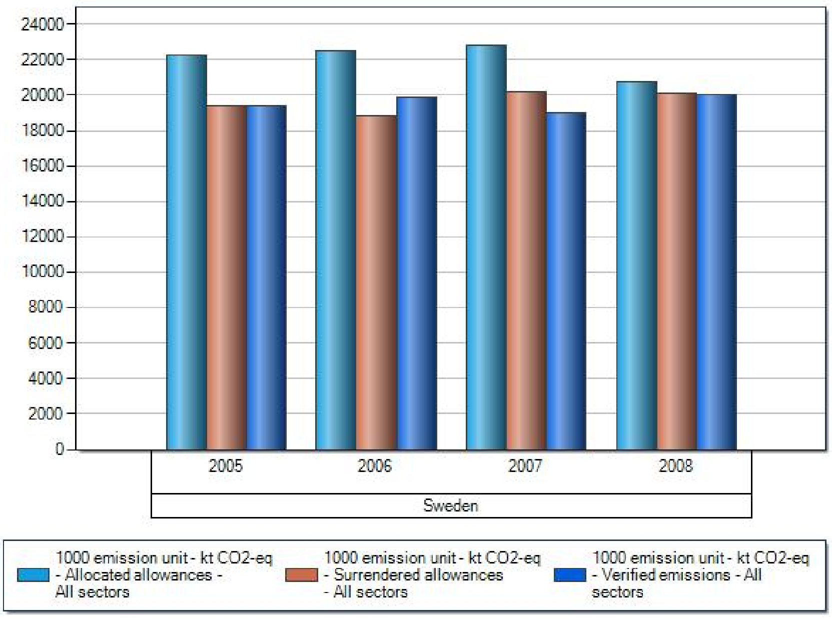


Fig. 4.1 - Swedish emissions with surrendered and allocated allowances in 2005-2008

During the 4 years 2005-2008 Swedish emissions by sectors in the EU ETS increased slightly. In 2005 the total amount of emissions to be included was 19382 thousand tonnes of carbon dioxide and equivalent. During the four years studied this amount increased with 625 thousand tonnes which equals to a 3.2 percent increase (EEA Pivot application, 2009). Disregarding 2007 when the Swedish emissions were lower than they were in the initial year, the total emissions have steadily increased until 2008 to a total of 20007 thousand tonnes in 2008 (ibid).

The amount of surrendered allowances in Sweden has covered the emissions in three of the four years. What this measurement says is how many allowances that have been either used to cover emissions made or which have expired. Expiration occurs because every allowance issued inherits a period of usage. The reason is to constantly control the amount of allowances in circulation; it also reduces the likelihood of speculation. Expiration can also occur between phases as it did in between the first and the second phase 2007 – 2008. In 2005 Swedish installations surrendered allowances to the exact amount of emissions made, 19382 thousand. The following year there was a surrender deficit of about 1000 thousand allowances. About a third of these can be explained by a registry malfunction in the company EC Nordkap (ec.europa.eu, 2007), but the rest are installations that did not cover all of their emissions thus being penalized for their transgression. In the third year there was a 1200 thousand EUA surplus in surrendered allowances (EEA Pivot application, 2009). The reason for this can to a large extent be explained by the expiration period. Since the allowances issued in the first phase were not transferrable to the second these automatically expired requiring their owners to surrender them within four months (European Parliament, 2003). Another explanation is that all emissions need to be covered, even previous transgressions. The uncovered emissions in 2006, though being fined, were still needed to be covered, consequently showing up in the next period. A surplus, albeit smaller than previous years, can also be observed in the last year. In total Swedish installations managed to match emissions with allowances surrendered three out of four years.

The last variable in the diagram above is perhaps the most interesting for this thesis; the amount of emission allowances that were allocated to Swedish installations. In combination with the amount of allowances surrendered and the amount of emissions made, it is possible to calculate the surplus or deficit in the amount of allowances used. This shows if Swedish installations have sold excess or bought additional allowances.

The first noticeable observation of the diagram above shows that in all four years of the EU ETS, Swedish installations have received more allowances than both emissions needing coverage and the surrendered amount. Another observation easily made is that the surplus in allocated allowances is bigger in the first phase 2005 – 2007 than in the second 2008. There are two reasons for this also explained earlier. The first being that both emissions and surrendered allowances have increased during the observed period and the second is the decrease in allowances allocated in the second phase. The reason for the emissions to increase though is the inclusion of previously exempted industries (Berggren PM, 2009). The total emissions excluding these installations actually decreased (ibid.).

In 2005 Swedish installations were given 22289 thousand EUA allowances to cover the 19382 thousand tonnes GHG emissions made which leaves a surplus of 2907 thousand allowances (EEA Pivot application, 2009). This surplus increased in 2006 when the allocated amount was raised slightly to 22484 thousand and the surrendered amount decreased to 18875, consequently leaving a surplus of 3609 thousand allowances. Further on, in 2007 the surplus decreased to 2645 even though the allocated amount increased to 22846 thousand (EEA Pivot application, 2009). Also, as explained previously, the reason for this is that the surrendered amount of allowances increased due to the downturn in the price of EUAs. The allocation decreased in 2008 due to the restrictions in emission targets when the EU lowered the central cap. The amount allocated in 2008 was 20775 thousand and once again, compared to the amount of surrendered allowances these resulted in a surplus of 674 thousand allowances. This means that Swedish installations have in total, during these four years, out performed the targets by a total of 9835 thousand EUA allowances. This is a quite large allowance surplus leaving a potential of almost ten million EUAs to be sold at market price. Once again, since it is an important notion, this surplus comprises the installations physically located in Sweden, not companies and institutions from Sweden.

When summarizing the Swedish emissions statistics above some concluding remarks can be made. The main carbon dioxide polluting sectors in Sweden is transportation, industry and energy. The main difference when comparing to other industrial states is that the Swedish energy sector emits far less carbon dioxide. The reason for this is the Swedish main use of non-carbon dioxide abundant technologies such as nuclear-, hydro- and wind powered sources. When analyzing statistics in the Swedish compliance to the EU ETS system it is clear that Swedish installations have increased the use of GHGs, though new inclusions played a certain role. Comparing 2005 levels with 2008 levels there has been a 3.2 percent increase in the sectors covered by the EU ETS (EEA Pivot application, 2009). This statistic also shows that Sweden in all four years has been over allocated in allowances and has received more allowances than has been surrendered as well. This over allocation has resulted in a surplus total of roughly 10 million allowances. Since we know from the statistics that these have not been surrendered and since this would also be the case if they were expired, the excess allowances are probably sold to be used in other installations.

4.4 Sweden's national allocation plans

The reason for analyzing the Swedish allocation plans is that these plans reflect the active policies of what industries to push towards emission reductions. As with differences in marginal cost of pollution between countries, differences in allocation across industries can imply differences emission reducing incentive.

As every EU ETS country, Sweden submits a national allocation plan (NAPs) to the EU commission for approval. This plan is based on the EPA projections and a set of allocation principles to determine which installation gets what quantity of allowances in the hand out process. These plans are based on annual allocations but are only submitted preceding a new phase. The allocation principles are set out by the government environmental department, confirmed by Riksdagen (the Swedish parliament) and practically set to use by the Swedish EPA. As the EU ETS is currently in the second phase, two national allocation plans have been made.

The first phase allocation plan stated that Sweden needed a total of 68.7 million emission allowances to cover emissions. This amounted to a total of 22.9 mission allowances allocated every year (Regeringskansliet, 2004). This amount was also cleared by the EU Commission without revisions (European Union, 2005). In reality the emissions amounted to an average of 19.3 million tonnes of carbon dioxide a year (EEA Pivot application, 2009). The reason for this 19 percent over allocation can be derived from the allocation reports leading up to the NAP. When assessed for the NAP these reports were thought conservative in numbers resulting in an added buffer for possible increases in emissions and new entrants, which resulted in an over allocation. When entering the NAP for the second phase Sweden requested 25.2 million allowances annually. 22.2 million of these were to be allocated to existing installations leaving 3 million to eventual new entrants (Regeringskansliet, 2006). This was a significant increase to the previously allocated 22.9 million. The second allocation plan though was not accepted by the EU Commission and after revising the plan the national cap was set to 22.8 million allowances annually (European Union, 2007).

The principles for the distribution of allowances in the two phases were conducted by introducing an economic model. The reason for implementing such equations was to fulfil the prerequisites of simplicity, transparency, predictability and non-bureaucracy (Regeringskansliet, 2004:16). These prerequisites were given by the EU commission in order to assure the NAPs objectivity and fairness in the allocation of allowances. These equations, presented below, were used, though slightly differing, for both NAPs and it determined how many allowances were to be given to a specific installation.

Existing installations – $Allocation_{05\text{-}07} = k\ (E_{98\text{-}01} \times K_{ex}) + ER_{05\text{-}07}$

New entrants – $Allocation_{05\text{-}07} = k \times Projected\ output_{05\text{-}07} \times BM/BAT$

The equations made a clear division of the industries into two groups, raw material related emissions and fuel-related emissions by the variable *k*. The first group included industries dealing with refinements of materials where carbon dioxide is bound, or the use of carbon dioxide to rid unwanted components. The second group includes industries that uses fossil fuel to produce power, heating or transport energy (ibid). The variable *k* assumes 0.8 if the installation is an energy sector combustion (the second group) and 1.0 if it isn't (the first group). The variables within the parenthesis, $E_{98\text{-}01} \times K_{ex}$, are the annual emission mean 98 - 01 multiplied with a correction if extraordinary events took place within those years. Lastly, the variable $ER_{05\text{-}07}$ gives the eventual supplements in projections for 2005 – 07.

The second equation, applied to new entrants, is basically the same as the first but instead of relying on previous emissions a projection of future emissions combined with a benchmark of the most efficient producer was used to determine the amount to allocate (Regeringskansliet, 2004:34).

The principles for allocation in the second phase were similar to the equation in the first phase with some changes. The equations above stayed relatively the same; the biggest difference being the calculation of the electricity and heating sector. In the second phase these were given allowances on a "what is left"-basis, after the allocations to all other industries was done. This sector was not considered a priority in the allocation. The model above was later revised due to the lowered cap by the EU commission though the basics of the equation were still used. However, the electricity and regional heating installations were now exempted allowance allocation (ibid.), the reason being that these sectors, especially regional heating, were evaluated as not as competitively challenged as other sectors

(Interveiw - Berggren, Sara, 2009). Another motive for this position was a directive by the Riksdag to act more restrictive in the existing energy sector (Regeringskansliet, 2007). Exempted from this position were the new entrants to the scheme where the electricity and regional heating sectors in this case were allocated allowances by a benchmarking evaluation (naturvardsverket.se, 2009).

It is therefore safe to say that there has been an agenda to restrict the energy market further in emissions.

4.5 Competitive advantage

The market for EUAs in the trading scheme is fairly different from a regular market because of different productions in both end product and in factors used. This makes comparing competitiveness in the emissions market different from other market.

Since it isn't really the EUAs that are the main product in this market, it is GHGs, companies want to produce as little as possible in order to avoid the additional cost of EUAs, thus if the market as a whole finds itself in a large amount of supply the demand actually diminishes. This is the short term perspective because of the price; big quantities in the market equal low prices leaving the GHG reduction incentive less attractive, thus the need for continual allowance reductions in the cap. The competitive advantage in this market is therefore also peculiar to measure. The competitiveness results in the notion that whoever can produce their products with the lowest amount of GHGs possible i.e. the most EUAs to spare are competitive in emission reduction. In turn, since emission reductions lower costs, the production itself also becomes more competitive.

Since firms that trade emission allowances aren't a homogenous group in the production, in order to compare competitiveness there is a need to differentiate the sectors of production. These are in turn to be compared in between countries; Sweden being the main country of interest. This means that not only competitiveness is being studied but also comparative advantage. This kind of study has been made by Peterson and Klepper (2008) which will be shown here.

The introduction of the EU ETS had explicit effects on the competitiveness for the industries included. In general, these policies had a negative effect on competitiveness in the EU as a whole because of reductions in production which led to fewer exports. These effects are however small and the damage has not been severe (Peterson and Klepper, 2008). Generally, it's mostly the energy intensive sectors that are most affected, though the export decrease in highly energy intensive sectors was compensated by increased competitiveness in other manufacturing industries (ibid.).

Sweden inhabits a fairly big industrial sector which includes the production of iron, steel, paper and pulp, minerals and chemicals. These are all energy intensive productions that usually mean a large amount of bi-products such as greenhouse gases. The entire industry sector in Sweden emitted about 10 million tonnes of carbon dioxide and other GHGs in 2007 (Naturvårdsverket, 2008). The production sectors mentioned above constitutes about half of that. It can also be noted that these are large scale productions in output. The main sector where Swedish production is relatively green is the mentioned production of electricity and heating. The main reason is that electricity production does not use any coal or oil and a large amount of the production in heating uses forestry waste or similar green technology.

In evaluating future competitiveness for Sweden and in which sectors these can be observed two things are to be taken into account. How competitive a sector in a specific country is now and how well these sectors have adopted new technology allowing them to avoid large costs in excess allowance purchasing.

The closest measured geographic subset to such data is Scandinavia (Sweden, Finland and Denmark) which roughly gives the same picture as Sweden, although it is important to be critical if these were to show unexpected results. Presented below is part of the Scandinavian result of a study in such future competitiveness (ibid.).

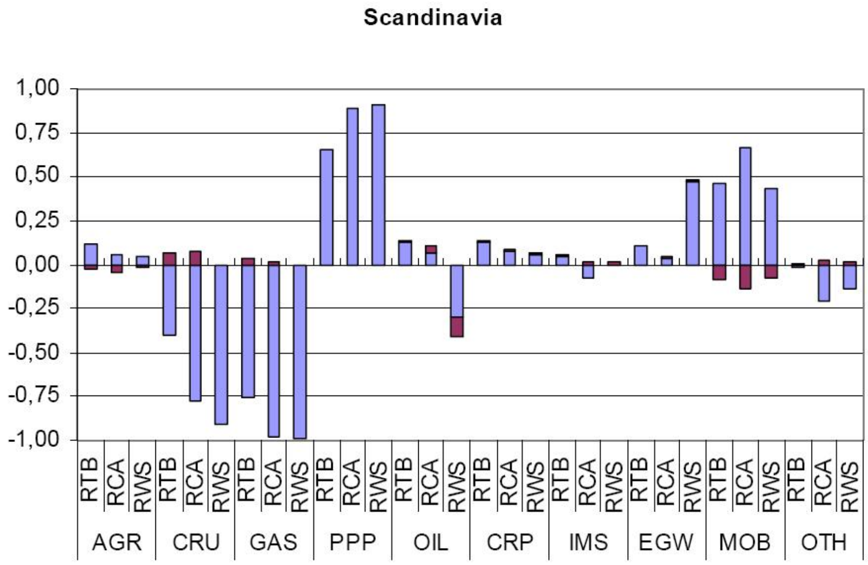


Fig. 4.2 - Future sector competitiveness in Scandinavia (Petersson and Klepper, 2008)

The diagram above shows the competitiveness for Scandinavian sectors in the EU ETS until 2020. The diagram is divided into 10 subgroups by sector in the x-axis and the y-axis gives the relative measurement in competitiveness ranging from +1 to -1. A positive fallout indicates a sector as competitive when compared to other countries or regions and vice versa. There are also three subgroups for every sector which gives the three measurements of the study. RTB stands for relative trade balance and is an indication of the reaction of the trade balance relative to total trade (ibid.). RCA is the revealed comparative advantage which measures the relative competitiveness across different industries within the same economy (ibid.). Lastly, RWS stands for the relative world share. This measurement shows the share of the sector exports relative to total exports, this is then compared to the same share internationally (ibid.). These three measurements give a balanced view of the expected future competitiveness.

Not surprisingly, the sectors where the Scandinavian countries will perform poorly are in the fossil fuels sectors, crude oil (CRU), gas and oil. The reason for this is quite simply that no Scandinavian country (expect Norway that isn't included here) is abundant in fossil fuel. When observing the electricity production (EGW) it is possible to conclude that this is a competitive market in the future. The main reason being the high share of renewable and nuclear energy previously mentioned (Petersson and Klepper, 2008). Due to the use of such sources in energy production in Scandinavia, as with the abundance of nuclear power in France, these regions can actually increase profits in entering the EU ETS (ibid.). The diagram above shows this sector to be the second most competitive in the relative world share measurement (RWS). The two Scandinavian sectors that best manage being competitive, are the Paper and pulp production (PPP) and transportation sector (MOB). The reason for the paper and pulp production being such a competitive sector in Scandinavia is the relative abundance in forestry and the large, robust industry within the sector. This industry is mainly located in Sweden and Finland, which is why it's safe to say that this is a competitive industry in Sweden. The other competitive sector is commercial transportation which can be considered peculiar. The transportation sector is the largest emitter in carbon dioxide in Sweden. In 2007 this sector emitted 20 million tonnes of carbon dioxide which amounts close to 40 percent of the total emissions in Sweden (Naturvårdsverket, 2008). The reason for Scandinavian transportation being competitive is the fact that it isn't included in the EU-ETS yet. When transportation is included the cost of carbon dioxide emissions will effectively decrease because the emission costs in Sweden for non-ETS sectors are among the highest in the EU (Petersson and Klepper, 2008). This is why they are competitive when including the ETS as a factor.

The statistics above shows that Swedish and Scandinavian sectors will be competitive over the next ten years. This is the case for all industries except for the fossil fuel sectors where it is shown that the Scandinavian countries are not competitive, as was expected.

4.6 Trade data

The trade data that is the basis for this part of the thesis comprises the Nord Pool exchange trade in EUA and CER allowances. The material includes a number of variables such as markets, countries and periods. The data was retrieved directly from Nord Pools statistical department and is therefore considered to be very reliable. Nord Pool is the second largest market place for trading emission allowances (uk.reuters.com, 2008), by itself it constitutes about 10 percent of the total market in both the spot market and in futures. Nord Pool is also an especially interesting market when studying Sweden since this market place is used frequently by the Nordic countries and is geographically placed in Oslo, Norway (nordpool.com, 2009). Nord Pool started out, in 1996, as an elspot market place and shortly became the leading spot price provider to the power market. The market has carried emission allowances since 2005.

The data is divided into monthly entries starting in January 2005 and ending in December 2008. The reason for studying this specific time period is that EUAs became a tradable commodity in 2005. It ends in December 2008 to avoid eventual offsets in monthly or seasonal trends. Every entry is counted in the volume of trade for a specific month. One quantity in the data means one contract traded and in turn one contract equals 1000 metric tonnes of emissions. Since, as previously said, one unit of EUA or CER allowance is the equivalent to one tonne of GHGs allowed to be emitted this means that one contract equals 1000 EUAs or CERs.

There are two kinds of markets in the data, exchange and ‘over the counter’ (OTC). The exchange is the market where Nord Pool is the intermediary between companies and the OTC is where Nord Pool facilitates contacts between companies to trade directly with each other. The OTC market is by comparison about three times bigger than the exchange in the selected period. In total world trade OTC constitutes about 50 percent. The data also divides the turnover into buy- contracts and sell- contracts, this measure is also known as double counted (DC). Using this variable makes it possible to easily count the net-trade for a specific country over the 48 (four years) periods.

The main tool used for analyzing the data is Microsoft Excel. The reason for using this program is that the analysis is not very complicated. To observe the net trade in a time series doesn’t demand a more statistically advanced program.

The unrefined data is compiled into trade originating countries, where the country is the compilation of trading firms originating from that country. This means that countries that aren’t included in the EU ETS can also take part in the data because of installations in the EU belonging to firms originating from non EU countries such as the United States of America and the Cayman islands. This means that a firm originating from one country but with a GHG emitting plant in another country will in the trade data be filed under the country of origin and not the country of the emission. Since trade in marketplaces is surrounded by confidentiality it is not possible to obtain quantities traded by a specific firm or transfer.

The data contains the total trade by all the countries in the Nord Pool market during the time period. As trade demands a buyer and a seller the posts, as previously said, includes the total quantity bought and sold for every period and for every country. Theoretically this means that the total trade (Σ bought – Σ sold) in the market should total to 0 which is also the case. This is a fairly obvious but important notion to point out because if this would not be the case the material would be proven incomplete, thus less reliable for the study. Further on, the quantities traded are analyzed both in total and in division by OTC and exchange. Also, since CERs and EUAs are equally valued they are summed in the total trade measurements but for the trade graph that includes price, the EUAs are analyzed separately.

In order to reduce the material into one graph the measured value is the net trade quantity of sales minus the quantity of bought allowances for every period. This means that a positive quantity for a specific period shows that Sweden has sold more emission allowances than was bought that month, and vice versa.

Because price is an important factor of trade, this is a necessary variable to account for. These statistics were also retrieved from Nord Pool directly. Since the price data differed from the quantity data in the interval of measure (daily instead of monthly) these were fitted to the trade data simply by calculating the average price for every month. Since no extreme short term price fluctuations were observed this method was considered to be fair.

Presented below are the figures compiled by the data. By presenting these in a series of aspects a complete picture of the Swedish trade in emission allowances at the Nord Pool market will be shown.

4.6.1 The Swedish total net trade

The diagram below shows the Swedish total trade in quantities between 2005 and 2008. At first glance it can easily be observed that the curve fluctuates quite frequently up and down. This can be explained by differences in reporting periods. Since a firm doesn't need to carry the needed amount of allowances at all times, but only in the reporting periods, it means that companies don't purchase the allowances needed until necessary or when the price is right.

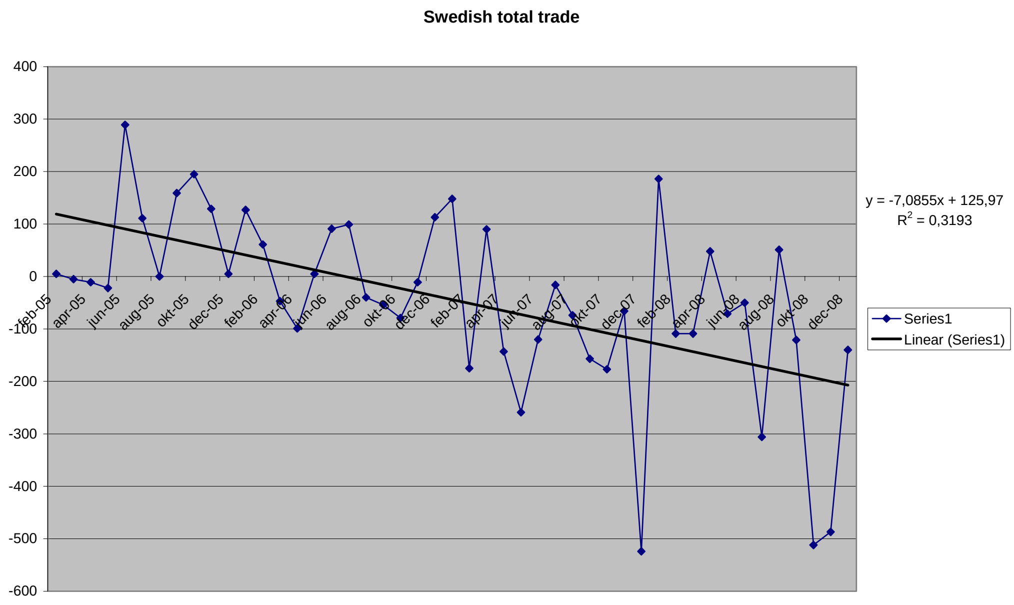


Fig. 4.3 - Total Swedish net trade in quantity

This figure also includes a linear equation. It is added to show the trend over time and gives an indication in what direction the country is headed. The equation for this line is specified as *y = -7.2901x + 125.97*, this tells us that for every period that goes by, Swedish firms buy roughly 7.3 more contracts than the previous period. The second parameter in the equation is the intercept which tells us what the net trade was when the trading commenced. The value 125.97 then tells us that Sweden was a net exporter of emission allowances in the beginning of the EU ETS system. Taking into account the x-variable this also tells us that about 18 periods into the scheme this changed and Sweden became a net importer of emission allowances.

In order to determine if the negative relationship shown above is specific for either the exchange or the OTC trade these are presented separately below. These show that, though there is a significantly steeper net trade in the exchange market and that the intersection with the x-axis occurs earlier than in the OTC trade, the negative relationship and the intersection is shared between the two.

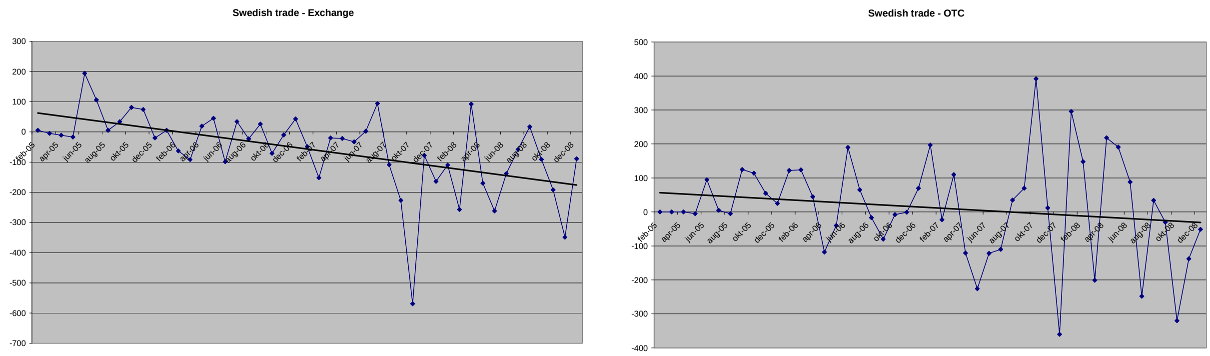


Fig 4.3.1 a and b - Swedish total net trade in quantity, division by market Exchange and OTC

It is a quite intriguing notion in the figures above, that Sweden as a country, over time, shows a negative net trade balance. This is interesting to this thesis because it in fact implies that the hypothesis, that Sweden is comparatively advantageous in trading emission allowances, might be incorrect. In order to conclusively determine if this is the case variations of the data must be analyzed.

4.6.2 The price mechanisms and trade

An interesting variable that could play a central role for the trade data is the price of emission allowances. Since variations in the price could cause substantial difference in the amount of allowances bought and sold it is important to also reflect this variable. As previously stated, the pricing has been a source of great criticism as to the functionality of the system, making it especially interesting to account for.

The diagram below shows the price curve of emission allowances during 2005 until 2008. As is clearly shown, the price varies a great deal over time, the most extreme variation being the great dip during 2007. This dip was the result of the over allocation in the first phase of the EU ETS (uk.reuters.com, 2007). The price was though fairly stable during the two preceding years. It was when the excess supply of allowances was discovered that the price almost immediately started to fall. In just a year, the price fell from just over € 26 to under € 1. In 2008 the price rose again with a spectacular increase, the reason being that it was not allowed to bank emission allowances between the second and first phase. Therefore, only phase two allowances, which were valued much higher, could be bought.

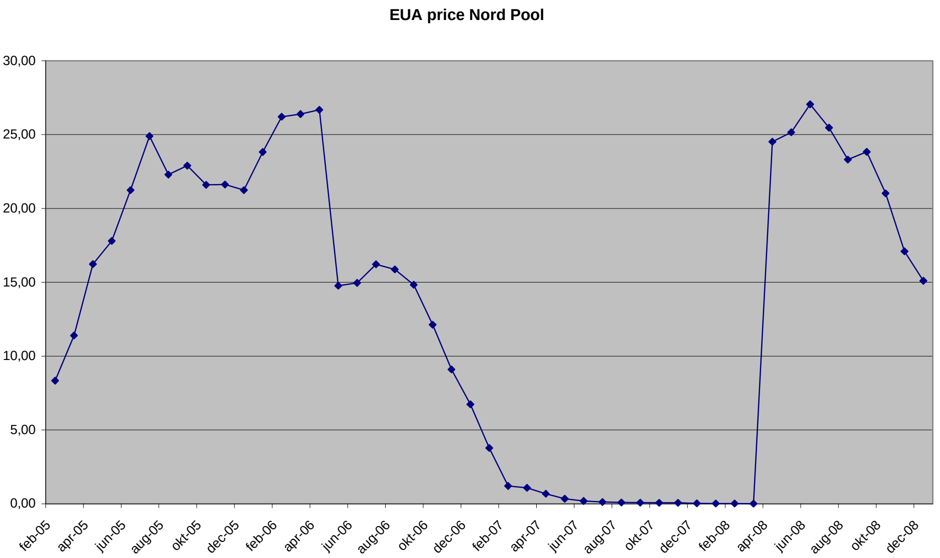
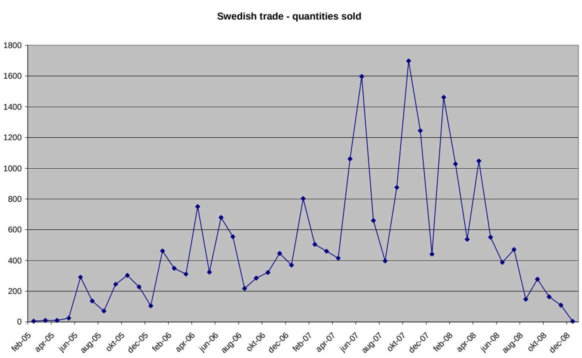


Fig. 4.4 – EUA price in Euro

Because of these rather substantial variations in the pricing of allowances this will be included in the analysis of the Swedish trade. To show the effect of the price dynamics the Swedish buy and sell quantities are below presented separately. It is clear that when price is not a factor, as in 2007, the variations in trade in between periods can be quite extreme.



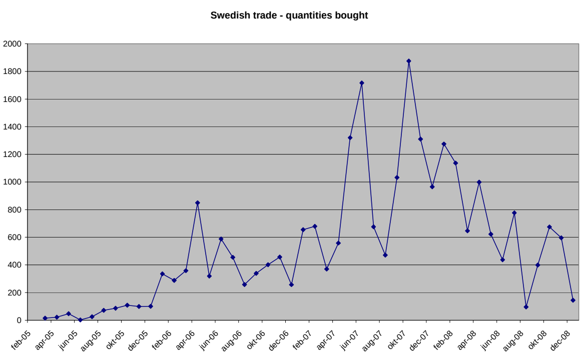


Fig. 4.4.1 a and b – Swedish turnover in quantities sold and bought

Even though the great price dip was not intentional in any way it was inevitable due to the excess of allowances issued. Taking into account the emission targets and the calculations of the national allocation plans it has be shown that this was to be expected (Peterson and Klepper, 2008:12). The price was not to reach € 1 in the first phase when modeling future prices. What is more interesting in studies of this kind is the price for the second period and onwards. These show that the price will rise to just under € 5 for the second phase and not rise higher until the third phase in 2013, € 10. After that, the price will gradually be growing for every year to come (ibid.).

The next diagram shows the Swedish trade including the price of EUAs. This diagram is not entirely based on the net quantities as previously mentioned (fig. 4.3) because the prices only comprise EUAs and not CERs. That is why the diagram below disregards the trade with CERs. However, the vast majority of trade in the Nord Pool market is conducted in EUAs. The diagram below though doesn't expose any major differences compared to the ones previously presented.

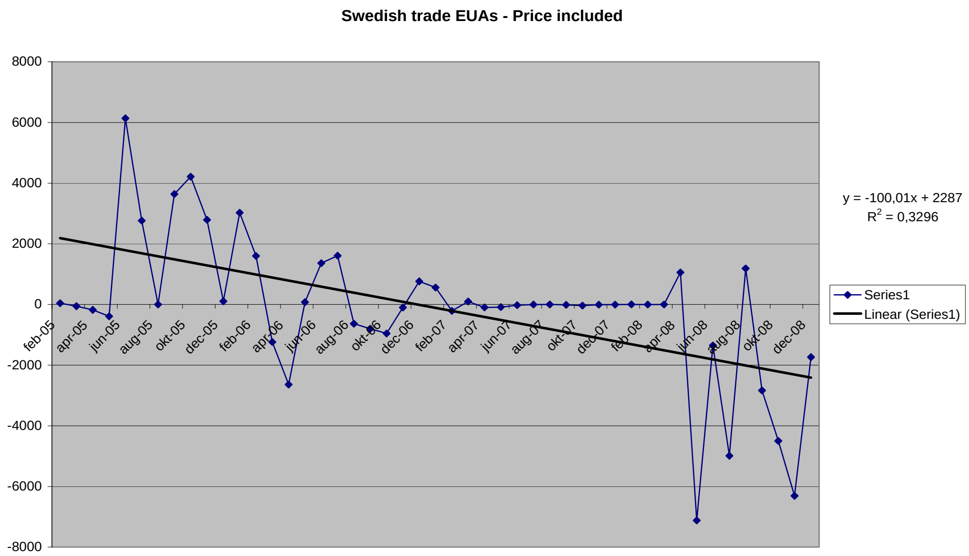


Fig. 4.5 – Total Swedish net trade in value (price included)

When compiling the price statistics with the Swedish net trade it is clear that this alters the data quite a bit, especially during 2007 when the prices were at a record low. The inclusion of prices doesn't show any change in the negatively sloping curve, the equation for this linear regression function being $y = -100.01x + 2287$. This implies the same conclusion as was previously stated. The equation shows that Sweden in the first part of the scheme went from being a net exporter to becoming a net importer of emission allowances. The equation also states that for every period that passes, Sweden loses 100.01 thousand Euros worth of emission allowance net trade.

4.6.3 Additional measurements

As mentioned above the latest diagram did not include CERs, only EUAs, for the purpose of including the variable of price. This makes it all the more interesting to also measure the trade in CERs in order to determine if there is any significant difference in the trade flow between the allowances. Two aspects must be noted before further comparing these data with the previous EUA data. The trade in CERs does not constitute as much trade as the EUAs, this means that the trade data is more vulnerable to temporary differences in trade. The second notion is that this commodity has not been tradable for as long time as EUAs in the Nord Pool market. These were first traded in August of 2007.

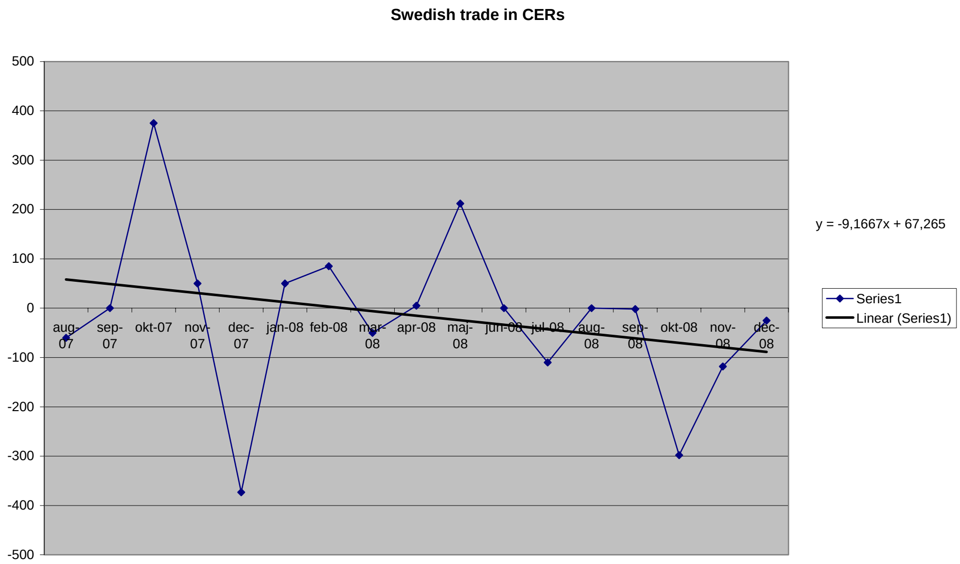


Fig. 4.6 – Swedish CER net trade in quantity

Before making any comparisons to the aggregate trade and the trade in EUAs, it is possible to observe the two mentioned notions in the diagram above. It is rather simple to observe that the trade didn't begin until August 2007 in the time series the other one being harder to spot. There are two main characteristics that indicate a sporadic trade in CER allowances, the swift changes in the net trade and five points of zero-trade. When comparing the data for the EUA and CER allowances it is quite clear that these both follow the same negative linear relationship. However, the point where the line intersects the x-axis occurs later (March 2008) in the CER data. Another observation that points to the correlation between these is center proximity to zero.

It is now conclusive to say that the hypothesis is incorrect. Sweden has a negative net trade in emission allowances. Measured in absolute numbers Sweden has, during 2005 – 2008, a net purchase of allowances amounting to 2072 contracts (2,072 million EUAs) worth € 5318.14 thousand in the Nord Pool market alone. In analyzing the diagrams above the negative slope seems quite steep, but it shall be stated that even though the balance between bought and sold allowances over time is negative, the curve is fairly centered on 0. The notion that especially proves the hypothesis of this thesis to be untrue in the Nord Pool market is the fact that Sweden went from being a net exporter to becoming a net importer. A fictive negative sloping curve that doesn't break the x-axis can still imply the hypothesis to be true.

4.6.4 Validity discussion on trade statistics

This thesis aims to quantify the trade with allowances by using aggregate statistical measurements. But, and this is a big but, the trade data above is unfortunately flawed. In measuring trade as done above, the data inherits these shortcomings. The reliability of the statistics is of good quality being collected from the direct source. It is the validity that suffers flaws. There are two main reasons for this. The first reason is that the data only covers the Nord Pool exchange and not all Swedish trade including over the counter (OTC) trade. The reason for not including trade quantities from other exchange marketplaces is quite simply that these have not agreed to share their data due to confidentiality. Three other exchanges have been asked, ECX, EEX and Bluenext. All of these declined for this reason. The Swedish authority of energy, that keeps registry of allowances in Sweden, has also been contacted but declined because of the lack of tools to extract the wanted data.

The second reason for the data to suffer flaws is the origin of the trade. It is not only GHG emitting companies that trade emission allowances. Even though anyone is free to buy these allowances it is first and foremost broker firms and banks causing alterations in the data. Corporations trading allowances can use these kinds of intermediaries to close a deal. This makes it impossible to know what company is behind the trade let alone their origin by the data above. These show up in the data under the intermediary corporation origin. At the Nord Pool exchange these kinds of intermediaries are used in 20 – 40 percent of the total turnover in trade depending on monthly variations (Interview - Voss, Fredrik, 2009).

Does this mean that the data above is useless? Fortunately not! Even though there are shortcomings in the data, corporations don't always use proxies as stated above. When they buy EUAs and CERs individually the data is correct, which is 60 – 80 percent of the time. The other part of the validity problem is the size of the market. Since this thesis deals with the net trade, as long as corporations do not specifically and continually buy their allowances in one marketplace and sell at another, there is no reason to believe that the Nord Pool aggregate data would differ extensively from other markets. The main reason for this is that the prices in the markets are the same because of price transparency in free markets. Another reason to imply this condition is that the entire market is very sizable and 10 percent of the entire market gives a fairly good picture of trade flows. It can also be noted that the Nordic countries are especially active in this specific marketplace.

This being said, the data above will not present an exact compilation of the trade and is therefore not valid enough to make a statistically safe conclusion, though it gives an implication of the trade flow. To further chart the trade it is suggested in further research to more extensively examine trade by gathering better data, if possible.

5 Discussion

The discussion will lead up to the final conclusions of this thesis. The chapter will discuss the results of the empirical analysis presented in the previous chapter by applying it to the question and the hypothesis.

This discussion will begin by assessing whether Sweden shows the needed prerequisites to be advantageous in trading allowances or not. Next, the trade statistics will be discussed as opposed to the prerequisites and lastly these will be summed up by possible explanations.

Sweden is one of the EU's least emitting nations per capita, the emissions included in the EU ETS totals to 22846 thousand tonnes (2007). Out of these, the electricity and heating- and industry sector constituted 20200 thousand tonnes of GHG emissions, the energy sector versus the industry sectors accounts for roughly 10 million each. The largest sector by international measurements is by far the electricity and heating sector which accounts for roughly 40 percent in industrialized countries. The reason for this being the largest sector is that the most commonly used source of energy is still fossil fuel. This is not the case in Sweden where the same sector constitutes just about 20 percent. This is mainly because Swedish production of electricity includes just a marginal amount of GHG emissions, two percent. The rest is mostly emitted by the heating sector such as regional heating.

When comparing Swedish emissions with allocated and surrendered allowances it is clear that Swedish installations emit much less GHGs than allowed. During the first four years of the EU ETS there has not been a single year that Swedish firms have surrendered more allowances than has been allocated. This means that Swedish emissions have been well within the limits for what has been allowed. Over the four years studied there has been an excess of allowances amounting to almost 10 million. This would imply that Sweden is a net provider in emission allowances given that firms behave rational under the cap and trade mechanisms. Though an observation that can be made is that Swedish firms (in the compliance to the EU ETS) tend to emit more emissions for every year, 2007 excluded; there was an increase of 3.2 percent during 2005-2008. This is partly because some new industries were included in the second phase. As the allocation of allowances was decreased in 2008, when entering the second phase, this net excess has also decreased over the four years.

Further on, the allocation principles in Sweden were analyzed because these play a certain role in the incentive to reduce emissions. By allocating a firm more allowances than needed, the incentives to reduce emissions are not as strong as if they were to be under allocated. By applying the Coase theorem there is something to be said of the allocation. The given allowances will eventually end up in the efficient equilibrium, how ever the initial distribution was made. This means that trade will exist until the equilibrium is reached. However, this is not to say that there aren't differences in incentives due to allocation. When allocating the allowances Swedish authorities first and foremost distributed these to the industry-sector. The energy sector was, especially in the second phase, allocated much less allowances. Therefore, the policy incentive to reduce emissions was to a greater degree ordered through the energy sector. This was also the intent of the Swedish authorities.

When assessing the competitiveness in different industries it is also shown in the empirical analysis that Sweden has an advantage in most sectors. The main industries where Sweden does not have an advantage is in industries that deal with fossil fuel such as crude oil, natural gas and refined oil. The reason for this is that Sweden is not abundant in these sectors nor is it sectors that Swedish industries specialize in. But in sectors like electricity, paper and pulp and transportation Sweden is expected to be competitive also in the future when including the economic impact of the EU ETS. It is mainly the changeover to renewable energy sources that imply competitiveness in the electricity sector. But the sector that is shown to be most competitive is the paper and pulp sector. This is a sector that Sweden is abundant in when assessing the resources, however the statistics shows it to be efficient also in the EU ETS.

To sum up, it would appear that Sweden holds the prerequisites to being a comparatively advantageous country in trading emission allowances, though hard to measure exactly to what degree. It is shown that Sweden is not dependant on fossil fuel to any large extent. Mainly the energy sectors are very efficient in the exclusion of GHG emissions when compared internationally. This is also shown by the fact that Sweden has preformed well under the limits for emissions under the first four EU ETS years, leaving emission allowances to spare every year. Combined with the fact that Swedish industries on a sector level is shown to be competitive when including the regulations of the EU ETS shows that prerequisites facing Swedish industries imply the country as being comparatively advantageous, thus proving the hypothesis.

The other measurement to the question is the Swedish trade data. The existence of a comparative advantage would assumingly show a positive net trade. What this would say is that Sweden is comparatively advantageous because it can produce products at such emission efficient levels that the allocated allowances are not fully needed.

The trade data presented in the previous chapter instead states a different relationship. Based on this data alone, Sweden is not comparatively advantageous. The data has been analyzed in aggregate numbers of quantity, in division of market type, by the inclusion of price and CERs separated. There were two main findings all of these measurements had in common. They all showed a negative linear relationship and they all crossed the zero net quantity line (x-axis).

The first finding showed that Sweden loses net trade in the Nord Pool market for every trading period that passes at a rate of 7300 allowances and 100 000 Euros in EUAs alone. This can possibly be explained by the increase in emissions in the EU ETS complying industries combined with the stricter cap when allocating allowances for the second phase. It is when observing the trade data including the price it becomes clear that it is in the second phase this loss is clearly negative in net trade. The second finding though is perhaps more interesting. This explicitly states that Sweden has gone from being a net exporter to a net importer of emission allowances. Even though the negative relationship itself would not have to contradict Sweden as being a comparatively advantageous country the fact that the trade data shows that Sweden has gone from being a net exporter to net importer is implication enough that this is not the case. The interesting question now is why this is not the case considering the previous finding?

This is a harder question to answer by analyzing the empirical material presented earlier. Some uncertainties to the data were considered in the 4.6.4 validity discussion, though it is more likely that another variable plays a role in possibly altering the statistics. There was an initial discrepancy in the definition of Sweden that might have played a role in the data. The trade data comprises Swedish firms trading at the Nord Pool exchange and the emissions are measured by installations physically located in Sweden. The reason for this to be included as a possible offsetting variable is that there are some Swedish companies that engage in GHG emitting productions in other EU countries i.e. trading allowances as a Swedish firm but emitting in another country. These firms would be allocated allowances by the country where the emissions take place because of the installation based distribution but trading as a Swedish labeled firm. A good example of this is the energy company Vattenfall that only uses non GHG emitting energy sources in Sweden such as hydro, nuclear and wind, (vattenfall.se, 2009) but fossil fuel generated electricity, mainly in Germany, accounts to just over 46 percent of the total production (vattenfall.com, 2009). Since Vattenfall is registered in Sweden the company is labeled as Swedish in the Nord Pool data. This is one, rather good, example of the possible explanation to the difference.

If this analysis is correct, that Sweden holds the prerequisites of being a comparatively advantageous country but the statistics imply otherwise, there is a rather interesting implication to be made by this study. Swedish firms act differently in Sweden as opposed to abroad when engaging in GHG emitting productions.

To conclude the discussion; it has been shown that Sweden has been successful in the switch to emission efficient production technology by analyzing the GHG abundant industries in Sweden. It has also been shown that most sectors, when including the EU ETS as a factor, are competitive internationally which further supports the notion that a "green" production changeover has been made. This change as it seems, when assessing the NAPs, has also been an active governmental policy. This can be shown by analyzing allocation to actual emissions and surrendered emission allowances. This would imply that Sweden holds a comparative advantage in trading emission allowances. However, the trade data suggests otherwise. This suggests that Sweden as a country is not advantageous and that it is a net importer of emission allowances. It is therefore inconclusive to say whether Sweden is comparatively advantageous or not.

On a side note, even though it is not what this thesis was set out to do, the variables presented in the empirical analysis quite clearly shows that there was an over allocation in the first phase and that the effect of this was a collapse in the price. The fairly non-critical attitude towards the NAPs in allocation and the subsequent result of a vast amount of unused allowances contrasted to the price makes it clear by the measurements of this thesis that the cap was not efficiently set. This resulted in an actual increase in emissions.

6 Conclusions

It has been the objective of this thesis to establish whether Sweden holds a comparative advantage in trading emission allowances or not. By analyzing emissions in division by sector, allocated and surrendered allowances, allocation principles, the competitiveness of Swedish firms and finally the actual trade, this study has comprehensively tried to answer this question. The working hypothesis was that such an advantage existed and that the chosen measurements would reveal this.

The analysis of Swedish GHG emitting industries showed that the origins of emissions differ from other industrialized countries. Mainly the energy sector accounts for a smaller portion compared internationally. The big reason being the almost non-existing fossil fuelled electricity production in Sweden. This is otherwise one of the single largest EU ETS complying sectors. Also, the national allocation plans for Sweden explicitly shows that there is an active policy to reduce emissions in the energy sector. When comparing the total emissions over the four years (2005-2008) to the allocated and surrendered allowances, Swedish firms, though narrowing, performed well under the limitations leaving a total excess of 10 million EUAs. Combined with the notion that Swedish sectors, excluding fossil fuel sectors, has been shown competitive when including the EU ETS as a factor, this suggested that the hypothesis was true.

By analyzing the actual trade in emission allowances by processing trade data collected from Nord Pool, this suggestion though became more uncertain. When measuring this data in a number of ways, the central being total quantity and total value (including price) net trade (sell – buy), these share two common characteristics, a negative linear relationship over time and the turn from being a net exporter to a net importer of allowances. Though facing some difficulties with the validity of the data the reason for these characteristics is rather the discrepancy in the definition of Sweden. The trade data, compared to the definition in the previous data, additionally includes Swedish companies owned installations abroad. Given the previous data suggesting another outcome this would imply that Swedish firms act differently in GHG emitting production domestically from abroad.

To answer the question of this thesis, if Sweden is comparatively advantageous in trading emission allowances, it cannot conclusively be stated whether this is the case or not. The thesis shows that the prerequisites for such an assumption would lead to believe that this is the case but when observing the actual trade data the results become contradictory. A satisfying answer to the question can therefore unfortunately not be made.

6.1 Suggestions for further research

This thesis was unsuccessful in the attempt to answer whether Sweden holds a comparative advantage in trading emission allowances or not. The main reason for this was the inconsistencies in the data. It was initially thought that the Nord Pool data would give a comprehensive picture of Swedish trade flows but discrepancies in definitions and other measurement difficulties presented an uncertain outcome. Though hard to obtain, it is suggested that better suited data is used for future studies of this kind.

An interesting implication though could be made. Based on the discrepancy, mentioned above, it was implied that Swedish firms as it seems would behave in a more polluting manner abroad than domestically. To conclusively determine if this is the case, it is suggested that more studies be made in the subject. However, the implication itself is interesting.

7 References

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