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Impact of Climate Policy Goals on Comptetiveness of Energyintensive Industry

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Impact of Climate Policy Goals on Competitiveness of Energyintensive Industry

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Foreword

In the spring of 2004, ITPS completed a Government commissioned analysis of the effects of a European emissions trading scheme on the competitiveness of Sweden's basic industries. The work was presented in a report on 2 July, 2004, *Basindustrin och Kyoto – Effekter på konkurrenskraft av handel med utsläppsrätter (Basic Industries and Kyoto – Effects on Competitiveness of Emissions Trading)* A2004:019. The commission was part of a review of climate policy which took place 2004 and in which the Swedish Energy Agency and The Swedish Environmental Protection Agency had parallel tasks. The present report is a synthesis and builds on the original report. For more detailed information, refer to the main report.

ITPS shows that an emissions trading scheme leads to an increase in costs in energy-intensive basic industry as compared with the situation under earlier[1] energy taxation. The effects are a deterioration in the competitiveness of basic industry. The long-term attainment of the climate policy goals means that there will be a shift towards industrial structures that are less fossil-intensive in energy consumption.

The work on this synthesis report has been carried out by a project group at ITPS consisting of Eva Alfredsson (project leader), Thomas Forsberg, Philip Löf and Elin Vinger. Professor Lennart Hjalmarsson has written chapters 3, 4, parts of chapter 2 and also submitted views on the other chapters. The working group that carried out the analysis on which this synthesis report is based also had as members PhD Ann Veiderpass, PhD Mattias Erlandsson, Professor Runar Brännlund and PhD Tommy Lundgren and Magnus Pettersson, ITPS.

Östersund, February 2005

Sture Öberg,
Director-General

[1]*Energy taxation before 1 January 2005.*

Contents

Summary

The cost increases associated with an emissions trading scheme have a considerable impact on the competitiveness of energy-intensive basic industries. In the long-term, compliance with climate goals will cause a gradual shift in the structure of industry towards a less fossil fuel-intensive economy.

For example, estimates suggest that without compensating effects such as cuts in product prices and profitability, technological adaptation or higher world market prices, Swedish cement and lime manufacturers will lose about 90 per cent of their exports, and petroleum refineries will suffer a loss in exports of about 10 per cent, all attributable to the emissions trading scheme.

The Swedish Government commissioned ITPS to analyse the effects of the implementation of an emissions trading scheme (ETS), and specifically examine the effects of emissions levels combined with emissions allowances trading on the competitiveness of energy-intensive industries. This synthesis report is a brief summary of the report *Basindustrin och Kyoto (Basic Industries and Kyoto)* (A2004:019) submitted to the Government on July 2, 2004.

The analysis, which covers manufacturing industry as a whole, focuses on energy-intensive basic industries, and only the effects on this part of the industrial sector are presented in this synthesis report.

ETS impacts industry through two main channels: the cost of emissions allowances and an increase in the price of electricity. The cost of emissions allowances only affects enterprises in the trading sector, i.e. enterprises that are required to have emissions allowances equivalent to their carbon dioxide emissions, while all enterprises are affected by the price of electricity.

The conclusions in this summary are based on the assumption of an emissions allowance price of 10 euros per tonne of carbon dioxide, an increase in the price of electricity of 4 Swedish öre/kWh, and two alternatives for carbon dioxide tax: one with unchanged carbon dioxide tax and emissions reduction rules, and another with the facilities covered by the ETS exempted from the carbon dioxide tax. The impact on price levels are as expected based on calculations in models on which the Swedish Energy Agency and the Swedish Environmental Protection Agency built scenarios in their parallel government commissions. The main report also presents the results of scenarios with both lower and higher figures for emissions allowance prices and electricity price increases.

It is always assumed that enterprises behave in an economically rational way and do not subsidise for longer periods of time facilities with variable costs that are not covered. Variable costs include, of course, the market value of the emissions allowances used, irrespective of whether these were allocated free of charge or bought on the market.

It is also assumed (in accordance with the assumptions of the National Institute of Economic Research model) that opportunities are very limited for enterprises exposed to international competition to pass on cost increases to the consumer.

Emissions allowance allocation and competitiveness

It has been claimed that a *generous and free allocation* of emissions allowances protects enterprises' competitiveness. The analysis demonstrates that this is far from being true.

However, from a business economics perspective the allocation of free allowances does give enterprises stronger financial positions, i.e. improved solidity. For enterprises with solidity that is "excessively low", the loans they are carrying can be reduced, or may be arranged at lower interest costs. Companies with "acceptable" equity ratios are given greater latitude to pay shareholder dividends. An improved equity ratio also makes it easier to finance new investments and acquisitions – although this effect should be relatively modest in economies with healthy capital markets.

What is decisive for the way enterprises' *competitiveness* is affected is the price of emissions allowances. This price is determined by the equilibrium between the total amount of emissions allowances allocated in the EU and the marginal costs of reduced emissions.

Free allocation does not affect an enterprise's decision to increase or cut back production. The profitability of increasing or reducing production, or investing in new technology, is determined by the price of production factors[2] including emissions allowances relative to revenue which, in the case of enterprises competing in international markets, is governed by the world market price.

Extra generous allocation to facilities with non-replaceable raw materials-related emissions is equally insignificant in terms of the *competitiveness* of individual *facilities*.

The major *difference between the allocation of free emissions allowances and the auctioning* of emissions allowances is that with free allocation, the capital value benefits go to the enterprises[3], while in the case of auctioning, the revenues from the auctions accrue to the state. From the distribution viewpoint, the allocation of free emissions allowances is relatively arbitrary. Some shareholders, i.e. the owners of facilities that are in the trading scheme, are compensated relatively well for *the capital losses* incurred, while others receive no compensation whatsoever.

[2] *In correct financial accounting, the market value of free emissions allowances is posted in the income statement for emissions allowances obtained at no cost, similar to the market value of "free" electricity from an enterprise's own power station or free raw materials from forests that an enterprise owns.*

[3] *Which is the case during the introductory period 2005-2007 when the EU decided on free allocation. During the first period of the Kyoto Protocol, the EU decided to allow auctioning of some emission allowances.*

The latter applies in particular to shareholders in those enterprises whose electricity-intensive facilities are not in the trading scheme. However, it is wage-earners who ultimately bear the costs of climate policy in the form of lower wage levels.

New facilities are allocated free emissions rights if the investment is made. This gives the allocation the character of a direct capital contribution, thus making it an investment subsidy. If the allocation is also linked to future emissions of carbon dioxide, investments in facilities with high emissions levels will be favoured over facilities with little or no emissions.

Effects on growth, sectors and production facilities

Until the introduction of the ET scheme on January 1, 2005, Sweden's energy-intensive basic industries were safeguarded by means of a range of tax reductions. The introduction of ETS also increases the costs of carbon dioxide emissions for enterprises covered by the scheme. At the same time, this scheme drives up the price of electricity, which affects enterprises both within and outside the trading scheme.

In practice, it is impossible to predict with any accuracy which facilities will be compelled to close and which facilities will survive when the scheme is implemented. Such an analysis cannot be done because the necessary data and models do not exist. Important areas of uncertainty include the extent to which higher world market prices for certain products can compensate for higher environmental costs in the EU, and what effects there may be on the relative competitive position between Swedish facilities and facilities in the rest of the EU.

In general, however, it may be said that in the competition for scarce emissions allowances, the enterprises that are most willing, or most able, to pay will maintain or increase their production, while production will fall off in other enterprises.

Another general conclusion is that enterprises with high carbon dioxide emission levels and a high proportion of non-replaceable raw materials-related emissions will suffer the greatest loss in competitiveness.

The ITPS calculations, which for reasons of confidentiality can only be presented by sector, show the following.

The whole energy-intensive industrial sector will experience an immediate rise in costs equivalent to three to four years' real wage increases. At least 15 facilities will experience cost increases equivalent to ten years' real wage increases.

The non-metallic minerals sector will face the greatest impact from ETS. The impact on mining and the iron and steel sectors is also fairly severe, and these are sectors sensitive to cost changes. Pulp and paper, as well as the steel and metal sector, are the sectors that by virtue of their size will suffer the greatest export losses for a given cost increase.

In many cases an electricity price rise resulting from ETS will have a more negative impact on industry's competitiveness than ETS itself. An example of this is pulp and paper.

In the longer term, there are considerable substitution possibilities between fossil energy sources and other factors of production. However, the long-term adjustment to the costs of emissions allowances will occur primarily through shifts from heavy industry to less fossil energy-dependent industry rather than by short-term substitution in individual facilities.

The calculations show that abolishing carbon dioxide tax may compensate to some extent for the cost increase associated with ETS. The differences between enterprises are, however, considerable. Withdrawing the tax on carbon dioxide would have a strong impact on a great many enterprises. This would, however, not provide any relief to many of the most severely affected enterprises, since under the reduction rules of the former scheme, the carbon dioxide tax they paid was negligible.

From a growth perspective, the concept of comparative advantage is more crucial than competitiveness. A shift towards less fossil energy-intensive production is also a shift in Sweden's comparative advantages. This is a natural consequence of the decline of the energy-intensive sector in relation to other production, which leads to costs in the form of factory closures and decreases in the labour force. If this environmental policy is applied in the long term, transition should be facilitated by the transfer of labour and capital to other production that has better long-term prospects, a move that will promote economic growth.

Sammanfattning

Ett handelssystem med utsläppsrätter innebär ökade kostnader för den energiintensiva basindustrin vilket får betydande effekter på konkurrenskraften. På lång sikt leder uppfyllandet av klimatmålen till att industristrukturen successivt förskjuts mot ett mindre fossilenergiintensivt näringsliv.

Beräkningar indikerar exempelvis att utan motverkande effekter, t.ex. sänkt produktpris och försämrad lönsamhet, teknologianpassning eller höjda världsmarknadspriser, tappar de svenska tillverkarna av cement och kalk cirka 90 procent av sin export och petroleumraffinaderierna får ett exportbortfall på cirka 10 procent, som konsekvens av handelssystemet.

ITPS har på regeringens uppdrag analyserat effekterna av införandet av ett utsläppshandelssystem, dvs. utsläppstak kombinerat med handel med utsläppsrätter, på den energiintensiva industrins konkurrenskraft. Denna syntesrapport är en kort sammanfattning av rapporten *Basindustrin och Kyoto*, A2004:019 som överlämnades till regeringen 2 juli, 2004.

Analysen omfattar hela tillverkningsindustrin men fokuserar på den energiintensiva basindustrin och det är endast effekter på denna del av industrin som redovisas i denna syntesrapport.

Ett utsläppshandelssystem påverkar industrin via i huvudsak två kanaler: kostnaden för utsläppsrätter och ett höjt elpris. Kostnaden för utsläppsrätter påverkar endast företag inom den s.k. handlande sektorn, dvs. företag som är ålagda att inneha utsläppsrätter motsvarande sina koldioxidutsläpp, medan priset på el påverkar alla företag.

Slutsatserna i denna sammanfattning baseras på antaganden om ett utsläppsrättspris på 10 euro per ton koldioxid, en elprishöjning på 4 öre/kWh, två alternativ för koldioxidskatten; ett med oförändrade regler för koldioxidskatt och nedsättningsregler och ett med en borttagen koldioxidskatt för de anläggningar som omfattas av handelssystemet. Prisnivåeffekterna är de förväntade utifrån de modellberäkningar som låg till grund för Energimyndigheten och Naturvårdsverkets scenarier i deras parallella regeringsuppdrag. I huvudrapporten redovisas även resultat av scenarier med både lägre och högre priser på utsläppsrätter och elprishöjningar.

Genomgående förutsätts att företagen agerar ekonomiskt rationellt och inte under någon längre tidsperiod subventionerar anläggningar som inte får täckning för sina rörliga kostnader. De rörliga kostnaderna inkluderar givetvis också marknadsvärdet av utnyttjade utsläppsrätter, oavsett om dessa erhållits genom gratis tilldelning eller genom inköp på marknaden. Det förutsätts också (i enlighet med Konjunkturinstitutets modellantaganden) att internationellt konkurrensutsatta företag har mycket liten möjlighet att övervältra ökade kostnader på konsumenterna.

Tilldelningen och konkurrenskraft

Det har hävdats att en *generös och gratis tilldelning* av utsläppsrätter skyddar företagens konkurrenskraft. Analysen slår fast att detta på intet vis är fallet.

Gratis tilldelning innebär dock ur företagsekonomisk synvinkel en förstärkning av företagens *finansiella ställning,* dvs. att soliditeten ökar. För företag med "alltför låg" soliditet innebär det att lånebördan kan reduceras, eller att lån kan erhållas till lägre räntekostnader. För företag med "lagom" soliditet innebär det att utrymmet för utdelning till kapitalägarna ökar. En förbättrad soliditet innebär också att finansieringen av nyinvesteringar och förvärv underlättas – men denna effekt torde vara relativt liten i ekonomier med väl fungerande kapitalmarknader.

Det som är avgörande för hur företagens *konkurrenskraft* påverkas är priset på utsläppsrätter. Priset bestäms i jämvikten mellan den totala tilldelade mängden utsläppsrätter inom EU och marginalkostnaderna för minskade utsläpp.

Gratis tilldelning påverkar inte företagets beslut om att öka eller minska produktionen. Lönsamheten av att utöka eller reducera produktionen, eller att investera i ny teknik, bestäms av priset på produktionsfaktorer[4] inklusive utsläppsrätter relativt intäkten, vilket för internationellt konkurrensutsatta företag styrs av världsmarknadspriset.

Extra generös tilldelning till anläggningar med icke utbytbara råvarurelaterade utsläpp är likaledes betydelselös vad avser *konkurrenskraften* för enskilda *anläggningar*.

Den stora *skillnaden mellan gratis tilldelning och auktionering* av utsläppsrätter är att företagen vid gratis tilldelning erhåller förmögenhetsvärdet av utsläppsrätter[5] medan auktionering innebär att intäkterna från auktioneringen, tillfaller staten. Ur fördelningssynpunkt är tilldelningen av gratis utsläppsrätter relativt godtycklig. Vissa kapitalägare, dvs. ägarna till anläggningar inom handelssystemet, kompenseras relativt väl för de *kapitalförluster* som uppstår, medan andra inte erhåller någon kompensation alls. Det senare gäller i synnerhet kapitalägarna till de företag vars elintensiva anläggningar inte ingår i handelssystemet. I slutändan är det dock löntagarna som genom en lägre lönenivå får bära kostnaderna för klimatpolitiken.

Till *nya* anläggningar tilldelas utsläppsrätter gratis om investeringen genomförs. I och med det har tilldelningen karaktären av direkt kapitaltillskott och därmed investeringssubvention. Om tilldelningen dessutom är proportionell mot framtida emissioner av koldioxid, kommer investeringar i anläggningar med stora utsläpp att gynnas relativt investeringar i anläggningar med små eller inga utsläpp.

[4] *Vid en korrekt ekonomisk redovisning belastas resultaträkningen med marknadsvärdet för gratis erhållna utsläppsrätter, i likhet med marknadsvärdet av "gratis" elenergi från egna kraftverk eller gratis skogsråvara från egna skogar.*

[5] *Vilket är fallet under den inledande perioden 2005-2007 då EU beslutat om gratis tilldelning. Under Kyotoavtalets första åtagandeperioden har EU beslutat att tillåta auktionering av del av utsläppsrätterna.*

Effekter på tillväxten, branscher och anläggningar

Den svenska energiintensiva basindustrins konkurrenskraft har fram till handelssystemets införande 1 jan 2005 värnats genom diverse skattenedsättningar. I och med att ett utsläppshandelssystem införs ökar kostnaderna för utsläpp av koldioxid för företag som ingår i systemet. Samtidigt ökar elpriset som en konsekvens av detta system, vilket påverkar företag både inom och utom handelssystemet.

I praktiken är det omöjligt att med större precision förutse vilka anläggningar som kommer att slås ut och vilka som kommer att överleva efter det att systemet trätt i kraft. En sådan analys går inte att göra då de data och de modeller som krävs för det inte existerar. Till de stora osäkerheterna hör i vilken utsträckning som ökade världsmarknadspriser på vissa produkter kan kompensera för ökade miljökostnader inom EU, samt hur det relativa konkurrensläget mellan svenska anläggningar och anläggningar inom övriga EU påverkas.

Generellt kan man dock konstatera att i konkurrensen om de knappa utsläppsrätterna kommer de företag som har den högsta betalningsviljan eller betalningsförmågan att bibehålla eller öka sin produktion medan övriga företags produktion minskar.

En annan generell slutsats är att företag med höga koldioxidutsläpp och hög andel icke utbytbara råvarurelaterade utsläpp kommer att förlora mest i konkurrenskraft.

ITPS beräkningar som av sekretesskäl endast kan redovisas på branschnivå visar att:

Hela den energiintensiva industrin riskerar få en momentan kostnadsökning motsvarande tre till fyra års reallöneökningar. Drygt 15 anläggningar får kostnadsökningar motsvarande 10 års reallöneökningar.

Jord- och stenindustrin är den bransch som påverkas mest negativt av utsläppsrättshandeln. Gruvor och järn- och stålindustrin påverkas också relativt kraftigt och är branscher som är känsliga för kostnadsförändringar. Massa- och pappersindustrin är tillsammans med stål- och metallindustrin de branscher som i kraft av sin storlek får det största exportbortfallet vid en given kostnadsökning.

Ett högre elpris till följd av utsläppshandel, får i många fall större negativ effekt på industrins konkurrenskraft än utsläppsrättshandeln i sig. Ett exempel på en industri för vilken detta är en kännbar effekt är massa- och pappersindustrin.

På längre sikt finns betydande substitutionsmöjligheter mellan fossila energikällor och andra produktionsfaktorer. Främst kommer dock anpassningen till kostnaderna för utsläppsrätter på sikt att i första hand ske genom förskjutningar från tung industri till mindre fossilenergiberoende industri, snarare än genom substitution på kort sikt inom enskilda anläggningar.

Beräkningarna visar att en slopad koldioxidskatt till viss del kan kompensera för den kostnadsökning som ett utsläppshandelssystem innebär. Skillnaderna mellan företag är dock stor. För ett stort antal företag skulle en slopad koldioxidskatt ha avsevärd betydelse. För många av de hårdast drabbade företagen innebär dock en slopad koldioxidskatt inte någon lättnad, eftersom de i det tidigare systemet i stort sett inte betalat någon koldioxidskatt p.g.a. nedsättningsreglerna.

Ur ett tillväxtperspektiv är komparativa fördelar snarare än konkurrenskraft ett nyckelbegrepp. En förskjutning mot mindre energifossilintensiv produktion, innebär en förskjutning av Sveriges komparativa fördelar. Det följer naturligt då den energiintensiva sektorn minskar i förhållande till annan produktion, vilket leder till kostnader i form av utslagning av anläggningar och arbetskraft. Om denna miljöpolitik är långsiktig bör omställningen underlättas genom att arbetskraft och kapital förs över till annan produktion som har bättre långsiktiga förutsättningar, för att därigenom gynna den ekonomiska tillväxten.

1 Introduction

In the spring of 2004, ITPS completed a Government-commissioned analysis of the effects of a European emissions trading scheme (ETS) on the competitiveness of Sweden's basic industries. This is a synthesis report based on the report *Basindustrin och Kyoto – Effekter på konkurrenskraft av handel med utsläppsrätter (Basic Industries and Kyoto – Effects on Competitiveness of Emissions Trading)* A2004:019. For more detailed information, please see the main report, which may be ordered from ITPS or downloaded from the ITPS web site, www.itps.se.

The most important differences between the synthesis report and the main report is that the synthesis report is very brief, the results (Chapter 5) are presented by sector (in the main report the results of different analysis methods are presented by chapter), but also that several complexes of issues are addressed more concisely and directly than in the main report. The following issues are given prominence in this report.

- The strengths and weaknesses of the calculations in the model, including the importance of the other EU member nations also implementing an emissions allowances trading scheme (Chapter 2).
- A comprehensive discussion of the effects of climate restrictions on industry's competitiveness, and the use of various policy instruments in climate policy (Chapter 3).
- The validity of the results from the model with regard to the introduction of types of policy instrument, primarily taxes, other than the emissions trading scheme (Chapter 4).

2 Methodology

This chapter contains a methods description and discusses the strengths and weaknesses of the calculations in the model, including the importance of other EU countries who were participating in the ET scheme.

2.1 Industries and enterprises covered by the analysis

As stated in the assignment description, the analysis focuses on the branches of industry covered by the ET scheme.

2.2 Basic data/Statistics

The basic data consists of Statistics Sweden's statistics on enterprises and energy. The information about workplaces and enterprises was taken from this source. Data were gathered for the years 1990 to 2001. The econometric analysis uses data for the whole period, while other calculations only use data from 2001, and occasionally from 2002.

2.3 Analysis assumptions and scenarios

The emissions trading scheme affects industry's competitiveness by driving up costs in the following two areas:

- **The price of emissions allowances**. Enterprises in the so-called trading sector must obtain (either free of charge or purchased) emissions allowances to cover the level of their emissions.
- **The price of electricity**. As the energy sector is part of the ET scheme, and EU countries consume substantial amounts of fossil fuels for the production of electricity, the ET scheme is almost certain to result in higher electricity prices.

Another factor with great significance for competitiveness is whether the carbon dioxide tax remains in place or is withdrawn for enterprises in the trading sector, and the level of carbon dioxide tax for enterprises outside the emissions trading scheme.

2.3.1 Emissions allowances price assumptions

For emissions allowances price scenarios, the ITPS analysis is based on the assumptions and scenarios that the Swedish Energy Agency and the Swedish Environmental Protection Agency produced in their parallel assignments for the Government: 5, 10 and 25 euros per tonne, with the price of 10 euros per tonne taken as the most probable alternative.

2.3.2 Electricity price assumptions

For electricity price increases, ITPS applies electricity price rise assumptions over one to two years that are in line with the figures in the ECON consultative report to the Swedish Ministry of Industry, Employment and Communications. Here, it is assumed that an emissions allowances price of 5 euros per tonne of carbon dioxide is expected to increase the price of electricity by 2 Swedish öre per kWh. A price of 10 euros gives an electricity price increase of 4 Swedish öre per kWh, and 25 euros an electricity price increase of 8 Swedish öre per kWh.

2.3.3 Carbon dioxide tax and reduction rules assumptions

Both general and specific reduction rules apply to the industrial sector (the 0.8 and 1.2 per cent rules). The analysis assumes that these reduction rules remain unchanged. In the case of carbon dioxide tax, it was not clear at the time of the analysis (spring 2004) whether or not facilities that were in the ET scheme would be exempt from carbon dioxide tax. Currently (Jan. 2005) the carbon dioxide tax has yet to be lifted for the trading sector. A recommendation is expected in the Government's 2005 spring budget.

2.3.4 Scenarios

In dealing with the areas of uncertainty related to the price of emissions allowances, electricity and carbon dioxide tax, the quantitative analyses apply six scenarios (Table 1) that are expected to cover the existing range of uncertainties. Scenarios 3 and 4 are considered to be the most probable. With some exceptions, this synthesis report only presents results based on scenarios 3 and 4.

Table 1 Scenarios for the price of emissions rights, electricity price increases and carbon dioxide tax. These scenarios are common to all the quantitative analyses in this report.

Scenario	Price of emission allowance (euro/ton)	Increase in price of electricity (öre/kWh)	Tax reduction for trading facilities
1	5	2	Yes
2	5	2	No
3	10	4	Yes
4	10	4	No
5	25	8	Yes
6	25	8	No

Electricity price rises are added to the electricity consumption of all facilities included in the data material. The cost of emissions allowances falls only on the approximately 130 facilities in the trading scheme. In the scenarios in which carbon dioxide tax is removed, the exemption applies only to facilities in the emissions trading sector.

2.4 Methods of analysis

In analysing the effects of the ETS on industry's competitiveness we have used several, partly overlapping, methods that may be divided into the following three main categories.

1. Theory: analysis based on economic theory of the concepts of competitiveness, the ETS and the importance of allocation
2. Market analysis: descriptions of the energy-intensive basic industries' markets and main competitor countries
3. Quantitative calculations, simulations and estimates of effects on a range of factors, including production volumes, value added, and export volumes.

The theoretical section itself (Chapters 3 and 4 of this report) generates the main results and conclusions of this work. These are tested, detailed, and confirmed by the market description and the quantitative analysis.

The market description is based on statistics of the basic industries' exports and main trade partners (recipient countries) and competitors. The detailed description shows that with some exceptions, the EU is the most important export market, but also that exports to non-EU countries amount to a significant percentage in some sectors. Both exports to EU and non-EU countries encounter competition from countries that are outside the Kyoto Protocol and which do not implement this type of climate policy. This means that higher costs affect industry's competitiveness and exports, irrespective of whether they are intended for EU or non-EU countries. It may be assumed that the effect on exports to non-EU countries is far greater than exports to EU countries, because all EU countries are in the ETS and are one another's most important trade partners. In calculating the effect on export losses, it is therefore simply assumed that exports to EU countries are not affected while exports to non-EU countries are.

A preliminary rough estimate of the effect of cost increases (cost increases that result in an increase in the product's price) on exports is obtained by multiplying the value of exports to non-EU countries by export price elasticities[6]. The export price elasticities used are those produced by Sweden's National Institute of Economic Research for their latest long-term economic outlook (2003/04). Export price elasticities are usually viewed with considerable uncertainty: making empirical estimates very difficult, partly due to insufficient and non-comparative basic data. The elasticities estimated are usually at branch level and not at the product level, which in this case is the relevant level. The elasticities used here are always high, which means that small changes in costs have major effects on export volumes. The level of the elasticities reflects the fact that the majority of Swedish enterprises are "price-takers" exposed to international competition. The quantitative analysis also uses partial methods, which means that there is nothing to ensure consistency between the effects at the enterprise level and the effects on, or the development of, the economy as a whole. With high export price elasticities, the partial effects for a number of facilities with considerable exports outside the EU are drastic, while also empirically unrealistic when the effects for all facilities in the EU are totalled. The results from this type of analysis indicate what could happen without adaptation mechanisms in the form of lower product prices and lower profitability,

[6] Price elasticity of demand is a measure used to describe how sensitive demand for a certain product (good or service) is to changes in the price of the product.

changes in world market prices, modifications to production technology etc., and must therefore be interpreted with great caution. It is likely that a significant part of this adjustment will be as price reductions and lower profitability.

The scenarios described in the previous section are used to estimate the effects on competitiveness of cost changes associated with the ETS.

The effect on the total export loss in percent and its percentage of the market value is estimated by calculating the cost increase in the different scenarios in each branch of industry. The cost increase is then converted to a corresponding real wage percentage increase. The result of this step is not presented in this synthesis report, but may be found in the main report. Effects expressed as real wage costs is an interesting measurement, since wage costs are often the only short-term variable production cost, while at the same time this cost item is affected by changes in competitiveness. In the long term, other production factors may also change. The percentage effects on export are used together with the estimate of cost increases to calculate the total percentage export loss and its percentage of the market value. A rough estimate is made of the effect on *employment* by multiplying the export loss as a percentage of the market value by the number of employees. The results are presented by branch. The main problem with this approach is similar to the earlier use of export price elasticities.

Two complementary methods were used to make further quantitative analyses of the effects of the ETS on enterprises' competitiveness. To some extent, these two methods focus on different effect variables, thereby complementing one another.

The effects on *profitability and the ability to survive* *for each individual workplace* is calculated by means of a so-called Salter analysis. Such analyses are used to produce statistical descriptions of the cost or profitability structure of branches of industry. In contrast to the average figures, for example, for profitability, the Salter analysis describes the distribution of profitability across workplaces. Among other things, one can see which facilities and what percentage of a branch had good prospects for new investments and growth, and which part has low profitability and risks closure. How big the gross profit percentage needs to be for an enterprise to make new investments and expand varies between branches of industry and enterprises. In capital-intensive sectors like the basic industries, the gross profit requirement is significantly higher than the average. For reasons of confidentiality, the results of the analysis are not presented in a way that would allow individual workplaces to be identified. The synthesis report contains only summaries of the effects on individual workplaces.

All the calculations presented up to now are static; they only produce figures on direct effects. This means that they do not consider adjustments in the form of substitution possibilities, changes in production, dimensioning of production volumes etc. that occur to a greater or lesser extent. In these methods, it is assumed that other countries' competitiveness is unchanged.

The third, and from the calculation viewpoint most advanced, method used in this study is a statistical factor demand model for Sweden's manufacturing sector. The model was estimated on the basis of industry statistics from 1990 to 1990–2001. The model allows some adaptation, for example, technological advance and substitution between the different production factors. The results of this analysis should be seen primarily over a longer time perspective compared to other methods that are immediate without adaptation. The demand and supply functions are estimated by sector, i.e. at the sub-industry level. The basic estimates result in demand elasticities used in simulations of effects of the different scenarios, foremost on production, employment, demand for electricity and fuel, profit and carbon dioxide emissions.

In this report we have therefore not used so-called GCE (computable general equilibrium) models for economic trends in a particular country or region, or globally. CGE models have the advantage of encompassing the whole economy, which means that the analysis is within a consistent framework in terms of access to resources in the economy. Their disadvantage is that these models require a great deal of data and resources to construct, and the results are at a relatively aggregated sectoral level.

The factor demand model used here is an approach that requires far less resources and data at the branch level. In the current case, the comparison is of changes in domestic energy costs in relation to the costs of foreign competitors, calculated in the same currency. Depending on the export pattern and on which countries take part in the ETS, the changes in competitiveness vary for individual companies.

In practice, it is therefore impossible to predict with any accuracy which facilities will be compelled to close and which facilities will survive when the scheme comes into effect. The data and the models that would be required for such an analysis do not exist. Important areas of uncertainty include the extent to which higher world market prices for certain products can compensate for higher environmental costs in the EU, and what effects there may be on the relative competitive position between Swedish facilities and facilities in the other EU countries. Some analyses indicate that Sweden's heavy industry benefits from comparative advantages in relation to other EU countries, since Sweden's basic industries are comparatively more fossil energy efficient[7].

As the ETS covers all EU countries, which have a substantial proportion of the world market in certain product areas, the world market prices for certain products will be affected. In that case, this means that part of the cost increase can be transferred to consumers worldwide.

[7] *See Lars Bergman and Marian Redetzki, The Continue Project – Global Climate Policy and Implications for the Energy Sector in a Small Open Economy: The Case of Sweden, Multiscience Publishing Co, 2003*

The conclusion that can be drawn from this is that analyses are needed of competitiveness at different levels; from the world market level, through the EU level to the branch, company and facility levels in individual countries, if more precise conclusions are to be reached about the effects on competitiveness of ETS implementation. However, even with such an arsenal of analyses, there will still be considerable uncertainty about the conclusions.

The methods used in this present inquiry all point in the same direction, which to some extent assures the quality of the analysis and the conclusions drawn from it. The estimate from the factor demand model gave robust econometric results.

3 General effects of climate policy on basic industries

This chapter contains a general discussion of the effects on the competitiveness of basic industries of climate restrictions and the use of different policy instruments in climate policy.

3.1 Allocation and competitiveness

Compliance with climate policy goals at the lowest, or at least at low, public cost requires effective policy instruments. Economic climate research, both theoretical and empirical, in recent decades has clearly demonstrated that the two economic policy instruments – taxes and the ETS – i.e. an emissions ceiling combined with the emissions trading scheme, are clearly superior to other policy instruments in achieving climate policy objectives. Alternative policy instruments such as subsidies, standards, information etc., have proved to be markedly less effective. While it has clearly become very difficult to achieve political consensus on environmental taxes of significance in the EU, the alternative route of the ETS has proved more accessible.

In the EU, the ETS covers primarily basic industries, which are energy-intensive and exposed to international competition, as well as the energy conversion sector. Sweden's energy conversion sector is partly protected from foreign competition, and at the same time the greater part of electricity production is hydro and nuclear power that is ecologically sound in climate policy terms, which makes this sector less sensitive to cost increases (cost increases can largely be passed on to the customers). This is not the case for the energy-intensive basic industries, and as a result it is foremost the effects of the emissions trading scheme on the competitiveness of the basic industries that is of interest to economic policy and, in Sweden, not least regional policy.

The most common criteria that apply to activities exposed to competition include the prices of the enterprise's products governed by the world market price, i.e. determined by the international market, which means that very little of the cost increases can be passed on to the consumers. This means that an enterprise is competitive if, and only if, its production costs are at least as low as those of its foreign competitors. In rational economic behaviour, an enterprise's own production has no added value in itself other that what the market is willing to pay for the resources used in production. From the cost viewpoint it is therefore the enterprise's alternative costs, i.e. the value of the production factors in the market, that are relevant – irrespective of whether the resources were obtained free of charge or not. The resources that enterprises in the ETS have from earlier periods of time, or have obtained free of charge in the short term, include the capital stock, i.e. plant and machinery, and the emissions allowances allocated free of charge. The alternative cost of capital is zero in the short term when the capital has no alternative use. It is profitable for the enterprise to use a facility for as long as its variable costs are covered. The alternative cost of emissions allowances is equivalent to the value the market is willing to pay for them. It is profitable for the enterprise to operate the facility as long as its revenues are equal to or exceed production costs, including the market value of the emissions allowances. Even in the case of high market prices for emissions allowances (allocated free of charge), access to free capital represents an important inertia factor *in the short term* when it comes to the elimination of capacity and closure of facilities in the basic industries. In the short term, it is therefore likely that not much will happen on the production volume side; rather, adaptation can be expected to take place through reduced profitability. *In the longer term,* when contracts expire or when investments or closures are under consideration etc. the volumes produced are also affected to a greater extent. In the long term the enterprise may choose between not investing and investing, and the alternative cost of capital is thus also a real cost. Climate policy's *long-term* effects on structural development may therefore be expected to be considerably greater than its *short-term* effects.

Regardless of whether enterprises are allocated emissions allowances free of charge, or whether these allowances must be bought at auction, *the price of emissions allowances* is determined by the total amount allocated in the EU on one hand and the marginal costs of reduced emissions on the other. Thus, the price level of emissions allowances is not affected by the way they are allocated. In the competition for scarce emissions allowances, the enterprises that are most willing, or most able, to pay will maintain or increase their production, while in other enterprises production will decrease.

Free allocation of emissions allowances therefore offers no protection for *competitiveness* in *individual facilities*, i.e. the allocation does not affect enterprises' decisions to increase or cut back production in these facilities. The profitability of increasing or reducing production, or investing in new technology, is determined by the *price* of emissions allowances. An extra-generous allocation to facilities with non-replaceable raw materials-related emissions is equally insignificant in terms of the competitiveness of individual facilities.

The prices of emissions allowances in a particular period of time may, however, be influenced by the principles for the allocation of emissions allowances in future periods. A possible principle is to base future allocations on the same principles and time period, period 0 that were applied prior to the first time period, period 1 (fixed grandfathering). A principle of this kind has evident effectiveness advantages, since the behaviour of enterprises in period 1 will not affect the allocation in period 2, yet it appears to be suspect from the distribution viewpoint. It is more likely that the allocation in period 2 is based either on enterprises' production or emissions in period 1 (updated grandfathering), or on the distance to some kind of benchmark, such as the best available technology (technological grandfathering). In both cases, a dynamic optimisation problem occurs for enterprises that face economic effectiveness losses as a consequence. Without the opportunity to lend (banking) or borrow (borrowing) emissions allowances between the periods, only the price level of emissions allowances, and not the total amount of emissions, is affected.

When allocations in period 2 are based on enterprises' emissions in period 1, enterprises are prepared to pay more for emissions allowances in period 1 since this will give them larger allowances in period 2. At the same time, the enterprises that sell want to be paid more for the emissions allowances because the allowances these enterprises will be awarded in period 2 will be smaller. The total amount of emissions is constant, but the price of emissions allowances will be comparatively higher. The reverse is true in the case of technology-based allocation.

Awarding free emissions allowances to *new* facilities differs from allocation to existing facilities in as much as free allocations to new facilities are a conditional capital contribution, and thus an investment subsidy, as allowances are only allocated if the investment is made. If the allocation is also linked to future emissions of carbon dioxide, investments in facilities with high emissions levels will be favoured over facilities with little or no emissions.

3.2 Allocation and distribution effects

The major difference between the allocation of free emissions allowances and the auctioning of emissions allowances is that with free allocation, the capital value benefits go to the enterprises, while in the case of auctioning the revenues from the auctions, i.e. the capital value of the emissions allowances, accrue to the state. From the business economics viewpoint, free allocation of emissions allowances improves enterprises' *balance sheets*, i.e. strengthens their solidity. On the other hand, the price of bought or sold emissions allowances affects enterprises' income statements. In correct financial accounting, the market value of free emissions allowances is posted in the income statement for emissions allowances obtained at no cost, similar to the market value of "free" electricity from an enterprise's own power station or free raw materials from forests that an enterprise owns.

From the distribution viewpoint, the allocation of free emissions allowances is relatively arbitrary. Some shareholders, i.e. the owners of facilities that are in the trading scheme, are compensated relatively well for *the capital losses* incurred, while others receive no compensation whatsoever. The latter applies in particular to shareholders in those enterprises whose electricity-intensive facilities are not in the trading scheme and that have therefore not been allocated any free emissions allowances. However, it is the wage-earners who ultimately bear the cost of climate policy and who, with free allowances allocation, are the major losers in the distribution policy game.

3.3 Calculated effects

Bearing in mind the reservations discussed earlier, the calculations indicate that the non-metallic minerals sector, with considerable partly non-replaceable raw materials-related carbon dioxide emissions, is the sector affected most by the ETS. In this context, the cement industry, which is exposed to international competition, appears to be the most vulnerable. In addition, the structure of the non-metallic minerals sector is relatively sensitive to cost changes. This is also true of mining and the iron and steel sectors, which account for the biggest, also partly raw materials-related, emissions in industry. Pulp and paper, as well as the steel and metal sector, are the sectors that by virtue of their size will suffer the greatest export losses for a given cost increase. However, the effects on profitability will be less than for mining and the non-metallic minerals sector, for example. With an emissions allowances price of 10 euros/tonne of carbon dioxide, some 20 facilities will have an immediate cost increase equivalent to five years' real wage increases. In many cases, an electricity price rise caused by ETS will have a greater negative impact on the industry's competitiveness than will ETS itself. The pulp and paper sector is an example of this.

In the longer term, there are considerable substitution possibilities between fossil energy sources and other factors of production. However, the long-term adjustment to the costs of emissions allowances will be foremost through shifts from heavy industry to less fossil energy-dependent industry rather than by short-term substitution in individual facilities.

The calculations show that abolishing carbon dioxide tax may compensate to some extent for the cost increase associated with an ET scheme. The differences between enterprises are, however, considerable. Withdrawing the tax on carbon dioxide would have a strong impact on a large number of enterprises. However, it would, not provide any relief to many of the most severely affected enterprises, since under the reduction rules of the former scheme the marginal tax they paid on carbon dioxide emissions was virtually non-existent.

From a growth perspective, the concept of comparative advantage is more crucial than competitiveness. Compliance with the climate target will shift Sweden's comparative advantages towards less fossil-intensive production. This is a natural consequence of the decline of the energy-intensive sector in relation to other production, which leads to costs in the form of factory closures and marginalisation of the labour force. If this environmental policy is applied in the long term, the transition should be facilitated by the transfer of labour and capital to other production that has better long-term prospects, a move that will promote economic growth.

4 Different policy instruments – different effects?

This chapter contains a discussion of the validity of the results of the calculations in the model relating to the implementation of different types of policy instrument other than an emissions trading scheme.

The choice between different policy instruments has been given considerable attention in research in recent decades. Particular attention was given to the two main alternatives in climate policy, namely tax on emissions, and trading schemes, i.e. an emissions ceiling in combination with trading in emissions allowances. The ETS has the evident advantage that the effect of emissions is set by the emissions ceiling, while the effects of a tax are not known until after the fact. Research shows that an ETS is preferable if the value of further emissions reductions increases more than their costs. This is not considered to be the case with greenhouse gases, and a general carbon dioxide tax, in theory, is preferable to a trading scheme. However from the political perspective, taxes, both in the EU and the USA, for example, proved to be far more controversial as instruments of environmental policy than (free) emissions allowances in a trading scheme.

When it comes to the effects on industrial competitiveness, is there a decisive difference between taxes (energy tax and carbon dioxide tax) and an emissions trading scheme, or would the results of the analyses be the same if we replaced the cost of emissions allowances with taxes at corresponding levels? In other words, is there a difference between these policy instruments with regard to competitiveness?

The answer to these questions is no, with the important provision that there is a second-hand market for emissions allowances with functioning competition. If that is the case, a carbon dioxide tax that is on the same level as the market price for emissions allowances will influence enterprises' competitiveness in the same way, irrespective of whether the allocation of emissions allowances is free or through auctions. A trading scheme with a smoothly-functioning price formation scheme for emissions allowances, and a carbon dioxide tax without exceptions or reductions for certain enterprises, is as effective in terms of the economy, i.e. it will lead to the elimination of the least competitive facilities. In the calculations in the report, the cost of emissions allowances is therefore treated in the same way as a tax.

A potential source of a lack of effectiveness is an emissions allowances market that does not work well. A market that functions poorly may, for example, mean that the turnover (liquidity in the market) is so low that there are strong fluctuations in the price of emissions allowances (high volatility) between different periods, from day to day or from week to week. Another effect may be that competition functions so poorly that the price level of emissions allowances, at least at times, rises above the price level that would apply if competition was working properly. Both cases may cause confusion about what the price of emissions allowances actually is. Experience from Nordpool 2002/2003 illustrates what can result from an increase in price volatility. Higher price volatility leads to higher financial security requirements for the institutes that trade in emissions allowances, which means that the volumes that can be traded are reduced, i.e. there is less liquidity in the market, and this leads to more intensive price volatility etc. A vicious circle is created that has adverse effects on the price formation of emissions allowances. Careful attention should therefore be given to both the structure, for example duration and expiry times, of the instrument traded, and in particular to the importance of so-called "banking", i.e. the possibility of saving and transferring emissions rights from one period to another, and also to the structure of the institution for trading, for example, the type of auction to be used.[8] International research in market design, i.e. how a smoothly functioning emissions allowances market should be organised, offers useful guidance here. International research also demonstrates the importance of utilising flexible mechanisms, the advantages of auctioning emissions allowances, the risk of the exercise of market power and the importance of equalising marginal costs over time.

Ineffectiveness may also occur through the risk for more or less camouflaged subsidies. The most obvious of these is the allocation of free emissions allowances to new facilities. Allocations of this type are in the nature of a direct capital contribution, thus making it a direct subsidy of this kind of investment. Since many existing facilities to which the ETS applies are relatively large, and often sensitive in terms of regional location, we may expect different governments to make great efforts to prevent the closure of such facilities. It is thus highly probable that substantially more or less camouflaged subsidies (cf. the SAAB package) will go to facilities that are at risk, which means that the burden of climate policy is passed on to other facilities in the ETS. There is then a risk that facilities that are comparatively more efficient will risk closure.

A major problem from the national economics perspective is that the ETS only covers a small number of facilities – albeit with high emissions levels. Economic effectiveness requires the marginal costs of emissions in facilities outside the trading system to be at the same level as the price of emissions allowances within the system. As there is no mechanism – except for the political mechanisms in each country – that can guarantee this, there is very little chance that marginal costs in industry will be the same both within and outside the trading system. On the other hand, ETS does not start from any optimum position in a national economics perspective (the so-called "first best optimum"), but rather from a variety of tax systems with widely differing tax burdens between the different industrial sectors. This is particularly true in Sweden, where a small part of industry (the 1.2 per cent enterprises and enterprises with emissions from raw materials), have no marginal tax on carbon dioxide, another small part of industry (0.8 per cent enterprises) has a considerably lighter marginal tax, and the rest of the industrial sector has 21 per cent of the general carbon dioxide tax while the rest of the economy pays full marginal tax. Whether or not the ETS, in this case, leads to greater or lesser economic efficiency is therefore an empirical question.

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[8] *Experiences gained by institutions in deregulated electricity markets illustrate the range of options open. There are a whole range of options with different characteristics to choose between, at the same time the legal framework can give rise to major differences between different institutions.*

As instruments of climate policy, taxation and ETS have broadly the same effect on enterprises' competitiveness. On the other hand, different types of regulations help drive up the cost of climate policy. An efficiently-operating trading system, free from more or less camouflaged subsidies and aspects of market power, creates competition on a level playing field in the EU, and can be expected to minimise the costs of climate policy in the short term. The long-term and dynamic aspects of the ETS should, however, be given greater attention than has hitherto been the case.

Compliance with climate policy targets will, even if achieved at the lowest cost to the state, put both environmental policy and economic policy in the EU under considerable strain. This is also true – perhaps particularly true – of Sweden. An ETS that is effective from the national economics viewpoint has the nature of a competition-neutral structural change policy, and in this respect is a radical break with the trends of the past 50 years in Sweden's energy tax policy. By means of a range of exemptions and reduction rules, this has to a very high degree been directed at protecting that part of the economy that would be eliminated by a high energy taxes, while the purpose of (or at least the consequences of) the ETS is the reverse, namely to bring about the elimination of that part of industry that has the smallest chances of managing – through investments in new technology or fuel substitution – higher direct, and via higher electricity prices indirectly, the costs of consuming fossil energy. It is most probable that every effort to reduce the cost to the state by means of various subsidies or exemptions will have the opposite of the intended effect, i.e. they will increase the national economic costs of climate policy.

5 Model calculations by sector

This chapter contains a summary interpretation of the results by sector from all calculations in the model. The calculations estimate the effects on costs, exports, production and employment.

5.1 Facilities expected to be included in the ETS

The quantitative analyses cover some 4,000 workplaces in the manufacturing sector, 134 of which are expected to be included in the ETS (Table 2)[9]. The dominant branches are pulp, paper and paper goods manufacturing, coal products manufacturing, refined petroleum products and nuclear fuel, non-metallic mineral product manufacturing and steel and metal production. In 2001 a total of about 54,000 people were employed at these 134 facilities. In 2001, Sweden's basic industries generated about 15.5 million tonnes of carbon dioxide, 10.4 million tonnes of which were generated by facilities included in the trading sector.

Table 2 Distribution of the trading facilities at the SNI 2 level

SNI 2	Industrial branch	Number of facilities
13	Mining of metallic ores	3
14	Other mineral extraction	1
20	Manufacture of wood products	1
21	Manufacture of pulp, paper and paper products	69
23	Manufacture of coal products, refined petroleum products and nuclear fuel	5
24	Manufacture of chemicals and chemical products	1
25	Manufacture of rubber and plastic products	1
26	Manufacture of other non-metallic mineral products	27
27	Manufacture of basic metals	22
28	Manufacture of metal goods	2
36	Manufacture of furniture, other manufacturing	2

5.2 Pulp and paper (SNI 21)

Pulp and paper manufacture, a highly electricity-intensive and a major export industry, is highly sensitive to the increases in electricity costs associated with the ETS.

In 2003 this sector exported to 164 markets, 141 of which were outside the EU. Total exports amounted to SEK 80 billion. About 26 per cent of the export value was exports to non-EU countries.

With an emissions allowance price of 10 euros per tonne of carbon dioxide and trading enterprises exempted from carbon dioxide tax, the immediate cost increase would be about SEK 0.8 billion, which is equivalent to 2.2 per cent of added value. In a somewhat longer perspective, the cost increase is calculated to result in a production loss of 2.4 per cent and a 4.1 per cent reduction in carbon dioxide emissions. (Table 3).

[9] The companies to be included in the trading sector had not been decided when the analysis was done.

Table 3 Short and long-term effects of the ETS on the pulp and paper sector

Pulp and paper	**SEK** (1000)	**Share of Value added** (percent)
Alternative 10 euro without tax		
Short-term effect		
cost of emissions allowance	158,169	0.4
increased electricity cost	955,509	2.6
reduced tax	282,226	0.8
Total	831,452	2.2
Long-term effect		
change in production	-	-2.4
change in CO_2	-	-4.1
change in profit	-	-0.6

5.2.1 Pulp manufacture[10]

The pulp manufacturing sector has about 16 plants in the ET scheme. Roughly 60 per cent of Sweden's production is exported, barely one fifth of which is exported to non-EU countries. The effect on exports of a rise in costs will therefore be relatively modest in the pulp manufacturing sector (Table 4).

Table 4 The effects on exports in the pulp industry

Scenario	**Cost increase** (percent)	**Export loss** (percent)	**Export loss as proportion of market value**
3	2.1	2.6	2.1
4	3.2	4.1	3.2

If export losses are compensated by workforce cutbacks, the loss in number of employees in scenario 4 (an emissions allowance price of 10 euros and carbon dioxide tax for trading enterprises) amounts to approximately 150. In scenario 3 (an emissions allowance price of 10 euros with trading enterprises exempt from carbon dioxide tax) the negative effect on employment would be reduced to about 100 employees.

5.2.2 Pulp and paper manufacture[11]

90 percent of pulp and paper manufacture is exported, barely 30 per cent of which is exported to countries outside the EU. About 45 plants are in the ETS.

As the paper and paper goods sector exports more than the pulp industry to non-EU countries, the percentage export loss will therefore be greater in that branch (Table 5).

[10] *SNI-branch 2111.*
[11] *SNI-branch 2112.*

Table 5 Effects on the paper and pulp industry's exports

Scenario	Cost increase (percent)	Export loss (percent)	Export loss as proportion of market value
3	2.5	4.6	4.0
4	3.3	6.0	5.2

Because the employment level is relatively high in this sector, the ETS will caused a relatively large reduction in the number of employees. The calculations show that scenario 4 would result in a decrease in employment of approximately 1,200 people, while the effect in scenario 3 would be less severe, at about 900 people.

5.3 The chemicals industry (SNI 23, 24 and 25)

The chemicals industry is very heterogeneous. It includes activities such as the manufacture of coal, refined petroleum products and nuclear fuels (SNI 23), chemicals and chemical products manufacture (SNI 24) and rubber and plastics manufacture (SNI 25).

Typical for these enterprises is that many of their boards of directors and owners are located in countries other than Sweden. It is also typical that most products manufactured in the chemical industry are used in other branches of industry, i.e. relatively few products are direct consumer goods.

About 41,000 people are employed in the chemicals industry, defined as SNI 24. When the definition is extended to include refineries and the rubber and plastics industries, i.e. SNI 23-25, the number of employees amounts to about 63,000 This corresponds to just under 9 per cent of Sweden's total industrial workforce.

The majority of Swedish enterprises work in an international market and export between 75 and 90 per cent of their production. This is the third largest export branch, and accounts for about 11 per cent of Sweden's total exports. In 2002 Sweden's chemicals exports amounted to about SEK 85 billion, equivalent to just over 70 per cent of total chemicals production in Sweden. Just over 50 per cent of chemicals exports were sold to other EU countries. The import of chemicals totalled about SEK 63 billion in 2002, rather more than 70 per cent of which was imported from other EU countries.

5.3.1 The international chemicals industry

The EU and USA account for the highest percentages of the world's production of chemicals. Together with Asia, not including Japan and China, these three areas account for about 75 per cent of the world's production of chemicals.

In Europe, the biggest chemicals producer is Germany, followed by France, Italy and Britain. Together, these countries produce 64 per cent of Europe's chemicals, compared to Sweden, which produces 2.5 per cent.

On average, 46 per cent of sales goes to other EU member nations, and 29 per cent is exported to customers outside the EU.

5.3.2 The petroleum industry

A petroleum refinery's purpose is fractionating, i.e. separating crude oil into various components that may then be sold on. The market's demand for the percentages of these fractions of the product flow varies from region to region. For example, demand for petrol has increased in Sweden, while a fall in the demand for domestic fuel oil has resulted in a greater demand for the conversion of heavy fractions to lighter fractions.

For natural reasons, the petroleum industry is entirely dependent on world market crude oil prices. The composition of crude oil varies, depending on from where in the world it originates. The choice of crude oil therefore depends on what is to be produced. The prices of crude oil vary depending on the differences in content of petrol, diesel, heating oil and heavy fuel oil.

5.3.3 Refined petroleum products[12]

The refinery industry is a branch with high levels of raw materials-related carbon dioxide emissions. This contributes to substantial cost increases in this sector as a result of ETS. According to our calculations, there will be a considerable effect on exports, even if the loss is limited by the fact that this sector's exports are less sensitive to cost increases than the other sectors studied. (Table 6).

Table 6 Effects on the export of refinery products

Scenario	Cost increase (percent)	Export loss (percent)
3	11.5	11.2
4	11.5	11.2

The percentage of exports of the market value cannot be calculated for this sector because here the foreign trade statistics report an export value that exceeds the sector's market value, according to the Structural Business Statistics. This also means that it is less interesting to attempt to calculate what impact the ETS would have on employment in this sector. However, if the price of emissions allowances is 10 euros per tonne (scenario 3 or 4), a preliminary figure is that the number of people employed would decrease by 750.

5.3.4 The chemicals sector in summary[13]

An emissions allowances price of 10 euros per tonne of carbon dioxide gives an immediate cost increase of about SEK 0.5 billion, which corresponds to 1.1 per cent of added value. In the slightly longer term, production in this sector goes down by 0.8 per cent, while carbon dioxide emissions are estimated to fall by as much as 21.3 per cent (Table 7). The major cost increases occur primarily in the petroleum industry.

[12] *SNI-branch 232.*
[13] *SNI-branch 23, 24 and 25.*

In the past, enterprises in this sector have not been taxed on raw-materials related carbon dioxide emissions (which is by far the biggest part of carbon dioxide emissions), but with the implementation of the ETS, emissions allowances must be obtained for these emissions as well, which will generate considerable cost increases.

Table 7 Short and long-term effects in the chemicals sector of emissions allowances trading

Chemical industry	SEK (1000)	Share of value added (percent)
Alternative 10 euro without tax		
Short-term effect		
cost of emissions allowance	216,568	0.5
increased cost of electricity	299,801	0.7
reduced tax	12,607	0
Total	503,763	1.1
Long-term effect		
change in production	-	-0.8
change in CO_2	-	-21.3
change in profit	-	-2.1

5.4 The non-metallic minerals sector (SNI 26)

The non-metallic minerals sector consists of capital- and energy-intensive areas such as the cement industry, but also less capital and energy-demanding areas such as concrete product manufacture. This sector is affected very little by increases in electricity costs – instead, it is most affected by the cost of emissions allowances, due to the substantial amount of raw materials-related carbon dioxide emissions. Just as in the refinery sector, for example, the implementation of the ETS will therefore be very costly. The effects of the cost increases will, however, be even more noticeable than for refinery industry because a large proportion of this sector's exports goes to markets outside the EU. (Table 8).

Table 8 Effects on cement and lime industry exports

Scenario	Cost increase (percent)	Export loss (percent)
3	43.6	88.6
4	46.5	94.3

The immediate cost increase with an emissions allowance price of 10 euros per tonne of carbon dioxide and with the carbon dioxide tax lifted, is about SEK 0.3 billion, which is equivalent to 4 per cent of added value. In a slightly longer perspective, production in this sector will fall by 6.2 per cent, while carbon dioxide emissions are estimated to fall by as much as 43.2 per cent. (Table 9). Considerable cost increases will occur here too in parts of this sector, because raw materials-related emissions, which have not been taxed in the past, will be included in the emissions trading scheme.

Table 9 Short and long-term effects of the ETS in the non-metallic minerals sector

Non-metallic minerals	SEK (1000)	Share of value added (percent)
Alternative 10 euro without tax		
Short-term effect		
cost of emissions allowance	271,285	4.1
increased cost of electricity	44,873	0.7
reduced tax	46,772	0.7
Total	269,386	4.0
Long-term effect		
change in production	-	-6.2
change in CO_2	-	-43.2
change in profit	-	-2.4

5.5 Mining and steel and metal manufacturing (SNI 13, 14, 27, 28)

In Western Europe, Sweden is among the leaders in the mining production of several different metals (Table 10).

Table 10 Sweden's share of mining production in the EU 2002

EU-15	(percent)		EU-25 (percent)	
Iron	92	1:a	88	1:a
Silver	62	1:a	18	2: after Poland
Lead	43	1:a	25	2: after Poland
Gold	33	1:a	29	1:a
Copper	44	2: after Portugal	11	3: after Poland, Portugal
Zinc	23	3: after Ireland, Spain	19	3: after Ireland, Spain

Source: The Swedish Association of Mines, Mineral and Metal Producers (Status Report, November 27, 2003, www.mining.se).

The mining industry is made up of two main sub-branches. Within iron ore extraction[14] about 80 per cent of iron ore production goes to exports, of which nearly half is exported to countries outside the EU. In extraction of non-iron ore[15] exports are significantly more limited. Just over 30 per cent is exported, of which only about 5 per cent goes to countries outside the EU. The effect of the ETS on exports, with the method of measurement used in this analysis, will thus be relatively limited (Table 11).

[14] *SNI 13100*

[15] *SNI 13200*

Table 11 Export effects in the mining sector (SNI 13)

Scenario	Cost increase (percent)	Export loss (percent)	Export loss as proportion of market value
3	2.3	6.1	3.7
4	3.8	10.3	6.3

If enterprises in the mining sector compensate for the loss in exports by cutting back on the number of people employed, the reduction in employment in this sector would amount to just over 250 people in scenario 4. In scenario 3, this effect is less severe at about 150 people.

The market for different metals extracted from the minerals mined in Sweden is dependent on constantly fluctuating world market prices. To some extent raw materials futures, currency futures or stockpiling can be used to reduce the price fluctuations, but considerable price fluctuations related to the business cycle occur.

Iron ore is used in areas outside the iron and steel industry itself, for example in the form of iron powder, heavy materials (ballast, including for oil pipeline cladding, oil platforms or bridge foundations, radiation shielding insulation material, and catalysts for ammoniac synthesis. In both the export and domestic markets, iron ore is priced in dollars, mainly because buyers want comparability primarily with the Japanese and European markets. The general price level on the world market is usually set by the major players; between Australian producers and Japanese consumers or between Brazilian producers and German consumers. With its limited proportion of the total world market, Sweden has little chance of influencing the general price level.

The production of iron ore is governed entirely by the steel industry and is therefore dependent on business cycle fluctuations in the steel products market. About 80 per cent of Sweden's steel production is exported, and most of the recipient countries are within the EU (Table 12).

Table 12 Sweden's steel exports, 36 (total: SEK 36 billion)

Recipient country	Share of total export, in percent
UK	15
Germany	15
Italy	8
France	7
Denmark	7
USA	6
Finland	6
Norway	5
Poland	3
Netherlands	2
Others	26

Source: The Swedish Steel Producers' Association.

The steel industry's most important competitor countries outside Europe are the USA, Japan and South Korea.

Twenty-two plants in the steel and metal production sector are in the ETS. Since the cost increases in this sector are lower than, for example, in the minerals sector, the introduction of the ETS will result in relatively limited export losses measured as a percentage of market value (Table 13).

Table 13 Export effects in steel and metal production

Scenario	Cost increase (percent)	Export loss (percent)	Export loss as proportion of market value
3	1.6	3.1	2.3
4	2.1	4.0	2.9

Turnover, and the number of people employed in this industry is, however, substantial, and the effects on turnover and employment in absolute numbers will therefore be considerable. If the full export loss is compensated for by employment terminations, scenario 4 would mean a fall in the number of people employed of 850, and about 650 in scenario 3.

For mining and the iron and steel industry, scenario 3 brings an immediate cost increase of SEK 0.6 billion, which is equivalent to 2.9 per cent of added value. In a slightly longer time perspective, production in the iron and steel sector falls by 2 per cent and carbon dioxide emissions by 20.7 per cent. (Table 14).

For iron ore extraction, the conditions in scenario 3 mean in a slightly longer time perspective that production falls by 2.2 per cent and carbon dioxide emissions by 16.2 per cent (Table 14).

Table 14 Short and long-term effects of ETS on mining and the iron and steel industry

Mining and iron and steel industry	SEK (1000)	Share of value added (percent)
Alternative 10 euro without tax		
Short-term effect		
cost of emissions allowance	408,009	1.9
increased cost of electricity	406,991	1.9
reduced tax	203,049	1
Total	**611,952**	**2.9**
Long-term effect iron and steel industry		
change in production	-	-2.0
change in CO_2	-	-20.7
change in profit	-	-0.6
Long-term effect iron ore extraction		
change in production	-	-2.2
change in CO_2	-	-16.2
change in profit	-	-1.5

5.6 Effects on the trading sector in summary

A scenario with an emissions price of 10 euros and the carbon dioxide tax lifted for the trading enterprises results in an immediate cost increase of SEK 1.8 billion which is equivalent to 3.5 per cent of added value. In a longer term perspective, production in the sector will fall by about 2.5 per cent, which gives a substantial fall in carbon dioxide emissions of 22.4 per cent (Table 15). Simulations of a scenario in which the common dioxide tax is still applied, shows very powerful adverse effects on competitiveness for a large number of enterprises. The effects are also largely dependent on what happens to the price of electricity.

Table 15 Short and long-term effects of ETS for the trading sector.

The so-called trading sector.	SEK (1000)	Share of value added (percent)
Alternative 10 euro without tax		
Short-term effect		
cost of emissions allowance	1,054,452	2.1
increased cost of electricity	1,246,778	2.5
reduced tax	545,397	1.1
Total	1,755,833	3.5
Long-term effect		
change in production	-	-2.4
change in CO_2	-	-22.4
change in profit	-	-2.9

5.7 Regional effects

To illustrate the regional effects, the country has been divided into the following seven regions.

1. Eastern Central Sweden; counties 1, 3, 4, 5, 18, 19
2. Småland and Öland and Gotland; counties 6, 7, 8, 9
3. Southern Sweden; counties 10, 12, 13
4. Western Sweden; county 14
5. Northern Central Sweden; counties 17, 20, 21
6. Lower Norrland; counties 22, 23
7. Upper Norrland; counties 24, 25

In each of these regions the number of employees at workplaces that had a negative gross profit percentage in 2001 have been totalled. Comparisons were then made with the number of employees in the places of work that were estimated to have a negative gross profit percentage after ETS has been established. (Table 16)

Table 16 Increase in the number of employees at workplaces with negative profit percentages.

	Whole industry			Trading enterprises/workplaces		
	5 euro	10 euro	25 euro	5 euro	10 euro	25 euro
Eastern Central Sweden	0	314	635	0	0	138
Småland and the islands	209	1,021	1,084	0	295	358
Southern Sweden	168	168	391	0	0	0
Western Sweden	70	1,077	1,814	0	211	709
Northern Central Sweden	442	471	1,858	346	346	1,511
Lower Norrland	0	212	770	0	0	374
Upper Norrland	21	21	766	21	21	659
Countrywide	**910**	**3,284**	**7,318**	**367**	**873**	**3,749**

For the country as a whole, the cost increases associated with the ET scheme mean that the number of employees at workplaces that do not cover wage costs rises by between 367 and 7,318 people, depending on the calculating alternative used.

The ETS will have the greatest effect in Northern Central Sweden, i.e. the counties of Värmland, Dalarna and Gävleborg. There will also be marked effects in West Sweden and in Småland (including Öland and Gotland). Since in many regions the basic industries have a dominant role in the economy, the effect on single districts and regions can, however, be considerable even if the number of employees in absolute numbers is relatively small.

5.8 Main results

The results of the theoretical arguments are confirmed by the calculations in this chapter.

In the short term, enterprises in the non-metallic minerals sector will be affected most by the ETS, because their carbon dioxide emissions are considerable, but also because the structure of this sector makes it sensitive to cost changes. Mining and the iron and steel industry are also affected to a great extent by the ETS, as the structures of these branches are also relatively sensitive to cost changes and they account for the largest carbon dioxide emissions in industry.

The pulp and paper industry is the sector affected most by a higher price of electricity. Pulp and paper, as well as the steel and metal sector, are the sectors that by virtue of their size will suffer the greatest export losses for a given cost increase.

In the slightly longer term, in many cases an electricity price rise caused by ETS will have a more negative impact on the industry's competitiveness than will ETS itself.

In the slightly longer term, there will also be considerable variations in effects between different sectors. The highest percentage loss in production is in the non-metallic minerals sector, followed by pulp and paper, iron ore extraction and the iron and steel industry.

The quantitative analyses also confirm that many of the enterprises in energy-intensive basic industries will be less competitive, which will affect exports as well as production and employment. Given that in many regions basic industries play a dominant role in the economy, the regional effects may be considerable.

6 Conclusions

The ITPS analysis shows that implementation of the emission trading scheme (ETS), including its impact on the price of electricity, means that the competitiveness of energy-intensive enterprises will worsen relative to the earlier energy taxation system, and assuming market factors, such as world market prices, do not change. For a number of sectors the effects are fairly extensive.

The ETS is, however, an effective economic policy instrument for achieving climate goals. An ETS that works properly, without more or less camouflaged subsidies and free from elements of market power, creates competition on equal terms in the EU and may be expected to minimise the costs of climate policy. However, if trading is to be effective, the way the scheme is structured is extremely important. The design of the system should be given greater attention in preparation for coming periods.

One cause of ineffectiveness is the allocation of free emissions allowances to *new* facilities, a system that passes on the burden of climate policy to other facilities in the ETS. Any subsidies or exceptions will very probably have the opposite effect of that intended, i.e. such measures will serve to increase the public cost of climate policy.

Whichever allocation method is used, i.e. allocations free of charge versus auctions, has no significance in terms of *existing* enterprises' competitiveness. What is decisive for the way enterprises' competitiveness is affected is the *price* of emissions allowances. However, from a business economics perspective the allocation of free allowances does give enterprises stronger *financial positions,* i.e. improved solidity. Free allocation also means that there are enterprises who derive capital value benefits for emissions allowances[16] while in the case of auctioning, revenues from auctions accrue to the state.

It is important that the carbon dioxide tax is lifted for companies in the trading sector. The effectiveness of an emissions trading scheme with a functioning price formation mechanism for emissions allowances and a carbon dioxide tax without exceptions or reductions for certain enterprises, are, it is true, comparable as policy instruments, i.e. they both result in the elimination of the least competitive facilities. A combination of policy instruments is not, however, a preferable alternative. With an ET scheme, the carbon dioxide tax should be withdrawn for enterprises covered by the scheme, because this tax has no further effect in promoting environmental control, i.e. it does not contribute to bringing down the total emissions level in the EU. On the other hand, abolishing the carbon dioxide tax is significant in terms of enterprises' competitiveness.

[16] *Which is the case during the introductory period 2005-2007 when the EU decided on free allocation. During the first period of the Kyotot Protocol, the EU decided to allow some emissions allowances to be auctioned.*

For a large number of companies, withdrawing the carbon dioxide tax would have a strong impact, because it can partly compensate for the cost increases associated with an emissions trading scheme. This would, however, not make any difference to many of the most severely affected enterprises, since under the reduction rules of the former scheme, the carbon dioxide tax they paid was negligible due to the reduction rules.

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- Statistic data and analyses of the structure and dynamics of industry – to obtain an up-to-date view of future challenges and opportunities
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