Lappeenranta University of Technology
School of Business and Management
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# Carbon pricing and its effect on company profitability

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**ABSTRACT**

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In order to reach the 2°C climate target, the carbon price should rise significantly in order for it to be financially rewarding for companies to reduce their emissions. This research aims to find how a significant increase in the carbon price would affect the profitability of companies. Prior research has not found consensus on how regulatory policies affect companies. This research looks at profitability factors of carbon pricing through a mix of related issues such as the carbon risk, carbon pricing mechanisms and cost pass-through of additional costs. The research is quantitative and examines financial data and emissions data regarding scope 1 and scope 2 emissions on 328 European companies. The data analysis method utilised is a sensitivity analysis conducted as a scenario analysis. Different price increases and cost pass-through rates are tested to see how company profitability is affected. As the companies are distributed between 9 sectors and 53 industries, the results vary. The industries that are found to be affected by an increase in carbon pricing show drastic negative changes in profitability. The results complement prior research identifying the most carbon-intensive industries, but also provide some new insights on industries that may be affected by carbon pricing. Industries related to manufacturing, electricity and energy are partly significantly impacted, but also industries related to tourism and food show potential signs of impact when an increased carbon price is introduced.

## TIIVISTELMÄ

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| **Tekijä:** | Juulia Kangas |
| **Tutkielman nimi:** | Hiilen hinnoittelu ja sen vaikutus yritysten kannattavuuteen |
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Kahden asteen ilmastotavoitteen saavuttamiseksi tulee hiilen hinnan nousta merkittävästi, jotta päästöjen vähentämiseen tarvittavat investoinnit ovat kannattavia yritysten näkökulmasta. Tutkimuksen tavoitteena on selvittää, kuinka merkittävä nousu hiilen hinnassa vaikuttaa yritysten kannattavuuteen. Aiemmat tutkimukset eivät ole päässeet yksimielisyyteen siitä, kuinka päästöjen sääntelypolitiikka vaikuttaa yrityksiin. Tämä tutkimus katsoo hiilen hinnoittelua kannattavuuden näkökulmasta, yhdistäen aihepiirin keskeisimpiä tekijöitä. Näihin kuuluu hiiliriski, hiilen hinnoittelumekanismit sekä hiilestä aiheutuvien ylimääräisten kustannusten siirtyminen asiakkaille. Tutkimus on kvantitatiivinen ja tarkastelee 328 eurooppalaisen yrityksen talous- sekä päästötietoja koskien suoria (scope 1) sekä epäsuoria (scope 2) kasvihuonepäästöjä. Datan analysointiin käytetään herkkyysanalyysia, joka toteutetaan skenaarioanalyysin muodossa. Tutkimuksessa käytetään erilaisia hinnan nousun sekä kustannusten siirron asteita, jotta voidaan arvioida, minkälaisia vaikutuksia niillä on kannattavuuteen. Yritykset jakaantuvat 9 sektorin ja 53 alan välille ja täten myös tulokset vaihtelevat. Aloilla, jotka ovat vaikutuksen alaisia, nähdään merkittäviä negatiivisia muutoksia yritysten kannattavuudessa. Tulokset täydentävät aikaisempia tutkimuksia hiili-intensiivisten alojen osalta, mutta tuovat esiin myös uusia näkökulmia sellaisten alojen kohdalla, jotka saattavat olla vaikutuksen alaisia hiilen hinnan noustessa. Alat, jotka kuuluvat tuotannon, sähkön ja energian piiriin ovat osin merkittävän vaikutuksen alaisia, mutta näiden lisäksi myös turismiin sekä ruokateollisuuteen liittyvät alat osoittavat merkkejä muutoksista, kun korotettu hiilen hinta otetaan käyttöön.

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| **CCS** | Carbon Capture and Sequestration |
| **$CO_2$** | Carbon Dioxide |
| **$CO_2e$** | Carbon Dioxide Equivalent |
| **COP21** | The United Nations Climate Change Conference, the 21st Conference of the Parties to the UNFCCC in Paris, 2015 |
| **CPT** | Cost Pass-Through |
| **DM** | Developed Markets |
| **EBITDA** | Earnings Before Interests, Taxes, Depreciation and Amortization |
| **ESG** | Environmental, Social, Corporate Governance |
| **EU ETS** | European Union Emissions Trading System |
| **EUA** | European Union Allowance |
| **GHG** | Greenhouse Gas |
| **$GtCO_2$** | Gigaton of carbon dioxide |
| **GVA** | Gross Value-Added |
| **$MtCO_2$** | Megaton of carbon dioxide |
| **PH** | Porter Hypothesis |
| **ROA** | Return on Assets |
| **ROE** | Return on Equity |
| **$tCO_2$** | Ton of carbon dioxide |

# 1 INTRODUCTION

This introductory chapter will give insight on the research topic. This thesis aims to detect how a significant price increase on carbon dioxide ($CO_2$) emissions, i.e. the carbon price, would affect the profitability of companies, and how this price increase is ultimately passed through for customers to pay. More broadly stated, in order to limit global warming to the required 2°C, the price of $CO_2$ emissions would have to rise significantly from its current level (approx. €5/t$CO_2$.). The purpose of this study is to evaluate the potential price increase on $CO_2$ emissions, and the impact that this increase will possibly have on the profitability of companies. The introduction will go through the background of the study, research questions, scope of the research and the research gap.

## *1.1 Background of the study*

The United Nations Climate Change Conference (the 21st Conference of the Parties to the UNFCCC, COP21) was held in Paris, early December 2015. The aim of the summit was to find an international agreement and objectives to fight climate change. An agreement was reached; countries agreed to put efforts into keeping the increase of the global average temperature below 2°C, aiming for 1,5°C, compared to pre-industrial levels. In order to reach these goals, greenhouse gas (GHG) emissions must be cut dramatically. (UNFCCC 2015, 22) According to scientific research carbon emissions should be reduced by 80% by 2050 compared to 1990 levels, to avoid the increase of more than 2°C in the average temperate (The CarbonNeutral Company).

The agreement reached in Paris has placed increasing pressure on pricing carbon. Carbon pricing around the world has expanded considerably during the last decade, with a threefold increase in the share of emissions being covered. Almost a quarter of global GHG emissions are currently priced through taxes or emissions trading, in all together 39 national jurisdictions and 23 cities or states. The largest single countries pricing carbon are China and the United States, but the European Union Emissions Trading System (EU ETS) covers the largest proportion of emissions in Europe than any other mechanism in the world, making it the single largest international instrument for carbon pricing. Carbon pricing instruments cover 1 gigaton of carbon dioxide equivalent ($GtCO_2e$) in China, 0.5 $GtCO_2e$ in the United States, and 2 $GtCO_2e$ by the EU ETS, respectively. Jurisdictions are increasingly implementing cap-and-trade programs to price carbon, including for example the Republic of Korea, China, California, Québec, and Ontario. Also carbon taxes are increasingly popular, lastly implemented in France and Mexico. Companies are also increasingly utilising internal carbon prices. (World Bank Group & Ecofys 2015, 10, 20)

From the globally combined carbon pricing instruments almost 70% are formed by ETSs and about 30% by carbon taxation. Currently, carbon prices vary tremendously – there is no consensus over a global price. This is because legislation, among other things, vary from one jurisdiction to another. Carbon prices range from less than 1 euro to over 300 euros per ton of carbon dioxide equivalent ($tCO_2e$), the majority of which (85%) are priced below €10/$tCO_2$. This price utilized by the majority is much lower than what has been estimated as the required price by economic models to meet the target of not exceeding 2°C in global warming. With global cooperation, the cost of reaching this target could be reduced. (World Bank Group & Ecofys 2015, 13-14; CDP 2015, 50-66) With the contract from COP21, one step further has been taken to enable global pricing.

Research on $CO_2$ pricing and the impact it has on company profitability is highly topical in the business world as well as academia. There is a strong consensus among scientists on global warming and that human influence is the main cause of it. Combustion of fossil fuels and deforestation have been found to be the key reasons for climate change. If GHG emissions continue to grow it will result in further climatic changes. Global warming presents enormous economic, social and financial risks. (IPCC 2013) This means that global warming also poses risks for companies and their operations. Companies alone cannot take on the responsibility to reduce the impacts of climate change but they do nonetheless have a big impact on the issue.

Companies have to be aware of the changes that carbon prices will bring upon the market. It is crucial to understand the market mechanisms of carbon pricing and emissions trading in order to identify and manage the risks involved but also to see the potential it may bring. This is increasingly important as it has been noticed that carbon prices must increase significantly in the future to meet the two-degree target. Considerable improvements must be made to reach this target. In most cases companies have set targets according to existing policies in a manner of compliance and anticipate weaker future policies than what would be needed to succeed in the 2°C scenario. Some companies have set higher targets but others lag behind. A point gap exists between the reductions that will be made according to current reduction rates and what is needed. (Sayani, Nishikawa & Shakdwipee 2015, 5) The European Commission states that when a sufficient price is put on carbon, it will entice investments in cleaner technologies. (The European Commission 2015a) When there is global regulation and it is implemented, strict environmental regulation creates lead markets for alternative or cleaner technologies (Beise & Rennings 2005).

The ability to make long-term plans and implement long-term investments are important issues for companies, in order to be able to plan the future of the business. This also applies to having a predictable $CO_2$ price signal and regulatory framework. (Ernst & Young 2015) However, as for example the EU ETS comprises of different stages, it makes it difficult for companies to make predictions on the behalf of carbon pricing (Maydybura & Andrew 2011, 126). This of course helps to implement the scheme step by step but it does make long-term planning more difficult.

With further policies on GHG emission regulation being developed, there is growing interest in what sort of effects these policies will have on the productivity, competitiveness and profitability of companies and whole industries to which they are applied (Bushnell, Chong & Mansur 2013, 78). It is a challenge to predict how emissions pricing will ultimately affect the profitability of companies. It is difficult to make a comprehensive and simplified general conception but this is the goal. In reality the impacts will depend on a myriad of things including the emissions quota and distribution as well as market prices of fuels. Measuring these impacts will be of relevance to policy makers as well, in deciding the timing of actions and and setting levels of reductions (Bushnell et al. 2013, 78).

### *1.2 Research gap and the research questions*

Previous research on the subject is scattered. Similar previous research (in academia as well as practice) has been industry or country specific or mostly concentrating solely on emission allowances and emissions trading, somewhat excluding the cost pass-through perspective. Previous research seems to be conducted mostly to concern the electricity sector and some other specific industries (e.g. pulp and paper). This is most likely because the EU ETS for example only covers certain industries. Most research on the subject focuses only on direct emissions, leaving out indirect emissions (scope 2 and scope 3). Literature is limited on the effects that carbon pricing has on the competitiveness or profitability of companies. Analyses on the post carbon price implementation barely exist as enough time has not yet passed to be able to thoroughly study this phenomenon. As the EU ETS is divided into phases, post analyses can be conducted on the first two phases but what kind of affects the third phase and policies after this will have, are still under examination and predictions.

When coupling environmental performance with financial performance, the perspective tends to be on firm value or general firm performance. Results on this have been divided as some researchers have found a dependency between these and others have not. In this study the dependence is clear in the sense that if the price of $CO_2$ emissions increases, it directly affects the costs of the company. In addition, this research narrows down the performance factor to the profitability of companies. There is limited research on how carbon pricing affects the profitability and competitiveness of companies. From the existing studies very few concentrate on profitability specifically; mostly the studies concern competitiveness effects. Profitability and competitiveness share many similar attributes but these two concepts nonetheless differ from each other and affect each other. These issues are further explained in chapter 2.3 on profitability. Post-scenarios on carbon pricing need to be researched. Previous studies concentrating on the effects of emissions trading on for example firm profits have been narrowed down to concentrate on solely one specific country or relevant market.

This thesis will contribute to former studies by giving an overview of the effects by examining companies without industry specifications, but rather taking a broader look at various listed Western European companies. However, from this broad approach, also industry specifications will be made. The study will also specifically take a look at the profitability aspect of companies, in regard to $CO_2$ emissions prices and hence costs. The division of costs within the value chain, i.e. cost pass-through, will also be inspected. Also Scope 2 emissions are taken into account in addition to Scope 1 emissions.

The main research question is:
**How would a significant price increase on $CO_2$ emissions affect the profitability of companies?**

Supporting findings to the research question are established through the following sub-questions:
SQ1. Which variable has a larger impact on profitability, the $CO_2$ price or cost pass-through rates?

SQ2. What kind of increase in the $CO_2$ price is needed for a significant impact on profitability?

SQ3. Which sectors and industries are affected the most and which ones are affected the least?

### *1.3 Delimitations and structure of the study*

This thesis will concentrate on $CO_2$ emissions pricing and the effects that increasing prices have on firm profitability. The selected companies will be listed Western European companies from the MSCI Europe Index. From these companies, the main focus will be on carbon-intensive companies and industries, or industries that otherwise seem to be significantly affected by carbon pricing. The financials' sector is left out of the examination. The study will focus on more or less manufacturing companies that are facing risks related to dealing with $CO_2$ emissions.

The study is based on the assumption that technological advances and additional technological investments are not presently carried out among the companies that are inspected. This is not to assume that these companies will not invest in new technologies in the future or anticipating to do so now but the delimitation is necessary in this research to enable demonstrations on what the effects will be if nothing is done to reduce emissions. Another important note is that the analyses are made on the assumption that emissions have stayed the same as when compared to the emissions in the data. This implies that the selected companies' emissions have not increased or decreased from what has been stated in the data, mainly from the year 2014. Investments made into cleaner technologies are not part of the main problem and this area is not looked into in depth, however, it is touched on in relation to the main issue. These are important delimitations in this study and enable the analysis on how price increases on $CO_2$ emissions would affect the profitability of companies when nothing is done in order to reduce these emissions.

A heavy reason as to why changes in emissions from 2014 and investments put into new technologies are not studied thoroughly in this research is that implementation of mitigation technologies varies between industries. Mitigation technologies include energy efficiency, renewable energy and fuels, and carbon capture and sequestration (CCS). According to MSCI (2013, 11), in the year 2013 the utilities sector was overall the only one where these technologies were strongly pursued. MSCI states that about 40% of companies did not invest in renewables and 75% did not participate in CCS projects in any way (figure 1). Oil and gas companies were strongly striving for renewables and CCS. Energy efficiency was the most utilised way for emissions reductions with 77% of companies in the utilities, energy, industrials and materials sectors being involved. The benefits that new technologies bring for companies, as well as potential policy incentives, have large roles in determining the conclusive appeal they induce. Figure 1 illustrates how mitigation strategies and technologies vary between the Energy, Industrials, Utilities and Materials sectors.

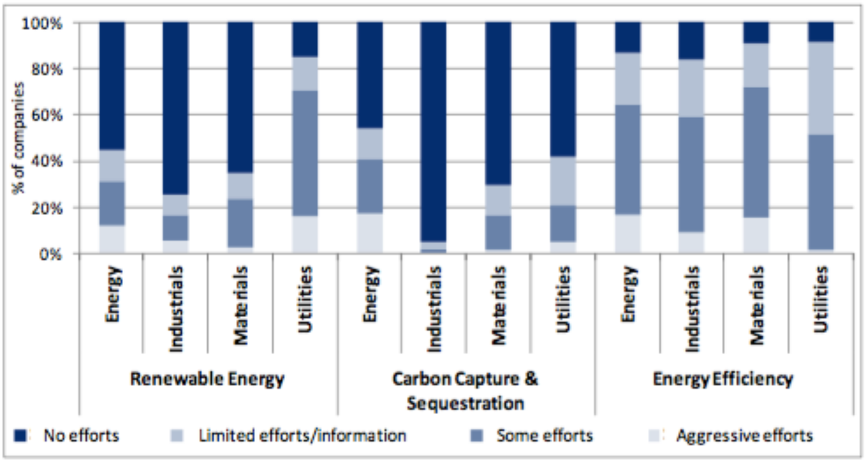



Figure 1. Gaps in Mitigation Strategies by Industry and Technology by MSCI ESG Research (MSCI 2013, 11)

The EU ETS is viewed as the main pricing mechanism in this research. This is because it is the largest mechanism for pricing $CO_2$ emissions and thus most of the previous research related to the subject has been conducted by examining this mechanism. Section 2.2.1 on emissions trading will concentrate on examining cap-and-trade systems, mainly the EU ETS.

A limitation that comes from using secondary data is that the thesis will largely make conclusions based on numbers. Many companies have made plan-of-actions to reduce emissions but these plans are not visible in numerical data. From the quantitative data utilized in this research, more qualitative questions considering these future plans cannot be answered. To get more precise answers, qualitative data, such as interviews, would be needed. Considering the scope of the thesis, interviews are not considered imperative.

The research opens up with a literature review where prior research regarding carbon pricing and profitability factors are examined. The literature review first examines how environmental regulations affect company operations, namely through the Porter Hypothesis and carbon risk factors. Carbon pricing mechanisms are then examined and how the carbon price has fluctuated over time. Finally, the theoretical section ends by examining cost and profitability issues related to carbon pricing.

In chapter 3 the theoretical framework is presented, linking the literature review to the empirical section. The research methodology is then presented, followed by the results of the empirical analysis. The last chapters examine the results in more depth, chapter 6 covering the discussion of the results and chapter 7 concluding the research by examining the contributions and implications of the study.

# 2 LITERATURE REVIEW

Prior research on the topic is reviewed to help find answers to the research question. This chapter aims to find out what has already been discovered concerning the relationship between $CO_2$ emissions and company operations, carbon pricing, and above all, profitability. Related aspects are reviewed, such as the EU Emissions Trading Scheme (EU ETS).

The first section will look into how $CO_2$ emissions relate to company operations. The second section will review carbon pricing mechanisms, including the EU ETS, and the third section will go through profitability factors. As the research focus is on Western European countries, the literature review also has an emphasis on Europe.

## *2.1 $CO_2$ emissions and company operations*

There are various carbon-intensive industries and then again industries which do not significantly contribute to overall $CO_2$ emissions. The way $CO_2$ emissions affect the operations of a company depend on the type of emissions it induces (Scope 1, 2 or 3). When $CO_2$ emissions carry a price, especially high-emitting industries will be exposed to new costs, and these costs can end up being significant. The costs that emissions bear are mainly derived from regulatory actions or then internal carbon pricing. These will be reviewed more closely in section 2.2 Carbon Pricing.

No matter what the price on $CO_2$ emissions will be, it will bring companies additional costs. Because of this, some companies have taken a proactive step and set an internal price on $CO_2$ emissions that they use in order to ease future planning and to prepare themselves for possible future government regulations. Shell is just one example of a company carrying an internal carbon price. Shell set the price at around 40 USD/t$CO_2$ (approximately €30/t$CO_2$ according to 2013 exchange rates). The price is set at this level according to what Shell estimates as necessary for reducing emissions in order for their products to be viable in the long run. This price already affects the decision-making in the company, as carbon-intensive projects have been rejected due to the price set on carbon, making the projects unappealing. (Gunther 2013)

Many similar examples to Shell exist and these costs are changing the way companies operate. Next we will look at some reasons why and how these operations are affected.

### 2.1.1 The effect of environmental regulation

Literature and conclusions regarding the relationship between environmental regulation and company profitability is a source of continuous debate. Consensus has not yet been found on whether environmental regulation enhances competitiveness or automatically restricts company operations and thus also reduces profits. The traditional way economists have viewed this is that environmental regulation and protection impose additional costs on companies, or otherwise restrict production or other actions of companies. The costs often stem from regulatory actions such as taxes, emissions trading or technological improvements, resulting in increased production costs. (Porter and van der Linde 1995, 19; Bushnell, Chong & Mansur 2013, 78) Michael Porter challenged this view (Porter 1991) and according to Porter (together with van der Linde, 1995), regulation can in fact enhance efficiency, innovativeness and competitiveness. Porter and van der Linde (1995, 2) state that: "-- properly designed environmental standards can trigger innovation that may partially or more than fully offset the costs of complying with them" and call these innovation offsets. According to their study, productivity is enhanced when pollution is mitigated because of the reduction in wasted resources. This is called the Porter Hypothesis (PH). Numerous studies have been conducted around this topic but there are conflicting findings and theories.

Porter and van der Linde (1995, 5) distinguish two types of innovations. The first type of innovation is the kind that improves for example pollution control but does not bring other benefits to the firm. This is sometimes referred to as the weak version of the PH and it has also gathered more support in latter studies. The second type, the innovation offset type, addresses environmental aspects while at the same time also improves the processes related to the issue or product at hand. The second type of innovation can offset and even outshine the cost of compliance. This can then improve the competitiveness of a company. This is called the strong version of the PH and it has gotten less support from latter studies than the weak version. (Porter and van der Linde 1995, 5; World Bank Group & Ecofys 2015, 54)

What Porter and van der Linde (1995, 10) want to highlight is that rather than focusing on preventing pollution, the focus should be on resource productivity or efficiency. By improving resource productivity, companies are able to go beyond reducing emissions and dealing with the costs derived from this action, to lowering the actual costs and raising the value of products. This is when environmental aspects go hand-in-hand with competitiveness factors.

The study by Porter and van der Linde points out that other studies found it hard to prove that regulation has adverse effects on competitiveness. An important notion is that the PH does not suggest that all regulation leads to maximizing innovation and profit but the ones that have been planned well, potentially do. (Porter & van der Linde 1995, 13-14) What needs to be understood from these studies is that regulations are not always detrimental to companies but sometimes they can rather be seen as opportunities.

The PH has been tested theoretically as well as empirically and there are conflicting and also supportive findings. Most studies state that stricter environmental regulation does not automatically result in a decline in competitiveness (e.g. Rennings, Kemp, Bartolomeo, Hemmelskamp & Hitchens 2004). In 1998 Albrecht provided an example of the validity of the PH. He identified the United States and Denmark as pioneers regarding the 1978 Montreal Ozone Protocol and showed how the competitiveness of relevant companies in these two countries enhanced. (Oberndorfer & Rennings 2007, 5) A more recent study by Brännlund and Lundgren (2010) tested the PH in the Swedish industry. Brännlund and Lundgren tested "the effect of a carbon tax on profitability by using firm-level data on output and inputs from Swedish industry between 1990 and 2004" (2010, 1). This study found there to be a "reverse effect" of the PH in energy-intensive industries in particular and in most industrial sectors in general. The study does however point out that there are problems when it comes to relating the results directly to the PH. The study agrees that there is positive evidence that regulation improves efficiency but it is not enough to prove that also overall profits would increase and costs are neutralized or offset. (Brännlund & Lundgren 2010, 62)

A study by Managi, Opaluch, Jin & Grigalunas (2005) found a positive relationship between productivity and regulation but also state that a general solution cannot be found where this would always happen. Also some other studies, for example by Lanoie, Patry and Lajeunesse (2008), have similar results for industry data in Canada. (Brännlund & Lundgren 2010, 73)

There are various studies on induced innovations as well that are closely related to the topic of this research. These theories are not thoroughly studied for this thesis because they are not a part of the core issue. What can be stated is that there are studies, theoretical as well as empirical, that confirm and support the idea that when a price is put on emissions, it can induce innovations that provide technological advances. (Ziesemer 2013, 194)

The question of how industries that are not heavy polluters themselves, are ultimately affected by $CO_2$ pricing, is noteworthy. Introducing a carbon price also impacts these industries indirectly. This research will later review (part 2.3.3) how additional costs resulting from carbon pricing are most likely passed on in for consumers to pay. At this stage it can be stated that increasing pricing on pollution will be reflected on output and thus also revenues and costs. (Bushnell et al. 2013, 79)

Companies tend to view emissions regulation solely as a cost. Porter and van der Linde (1995, 15) pointed out that regulations should be able to encourage innovativeness costwise. When forming new regulations, be it carbon tax or emissions trading, this is important for regulators to bear in mind. However, it is also worth pointing out that economic considerations should not diminish the importance of environmental impacts that are pursued with regulation policies. It is favorable that companies can do this cost-efficiently but the goal of environmental regulation is not to improve competitiveness or lower costs. In the best scenario, market incentives (taxes or allowances) create incentives for companies to innovate. (Oberndorfer & Rennings 2007, 13-15)

### 2.1.2 Carbon risk

Climate change and GHG emissions expose companies and carbon assets to a range of potential risks. Estimating these risks is challenging but valuable definitions and research have been distinguished in order to aid companies and other actors in realizing them. Various companies and assets could be exposed to carbon risks but most often the attention is drawn to companies and operations that are connected to fossil fuels. (UNEP FI & WRI 2015, 14) Governments have introduced policies to cut back on emissions and these will be specified in chapter 2.2.

When reviewing carbon as a risk there are two definitions to be distinguished. There are carbon risks and physical climate risks, from which this research focuses on the former. Physical climate risks are associated with physical impacts (operational risks) that can include for example damages that have occurred due to extreme variations in weather patterns. These variations include droughts, floods and severe storms. Carbon risk on the other hand faces assets and companies, but is considered a non-physical climate-change related issue. These risk factors are often connected to carbon-intensive companies and industries, and also to investors and financial intermediaries and their role in the matter. The risks that are related to carbon risk are technology, policy and legal, market and economic and reputational risks (figure 2). These risks can bear financial implications for corporations. Carbon risk can be further broken down into operator carbon risk and carbon asset risk. Operator carbon risk refers to the operators of carbon assets, i.e. companies that face the carbon risk. Carbon asset risk refers to the investors and financial intermediaries that may be indirectly affected by impacts related to carbon issues (resulting from unmanaged operator carbon risk) through increased credit risk or loss in revenue. (UNEP FI & WRI 2015, 14-15)

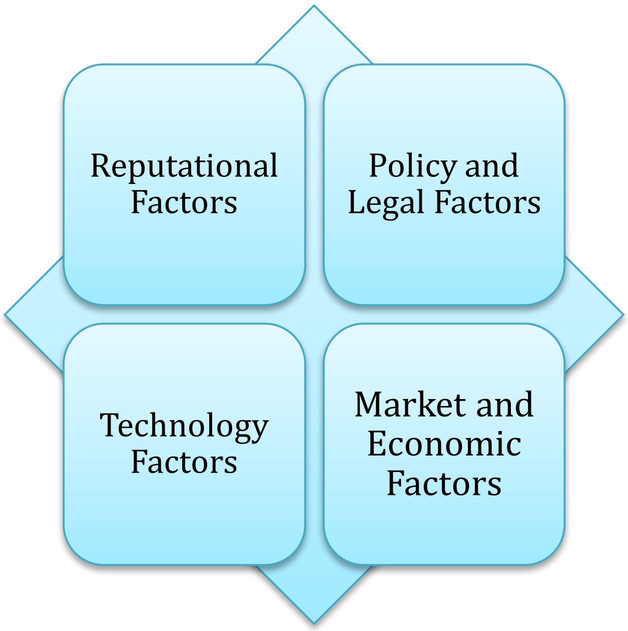



Figure 2. Core risk factors related to carbon risk (UNEP FI & WRI 2015, 16)

Figure 2 presents the risk factors related to carbon risk. This is one way of categorizing risk factors but also Mercer (2011) among others have come up with similar factors. Policy and legal, technology, and market and economic factors can be considered as the primary types of carbon risk factors. Table 1 summarizes these factors and their potential impacts. (UNEP FI & WRI 2015, 16-17)

Table 1. Carbon risk factors and their impacts, including reputational factors (UNEP FI & WRI 2015, 17)

| **Risk category** | **Potential impact** |
|---|---|
| Policy and Legal | Potential financial and operational impacts on carbon assets and companies due to government policies or regulations. Example: emissions trading systems. |
| Technology | Alternative and low-carbon technologies develop and become more available and affordable. Affects technology choices, costs and deployment. Example: technologies for storing energy. |
| Market and Economic | Negative impacts on carbon assets and companies due to changes in the economic or market situations. Example: changes in fossil fuel prices. |
| Reputational | Financial or non-financial damage to a company's reputation. Example: damage on brand value leading to a loss in revenue. |

**Policy and legal risks**

Policy and legal factors consist of changes in government policies or regulations that may affect carbon assets from an operational and financial perspective. These regulations can for example pose limits on GHG emissions, like the carbon pricing systems such as the EU ETS or carbon taxation. In addition, regulations that do not directly address emissions might also impact carbon assets. These regulations that indirectly impact emissions may include for example policies on the use and discharge of industrial water or energy efficiency standards. Policies on low-carbon technologies may also impact carbon-intensive sectors. In addition to policy factors, legal risks are also noteworthy. Legal risks may arise from litigation deriving from noncompliance with regulations or policies. COP21 and the agreements made there are also big factors in shaping future policies. (UNEP FI & WRI 2015, 17-18)

**Technology risks**

Technology risks are associated with low-carbon and alternative technologies and the development of these technologies so that they become more attractive, available and cost-effective, compared to carbon-intensive technologies. Technology risks are not industry-specific but rather affect various industries, as many of them face these risks in some form. Technological breakthroughs have the potential of quickly displacing existing technologies if they are radical enough. These new technologies can bring value through cost factors or design. Also incremental changes can lead to displacing technologies and are also more common. Existing technologies face risks when new technologies have better functionality, reliability, efficiency or reduce costs and emissions. Technologies that introduce energy efficiency also carry the potential of reducing energy demand in general, thus reducing the utilization of existing technology assets as a side effect. Some examples consist of developments in battery storage and smart grid technologies, in order to deploy renewable energy more efficiently. (UNEP FI & WRI 2015, 18-19)

**Market and economic risks**

Changes in the market and economic conditions also impose risks on carbon assets and companies. These changes affect companies operationally or financially. Market and economic changes can derive from aforementioned changes in government policies, technological developments or changes in consumer demands. There are various factors that affect how market and economic changes impact companies. These include elasticity of demand, type of company and what it produces and barriers of entry to the industry. An example of how market changes can affect companies is the radical decline in oil prices and how the demand for oil has decreased for a number of factors, including lower economic growth rates, increased efficiency and new sources utilized due to hydraulic fracturing (new technologies). Emerging economies and economic growth trends in the future, along with technology advances, will have a big impact on the future trends in global energy demand. (UNEP FI & WRI 2015, 19)

**Reputational risks**

Reputational risks involve financial or non-financial damage to a company's reputation. Damages can occur on brand value, additional costs or loss in revenue. Reputational risk is associated with public concerns or criticism in regard to the nature of a company's operations and their impacts. Investors have partially decided to divest from carbon-intensive companies on ethical grounds, due to concerns regarding climate change. Investors may also face reputational risks themselves if they invest in carbon-intensive companies, projects or other operations. Reputational risks can occur all of a sudden, in comparison to other risk factors formerly mentioned. Market and economic changes can also occur suddenly but most often they require a longer timeframe, whereas reputational damage can occur abruptly due to vast communication networks. (UNEP FI & WRI 2015, 19-20)

In addition to the aforementioned risks, carbon leakage can also be considered a risk. Carbon leakage is defined as companies moving their production or other operations to jurisdictions where emissions are not as heavily priced (to reduce costs), thus increasing emissions in the destination. Carbon leakage has nonetheless not been found significant as it only seems to affect sectors that are intensive in both emitting emissions and also trade. The risk is mitigated as jurisdictions increasingly take on initiatives to place a price on carbon. International cooperation is key in avoiding carbon leakage. (World Bank Group & Ecofys 2015, 14)

Certain companies have taken initiative to set more ambitious targets than what current policies demand of them. Other companies lag behind and thus may face larger risk regarding costs in the future. Lagging companies may face increased costs of compliance from carbon tax, fines and more expensive capital expenditure. (Sayani, Nishikawa & Shakdwipee 2015, 5)

### 2.1.3 Emissions by scope

In order to assess the risks and costs related to emissions, identifying and categorizing these emissions regarding company operations is essential. The GHG emissions companies emit are divided into direct and indirect emissions and further into scopes. Three categories of scopes are identified, of which scopes 1 and 2 are examined in this thesis. Scopes are defined to help make distinctions between direct and indirect emissions, to improve transparency and to set goals. These scopes are utilized in accounting and reporting emissions. (The Greenhouse Gas Protocol 2004, 24-25)

Scope 1 emissions consist of direct emissions, i.e. emissions from sources the company controls or owns. Scope 1 does not take into account GHG emissions that are not included in the Kyoto Protocol. Scope 1 emissions include for example the burning of fossil fuels on-site, mobile combustion of fossil fuels by company owned or controlled vehicles and so called fugitive emissions. Fugitive emissions are unintentional or intentional releases of GHGs, such as leakage of HFCs (hydrofluorocarbons) from air conditioning equipment and also the release of $CH_4$ (methane) from company-owned farm animals. (The Greenhouse Gas Protocol 2004, 25-27; MSCI 2014, 2)

Scope 2 emissions are indirect emissions. More precisely stated, scope 2 includes emissions from the generation of purchased electricity, heat or steam that a company consumes. Because purchased electricity often represents one of the largest sources of emissions for certain companies, it is also an area which presents the company with a significant opportunity to decrease its emissions. (The Greenhouse Gas Protocol 2004, 25-27) Scope 3 emissions comprise of all other indirect GHG emissions. These other emissions are still a consequence of the company's activities but they originate from sources that are not controlled or owned by the company itself. These include emissions deriving from waste disposal, outsourced activities and commuting, to name a few. According to GHG Accounting and Reporting Principles, Scope 3 is not an obligatory reporting category for companies, unlike Scope 1 and 2. Figure 3 illustrates the relationship between the three scopes within a company's value chain. (The Greenhouse Gas Protocol 2004, 25-27) Scope 3 emissions can represent the largest source of GHG emissions for companies heavily involved in outsourcing activities.

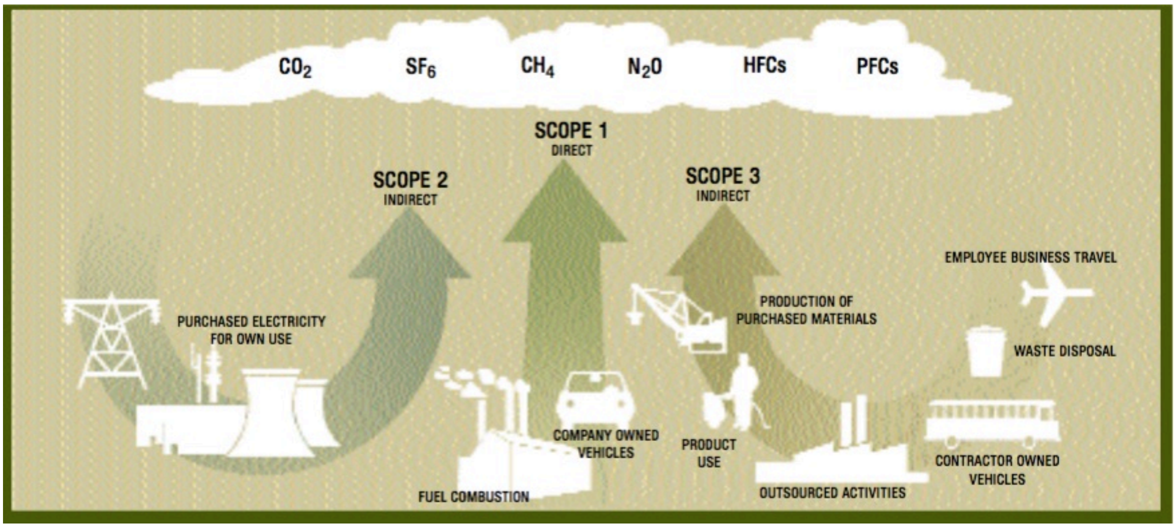


Figure 3. Scopes (The Greenhouse Gas Protocol 2004, 26)

### *2.2 Carbon pricing*

Carbon pricing is a general concept for pricing the largest GHGs. The EU ETS for example includes nitrous oxide ($N_2O$) and perfluorocarbons (PFCs) in addition to carbon dioxide ($CO_2$). (The European Commission 2015a) The term carbon price is widely used as $CO_2$ makes up the largest proportion of carbon-based energy.

Carbon pricing acts as a way to mitigate emissions and is also a source of revenue for the government (World Bank Group & Ecofys 2015, 17). There are currently three main mechanisms for pricing carbon: emissions trading, taxing $CO_2$ emissions and internal carbon pricing. This thesis examines mechanisms that place a direct price on carbon. Mechanisms that indirectly place a price on carbon (e.g. energy taxation or the increase in renewable energy) are not reviewed. Taxation and trading mechanisms both have good and bad qualities, and the benefits gained from these regulations depend on situational and market factors. Taxation sets a price on emissions while emissions trading sets a limit on the amount of emissions, in addition to issuing a price variable. Hybrid models combining taxation and emissions trading have also been examined, but they are difficult to implement and would not stand without challenges either.

Carbon taxes and cap-and-trade programs do not need to compete with one another, but could rather be seen as mechanisms that could well complement one another. These mechanisms ought to be used according to situational factors and what is deemed politically and economically efficient at that time and place. Additional ways to carbon pricing (e.g. utilization of renewable energy) are nonetheless also needed to decrease emissions. (World Bank Group & Ecofys 2015, 27; Taschini, Dietz & Hicks 2013)

A global price would be preferred on $CO_2$ emissions. Companies, multinationals and investors wish for a uniform price so that they could better plan their operations related to $CO_2$ emissions. Depending on the region and policies utilized, many countries already have a price put on $CO_2$ emissions. The EU has an emissions trading scheme (EU ETS) and many other countries are looking to follow suit. In the countries where pricing mechanisms have been implemented, an increase in these prices is anticipated. The EU ETS for example has given away allowances for free, whereas the main method of emissions allocation from the year 2013 onwards has been auctioning. The EU legislation has set a goal of completely moving away from free allocation by 2027. This way the polluter pays for its emissions and transparency thrives. The higher the market price for emissions allowances is, the more it also creates incentive to invest in new and cleaner technologies to reduce emissions. (The European Commission 2013, 3-5) If there is no price set on emissions, companies do not have an incentive to lower their emissions. It has been argued that the price must increase significantly from its current level in order to create a sufficient incentive for all polluters. According to Lee, Min and Yook (2015, 10), investing in clean technologies as well as research and development can result in positive financial outcomes as well as reduce emissions.

Abadie and Chamorro (2008, 2993-2994) conducted a research where they found that a fluctuating carbon price negatively affects the investment decisions of companies to reduce their emissions. An investment example for reducing emissions can be a carbon capture and storage unit. When the carbon price fluctuates and is unpredictable, companies cannot make justified investment decisions for carbon abatement as they cannot accurately calculate whether the investment will be worthwhile. If the carbon price were to collapse in the future after a company has made a significant investment to reduce its emissions, the investment would not be profitable in the end. In this case it would be more beneficial to continue emitting and paying for allowances. The value of allowances must be weighed with the value of investments.

Systems for pricing carbon are being developed all over the world. In 2014, approximately forty different systems were either operated or are still under development. (World Bank Group & Ecofys 2015, 10) As stated by Carbon Trust (2008, 8), all sectors should be included in carbon pricing. This is the only way to succeed in the implementation of a low carbon economy.

### 2.2.1 Emissions trading

Due to the research focus on European companies and also because the EU ETS is the largest established cap-and-trade program, emissions trading will mostly be reviewed through the EU ETS.

The EU ETS started in 2005 to fight climate change and to reach EU’s climate policy: reducing GHG emissions by 20% by 2020, when compared to 1990 levels. The EU ETS was established on the basis of the Kyoto Protocol and its focus is on high-emitting industry sectors and emissions that can be addressed meticulously. (The European Commission 2013, 3; The European Commission 2015a) The EU ETS thus does not cover all sectors. The industries that are more or less covered are energy, metals and minerals (their production and processing), as well as pulp and paper (Oberndorfer & Rennings 2007, 2). The EU ETS is the first and also the largest international system for trading emission allowances. The EU ETS does not cover all the emissions within the European Union but almost half (45%) of them. All together over 11,000 power stations and industrial plants are covered by the EU ETS in 31 countries (the 28 EU countries and the three EEA-EFTA states Norway, Iceland and Liechtenstein). The scheme also includes the aviation sector. Companies operating in the sectors included in the EU ETS do not have a choice but to participate in the system (unless considered small enough to be excluded). (The European Commission 2015a)

The EU ETS works as a cap-and-trade system. A limit (the cap) is set on the total amount of emissions that can be nationally emitted, after which the governments divide and allocate the cap between companies participating in the scheme, in the form of allowances or permits. (Chan, Li & Zhang 2013, 1056; The European Commission 2015a) Over time, the limit is then lowered to cut back on emissions. The European Commission proposes that the emissions from the sectors covered by the EU ETS will be 21% lower in 2020 than they were in 2005. By 2030 the proposed amount is 43% lower. (The European Commission 2015a) This system has been seen as the most cost-efficient way for companies to reduce their emissions. (The European Commission 2013, 1-2) This is because with the method introduced by the ETS, companies can choose for themselves, which alternative suits them the best and also costs the least to reduce emissions. These alternatives are (1) acquiring and buying allowances in order to cover emissions, or (2) investing in new technologies to reduce emissions. (Oberndorfer & Rennings 2007)

Companies receive or buy emission allowances within the set cap. These allowances can be traded between companies, or then companies can keep spare allowances for the next year. Companies must submit enough allowances to cover their emissions each year, otherwise they will be fined. (The European Commission 2015a)

Some companies in energy-intensive industries anticipated a loss in competitiveness due to the ETS and criticized the scheme because of this. The loss in competitiveness was anticipated due to increasing electricity prices, among others. This view has been challenged by the notion that energy costs are considered a small portion of a company's costs (even in energy-intensive companies) when compared to for example labor costs. Also the PH is against this, as has previously been mentioned. Costs derived from inaction (external costs of climate change) should also be kept in mind. (Oberndorfer & Rennings 2007, 2) In the short run, three factors have been identified to have an impact on the competitiveness of a company; its (1) ability to pass cost increases on to customers, (2) energy intensity and (3) possibility to reduce carbon emissions. These factors were identified by the Carbon Trust (2004, 6). (Oberndorfer & Rennings 2007, 3) Cost pass-through issues are further discussed in section 2.3.3.

Within a certain limit, companies can also buy allowance credits from specific approved projects that aim to reduce emissions around the world (e.g. the Kyoto Protocol’s Clean Development Mechanism or Joint Implementation mechanism). The Commission proposes that by enabling the purchasing of credits from these projects, the ETS also acts as a big impact on investments in low-carbon solutions as well as clean technology in developing countries. (The European Commission 2013, 2-5)

The EU ETS was primarily divided into three phases. The first phase covered years 2005-2008, acting as the trial-period, before the actual implementation of the EU ETS in the second phase. The second phase ran through years 2008-2012. In the first phase, nearly all allowances were allocated for free. The allocated allowances exceeded demand, due to the lack of sufficient data, which led to over-allocation. (The European Commission 2015b) The first phase gathered a lot of criticism from the scientific community due to its "lack of environmental effectiveness and economic efficiency" (Oberndorfer & Rennings 2007, 2). The cap was tightened by the European Commission in the second phase by cutting the volume of total emissions allowances. (The European Commission 2015b) As the ETS is built on a market-based pricing system, the price of allowances is naturally set according to supply and demand (The European Commission 2013, 6). There have been problems (and also continue to be problems) with the prices due to over-allocations and surplus of allowances and the financial crisis in 2008, to name a few. (The European Commission 2015b)

Phase 3 (covering years 2013 to 2020) differs from the first two phases. Perhaps the most important changes that have been implemented are that (1) national caps no longer exist, but rather a Europe-wide cap has been set, (2) auctioning became the prevailing way for allocating allowances instead of free allocation, (3) and some new sectors as well as gases have been added to the system. (The European Commission 2015a) The goal set by the EU legislation is to get rid of free allocation of allowances completely by 2027 (The European Commission 2013, 3). The European Commission has presented a revision for a phase 4, the period after 2020. Phase 4 will take place between years 2021 to 2030. (The European Commission 2015c)

Because allowances have mainly been allocated for free until phase 3, some companies have been able to profit from this. When companies are given free allowances more than they will eventually need, they can sell their spare allowances and thus profit from the emissions trading. These profits are referred to as windfall profits. (Oberndorfer & Rennings 2007, 4) Many companies benefited especially from phase 1 due to the free allowances, as they were able to pass through some of the (opportunity) costs to raise the prices of goods, resulting in increased revenue (Bushnell et al. 2013, 80). However, because of the risk of carbon leakage, it has been argued that ETS programs cannot completely discard the option of allocating some of the allowances for free also in the future. China and the Republic of Korea have decided to continue allocations at least partly due to this problem. (World Bank Group & Ecofys 2015, 29) Nonetheless, even though allowances are allocated according to the amount of emissions companies emit, several studies have come to the conclusion that this probably results in overcompensation. Bushnell et al. (2013, 79) state that these studies have found that already a less than 20% compensation of emissions offsets the impacts that regulations have on profitability. This is applicable for most industries, but not necessarily all. These studies have been conducted by Bovenberg and Goulder (2000), Goulder, Hafstead, and Dworsky (2010), Burtraw and Palmer (2008) and Smale et al. (2006). According to Kirat & Ahamada (2011, 995), the energy sector, especially the electricity-generation sector, is the largest emitter of $CO_2$. In phases 1 and 2, the energy sector also received most of the allocated allowances.

Although the EU has the largest emissions trading scheme, it is not the only one. Countries outside the EU have adopted similar models or are planning to. These other emissions trading systems have mainly been inspired by the EU ETS. The aim is to eventually combine different ETS programs in order to create an extended international carbon market. (The European Commission 2015a) In addition to Europe, for example Australia, New Zealand, Japan, The United States and Switzerland also have similar systems. China, Canada and South Korea are planning on implementing, and partly also started implementing, similar programs. (The European Commission 2013, 5) There are numerous benefits that are expected from an extended carbon market. These benefits include a more stable carbon price, reduction of the cost of cutting emissions, market liquidity increase and improving cooperation on climate change on a global level. (The European Commission 2013, 5) There is some evidence of singular cap-and-trade programs linking up, as for example the California and Québec programs did in January 2014. Since 2014, both programs have widened their scope and the coverage of emissions in Québec and California has increased to 85%. (World Bank Group & Ecofys 2015, 40)

Some companies have been afraid of the costs that reducing emissions will bring upon them. These costs are related to either investing in new technologies or then buying emission allowances. According to Oberndorfer and Rennings (2007), these fears that corporations have are relatively unnecessary. In their study they use costs (reduction and increase) as a sign for competitiveness as the costs propose a part of productivity as well. They state that according to the business-as-usual scenario, the EU ETS has not significantly affected the competitiveness of companies. Oberndorfer and Rennings do criticize the EU ETS of not being efficient enough and hope that more sectors would be able to be included. Then again, without any emissions trading, countries would have dramatically increased costs from trying to reach their mandatory emissions reduction targets set by the Kyoto agreement and the EU ETS can even improve the competitiveness of companies when compared to other regulation methods. (Oberndorfer & Rennings 2007) The EU ETS has made progress since, with more sectors and GHG emissions included in the system.

The main idea behind the EU ETS is to reduce $CO_2$ emissions. This requires innovations and hence incentives for companies to innovate. As long as the price on $CO_2$ emissions is low, there is not enough incentive to invest in innovating. The EU ETS has the opportunity to create these incentives. The European Commission's DG Environment, McKinsey and Ecofys (2005) conducted a survey on companies, through which they found that the EU ETS had had a strong or at least medium influence on the companies' decisions on innovations. This was already in phase 2. (Oberndorfer & Rennings 2007, 5)

### 2.2.2 Carbon tax

Carbon taxation is the second most utilized mechanism for pricing carbon. In addition to cap-and-trade systems, carbon tax is another, yet different, market-based mechanism for pricing carbon. (Maydybura & Andrew 2011, 124) Carbon taxes are also referred to as price-based policy instruments (Chiu, Kuo, Chen & Hsu 2015, 164). Carbon tax provides incentive to reduce emissions, when paying a tax is more expensive than reduction. The tax is imposed on the units of GHG emissions (or carbon content of fossil fuels), and thus the amount of reduced emissions depends on the level of the tax. It is essential that the tax is set on just the right level; the level cannot be too high, otherwise costs are higher than what is necessary to reduce emissions and this will negatively impact the society. On the other hand, if the tax is low there is no incentive to reduce emissions. This is because the tax is set according to assessments on how much the damage caused by emissions would cost, and also how much controlling the emissions costs. (Taschini, Dietz & Hicks 2013) There is evidence that when the price of a pollutant is directly increased by taxation, it reduces demand for it. (Maydybura & Andrew 2011, 124) The main difference between cap-and-trade systems and a carbon tax is that the price is predefined with a carbon tax, but the outcome of emissions reduction is not, as it is with cap-and-trade systems (The World Bank 2016).

A carbon tax is slightly easier to implement than a cap-and-trade program. New taxes can build on existing taxation systems, whereas a cap-and-trade program needs to introduce a new commodity, the allocation of allowances and also a market for trading allowances. A carbon tax can be incorporated into an existing system by for example expanding the energy taxation policy. A carbon tax may be used as a first step before introducing an ETS, or then together with an ETS. (World Bank Group & Ecofys 2015,

28) In the case of a tax perceived as too low over a certain time period, it can be compensated in future taxation by slightly increasing future taxes. Taxes may also be seen as more transparent in comparison to emissions trading for example. (Cramton & Kerr 2002, 333-334)

The advantages of a carbon tax in relation to emissions trading is a more stable carbon price as emissions trading sets a limit on the amount of emissions, not on the price. A carbon tax also produces incentive to use alternative (cleaner) energy sources when a cheaper fuel becomes more expensive. A carbon tax would nonetheless have differing impacts between countries as market structures as well as energy technologies vary somewhat between jurisdictions. (Chiu et al. 2015, 165)

### 2.2.3 Internal carbon pricing

The third carbon pricing mechanism reviewed in this report is the internal carbon price (or corporate carbon price) utilized by increasingly many companies. Internal carbon pricing is not a market-based mechanism, but rather a proactive step taken by companies independently. It is often used in jurisdictions where compulsory carbon pricing mechanisms are not yet implemented. However, internal carbon prices may be driven by market prices from other jurisdictions, predictions based on the company's own calculations or analysts and experts from the outside, or even resent events. The internal price may also be utilized in jurisdictions that already have a working carbon pricing instrument: usually when this is the case, companies want to be prepared in the case the carbon price significantly increases. (World Bank Group & Ecofys 2015, 48)

Companies use carbon pricing as a tool to analyze overall business and investment strategies. Internally used prices are often considerably higher than prices set by compulsory carbon pricing instruments. These internal prices may help companies establish their support for actual carbon pricing policies and entice governments to act on the issue. Governments can learn from the experiences of companies and lessons learned regarding internal carbon pricing, when designing a mechanism for carbon pricing. (World Bank Group & Ecofys 2015, 14; 48)

Some companies have set their own price on carbon to cut down on emissions, or to enable analysis on the effect a current or growing carbon price could have on their operations. It is set in order to estimate risk: risk that is related to carbon pricing in particular. These companies have started using internal carbon prices in their planning and projections. This measure is taken to meet possible future governmental regulations and to identify opportunities in regard to cost savings and revenue stemming from low-carbon investments. (World Bank Group & Ecofys 2015, 14; CDP 2015, 2-4)

The Carbon Disclosure Project (CDP) conducted a report stating that more than 1000 companies are putting a price on their carbon emissions (either currently or intending to within the next few years). Companies do this in order to meet risks regarding climate change. Companies are introducing internal carbon pricing to their operations in growing numbers. The idea behind internal pricing is to balance the risks and costs related to emissions and also finance the needed transition to obtaining low-carbon energy. (CDP 2015, 2-4) As internal carbon pricing is done voluntarily, there are no rules on how to implement it. Because of this, there is a myriad of ways to implement an internal carbon price. Some companies may set the price at a certain level just to see how it would affect the company but not actually transferring money in any way, while others might use it to direct costs regarding emissions offsetting to business units. (World Bank Group & Ecofys 2015, 48)

Even though corporate carbon pricing is becoming increasingly widespread, not all companies are interested in the concept. These companies most often operate in industries that are not energy-intensive or regulated and thus they do not see carbon pricing as sensible or necessary for their company or industry. The other reason might be that the company has not distinguished a clear system for creating an internal carbon pricing program. (World Bank Group & Ecofys 2015, 50)

When companies manage to successfully implement a corporate carbon pricing program, it is usually done in a simplistic manner. The successful carbon prices are constructed from the company's perspective, looking at investment needs, outlooks and market interests. Table 2 provides a summary on the most common benefits and challenges of carbon pricing within companies. According to the World Bank Group and Ecofys (2015, 50), companies utilizing an internal price do at least one of the following:

1. Consider carbon pricing in an equal manner to any other financial risk, market opportunity or cost
2. Found a moderate carbon price in order to create internal awareness, incentives and funds to support the reduction of emissions
3. Generate internal knowledge and expertise on the issue and find influential channels to share their opinions

Table 2. Most common benefits and challenges of carbon pricing (World Bank Group & Ecofys 2015, 50)

| | Most common benefits of carbon pricing | Most common challenges of carbon pricing |
|---|---|---|
| **1** | Helps translate carbon into business-relevant terms and engage internally | Lack of common method or guidance to set a carbon price |
| **2** | Increases support and investment for energy efficiency projects | Lack of clarity and long-term certainty in countries' climate policies |
| **3** | Helps company achieve ambitious GHG reduction targets | Prices (internally or externally) too low to shift investment decisions |

In 2015, 436 companies announced that they are using an internal carbon price, and many more reported intentions of starting to use one. The corporations have reported a number of different drivers for this, including risk mitigation in relation to possible future regulations, to encourage investments regarding clean technologies and to improve efficiency. According to CDP, these are clear signs that companies are starting to take and are already taking climate change factors into consideration in everyday decision-making. (CDP 2015, 4; Gunther 2013)

The study by CDP shows data on internal carbon prices by sector. These prices that corporations use, vary from 0,95 USD (0,85 EUR) to 357,37 USD (318,06 EUR) per metric ton. According to the data, highest prices are formed within the utilities, materials, consumer discretionary, energy, and somewhat the industrials sector. These industries have their emphasis on prices over 20 USD (approximately 17,80 EUR), ranging to well over 50 USD (44,5 EUR), 80 USD (71 EUR), 100 USD (89 EUR) and even 300 USD (267 EUR). Sectors using mostly lower prices (although these sectors consist of average prices around 20 USD as well) are financials, consumer staples, health care, and information technology. There is a lot of variety among the prices used internally within sectors and even within companies. According to the graphs, one company can have ranging prices within or then use two separate prices. Prices within a company can vary due to for example global operations and types of projects. (CDP 2015, 6-10; Gunther 2013) Many of the prices utilized internally circle around 8 USD (7,12 EUR) to 9 USD (8 EUR), which also reflects the market price. (CDP 2015, 50-66) In 2015, the market price for $CO_2$ was approximately €8/t$CO_2$. (The European Energy Exchange 2016). In Europe, however, the internally used market prices are higher, approximately 20-40 USD (17,80-36 EUR) roughly. North American companies have also set higher prices, but not as high as Europe respectively. (CDP 2015, 50-66)

### 2.2.4 Carbon price fluctuations

Carbon emissions can be considered a new group of traded financial assets (Sadorsky 2012, 99). There is significant variation among carbon prices as they range from less than €1/t$CO_2$ to over €300/t$CO_2$. (CDP 2015) According to the World Bank Group and Ecofys (2015, 24), 99% of emissions are priced below 30 USD/t$CO_2$e (€26/t$CO_2$) and 85% priced below 10 USD/t$CO_2$e (€9/t$CO_2$). According to the same study, a global average on the price of carbon in 2030 should be approximately between 80 USD/t$CO_2$e (€71/t$CO_2$) and 130 USD/t$CO_2$e (€115/t$CO_2$), in order for the two-degree climate goal to be possible. (Currency conversion factor 0,89 EUR, 2015)

The carbon price has changed considerably over the time from when it was first established. It is natural that in the EU ETS the price fluctuates as much as it does. Especially during the first phase, prices were volatile in the EU market. For a part of the first period, prices were high (over €30/t$CO_2$), but then near the end, prices fell to near zero. Prices fell because the surplus situation of allowances was recognized and because allowances were not storable for later use beyond 2007. Information on prices and the underlying value of carbon permits is difficult to come by, as is normal under imperfect competition. (Maydybura & Andrew 2011, 123; Bushnell et al. 2013, 79-81) It is assumed that carbon prices fell due to delays in the international negotiations related to climate change (MSCI 2013).

Structural flaws have been seen to affect the prices. This happened in phase 1 in 2006 for example, when allowances were over-allocated (there were more allowances than actual emissions) and European Union Allowances (EUA) prices collapsed. In phase 1 the price rose to €30/t$CO_2$, but then fell below €10/t$CO_2$. In phase 2 the price altered between €8-€30/t$CO_2$. Dividing the ETS into phases has gathered criticism due to the creation of uncertainty regarding the market for trading allowances. (Maydybura & Andrew 2011, 123 & 126-127; Kirat & Ahamada 2011, 995)

In 2014, the price of allowances increased slightly, from less than €5/t$CO_2$ to almost €7/t$CO_2$ in the EU ETS, the average price of that year being €6/t$CO_2$. In December 2015, the carbon price was approximately €8/t$CO_2$ and had stayed relatively fixed since August 2015. (World Bank Group & Ecofys 2015, 44) After the agreement was signed in Paris (COP21), the price of carbon fell on the EU ETS. This was not the intent of the COP21. What is noteworthy is that the agreements of the COP21 mainly concern the period after 2020, while the EU ETS works in the short time. During the first quarter of 2016 the carbon price has settled to approximately €5/t$CO_2$ (EEX 2016; ICE 2016a) According to Carbon Trust (2008, 4), it is likely that the carbon price will be approximately €20-€40/t$CO_2$ by 2020.

For investments in emissions reductions to be profitable, it has been stated that the carbon price must be higher. In the study conducted by Abadie and Chamorro (2008, 3012) this was researched and they concluded that for investments (for reducing emissions) to be of value, the $CO_2$ price would need to be close to €55/t$CO_2$. The estimated price varies depending on the method of calculation: with a net present value estimation the price is significantly lower, €13,95/t$CO_2$ - although here the carbon price itself is not taken into consideration. The higher price of €55/t$CO_2$ is related to the volatility of carbon pricing. If the price did not fluctuate as much, the required price would be lower, €32/t$CO_2$, and planting investment decisions would also be easier. These figures are not generalizable, but it does give an understanding on how much higher the price for carbon should be and what a significant impact the variation in price has. For this to happen, climate policies must be tighter – and given the decisions made in COP21, this will take place.

In addition to the EUAs, other environmental products have been developed. These include Certified Emissions Reductions (CERs), White Certificates (energy efficiency credits) and Renewable Energy Certificates. Markets have also developed regarding these products. (Maydybura & Andrew 2011, 123)

Demand and supply of allowances determine the price within the short term, but it is necessary to also understand what affects prices in the medium term. Futures offered by the market may be used for hedging against increases in the price or as speculative instruments by sellers and buyers. (Maydybura & Andrew 2011, 124) The price of allowances is set by the marginal cost of reducing emissions, i.e. the demand for allowances and the supply of permits given by the trading system. The price of energy for example is thus dependent on the price of allowances, carbon intensity of the marginal energy source and the elasticity of supply and demand. (Cramton & Kerr 2002, 334-335) The carbon market is under imperfect competition, as the number of sellers and buyers is limited, there are several platforms for trading where only one commodity is traded and adequate information on prices and the underlying value of carbon permits is not obtainable for either parties of the transaction. (Maydybura & Andrew 2011, 123)

Through gathered experience from differing pricing mechanisms, new instruments can be developed and older ones improved, according to reviewed progress. Carbon tax concentrates more on the actual pricing, whereas cap-and-trade programs are more reliable in reducing emissions because of the set caps. The price signal in ETS' derive from regulating emissions (more precisely the amount of allowances available) and economic cycles. A stable price would be positive to encourage low-carbon technologies and investments. Dynamic adjustments can nonetheless be made when necessary, in order to increase the degree of certainty in meeting environmental goals or to boost the price signal. Dynamic adjustments can be made through altering tax rates to level with the actual progress in emission reductions, or the supply of allowances can be adjusted to impact prices. (World Bank Group & Ecofys 2015, 27-28)

There are several platforms operating for trading contracts on emission allowances. The Intercontinental Exchange (ICE 2016a) and the European Energy Exchange (EEX 2016) are mostly reviewed in this research to find out the current carbon prices. (Maydybura & Andrew 2011, 130; Abadie & Chamorro 2008, 2996) Figure 4 shows the $CO_2$ price fluctuations according to the ICE and figure 5 illustrates the $CO_2$ price fluctuations according to the EEX. In addition, figure 6 illustrates the price fluctuations from the start of phase 3 in the EU ETS. The prices vary slightly between the platforms, but the trends are similar. Figures 4 and 5 both show a steep fall in the $CO_2$ price from the beginning of the year 2016, starting already in December 2015.

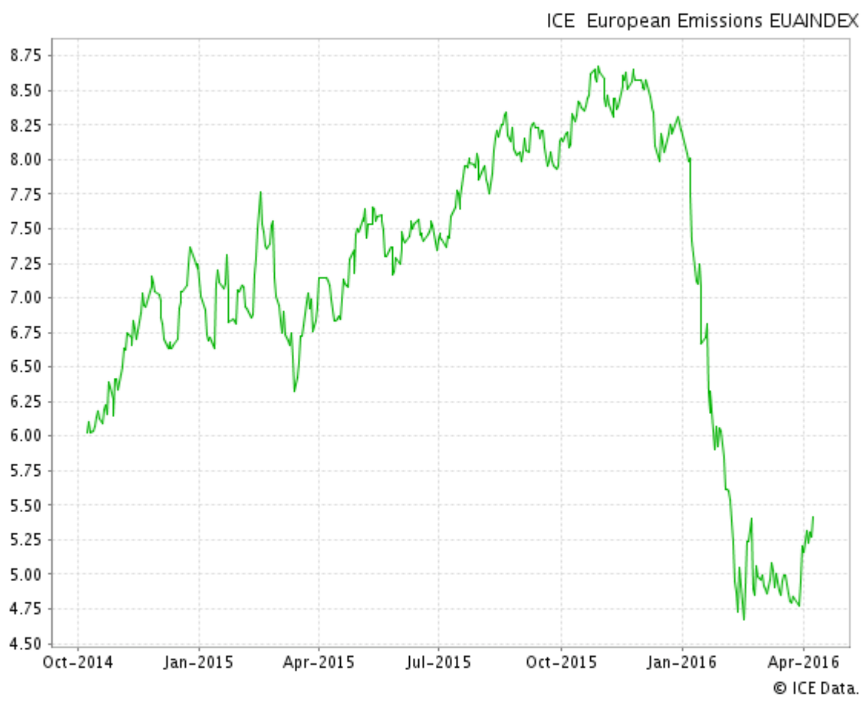



Figure 4. $CO_2$ price fluctuations from October 2014 to April 2016 in the ICE EUA Futures - Emissions Index (ICE 2016b)

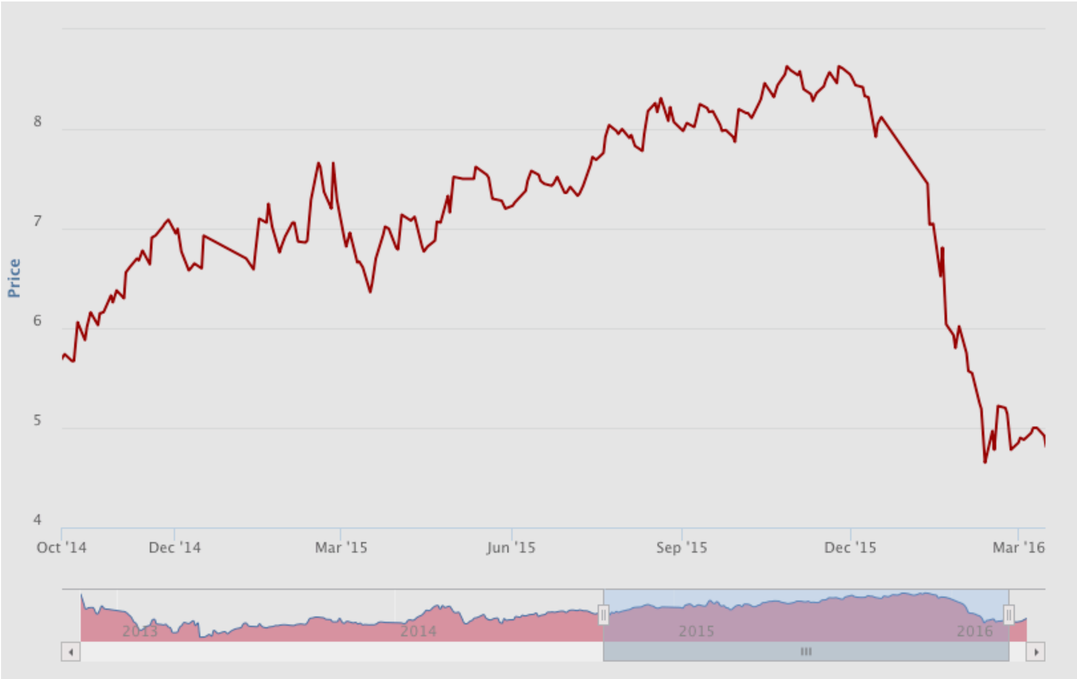



Figure 5. $CO_2$ price fluctuations from October 2014 to March 2016 in the EEX EU Emission Allowances / Primary Market Auction (EEX 2016)

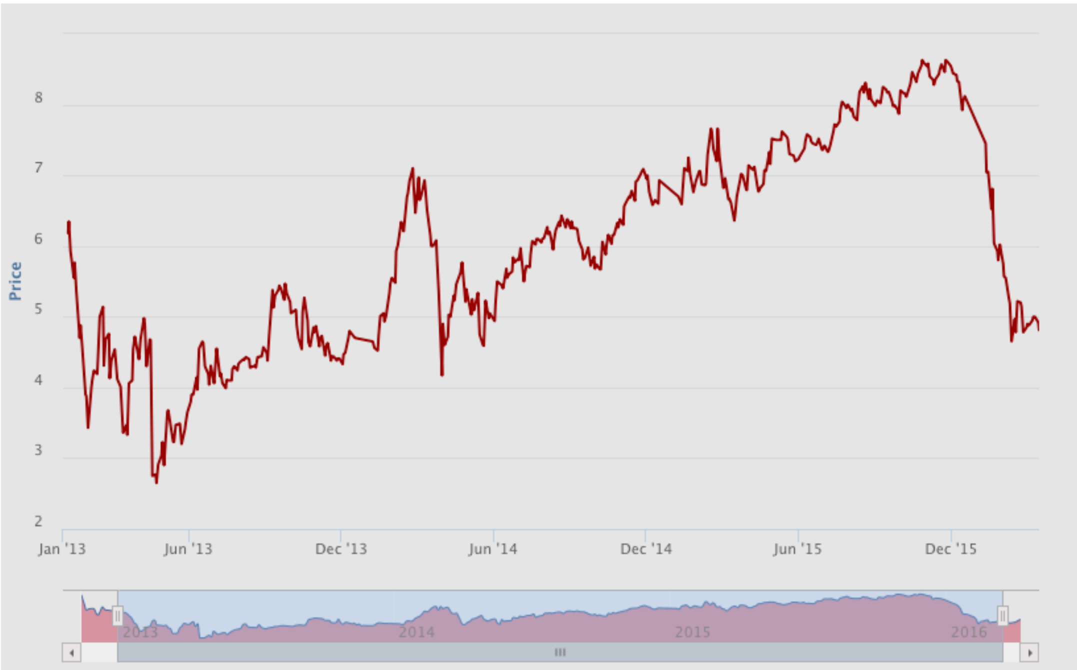



Figure 6. $CO_2$ price fluctuations from January 2013 to December 2015 in the EEX EU Emission Allowances / Primary Market Auction (EEX 2016)

In order to control extreme price fluctuations in cap-and-trade programs, it is possible to implement floor and ceiling prices. These price limits do not have to be steadfast but can be somewhat flexible. Price limits have been placed in California's cap-and-trade program. Also a reserve for allowances may be implemented, as has been done in the Republic of Korea. Having a predictable price on $CO_2$ emissions is important also in regard to low-carbon investments. When the price is predictable, the investment risk on low-carbon technologies can be minimized. Weakening in the price, as happened in the beginning of the EU ETS when there was a surplus on emissions allowances, should be avoided. The EU backloaded some of the allowances again in 2014 and implemented a market stability reserve (MSR), which is expected to be put into operation in 2019. (World Bank Group & Ecofys 2015, 29)

Due to the climate targets set in Paris (COP21), EU's roadmap to 2050 is in need of a reform. Europe has done well in reducing its emissions according to set targets, as 23% has already been reduced (compared to levels in 1990) years in advance – the initial target was set on 2020. EU's target of reducing emissions 40% by 2030 requires more ambition. (Charveriat 2015)

### *2.3 Costs and profitability*

In addition to growth, one of the main goals and prerequisites of any company is to be profitable in the long-term. Profitability provides the base for continuity as well as generating value. (Kinnunen, Laitinen, Laitinen, Leppiniemi & Puttonen 2007, 55) Competitiveness and profitability are often measured on firm-level, industry-level or economy-level (international competitiveness). Previous studies on emissions trading have mostly used the sector or industry level as their level of analysis. The economic performance is often analyzed through measures of productivity or sales for example. Oberndorfer and Rennings (2007, 3) used cost reductions and increases as the measure of competitiveness, and stated that generally speaking, cost increases can be seen as loss in productivity. Alternatively, one can also analyze changes in output to understand changes in economic performance. (Oberndorfer & Rennings 2007, 3) The issue of cost variation is highly relevant in this study.

Carbon pricing relates to company operations as additional costs. When companies are faced with increases in input costs, it can be said that they have three options to choose from: (1) reduce profit margins by absorbing the costs, (2) improve the efficiency of company operations and thus decrease costs, or (3) pass the costs through to customers (Laing, Sato, Grubb and Comberti 2013). This section of the study will theoretically review how increasing prices are transferred in the company, who pays for the additional costs and how it ultimately affects profitability. In consideration to the scope of the topic, these issues will not be assessed extensively, but rather in concentration to the most seminal parts.

### 2.3.1 Profitability factors

Companies continue to develop profitability aspects throughout the company's lifecycle. The starting point for profitability is that the return on investment is larger than what raising and using capital costs the company. (Alhola & Lauslahti 2002, 50-51, 71) There are various ways of calculating and determining the profitability of companies. This section will concentrate on the most essential ways concerning this study. This research will mainly concentrate on the profitability factors related to turnover, earnings before interests, taxes, depreciation and amortization (EBITDA) and costs.

Profitability can be assessed in terms of turnover or the balance sheet. In consideration of the scope and focus of this research, profitability is viewed in terms of turnover (sales). Profitability ratios related to the balance sheet, such as return on assets (ROA) or return on equity (ROE) are not inspected. This is because changes within the balance sheet regarding costs related to the carbon price are expected to be relatively small. The changes in turnover reflect the change in a company's prices and costs in a straightforward manner. Moreover, these changes happening in sales will eventually reflect as changes in the balance sheet and the aforementioned ratios. Inspecting changes related to turnover gives a more direct response to the issue at hand, as carbon costs derive directly from production and output volumes. Emission reserves that may be placed in the balance sheet of companies is left out of inspection in this research. This is the main reason why the balance sheet aspect is not reviewed.

Profitability can be defined as either absolute or relative profitability. Absolute profitability can be stated as the difference between revenue and cost (monetary value), and relative profitability can be calculated as the aforementioned difference in relation to for example capital invested (percentage). In the most simplistic manner, profitability is equal to reducing costs from revenue. Profitability is however not an unequivocal concept, as a lot of information is needed on for example capital and how it has been constructed. However, the basic components of profitability are returns and costs. (Alhola & Lauslahti 2002, 50-51)

There are various ways to increase the profitability of a company. The effectiveness of these ways varies drastically between companies and operations, but according to Alhola and Lauslahti (2002, 72-73) some ways to improve profitability are increasing sales, changing the product range, cutting costs, raising prices and/or more efficient use of capital.

In order to be able to analyze profitability aspects of companies, terms related to the income statement need to be specified within the scope of this topic. As stated, mainly factors related to costs, turnover and EBITDA are considered.

There are four levels of profit (margins) in the income statement: gross profit, operating profit, pretax profit and net profit (margin). (Alhola & Lauslahti 2002, 137; Investopedia 2016a) Often the term profit margin simply refers to the net profit margin, but this is not the case in this research. This thesis will focus on EBITDA. There is no legal requirement for companies to disclose their EBITDA. In order to get the EBITDA, the operating profit i.e. earnings before interest and tax (EBIT) is reviewed and depreciation and amortization added to it. The official, published income statements' first interim result is the EBIT. This number indicates how much profit from the actual business operations is left before interest and taxes. The gross profit ratio cannot directly be used to compare companies in different industries. It is however a good tool to measure the cost of production, view the development of a company or to compare companies within the same industry. The EBITDA ratio is a better tool to compare companies between different industries than the gross profit ratio. The net profit margin measures the overall profitability of a business. (Alhola & Lauslahti 2002, 137-140)

Turnover is then inspected, because it is directly affected by the change in pricing. This thesis uses the terms turnover, sales and revenue interchangeably. Revenue is the financial compensation a company receives from selling its goods. When adjustments to these sales is subtracted, e.g. discounts and VAT, the turnover of a company is available. In a simplistic manner, turnover is the volume of outputs times the unit price of the goods. Turnover is a good indicator of the size and scale of a company. (Alhola & Lauslahti 2002, 52)

Margins can be viewed as absolute numbers or as relative numbers to turnover, giving a percentage. Profit margin analysis (or profitability indicator analysis) is conducted as a percentage calculation to provide the opportunity to compare companies with each other and industry benchmarks. The profit margin is calculated by dividing profit (where it any of the four aforementioned profits) with turnover. (Alhola & Lauslahti 2002, 138-139) Numbers alone are a poor indicator of profitability and thus getting a percentage with the turnover denominator helps to track the company's ability to manage costs and create profits. When for example sales grow, it does not make the company more profitable if costs also continue to increase. The percentage tells us how much profit is made with each monetary sale. The EBITDA to sales ratio (EBITDA margin) is a good indicator for what the profitability of a company looks like after operating expenses. (Investopedia 2016b) The EBITDA margin is presented in equation 1.

$$EBITDA\ Margin = \frac{EBITDA}{Sales}$$

Equation 1. The EBITDA to sales ratio

If the focus would be on estimating profitability in relation to the balance sheet, profitability ratios would be utilized to measure the ability of a given company to generate revenue or profit by using its resources and the amount of costs it induces. ROA is often compared to income (net or operating), in order to see the rate of return. ROA tells how effectively business assets are used to generate profit. The greater ROA is, the more profitable the company usually is. (Alhola & Lauslahti 2002, 112) ROA is calculated by dividing the net income by total assets. ROA can also be calculated in relation to turnover. (Kinnunen et al. 2007, 59). When comparing the ROA between companies, these companies must have similar businesses and product lines; otherwise making comparisons is not compatible. Solely being in the same industry is not enough. Return on investment (ROI) and ROE are also some of the most common ratios. ROI measures how much profit is made with capital invested and ROE calculates profitability from the shareholders' equity perspective. (Alhola & Lauslahti 2002, 140)

Carbon risk was reviewed in earlier sections and how it can arise from emerging regulations on carbon emissions. Costs stemming from operational and regulatory actions can decrease the profitability of companies and also increase reputational risks, in addition to other risks, depending on the situation. (UNEP 2013, 21) As Bushnell et al. (2013, 91) state, the profitability drivers related to emissions trading include the extent of cost exposure to the market where emissions are traded, according to the relation of how much the company emits GHGs and how much it holds allowances. In addition, revenue effects are potential, depending on cost impacts regarding competitors within the industry. As the EU ETS affects both fixed and variable costs, this research does not specify fixed and variable costs separately (Smale et al. 2006, 35).

In Abadie & Chamorro (2008, 2993), according to Sijm et al. (2006, 52) and Böhringer, Hoffmann, Lange, Löschel & Moslener (2005) the purpose of free allocations at the beginning of the EU ETS, was to ensure the political support of large emitters. Allowances were thus allocated for free in order not to reduce the profitability of companies. Companies have gained profits due to the free allocations and increases in electricity prices. In some cases, a certain degree of grandfathering is justified, but this highly depends on the carbon intensity of firms and price elasticity, resulting in whether the emissions trading induced carbon price is less or more than the price of electricity. Windfall profits may have varied between €5.3-€7.7 billion at a carbon price of €20/t$CO_2$, depending on the scenario and different factors (Sijm et al. 2006, 53). Allocating allowances in order not to interfere with the profitability of companies is controversial in the sense that the ETS was established to reduce emissions, not to make corporations satisfied. The EU ETS aims to be the most cost-effective way for companies to reduce emissions and this is right-minded, but its most important mission is to reduce emissions. If the transition is made too convenient for companies, they are not under the same strain to cut back than they are when they face real risk in the case that they do nothing.

### 2.3.2 Competitiveness vs. profitability

The focus of this thesis rests on profitability. Previous research on how $CO_2$ pricing affects companies, has mostly focused on how it might affect the competitiveness of companies. Competitiveness and profitability have many similar attributes and are closely related; nonetheless, they are different concepts. Competitiveness measures the ability of a company to compete in a market with its competitors and how its operations measure up in comparison. Concerns over how carbon pricing affects competitiveness derives from the way carbon pricing differs over markets and thus affects the way competitors are impacted. In terms of how the EU ETS has impacted companies, we can see how these two concepts are often opposites, as higher prices generate profits from free allowance allocations, but also attract imports. Sectors that receive free allocations can profit in the short term by passing carbon costs through to consumers. Nonetheless, the more product prices rise due to cost pass-through, the more market share is at risk to be lost to foreign competition. (Carbon Trust 2008, 5) Smale, Hartley, Hepburn, Ward & Grubb (2006) also expressed that most companies have profited from cost pass-through due to free allowances.

Carbon prices, or the future expectations of what carbon prices will become, differ between jurisdictions. This may create unequal barriers or reliefs for companies between jurisdictions. The unilateral approach of the EU ETS for example has posed such concerns (Chan, Li & Zhang 2013, 1057). As has been previously stated, this may also result in carbon or emissions leakage. In a simplified situation where all else stays constant and one company faces an additional cost that competitors in another jurisdiction do not face, the company with additional costs may be confronted with a loss in market share or a reduction in their profit margin, or both. Emissions leakage may then occur as a result, when companies move their production to jurisdictions where emissions are not as highly priced. (World Bank Group & Ecofys 2015, 10, 52)

The situation is, however, not as simple as the previous example. Carbon pricing does add to the costs of companies, but this does not necessarily affect competitiveness factors as companies do not compete solely based on costs. Often increases in labour or energy costs actually happen somewhat simultaneously with increased productivity and profits. This is a sum of many factors, but with industries involved in producing homogenous products and where differentiation is difficult, e.g. electricity, cement and steel industries, competing with costs is vital. Within similar industries, cost reductions and improvements related to production are the ways to increase market share or profit margins. These industries are also often high emitters of GHG emissions and carbon pricing may have a significant effect on their operations and result in a loss in competitiveness. International cooperation on carbon pricing is essential in order to reduce the risk of carbon leakage and inequality issues in competitiveness. The costs that derive form carbon pricing should be handled in the same manner as any other business costs and risks and actions should be taken accordingly. (World Bank Group & Ecofys 2015, 10, 53) According to Carbon Trust (2008, 5), slight trade impacts have been noted with higher carbon prices for household paper products, tyres, glass manufacturing and copper.

Chan, Li & Zhang (2013, 1057) conducted a study on the impact of the EU ETS on the competitiveness of firms. They studied the unit material costs, revenue and employment of companies during a time period between years 2005-2009. They found that the EU ETS did not have an effect on the performance of iron and steel and cement industries. The EU ETS was found to have an impact on increased material costs and revenue of the power industry. However, the study found no evidence to support any negative impacts on the competitiveness of firms in relation to the cap-and-trade system. Nonetheless, some of the most exposed sectors that could potentially be affected and could lead to carbon leakage are ones such as cement and steel sectors (Carbon Trust 2008, 3). The observations might have been different though, had the carbon prices been higher and emissions permits had not been free at that time.

According to Chan et al. (2013, 1057), there is little support overall that would provide evidence of the EU ETS having significantly unfavorable impact on firm competitiveness. Studies have been conducted both predictively and also empirically on existing data. Studies are plentiful on the predictive side (e.g. Reinaud 2008; Ponssard and Walker 2008; Demailly and Quirion 2008), but relatively scarce on empirical analysis conducted on existing data (e.g. Anger and Oberndorfer 2008; Jaraite and Maria 2011; Abrell et al. 2011). Predictive research has been based on assumptions on potential $CO_2$ prices, trade exposure and demand elasticity and they found carbon leakage to take place on a scale from very low rates to significant (30%+). The empirical studies, however have found very little evidence that competitiveness would suffer due to the EU ETS. The empirical studies have been conducted on firms around Europe or specific countries and during certain time periods. Empirical studies have also found little evidence that the EU ETS affects profit margins (Abrell et al. 2011). However, this was based on the years of the first phase (2005-2008), after which the ETS has changed notably. New estimations are needed on how carbon pricing affects profitability, according to the situations after phase 3.

### 2.3.3 Cost pass-through

When costs rise (in this case deriving from increasing carbon prices), companies aim at passing these costs through, in order to relieve the cost increase posed on the firm. Costs are passed on for example to the end customer by increasing market prices. Firms' possibilities to pass through costs have dramatic differences. These differences vary between sectors, industries and even companies within the same industries. Smale et al. (2006, 47) found that steel manufacturers in Europe can pass on as much as 65% of marginal cost increases (from the EU ETS) to customers. Theory also suggests that within some sectors, in addition to passing on costs to consumers, net profits are made from increased prices combined with free allocation of allowances. Results suggested that most companies would profit from the free allocations. However, these conclusions where made when the EU ETS mainly allocated allowances. (Smale et al. 2006, 31) The situation with later phases (starting with phase 3) has been different as a growing majority of allowances are auctioned rather than allocated.

In the study by Laing et al. (2013), according to Neuhoff (2011), in order to reduce emissions, cost pass-through can be seen as a desirable attribute. This is due to the fact that cost pass-through can mitigate demand through demand substitution. Laing et al. (2013) suggest that when prices are passed on to consumers by increasing market prices, consumers are likely to find less carbon-intensive products more appealing. This increases the demand for low-carbon produces and decreases demand for carbon-intensive produces. In comparison, when industries absorb the prices themselves and do not pass the additional costs through in their value chain, there is incentive for companies to reduce their emissions, although in this case consumers do not receive the incentive themselves. It would be preferable for the companies to reduce their carbon content to lower their costs.

An example of cost pass-through and windfall profits is related to power generators. According to the European Commission (2013, 3), power generators have been obligated to buy all their allowances from 2013 onwards. The Commission states that experience has shown power generators to be able to pass costs of allowances on to customers – even when additional costs do not occur and allowances are received for free, thus creating windfall profits for these companies. The power sector is capable of strongly passing through costs.

A report by Carbon Trust (2004, 6) states that energy-intensive companies are exposed to additional costs deriving from carbon pricing. This covers sectors that are both covered by the EU ETS and those that are not. This is due to increasing input costs and additional costs that will be placed upon firms, given that these companies do not reduce their energy consumption. It means that in addition to the energy-intensive companies within the EU ETS that have direct emissions and will potentially lead to buying additional allowances (if the initial allowances do not cover all the emissions emitted by the company), also companies that are not even a part of the EU ETS will suffer from increased costs, due to increases in electricity prices. If the company is not able to pass these rising costs on to consumers (depending on price elasticity of demand), they will possibly lose in sales. However, this cost increase has been said to be lower under the EU ETS than what it would be under an alternative regulatory policy (Oberndorfer & Rennings 2007, 4).

Oberndorfer and Rennings (2007, 3-4) state that in a study by Reinaud (2005), additional costs stemming from carbon prices that are not shared by trading partners in other countries not following $CO_2$ prices, can have an effect on the competiveness of the companies that need to pay the additional costs. Costs derived from the EU ETS could affect the competitiveness of sectors and possibly even whole economies in a negative manner. The competitive situation and price elasticity of demand are key issues in cost pass-through. The less there is competition and elasticity, the less impact carbon pricing will have on output and sales.

If the company fails to pass on the additional costs deriving from increasing carbon prices, its profitability will suffer. Pricing and costs are directly connected to profitability and this is why many companies raise their market prices and pass the costs on to consumers. The market price must cover the costs of production and the targeted profit margin. (Alhola & Lauslahti 2002, 221) The question is, to what extent does the profitability suffer? According to Carbon Trust (2008, 4), in the case of manufacturing companies and the $CO_2$ price being approximately €10/t$CO_2$, for the most carbon-intensive activities their input costs would increase by more than 2% of gross value-added (GVA) for every ton paid. Respectively, the percentage is around 4-8% for the price varying between €20-€40/t$CO_2$.

Carbon Trust (2008, 4) finds that the most carbon-cost-sensitive activities are the production of cement and lime and basic iron and steel. For these activities, paying €20/t $CO_2$ would increase production costs by more than 25% of GVA. After these, the most carbon-sensitive activity is refining, although the EU ETS is expected to have little effect on oil products and their trading. With the same price of €20/t $CO_2$, the cost is under €1per barrel of oil equivalent thus making it minor when compared to daily oil price fluctuations. Other substances exposed to carbon prices are aluminium, fertilisers, inorganic basic chemicals and pulp and paper, of which the latter three are impacted by almost 5% of GVA in costs per €10/t$CO_2$. For these products, about a 1%

increase in product prices for each €10/t$CO_2$ paid would offset the costs. If the carbon price increases, also these product price increases may become quite significant.

The study by Chan, Li and Zhang (2013, 1057) points out that the power sector is the most affected by carbon regulation, as it is often short of allowances and a net buyer within the EU. The iron and cement industries on the other have been posed with the risk of carbon leakage, as both rely on trading and cannot pass on costs (increased energy costs) effectively, without facing possible loss in market share. The turnover of power companies increased in the second phase of the EU ETS, on average. This is a likely implication of passing through costs deriving from regulations and resulting in increased electricity prices and revenue. (Chan et al. 2013, 1057) The affect that cost pass-through has on carbon leakage however still remains equivocal (Laing et al. 2013) According to Berners-Lee (2015), a carbon price in the future will be an additional cost that is passed on in the supply chains of all produces and will eventually be evident for consumers in the increased prices paid for these goods. The estimated price according to Berners-Lee is 100 USD/t$CO_2$, (approximately €89/t$CO_2$) which is said to be higher than what most companies assess.

In consideration of the scope of this research, cutting costs and raising prices are the most seminal. Cutting costs can be directed at variable or fixed costs. For example, re-negotiating the price of raw materials and comparing and changing suppliers can be a way to pass on the costs deriving from $CO_2$ emissions. Also getting rid of some fixed costs and fixing the administrative processes can bring efficiency and thus increase profitability. Prices are often raised as a result of rising costs. Raising prices does not, however, guarantee an increase in profitability. The downside to raising prices may be a decline in demand. Generally, the more competition there is, the less an increase in price ultimately affects profitability in a positive manner. (Alhola & Lauslahti 2002, 72-73) When an increase or decrease on the price of a product affects the demand significantly, then there is elasticity between the price and demand. When the demand for a product or service is not strongly affected by the changes in price, demand is inelastic and the company can increase its prices without it strongly affecting demand. The price elasticity of demand can be calculated by the relative change in demand divided by the relative change in price. The magnitude of the price elasticity of demand depends on competition and the importance of the product to the customer. Price elasticity also affects the profit margin as this is added to the cost; the more elasticity there is, the lower prices usually are. (Kinnunen et al. 2007, 123-124; UNEP FI & WRI 2015, 19)

In the beginning of the EU ETS allowances were mainly allocated for free within the power sector. Of the free allowances allocated by the EU ETS in total, 60% were directed to the power sector. (Reinaud 2005; Sijm, Neuhoff & Chen 2006) According to studies, even though allowances were free, the costs of allowances were passed on in the price of electricity, increasing electricity prices for consumers. Cost pass-through rates within the energy sector have been estimated as large as 60-100% of $CO_2$ costs. The rate of cost pass-through depends on a range of factors, including the carbon intensity of outputs and various market and technology related factors. (Sijm et al. 2006, 49; Cramton & Kerr 2002, 334) This has been one of the biggest challenges with free allocation of allowances, as power companies have been able to collect substantial windfall profits in the process.

Whether the allowances are auctioned or allocated, they represent an opportunity cost for the company. According to economic theory, companies need to add the cost of allowances to other variable costs, even when they do not actually pay for the allowances. This indicates that regardless of how allowances are distributed (auctioning or free allocation), the energy price will be the same. Opportunity costs derive from the fact that if the permit would not be used, it could be sold on the market. Opportunity costs vary per unit of power produced and also on the carbon intensity. For a price of €20/t$CO_2$, the generation cost differs for individual plants, e.g. gas or coal. The costs are not fully added to the price, as the price is determined through various market forces and the demand could suffer. (Reinaud 2004; Burtraw, Palmer, Bharvirkar & Paul 2002; Sijm et al. 2006, 51; Cramton & Kerr 2002, 334)

In 2005, the identified pass-through rates within the power sector varied between 60% during off-peak and as high as 117% for peak hours in Germany and between 64% and 81% in the Netherlands, respectively. (Sijm et al. 2006, 51-57) Another study by Fabra and Reguant (2013) found similar high rates around 80% and 100%. The power sector has the ability to pass through costs efficiently because competition is limited in regard to imports. The sector has market power and there is an absence in trade, as prices are determined according to the energy mix and cost of fuel. (Arlinghaus 2015)

For manufacturing companies, the price formation is more complex as products are often traded, and market power and product differentiation vary, resulting in differing elasticity of demand and substitution. De Bruyn, Markowska, de Jong and Bles (2010) conducted a study on the energy-intensive industries iron, steel, refining and chemicals, to see how costs from carbon pricing are passed through. Cost pass-through rates in manufacturing have been found to potentially rise quite high. De Bruyn et al. estimated that cost pass-through could be as high as 100% for iron, refineries and steel, but it is less clear regarding chemicals. Oberndorfer, Alexeeva-Talebi and Löschel (2010) conducted an empirical analysis on the carbon cost pass-through within the UK refinery, glass, chemicals and ceramics sector. Pass-through rates of above 100% and 50% are found in the chemicals sector, depending on the chemical. Glass products seem to have lower rates: no pass-through for container glass and 20-25% pass-through for hollow glass. Ceramic goods had an energy cost pass-through rate of 100%, and 30-40% for ceramic bricks. Retail consumers of diesel were passed 50% of energy price increases and gasoline retail consumers 75% of price increases. Considerable variation in cost pass-through rates can thus be found among the manufacturing sector. (Arlinghaus 2015, 18-19)

On the whole, significant cost pass-through of carbon prices can be recognized within the manufacturing and electricity sectors. The rates of cost pass-through lie between 60-100% (or more) within the electricity sector. The rates are, however, more scattered within the manufacturing sector with 0%, 20% and over 100% cost pass-through. These results indicate that companies are able to pass on the carbon costs and only bare a minor share of the price increases. (Arlinghaus 2015, 20)

MSCI conducted estimations regarding Australia's carbon pricing policy. In this research MSCI made the assumption that Scope 2 emissions costs pass-through would be 100%. (Fryer & Parks 2011)

When $CO_2$ prices increase, companies will most likely reduce output. The price increase will possibly increase the price of inputs (electricity), resulting in increasing the costs of downstream companies and thus also increasing market prices. (Bushnell et al. 2013, 89)

Figure 7 summarises the factors that impact the extent of how much changes in $CO_2$ pricing affects companies. Bushnell et al. (2013, 89) have identified four seminal factors. The first factor is whether the firm operates in a market that is susceptible to environmental regulation, directly or indirectly. The price elasticity of demand in that market and the amount of permits the company holds are also key issues. The amount of permits is essential in the case the company is a large emitter and is short in allowances and needs to buy more: the company then has high cost exposure to the price of allowances. If the company is emitting less than it could, in regard to the amount of permits is holds, its value will be amplified when allowance prices rise. Fourth, the relation between costs and allowance prices in the industry plays an important role. In addition, according to Carbon Trust (2008, 5), the ability of a company to reduce its emissions will have an impact on the net effect of carbon cost exposure on the firm's operations.

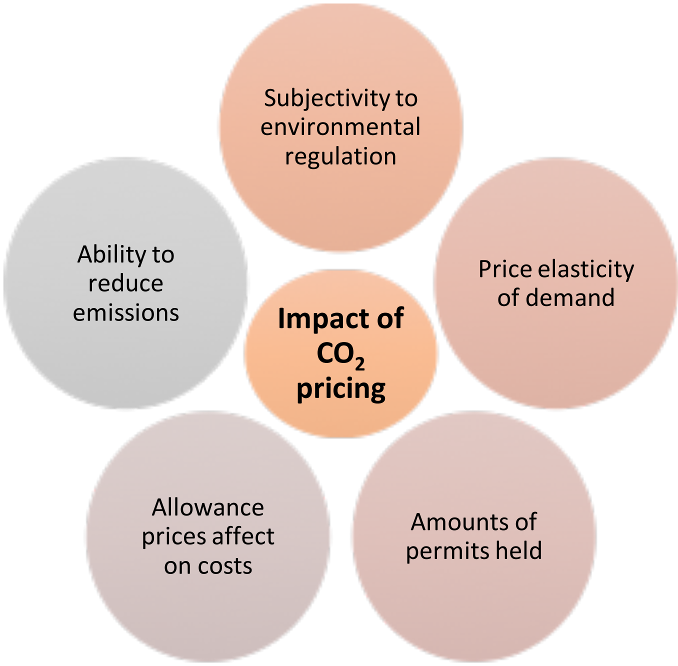



Figure 7. Issues that affect the magnitude of the impacts that changes in $CO_2$ pricing will have on firms (Bushnell et al. 2013, 89; Carbon Trust 2008, 5)

# 3 THEORETICAL FRAMEWORK

Carbon pricing is a broad topic and is affected by numerous aspects, for example policy and regulatory measures or market and economic shifts. Carbon pricing and environmental regulations also affect different industries and companies in various ways, depending largely on their carbon intensity and operations. Carbon thus poses risks for companies and their operations on different levels, depending on the aforementioned reasons. Carbon risks can be mitigated by for example taking measures to increase efficiency and decrease GHG emissions. For companies that have not been prepared for carbon pricing and where the risks that carbon may pose have not been identified, the consequences may be substantial. In regard to the context of this research, carbon risk as a concept focuses on the financial risk that companies face regarding carbon emissions. The financial risk derives from a blend of the reviewed risk factors (policy and legal, technology and market and economic), but in the empirical section the risk is the price of carbon and how it will affect company profitability.

The main objective of pricing carbon is to decrease GHG emissions. In order for companies and jurisdictions to find this appealing, emissions must bear a price. Otherwise a financial incentive for reduction does not exist. Three main direct pricing mechanisms for carbon are reviewed for this study. As the empirical section concentrates on a number of Western European companies, the literature review also mainly focuses on European mechanisms for pricing carbon, of which the EU ETS is the largest system. The EU ETS is not only the largest mechanism induced in Europe, but also globally. In the first quarter of 2016, the price set on carbon in the EU ETS decreased from roughly €8/ $tCO_2$ to approximately €5/$tCO_2$. This price is arguably too low to entice emissions reductions, and the agreement reached in COP21 requires a much higher price. The price has been fluctuating since it was first implemented. In addition to the EU ETS, also carbon taxes have been introduced, although these are not as widely used. Companies are also increasingly utilizing so called internal carbon prices, which most often are much higher than the market prices for allowances. These prices often predict future policies and prepare companies for carbon pricing in general, and also possible price increases.

This thesis aims to find how the price increases would affect company profitability. The theoretical section thus also looks at profitability and competitiveness factors, in addition to carbon pricing elements. What is also essential is the research on how well these increased and additional costs are passed through for customers to pay. This cost pass-through rate varies dramatically, depending on the industry, company, competitiveness and the price elasticity of demand. Cost pass-through rates are difficult to appoint unequivocally, as not many studies specifically focus on these and they change according to positions in competitiveness as well as market and economic shifts. However, with the help of some prior studies, guidelines for these are acquired.

Figure 8 illustrates the causality of the $CO_2$ price. Between the main three factors ($CO_2$ price, increase in the price and profitability), there are concepts that signify the cause and effect between each step. The figure starts with the $CO_2$ price, which is increased due to identified carbon risk, internal carbon prices and regulations along with the prices induced by a cap-and-trade system and taxation. These affect the $CO_2$ price and (most likely) lead to an increase. When the $CO_2$ price has increased due to the mentioned factors, company profitability is affected due to changes in turnover and EBITDA. The changes in turnover and EBITDA depend strongly on the price elasticity of demand, i.e. the cost pass-through rate.

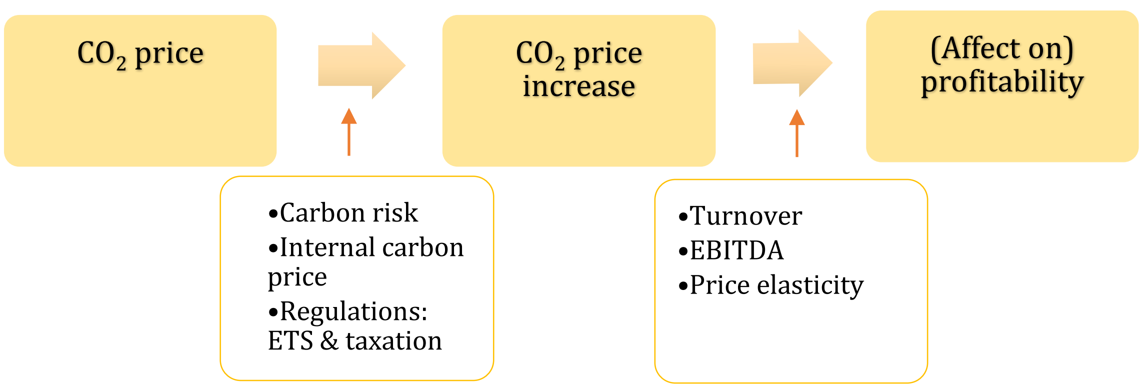



Figure 8. Research framework

The literature on these issues is scattered and there are only a few studies that concentrate on how $CO_2$ pricing affects the profitability of companies. These studies are mostly concentrated on specific companies, industries or countries. In order to find relevant information and information on current policies, academic research is combined with practical research. Practical research comprises of field studies and observations, reports and researches conducted by non-profits and companies. Even though these studies are not categorized as academic, they give valuable information on the current state of $CO_2$ pricing as well as observations and insights from companies themselves, on how they have found $CO_2$ pricing to affect the way they conduct business. Academic studies related to the EU ETS are outdated in the sense that phase 3 is now ongoing and there are no academic studies yet on this phase. The academic studies mostly regard phase 1, and some review the impacts of phase 2. As the theoretical section states, the EU ETS has changed dramatically from its first phases, and further improvements and changes continue to take place. In addition, the COP21 agreement has influenced stricter emissions reduction targets, which is not yet evident in academic research. It is thus crucial to review current reports on the issue. In addition, most academic studies solely review EU ETS as it is the largest pricing mechanism, but for example studies on internal carbon pricing are hard to find from academic literature as it is a relatively new concept. Table 3 summarizes the main concepts regarding this research and provides working definitions for each.

Table 3. Main concepts and working definitions

| **Concept** | **Working definition** |
|---|---|
| $CO_2$ emissions pricing / carbon pricing | The price put on carbon dioxide (and some other GHG) emissions (by for example the EU) per tonne. |
| Carbon risk | A financial or image risk for example, that carbon emissions pose on a company. Carbon risk is related to assets and companies, and is considered a non-physical climate-change related issue. |
| Emissions trading/ cap-and-trade | A system for reducing carbon emissions, where a cap or limit is determined on the amount of GHG emissions that companies can emit and a price is formed for emissions allowances. Allowances are traded between companies and on the market. The largest cap-and-trade system is the EU ETS. |
| Carbon tax | Another form of carbon pricing in addition to emissions trading. A tax paid on the carbon content of fuels. |
| Internal carbon price | The price set and defined on carbon by companies themselves. The price might not actually be utilised i.e. paid, but the company prepares its operations for the carbon risk or increased carbon prices. |

The most studied sector regarding $CO_2$ pricing has been the power sector. Many studies have been conducted on the way carbon pricing has affected electricity prices (e.g. Sijm et al. 2006), mainly in Europe.  Also some other industries which have been included in the EU ETS have been studied but there are no studies that view carbon price impacts more comprehensively across sectors and provide a way to compare them. This research aims to give a more general view on the impacts according to company profitability. The methodology used for the research differs from earlier studies as a scenario analysis is conducted to view the impacts different prices and cost pass-through rates would potentially have on companies.

# 4 RESEARCH METHODOLOGY

This research is conducted to answer the question on how an increase in the $CO_2$ price could affect the profitability of companies. The focus is not on one particular industry, but in contrast, the research aims to give an overall view on the issue, and then also focus on industries that are most affected by the changes in $CO_2$ pricing.

In this chapter the research design and methods will be presented. The research is conducted as quantitative research. Data on scope 1 and 2 emissions of companies and also financial data concerning profitability factors are utilized. With the data and knowledge on the $CO_2$ pricing mechanisms as well as other influences on the $CO_2$ price, a scenario analysis will be conducted. Scenario analysis has been determined the best way to help visualize the effects that changes in the $CO_2$ price can have on the profitability of companies. The scenarios themselves and information used in the scenarios have been carefully assessed and selected according to existing observations (covered in the theory section) and utilization of the empirical data.

## *4.1 Research description*

The research question asks how an increase in $C0_2$ pricing affects company profitability. This research aims to answer the main research question through secondary, quantitative data. Secondary data is used because of the researcher's access to databases such as MSCI and FactSet. These databases consist of reliable and high-quality data, thus separately gathered primary data is not necessary.

The research question states an investigation between two variables, price and profitability. An answer is sought to solve how the price increase affects profitability (effect of price on profitability). A number of other variables are also needed and these are presented in section 4.2 on data collection methods. Numerical data is utilised and thus a quantitative approach is chosen as the method of research.

A deductive approach is chosen for the study, as a causal relationship could be established between two variables. (Saunders, Lewis & Thornhill 2009, 124-140) A scenario analysis is considered the best choice for analysing the data in this research because it provides an opportunity to present and visualise different stages (different price alternatives and cost pass-through rates) in a straightforward manner, as the future price on $CO_2$ emissions is not known. There will be various stages or scenarios that will be introduced, the methodology being a traditional sensitivity analysis. A sensitivity analysis is utilised as the method of approach because the empirical part will be testing how the selected companies' profitability will react to specific uncertainties; the uncertainties in this case being the $CO_2$ price and cost pass-through rates. The idea behind the scenarios is to see how different situations regarding the variables affect the profitability. These scenarios can then be analysed in a general manner, and also on industry level. The scenarios are explained further in section 4.3 on data analysis methods.

The data on scope 1 and 2 emissions and financials are obtained from databases by MSCI and FactSet, respectively. The data is multiple-source secondary data, as both data are collected from multiple sources (Saunders et al. 2009, 262-263). A case study approach could have also been a good option, as this could have been conducted if a few industries or companies would stand out in the findings, by for example conducting interviews to further find out how the representatives of the companies see the effects. However, as the data is widespread and the aim is to get an overall understanding on the issue, the case study approach is not considered essential.

As an extensive answer is sought in relation to the research question, a large group of companies is needed for the analysis. A group of listed, Western European companies were chosen to be inspected. The decision on inspecting listed companies rather than non-listed became one of the selection criteria, in order to obtain the needed information on financials as well as emissions. Western European companies are studied because the group of companies under examination is selected according to the MSCI Europe Index. The MSCI Europe Index covers enough companies in relation to Western European countries and also narrows the research well to cover just a certain portion of companies.

It is important to note that the reference scenario the analyses are based on is business as usual. This means that the study is based on the assumption that technological advances and additional technological investments are not currently carried out among the companies that are inspected. Another important note is that the analyses are made on the assumption that emissions have stayed the same in the analyses compared to the emissions in the data. The emissions data mainly concerns the year 2014, thus radical changes in emissions are unlikely. The data can be considered up to date, as more recent widespread data is not available. This is an important note on the research as the fundamental purpose of this study is to demonstrate how a $CO_2$ price increase would affect companies and profitability in the case that no efforts are put into decreasing emissions.

Investments made into cleaner technologies are not part of the main problem and is not looked into in depth. Even though emissions trading is one of the main mechanisms in pricing carbon, allocation and trading of allowances and their relation is also left out of the analysis. This means that the ratio on the proportion of allowances that are allocated for free and how much are bought by the companies will not be inspected. This is because the ratio varies drastically between industries, and would make the analysis extremely challenging. In addition, the form of allocating permits does not necessarily even change costs and cost pass-through rates as such, if they have been marked as opportunity costs when allowances are allocated for free (as seems to have been the case with the power sector). (Bushnell et al. 2013, 80; Reinaud 2004; Burtraw, Palmer, Bharvirkar & Paul 2002; Sijm et al. 2006, 51; Cramton & Kerr 2002, 334). This also gives support to leaving the ratio out of the analysis.

Changes regarding demand and output volumes according to the fluctuation of the $CO_2$ price are not taken into account. The $CO_2$ price may affect demand and output volumes, depending on the amount of additional costs it reflects on the consumers and production. In the end these changes also affect sales numbers.

The financial data collected for the analysis is from FactSet. Financial data consists of numerical data on the companies' EBITDA and turnover (sales) figures. The profitability of the given companies is calculated by utilising these two variables, according to the EBITDA to sales ratio (EBITDA margin). EBITDA and sales data is gathered for years 2013 and 2014, but data on 2015 was not yet available.

The research is directed at Western European companies. As all the Western European companies could not be studied, the MSCI Europe Index was chosen as the sample. The data comprises of 434 companies. The financials' sector is left out of the examination because this study does not look into emissions reserves related to the balance sheet. As this sector is excluded, the final data is left with 335 companies to be examined, leaving 99 of the financials' sector companies out. 12 companies were found in the data twice and these doubles were removed. The companies are classified according to the Global Industry Classification Standard (GICS), developed by MSCI and Standard and Poor's (MSCI 2016d). This standard comprises of 10 sectors, 24 industry groups, 67 industries and 156 sub-industries. After the aforementioned exclusions, the final data is left with 9 sectors, 20 industry groups and 53 industries (figure 9). Three companies in the MSCI data lacked information on emissions, thus these companies had to be removed. The two companies which had reported their emissions data regarding the year 2015 also had to be removed, because financial data from this year was not yet available. EBITDA figures on one company were not received and another company was missing sales figures, resulting in also removing these two companies from the data. The seven companies were removed because the calculations could not be conducted due to missing information, and to not skew the results by lack of information regarding these specimens. These left the final data to consist of 328 companies.

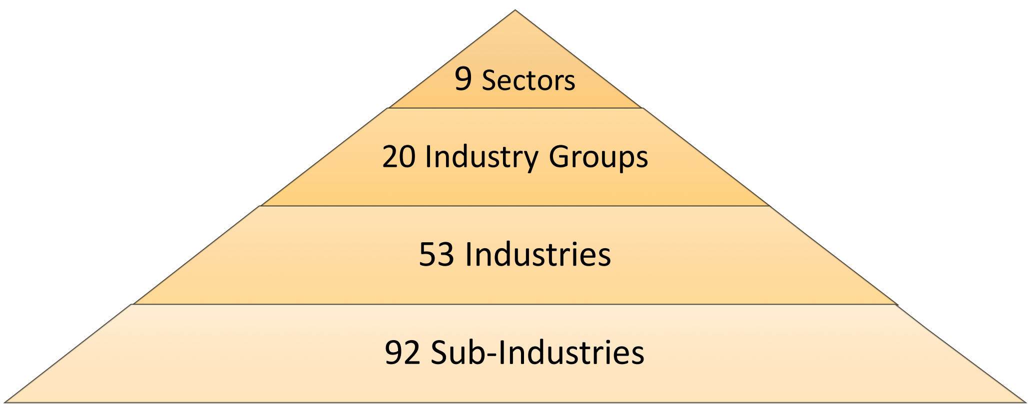



Figure 9. Global Industry Classification Standard (GICS)

### 4.2 Data collection methods

MSCI (Morgan Stanley Capital International) and FactSet have collected the data from multiple sources. MSCI's indices and analytics are directed at investors to provide them with reliable data and deeper insights on the drivers of performance in their portfolios. MSCI's ESG analysis covers over 5700 listed companies, taking into account their ESG risk exposure and also the performance and practices of management. (MSCI 2016a; MSCI 2016b) The ESG-data will provide information on the Scope 1 and 2 emissions of the selected companies.

The MSCI Europe Index data consists of 15 Developed Markets (DM) countries in Europe. These Developed Markets include Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the UK. This particular data covers 446 companies, with 85 % of the free float-adjusted (i.e. largely traded) market capitalization across the European Developed Markets equity universe. The index is based on the MSCI Global Investable Market Indexes (GIMI) Methodology. This approach is extensive and provides a broad view and the capacity for cross regional comparisons across market sectors. (MSCI 2016c)

MSCI ESG data is collected yearly from the most recent sources available, including Corporate Social Responsibility Reports, company websites or Annual Reports. However, when the data is not available from direct company sources, MSCI uses the GHG data reported through the CDP or government databases. When there is no data disclosed by companies themselves, MSCI utilises a proprietary methodology in order to estimate direct (scope 1) and indirect (scope 2) emissions. Scope 3 emissions are reported by MSCI, but they are not estimated due to insufficient definitions on what Scope 3 emissions should entail, inconsistent calculations by companies, and also because they are not fully controlled by the companies. (MSCI 2014, 2-3) Scope 3 emissions are also left out of this research due to the aforementioned reasons and because in the worst case, utilising them might lead to skewed interpretations.

The emissions in the data used in this research are from the years 2013 and 2014, as MSCI estimates the emissions of each year when the reporting companies have done the estimations (e.g. estimations for the year 2014 are conducted in late 2015). Table 4 shows the four different models MSCI uses when no reported data is available. (MSCI 2014, 3) The MSCI data for this study was gathered on 25.2.2016 with the portfolio/benchmark 990500.

Table 4. The four models MSCI uses when there is no reported data by companies

| | |
|---|---|
| Company Specific Intensity Model | This model is based on data that a company has previously reported. The advantage here is that the model reflects the company's production processes and also the specifics of the businesses the company is in. |
| Company Production Model | This model is used when the company does not report data. In some industries, general data often reported by other companies can be used to provide good estimations of emissions. |
| Global Industry Classification Standard (GICS) Sub-Industry Model | This model is used when data on production or is not available or usable for estimation. This model is more generalized, but MSCIs own emissions database is utilised. |
| Economic Input-Output Life-Cycle Assessment Model | This model is used for companies that have not reported data and whose GICS Sub-Industry is not represented in MSCIs data set. This is a generalized model based on Standard Industrial Classification (SIC) codes. |

In order to then determine and calculate the profitability of the selected companies, data on EBITDA and sales were gathered through FactSet. FactSet provides powerful analytics and accurate data for companies and investors. (FactSet 2016) Data from the two different sources (MSCI and FactSet) were gathered into one file and combined. The information gathered from the two databases is shown in table 5.

Table 5. Information gathered and combined on the financials and emissions for the selected companies.

| Factor name | Explanation |
|---|---|
| **SEDOL** | The SEDOL identification code is utilized to combine the information from the FactSet and MSCI data |
| **SEDOL with check digit** | SEDOL with a check digit is applied because the MSCI data utilized this form of the SEDOL code |
| **Company name** | The name of the company under inspection |
| **Country** | The country where the company is situated (headquarter) |
| **Sector** | The sector that the company belongs to (10 sectors according to GICS) |
| **Industry group** | The industry group that the company belongs to (slightly more exact than sector, 24 industry groups according to GICS) |
| **Industry** | The industry that the company belongs to (more exact than industry group, 67 industries according to GICS) |
| **Sub industry** | The sub industry that the company belongs to (the most exact category, 156 sub industries according to GICS) |
| **Sales/turnover 2013 & 2014** | The sales or turnover of the company in 2013 and also 2014 |
| **EBITDA 2013 & 2014** | Earnings before interest and taxes, excluding depreciation and amortization of the company in 2013 and 2014 |
| **Scope 1 emissions** | Scope 1 emissions of the company in metric tons |
| **Scope 1 key** | The scope key represents the source of information (reported by company or estimated by MSCI) |
| **Scope 2 emissions** | Scope 2 emissions of the company in metric tons |
| **Scope 2 key** | The scope key represents the source of information (reported by company or estimated by MSCI) |
| **Scope 1+2 emissions** | Scope 1 and 2 emissions together in metric tons |
| **Scope 1+2 key** | The scope key represents the source of information (reported by company or estimated by MSCI) |
| **Carbon emissions year** | The year the reported emissions in question occurred |
| **Carbon industry intensity - Carbon emissions scope 1 & 2 (t/USD million sales)** | The average carbon emissions intensity at the GICS sub-industry level. Allows for comparison of intensities between industries and also between the company intensity in comparison to average industry intensity |
| **Carbon emissions - Scope 1 & 2 intensity (t/USD million sales)** | Company's Scope 1 & 2 GHG emissions normalized by sales in USD, allowing for comparison between companies of different sizes |

The keys on the scopes were also gathered because they indicate the reliability of the information. The keys indicate whether the information has been gathered directly from the companies or whether they have been calculated from reliable information or rather estimated according to industry averages. The keys specify which of the four models presented in table 4 have been utilized in the case that direct information has not been available.

The carbon intensities are in US dollars and were not converted to euros or calculated separately in euros, because the industry intensities have been calculated by MSCI from a larger group of companies than in the data. The company carbon intensities are also in US dollars so that they can be compared to the industry intensity.

### *4.3 Data analysis methods*

Data analysis is conducted mostly with Excel, excluding the sector summaries for which Minitab is utilized. As stated earlier, the profitability of the companies in the sample for this thesis was calculated by the EBITDA to sales ratio, to compare the company's revenue to its earnings. This gave the profitability of the starting point. After this the cost increase for scope 1 and scope 2 emissions were calculated separately. This was calculated by multiplying the scope emissions data by the expected cost increase of the $CO_2$ price. Also the sales and EBITDA were calculated again with the cost increases and cost pass-through rates, to have the EBITDA and sales after the changes in these variables. These were calculated because the turnover is affected, as when the additional cost deriving (from carbon costs) is for example partly passed through, the turnover actually increases due to the increase in the market price as the company receives more revenue for the same amount of goods sold. This is a simplified example, but the CPT rate then varies according to the elasticity of demand. The EBITDA changes due to added costs. From the new EBITDA and sales numbers, the profitability after change was then calculated according to the EBITDA to sales ratio. To see the change, the change in profitability was calculated by comparing the profitability ratios before and after the change in the $CO_2$ price and cost pass-through rates (percentage change).

As was stated in section 4.1, the analysis is conducted with the help of scenarios, i.e. by conducting a sensitivity analysis. Different stages or scenarios will be introduced. These scenarios will be constructed according to different values in the increase of the $CO_2$ price and also the cost pass-through attributes. Various scenarios will be made with changes to the variables, i.e. $CO_2$ price and cost pass-through rates. The data is constructed so that these variables can be changed and results inspected according to different input values.

Depending on the results, further inspection will be conducted on industries where these cost issues seem to have a clear impact on the profitability of companies. Different combinations of $CO_2$ prices and cost pass-through rates will be assessed to see the impacts they have on each sector. These future scenarios can then be analysed in a general manner, and also on an industry-level. Figure 10 illustrates the basic idea of the scenarios. The price increases are estimated according to previous studies, internal carbon prices used by companies, and increased prices deriving from climate change targets. Cost pass-through rates are also based on previous studies, bearing in mind the differences between industries.

The $CO_2$ prices in the data analysis reflect the price increase. If the utilised price in the data analysis is for example €40/t$CO_2$, this means that the $CO_2$ price has increased by €40, not the actual price being €40. This is because the information in the data already includes the costs related to $CO_2$ pricing that companies have had to pay at that time. In 2014, the $CO_2$ price fluctuated between €4-€8/t$CO_2$, the average price of that year being approximately €6/t$CO_2$ (World Bank Group & Ecofys 2015, 44). The average price of the year 2014 is close to the current €5/t$CO_2$ price. Thus, when the $CO_2$ price increase in the data is €40/t$CO_2$, the actual $CO_2$ price for the company is €46/t$CO_2$.

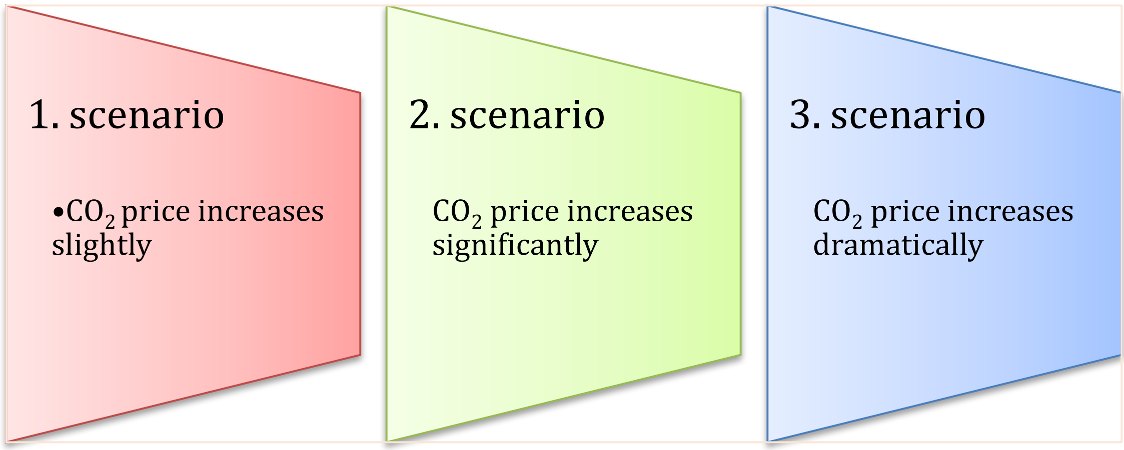



Figure 10. Scenario examples

The scenario analysis is the best way to approach this matter most importantly because it cannot be known what the price of $CO_2$ emissions will be in the future. This makes it crucial to conduct an analysis where options are given and various situations and their impacts can be visualized and analysed. In order to reduce emissions globally and make this worthwhile for companies, the costs affiliated with carbon must be increased. Companies make decisions according to numbers and what is profitable, and if $CO_2$ emissions become costly and severely intervene with profits, companies will find ways to reduce emissions. The data analysis will start with exploratory data analysis. Diagrams will be made to help visualize the data. (Saunders et al. 2009, 428)

### *4.4 Reliability and validity*

MSCI (2015, 9) strives to produce reliable and quality data. The MSCI ESG Research has its own quality review process, which includes peer reviews, industry leads reviews and company data verification. The carbon emissions data is cross-checked by peers, reviewed by senior analysts (covering the utilities, materials and energy sectors) and also the companies reporting their carbon emissions have been requested to confirm the data. To the researcher's knowledge, the information on emissions by MSCI is the most extensive data available. The proportion of reported emissions by companies is high in relation to the amount of companies not reporting their emissions. Most of the data is disclosed by companies, as shown in table 6. The relations have been calculated according to each sector. The data by FactSet has been gathered from company income statements.

Table 6. Percentage of ESG data reported by companies and estimated by MSCI, in relation to the number of companies in each sector.

| Sector | Data disclosed by company | Data estimated by MSCI |
|---|---|---|
| **Consumer Discretionary** | 76 % | 24% |
| **Consumer Staples** | 85 % | 15 % |
| **Energy** | 94 % | 6 % |
| **Health Care** | 88 % | 12 % |
| **Industrials** | 82 % | 18 % |
| **Information Technology** | 78 % | 22 % |
| **Materials** | 85 % | 15 % |
| **Telecommunication Services** | 94 % | 6 % |
| **Utilities** | 100 % | 0 % |
| **On average** | 87 % | 13 % |

The validity of the research is high as the topic of the research is exactly what was initially planned. The data utilised for the study is relevant and fills the purpose of the research. The amount of companies is above what is usually perceived as sufficient (200-300 specimen) in quantitative analysis. However, the sectors do not all comprise of at least the 30 companies that is advised. (Heikkilä 2008, 45) The most crucial aspect is to see how the profitability is impacted and this is what can nonetheless be detected according to companies within each sector. Due to the smaller number of companies in some sectors, all the results cannot be generalized, but the impacts can nonetheless be tested and analysed, which is the purpose of the study.

Because it is hard to accurately predict the future $CO_2$ price, it is essential to present different alternatives. Cost pass-through rates are altered according to the sectors and what is needed to entice emissions reductions. The prices and rates have been studied and are based on previous research. The results will be incidental in the sense that results can vary, even highly, between industries within the sectors. Nonetheless, this is beneficial in order to see extensive results, how they vary depending on the sector. In this sense the variation is good. The companies have been selected objectively without selecting them according to what extent they may be impacted, and thus many different outcomes will be reviewed. This excludes the financial sector as it differs strongly from other sectors in regard to its operations and structure. Because it is known that results will vary, the reliability can be stated as relatively high, because this is also the target of the research. The data utilised for the analysis are also of high quality.

# 5 FINDINGS

This chapter will present the empirical results. The first section will present the data through statistics. The next section will go through the findings regarding test value impacts on company profitability. The third section will go through the results of the scenario analysis. The findings are done on sector basis, and then within the sectors that are most affected industry specifications and analyses are also conducted.

## *5.1 Introducing the data*

The final data provided information on 328 companies. The accurate distribution of the number of companies between sectors, industry groups, industries and sub-industries can be viewed in appendix 1, figure A.1. The companies are branched out between the 15 DM countries as shown in figure A.2 in appendix 1. The countries that contain the largest number of companies in this data, are the United Kingdom (81 companies) France (56 companies), Germany (43 companies) and Switzerland (28 companies).

To comprehensively analyze the data, the companies were primarily reviewed according to sector. As was illustrated in figure 9, sectors are the highest class of standardization in the GICS. Starting the analysis according to the sectors gives a good overview of the data, after which further analysis can be made on an industry level in order to get more specific insights. The companies were distributed across the nine sectors as shown in figure 11.

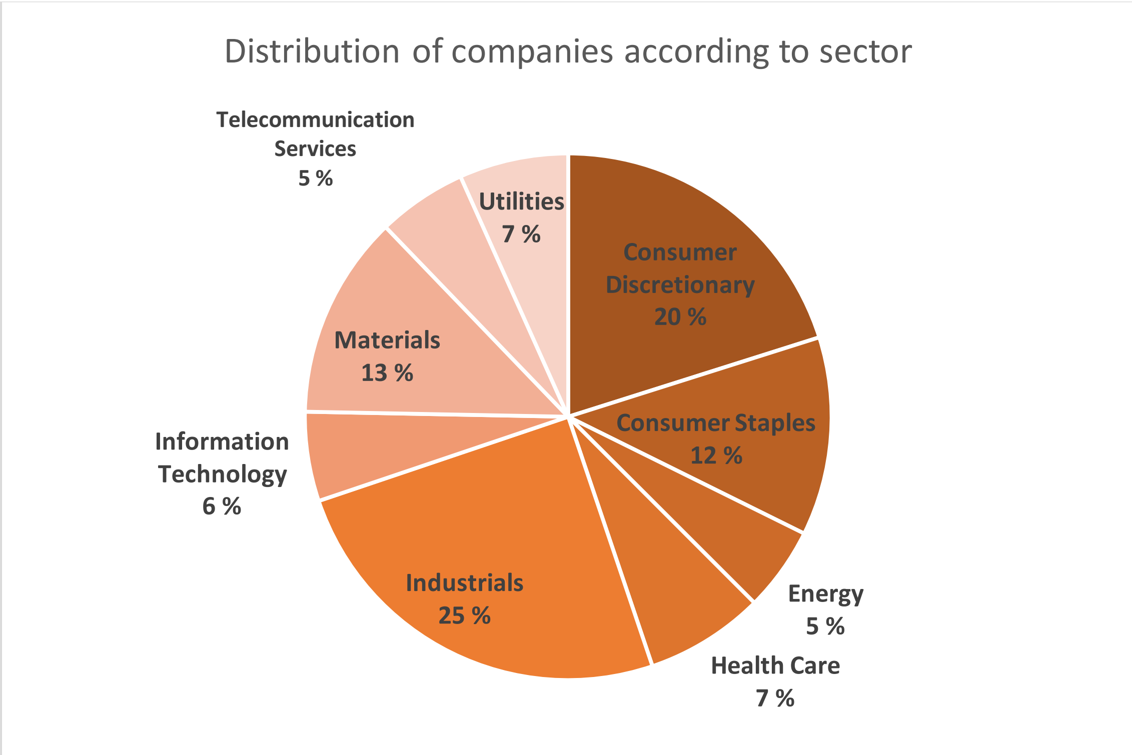



Figure 11. Distribution of companies across sectors

The largest sectors in the data are industrials (N=82), consumer discretionary (N=66), materials (N=41) and consumer staples (N=40). From these largest sectors, industrials and materials are also found among the four sectors, that have the highest carbon intensities on average (figure 12). Figure 12 illustrates the average carbon intensity of each sector. The carbon intensities had been calculated for each company individually, based on their carbon emissions in metric tons and sales in dollars (US). The average of each sector was calculated as the arithmetic mean of the companies' carbon intensities. According to these numbers, the most carbon-intensive sector is utilities, followed by materials, energy and industrials. Consumer staples and consumer discretionary may have some industries within the sectors, that are more carbon-intensive than others. Health care, information technology (IT) and telecommunication services are the least carbon-intensive sectors according to this study.

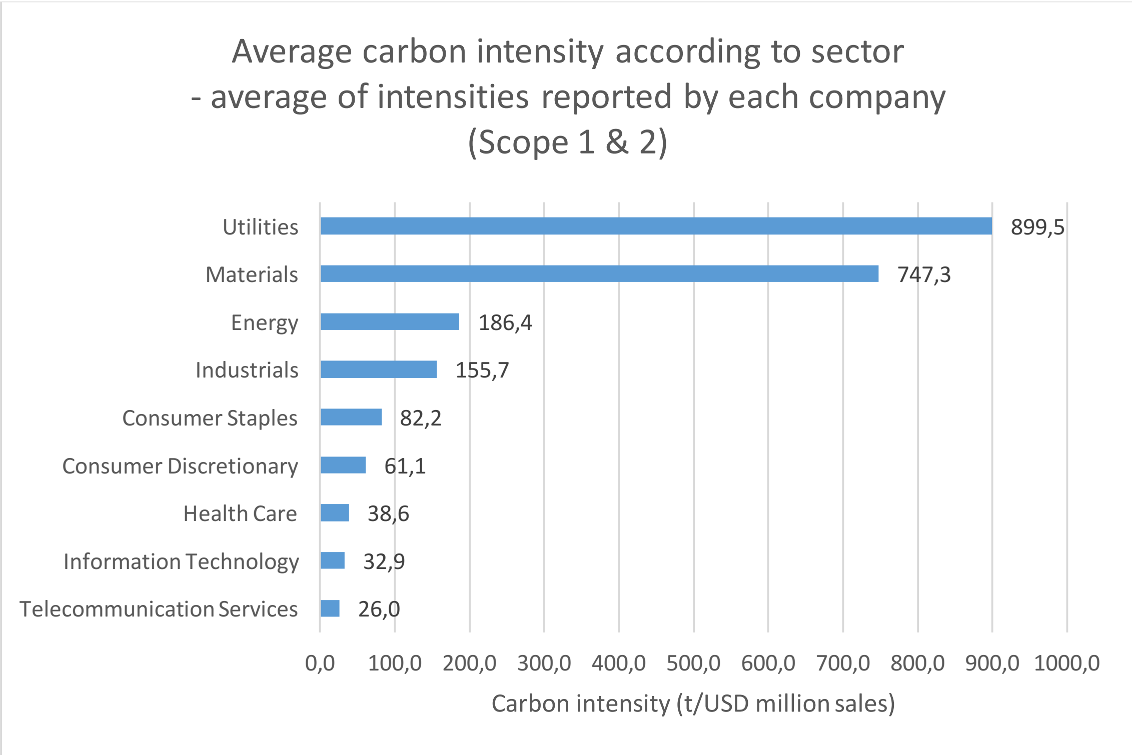



Figure 12. Average carbon intensity according to sector. Calculated as the average of company reported emissions within each sector.

The carbon intensities given by each company and calculated as an average provides information on how carbon-intensive the companies selected for this research are, on average. MSCI also provides data on the level of industry carbon intensities, so these levels of carbon intensities that companies provide, can be benchmarked according to what the industry level is. This way companies know whether they approximately emit less or more than the average company within the same industry. MSCI has calculated these intensities on the sub-industry level, but to provide a better overview, the carbon intensities have been calculated as the average of the sub-industry levels for each relative sector, according to the amount of companies within each sector in the research data. Figure 13 displays the sectors according to the average carbon intensities of the sub-industries within each sector.

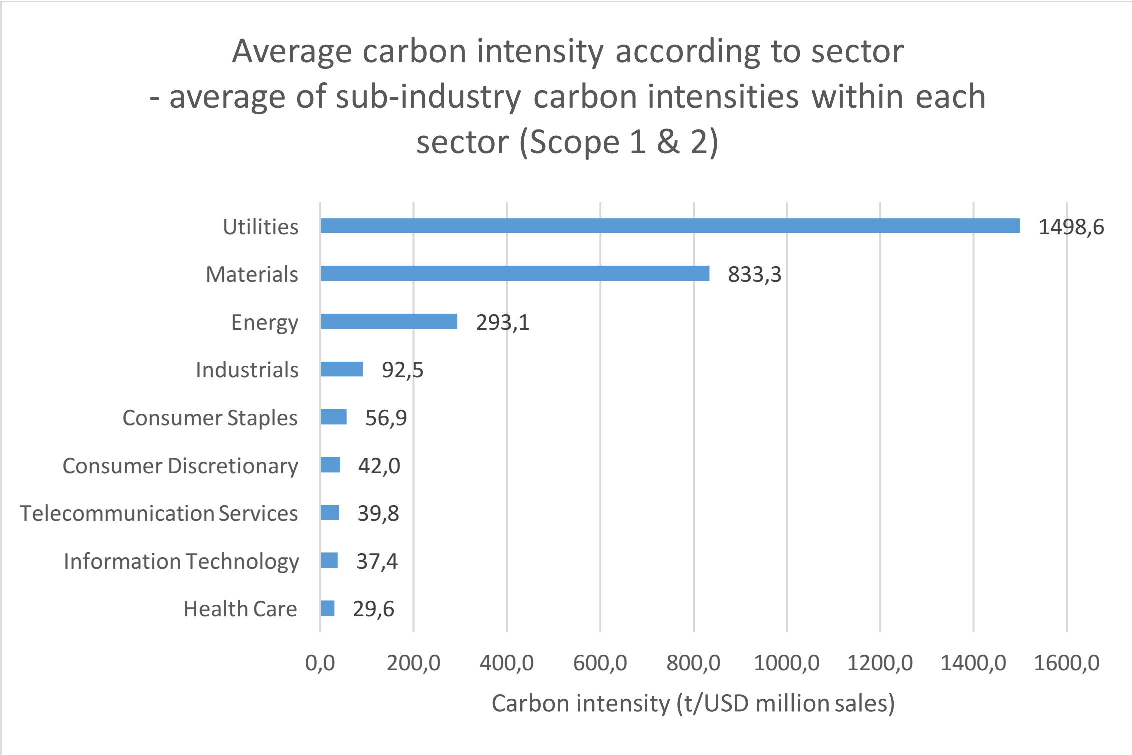



Figure 13. Average carbon intensity according to sector. Calculated as the average of sub-industry carbon intensities within each sector.

The carbon intensity values in figure 13 differ from the ones in figure 12 because the sub-industry level carbon intensities have been calculated according to a group of companies slightly different from the data for this research contains. However, the same sectors can be detected in both figures regarding the most carbon-intensive sectors. There are slight differences among the three least carbon-intensive sectors; telecommunication services, information technology and health care. These differences may be explained by the selection of companies within this research, as the companies within the MSCI Europe Index may contain some additional companies that are above or below the averages of initially calculated sub-industry intensities, thus resulting in slightly different sector averages. Nonetheless, it is evident from both figures, that utilities and materials are clearly the most carbon-intensive sectors. Energy and industrials follow suit, but there is a clear gap in intensity between the energy and materials sector. According to the figures, the research data may comprise of less carbon-intensive companies from the original data, which the sub-industry level carbon intensities have been calculated from, regarding the utilities, materials, energy, telecommunication services and information technology sectors. In contrast, the data used for this research may also comprise of some of the more carbon-intensive companies within the industrials, consumer discretionary, consumer staples and health care sectors. The 25 most carbon-intensive industries are illustrated in figure A.3 found in appendix 1, providing a more detailed view in relation to figure 13.

Figure 14 illustrates the heaviest emitters (amount of $CO_2$ emissions in metric tons) and figure 15 displays the rest of the industries, which emit less on average. These figures also present the relation of scope 1 and scope 2 emissions. Among the 25 heaviest emitters, almost all industries show a majority of scope 1 emissions in relation to scope 2 emissions. Figure 15 with the industries emitting less, shows the opposite. Less carbon-intensive industries with less emissions have a majority of scope 2 emissions, i.e. indirect emissions.

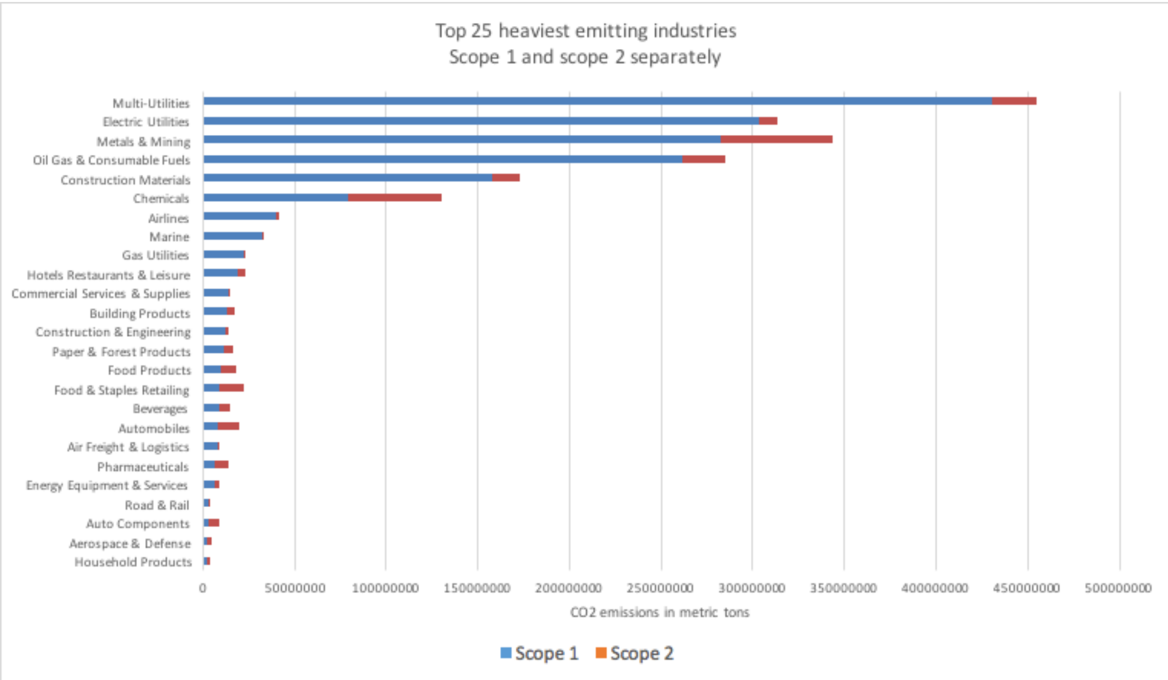



Figure 14. The heaviest emitters of $CO_2$ by industry. Scope 1 and scope 2 emissions separately

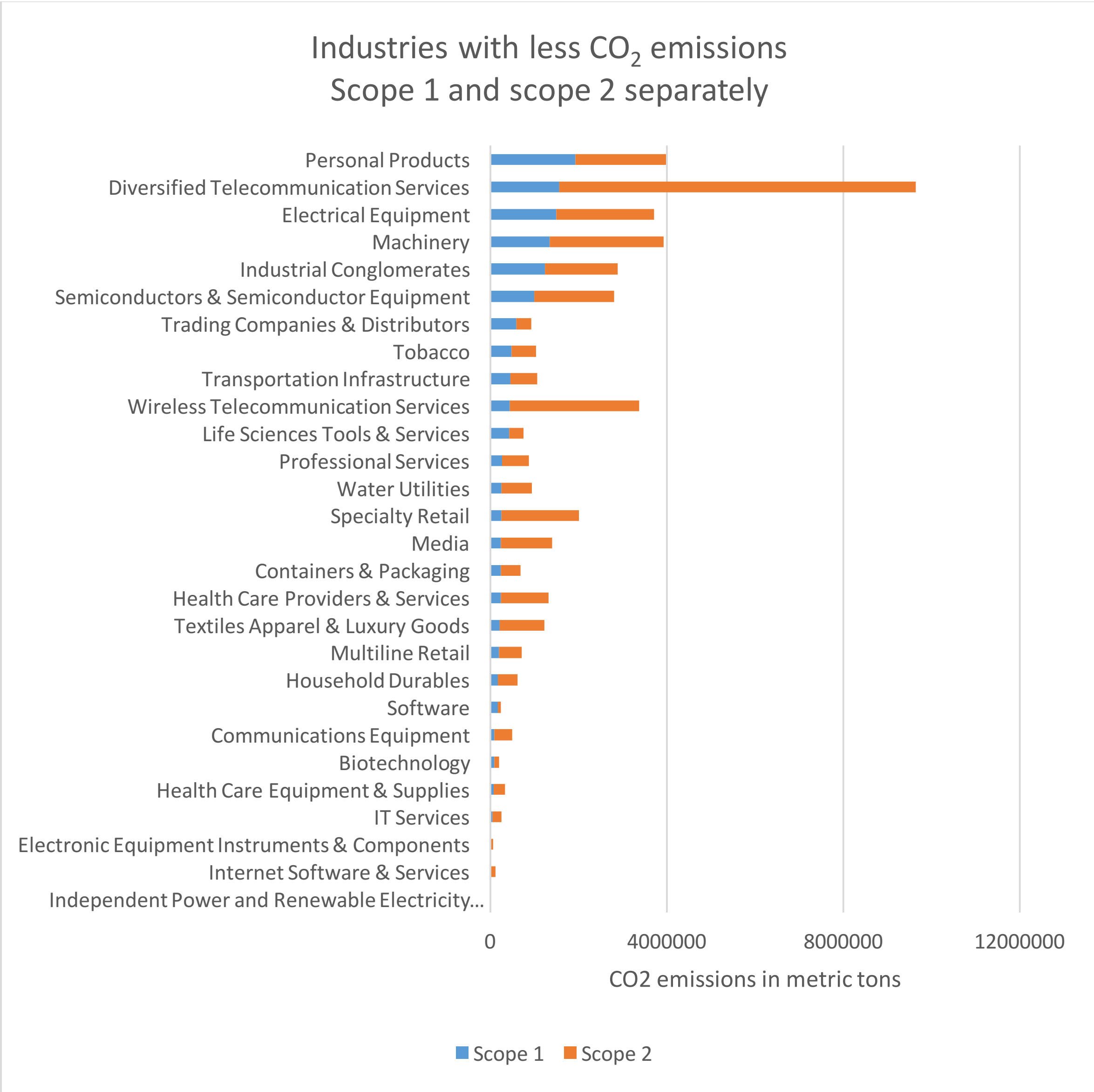



Figure 15. The least emitting industries. Scope 1 and scope 2 emissions separately.

More detailed information on the data: the means, standard deviations as well as minimum and maximum indications can be found in table 7.

Table 7. Mean, standard deviation, min, max and N of selected variables.

| Variable: | Mean | Standard Deviation | Min | Max | N |
|---|---|---|---|---|---|
| **Sales 2014 (MEUR)** | 18431,13 | 33109,88 | 282 | 317468 | 328 |
| **EBITDA 2014 (MEUR)** | 2730,74 | 4251,01 | -101 | 33456 | 328 |
| **Scope 1 emissions (metric ton)** | 5360236,00 | 19604687,95 | 262 | 175100000 | 328 |
| **Scope 2 emissions (metric ton)** | 898906,76 | 2107927,39 | 0 | 16480000 | 328 |
| **Scope 1 & 2 emissions (metric ton)** | 6256830,38 | 20747379,34 | 1021 | 191580000 | 328 |
| **Carbon intensity (Scope 1 & 2) (t/USD million sales)** | 230,68 | 603,72 | 0,30 | 5723 | 328 |

## *5.2 Test value findings on profitability*

The findings on profitability are viewed according to sector. The analysis starts with a test price and cost pass-through rate. These values indicate an increase to the carbon price and a relatively high rate for cost pass-through. The purpose of the test values is to see how the profitability of each sector reacts to this somewhat moderate change in the carbon pricing system. According to the results from the first step, further analyses are made on the impacted sectors with increased prices and cost pass-through rates selected separately according to each sector. The results do not intend to claim these are the alternatives that will be realized in the market, but rather to demonstrate what they could be, and were they to happen, what the impacts on profitability could be. The analysis will start with the most carbon-intensive sectors and move on to the less carbon-intensive.

The first section of the analysis is conducted with a test price increase of €40/t$CO_2$ and an 80% cost pass-through for both scope 1 and scope 2 emissions. This price increase is not unrealistic or too steep, and also the cost pass-through rates suggest that the market is relatively inelastic, so the companies are able to pass the majority of the additional costs on in the value chain. This scenario is not too hard on companies, but is enough to distinguish the sectors that are impacted by the price increase from the ones that are not. Already a change of a few percentages in profitability can be qualified as significant, as the relative amount in monetary value is large. In this study, a change of 5% in profitability and anything beyond that, is considered significant. According to the preliminary findings displayed in figure 16, utilities, materials, energy and industrials seem to be the most affected industries, although energy and industrials are not significantly impacted.

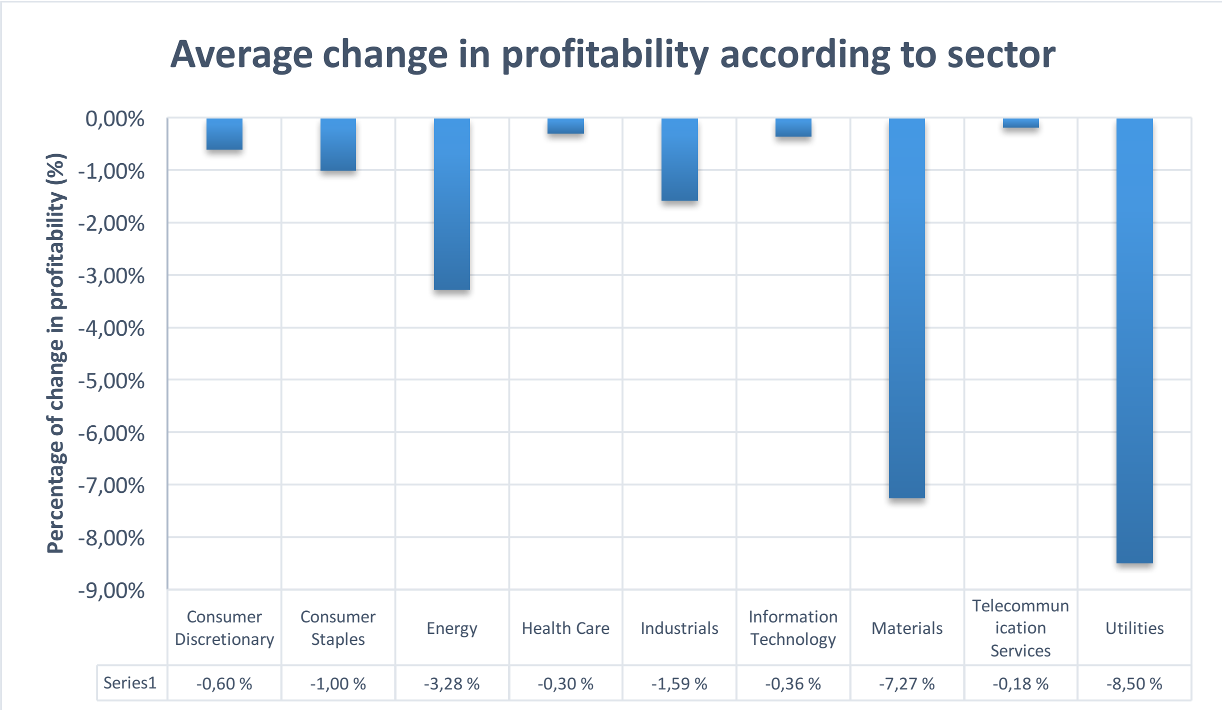



Figure 16. Test value findings on the average change in profitability

The preliminary results go together with the results on carbon intensities and emission rates. It is expected that the sectors which are categorized as high emitters of $CO_2$ or have high carbon intensities would also be most impacted by the increasing carbon price. Summaries on the results with a €40/t$CO_2$ price increase and cost pass-through of 80% according to each sector are displayed in Appendix 2.

Figure A.4 in appendix 2 displays how the utilities sector is clearly affected by the carbon price, with no outliers distinguished in the summary, as the mean and standard deviation (0,081) are of similar values. Even though the number of companies within the sector is relatively small (N=22), the data within this sector can be described as reliable due to the distribution of results, resulting in no anomalies. This gives the impression that the whole sector is impacted by the price increase. With just a price increase of €40/t$CO_2$ and relatively high cost pass-through rates, the average change in profitability for this sector is as high as -8,5%. The median of the changes in profitability within the Utilities sector is -0,059 (-6%).

Some of the sectors have a larger standard deviation compared to the mean, raising the issue of outliers (appendix 2). It is however expected that there could even be significant variation within the sectors as to how much companies and industries within the sectors are impacted. This is because as the companies for this research where randomly selected, i.e. not according to for example carbon intensities, there can be various types of companies within each sector. The sectors cover numerous industries, which may differ from one another. Because of this, the results are not normally distributed. This is why it is preferable to also look at the median of each sector, as this is a good indicator of the changes in profitability within skewed and dispersed distributions, lacking a clear centre. The outliers in this research present interesting findings within the sectors and this is why industry-level analyses are further conducted.

The materials sector is the second most impacted sector according to figure 16 and also figure A.5 in appendix 2. The materials sector comprises of 41 companies, with an average of a -7% impact on profitability. The median of this sector is -0,046 (-4,6%). This sector has three outliers with a larger standard deviation (0,088) compared to the mean. These outliers have high impact percentages (approximately -30% to -40%). The median suggests that the sector is quite impacted and the outliers should be further studied as they may present carbon-intensive industries within the sector.

The energy sector is the third most impacted sector, with 17 companies. On average, the change in profitability is -3% and the median is -0,027 (-2,7%) (figure A.6). The results are evenly distributed approximately between 0% and -4%, but the rest of the companies are more widely distributed. The industries on the outskirts are heavily impacted by the carbon price increase with approximately -8% and -16% impacts. Even though the sector is not significantly impacted by the $CO_2$ price increase of €40/$tCO_2$, due to its carbon intensity and outliers, the sector is in need of further analysis.

Industrials is the largest sector in the study consisting of 82 companies. The average impact on profitability is only -1,6%, which is not considered significant (figure A.7). The median for this sector is even lower, -0,003 (-0,32%). The companies are very scattered within this sector with a higher standard deviation related to the mean, resulting in having the most outliers compared to the other sectors. However, as this sector comprises of the highest number of companies compared to the rest of the sectors, this distribution is somewhat expected. Nonetheless, because this sector beholds quite a few companies that are significantly affected, the sector is in need of further analysis.

Consumer staples comprises of 40 companies with companies closely situated, but some outliers, with one as far as -10% (figure A.9). This is a big difference from the mean, which is -1% and the median 0,008 (0,8%). The outliers will be further analysed.

The rest of the sectors, consumer discretionary (figure A.8), health care (figure A.10), telecommunication services (figure A.11) and IT (figure A.12) are not significantly impacted by the carbon price increase. Consumer discretionary consists of widely distributed companies, with some industries that could be found interesting within the sector. The rest of the sectors are not impacted. The IT sector consists of three outliers, with one outlier exception resulting in a -3% impact on profitability, which is also the largest impact regarding these three sectors. The telecommunication services sector is the closest to having a normal distribution with no anomalies. This also makes it clear to have not been impacted by the carbon price as the largest change is -0,44%. The health care sector is mostly distributed between the impacts of 0% to -0,40%, with a few outliers having the biggest impact of -1,6%. As these last three sectors do not have interesting results from the point of view of this study, they will only be briefly analysed.

### *5.3 Scenario analysis*

This section will present the findings on the scenarios and the main results of the research. The sectors that are further analysed are the utilities, materials, energy and industrials sectors. As was discovered from the figures in appendix 2, also consumer discretionary and consumer staples possibly offer some insight on industries that are more affected than the average industries within these sectors. In addition to these sectors, some additional insight on the health care, telecommunication services and IT will be provided, in order to demonstrate how much less these sectors are impacted overall.

The scenario analyses are conducted according to the same price alternatives across the sectors, but the cost pass-through rates vary accordingly. The prices reflect a realistic price increase (€55/t$CO_2$), a steep price increase (€105/t$CO_2$) and a heavy price increase (€200/t$CO_2$). These prices are then tested with different cost pass-through (CPT) rates, depending on the sector. The CPT rates are explained according to each sector. The sectors are analysed individually, starting with the utilities sector. Appendix 3 provides more extensive disclosure on the impacts within each sector.

**Utilities**

The utilities sector shows impacts throughout the sector. This sector consists of only 22 companies within five industries, but it has the highest average in the change in profitability. As was stated, with the test values of €40/t and 80% CPT, the average change in profitability was already significant (-8,5%). This can be considered a sector that is heavily impacted by an increase in the $CO_2$ price as with already a realistic €40 increase and an 80% CPT rate, significant impacts emerge. With this CPT rate the company does not end up paying but a minority of the additional costs deriving from the price increase.

For the scenario analysis, the utilities sector is set with the aforementioned price increases of €55/t$CO_2$, €105/t$CO_2$ and €200/t$CO_2$. These prices are tested with CPT rates of 0%, 40%, 60%, 80% and 100%. All the sectors are tested with 0% and 100% CPT rates as these give the worst case and the best case of passing costs. They provide good benchmarks in between sectors as well. The CPT rates between these benchmarks slightly vary between sectors.

The companies within the utilities sector are likely to have relatively high CPT rates. This is why the sector is reviewed according to higher rates, mostly between 60-100%, whereas a 40% CPT is not as likely. (Sijm et al. 2006, 49; Cramton & Kerr 2002, 334) Figure 17 shows the average impacts within the sector according to the given CPT rates and price increases. Naturally the heaviest impacts derive from the lower CPT rates and the highest prices. The heaviest impacts are as much as -78,47%, -55,28% and -136,07%. These are the worst case scenarios with the €200 price increase per ton, but also the other price increases impact the profitability figures notably.

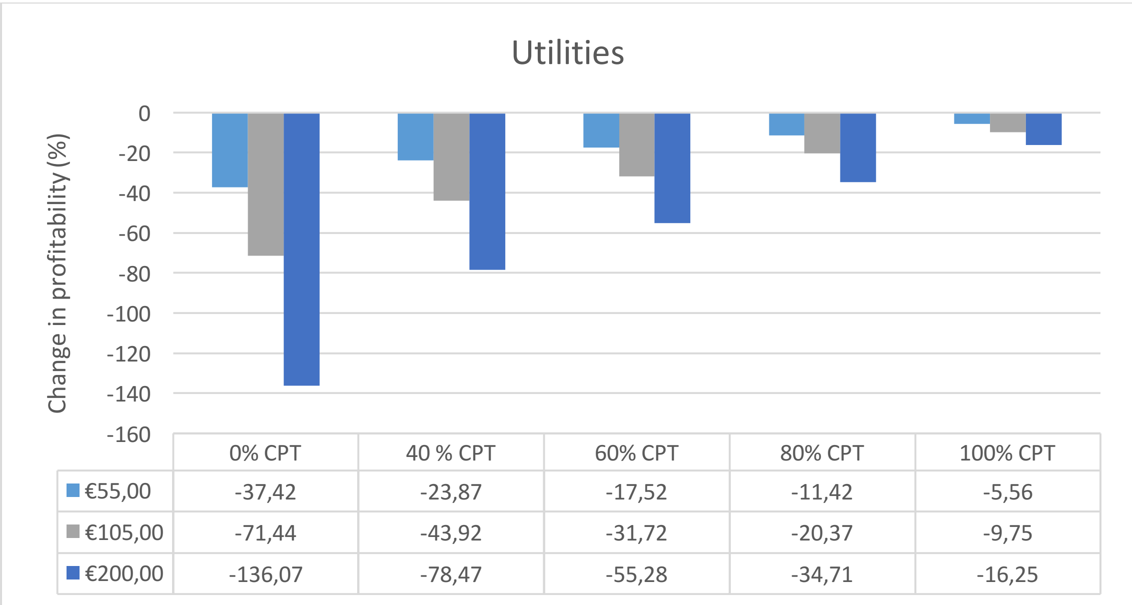
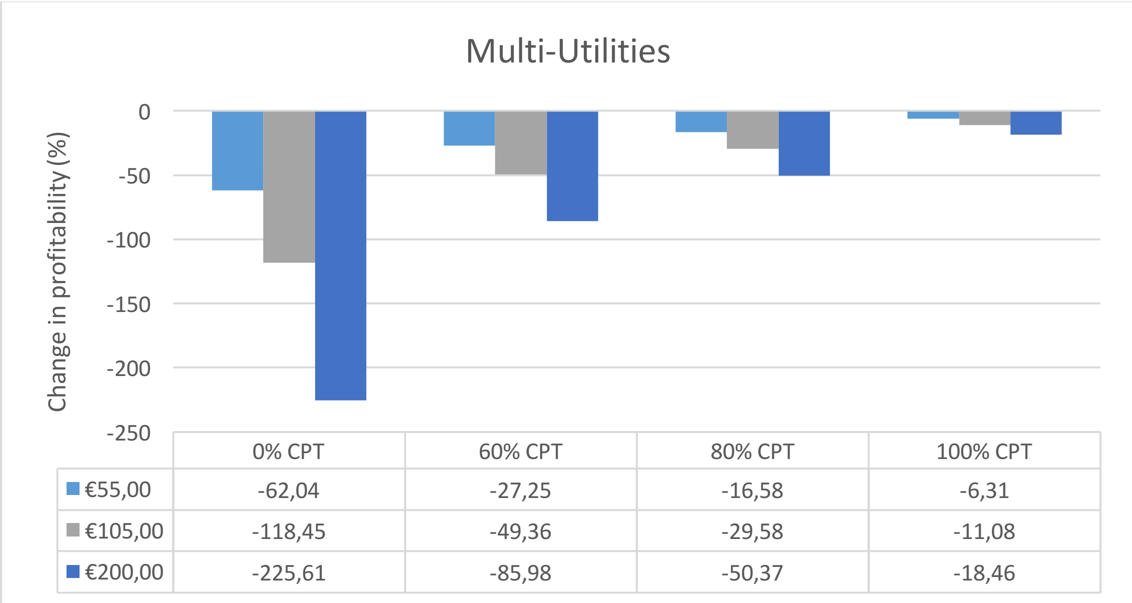


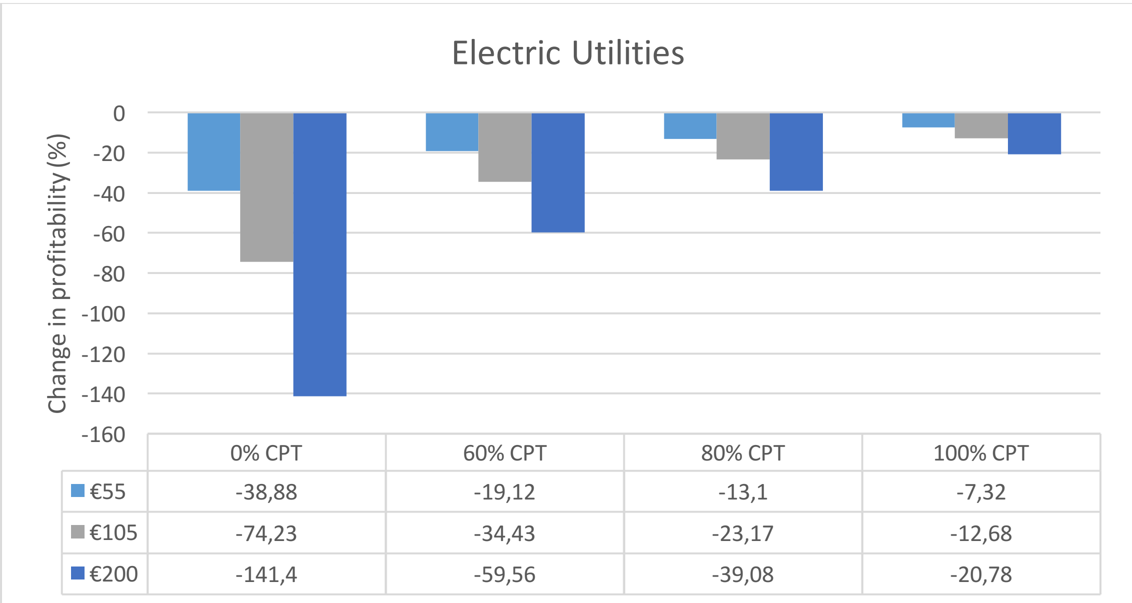

Figure 17. Utilities sector profitability changes with different prices and cost pass-through rates

What is noteworthy, is that the impact even with a 100% CPT rate and the lowest price increase is beyond the -5% impact. Everything else after this best-case scenario is of heavier impact. The most affected industries within the sector are the multi-utilities (figure 18) and electric utilities (figure 19). The largest changes in profitability are drastic. The least impacted industry in this sector is the independent power and renewable electricity producers, which consists of just one company. This company is a renewable electricity company.




| | 0% CPT | 60% CPT | 80% CPT | 100% CPT |
|---|---|---|---|---|
| €55,00 | -62,04 | -27,25 | -16,58 | -6,31 |
| €105,00 | -118,45 | -49,36 | -29,58 | -11,08 |
| €200,00 | -225,61 | -85,98 | -50,37 | -18,46 |

Figure 18. Impacts on the Multi-Utilities industry




| | 0% CPT | 60% CPT | 80% CPT | 100% CPT |
|---|---|---|---|---|
| €55 | -38,88 | -19,12 | -13,1 | -7,32 |
| €105 | -74,23 | -34,43 | -23,17 | -12,68 |
| €200 | -141,4 | -59,56 | -39,08 | -20,78 |

Figure 19. Impacts on the Electric Utilities industry

Despite the high CPT rates, the multi-utilities and electric utilities industries show significant impacts on company profitability. To compare, the five industries of the sector were all separately tested according to the 80% CPT rate. Figure 20 shows the differences between industries.

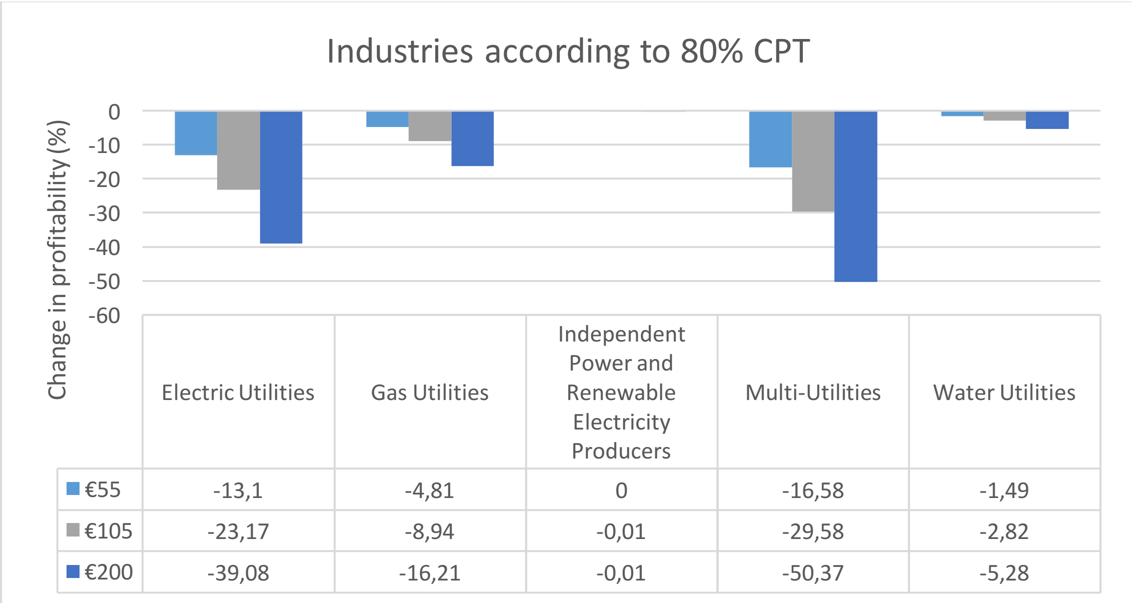



Figure 20. Industries of the Utilities sector compared with 80% CPT

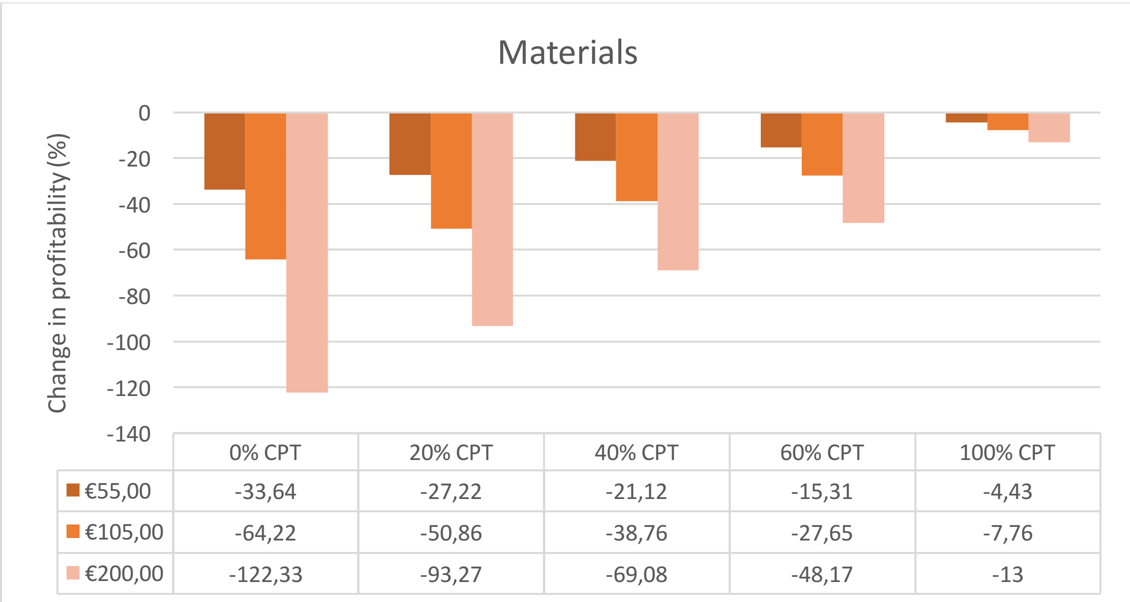
The gas utilities industry is the third most impacted industry, followed by the water utilities industry. However, the water utilities industry is only significantly impacted with the €200 price increase. The renewable electricity company remains unaffected. Even with a high CPT rate of 80%, three of the industries are significantly impacted by all the provided price increase alternatives.

The largest companies according to sales within this sector are found in the multi-utilities and electric utilities industries. Most of the sectors' companies are situated in these industries. These two are the largest industries with larger sales (bigger companies) and also most impacted by the change in the $CO_2$ price.

**Materials**

The materials sector is significantly affected by $CO_2$ price increases, after the utilities sector in comparison. This sector contains 5 industries and 41 companies. This sector differs from the previous utilities sector as the industries have more variance because they consist of companies conducting business with various materials. These materials bring changes into how well costs can be passed through and also notable variance between the industry impacts. This sector includes three outliers that need to be further inspected as they signify drastic changes in profitability.

As the industries vary from one another, it is challenging to place a CPT rate that could apply to all the industries. The average CPT is nonetheless slightly lower than in the utilities sector. This is because iron, cement and some paper products industries for example are relatively dependent on trade and thus may not be able to pass through costs as efficiently. (Carbon Trust 2008, 5; Arlinghaus 2015, 20; World Bank Group & Ecofys 2015, 10, 53) Figure 21 shows the impacts on profitability with CPT rates of 0%, 20%, 40%, 60% and 100%. Within all of the price and CPT alternatives the impacts are considerable. With an average CPT rate of 60% the impacts are still as notable as -15%, -27% and -48%. Even with a full CPT rate (100%) the changes are significant.




| | 0% CPT | 20% CPT | 40% CPT | 60% CPT | 100% CPT |
|---|---|---|---|---|---|
| €55,00 | -33,64 | -27,22 | -21,12 | -15,31 | -4,43 |
| €105,00 | -64,22 | -50,86 | -38,76 | -27,65 | -7,76 |
| €200,00 | -122,33 | -93,27 | -69,08 | -48,17 | -13 |

Figure 21. Materials sector profitability changes with different prices and cost pass-through rates

Figure 22 demonstrates the impacts on profitability with a 60% CPT rate according to industry. Construction materials is most heavily impacted by the increase in the $CO_2$ price, followed by metals and mining, then paper and forest products and also chemicals. The impacts are nonetheless significant in all the industries, but smallest within the containers and packaging industry, reaching a significant impact with the €105/t$CO_2$ price increase.

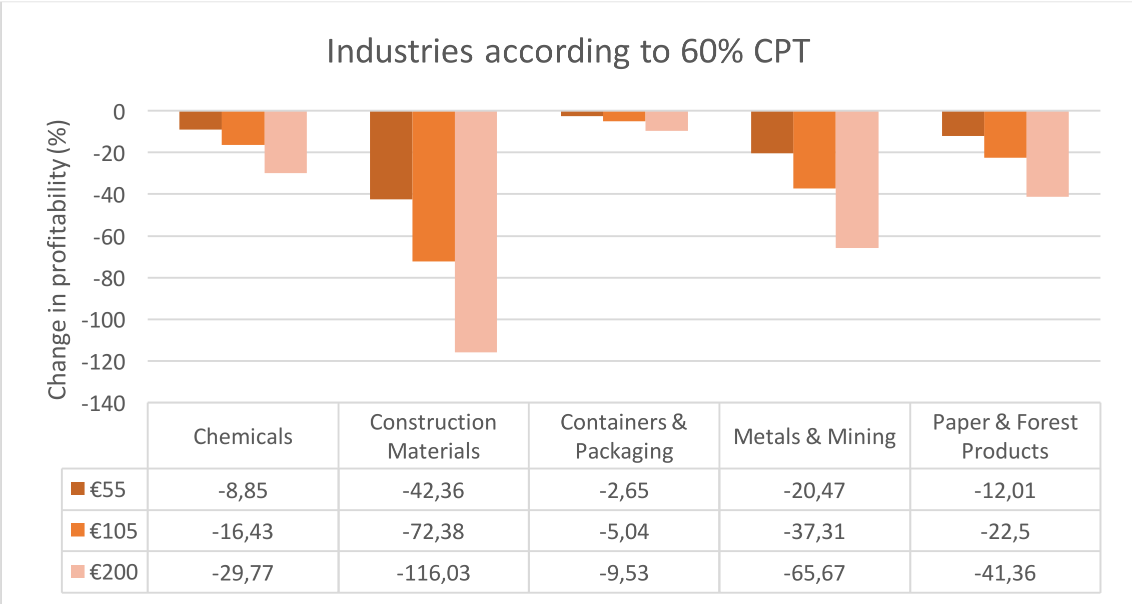


Figure 22. Industries of the Materials sector compared with 60% CPT

Figure 23 shows the different impacts within the construction materials industry. Even with a CPT of 100%, the effects are significant on profitability with -13%, -21% and -31%.

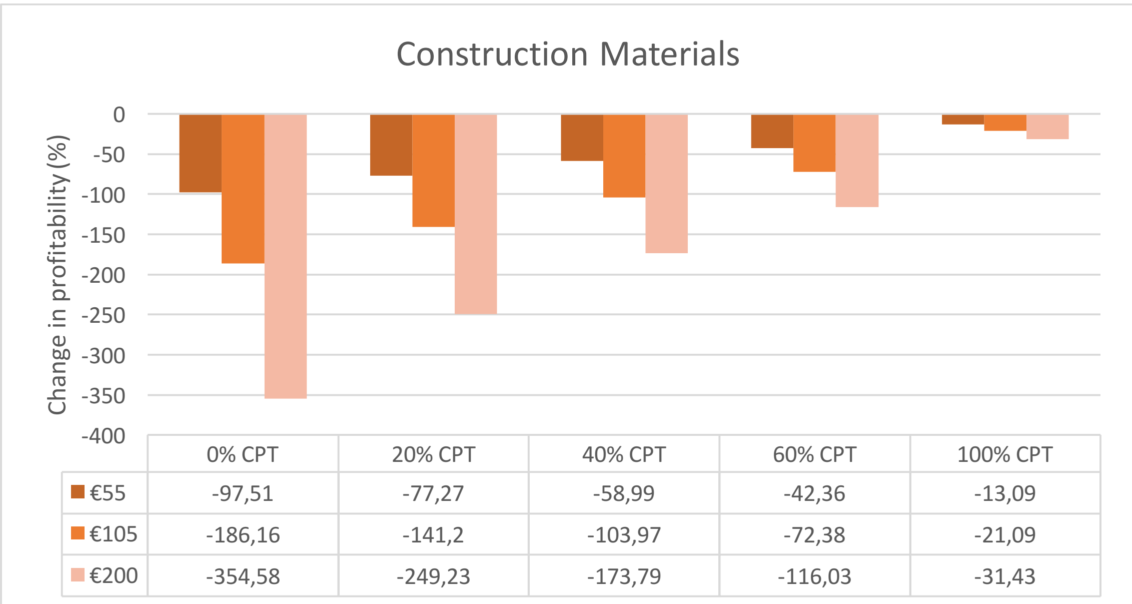
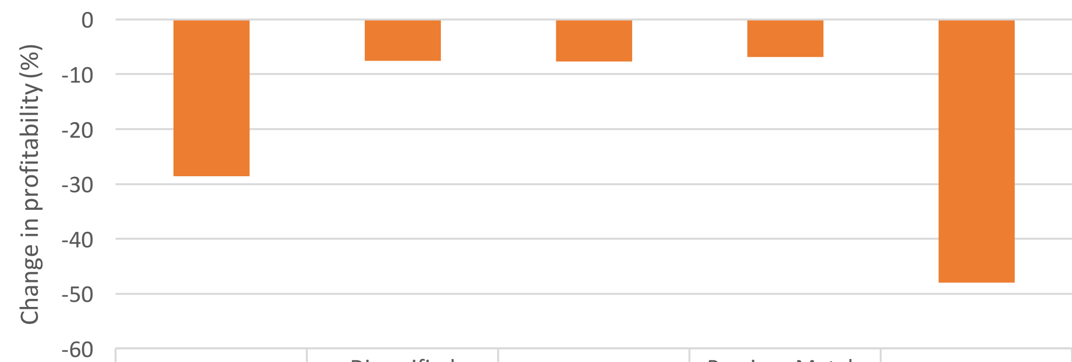


Figure 23. Impacts on the profitability on Construction Materials

As the metals and mining industry contains various distinctive sub-industries, closer examination is conducted on the sub-industry level. Figure 24 displays the impacts on the five sub-industries of the metals and mining industry, according to a €55 price increase and 60% CPT. This industry contains 11 companies with the largest number of companies (five) within the diversified metals and mining SI and three companies within the Steel SI. Otherwise the SI's include 1 company per SI. The number of companies is small, so generalizable findings cannot be distinguished, but they do give an idea of how these SI's might react to an increased $CO_2$ price. The aluminium and steel sub-industries are heavily impacted within this industry. The other sub-industries (SI) are also significantly affected, but not as drastically. The metals and mining industry as a whole is impacted by as much as -20,47% on average with the scenario displayed in figure 24.




| | Aluminum | Diversified Metals & Mining | Gold | Precious Metals & Minerals | Steel |
|---|---|---|---|---|---|
| Series1 | -28,54 | -7,6 | -7,74 | -6,9 | -47,98 |

Figure 24. Impacts within the Metals & Mining industry on sub-industry level

Within the remaining industries, containers and packaging may have particularly low CPT rates in reality. These CPT rates can even be as low as 0% or 20%-25%. (Oberndorfer, Alexeeva-Talebi and Loeschel 2010; Arlinghaus 2015, 18-19) The outliers of the materials sector belong to the construction materials industry, aluminium and steel SI's.

The largest companies according to sales figures are found within the metals and mining, chemicals and construction materials industries.

**Energy**

The energy sector comprises of 17 companies and two industries. The sector was not significantly impacted according to the test values (figure 16) as the average impact was approximately -3% and significant outliers where detected within the sector. Figure 25 illustrates the impacts on the sector with the selected cost increases and CPT rates.

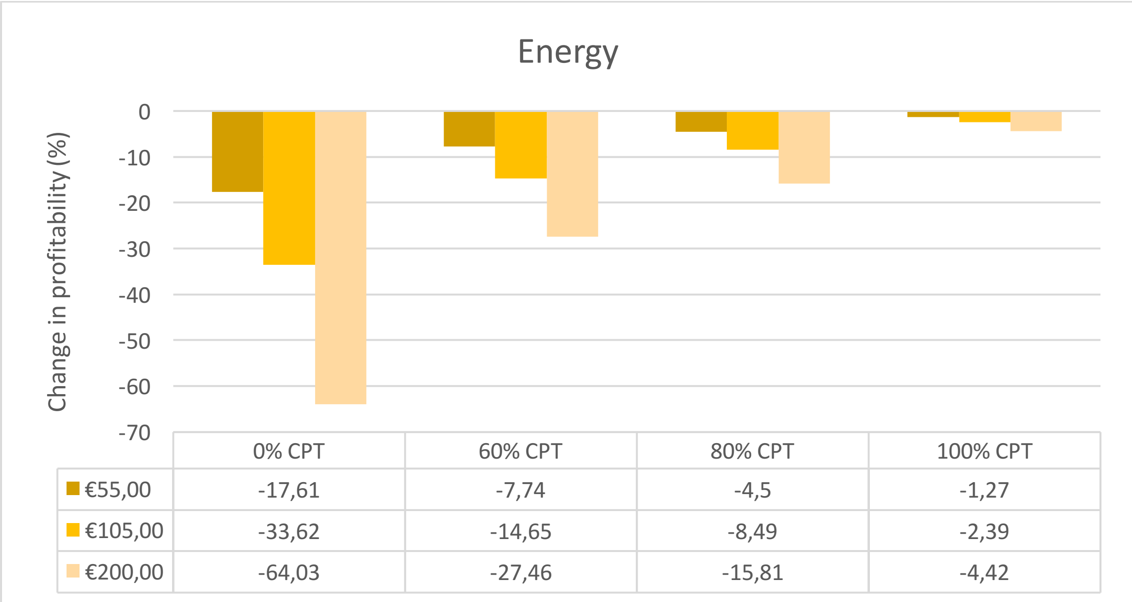



Figure 25. Energy sector profitability changes with different prices and cost pass-through rates

The energy sector is one that will most likely be able to pass on the majority of its additional costs. The figure above shows the profitability affects with CPT rates of 0%, 60%, 80% and 100%. It has been stated that the energy sector is able to pass through as much as 60-100% of its additional costs. (Sijm et al. 2006, 49; Cramton & Kerr 2002, 334; Arlinghaus 2015, 20) With the high rate of 100%, there is no significant effect on company profitability. The lower rates show impacts. As was stated previously in regard to the summary statistics, there are outliers within the sector that showed significant changes in profitability. Because the energy sector only comprises of two industries and important sub-industries, they are not studied separately but rather the impacts of all of them are displayed in table 8 with a price increase of €55/t$CO_2$ and a CPT rate of 60%.

Table 8. Profitability impacts within the Energy sector regarding the industries and SI's

| Comparing industries and sub-industries with €55/60% CPT | Change in profitability |
|---|---|
| **Energy** | **-7,74 %** |
| **Energy Equipment & Services, N=6** | **-2,44 %** |
| Oil & Gas Drilling, N=1 | -2,08 % |
| Oil & Gas Equipment & Services, N=5 | -2,51 % |
| **Oil Gas & Consumable Fuels, N=11** | **-10,64 %** |
| Integrated Oil & Gas, N=8 | -11,29 % |
| Oil & Gas Exploration & Production, N=1 | -0,32 % |
| Oil & Gas Refining & Marketing, N=1 | -23,73 % |
| Oil & Gas Storage & Transportation, N=1 | -2,66 % |

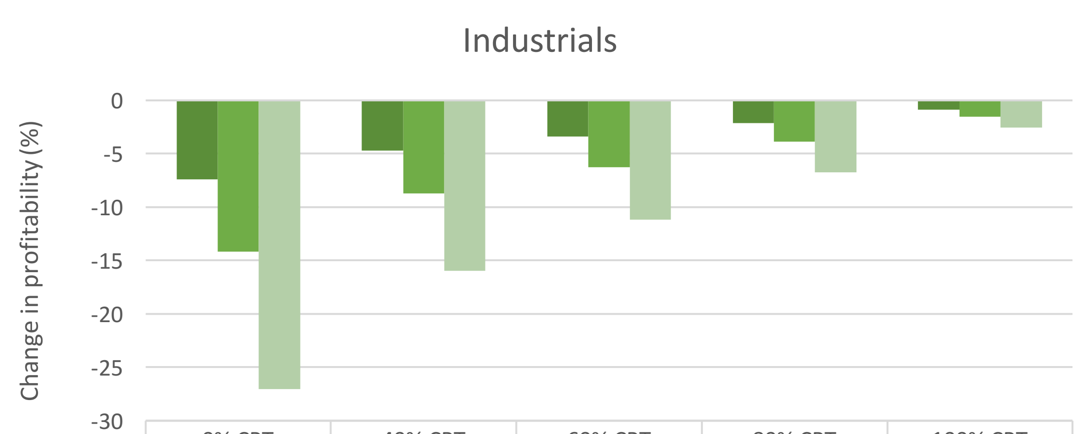
As table 8 displays, the impacts are greater in the oil gas and consumable fuels industry than within the energy equipment and services industry. The outliers detected in the summary statistics were found within the oil gas refining and marketing SI consisting of one oil company, and one company within the integrated oil and gas SI. The other companies within the integrated oil and gas SI were not as heavily impacted as this one particular company, but the SI as a whole was impacted by an average of -11,29%.

As we can see from the table disclosed in appendix 3, the impacts are not significant with a 100% CPT rate. Some significance can be detected with an 80% CPT rate, especially within the oil gas and consumable fuels industry. It is evident that this sector needs a smaller CPT rate in order to be notably affected on a wider scale. All the larger companies within this sector are found within the oil gas and consumable fuels industry.

### Industrials

Industrials is the largest sector within this research. The sector has the largest amount of companies (N=82), industries (N=14) and sub-industries (N=21). Despite the average change in profitability not being significant on a whole, it requires further analysing due to its size. The sector contains industries that are more vulnerable to $CO_2$ price changes than the average industries within the sector and thus require closer inspection. Figure 26 shows the sector according to the three price increases and CPT rates substantive for this sector. The chosen CPT rates for this sector are 0%, 40%, 60%, 80% and 100%.

The only significant change within the lower price increases is when the CPT rate is 0. With a price increase of €105/t$CO_2$ and a 60% CPT rate, the impact is also significant with a -6% effect on profitability. Even with a €200/t$CO_2$ price increase, the impacts are trivial when the costs are fully passed through. However, as the summary statistics in appendix 2 demonstrate, the specimen within this sector were widely distributed and many showed significant affects regarding the test values. Due to the large number of industries and companies within the sector, a table was made with the effects regarding a €55/t$CO_2$ price increase and a 60% CPT rate in order to show the results regarding all the industries within the sector (table 9).




| | 0% CPT | 40% CPT | 60% CPT | 80% CPT | 100% CPT |
|---|---|---|---|---|---|
| €55,00 | -7,43 | -4,71 | -3,41 | -2,14 | -0,9 |
| €105,00 | -14,19 | -8,75 | -6,25 | -3,86 | -1,55 |
| €200,00 | -27,03 | -15,95 | -11,2 | -6,77 | -2,59 |

Figure 26. Industrials sector profitability changes with different prices and cost pass-through rates

With the values €55/t and 60% CPT, the industries which show significant impacts are airlines, commercial services and supplies, marine, and road and rail. The construction and engineering industry comes close as well with -4,65% change in profitability. From these industries airlines is also significantly impacted with the same price and CPT rate of 100%. The other industries are impacted notably with a €105 price increase along the 100% CPT rate. Among the varying CPT rates and price increases, extremely heavy impacts are detected. These are reported in the table displayed in appendix 3. Table 9 supports the findings of the test values in section 5.2 and shows the amount of variance between the industry impacts, as some of the industries are only marginally impacted.

Table 9. Profitability impacts within the Industrials sector regarding the industries and SI's

| Comparing industries and sub-industries with €55/60% CPT | Change in profitability |
|---|---|
| **Industrials** | **-3,41%** |
| **Aerospace & Defense, N=9** | **-0,74 %** |
| **Air Freight & Logistics, N=4** | **-8,97 %** |
| **Airlines, N=3** | **-25,65 %** |
| **Building Products, N=3** | **-3,92 %** |
| **Commercial Services & Supplies, N=7** | **-8,16 %** |
| Diversified Support Services, N=4 | -13,50 % |
| Office Services & Supplies, N=1 | -0,61 % |
| Security & Alarm Services, N=2 | -1,26 % |
| **Construction & Engineering, N=6** | **-4,65 %** |
| **Electrical Equipment, N=6** | **-1,51 %** |
| Electrical Components & Equipment, N=5 | -1,76 % |
| Heavy Electrical Equipment, N=1 | -0,22 % |
| **Industrial Conglomerates, N=3** | **-0,58 %** |
| **Machinery, N=18** | **-0,67 %** |
| Agricultural & Farm Machinery, N=1 | -0,43 % |
| Construction Machinery & Heavy Trucks, N=3 | -0,53 % |
| Industrial Machinery, N=14 | -0,72 % |
| **Marine, N=2** | **-5,69 %** |
| **Professional Services, N=7** | **-0,45 %** |
| Human Resource & Employment Services, N=3 | -0,27 % |
| Research & Consulting Services, N=4 | -0,58 % |
| **Road & Rail, N=1** | **-19,30 %** |
| Trucking, N=1 | -19,30 % |
| **Trading Companies & Distributors, N=7** | **-0,46 %** |
| **Transportation Infrastructure, N=6** | **-0,52 %** |
| Airport Services, N=3 | -0,61 % |
| Highways & Railtracks, N=3 | -0,42 % |

The outliers of the industrials sector belong to the aforementioned impacted industries. One company showed significant impact also within the air freight and logistics industry and one within the diversified support services SI, which lifted the overall percentage of the commercial services and supplies industry. For the latter industry it can thus be stated that the industry is not wholly affected, but rather there can be company exceptions such as the mentioned one. Construction and engineering and also building products showed a few slight impacts so they could be potential industries that could be significantly affected did the carbon price rise notably. Marine also included just one company (out of the two) which was significantly affected so this result can neither be generalized. This also applied to road and rail, which only comprised of one company in this study, but it could show potential carbon price vulnerability for the industry. Thus the outcome is that from the industrials sector, we can say that the airlines industry is the only one that is significantly impacted. The other industries which show impacts in table 9 may potentially be vulnerable. The largest companies of the sector are found within the industrial conglomerates, aerospace and defence, air freight and logistics, building products and construction and engineering industries.

**Consumer Discretionary and Consumer Staples**

The consumer discretionary and consumer staples sectors are not comprehensively impacted by carbon pricing. There are nonetheless a few specific industries that stood out through further analysis. The consumer discretionary sector (N=66) showed impacts within the hotels, restaurants and leisure industry, more specifically the hotel resorts and cruise lines sub-industry (see appendix 3). Within this sub-industry, three companies showed significant impact and one company showed slight impact. Also auto components industry and the computer and electronics retail sub-industry within the speciality retail showed some impacts. However, this sub-industry only comprised of one company so this cannot be generalized.

The Consumer Staples sector (N=40) showed impacts within the food and staples retailing industry (N=12) and food products (N=9). These are not heavily impacted, excluding a few exceptions, but they could face potential threats in the case the price increase of $CO_2$ is steep. If costs are passed through, the industries are not notably impacted.

**Health Care, Information Technology and Telecommunication Services**

The remaining sectors are reported together because none of them showed notable changes in the profitability of the companies. Some of the industries show affects at the steep price increase (€200), with one exception showing some impact with a €55 price increase and no CPT (see appendix 3).

# 6 DISCUSSION

This chapter will go through the findings, establishing their relation to earlier research on the topic. The profitability impacts of emissions pricing have not been widely studied, rather prior studies have mostly concentrated on the competitiveness effects. In addition, these effects have seldom been studied as extensively as in this research, as prior research has mostly concentrated on a few specific sectors or industries (e.g. power, energy or pulp and paper). Competitiveness factors are nevertheless closely linked to the topic and important issues to consider when studying profitability impacts because competitiveness also affects cost pass-through possibilities. CPT then directly affects profitability.

In this research, all the sectors were analysed according to the same prices; €55/t$CO_2$, €105/ t$CO_2$ and €200/ t$CO_2$. The CPT rates were similar, but slightly altered between the sectors. The reason why the prices were determined the same for all the sectors is because the three prices already are widely scaled and give a comprehensive perspective on the possible effects of carbon pricing. This also makes it easier to compare the level of impact between industries. In reality, carbon pricing will probably vary more according to the sectors and industries, but the aim of this research is to determine the effects on profitability and this is fulfilled. The prices are thus not precise (and cannot be) but they give a perspective on the impacts, as there is notable scale between the utilised prices. It is expected that the carbon price will nonetheless increase in the future to meet the 2° target, and this is what the research relies on. Especially as the COP21 agreement has been ratified, actions must next be taken to reduce emissions. Increasing the carbon price is one way to encourage companies to do so.

The carbon price increases were determined from prior studies. It has been stated (Ch. 2.2.4), that for investments (in emissions reductions) to be of value for companies, the carbon price should be close to €55/t$CO_2$ (Abadie and Chamorro 2008, 3012). It was also said that in order to meet the 2° target, carbon prices should range between 80 USD/t$CO_2$e (€71/t$CO_2$) and 130 USD/t$CO_2$e (€115/t$CO_2$) (World Bank Group and

Ecofys 2015, 24). The price of €105/t$CO_2$ was determined from these. The steeper rise of €200/t$CO_2$ is not the highest price utilised, but this was obtained from internal carbon pricing values (Ch. 2.2.3) and was determined as a steep enough rise to be considered as the highest rise in price for this research.

The CPT rates utilised were also generalized and not specific. This is also to be able to give a wide understanding on the effects and approximate rates. It has been stated that iron, refineries and steel industries would be able to pass through costs completely (100%) (De Bruyn et al. 2010), and others have said that the CPT rate for steel manufacturers is 65% (Smale, et al. 2006, 47). Trade impacts and carbon leakage are problematic for iron, cement, glass, tyres, copper and household paper products (Carbon Trust 2008, 5). The manufacturing sector as a whole has been said to be quite open to international trade. This could mean that the realized CPT rates could be even lower than expected for these industries, if competitiveness factors suffer with higher CPT rates. The energy sector has been able to pass costs through effectively. The electricity industry has also been able to pass costs on well in electricity prices. As previous research is not unequivocal concerning CPT rates, general rates were utilised and slightly altered as higher or lower, depending on how prior research has seen industries to be able to pass additional costs through. The same rates were also utilised for both scope 1 and scope 2 emissions because not enough information was available to determine how these CPT rates could potentially differ from each other.

The data introductory distinguished how the scope 2 emissions were riskier for less carbon-intensive industries than scope 1 emissions. This is because these industries produce little if any direct emissions and scope 2 emissions are the emissions which could affect them, and where reductions and cost savings could be made. These scope 2 emissions comprise of the electricity the company utilises. For the majority of the carbon-intensive industries this works in the opposite way as scope 1 emissions are the emissions they need to reduce, in order to decrease their carbon risk. Identifying the risk source, i.e. scope 1 or scope 2 emissions, could help companies to reduce the carbon costs involved. This could even be used as an advantage if for example a company utilises a lot of electricity in its operations but hardly produces any emissions of its own, it will benefit from targeting energy efficiency or buying electricity from renewable electricity producers, through reductions in electricity bills and also the carbon costs associated. It is noteworthy that companies with lower, and mainly scope 2 emissions, are nevertheless impacted by increasing carbon prices even though these companies would not be included in emissions trading and directly priced for their $CO_2$ emissions. These companies and industries are indirectly affected by carbon pricing due to increases in input prices, e.g. electricity.

CDP stated in their study that the highest internal carbon prices are detected within the utilities, materials, consumer discretionary, energy and partly the industrials sector (Ch. 2.2.3). Sectors that utilise lower prices are consumer staples, health care and IT. This is interesting as the higher prices are utilised within the sectors that are most vulnerable to the carbon price increases, according to the findings of this research. This means that these sectors may be severely affected by the increase in carbon pricing, if they are also subject to the end of the spectrum, where higher prices are utilised. The sectors that utilise lower internal prices may then be even less affected by carbon pricing than what the results of this research shows. Lower prices are utilised by sectors that do not see carbon pricing as a risk for their operations. This is an intriguing finding in the case that future carbon prices will vary notably between sectors and industries. According to this finding, the profitability within industries with high emission rates will undergo significant impacts, while the industries with less emissions will be faced with smaller carbon prices. This leaves an open question regarding the outliers within the less carbon-intensive industries that have higher emission rates than the average – will they also be left with the lower carbon price even though their emissions could be relatively high?

As reported earlier, ETS' are constantly expanding and changing. Currently the EU ETS for example only covers certain industries (e.g. power and manufacturing) and GHGs. Industries that are not yet covered and have relatively substantial emission rates (for example the food industry or real estate), however, need to be cautious as the system may be expanded towards them in the future due to the pressure deriving from the 2° target. Carbon Trust (2008, 8) has stated that all sectors will be required to face carbon costs if a low carbon economy is to be achieved. They predict that the carbon price will be approximately €20-40/t$CO_2$ already by 2020. Many industries emitting $CO_2$ are not yet included in the system, as the EU ETS covers 45% of EU's GHG emissions. This is the reason this research aimed to look into the 9 sectors comprehensively as many industries have distinctively been left out of the academic research. Carbon pricing should be implemented on a global scale as well to mitigate carbon leakage and to avoid creating unequal positions regarding competitiveness factors for trade-exposed industries.

According to this research, the sectors that are most affected by increases in the carbon price are the utilities, materials, energy and partly the industrials sectors. The industries within these sectors show significant changes in the profitability when the carbon price increases (approximately a 5% decrease in profitability or more). The findings support the data statistics on which sectors and industries are most carbon-intensive. These carbon-intensive industries are naturally also the industries that are vulnerable to carbon pricing as they emit more GHG gases.

The largest sectors within the study are industrials (N=82), consumer discretionary (N=66), materials (N=41) and consumer staples (N=40). From the data researched, these four sectors provide enough information to make generalizations and interpretations on the results on a sector-level. The rest of the five sectors do not provide enough data to make comprehensive interpretations. However, even though these sectors do not provide extensive information given the number of companies, they do provide information and insight on how these sectors may potentially be affected by carbon pricing. The utilities sector for example only discloses information on 22 companies, but the results provide such unanimous information, that it is veracious to state that this sector is highly impacted by increasing carbon prices. It is also the most carbon-intensive sector, which provides additional support to the result. The energy sector (N=17) is also carbon-intensive and also among of the previously studied sectors when it comes to carbon pricing that these results can also be seen as complementing to what is already known. The sectors that were not significantly impacted according to the research were health care (N=24), IT (N=18) and telecommunication services (N=18). These sectors comprised of relatively few companies, but there were still enough companies to make assumptions on how these sectors are left with relatively no impact. Not enough data was available to make generalizations, but the information obtained is also complementary to earlier studies nonetheless.

The utilities sector consists of various electricity companies and discloses information on how even among CPT rates of 100% the impacts are significant. This underlines how strongly price increases in carbon policies could hit this sector. Profitability is impacted even with complete cost pass-through due to the changes in turnover. When the CPT rate is 100%, the EBITDA stays the same, but sales grow due to the increased market price. Thus the profitability actually decreases according to the EBITDA to sales ratio. The increase in turnover does not indicate an increase in profit because it simply offsets the additional carbon cost, without adding value. All industries were impacted within this sector, excluding one industry focusing on renewable electricity. The utilities sector was reviewed with high CPT rates because prior studies have discovered that electricity companies have been able to pass costs through effectively (Ch. 2.3.3). The heaviest impacts within the industries reach as high as a -225% (multi-utilities) change in profitability with a CPT rate of 0% and a €200/t$CO_2$ price increase. Within the most impacted industries multi-utilities and electric utilities, heavy impacts are already witnessed with full CPT. With the 80% CPT water utilities was not significantly affected until the €200/t$CO_2$ price increase. Gas utilities is just on the verge, almost reaching -5% with a €55/t$CO_2$ price increase and 80% CPT.

Within the utilities sector, the largest companies according to sales were found among the most impacted industries, multi-utilities and electric utilities. These two industries are also found at the top of the heaviest emitting industries (figure 14). This means that these industries have a tremendous impact on the environment as their operations are most likely widespread due to their size. These industries are the ones most likely to also face increasing carbon prices. If carbon price increases are distributed according to sectors and industries, these mentioned industries are most likely among the ones that will be penalised with the higher prices. This means that the whole sector will face large difficulties in obtaining good profits, given that free allocations within the EU ETS are completely replaced by auctioning. Even though the sector would be able to keep high CPT rates, the impact is drastic.

The top 10 emitting industries of scope 1 emissions are found within the utilities, materials, energy, industrials and consumer discretionary sectors. (figure 14). Within the top 20 emitters of scope 1, in addition to the ones in top 10, also some industries from within the consumer staples are found, and also one industry from the health care sector. From these also some of the same industries have the largest sales (in 2014) in the data, including for example oil gas and consumable fuels, metals and mining, multi-utilities, and electric utilities to name a few.

The top 10 heaviest emitters of scope 2 emissions are found within the same sectors as scope 1 emitters, with the exception of a few industries belonging to consumer staples and also telecommunication services. Within the top 10 the industrials sector is actually left out. Within the top 20, also more consumer staples, consumer discretionary telecommunication services and health care industries are found, in comparison to the scope 1 emitters (also including industrials within the top 20). Many industries of the largest emitters of scope 2 emissions were also found among the largest companies by sales (in 2014), including for example automobiles, chemicals, diversified telecommunication services and also food related industries.

The materials sector also offered intriguing insights as this sector had notable variance within, due to industries handling very different materials and these materials most likely having various CPT rates in reality. The oil gas and consumable fuels industry (from the energy sector) consists of well-known oil companies. These companies are not under significant impact regarding the increase in carbon prices unless there is a change in its cost pass-through rates. This industry is also seen among the top emitters of $CO_2$, but in reality its emissions may be even larger. This is because oil products are in everyday use when driving or flying, a large portion of the $CO_2$ emissions actually released only when utilised by end-customers. These scope 3 emissions are formed through using the product. Another industry that will also potentially have increase total emissions were scope 3 emissions taken into consideration is the car industry.

This research showed the automobiles and auto components industries to be higher in scope 2 emissions, but the largest emissions come from driving thus increasing the overall GHG emissions of the industry. The potential increase of renewable fuels and electric cars may well change this in the future however.

The largest sector, industrials, also had variance between the industries. Further analysis showed that the only industry facing true risk from increasing carbon prices was airlines. The results from other industries could not be generalized, but air freight and logistics, commercial services and supplies, construction and engineering, building products, marine and road and rail showed some signs of impacts.

Some surprising and new insights were gathered from the data. The consumer discretionary sector provided results showing that the hotels, restaurants and leisure industry was impacted by an increase in the carbon price. Within the hotel resorts and cruise lines SI (N=4) all companies were impacted. The computer and electronics SI was surprisingly also impacted, although this only comprised of one example. The consumer staples sector was also impacted regarding food related industries. If the price increases are steep it will create challenges among these industries. Information on the food industries regarding CPT rates is also hard to find and if the CPT rate for these industries is very low, this also impacts the industries. In addition, these industries also face large increases in their emissions if scope 3 emissions are taken into account through outsourcing activities.

It was surprising to see how drastically some sectors and industries were ultimately affected by the carbon price increase. All sectors are actually affected at least partly when the CPT rate is 0%. There are also some impacts in every sector when the CPT rate is 100% and the price increases significantly. However, what distinguishes the industries at risk from those facing less risk regarding carbon prices, are the industries which are strongly impacted even with CPT rates of 100%.

Overall the findings support the assumption that heavy emitters will face greater carbon risk and impacts on profitability. Some of the mentioned industries could face real issues regarding carbon pricing in the future, if they choose not to act and reduce carbon emissions. The research provides new information on the amplitude of the impacts on profitability and also on sectors and industries which have been left on minimal, if any, research prior to this study. What also became evident from the research is how important the CPT rates are. The CPT rate is central when determining what kind of impact carbon pricing could have on profitability. As the results show, even within industries, the impacts vary tremendously depending on how well the costs can be passed.

Through the findings, it is valuable to also reflect on how the specific industries which show signs of being impacted could mitigate their carbon risk. As the whole business model for some industries is based on something carbon-intensive it can be a tremendous challenge to reduce emissions, if at all possible, without altering the business model in the process. A lot of potential is offered to the utilities sector by continuously enhanced renewable energy sources. One company within the data showed evidence of how drastically the financial carbon risk can be mitigated by focusing on renewable electricity. This company was basically not impacted at all by the carbon prices, the highest impact being -0,02 %. Passing through the marginal carbon costs to consumers may be helpful towards companies involved in renewable energy as they are not as affected by carbon pricing and in the end may provide cheaper electricity to their customers compared to traditional electricity companies. This would however take time and traditional electricity companies are also increasingly looking into renewable energy sources. Some companies within the energy sector have also drastically changed their business models and have widened their operations from oil to renewable fuels. This still requires further research, but some promising results have been reported from utilizing renewable fuels. This is a disruptive innovation and a somewhat drastic move from oil companies, which naturally not all will follow.

The materials sector is one that will face difficulties in reducing environmental impacts. Machinery being utilized in extracting metals and mining for instance can be updated and processes can be made as efficient as possible. In totality however, the industry will still impact the environment. Paper and forest products will also need raw material from the nature which will continue to release $CO_2$. Within this industry there is however an emphasis on improving efficiency and finding new ways to improve sustainable forestry.

Overall the results have shown that both the price increase and CPT rates have an impact on company profitability. The CPT rate however determines the magnitude of the impact. When the CPT rate is close to 100%, the profitability is not impacted nearly as much as when the rate is lower. Together with a steep price increase and low CPT rates, the impact is heavy on certain industries. The EU ETS covers 45% of the GHG emissions in the EU. In order to reach climate targets, the percentage needs to be higher and more industries and gases introduced to the system in the future. If companies do not have a financial incentive to reduce emissions, they will not do it. There are still various industries with high $CO_2$ emissions excluded from the system. Free allocation of allowances has also brought many problems within the system by for example increasing the profits of electricity companies. This is however changing within phase 3 as the percentage of free allowances is dropped each year. Thus, to motivate emissions reductions, more industries need to be included in carbon pricing and also the price needs to increase.

According to the findings, it can be stated that environmental regulation (in the form of carbon pricing) does impact company profitability. This study displays supportive findings regarding the PH and regulatory impacts. Environmental regulation can indeed reduce company profits if nothing is done to reduce emissions. Regulation also creates incentive to enhance operations in this sense. It is true that environmental regulations restrict companies to a certain extent and also create additional costs, but this is the case when companies do nothing to reduce their emissions. The results thus provide support to the PH in that regulations can enhance efficiency, innovativeness and competitiveness. However, for this to be the case, the carbon price must increase to make investments worthwhile. Innovations should be encouraged costwise, as Porter and van der Linde state.

# 7 CONCLUSIONS

The aim of the research was to find how company profitability could be affected by an increase in carbon pricing. Carbon pricing is one way to entice emissions reductions among companies. Carbon pricing should be utilized across more sectors and the price increased, in order for companies to view emissions reduction as a viable option. As the current price is approximately €5/t$CO_2$, in most cases it costs companies less to pay the price of carbon than to invest in more energy efficient and sustainable equipment or machinery. Altering company processes in general require investments. The fluctuation of the carbon price has also been relatively high since its implementation through the EU ETS in 2005. This uncertainty of the carbon price has kept company representatives reluctant to invest in new technologies, as it is uncertain whether these investments would bring the company more value in the end in comparison to paying for carbon emissions.

In the likely case that the carbon price will increase, it will affect industries in a varying manner. Currently the ETS covers some manufacturing and power generation industries and aviation activities. To fulfill the purpose of carbon pricing, which is to reduce emissions, the system needs to cover more industries. If the carbon price were to affect all the industries studied in this research, significant impacts would be seen in every sector. For some carbon-intensive sectors like the utilities and materials, the results could be drastic, depending on the final price and also on how well the companies would be able to pass through the additional costs deriving from the cost of carbon.

When the price of carbon has increased and companies are paying an additional cost related to their operations, given that the price has increased enough, many companies might come to realize that in the long-term, it would be more profitable to invest in cleaner technologies and operate in a more sustainable manner. The fact is that somehow carbon emissions must be reduced to achieve the 2° target set in Paris 2015. If companies were to do nothing to reduce their emissions, company profitability could decrease tremendously.

The impact carbon pricing will have on companies depends highly on the company operations and how carbon-intensive it is. If the company is subjected to environmental regulation, has relatively high price elasticity of demand and cannot reduce its emissions easily, the impact on profitability can be substantial. This is due to the fact that the company then has to pay an additional cost to get permits and is not able to move the costs into market prices efficiently. The results of the study were obtained through quantitative research concerning the emissions and financials data of 328 European companies. The results are summarized in table 10 in relation to the research questions and further in table 11.

Table 10. The research questions and results

| **The main research question and sub-questions** | **Result** |
|---|---|
| RQ: How would a significant price increase on $CO_2$ emissions affect the profitability of companies? | The $CO_2$ price has a negative effect on company profitability through rising costs. The impact however ultimately depends on how high the $CO_2$ price is and on cost pass-through rates which vary between industries. (Ch. 5.3) |
| SQ1. Which variable has a larger impact on profitability, the $CO_2$ price or cost pass-through rates? | Both variables affect company profitability, but in the end the cost pass-through rate is an enormous factor on how big the impact is. The CPT rate can determine the difference of whether the impact is for example -2,83% or -18,35%. (Ch. 5.3 and appendix 3) |
| SQ2. What kind of increase in the $CO_2$ price is needed for a significant impact on profitability? | The lowest price tested in this study was €40/t$CO_2$, which showed significant impacts. This ultimately depends on the industry. Carbon-intensive industries require a smaller price increase than less carbon-intensive industries for an impact to occur. (Ch. 5.3) |
| SQ3. Which sectors and industries are affected the most and which ones are affected the least? | The utilities and materials sectors are affected the most and the IT and telecommunication services are affected the least. (Ch. 5.3) See table 11 for more information. |

The second sub-question concerning the price level needed for a significant impact in profitability cannot be answered unequivocally. The price level for creating impact greatly depends on the industry. Carbon-intensive industries will need a lower price level for significant changes to occur, whereas less carbon-intensive industries require a steeper increase in the carbon price to be significantly impacted. As was stated in the literature review, the decision-making at Shell for example was already affected with an internal price of approximately €30/t$CO_2$. Table 11 summarizes which sectors and industries are affected the most, are likely to be affected and which ones are least impacted.

Table 11. The most, potentially and least impacted sectors and industries

| **Most impacted** | **Potentially impacted** | **Least impacted** |
|---|---|---|
| Utilities:<br>- Electric utilities<br>- Multi-utilities<br>- Gas utilities<br><br>Materials:<br>- Chemicals<br>- Construction materials<br>- Metals & mining<br>- Paper & forest products<br><br>Energy:<br>- Oil gas & consumable fuels<br><br>Industrials:<br>- Airlines<br><br>Consumer discretionary:<br>- Hotels, restaurants & leisure (hotels, resorts and cruise lines) | Utilities:<br>- Water utilities<br><br>Industrials:<br>- Air Freight & logistics<br>- Building products<br>- Commercial services & supplies<br>- Construction & engineering<br>- Marine<br>- Road & rail<br><br>Consumer discretionary:<br>- Car industries<br>- Computer & electronics retail (SI)<br><br>Consumer Staples:<br>- Food & staples retailing<br>- Food products | Health care<br><br>Information technology<br><br>Telecommunication services |

## *7.1 Theoretical contributions*

Prior research has not looked into how carbon pricing specifically affects company profitability to the extent that this research does. Prior studies have focused more on how carbon pricing might affect the competitiveness of companies, excluding a few studies also looking at the profitability aspect. The studies that have studied profitability issues have looked into a few certain industries in depth, or alternatively studied specific market impacts within countries. Research has mainly focused on direct emissions, whereas this research also included scope 2 emissions. The cost pass-through perspective has also been left on minimal attention in prior research. Overall the literature is scarce on the impact of carbon pricing concerning profitability aspects. Analyses on the post carbon price implementation barely exist, as enough time has not yet passed to be able to thoroughly study this phenomenon. Studies related to carbon pricing have mainly looked at specific industries which are under the EU ETS, i.e. manufacturing, electricity and aviation. This research gives a more general view on the issue, also looking into industries which have been excluded prior to this study. It is important to also look at these industries that are not yet under the EU ETS as they also include industries comprising of carbon-intensive companies. The EU ETS covers roughly half of the GHG emissions in Europe, and needs to be extended to cover more industries and gases. The ETS is under constant development and has gradually extended its influence.

This research introduces a view on the impacts carbon pricing may have on 9 sectors and 53 industries. It shows that many industries are under severe financial losses, were the carbon price to rise and chose the companies not to react to this in any way. The carbon price must increase in order for companies to find financial incentive to invest in cleaner technologies and reduce emissions.

A majority of the studies relating to the issue have been practical researches. Academic articles are somewhat outdated when it comes to carbon pricing as the price fluctuates and also mechanisms for pricing carbon are under constant development. For example, the overall understanding regarding cost pass-through has been that it helps companies to increase profits because allowances have mainly been allocated free of charge. This has changed since increasing amount of permits are being auctioned instead of allocated in phase 3 of the EU ETS. This study contributes to academia in bringing more up to date information on carbon pricing and also how it could potentially impact company profitability were the price to increase. This study also provides a starting point for further research on the profitability impacts of carbon pricing. In addition, the study presents supportive findings regarding the PH by displaying how regulatory policies could induce companies to invest in new technologies and reduce emissions. This, however, requires an increase in the carbon price.

### *7.2 Practical implications*

The research aimed to conduct an analysis on how price increases on $CO_2$ emissions would affect the profitability of companies, when nothing is done in order to reduce these emissions. As the results show potentially significant impacts on company profitability, the findings indicate an importance of reducing emissions, so that the profitability of companies will not suffer in the long term.

Practical implication of this thesis are to show company representatives how an increase in the carbon price could affect profitability. Especially the carbon-intensive companies within industries that are found to be significantly impacted benefit from the results and could help them identify their financial carbon risk. Managers seeking numerical incentive to reduce emissions may find some from this research. Carbon-intensive companies can find an incentive to research potential investments to cleaner technologies. This research combined practical and academic research, contributing to both.

Policy-makers may also find the results useful when contemplating future steps regarding environmental regulation and emissions pricing. Policy-makers must bear in mind that the carbon price works best when it provides incentive for companies to innovate and invest in new technologies. The research also contributes to the investor viewpoint when contemplating financial carbon risks regarding carbon-intensive companies. Investors as well as the managerial level should identify the carbon asset risk also related to capital expenditure. Companies lagging behind in reducing their emissions may face increases in their financing, e.g. through increased interest rates due to the carbon risk identified by investors.

### *7.3 Limitations and future directions*

In order to fulfill the target of this study a lot if simplifications had to be made. This was due to the scope of the thesis and thus thorough analysis regarding each sector could not be made. The main target of giving a general explanation was nonetheless reached. To get a more in-depth analysis on the various sectors and industries, they would still need to be researched separately regarding the topic. In addition, as the financials' sector was for example excluded from the study, this could also be researched from the viewpoint of emissions reserves that financial institutions may have in their balance sheets. Not enough information on reserves was disclosed in the data utilized for this research to make such analyses. In addition, real estate is a big factor regarding overall $CO_2$ emissions and should thus be inspected in detail, in order to reduce overall emissions. As we could see in the findings, the construction and engineering industry also showed potential signs of being impacted by carbon pricing, which is one part of the real estate industry. Real estate investments for example may carry substantial carbon risks if they are failed to be recognized.

Another industry which is a large impact on overall $CO_2$ emissions is the food industry. This should also be further researched if $CO_2$ emissions need to decrease as much as to meet the 2° target. Especially the meat industry is a large contributor to GHGs. This also leads up to the verdict that these sorts of industries, food and real estate among other, should be included in cap-and-trade systems since the target is to significantly reduce emissions globally.

This research was conducted solely on the basis of information gathered from the given databases provided by MSCI and FactSet. It would also be worth researching whether company reported emissions would in any way differ from emissions when they were estimated by a third party. The data did not take a stand on how the emissions were calculated when reported by companies, concerning for example lifecycle costs of the emissions. Also scope 3 emissions play a big part in the overall emissions of companies and would surely magnify the total amount of emissions for numerous companies and industries, were they included in this research. Scope 3 emissions are however problematic to calculate and define. This is because scope 3 emissions can only be fully realized at the end of a products lifecycle and through value chains.

Future research could also take a stand on how investing in new technologies affect companies. This research only brushed upon this topic due to the scope. It is also a very challenging issue as the true potential will be seen over long-term. It is however an area that is in need of further research to help companies in deciding whether it could be of value for them. This could be linked to the topic of this thesis by expanding it into looking at how company profitability is impacted by $CO_2$ pricing when companies are also investing in cleaner technologies and how long it would take for these investments to become more valuable to the company than settling to pay for emissions.

Future research could take into account the emissions data over a period of time rather than one specific timeframe, also including a larger number of companies in the analysis. This research had data concerning static information on just one year. If future research wanted to look into how the emissions have changed and have companies been able to reduce them, this approach would be more informational. It would be an interesting angle to research how emissions have changed after the ratification of the COP21 agreement and how new technologies have fit in. With this also further research could be conducted on what kind of possibilities energy-intensive industries face in reducing their emissions. This was not the aim of this research as the target was to see how large impacts could be when nothing is done in order to reduce emissions.

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# APPENDICES

## APPENDIX 1: Data information and statistics

Figure A.1. Distribution of companies between sectors and within sectors.

| Sectors, industry groups, industries and sub-industries | Number of companies |
|---|---|
| **Consumer Discretionary *(sector)*** | **66** |
| **Automobiles & Components *(industry group)*** | **11** |
| Auto Components *(industry)* | 5 |
| Auto Parts & Equipment *(sub-industry)* | 3 |
| Tires & Rubber | 2 |
| Automobiles | 6 |
| Automobile Manufacturers | 6 |
| **Consumer Durables & Apparel** | **16** |
| Household Durables | 5 |
| Homebuilding | 3 |
| Household Appliances | 2 |
| Textiles Apparel & Luxury Goods | 11 |
| Apparel Accessories & Luxury Goods | 11 |
| **Consumer Services** | **10** |
| Hotels Restaurants & Leisure | 10 |
| Casinos & Gaming | 2 |
| Hotels Resorts & Cruise Lines | 4 |
| Leisure Facilities | 1 |
| Restaurants | 3 |
| **Media** | **21** |
| Media | 21 |
| Advertising | 3 |
| Broadcasting | 3 |
| Cable & Satellite | 7 |
| Movies & Entertainment | 1 |
| Publishing | 7 |
| **Retailing** | **8** |
| Multiline Retail | 2 |
| Department Stores | 2 |
| Specialty Retail | 6 |
| Apparel Retail | 2 |
| Computer & Electronics Retail | 1 |
| Home Improvement Retail | 1 |
| Specialty Stores | 2 |
| **Consumer Staples** | **40** |
| **Food & Staples Retailing** | **12** |
| Food & Staples Retailing | 12 |
| Food Retail | 9 |
| Hypermarkets & Super Centers | 3 |
| **Food Beverage & Tobacco** | **21** |

| | |
|---|---|
| Beverages | 9 |
| Brewers | 5 |
| Distillers & Vintners | 3 |
| Soft Drinks | 1 |
| Food Products | 9 |
| Packaged Foods & Meats | 9 |
| Tobacco | 3 |
| Tobacco | 3 |
| **Household & Personal Products** | **7** |
| Household Products | 3 |
| Household Products | 3 |
| Personal Products | 4 |
| Personal Products | 4 |
| **Energy** | **17** |
| **Energy** | **17** |
| Energy Equipment & Services | 6 |
| Oil & Gas Drilling | 1 |
| Oil & Gas Equipment & Services | 5 |
| Oil Gas & Consumable Fuels | 11 |
| Integrated Oil & Gas | 8 |
| Oil & Gas Exploration & Production | 1 |
| Oil & Gas Refining & Marketing | 1 |
| Oil & Gas Storage & Transportation | 1 |
| **Health Care** | **24** |
| **Health Care Equipment & Services** | **9** |
| Health Care Equipment & Supplies | 6 |
| Health Care Equipment | 4 |
| Health Care Supplies | 2 |
| Health Care Providers & Services | 3 |
| Health Care Facilities | 1 |
| Health Care Services | 2 |
| **Pharmaceuticals Biotechnology & Life Sciences** | **15** |
| Biotechnology | 2 |
| Biotechnology | 2 |
| Life Sciences Tools & Services | 2 |
| Life Sciences Tools & Services | 2 |
| Pharmaceuticals | 11 |
| Pharmaceuticals | 11 |
| **Industrials** | **82** |
| **Capital Goods** | **52** |
| Aerospace & Defense | 9 |
| Aerospace & Defense | 9 |
| Building Products | 3 |
| Building Products | 3 |
| Construction & Engineering | 6 |

| | | | | |
|---|---|---|---|---|
| | | | Construction & Engineering | 6 |
| | | Electrical Equipment | | 6 |
| | | | Electrical Components & Equipment | 5 |
| | | | Heavy Electrical Equipment | 1 |
| | | Industrial Conglomerates | | 3 |
| | | | Industrial Conglomerates | 3 |
| | | Machinery | | 18 |
| | | | Agricultural & Farm Machinery | 1 |
| | | | Construction Machinery & Heavy Trucks | 3 |
| | | | Industrial Machinery | 14 |
| | | Trading Companies & Distributors | | 7 |
| | | | Trading Companies & Distributors | 7 |
| | **Commercial & Professional Services** | | | **14** |
| | | Commercial Services & Supplies | | 7 |
| | | | Diversified Support Services | 4 |
| | | | Office Services & Supplies | 1 |
| | | | Security & Alarm Services | 2 |
| | | Professional Services | | 7 |
| | | | Human Resource & Employment Services | 3 |
| | | | Research & Consulting Services | 4 |
| | **Transportation** | | | **16** |
| | | Air Freight & Logistics | | 4 |
| | | | Air Freight & Logistics | 4 |
| | | Airlines | | 3 |
| | | | Airlines | 3 |
| | | Marine | | 2 |
| | | | Marine | 2 |
| | | Road & Rail | | 1 |
| | | | Trucking | 1 |
| | | Transportation Infrastructure | | 6 |
| | | | Airport Services | 3 |
| | | | Highways & Railtracks | 3 |
| **Information Technology** | | | | **18** |
| | **Semiconductors & Semiconductor Equipment** | | | **5** |
| | | Semiconductors & Semiconductor Equipment | | 5 |
| | | | Semiconductor Equipment | 1 |
| | | | Semiconductors | 4 |
| | **Software & Services** | | | **9** |
| | | Internet Software & Services | | 2 |
| | | | Internet Software & Services | 2 |
| | | IT Services | | 3 |
| | | | Data Processing & Outsourced Services | 1 |
| | | | IT Consulting & Other Services | 2 |
| | | Software | | 4 |
| | | | Application Software | 4 |

| | |
|---|---|
| **Technology Hardware & Equipment** | **4** |
| Communications Equipment | 2 |
| Communications Equipment | 2 |
| Electronic Equipment Instruments & Components | 2 |
| Electronic Equipment & Instruments | 2 |
| **Materials** | **41** |
| **Materials** | **41** |
| Chemicals | 22 |
| Commodity Chemicals | 1 |
| Diversified Chemicals | 4 |
| Fertilizers & Agricultural Chemicals | 4 |
| Industrial Gases | 2 |
| Specialty Chemicals | 11 |
| Construction Materials | 4 |
| Construction Materials | 4 |
| Containers & Packaging | 1 |
| Metal & Glass Containers | 1 |
| Metals & Mining | 11 |
| Aluminum | 1 |
| Diversified Metals & Mining | 5 |
| Gold | 1 |
| Precious Metals & Minerals | 1 |
| Steel | 3 |
| Paper & Forest Products | 3 |
| Paper Products | 3 |
| **Telecommunication Services** | **18** |
| **Telecommunication Services** | **18** |
| Diversified Telecommunication Services | 15 |
| Alternative Carriers | 2 |
| Integrated Telecommunication Services | 13 |
| Wireless Telecommunication Services | 3 |
| Wireless Telecommunication Services | 3 |
| **Utilities** | **22** |
| **Utilities** | **22** |
| Electric Utilities | 9 |
| Electric Utilities | 9 |
| Gas Utilities | 3 |
| Gas Utilities | 3 |
| Independent Power and Renewable Electricity Producers | 1 |
| Renewable Electricity | 1 |
| Multi-Utilities | 7 |
| Multi-Utilities | 7 |
| Water Utilities | 2 |
| Water Utilities | 2 |
| **Grand Total** | **328** |

Figure A.2. Distribution of companies according to country

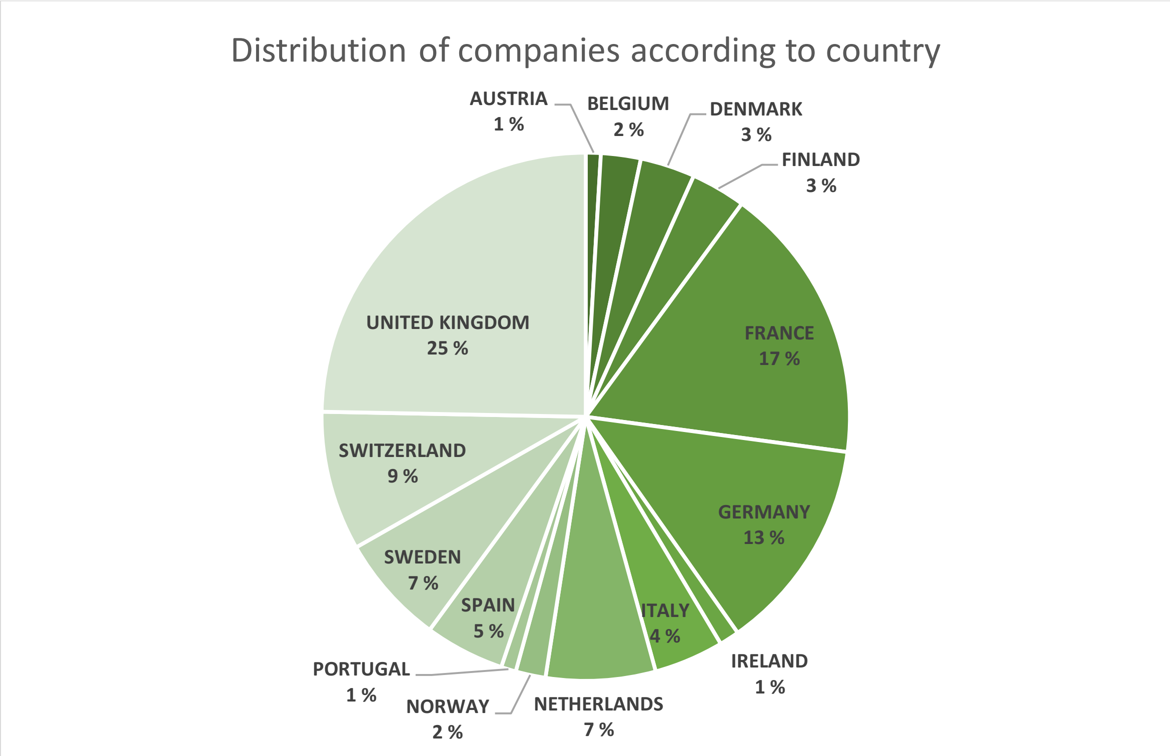
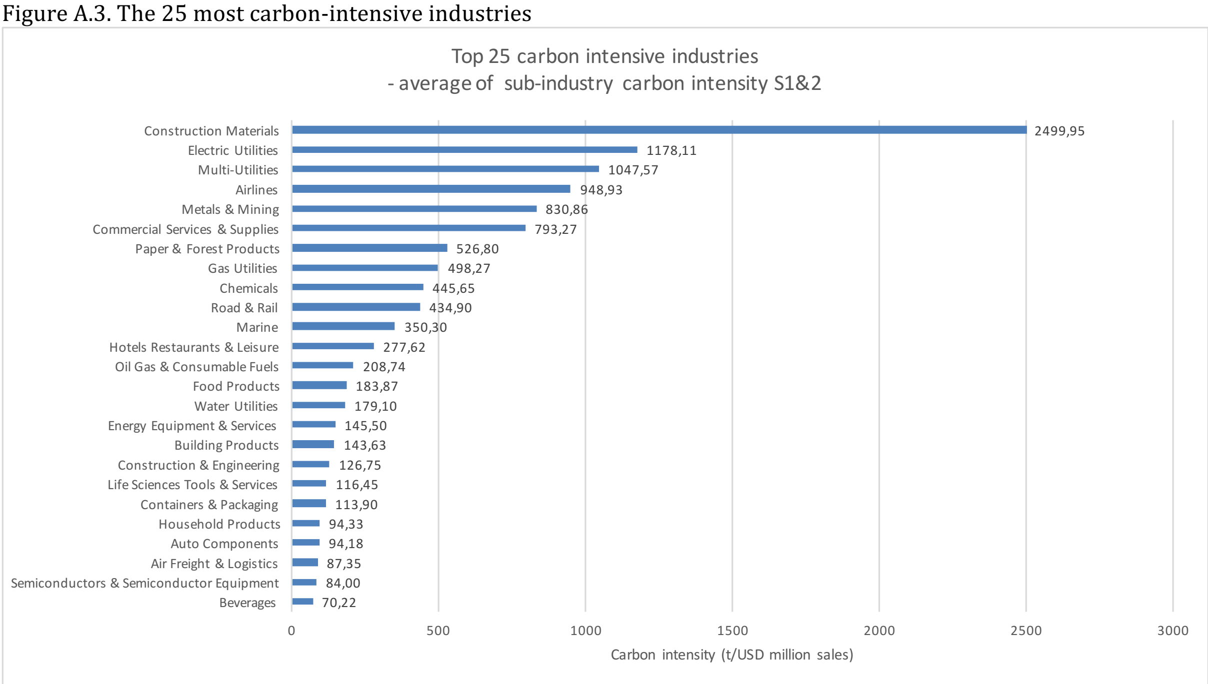



Figure A.3. The 25 most carbon-intensive industries



**APPENDIX 2**: Summary statistics

Summaries according to each sector on the test values (€40/$tCO_2$ price increase and 80% cost pass-through).

Figure A.4

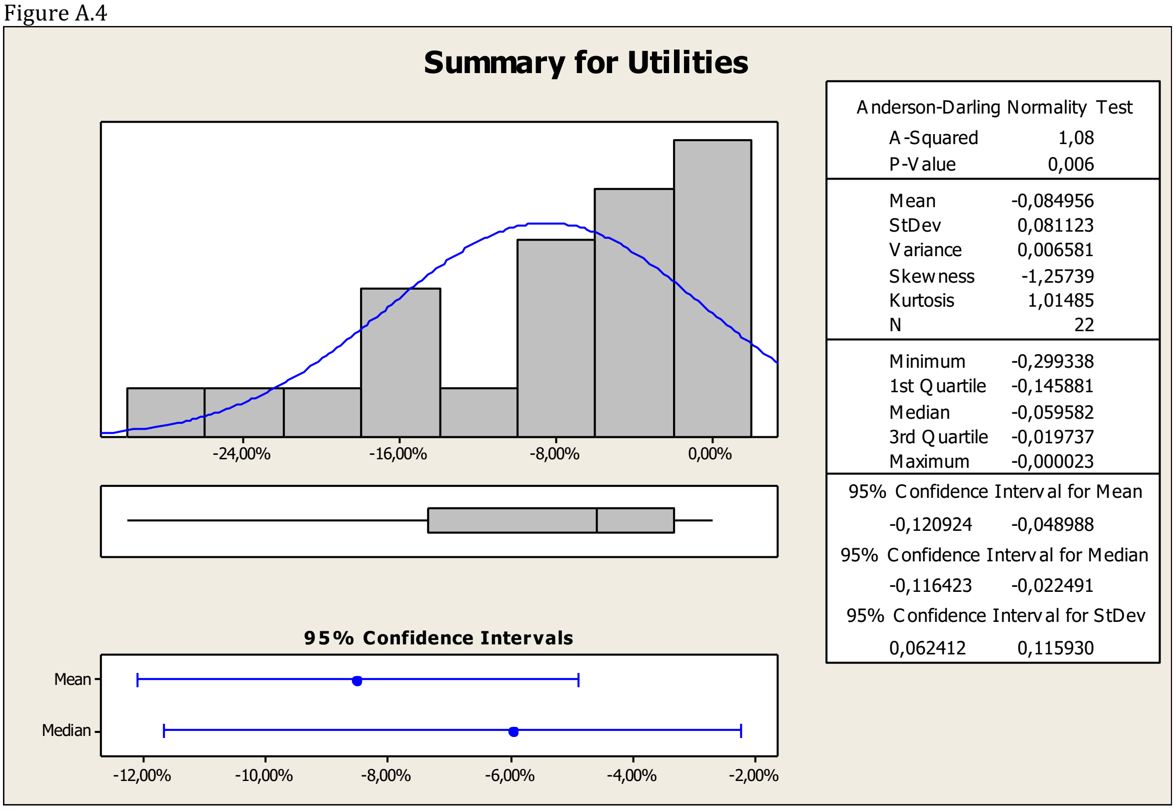



Figure A.5

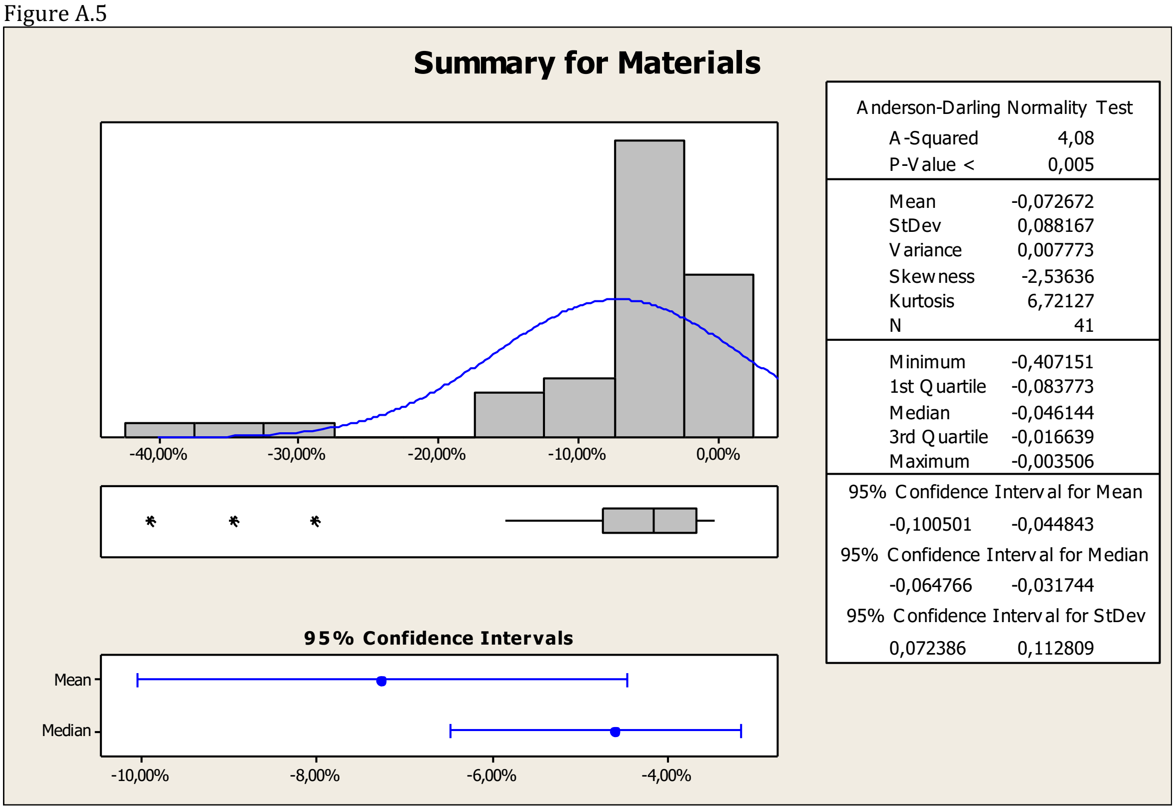


Figure A.6

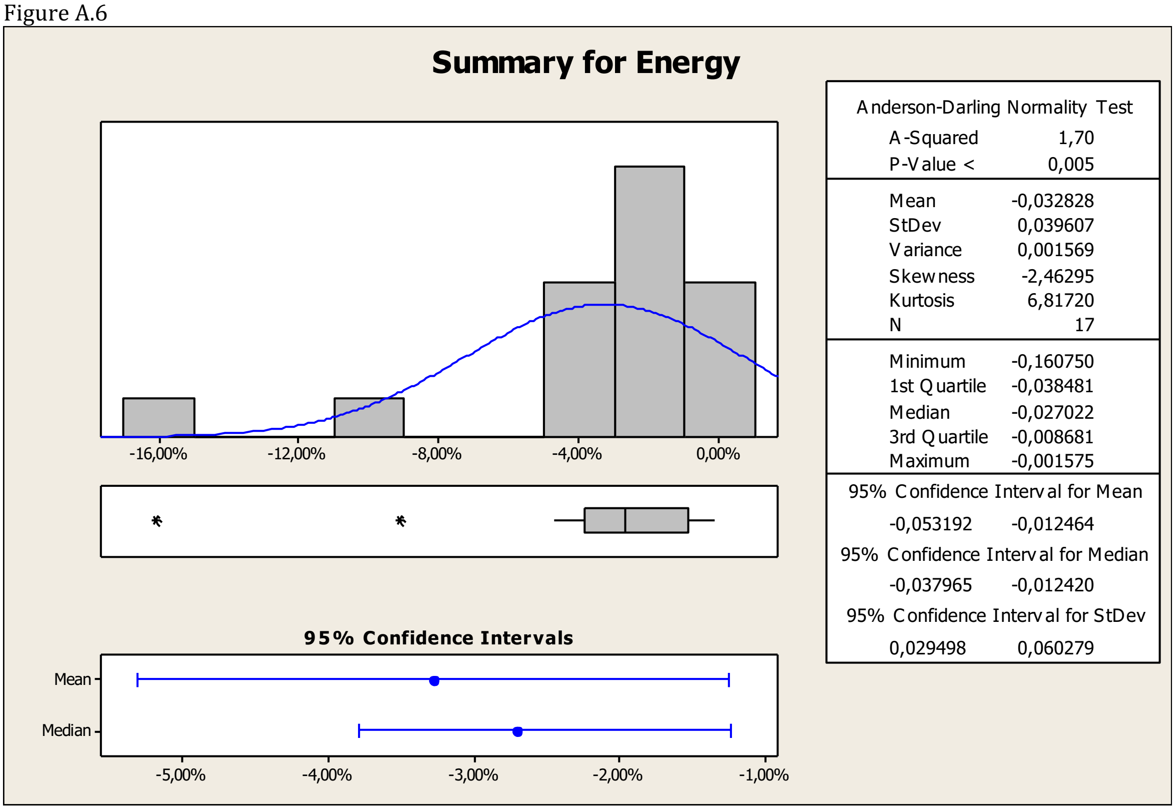



Figure A.7

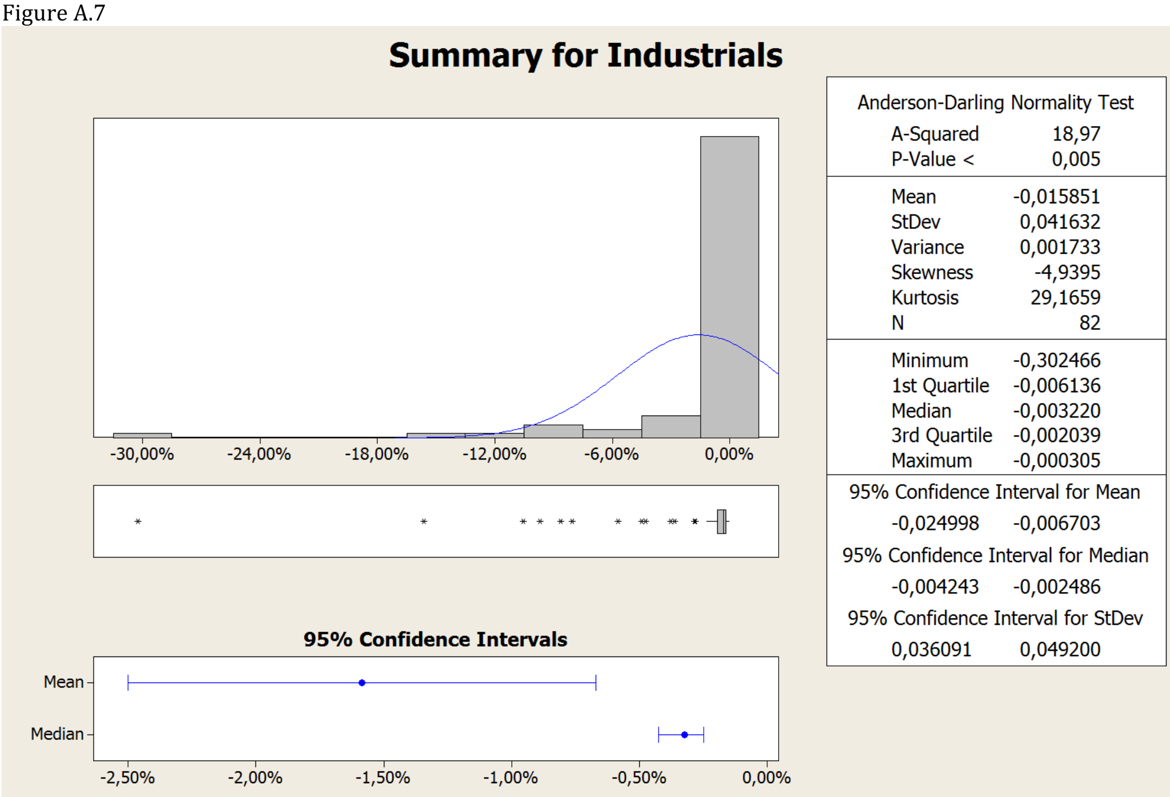


Figure A.8

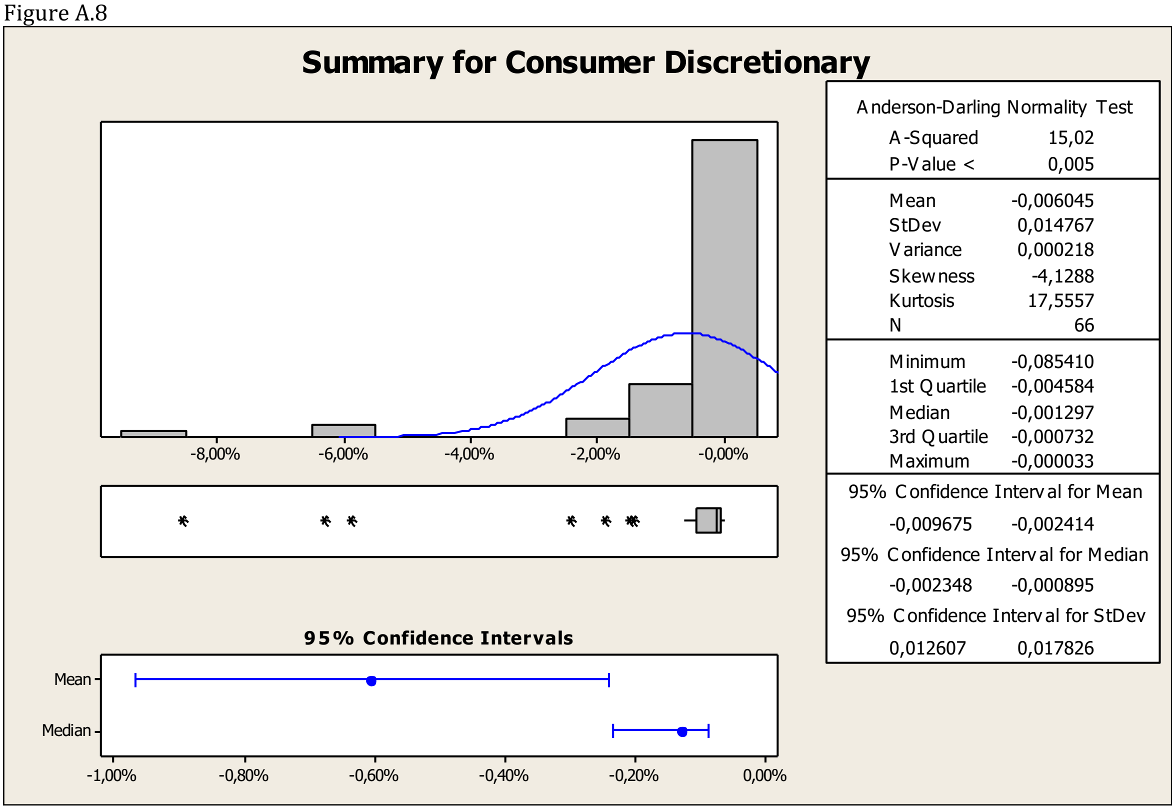



Figure A.9

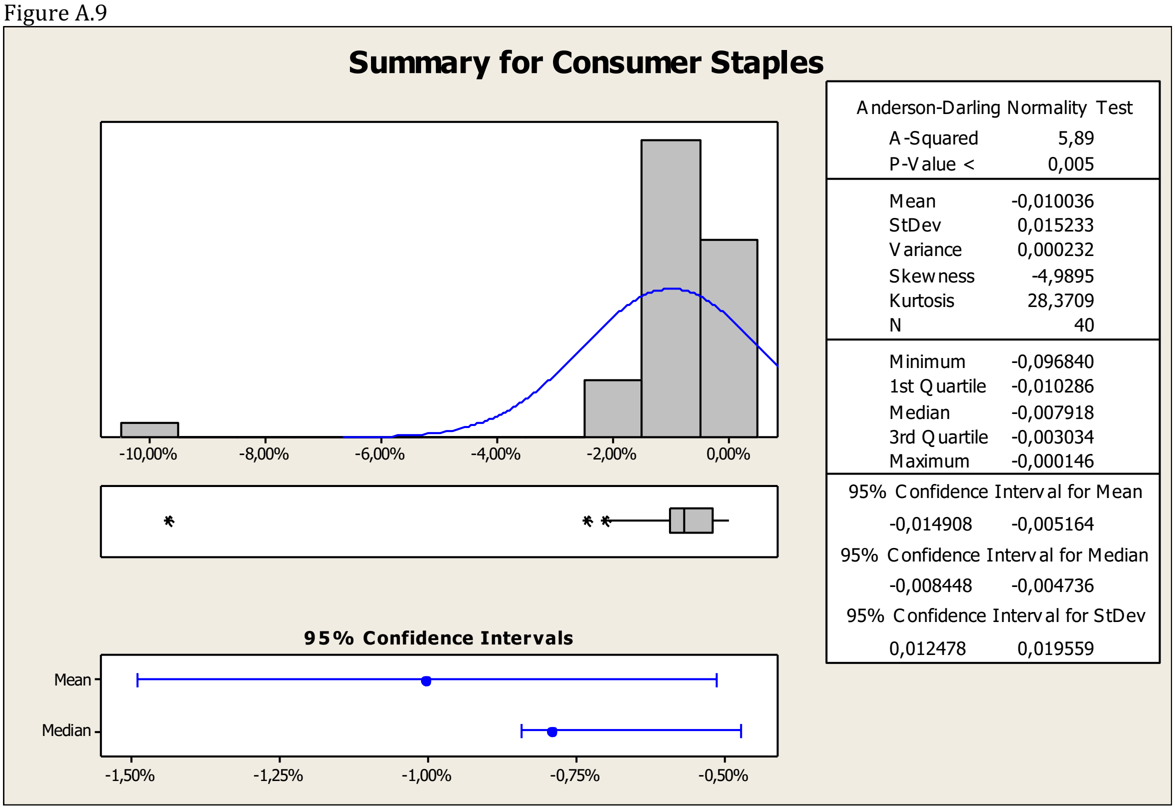


Figure A.10

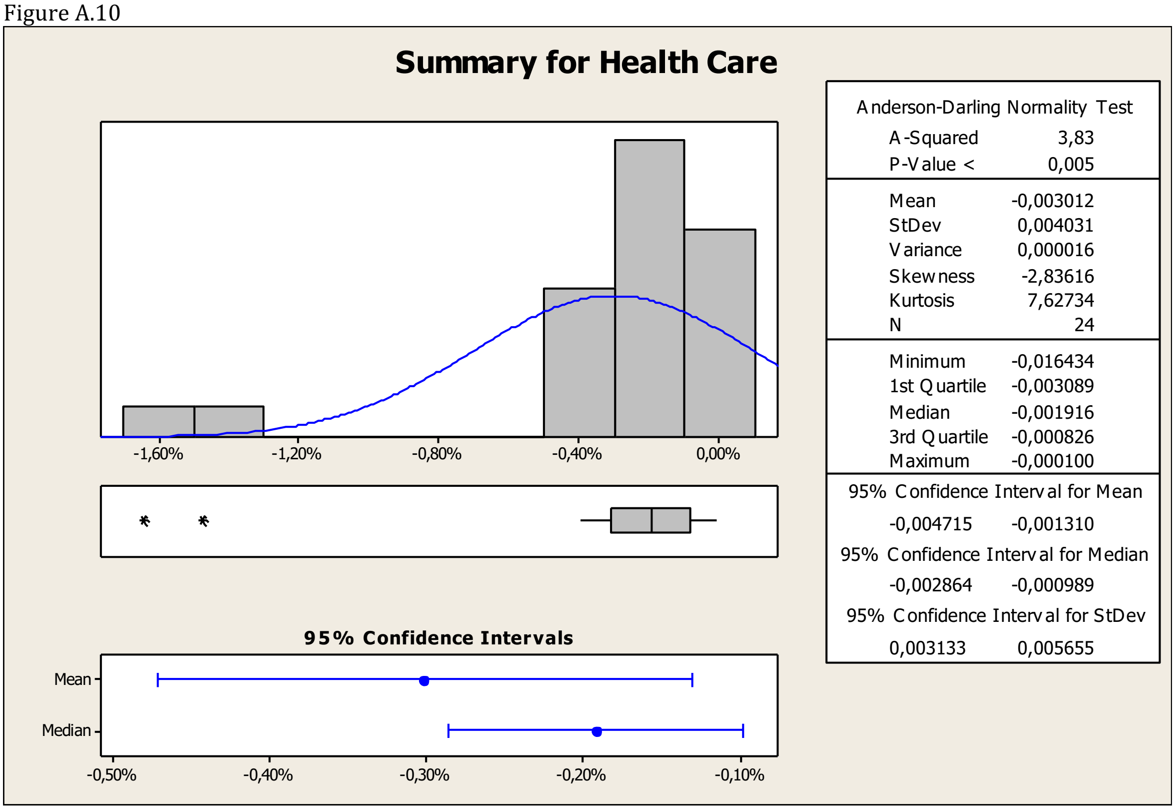



Figure A.11

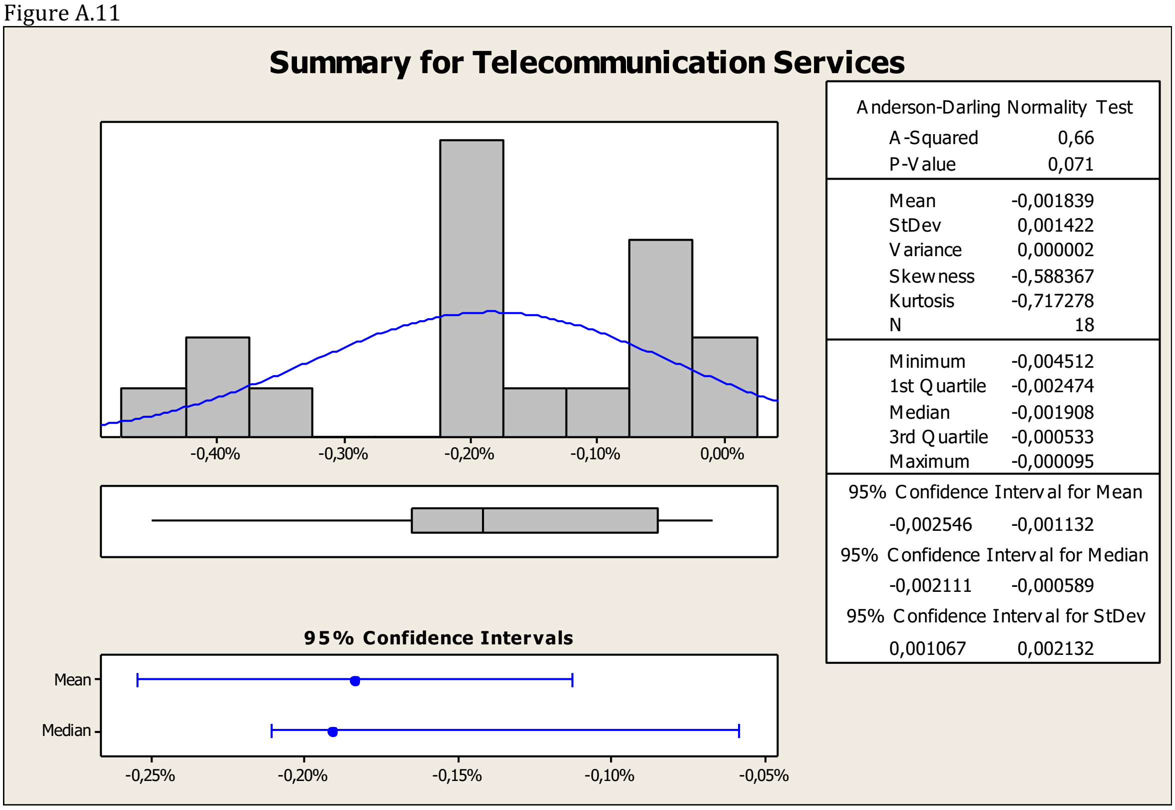
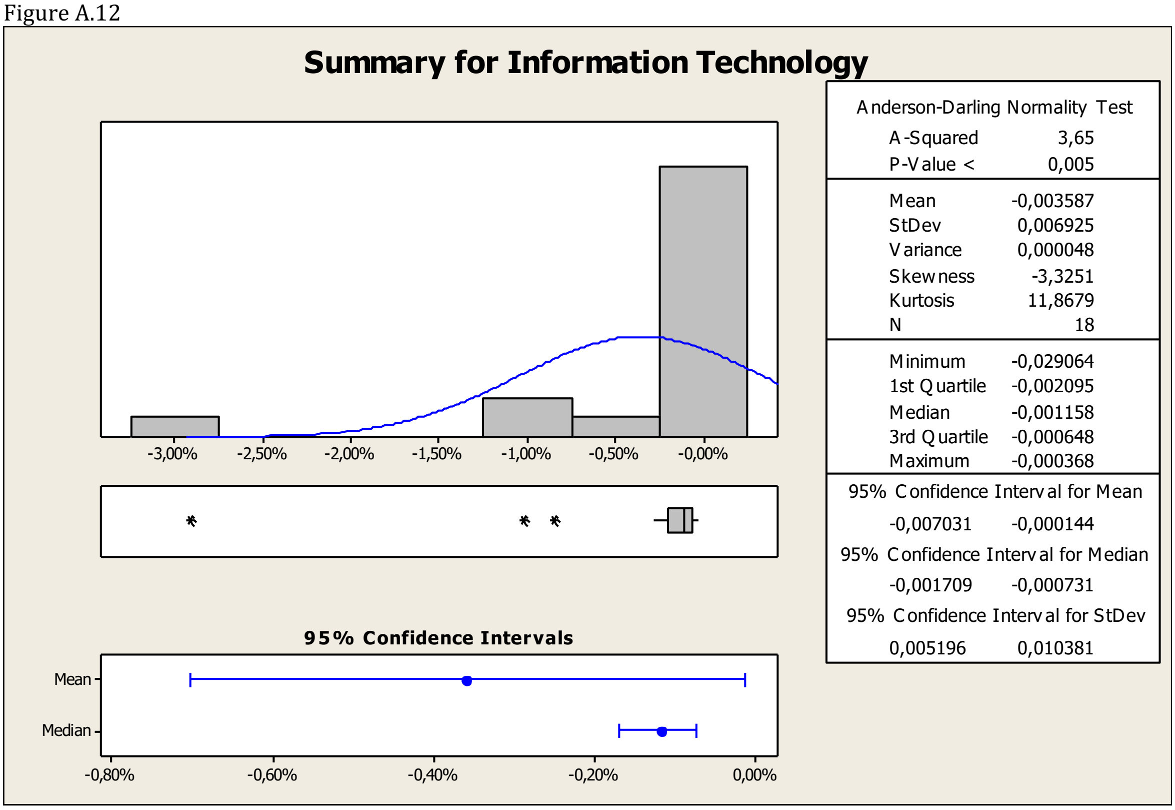


Figure A.12



Summary for Information Technology
Anderson-Darling Normality Test
A-Squared 3,65
P-Value < 0,005
Mean -0,003587
StDev 0,006925
Variance 0,000048
Skewness -3,3251
Kurtosis 11,8679
N 18
Minimum -0,029064
1st Quartile -0,002095
Median -0,001158
3rd Quartile -0,000648
Maximum -0,000368
95% Confidence Interval for Mean
-0,007031 -0,000144
95% Confidence Interval for Median
-0,001709 -0,000731
95% Confidence Interval for StDev
0,005196 0,010381
-3,00% -2,50% -2,00% -1,50% -1,00% -0,50% -0,00%
95% Confidence Intervals
Mean
Median
-0,80% -0,60% -0,40% -0,20% 0,00%

**APPENDIX 3**: Profitability impacts

Disclosure on the changes in the profitability of companies according to each sector.

| UTILITIES | 0 % CPT | | | 60 % CPT | | | 80% CPT | | | 100 % CPT | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | €55 | €105 | €200 | €55 | €105 | €200 | €55 | €105 | €200 | €55 | €105 | €200 |
| Electric Utilities, N=9 | -38,88 % | -74,23 % | -141,40 % | -19,12 % | -34,43 % | -59,56 % | -13,10 % | -23,17 % | -39,08 % | -7,32 % | 12,68 % | -20,78 % |
| Gas Utilities, N=3 | -11,34 % | -21,65 % | -41,23 % | -6,40 % | -11,96 % | -21,92 % | -4,81 % | -8,94 % | -16,21 % | -3,24 % | -6,00 % | -10,82 % |
| Independent Power and Renewable Electricity Producers, N=1 | -0,01 % | -0,01 % | -0,02 % | 0,00 % | 0,0,1% | -0,01 % | 0,00 % | -0,01 % | -0,01 % | 0,00 % | 0,00 % | 0,01 % |
| Multi-Utilities, N=7 | -62,04 % | -118,45 % | -225,61 % | -27,25 % | -49,36 % | -85,98 % | -16,58 % | -29,58 % | -50,37 % | -6,31 % | -11,08 % | -18,46 % |
| Water Utilities, N=2 | -2,48 % | -4,73 % | -9,02 % | -1,74 % | -3,29 % | -6,19 % | 1,49 % | -2,82 % | -5,28 % | -1,25 % | -2,35 % | -4,38 % |

| MATERIALS | 0 % CPT | | | 20 % CPT | | | 60 % CPT | | | 100 % CPT | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | €55 | €105 | €200 | €55 | €105 | €200 | €55 | €105 | €200 | €55 | €105 | €200 |
| Chemicals, N=22 | -18,35 | -35,04 | -66,74 | -15,12 | -28,58 | -53,48 | -8,85 | -16,43 | -29,77 | -2,83 | -5,15 | -9,04 |
| Construction Materials, N=4 | -97,51 | -186,16 | -354,58 | -77,27 | -141,2 | -249,23 | -42,36 | -72,38 | -116,03 | -13,09 | -21,09 | -31,43 |
| Containers & Packaging, N=1 | -5,48 | -10,46 | -19,93 | -4,53 | -8,65 | -16,42 | -2,65 | -5,04 | -9,53 | -0,78 | -1,48 | -2,78 |
| Metals & Mining, N=11 | -45,81 | -87,45 | -166,57 | -37,02 | -69,48 | -128,29 | -20,47 | -37,31 | -65,67 | -5,09 | -9,11 | -15,59 |
| Paper & Forest Products, N=3 | -25,36 | -48,42 | -92,22 | -20,85 | -39,54 | -74,4 | -12,01 | -22,5 | -41,36 | -3,43 | -6,33 | -11,38 |

| ENERGY | 0 % CPT | | | 60 % CPT | | | 80 % CPT | | | 100 % CPT | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **€55** | **€105** | **€200** | **€55** | **€105** | **€200** | **€55** | **€105** | **€200** | **€55** | **€105** | **€200** |
| **Energy Equipment & Services, N=6** | -4,69 | -8,94 | -17,04 | -2,44 | -4,61 | -8,61 | -1,7 | -3,21 | -5,94 | -0,97 | -1,82 | -3,34 |
| **Oil Gas & Consumable Fuels, N=11** | -24,66 | -47,07 | -89,66 | -10,64 | -20,13 | -37,74 | -6,02 | -11,36 | -21,19 | -1,43 | -2,7 | -5 |

| INDUSTRIALS | 0 % CPT | | | 40 % CPT | | | 60 % CPT | | | 100 % CPT | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **€55** | **€105** | **€200** | **€55** | **€105** | **€200** | **€55** | **€105** | **€200** | **€55** | **€105** | **€200** |
| Aerospace & Defense, N=9 | -1,53 | -2,91 | -5,55 | -1 | -1,91 | -3,64 | -0,74 | -1,41 | -2,68 | -0,22 | -0,42 | -0,79 |
| Air Freight & Logistics, N=4 | -22,5 | -42,96 | -81,83 | -13,46 | -25,61 | -48,46 | -8,97 | -17,04 | -32,13 | -0,04 | -0,07 | -0,15 |
| Airlines, N=3 | -56,8 | -108,43 | -206,54 | -35,79 | -66,87 | -122,44 | -25,65 | -47,43 | -85,28 | -6,07 | -10,95 | -18,92 |
| Building Products, N=3 | -8,49 | -16,2 | -30,86 | -5,43 | -10,29 | -19,34 | -3,92 | -7,4 | -13,82 | -0,93 | -1,76 | -3,25 |
| Commercial Services & Supplies, N=7 | -16,36 | -31,22 | -59,47 | -10,57 | -18,25 | -29,53 | -8,16 | -13,55 | -20,84 | -4,03 | -6,23 | -8,76 |
| Construction & Engineering, N=6 | -10,45 | -19,95 | -38 | -6,58 | -12,51 | -23,67 | -4,65 | -8,83 | -16,64 | -0,83 | -1,56 | -2,88 |
| Electrical Equipment, N=6 | -3,31 | -6,32 | -12,03 | -2,11 | -4,01 | -7,62 | -1,51 | -2,87 | -5,43 | -0,31 | -0,59 | -1,12 |
| Industrial Conglomerates, N=3 | -1,21 | -2,3 | -4,38 | -0,79 | -1,5 | -2,86 | -0,58 | -1,1 | -2,09 | -0,16 | -0,3 | -0,58 |
| Machinery, N=18 | -1,4 | -2,67 | -5,09 | -0,91 | -1,74 | -3,31 | -0,67 | -1,28 | -2,43 | -0,19 | -0,35 | -0,67 |
| Marine, N=2 | -10,81 | -20,64 | -39,31 | -7,37 | -13,83 | -25,54 | -5,69 | -10,6 | -19,29 | -2,43 | -4,45 | -7,87 |
| Professional Services, N=7 | -0,88 | -1,68 | -3,19 | -0,59 | -1,13 | -2,14 | -0,45 | -0,85 | -1,62 | -0,16 | -0,3 | -0,57 |
| Road & Rail, N=1 | -44,75 | -85,44 | -162,74 | -27,69 | -52,32 | -97,74 | -19,3 | -36,29 | -67,17 | -2,82 | -5,24 | -9,53 |
| Trading Companies & Distributors, N=7 | -0,99 | -1,88 | -3,59 | -0,64 | -1,21 | -2,31 | -0,46 | -0,88 | -1,67 | -0,11 | -0,21 | -0,39 |
| Transportation Infrastructure, N=6 | -0,79 | -1,5 | -2,87 | -0,61 | -1,16 | -2,2 | -0,52 | -0,98 | -1,86 | -0,33 | -0,64 | -1,21 |

| CONSUMER DISCRETIONARY | €55/0% CPT | €55/40% CPT | €55/60% CPT | €55/100% CPT | €105/60% CPT | €200/60% CPT |
|---|---|---|---|---|---|---|
| ***CD Sector change, N=66*** | ***-2,47 %*** | ***-1,64 %*** | ***-1,23 %*** | ***-0,42 %*** | ***-2,31 %*** | ***-4,28 %*** |
| **Auto Components, N=5** | **-4,16 %** | **-2,74 %** | **-2,03 %** | **-0,63 %** | **-3,87 %** | **-7,31 %** |
| **Automobiles, N=6** | **-1,49 %** | **-0,96 %** | **-0,69 %** | **-0,16 %** | **-1,32 %** | **-2,51 %** |
| **Hotels Restaurants & Leisure, N=10** | **-9,74 %** | **-6,52 %** | **-4,95 %** | **-1,89 %** | **-9,23 %** | **-16,82 %** |
| Casinos & Gaming, N=2 | -0,97 % | -0,69 % | -0,55 % | -0,28 % | -1,05 % | -2,00 % |
| Hotels Resorts & Cruise Lines, N=4 | -22,71 % | -15,17 % | -11,49 % | -4,32 % | -21,36 % | -38,81 % |
| Leisure Facilities, N=1 | -1,52 % | -1,11 % | -0,91 % | -0,50 % | -1,73 % | -3,27 % |
| Restaurants, N=3 | -1,03 % | -0,69 % | -0,52 % | -0,18 % | -0,99 % | -1,89 % |
| **Household Durables, N=5** | **-1,18 %** | **-0,75 %** | **-0,53 %** | **-0,11 %** | **-1,02 %** | **-1,94 %** |
| **Media, N=21** | **-0,37 %** | **-0,26 %** | **-0,20 %** | **-0,08 %** | **-0,38 %** | **-0,72 %** |
| **Multiline Retail, N=2** | **-1,57 %** | **-1,03 %** | **-0,76 %** | **-0,23 %** | **-1,46 %** | **-2,77 %** |
| **Specialty Retail, N=6** | **-2,68 %** | **-1,72 %** | **-1,24 %** | **-0,28 %** | **-2,35 %** | **-4,46 %** |
| Apparel Retail, N=2 | -0,76 % | -0,52 % | -0,41 % | -0,17 % | -0,77 % | -1,47 % |
| Computer & Electronics Retail, N=1 | -9,75 % | -6,16 % | -4,38 % | -0,83 % | -8,32 % | -15,72 % |
| Home Improvement Retail, N=1 | -2,22 % | -1,40 % | -1,00 % | -0,19 % | -1,91 % | -3,62 % |
| Specialty Stores, N=2 | -1,31 % | -0,85 % | -0,61 % | -0,15 % | -1,17 % | -2,23 % |
| **Textiles Apparel & Luxury Goods, N=11** | **-0,27 %** | **-0,18 %** | **-0,14 %** | **-0,06 %** | **-0,27 %** | **-0,52 %** |

| CONSUMER STAPLES | €55/0% CPT | €55/40% CPT | €55/60% CPT | €55/100% CPT | €105/60% CPT | €200/60% CPT |
|---|---|---|---|---|---|---|
| ***CS Sector change, N=40*** | ***-4,79 %*** | ***-3,07 %*** | ***-2,22 %*** | ***-0,54 %*** | ***-4,20 %*** | ***-7,86 %*** |
| **Beverages, N=9** | **-2,22 %** | **-1,52 %** | **-1,17 %** | **-0,48 %** | **-2,23 %** | **-4,23 %** |
| Brewers, N=5 | -2,63 % | -1,83 % | -1,43 % | -0,64 % | -2,73 % | -5,16 % |
| Distillers & Vintners, N=3 | -0,58 % | -0,42 % | -0,34 % | -0,18 % | -0,65 % | -1,24 % |
| Soft Drinks, N=1 | -5,04 % | -3,26 % | -2,37 % | -0,60 % | -4,51 % | -8,55 % |
| **Food & Staples Retailing, N=12** | **-6,37 %** | **-3,95 %** | **-2,74 %** | **-0,32 %** | **-5,22 %** | **-9,90 %** |
| Food Retail, N=9 | -5,50 % | -3,43 % | -2,40 % | -0,34 % | -4,57 % | -8,66 % |
| Hypermarkets & Super Centers, N=3 | -8,98 % | -5,50 % | -3,76 % | -0,29 % | -7,16 % | -13,61 % |
| **Food Products, N=9** | **-8,83 %** | **-5,69 %** | **-4,16 %** | **-1,15 %** | **-7,78 %** | **-14,33 %** |
| Packaged Foods & Meats, N=9 | -8,83 % | -5,69 % | -4,16 % | -1,15 % | -7,78 % | -14,33 % |
| **Household Products, N=3** | **-3,58 %** | **-2,38 %** | **-1,79 %** | **-0,60 %** | **-3,39 %** | **-6,38 %** |
| **Personal Products, N=4** | **-0,83 %** | **-0,55 %** | **-0,42 %** | **-0,14 %** | **-0,79 %** | **-1,50 %** |
| **Tobacco, N=3** | **-0,55 %** | **-0,39 %** | **-0,31 %** | **-0,16 %** | **-0,60 %** | **-1,14 %** |

| HEALTH CARE, IT AND TELECOMMUNICATION SERVICES | €55/0% CPT | €55/40% CPT | €55/60% CPT | €55/100% CPT | €105/60% CPT | €200/60% CPT |
|---|---|---|---|---|---|---|
| ***Health Care, N=24*** | ***-1,09 %*** | ***-0,75 %*** | ***-0,58 %*** | ***-0,25 %*** | ***-1,11 %*** | ***-2,09 %*** |
| Biotechnology, N=2 | -0,52 % | -0,38 % | -0,31 % | -0,16 % | -0,58 % | -1,10 % |
| Health Care Equipment & Supplies, N=6 | -0,39 % | -0,28 % | -0,22 % | -0,11 % | -0,42 % | -0,79 % |
| Health Care Providers & Services, N=3 | -1,26 % | -0,85 % | -0,65 % | -0,24 % | -1,24 % | -2,36 % |
| Life Sciences Tools & Services, N=2 | -3,64 % | -2,48 % | -1,91 % | -0,77 % | -3,63 % | -6,83 % |
| Pharmaceuticals, N=11 | -1,06 % | -0,73 % | -0,57 % | -0,24 % | -1,08 % | -2,05 % |
| ***Information Technology, N=18*** | ***-1,51 %*** | ***-1,00 %*** | ***-0,75 %*** | ***-0,24 %*** | ***-1,42 %*** | ***-2,67 %*** |
| Communications Equipment, N=2 | -0,56 % | -0,37 % | -0,27 % | -0,08 % | -0,51 % | -0,98 % |
| Electronic Equipment Instruments & Components, N=2 | -0,28 % | -0,20 % | -0,16 % | -0,07 % | -0,30 % | -0,57 % |
| Internet Software & Services, N=2 | -0,76 % | -0,54 % | -0,43 % | -0,21 % | -0,82 % | -1,56 % |
| IT Services, N=3 | -0,42 % | -0,27 % | -0,20 % | -0,06 % | -0,38 % | -0,72 % |
| Semiconductors & Semiconductor Equipment, N=5 | -4,30 % | -2,82 % | -2,09 % | -0,63 % | -3,97 % | -7,47 % |
| *Semiconductor Equipment, N=1* | *-0,33 %* | *-0,24 %* | *-0,19 %* | *-0,10 %* | *-0,37 %* | *-0,71 %* |
| *Semiconductors, N=4* | *-5,29 %* | *-3,47 %* | *-2,56 %* | *-0,77 %* | *-4,86 %* | *-9,15 %* |
| Software, N=4 | -0,30 % | -0,21 % | -0,16 % | -0,07 % | -0,31 % | -0,59 % |
| ***Telecommunication Services, N=18*** | ***-0,58 %*** | ***-0,42 %*** | ***-0,33 %*** | ***-0,17 %*** | ***-0,64 %*** | ***-1,21 %*** |
| Diversified Telecommunication Services, N=15 | -0,52 % | -0,37 % | -0,30 % | -0,16 % | -0,57 % | -1,09 % |
| Wireless Telecommunication Services, N=3 | -0,88 % | -0,63 % | -0,50 % | -0,25 % | -0,96 % | -1,82 % |