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***Impacts of carbon performance on financial performance: case of ICT sector***

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Aidana Zhalubayeva \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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# Introduction

The concept of corporate social responsibility (CSR) refers to managing a business in a manner that creates positive social and environmental impacts. Nowadays different companies are trying to incorporate CSR into their business practices. While the positive impact of CSR on society and the environment is unquestionable, most researchers still argue about its benefit for the organizations themselves. Hence, the literature on this topic is various. However, the focus is mainly dedicated to such industries as oil and gas or transportation and their carbon-related activities. Carbon-related activities are the actions of companies intended to decrease the amount of carbon emissions. Meanwhile, there are still different industries that have been studied comparatively less, such as the ICT sector. ICT refers to Information and Communication Technology. The OECD stated that the ICT sector “must primarily be intended to fulfill or enable the function of information processing and communication by electronic means, including transmission and display”. Thus, the ICT sector includes such industries as IT Software and Services, Technology Hardware and Equipment, and Telecommunication services. ICT poses a two-sided impact on the environment. On the one hand, many researchers believe that its innovations will help to cope with climate change. On the other hand, it still can harm the environment by their carbon emissions. For example, by the emissions from the data servers or production of hardware.

Thus, the goal of the paper is to evaluate the financial performance of carbon-related activities in the ICT sector. To do so, six objectives of the research are presented. First, this paper will examine ECSR related theoretical approaches and then, on its basis, the hypotheses are formulated. Next, the methodology to check the hypotheses will be established. After that, the dataset based on carbon performance and company rankings will be created. The following objective would be to correlate both carbon performance and financial indicators of companies by using the regression technique. Having done that, the results ought to be interpreted. Finally, possible reasons for these results and the following discussion will be provided. The object of this research is the companies of the ICT sector, and the research subject is carbon performance and financial performance. The source of information is secondary data, including the reports of companies and open sources.

The paper is structured in the next order. First, the theoretical framework will be built with a help of the literature review part, where the relationship between CSR, carbon performance and disclosure, and financial performance, the ICT sector, and its environmental implications will be examined. After, based on the gathered information, the hypotheses will be formulated. To test the hypotheses, the research methodology will be discussed. Then, the analyses will be conducted and the results will be presented in the results section. Finally, the last section of the paper is the discussion of the results. Thus, the next section is dedicated to the literature review.

# Literature review

In this section of the paper, the theoretical concept will be established based on the previously written researches and its results. First, we will examine the concept of CSR and its implications on the financial performance of different firms. Then, we will focus on the environmental aspect of CSR, precisely the carbon performance, carbon disclosure, and its relationship with corporate financial performance. Thirdly, we will move to the ICT sector itself and examine its environmental impact. After that, the relevance of the paper will be established in the research gap section. Finally, we will move to the hypotheses formulation part.

## CSR and financial performance

Sustainability, from its very beginning, is defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” [University of Alberta, 2013]. Throughout the years, however, it was re-interpreted as encompassing three different dimensions: environmental, social, and economic [Kuhlman and Farrington, 2010]. Companies, being a part of society, also should be a part of sustainable development. The concept of corporate social responsibility (CSR) refers to managing a business in a manner that creates positive social and environmental impacts [Cornelia et al., 2010]. To illustrate, William Mulligan, environmental affairs manager at Chevron Corporation, once said that “…environmental excellence has to become part of strategic thinking”, and “whenever we are forced to change, we often find opportunities” [Deloitte, 1992]. Undoubtedly, there is a positive impact from CSR activities on the environment, but are there any positive implications for a company itself?

There have been various studies on the implications of CSR on organizations. From a theoretical point of view, some theories can explain the relationship of carbon performance on the financial performance of companies. One of these theories could be stakeholder theory. Stakeholder theory suggests that the essence of organizations is to build a relationship and create values for all its stakeholders [Freeman, 1984]. By a stakeholder, the author meant “any group or individual who can affect or is affected by the achievement of the organization's objectives”. Stakeholders, including shareholders, may make demands on the enterprise, conferring societal legitimacy. Firms must respond to these requests or risk unfavorable confrontations from non-shareholder groups, which can result in lower shareholder value via boycotts, lawsuits, protests, and other means [Ruf et al., 2001]. Stakeholders can be divided by three groups [González-Benito and González-Benito, 2006]. As the authors outlined, the most crucial groups are organizational and regulatory, and firms should comply with their demands, as they can crucially affect business performance. Organizational stakeholders are that group of stakeholders that created the organization, as companies exist for or by them. It includes customers, employees, shareholders, and suppliers [Sarkis et al., 2010]. The second group has the regulatory power to make an organization adopt the green initiatives [Backer, 2007]. They consist of governments, trade associations, media, and other regulatory entities.

Other theories and researches were developed to explain the effect of CSR on financial performance. [Yu and Zhao, 2015] proposed two opposite theories: value-creating and value-destroying theories to examine the effect of sustainability on companies’ financial performance. On the one hand, according to value-creating theory, risks are reduced by being socially and environmentally responsible. Companies with a higher level of CSR activities (including both social and environmental dimensions) can observe higher financial performance due to lower capital constraints, reduced agency costs [Cheng, Ioannou and Serafeim, 2013], aligning social objectives with the company’s objectives [Sayekti, 2015], and involvement in socially responsible initiatives [Giannarakis, Konteos, Zafeiriou and Partalidou, 2016]. [Fry et al., 1982] showed that investing in CSR creates corporate identity, builds a reputation of a firm. Moreover, it allows spending less on advertising, which in turn, decreases the costs of the company. According to [Hammond and Slocum, 1996)], companies engaging with CSR have lower financial risks. In other words, enterprises that invested in CSR, compared to companies that did not, have less tendency to go bankrupt.

On the other hand, value-destroying theory demonstrates that with the adoption of social and environmental responsibility, companies lose focus on profitability to please shareholders [Yu and Zhao, 2015]. СSR can negatively impact firms’ profitability “by pushing to engage in investment generating costs” [Elouidani and Zoubir, 2015], and prevents more profitable potential investments [Bird, Hall, Momentè and Reggiani, 2007]. [Henderson, 2001] calls CSR a “deeply flawed” doctrine and states that its adoption decreases welfare and undermines the economy. In his article called “The Case Against ‘Corporate Social Responsibility,” he argues that the adoption of CSR involves new systems of accounting, monitoring, and auditing. Moreover, it makes companies have wider goals and concerns with time-consuming processes of consultation with outside stakeholders. On a broader view, companies that more socially responsible, with higher costs and lower profits, are trying to press out less socially responsible companies. This, in turn, reduces the competition and performance in the economy. Similarly, [Reich, 2008] states that companies have to sacrifice revenues for certain social goods.

Along with negative and positive opinions concerning the impact of CSR, some articles have neutral positions. For example, [O’Neill, Saunders, and Derwinsky McCarthy, 1989] analyzed the implications of corporate social responsiveness on profitability. They found that there is no effect from the level of director social responsiveness on corporate profitability. [Kraft and Hage, 1990] were analyzing the correlation between community service goals of 82 business companies with different organizational characteristics (goals, niches, structure, context, performance). The results showed that community service goals do not correlate with profit goals, low-price niches, the multiplicity of outputs, workflow continuity, qualifications, or centralization. [Griffin and Mahon, 1997] examine the relationship of corporate social performance (CSP) with corporate financial performance (CFP) in the chemical industry. Their work was significant in the way that the paper is industry-related. Moreover, it assesses two other critical areas. First, they used multiple sources of data: perceptual-based (KLD index and Fortune reputation survey) and performance-based (corporate philanthropy and TRI database). Second, they applied the five most common accounting measures in the CSP and CFP literature to assess CFP. They found that accounting measures can predetermine CSP/CFP relationship. Besides, Fortune and KLD similarly track each other, while TRI and corporate philanthropy show high and low social performers and they do not correlate with companies’ performance. Controversially, having analyzed S&P 500 firms in the years of 2005 till 2014, [Mentor, 2016] found that CSR had a positive effect on a company’s profit and a negative effect on future stock returns.

To summarize, different scholars were assessing CSR with financial performance. Mainly, their findings may be divided into three groups. The first group of results implies a positive outcome of CSR on financial performance. Their main arguments are that CSR helps to reduce costs and financial risks, builds reputation. The second group, on the other hand, believes that there is a negative impact from CSR adoption due to increased risks, prevention from more profitable investments, and time-consuming initiatives. The third group does not find any impact from CSR activities.

As it was mentioned, CSR is mostly divided into three parts. Undoubtedly, all these three parts can have their influence on companies’ performance. To illustrate, [Lv et al., 2019] found out that environment-related CSR is positively associated with long-term growth. Consequently, [Zelazna, Bojar, and Bojar, 2020] conducted a survey concerning environmental activities undertaken by companies. Respondents of the survey point out various tangible benefits from ecological activities. Similarly, [Sila and Cek, 2017] observed a positive correlation between environmental CSR and the economic performance of organizations. The environmental aspect of CSR (ECSR) consists of different aspects that can influence the environment. One of these aspects is carbon emissions or Greenhouse Gas (GHG) emissions. The next section of the literature review focuses on carbon emissions, disclosure, and their impact on financial performance.

## Carbon emissions, carbon disclosure, and financial performance

Carbon disclosure or carbon reporting is companies’ report on their carbon performance. Over the years, the amount of these disclosures is decreasing. Moreover, most of them are disclosed voluntarily [Andrew and Cortese, 2011].

Carbon emission is the main driver of climate change. Therefore, companies are more pressured or motivated to reduce emissions and involve in environmental activities. Thus, the relationship between carbon performance and financial performance can be two-sided: value-creating and value-destroying. On the one hand, involving more in carbon-reducing activities helps to reduce the carbon footprint of the company [Bansal, 2005] and avoid inefficient and ineffective usage of resources [Porter and van der Linde, 1995; Albertini, 2013]. Moreover, integrating environmental issues into product creation (for example, design of the product or manufacturing) can make a company a “first mover”, and thus creates a competitive advantage [Lieberman, 2016]. [Raida et al., 2014] were analyzing Malaysian manufacturing companies. They found a positive relationship between carbon reporting and firm performance. Similarly, [Siddique et al., 2020] observed that carbon disclosure has a positive relationship with financial performance but only in the long term. The companies that are intended to incorporate more green business practices can receive additional funds or help from some governments [Ge and Lei, 2014]. Moreover, carbon pricing can induce innovation [Cui et al., 2018]. In other words, companies, to avoid paying for the emitted carbon, invest in low-carbon technologies. This, in turn, can affect financial performance in two ways. Firstly, it allows reducing the carbon tax or price, which the company would have to pay without the low-carbon technology. Secondly, the firms with new technologies tend to outperform other organizations in terms of profit and cost-based performance [Bharadwaj and Anandhi, 2000].

There were also different findings. For example, spending more money on environmental protection improves financial performance, however, smaller companies’ performance is more or less negatively affected by these carbon-related activities [Grewer et al., 2016]. The authors defined carbon-related activities as activities that seek to decrease amount of carbon footprint. Controversially, [Liouia and Sharma, 2012] observed a negative relationship between ECSR and CFP. [Matsumura et al., 2014] found that companies disclosed their carbon emissions had a major decrease in firm value. To be precise, for every additional thousand metric tons of CO2 emissions, the value of the firm decreased by $212 000 dollars. In 2014, [Tang and Luo] have analyzed the relationship between the carbon tax and the financial market return on Australian companies. Their sample comprised 48 different organizations from Carbon Disclosure Project (CDP) reports. The study showed that most businesses have weak carbon policies and that businesses that specifically produce significant quantities of carbon are highly likely to be penalized by investors. Moreover, some countries impose a carbon tax or pollution tax, which affects companies with higher carbon emissions [Ionescu and Luminita, 2019]. To illustrate, the higher the emitted CO2, the higher the tax. Thus, companies are paying more than the companies that emit less carbon. Besides, higher carbon efficiency implies higher profitability and lower systematic risk [Trinks, Mulder, and Scholtens, 2020].

All in all, as we can see most studies focus either on the impact of CSR in general or the impact of carbon emissions in manufacturing or various companies. However, there were fewer studies concerning the impact of carbon performance on CFP. Most researchers find a negative relation between companies’ emissions and overall performance, and they suggest that there should be a positive correlation if green activities are made. Therefore this paper aims to estimate the impact of carbon performance on the financial performance of the company. The previous papers were considering this theme in general or by assessing different industries. Undoubtedly, different industries pollute differently. Therefore, to have a more precise assessment, the next section focuses on the industry choice.

## ICT and environmental impact

Some industries may have a bigger environmental impact compared to others (for example oil and gas or transportation). Therefore, to have more accurate research, it is better to focus on a particular industry. The relationship of digital technologies with the environment is an issue that triggers interest in lots of researchers. While one half expects digital technologies to be a solution to cope with climate change, the other half demonstrates their concern about the digital carbon footprint. To illustrate, various studies [IEA, 2017; Ericsson, 2021; Ekholm and Rockström, 2019] show a positive impact of ICT.

ICT refers to Information and Communication Technology. The ICT sector was introduced with the rise of technologies, however, there was not an official definition for this term [Kelly, Lewin, and Huynh, 2009]. The [OECD, 2002] stated that the ICT sector “must primarily be intended to fulfill or enable the function of information processing and communication by electronic means, including transmission and display”. Thus, the ICT sector includes such industries as IT Software and Services, Technology Hardware and Equipment, and Telecommunication services.

Returning to the positive impact of the ICT, IEA suggests that these digital technologies are helping to improve energy efficiency and reduce maintenance costs. In the recent IEA report, it was found that using digital solutions to truck operations and logistics could reduce road freight’s energy use by 20-25% [Ericsson, 2021]. According to [GeSI and Deloitte’s Digital with Purpose report, 2021], digital technologies could enable reductions in carbon emissions equivalent to almost seven times the amount that emissions of the ICT sector will grow by 2030.

The ICT sector certainly provides many solutions and applications that have different beneficial effects on the natural environment. However, there are many environmental threats that the ICT sector still poses. To illustrate, computers can contain heavy metals and other hazardous chemicals as parts of their various components. Greenpeace in 2007 found that most laptops have heavy metals (lead, mercury, cadmium, and hexavalent chromium), bromine content, to indicate the presence of brominated flame retardants (BFRs), four specific brominated flame retardants (BFRs), PVC (polyvinyl chloride), phthalates esters (phthalates) [Brigden et al., 2007]. Moreover, [Grant et al., 2013] have found that with exposure to e-waste there are increases in spontaneous abortions, stillbirths, and premature births, and reduced birthweights and birth lengths.

In 2001, [Berkhout and Hertin], as a part of a report to the OECD, have summarized that the ICT sector has a profound environmental impact, both positive and negative. Furthermore, they identified three main types of these environmental effects:

1. First-order impacts include direct environmental effects of the production and use of ICTs. In other words, it consists of pollution and usage of resources to produce ICT infrastructure and devices, the electricity consumption of ICT hardware, electronic waste disposal;
2. Second-order impacts are about indirect environmental impacts related to the effect of ICTs on the structure of the economy, production processes, products, and distribution systems. The key forms of positive environmental effects are dematerialization (more production for less input of resources), virtualization (substitution of tangible goods for information goods), and demobilization (the substitution of communication at a distance for travel);
3. The impacts of the third order are indirect effects on the environment, primarily through the stimulus by ICTs 'rebound effect' of further consumption and higher economic development, and through impacts on lifestyles and value systems.

Similarly, in 2007, [Yi and Thomas] proposed that environmental impacts of ICT, which consisted of three-order effects:

1. First-order effects are about direct impacts and opportunities created by the physical existence of ICT and the processes involved;
2. Second-order effects take into consideration indirect impacts and opportunities created by the ongoing usage and application of ICT;
3. Third-order effects are the impacts and possibilities produced over the medium to long term by the combined effects of a large number of people using ICT.

[Hilty, 2008] presented a conceptual framework on the Environmental impact of ICT. Aside from first-order effects, he mentioned six other effects: (1)optimization effects, (2)substitution effects, (3)induction effects, (4)deep structural change toward the dematerialized economy, (5)rebound effects and (6)new critical infrastructure. The next figure represents the effects of the framework.



1. Environmnetal impact of ICT

Source: [Hilty, 2008]

Let us look closer at each impact.

1. The optimization effect with a help of ICT can occur in all production phases of a product. The effect has a positive impact, as it can make processes, products, and services more effective by automating steps or making conversions disappear. Overall, optimization affects time, costs, and environmental impact, or in other words, the same process can be done faster, cheaper, and has less environmental impact respectively.
2. The substitution effect takes place when ICT services replace the usage of a physical product. For example, when paper-based mail was replaced by e-mail. Due to the absence of necessity to buy and use paper, use transportation services, the effect also has a positive impact. However, these substitutions may not have entire functionalities, and thus cannot be entirely substituted.
3. The induction effect occurs when an ICT service stimulates the usage of another product. Consequently, it requires more time and energy to finish
4. Deep structural change toward a dematerialized economy. This effect states that ICT separates economic growth from growth in the use of natural recourses. Traditionally, an economy was functioning with the use of natural resources, labor, and capital. With the introduction of ICT, an economy started requiring skills, knowledge, and information. With the rice of ICT usage, another immaterial component became visible – digital or virtual goods.
5. The rebound effect is a response to introduced change by ICT. This effect may be visible when something becomes so efficient, it is almost free (e-mail example). It normally saves time or money if anything becomes more efficient, and it makes sense to ask the question of what happens on a system level with that time or money: do we use it to send more e-mails or do we spend it on other activities? How eco-friendly are these activities? To sum up, this change can have both negative and positive impacts, depending on the outcomes of the change.
6. New critical infrastructure. ICT provides an infrastructure that we rely on in our everyday lives, as with all technology that is an integral part of our lives. For example, most of us cannot imagine a life without the Internet. Moreover, as ICT is a technology for general purposes, it also forms part of other infrastructures, such as energy and transport infrastructures.

At the end of the framework, [Hilty, 2008] has presented recommendations for organizations, hardware and software developers, as well as individual users. The main idea of these recommendations was saving and minimizing energy use. As there is an impact of ICT on the environment, it is possible to focus on one of the parts of environmental aspects: carbon performance. The next section of the literature review outlines the relationship between ICT and carbon performance.

## ICT and carbon performance

[Hoffmann and Busch, 2008] defined carbon performance as the quantitative GHG emissions as well as processes and measures for reducing air emissions. Emissions are to be reported yearly in many countries. To make the reports more consisted, a framework has been developed by world resources institute called Greenhouse Gas Protocol (GHG Protocol). GHG Protocol breaks down the emissions by 3 scopes. Scope 1 are direct emissions, while Scope 2 and 3 are indirect emissions. In scope 1 we account the emissions that result from the activities of a company or under its control. It includes gas boilers, fleet vehicles, and air-conditioning leaks. Scope 2 represents emissions from electricity purchased and used by the company. In other words, it includes emissions created during the production of the energy and eventually used by the organization. Finally, Scope 3 is accountable for all other indirect emissions from company’s activities that they do not own or control. It includes business travel, usage of the product by customers and etc [GHG Protocol, 2021].

 Overall, the ICT sector did not bring much attention to previous researchers. Most carbon emission papers are focused on other industries, such as oil and gas, transportation services, etc [Chevallier et al., 2021; Abreu et al., 2021]. The reason for this choice is understandable: these companies emit more. However, the ICT sector should not be underestimated. [Malmodin et al., 2010] was assessing 2007’s GHG emissions and global operational electricity use in the ICT sector. They found that the ICT sector is responsible for 1,3% of global CO2 emissions and 3,9% of global electricity consumption in the use phase. In their next paper [Malmodin and Lundén, 2018], they continued the research, analyzing the years of 2010-2015. The following table are the total results of this study.

1. Total results

Source: [based on the findings of Malmodin and Lunden, 2018]

As we can see from the chart, the total carbon footprint of the ICT sector in 2010 and 2015 have similar results. According to the authors, the ICT sector “has stopped growing its energy and carbon footprint”. Overall, the carbon footprint of the ICT sector is 1,4% and the energy footprint is 3,6%. Reasons for these changes authors explain by decreased sales of new TVs and PCs, consumer electronics are replaced by apps, improved material, and energy efficiency of technologies, decreased paper consumption, energy-efficient devices (deep structural change toward a dematerialized economy, substitution effect, rebound effect). Moreover, it was outlined that many large ICT data services and network operators are using “green electricity”. The IEA reports that more than 50% of the corporate use of renewable power purchasing agreements (PPAs) can be attributed to the ICT market [IEA, 2021]. The reason for this shift can be the motivation of companies moving towards sustainable development [Sawin, et al., 2016].

The impact of ICT on GHG emissions also can be ambiguous. On the one hand, the sector helps with mitigating the level of carbon emissions [Zhang and Liu, 2015; Lv, 2018; Wang et al., 2015]. Besides, [Ozcan and Apergis, 2017] found that internet usage decreases the CO2 emission in developing countries. In other words, the usage of the internet can reduce the usage of outdoor activities, which in turn reduces CO2 emissions and energy consumption.

On the other hand, the ICT can stimulate carbon emissions [Lee et al., 2016]. To illustrate, with higher usage of the internet, the energy consumption from the internet raises the emissions. [Lee and Brahmasree, 2018] showed that the ICT impacts negatively carbon emissions and positive economic growth. Therefore, it gives a reason to focus more on the carbon performance of the ICT and see whether these changes gave any benefit to the financial performance of companies.

To summarize, the literature review part gave an insight into CSR and its impact on financial performance. Precisely, CSR has three different dimensions. One of these dimensions is ECSR, which also consists of carbon emissions. The next table is the representation of the previous scientific literature that was the basis of this part of the paper. The next section consists of formulating the hypotheses based on the theoretical framework. After that, the research methodology is presented.

1. Literature review

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Author | Journal name | Theme | Year | Methodology | Findings |
| Noor Raida Abd Rahman, Siti Zaleha Abdul Rasid, Rohaida Basiruddin  | Procedia - Social and Behavioral Sciences | Exploring the relationship between carbon performance, carbon reporting and firm performance: A conceptual paper | 2014 | Analyzing energy audit report through carbon reporting index.  | The positive relationship between carbon reporting and firm performance. |
| Fortune Ganda and Khazamula Samson Milondzo | Sustainability | The Impact of Carbon Emissions on Corporate Financial Performance: Evidence from the South African Firms | 2018 | Multiple regression techniques | Negative relationship between carbon emissions and corporate financial performance. Thus companies investing in green initiatives can have positive financial performance  |
| Fortune Ganda | Social Responsibility Journal | The effect of carbon performance on corporate financial performance in a growing economy | 2018 | Multiple linear regression analysis | carbon performance pays off and that the relationship with financial performance deepens as the corporate growth rate increases. |
| Abraham Liouia and Zenu Sharma | Ecological Economics | Environmental corporate social responsibility and financial performance: Disentangling direct and indirect effects | 2012 | fixed effects regression with industry year fixed effects and standard errors clustered at firm year level | Negative relationship between ECSR and CFP. Also, ECSR benefits R&D |
| Yang WANG, Jun Liu, Xiuping Sui, Libing Liu | Finance Research Letters | Does corporate social responsibility improve financial performance? -evidence from pure green side | 2020 | CSR index by province | environment protection expenditure improves financial performance, small companies have more influence |
| Md Abubakar Siddique, Md Akhtaruzzaman, Afzalur Rashid, Helmi Hammami | International Review of Financial Analysis | Carbon disclosure, carbon performance and financial performance: International evidence | 2021 | Multiple regression techniques | Carbon disclosure negatively (positively) affects financial performance in the short-term (long-term). |
| Yu and Zhao | International Journal of Accounting and Information Management | Sustainability and firm valuation: an international investigation | 2015 | Empirical tests | The impact of CSR on financial performance can be two-sided: value-creating and value-destroying.  |
| Cheng, Ioannou and Serafeim | Strategic Management Journal | Corporate social responsibility and access to finance | 2013 | paired analysis based on a ratings shock to CSR performance, an instrumental variables approach, and a simultaneous equations approach | Higher financial performance is observed due to lower capital constraints and reduced agency costs |
| Sayekti | Procedia - Social and Behavioral Sciences | Strategic Corporate Social Responsibility (CSR), Company Financial Performance, and Earning Response Coefficient: Empirical Evidence On Indonesian Listed Companies. | 2015 | Multiple regression techniques | Higher financial performance is observed by aligning social objectives with the company’s objectives |
| Giannarakis, Konteos, Zafeiriou and Partalidou | Investment Management and Financial Innovations | The impact of corporate social responsibility on financial performance. | 2016 | OLS | Higher financial performance is observed due to involvement in socially responsible initiatives |
| Fry et al.  | Academy of Management Journal | Corporate Contributions: Altruistic or For-Profit? | 1982 | OLS and ANCOVA | Investing in CSR increases the reputation of a firm, and decreases costs due to lower marketing expenses |
| Hammond and Slocum | Journal of Business Ethics | The impact of prior firm financial performance on subsequent corporate reputation | 1996 | OLS | Companies engaging with CSR have lower financial risks |
| Elouidani and Zoubir | African J. of Accounting, Auditing and Finance | Corporate social responsibility and financial performance | 2015 | Multiple regression techniques | CSR negatively impacts profitability “by pushing to engage in investment generating costs” |
| Bird, D. Hall, Momentè and Reggiani | Journal of Business Ethics | What Corporate Social Responsibility Activities are Valued by the Market? | 2007 | Multiple regression techniques | CSR prevents from more potential investments |
| Henderson | Policy | The case against 'Corporate Social Responsibility' | 2001 | - | The adoption of CSR decreases welfare and undermines the economy. Involves new system of accounting, monitoring, and auditing.  |
| Reich | SSRN | The Case Against Corporate Social Responsibility | 2008 |  | CSR makes to sacrifice revenues for certain social goods. |
| O’Neill, Saunders and Derwinsky McCarthy | Journal of Business Ethics | Board members, corporate social responsiveness and profitability: Are tradeoffs necessary?. | 1989 | Multiple regression techniques | No effect from the level of director social responsiveness on corporate profitability |
| Kraft and Hage | Journal of Business Ethics | Strategy, Social Responsibility and Implementation | 1990 | Multiple regression techniques | Community service goals do not correlate with profit goals, low-price niches, the multiplicity of outputs, workflow continuity, qualifications, or centralization |
| Griffin and Mahon | Business & Society | the Corporate Social Performance and Corporate Financial Performance Debate : Twenty-Five Years of Incomparable Research | 1997 | Regression techniques | TRI and corporate philanthropy show high and low social performers and they do not correlate with companies’ performance |
| Mentor | Honors | The Effects of Corporate Social Responsibility on Financial Performance | 2016 | cross-sector/panel data time-series regressions | CSR had a positive effect on a company’s profit and negative effect on future stock returns |
| Malmodin et al | Journal of Industrial Ecology | Greenhouse Gas Emissions and Operational Electricity Use in the ICT and Entertainment & Media Sectors | 2010 | bottom-up data collection and modelling approaches  | ICT sector is responsible for 1,3% of global CO2 emissions and 3,9% of global electricity consumption in the use phase |
| Malmodin and Lundén | Sustainability | The Energy and Carbon Footprint of the Global ICT and E&M Sectors 2010–2015 | 2018 | bottom-up data collection and modelling approaches | the ICT sector “has stopped growing its energy and carbon footprint” |
| Bansal | Strategic Management Journal | Evolving sustainably: a longitudinal study of corporate sustainable development | 2005 | Regression techniques | involving more in carbon reducing activities helps to reduce the carbon footprint of the company |
| Porter and van der Linde | Harvard Business Review | Green and Competitive: Ending the Stalemate | 1995 | - | involving more in carbon reducing activities helps to avoid inefficient and ineffective usage of resources |
| Lieberman | The Palgrave Encyclopedia of Strategic Management | First-Mover Advantage | 2016 | - | integrating environmental issues into product creation can make a company a “first mover” |
| Matsumura, Ella Mae, et al | The Accounting Review | Firm-Value Effects of Carbon Emissions and Carbon Disclosures | 2014 | Primary data | companies disclosed their carbon emissions had a major decrease of firm value. |
| Tang and Luo | Australian Accounting Review | Carbon Management Systems and Carbon Mitigation | 2014 | Created the new approach from CDP data | Companies producing significant amounts of carbon, most likely will be penalized by investors |
| Ionescu and Luminita | Geopolitics, History, and International Relations | Climate Policies, Carbon Pricing, and Pollution Tax: Do Carbon Taxes Really Lead to a Reduction in Emissions?” | 2019 | Primary data, equation modelling | Carbon tax and pollution tax affect financial performance of companies with higher carbon emissions |
| Trinks, Mulder and Scholtens | Ecological Economics | An Efficiency Perspective on Carbon Emissions and Financial Performance | 2020 | Multiple regression techniques | higher carbon efficiency implies higher profitability and lower systematic risk |
| Cui, Jingbo, et al. | AEA Papers and Proceedings | Carbon Pricing Induces Innovation: Evidence from China’s Regional Carbon Market Pilots | 2018 | difference-in-difference-in-differences (DDD) approach | Carbon pricing induces the innovation |
| Bharadwaj and Anandhi | MIS Quarterly | A Resource-Based Perspective on Information Technology Capability and Firm Performance: An Empirical Investigation. | 2000 | Matched sample comparison group | The firms with new technologies tend to outperform other organizations in terms of profit and cost-based performance |

Source: [Made by the author]

## Research gap

As it was identified in the literature review, various studies have been dedicated to ECSR and financial performance in different industries. There are fewer studies that have been examining the ICT sector and carbon performance of companies. Moreover, the studies dedicated to the impact of carbon performance of ICT companies on financial performance have not been studied yet. Therefore, this paper aims to examine this relationship.

## Hypotheses formulation

In this part of the paper, we will focus on establishing the hypotheses of the research. Overall, there are two main hypothesis:

*H1: Higher (lower) amount of CO2 emissions negatively (positively) affects financial performance of ICT companies*

The hypothesis involves the amount of CO2 emissions. By CO2 emissions I mean Scopes 1 and 2 of the emissions. As for the financial performance, there can be various ways of assessment. Not to have only one-sided financial performance, it was decided to have two different assessments of financial indicators. From one side, the accounting metrics will be measured. From the other side, market values will be taken into account. Thus, the main hypothesis has two sub-hypotheses:

*H1a: Higher (lower) amount of CO2 emissions negatively (positively) impacts the ROA of ICT companies*

*H1b: Higher (lower) amount of CO2 emissions negatively (positively) impacts the Tobin’s Q of ICT companies*

According to stakeholder theory, certain parties are involved with a company and they can influence in some way the business operations of an organization. Thus, the hypotheses suggest that if the amount of carbon emissions is rising, it will affect the financial performance negatively [Gallego-Alvarez et al., 2014]. [Kleindorfer et al., 2005] found that manufacturing organizations were pressurized into following the green practices, due to higher resource usage and carbon emissions. In other words, some stakeholders would pressure a company, because the company did not respond to the suggested environmental demands of that particular stakeholder.

The next hypothesis suggests the following:

*H2: Higher (lower) carbon disclosure positively (negatively) affects financial performance of ICT companies*

As we can see, the hypothesis involves a carbon disclosure. It suggests that organizations can have a higher financial performance by disclosing their carbon performance. Similar to the previous main hypothesis, to estimate the financial performance two financial indicators will be assessed. Thus, the hypothesis is divided into two sub-hypotheses:

*H2a: Higher (lower) carbon ranking positively (negatively) impacts the ROA of ICT companies*

*H2b: Higher (lower) carbon ranking positively (negatively) impacts the Tobin’s Q of ICT companies*

On the one hand, it is suggested that carbon disclosure affects positively the ROA. That is if carbon performance is disclosed it can receive a positive reaction from certain stakeholders, which can affect the ROA of the firm. On the other hand, carbon disclosure can affect positively Tobin’s Q of the organization.

Overall, the results of this kind of correlation have been different. In other words, there can be three different results. First is the positive correlation between the variables [Rahman et al., 2014; Ganda 2018; Wang et al., 2020]. Second is negative impact on two variables [Ganda and Milondzo, 2018; Liouia and Sharma, 2012; Elouidani and Zoubir, 2015]. Lastly, the third result states there is no correlation between financial performance and carbon performance [Hammond and Slocum, 1996; O’Neill, Saunders and Derwinsky McCarthy, 1989; Griffin and Mahon, 1997].

Having established the hypotheses of the research, it is needed to identify how these hypotheses will be tested. Thus, the next part of the paper is research methodology.

# Research Methodology

This part of the paper is dedicated to establishing techniques and procedures to test the mentioned hypotheses. Thus, this part will consist of comparing different methodologies and establishing the most appropriate one. As the literature review showed, most of the studies’ analysis method was regression analysis. Moreover, the established hypotheses suggest the quantitative assessment, which, in turn, makes qualitative assessment unreasonable. In other words, a qualitative assessment is unable of providing accurate testing of mentioned hypotheses. Therefore, this research is aimed to conduct a regression analysis.

The section consists of four parts. Firstly, we will identify the sample of the research. Then, the variables of the analysis will be identified. After we will move to the methodology itself, thus we will compare and choose techniques that are appropriate to examine the assumptions. Finally, we will focus on the chosen regression model, and establish how the analysis will be processed. Thus, the next sub-section is dedicated to the research sample.

## Identifying the research sample

The research sample should consist of a list or a rating of companies with their carbon performance. Moreover, as the research aims to observe the example of digital companies, it is needed to extract certain them from the list. Therefore, a carbon performance list of companies will be identified first. Then, the list of digital companies will be chosen. Finally, by intersecting both lists, the overall sample of the research will be presented.

While some organizations have their methodologies, other organizations can have their rating of companies according to different environmental issues. Following is the list of different sustainability projects.

1. Sustainability projects

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Goal** | **Scope** | **Environmental aspects** | **Type of rating** |
| Carbon Disclosure Project (CDP) | Standardizing data disclosure concerning climate change, water and forests | Companies from different industries are presented | Climate change, water and forest | Carbon performance |
| RMI | Reducing the amount of GHG emissions | Considers transportation companies | GHG emissions | Carbon performance |
| ABS | Reducing the amount of GHG emissions | American vessels and fleets companies | GHG emissions | Carbon performance |
| Greenhouse Gas Protocol (GHG Protocol) | Providing standards, guidance and tools to measure and manage climate-warming emissions | The standards for different companies are provided. | GHG emissions | No rating |
| International Integrated Reporting Council (IIRC) | Promoting prosperity for all and to protect our planet. | Accelerates the adoption of integrated reporting across different companies | Quality of disclosure | No rating |
| Morningstar Sustainability rating | Providing the insights to make more informed decisions that lead to a more just and sustainable global economy. | Companies from different industries are presented | Environmental, social, governance | ESG rating |

Source: [Made by the author]

Overall, seven different sustainability projects are presented. The organizations RMI and ABS do have carbon performance ratings. However, the scope of the companies is narrow. In other words, they represent only transportation companies, which is different from the research’s industry choice. Next are the GHG Protocol and IIRC. They provide companies with different insights and guidelines on more thorough reporting, however, it presents no rating of carbon performance. Morningstar's Sustainability rating rates the ESG (environmental, social, and governance aspects) of various companies. Although carbon performance is a part of the environmental aspect, the rating presents the overall score on all three dimensions. Thus, if choosing this dataset, the results will be inaccurate. Finally, the Carbon Disclosure Project (CDP is presented. It provides a rating from A to F (A being the highest) on three different environmental aspects across different industries. Their so-called A-list in 2020 comprised more than 9600 companies among which 277 firms had the A score. The climate change area focuses mostly on the carbon performance of different companies and different cities. All in all, for the carbon performance rating the CDP’s A-rating is the most suitable proposition.

Carbon Disclosure Project is an organization trying to prevent dangerous climate change and environmental damage. The organization incentivizes and guides companies and cities towards becoming a “leader and on environmental transparency and action” [CDP, 2021]. Starting from 2010 CDP gathers disclosures of different organizations and cities and creates two different ratings according to their environmental performance. The rating has three dimensions: forest, water, and climate change. Forest area includes deforestation and forest degradation, whereas water area is about water security. Climate, on the other hand, is involved with fighting climate change by assessing companies’ carbon and climate change risks. The uniform and internationally recognized reporting method of CDP eliminates the burden of data collection and submission, making assessment and comparison easier [CDP, Climate change, 2021].

However, CDP has a rating of different organizations from different industries. To illustrate, for the year 2021 the rating consisted of 9617 companies that disclosed the information. As this paper is aimed to examine digital companies, there is a need in sorting these enterprises, thus deciding what organization is relevant for the assessment. To do so, it makes sense to have a list or rating of digital companies. Therefore, the next table is the comparison of different rankings of companies.

1. Rankings of companies

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Name of the organization | Number of companies | Industry | Methodology | Year | Country |
| Forbes | 2000 | All | 3 metrics | 2020 | Worldwide |
| Bloomberg | 75 | Technology | Profit | 2013 | USA |
| Fortune | 500 | All | Total revenue | 2020 | Worldwide |
| Statista | 100 | All | Market capitalization | 2020 | Worldwide |
| World Benchmarking Alliance | 100 | Digital | Digital inclusion | 2020 | Worldwide |

Source: [Made by the author]

Overall, five different rankings are presented. Bloomberg over the years had made different rankings. However, their recent ratings are hardly suitable for this assessment. In 2013, the company presented a list of 75 of the most profitable technology companies in the US. Nevertheless, the year 2013 is considered to be outdated. The next is the recent Fortune’s Global 500 list. It considers companies according to their total revenues and considers worldwide companies. Similarly, Statista has its list of 100 worldwide companies assessing their market capitalization. Both these rankings take into account all companies, regardless of their industries. World Benchmarking Alliance also presented a list of 100 digital companies worldwide, however, the ranking is based on companies’ digital inclusion, which is irrelevant to the aims of this research. The last one is Forbes’ list of 2000 companies. The methodology of the Forbes’ Global 2000 list consists of 3 different metrics. These metrics are sales, profits, and market value. The assessment list is taken from Thomson Reuters Fundamentals and Worldscope databases. Thus, as this ranking consists of 2000 worldwide companies and the last results are of 2020, this ranking is the most suitable. However, there we can see no relation to the industries. Therefore, when using this ranking it is necessary to take companies that are ICT sector appropriate. Gladly, the rating can be divided by industries. As the ICT sector can involve different industries, the next markets are chosen: IT Software and Services; Technology Hardware and Equipment; telecommunication services, and media. Next, when extracting CDP data, it is needed to have the years of the analysis. CDP proposes reports from 2010. However, little amount of companies are doing these reports for ten years. Therefore, it was decided to take the last five years of 2016-2020. Finally, by intersecting these lists it is possible to get the overall sample size. Following is the representation of that result.

1. Sample

|  |  |  |
| --- | --- | --- |
|  | **ROA** | **Tobin’s Q** |
| **Companies from Forbes Global 2000** | 2000 | 2000 |
| **Companies that are not industry appropriate** | 1798 | 1798 |
| **Excluded due to lack of CDP data** | 80 | 80 |
| **Excluded due to lack of financial data** | 23 | 23 |
| **Sample:** | 99 | 99 |

Source: [Made by the author]

Overall, the total amount of sample is 99 ICT-related companies. Unfortunately, some official financial company data was not found, therefore, 23 companies will not be analyzed when assessing ROA’s impact. However, it was possible to estimate Tobin’s Q for each company from the list. The final list of companies with their variables can be found in Appendix 1. The criteria used to exclude some companies, i.e. variables (ROA and Tobin’s Q) are explained in the variables part.

## Variables

The research has three different variables: dependent, independent, and control variables. The dependent one is financial performance, which comprises accounting measures and the stock market measures. Precisely, return on assets (ROA) [Griffin and Mahon, 1997; Elouidani, 2015, Giannarakis et al., 2016; Luo and Tang, 2014] and the trade performance [Griffin and Mahon, 1997; Eluidani, 2015; Mentor, 2016]. To measure the trade performance the Tobin’s Q (Q ratio) [Bird et al., 2007; Eluidani, 2015] will be taken into account. The accounting measures are outlining the economic performance of companies, however, it can be a subject of the organization’s management. The stock market measures, on the other hand, are less affected by the managerial judgment, but they demonstrate the subjective assessment of different investors [Allouche and Laroche, 2006]. The financial data will be taken from companies’ annual reports, the historical stock price of the shares or will be calculated. For example, the Q ratio will be calculated by dividing the market value of a firm by its total assets.

Two independent variables will be assessed. The first one is the number of carbon emissions, and the second one is the scope from CDP’s rating. The amount of carbon emissions includes Scopes 1 and 2 of CO2 emissions of each company. The data will be taken from CSR and CDP reports of companies. The reason for taking the first two scopes is that there is an unavailability of the data on the third scope. Undoubtedly, the third scope would be valuable within the analyses. However, due to its complexity of estimation and unavailability in the CDP and CSR reports, this scope is not taken into account.

The next independent variable is the score from CDP’s rating. The data will be extracted from the official website of the organization and the CDP disclosure reports of the listed companies. However, the CDP score is based on the letter system (A, B, C…), which means it is a categorical variable. There are different ways of interpreting categorical values. One of these methods is employing a “dummy variable”. Thus, for each CDP score, there will be a numerical value. The next table is the representation of this assignment.

1. CDP score to numerical value

|  |  |
| --- | --- |
| CDP Score | Numerical Value |
| A | 1 |
| A- | 1,5 |
| B | 2 |
| B- | 2,5 |
| C | 3 |
| C- | 3,5 |
| D | 4 |
| D- | 4,5 |
| E | 5 |
| E- | 5,5 |
| F | 6 |

Source: [Made by the author]

Overall, as we can see there are 11 different numbers assigned to the CDP score.

Control variables are the variables that are not the aims of the study, but they still can be valuable for the outcome of the research. In this study, two different control variables were employed: number of employees and profits. Both of them can reflect the decision-making of companies, and their increase and decrease can impact the financial indicators (ROA, Tobin’s Q).

## Econometric models

Having established the dataset of the research, it is necessary to choose the particular way of testing the hypotheses. Regression analyses have their different types. Following is the table of different types of regression techniques used by previous researches.

1. Types of regression techniques

|  |  |
| --- | --- |
| Name | Description |
| ordinary least squares (linear regression) | There is a linear relationship between dependent and independent variables |
| Multiple regression | Similar to linear, but has more than 1 independent variables |
| polynomial regression | There is a non-linear (cervical) relationship between dependent and independent variables |
| hierarchical ordinary least squares | Similar to linear, takes into account hierarchical data.  |
| Panel data regression | Studies the relationship between dependent and independent variables over given time period. Used when variables are changing over the years.  |

Source: [Made by the author]

Overall, in previous papers, four different regression analyses were used. The most common one is ordinary least squares (OLS) or linear regression. It assesses the linear relationship between dependent and independent variables. The next one is multiple regression. It is based on OLS, however, it can incur more than one independent variable. The polynomial regression assumes that the relationship between two variables is not linear, but cervical. The last one is hierarchical ordinary least squares, which are also based on OLS. However, it is used when the data has hierarchical order. The last one is panel data regression which looks into the relationship between variables over the given period. That is to say, if the dataset consists of variables gathered within five years, the regression will be able to take into account not only the numbers of variables but also the change of these values, which will impact the overall outcome. To sum up, the most appropriate analysis is panel regression analysis, as there are independent and control variables, as well as the period of five years. In the next section, we will look into the panel regression analysis.

## Panel data regression

Panel data models help with analyzing the individual behavior of variables, both across individuals and over time. Both cross-sectional and time-series dimensions are present in the data and models. When all individuals are observed in all periods, panel data is balanced; when individuals are not observed in all periods, panel data is unbalanced. In our case, the panel data includes 99 individuals at 5 regular periods and is balanced i.e. all the variables have data on each time. Moreover, the research involves a short panel. In other words, it consists of many individuals (99) and few periods (5). As for the variation for the dependent variables and regressors, there are three different ways possible: overall, between, and within variations. Overall looks into variation over time and individuals. Between assumes the variation between individuals. That is to say, it looks over the change of values and compares them to the values of different companies. As for within, it is the variation within individuals over time. That is to say, it estimates the relationship with no relation to other individuals. In our case, it was decided to take within variation as it is needed to see the relationship of companies’ indicators with no comparison to each other.

There are three different types of models: the pooled model, the fixed effects model, and the random-effects model. The next table presents the differences between these three models.

1. Panel data models

|  |  |  |
| --- | --- | --- |
|  | Description | Formula |
| Pooled model | Specifies constant coefficients | $$y\_{it}=α+x\_{it}β+u\_{it}$$ |
| Fixed effects model | Allows the individual-specific effects to be correlated with the regressors | $$y\_{it}=α\_{i}+x\_{it}β+u\_{it}$$ |
| Random effects model | Individual-specific effects are distributed independently of the regressors | $$y\_{it}=β\_{0}+x\_{it}β+(a\_{i}+e\_{it})$$ |

Source: [Made by the author]

Focusing on the formula of the pooled model, there is a dependent variable yit and the independent variable of xit and the coefficient of $β$ that does not vary. This model does not take into account the individual traits of each company. Whereas the next two models consider individual-specific effects ($α\_{i}$). Thus, there are two possible models of conducting a panel regression: the fixed-effects model and the random-effects model. To identify which one is more suitable, it is necessary to conduct a Hausman test. Hausman test identifies whether there is a significant difference between fixed and random effects estimators. If the Hausman test is insignificant (the p-value is less than 0,05), we should consider random effects. Reversely, if a p-value is higher than 0,05, then the fixed-effects estimator should be conducted.

Hence, if the random-effects model is suggested, the equations will be the following:

|  |  |
| --- | --- |
| $$ROA\_{it}=β\_{0}+β\_{1}CDP\_{it}+β\_{2}Emissions\_{it}+β\_{3}Profits\_{it}+β\_{4}Employees\_{it}+(a\_{i}+e\_{it})$$ | (1) |

|  |  |
| --- | --- |
| $$TQ\_{it}=β\_{0}+β\_{1}CDP\_{it}+β\_{2}Emissions\_{it}+β\_{3}Profits\_{it}+β\_{4}Employees\_{it}+(a\_{i}+e\_{it})$$ | (2) |

Comparatively, if the Hausman test’s results will be significant, the fixed effects model will be employed. Thus, the equation is below:

|  |  |
| --- | --- |
| $$ROA\_{it}=α\_{i}+β\_{1}CDP\_{it}+β\_{2}Emissions\_{it}+β\_{3}Profits\_{it}+β\_{4}Employees\_{it}+u\_{it}$$ | (3) |

|  |  |
| --- | --- |
| $$TQ\_{it}=α\_{i}+β\_{1}CDP\_{it}+β\_{2}Emissions\_{it}+β\_{3}Profits\_{it}+β\_{4}Employees\_{it}+u\_{it}$$ | (4) |

With *i* being each company, and *t* being the periods (*t = 2016, 2017, 2018, 2019, 2020*). Tobin’s Q assesses companies’ market indicators, whereas the return on assets the accounting measures. The calculation of the regression analysis will be made with a help of R software as it proposes the tool of conducting panel regression (via the “plm” package).

Overall, having compared different ratings and company lists, the sample of the research was established. Moreover, the variables of the paper were discussed too. Different methodologies used by previous researches were compared and on its basis, the panel data regression analysis will be employed. Therefore, having established that, the next part will consist of the results of the analyses itself.

# Results

This part of the paper presents the results of the research. Overall, the dataset consisted of 99 companies for TQ and ROA analyses. In the first part of this section, we will look at the research sample overview and then move to regression analyses of ROA and TQ.

## Research sample overview

The full research sample can be seen in appendix 1. There are 99 companies from three different industries. The table demonstrates the allocation of companies by industries. We can observe that the industries are allocated comparatively equally.

1. Sample allocation by industries

Source: [Made by the author]

Moreover, the companies are very diverse, coming from 25 different countries such as France, Germany, the USA, Malaysia, India, South Africa, etc.

## Correlation test

Before moving to the analyses themselves, it is necessary to conduct the correlation test between the independent variables. Overall, the correlation between variables should not exceed 0,7, as it can affect significantly the analyses. The next table presents the correlation matrix between the variables.

1. Correlation matrix

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variables | cdp | nemp | profits | scope |
| cdp | **1** |  |  |  |
| nemp | **-0,242** | **1** |  |  |
| profits | **-0,136** | **0,222** | **1** |  |
| scope | **-0,198** | **0,381** | **0,146** | **1** |

 Source: [Made by the author]

As we can observe, the correlation between variables does not exceed 0,7. This, in turn, allows us to proceed with the analysis.

## Hausman Test

As it was mentioned earlier, the Hausman test helps us to understand which estimator is more suitable to use. Thus, the next table shows us the results of the Hausman test for our two analyses: Tobin’s Q and return on assets.

1. Hausman test

|  |  |  |
| --- | --- | --- |
| **chisq** | **df** | **p-value** |
| **Tobin’s Q** |
| 98,138 | 4 | 2,2e-16 |
| **Return on assets** |
| 29,953 | 4 | 5,004e-06 |
| Alternative hypothesis: one model is inconsistent |

Source: [Made by the author]

In both analyses, the values may be different. However, in both cases, the p-value is lower than 0,05. For Tobin’s Q and ROA, the numbers are 2\*10-16 and 5\*10-6 respectively. This, in turn, means that the random-effects model does not hold, and to get more accurate results it is necessary to conduct a fixed-effects model.

In the next two sub-sections, we will analyze the results of Tobin’s Q and ROA panel regressions accordingly.

## Tobin’s Q regression analysis

In this sub-section, we will look at the results of conducted panel regression. The next table represents the range of the data. It means that the minimum value of the data is -6,47 and the maximum is 16, whereas the median of the dataset is -0,24.

1. Tobin’s Q: Data overview

|  |
| --- |
| Residuals: |
| **Min.** | **1st Qu.** | **Median** | **3rd Qu.** | **Max.** |
| -6.47367 | -0.93302 | -0.24126 | 0.58900 | 16.00744 |

Source: [Made by the author]

The next table is the result of the conducted regression analysis. It shows us the variables, the estimate, standard error, t-value, and p-value. Also, it outlines the more significant variables.

1. Tobin’s Q: Panel regression

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|   | Estimate | Std. Error | t-value | Pr(>|t|) | Sig. |
| Xcdp | 0,0951510 | 5.9953e-02 | 1.5871 | 0.11330 | - |
| Xnemp | -0,0000006 | 9.9919e-07 | -0.6460 | 0.51863 | - |
| Xprofits | 0,0000082 | 1.0843e-05 | 0.7566 | 0.44977 | - |
| Xscope | -0,0000001 | 4.6924e-08 | -2.9938 | 0.00293 | \*\* |

Source: [Made by the author]

Overall, what we can observe from the table is that three out of four variables do not have any relationship with Tobin’s q. The p-value of the CDP variable is 0,11, which means that the analysis is not statistically significant. This, in turn, implies that hypothesis H2b does not hold.

 On the other hand, the amount of emissions has a low value of p-value (0,0029), which means that the analysis is statistically significant. Hence, if we look at the ‘estimate’ column, we can observe that the relationship between the amount of CO2 emissions (scope 1 and scope 2) and Tobin’s q is negative. Consequently, hypothesis H1b does hold: the amount of CO2 emissions has a negative relationship with Tobin’s Q of ICT companies.

Having identified that, let us proceed to the next results, which are about the results of ROA regression analysis.

## Return on assets regression analyses

In this part, we will focus on the panel regression of the return on assets of companies. In the next table, we can see the range of the dataset.

1. ROA: Panel regression

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Estimate** | **Std. Error** | **t-value** | **Pr(>|t|)** | **Sig.** |
| Xcdp | 8,2398e-04 | 2,9987e-03 | 0,2748 | 0,78363 | - |
| Xnemp | 9,8865e-08 | 5,4418e-08 | 1,8167 | 0,07002 | - |
| Xprofits | -5,1976e-09 | 2,2281e-07 | -0,0233 | 0,98140 | - |
| Xscope | -5,9888e-09 | 2,3326e-09 | -2,5674 | 0,01062 | \*\* |

Source: [Made by the author]

As for the panel regression, the results from the table above resemble the results of Tobin’s q regression analysis. Overall, CDP, the number of employees, and profits’ data are not statistically significant (the p-value is higher than 0,05), which implies we can reject them. This signifies that hypothesis H2a does not hold: no relationship was found between CDP and ROA among the suggested dataset.

 As for the number of emissions, its p-value is 0,01, which is more than Tobin’s Q. However, it is still statistically significant. This implies that the number of emissions harms ROA. Thus, hypothesis H1a is accepted.

Overall, hypothesis H1 was verified. A negative relationship between the amount of CO2 emissions and ROA and CO2 emissions of Tobin’s Q was found. However, the analysis could not find the relationship between carbon rating and the financial performance of ICT companies. To verify these results it was decided to conduct a robustness check. The next part of the paper is dedicated to this testing.

## Robustness check

As both panel regressions have shown, the CDP variable does not correlate with financial performance. However, it may not be one hundred percent accurate, as different countries are operating in different countries with different regulations. In other words, the CDP rating can be crucial in one country and less important in others. Therefore, this part of the paper is dedicated to the robustness check of the second hypothesis. Robustness testing, in broader terms, systematically evaluates alternatives of a model [Neumayer and Plümper, n.d.]. To do so, it was decided to divide companies by country. Overall, there are 99 companies from 25 different countries. Some countries may have different or relative stances towards environmental protection. Hence, it was decided to categorize countries according to environmental resilience. The next table represents different environmental ratings of countries.

1. Environmental ratings by countries

|  |  |
| --- | --- |
| Name | Description |
| Environmental Sustainability Index (ESI) | Compares overall environmental performance |
| Human Development Index (HDI) | Index of life expectancy, education, and per capita income indicators |
| Environmental Performance Indicators (EPI) | Similar to ESI, but focuses on a smaller set of environmental issues |
| Social Progress Index (SPI) | Measures the extent to which countries provide for the social and environmental needs of their citizens |

Source: [Made by the author]

Overall, the HDI and SPI ratings do not seem to be appropriate, as they measure not only environmental issues but also social aspects. Therefore, let us focus on EPI and ESI. Both ratings are estimating environmental issues. However, the ESI takes into account much broader aspects, such as social and institutional capacity. Comparatively, EPI considers a smaller aspect of environmental issues, such as climate change and air pollution. As the research is directly related to that issues, it was decided to take EPI as a ranking of counties. Having gathered the rankings for 2016, 2018, and 2020 for every 25 countries, the next table is presented.

1. EPI by countries by years

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number | Country | 2016 | 2018 | 2020 | Average |
| 1 | Switzerland | 86,93 | 87,42 | 81,5 | 85,28 |
| 2 | France | 88,2 | 83,95 | 80 | 84,05 |
| 3 | Sweden | 90,43 | 80,51 | 78,7 | 83,21 |
| 4 | United Kingdom | 87,38 | 79,89 | 81,3 | 82,86 |
| 5 | Finland | 90,68 | 78,64 | 78,9 | 82,74 |
| 6 | Norway | 86,9 | 77,49 | 77,7 | 80,70 |
| 7 | Spain | 88,91 | 78,39 | 74,3 | 80,53 |
| 8 | Germany | 84,26 | 78,37 | 77,2 | 79,94 |
| 9 | Ireland | 86,6 | 78,77 | 72,8 | 79,39 |
| 10 | Australia | 87,22 | 74,12 | 74,9 | 78,75 |
| 11 | Netherlands | 82,03 | 75,46 | 75,3 | 77,60 |
| 12 | Italy | 84,48 | 76,96 | 71 | 77,48 |
| 13 | Japan | 80,59 | 74,69 | 75,1 | 76,79 |
| 14 | Canada | 85,06 | 72,18 | 71 | 76,08 |
| 15 | United States | 85,72 | 71,19 | 69,3 | 75,40 |
| 16 | Singapore | 87,04 | 64,23 | 58,1 | 69,79 |
| 17 | Taiwan | 74,88 | 72,84 | 57,2 | 68,31 |
| 18 | South Korea | 70,61 | 62,3 | 66,5 | 66,47 |
| 19 | Russia | 83,52 | 63,79 | 50,5 | 65,94 |
| 20 | United Arab Emirates | 69,35 | 58,9 | 55,6 | 61,28 |
| 21 | Malaysia | 74,23 | 59,22 | 47,9 | 60,45 |
| 22 | Thailand | 69,54 | 49,88 | 45,4 | 54,94 |
| 23 | South Africa | 70,52 | 44,73 | 43,1 | 52,78 |
| 24 | China | 65,1 | 50,74 | 37,3 | 51,05 |
| 25 | India | 53,58 | 30,57 | 27,6 | 37,25 |

Source: [Made by the author based on the yearly rankings of EPI]

As there are 25 different countries, it would not be accurate to conduct analyses by each country. The reason for that is that there would not be enough data. To illustrate, in our sample there is only one Russian company (Sistema). Hence, having the list of countries by ratings, it is possible to categorize them. However, as there are three different rankings from three years, the ranking does not show the overall “picture”. Therefore, an average of three years is taken for each country. Overall, several categorizations are possible. One of them is categorization by region. However, different countries have different environmental strategies and regulations. Moreover, some categories would have an uneven amount of countries, thus a considerably uneven amount of observations. Another way of categorization is by setting thresholds. It would allow dividing countries by their environmental performance.

The suggested thresholds are the following:

1. The threshold of categories

|  |  |  |
| --- | --- | --- |
| **Categories** | **Bottom line** | **Upper line** |
| Category 1 | $\geq $ 80 | $<$90 |
| Category 2 | $\geq $ 70 | $<$80 |
| Category 3 | $\geq $ 60 | $<$70 |
| Category 4 | $\geq $30 | <60 |

Source: [Made by the author]

As we can see, the countries are divided by four. The first category includes the countries that have an average EPI index of 80 and higher (the green color). The second category is the countries that have an index from 70 to 80 (the blue color), whereas the third category has the index from 60 to 70 (the yellow color). The last category is countries having an index lower than 50 (the orange color). Thus, the categories are divided by the highest countries to the lowest countries that have an EPI index. The biggest category by observations is the second (260). The reason for that is that it includes the USA, and the States have the most amount of companies among different countries from the dataset (26 out of 99). The lowest category by observations is the fourth category, it consists of 11 companies and 55 observations.

Having established the categories, it is possible to conduct four different panel regression analyses. Hence, the next four sub-parts consist of the results for each category.

### Category 1

Category 1 consists of companies that originated from countries of category 1. There are overall 16 companies, such as Orange, Nokia, Swisscom, etc. When conducting a panel regression overall 80 observations were taken into account. The next table is the representation of that analysis.

1. Category 1: Panel regressions

|  |  |  |
| --- | --- | --- |
|  | **ROA** | **Tobin’s Q** |
|  | Estimate | p-value | sig | Estimate | p-value | sig |
| Xcdp | 0,0148950 | 0.001103 | \*\* | 0,133110000000 | 0.2960 | - |
| Xnemp | 0,0000000 | 0.848573 | - | -0,000005997700 | 0.1052 | - |
| Xprofits | 0,0000006 | 0.205663 | - | 0,000010171000 | 0.4402 | - |
| Xscope | 0,0000000 | 0.438202 | - | 0,000000004015 | 0.9297 | - |

Source: [Made by the author]

The table shows us the results of panel regression conducted for Tobin’s q and ROA on category 1 companies. Overall, we can see that the p-value in almost all cases is statistically insignificant. However, focusing on the relationship between ROA and CDP, we can see that the p-value is 0,001. Moreover, the estimate shows that there is a positive correlation of 1%.

### Category 2

Category 2, on the other hand, consists of 52 companies, such as Apple, Alphabet, Facebook. Overall, there are 260 observations. We can observe the results on the following table.

1. Category 2: Panel regressions

|  |  |  |
| --- | --- | --- |
|  | **ROA** | **Tobin’s Q** |
|  | Estimate | p-value | sig | Estimate | p-value | sig |
| Xcdp | 2.4035e-03 | 0.66479 | - | 1.4324e-01 | 0.18197 | - |
| Xnemp | 9.6861e-10 | 0.99319 | - | -2.6225e-06 | 0.23208 | - |
| Xprofits | 1.6761e-06 | 0.05384 | - | 5.6348e-06 | 0.73600 | - |
| Xscope | -5.1190e-09 | 0.25489 | - | -1.8743e-07 | 0.03155 | \* |

Source: [Made by the author]

For the second category of companies, there is a negative relationship between Tobin’s Q and the scopes of emissions. As for the other variables, p-values are higher than 0,05 to consider the results.

### Category 3

In the next category, there are 20 companies and 100 observations in total. In this category, there are companies such as Sistema, Samsung SDI and Samsung SDS, and LG Uplus, etc. Let us focus on the results of panel regression.

1. Category 3: Panel regressions

|  |  |  |
| --- | --- | --- |
|  | **ROA** | **Tobin’s Q** |
|  | Estimate | p-value | sig | Estimate | p-value | sig |
| Xcdp | 4.4857e-03 | 0.12809 | - | 1.2124e-01 | 0.09085 | - |
| Xnemp | 1.6558e-07 | 0.01445 | \* | 1.8884e-06 | 0.24329 | - |
| Xprofits | -1.8128e-06 | 0.18913 | - | -2.7330e-05 | 0.41319 | - |
| Xscope | -2.4261e-08 | 0.00463 | \*\* | -3.2036e-07 | 0.11664 | - |

Source: [Made by the author]

In this category, there is a negative relationship between ROA and the amount of CO2 emissions. That is, the p-value is 0,004 and the estimate is negative.

### Category 4

In the fourth, and last category there are 11 companies and 55 observations. In this category, there are companies such as Lenovo Group, Tata Consultancy Services, China Communications services, etc. In the following table, we can see the results of panel regression of that category.

1. Category 4: Panel regressions

|  |  |  |
| --- | --- | --- |
|  | **ROA** | **Tobin’s Q** |
|  | Estimate | p-value | sig | Estimate | p-value | sig |
| Xcdp | 7.4019e-03 | 0.17635 | - | 2.9269e-01 | 0.02632 | \* |
| Xnemp | 5.7129e-07 | 1.411e-05 | \*\*\* | 1.1917e-05 | 8.538e-05 | \*\*\* |
| Xprofits | 9.9804e-07 | 0.38556 | - | 7.2584e-06 | 0.78823 | - |
| Xscope | -5.3976e-08 | 0.05995 | - | -9.6847e-08 | 0.88369 | - |

Source: [Made by the author]

In this category there is an impact of CDP on Tobin’s Q, having a p-value of 0,02 and an estimate of 0,29 or 29%. As for other variables, the p-values are higher than 0,05, which makes them statistically insignificant.

## Limitations

In this section, we will look at the possible limitations of the research. Overall, there are different limitations in the regressions analysis made. The first limitation is that still a lot of companies do not disclose the carbon performance and the amount of CO2 emissions emitted. This implies that the dataset is limited in terms of observations. If companies are disclosing more data on environmental performance, it would affect the results of the research. Also, when analyzing different categories of companies, there was a different amount of observations. This, in turn, made the number of observations within the categories uneven. The reason for that can be that the dataset of 99 companies may not be enough. Moreover, adding more control variables would be valuable.

Having analyzed the limitations of the paper, it is possible to interpret the results. Thus, the next section will be dedicated to that issue.

## Interpretation of results

In this part, we will look at possible factors that influence the established results. The following factors are suggested reasons that could impact the relationship between the variables. To ensure these factors, further analyses is required.

The results showed that the first hypothesis does confirm. That is, there is a negative impact of carbon emissions on ROA and Tobin’s Q. To summarize all the analyses conducted by categories, it is possible to rely on this table.

1. CDP regression results by categories

|  |  |  |
| --- | --- | --- |
|  | ROA | TQ |
| Category 1 | \*\*, 1,5% | - |
| Category 2 | - | - |
| Category 3 | - | - |
| Category 4 | - | \*, 29% |

Source: [Made by the author]

Overall, four panel regressions analyses were conducted. However, the relationship was identified between category 1 and ROA, and between category 4 and Tobin’s Q. Both relationships are positive, having 1,5% and 29% respectively. This suggests that we can accept hypothesis H2, but with certain limitations. Not every company may have a relationship between carbon rating and financial performance. Companies residing from countries with the highest and lowest rankings of Environmental Performance Index are affected. To be precise, companies that originated from countries with the highest EPI (according to the categorization) experience the impact of CDP rating on their return on assets. On the other hand, companies that originated from countries with the lowest EPI experience the impact of carbon rating on their Tobin’s Q.

As it was outlined in the literature review, the ICT sector has its positive and negative environmental impacts. Thus, the research was intended to find the implications of these positive and negative environmental impacts by assessing the number of carbon emissions and carbon ranking. Later, the results showed that the higher the CO2 emissions are, the lower the financial performance of ICT companies. Thus, the impact of one variable on another is negative. The reason for this relationship can be explained by stakeholder theory. As it was mentioned, stakeholder theory suggests that businesses can be affected by the entities involved with them. To illustrate, stakeholders can pressurize businesses to adopt green production practices, which can be assessed by CO2 emissions [Baah et al., 2020]. In that case, two different types of stakeholders would affect the financial performance: organizational and regulatory. Organizational type includes customers, shareholders, and employees. As for the regulatory, it consists of government, trade associations, media, and other regulatory entities.

The second part of the results suggested that the carbon ranking (CDP ranking) can affect financial performance. Precisely, the higher the rank of a company, the higher the financial performance. Results, in this case, did not show the explicit answer. The reason for that could be that carbon disclosure is a comparatively “young” concept. Therefore, we could not reflect the overall trend. Nevertheless, we could observe that the CDP ranking can affect organizations according to the country they are residing in. That is, if a company is from a country with higher environmental performance (EPI), the higher the ROA will be. On the other hand, if a company is from the country with the lowest values of EPI, Tobin’s Q is affected. In both cases, there is a positive relationship between these variables. Similarly, the reason for these results can be because of organizational and regulatory stakeholders. That is, companies with the first category and the fourth category can be pressurized by governmental regulations to employ green practices and disclose the carbon performance. On the other hand, they can be pressurized by the media and shareholders.

# Discussion

In this part, possible implications of the analyses will be presented. The part will be divided into two. In the first part, the theoretical implications are presented, whereas in the second part we will focus on the on the practical implications themselves.

## Theoretical implications

This paper aimed at evaluating the impact of carbon performance on the financial performance of ICT companies. From a theoretical perspective, the research based its assumptions through the lens of stakeholder theory. Later, the results of hypothesis H1 showed a positive correlation between the amount of carbon emissions and financial indicators. This finding was supported by [Baah et al., 2020], who found that green practices and environmental performance are significantly influenced by organizational stakeholders. The organizational stakeholders pressurize firms into following green production practices, which, in turn, has its impact on financial performance of these enterprises. The results are also confirmed by [Tang and Luo, 2014] who asserted that organizations that have significant carbon emissions are highly likely to be penalized by investors. This, in turn, is confirming the theory. Thus, some stakeholders can impact organizations to implement carbon-related activities.

The results of hypothesis H2 were unambiguous. In other words, the initial hypothesis H2 did not confirm. That is to say, the regression analysis showed no relationship between the variables. Similar results were also found by [O’Neill, Saunders and Derwinsky McCarthy, 1989] when they observed corporate social responsiveness and profitability. To understand this outcome, it is necessary to consider that carbon disclosure is comparatively young concept, which means not every company may be influenced by disclosing the carbon performance. However, by categorizing companies by countries’ EPI index, the results showed that carbon disclosure can affect financial performance of companies in different countries. The positive relationship between CDP and financial indicators were supported by [Trinks et al., 2020]. They asserted that the higher carbon efficiency, the higher the profitability of firms. [Raida et al., 2014] also found the positive relationship between carbon reporting and financial performance, which also sustain the results of the paper.

Moreover, as the research gap emphasized, there have been various studies that were dedicated to examining the relationship between ECSR and financial performance in different industries. However, there was no research found that reviewed the relationship between carbon performance and financial performance in the ICT sector. Thus, the findings of this study contribute to the carbon performance literature as the results showed that there is a positive relationship between carbon disclosure and financial performance of ICT companies. Moreover, previous researches [Siddique et al., 2020; Rahman et al., 2014; Ganda, 2018; Wang et al., 2020] found relationship between carbon disclosure and financial performance, whereas the findings of this paper confirm these results, but also indicate that this relationship is contingent upon a country. In addition, the research found that carbon emissions negatively impact the financial indicators. Similar results were also found by [Ganda and Milondzo, 2018], however, they did not have industry-specific perspective. While the results of this research are industry-related. This also contributes significantly to the literature of ICT sector and ECSR, as the carbon performance of ICT sector was rarely examined.

Furthermore, the research suggests two different directions for further investigation. As the hypothesis H2 showed, different countries may respond to the impact of carbon disclosure on financial performance differently according to the country of origin. Thus, the first direction would be to continue the research by extending the sample and investigating the relationship by different countries. Another direction of the research could be identifying the reasoning behind the results. That is to say, to examine how stakeholders, organizational and regulatory stakeholders in particular, can influence companies environmental decision-making.

Having established the theoretical implications, let us focus on practical implications next.

## Practical implications

Focusing on the practical implications, the findings of the paper can be valuable to three different parties: managers of ICT companies, investors and governmental regulators. Let is focus on each party one by one.

As the results found that the increase of carbon emissions negatively affects financial performance, whereas carbon disclosure (in particular countries) can positively affect financial indicators. Thus, an implication for managers of ICT companies is to contribute more to carbon-related activities, as it can increase the financial situation of companies. Companies should consider the implementation of low-carbon practices as it may not only exert pressure from stakeholders, but also it could positively affect ROA and Tobin’s Q. Similarly, the carbon disclosure may significantly affect the market position (by 29%) for companies residing in countries with lower EPI. Moreover, companies from the first category may see a positive outcome on ROA due to carbon reporting. Additionally, companies should consider incorporating environmental aspect into strategic decision-making. As for investors, the findings assert that the more carbon efficient the company is, the higher the financial performance is. That is, the results suggest that investors should rely upon companies’ carbon performance when deciding whether to invest in a firm. Focusing on the governmental regulators, the results suggest that they can pressure or motivate organizations to switch to green production practices. If a company follows the request of the government, it can experience positive effect. Whereas if a company is disobeying the regulations, it could harm the financial indicators.

# Conclusion

To conclude, the paper included four main parts. The theoretical background, as well as previous assessment of carbon performance and financial performance, was provided with a help of a literature review tool. It showed that the previous researches, that were conducting industry-related analyses, were mainly dedicated to oil and gas, transportation, and other manufacturing industries. However, less attention was brought to the ICT sector. In the paper, we analyzed what kind of harm the ICT can pose, and also the benefits that the ICT sector brings. Then, it was decided to analyze what is the impact for the ICT sector companies from involving with carbon-related activities. Therefore, two hypotheses were formulated. The first hypothesis suggested that there is a relationship between the amount of CO2 emissions and financial performance, whereas the second assumed there is a relationship between carbon disclosure and financial performance. To test the hypotheses a sample of 99 companies from 25 different countries was collected, and the panel regression analyses were conducted.

Overall, focusing on the results, the first hypothesis was proven to be right. There is a negative relationship between the number of carbon emissions and financial performance. In the next section, it was discussed that two types of stakeholders could be the reason for this relationship. These groups are organizational and regulatory stakeholders. They can pressure companies to adopt green production practices. In other words, to decrease CO2 emissions. As for the results of the second main hypothesis, in this case, the results were not so explicit. That is, the general panel regression did not show any relationship between the variables. One of the possible reasons could be that the concept of CDP is comparatively new, therefore the panel regression analysis could not reflect the overall trend. However, to verify this result, it was decided to conduct a robustness check. In other words, I checked whether the results will stay the same if individuals are divided by country. The countries were divided into four categories. For each category, an independent panel regression analysis was conducted. The results showed that the first category has a positive relationship between CDP disclosure and ROA of companies. The first category comprised companies that resided from countries with the highest Environmental Performance Index (EPI). The results also showed that companies from the fourth category have the relationship between CDP and Tobin’s Q.

Overall, the findings showed that there is not only relationship between carbon disclosure and financial performance, but also that this relationship is contingent upon a country. Focusing on the implications, managers should consider to decrease of carbon emissions, disclosing carbon performance and contribute more to carbon-related activities. Investors can choose companies to invest by the carbon performance, whereas financial regulators can impact organizations into adopting carbon-related activities. Also, two different directions for the further analyses were proposed. First, further analysis could investigate the impact of carbon disclosure on financial performance regarding companies’ country of origin. The next direction could be identifying the reasons behind these relationships.

# Appendix

1. The sample and CDP rankings

|  |  |
| --- | --- |
|   | **CDP** |
| **Company Name** | **CDP 2020** | **2019** | **2018** | **2017** | **2016** |
| **Apple** | 1 | 1 | 1 | 1 | 1 |
| **AT&T** | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 |
| **Alphabet** | 1 | 1 | 1 | 1 | 1 |
| **Microsoft** | 1 | 1 | 1 | 1 | 1 |
| **Verizon Communications** | 3 | 2 | 1,5 | 1,5 | 1,5 |
| **Facebook** | 6 | 6 | 6 | 6 | 6 |
| **Nippon Telegraph & Tel** | 1 | 2 | 2 | 1,5 | 1,5 |
| **IBM** | 1,5 | 2 | 2 | 2 | 2 |
| **Softbank** | 1,5 | 4 | 6 | 3 | 6 |
| **Deutsche Telekom** | 1 | 1 | 1 | 1 | 1 |
| **Cisco Systems** | 1 | 1 | 1 | 1 | 1 |
| **Oracle** | 1,5 | 1,5 | 1 | 1 | 1 |
| **Hon Hai Precision** | 2,5 | 4 | 3 | 4,5 | 4 |
| **KDDI** | 2 | 2 | 3 | 2 | 2 |
| **SAP** | 1 | 2 | 2 | 1,5 | 1,5 |
| **Orange** | 2 | 1 | 1,5 | 1,5 | 2 |
| **Accenture** | 1 | 1 | 1 | 1,5 | 1 |
| **Telefonica** | 1 | 1 | 1 | 1 | 1 |
| **BCE** | 1,5 | 1,5 | 1 | 1,5 | 1,5 |
| **HP** | 1 | 1 | 1 | 1 | 1 |
| **BT Group** | 1 | 1 | 1 | 1 | 1 |
| **Etisalat** | 6 | 6 | 6 | 6 | 6 |
| **Tata Consultancy Services** | 1,5 | 1,5 | 2 | 1,5 | 1,5 |
| **VMware** | 1 | 2 | 2 | 1,5 | 1,5 |
| **Adobe** | 1 | 1 | 1 | 1 | 1,5 |
| **Fujitsu** | 1 | 1 | 1 | 1 | 2 |
| **Hewlett Packard Enterprise** | 1 | 1 | 1 | 1 | 1 |
| **Telstra** | 1,5 | 1 | 1 | 1,5 | 1 |
| **Vodafone** | 1 | 1,5 | 2 | 1,5 | 2 |
| **Murata Manufacturing** | 2 | 2 | 2 | 1,5 | 2 |
| **SingTel** | 1,5 | 1,5 | 1,5 | 1,5 | 2 |
| **Swisscom** | 3 | 2 | 1,5 | 1 | 1 |
| **Cognizant** | 6 | 6 | 4 | 3 | 3 |
| **Telecom Italia** | 1,5 | 2 | 2 | 2 | 2 |
| **Kyocera** | 1 | 1,5 | 1,5 | 2 | 2 |
| **Rogers Communications** | 3 | 4 | 3 | 3 | 2 |
| **NetEase** | 6 | 6 | 6 | 6 | 6 |
| **TELUS** | 2 | 1,5 | 2 | 3 | 1,5 |
| **Infosys** | 1,5 | 1,5 | 1 | 1 | 1,5 |
| **SK Telecom** | 2 | 2 | 3 | 1,5 | 1,5 |
| **Nokia** | 1 | 1,5 | 1,5 | 1,5 | 1,5 |
| **NEC** | 1 | 1 | 1,5 | 2 | 1,5 |
| **Capgemini** | 1,5 | 1 | 2 | 1,5 | 1,5 |
| **TE Connectivity** | 3 | 3 | 3 | 3 | 3 |
| **Lenovo Group** | 1 | 1,5 | 2 | 1,5 | 1,5 |
| **Telenor** | 2 | 2 | 2 | 1,5 | 1,5 |
| **Ericsson** | 2 | 3 | 2 | 2 | 2 |
| **Baidu** | 3 | 6 | 6 | 6 | 6 |
| **Keyence** | 6 | 6 | 6 | 6 | 6 |
| **Telia** | 2 | 2,5 | 4 | 2 | 2,5 |
| **TDK** | 1,5 | 1,5 | 4 | 4 | 3 |
| **Chunghwa Telecom** | 2 | 4 | 6 | 3 | 3 |
| **HCL Technologies** | 4 | 2,5 | 3 | 6 | 2,5 |
| **CDW** | 6 | 6 | 6 | 6 | 6 |
| **Quanta Computer** | 2,5 | 3 | 2,5 | 3 | 2 |
| **Seagate Technology** | 1 | 1,5 | 1,5 | 2 | 2 |
| **Corning** | 3 | 3 | 2,5 | 3,5 | 4 |
| **Pegatron** | 3 | 3 | 4 | 3 | 3 |
| **Wipro** | 1,5 | 1,5 | 1,5 | 2 | 1 |
| **Western Digital** | 2 | 3 | 2 | 3 | 4 |
| **Iliad** | 6 | 6 | 6 | 6 | 6 |
| **CGI Group** | 2,5 | 3 | 3 | 2,5 | 3 |
| **Hoya** | 4 | 4 | 6 | 4 | 4 |
| **KT** | 1,5 | 1,5 | 1,5 | 1 | 1 |
| **ATOS** | 1 | 1 | 1,5 | 1 | 1 |
| **Twitter** | 6 | 6 | 6 | 6 | 6 |
| **Dassault Systemes** | 6 | 6 | 6 | 6 | 3 |
| **Advanced Info Service** | 6 | 6 | 6 | 6 | 4,5 |
| **Delta Electronics** | 1 | 1,5 | 2 | 1,5 | 1,5 |
| **Olympus** | 1,5 | 1,5 | 2 | 1,5 | 1,5 |
| **VeriSign** | 6 | 6 | 6 | 6 | 6 |
| **LARGAN Precision** | 6 | 6 | 6 | 6 | 6 |
| **MTN Group** | 3 | 3 | 3 | 3 | 3 |
| **Samsung SDI** | 1,5 | 1,5 | 2 | 1,5 | 1,5 |
| **Garmin** | 6 | 6 | 6 | 6 | 6 |
| **OMRON** | 1,5 | 1,5 | 2 | 2 | 2 |
| **KPN** | 1 | 1 | 1,5 | 1 | 1 |
| **NetApp** | 3 | 2,5 | 3 | 2 | 2 |
| **Samsung SDS** | 6 | 6 | 2 | 1,5 | 2 |
| **VEON** | 6 | 6 | 6 | 6 | 6 |
| **Sistema** | 2 | 6 | 6 | 4,5 | 6 |
| **China Communications Services** | 6 | 6 | 6 | 6 | 6 |
| **Flex** | 1,5 | 1,5 | 2 | 3 | 2 |
| **Akamai Technologies** | 2 | 3 | 1,5 | 2 | 2 |
| **Compal Electronics** | 2 | 2,5 | 2,5 | 2 | 2 |
| **Autodesk** | 1,5 | 1,5 | 3 | 1,5 | 1 |
| **Otsuka** | 6 | 6 | 6 | 6 | 6 |
| **Cellnex Telecom** | 1 | 1 | 2 | 2 | 2 |
| **Wistron** | 1,5 | 3 | 3 | 2 | 2 |
| **LG Uplus** | 1 | 1 | 1,5 | 1,5 | 1 |
| **Splunk** | 6 | 6 | 6 | 6 | 6 |
| **Constellation Software** | 6 | 6 | 6 | 6 | 6 |
| **Axiata Group** | 4 | 4 | 4 | 4 | 6 |
| **Tech Mahindra** | 1 | 1,5 | 1,5 | 1,5 | 1 |
| **Palo Alto Networks** | 3 | 6 | 6 | 6 | 6 |
| **Fortinet** | 6 | 6 | 6 | 6 | 6 |
| **Inventec** | 6 | 6 | 6 | 2 | 2 |
| **Asustek Computer** | 2 | 3 | 3 | 3 | 2 |
| **Frontier Communications** | 6 | 6 | 6 | 6 | 6 |

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