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An Initial Look at the EU Taxonomy for Sustainable Activities and its Relationship with Greenhouse Gas Emissions

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Abstract

The EU taxonomy for Sustainable Activities are the criteria by which the EU defines what investments are sustainable and which are not. This paper looked at measures of taxonomy-eligibility (revenue, capex, opex) to see if this was related with more direct (scope 1 & 2) or indirect (scope 3) emissions across firms in the energy sector. This was done to see if taxonomy-eligibility can be used as a signal of a firm being more sustainable than a competitor, or if it could potentially be used for greenwashing. Through collecting data of firms from annual and sustainability reports OLS regression was used to analyze the relationship. The only significant relationship that was found is that between taxonomy-eligible operating expenditure and scope 1 & 2 emissions.

Key words: EU Taxonomy; Greenwashing; Scope 1, 2 & 3 Emissions; Sustainability

Table of Contents

1. Introduction

1.1 Introduction to the EU Taxonomy

The world faces many big issues, but one of the largest and most pressing issues is climate change. Greenhouse gasses released by human activity are resulting in an increase in average temperatures, resulting in the sea level rising, increases in the occurrence of extreme weather events and the reduction in biodiversity, as some of the many consequences (IPCC, 2018). These are leading and will lead to increased forced migration and increases in deaths due to changing climate patterns. It is relevant for society to find an effective response to stop this before it is too late. To slow down the rate of climate change and work towards resolving it, there needs to be a response from stakeholders of all sizes across the entire world. From individuals, to firms, to investors, to governments, all need to change their behavior. This can be from an individual changing their diet to vegetarian or vegan (Scarborough et. al., 2014) to large global agreements like the Paris Climate Accords in 2016. One recent method the EU is implementing to reach its climate goals, through increasing greener thinking and behavior among investors, is the framework of the EU Taxonomy.

The EU Taxonomy for sustainable activities has been created to enable the EU to achieve its 2030 climate targets and green deal objectives (European Commission, 2021). The taxonomy sets out to classify what an environmentally sustainable economic activity is. By universally defining what counts as sustainable and what does not, it provides investors with a clear and comparable definition of what actions are green and provides firms with a more clear guideline of what actions to take to become truly sustainable. The EU Taxonomy is a solution that is still in the making, however the initial regulations have come into force. These initial regulations cover sustainability in terms of climate change mitigation or climate change adaptation. From the beginning of 2022, large listed companies in the EU are required to disclose certain taxonomy measures relating to these objectives of sustainability. These are the percentages of their revenue, capital expenditure (CapEx) and operating expenditure (OpEx) that are taxonomy-eligible. A firm can define actions as taxonomy-eligible when they are covered by the criteria as defined by the taxonomy (Bodart et al., 2022). The difference between CapEx and OpEx is that capital expenditures are those on assets used in the longer term, while operating expenditures are seen as the shorter term spending on day-to-day items used in the operations of a firm.

The roadmap for the taxonomy sees it expand its scope. In the short term it aims to expand from just covering climate change objectives, to covering companies acting sustainably in terms of water usage, enabling the circular economy, preventing pollution and creating a healthy ecosystem. The disclosures required by the EU are also going to be expanded as firms will also need to publish the taxonomy-aligned revenue, CapEx and OpEx. Taxonomy-alignment expands on taxonomy-eligibility; not only do the operations of a firm's actions need to be eligible under one of the six objectives, but the actions may do no significant harm to other objectives and need to meet some minimum social safeguards. An example of one social safeguard is that the production process does not include any child labor. This expansion will be able to tell more about the sustainability of firms, however, will not be covered in this paper as it has not been implemented yet.

Since the disclosure of the taxonomy-eligibility of firms only started this year, there has been very little study into what the data disclosed actually means and how it can be used by firms and investors to behave in a greener fashion. Eligibility does not necessarily mean it is a sustainable activity as the activity may do significant harm to other environmental objectives, with only a limited amount of conclusions that can be drawn in regards with a companies sustainability profile (Gamsjäger & Ray, 2022). Whether or not the taxonomy-eligibility can be used as a tool to gauge what a green company is, is questioned and thus should be delved into to prevent investors from taking actions with data that does not tell the complete story. If it is the case that the taxonomy is misleading, there might be an argument that the taxonomy in its current form can be used as a tool for greenwashing, rather than a method to standardize green disclosures and combat this problem. There have been some arguments made that this is the case, partially due to the ambiguity in the method firms can use to calculate the taxonomy-eligibility (Gamsjäger & Ray, 2022), or due to the inclusion of gas and nuclear power as sustainable fuels during the energy transition (Schreiber, 2022). To test whether or not this is true it can be useful that the taxonomy in its current form only covers climate change objectives. One of the main causes of climate change is the emission of greenhouse gasses, of which approximately 76% is carbon dioxide (Center for Climate and Energy Solutions, 2022). By comparing the emissions of firms operating within the same industries with their taxonomy-eligibility criteria, it can be seen whether or not taxonomy-eligibility has a significant relationship on the greenness of firms. This can also show whether or not taxonomy-eligibility should be used to do that. This raises the following research question:

To what extent is there a relationship between the values of taxonomy-eligible Revenue, CapEx and OpEx and the greenhouse gas emissions of firms that operate in the same industry?

2. Theoretical Framework

2.1. Shareholder vs. Stakeholder view

Firms having to disclose information on issues like climate change is a relatively new development. Pioneered by Milton Friedman in the 1970's, the shareholder view said that the only "social responsibility of business is to increase profits" (Friedman, 1970). Friedman views that a business as an entity could have no social responsibilities, only people could have those, and that the businesses only need to best serve the shareholders needs, maximizing profits, as long as it stays within the rules of law. Moore (1999) summarized the theory that when directors' fiduciary duties are to the shareholders, they act in a way to maximize the returns for the shareholders, which in the end results in the largest increase in wealth for society. In the 1990's this was also the predominant view among accounting scholars to guide management decision making (Wall & Greiling, 2011). This aims to solve the principal-agent dilemma of agency theory; if the incentives of a principal and agent are misaligned, the agent may take actions which harm the principal. By aligning the incentives, the payoff for the principal can be maximized (Elsayed & Elbardan, 2018). The shareholders thus do not put the importance on disclosing information related to issues like climate change as the only information that needs to be provided that is needed by shareholders to be able maximize their wealth, which in most cases will not include information about emissions.

The shareholder view has always been a contentious view and more recently has seen a large group of scholars in both accounting and other fields of study support an opposing view, the stakeholder view (Wall & Greiling, 2011). Although the view has existed in some form or another for a longer time, R. Edward Freeman is seen as one of the greatest early contributors to the view. Freeman and Reed (1983) believe that firms are not just responsible to shareholders, but to all entities who have a stake in the business, without whom the business could never function. Stakeholders can include investors, employees, the community, the government, customers and many more (Donaldson & Preston, 1995). This means that unlike the shareholder view, companies are able to and should be socially responsible. This social responsibility that firms have within the stakeholder provides a drive to disclose more information than that just that useful for shareholders to make decisions to maximize their wealth. This increased social consciousness in firm disclosure and decision making is known as Corporate Social Responsibility (CSR). This can be defined as "a commitment to improve (societal) well-being through discretionary business practices and contributions of corporate resources." (Du et al., 2010). This means that firms use CSR to contribute to creating a better environment around them and to disclose these actions to their stakeholders. One of the most popular methods to disclose these actions to their stakeholders is by reporting on them using the Global Reporting Initiative (GRI) Standards. The GRI standards provide a framework from which firms can voluntarily report on sustainability issues like the environment, the economy and people (GRI, 2022). Firms provide this information to show the impact they are having, but part of it is also due to signaling. When there is an asymmetry in information between buyers and sellers, sellers can provide a signal of their better quality goods through offering warranties as an example (Morris, 1987). This signals to consumers that the quality of this brand is superior. Through providing more information on their responsible actions, stakeholders such as consumers will get a signal that this firm is more sustainable, creating a better image of the brand which could result in being able to charge higher prices. On average sustainable products can charge an 80% markup (Kearny, 2020) compared to the same conventional products showing the importance of signaling when your product is sustainable. Next to this it shows the power that creating a green perception can have.

2.2. Greenwashing

Not all firms report on environmental performances to provide stakeholders with information on the environmental friendliness of their products and how they are improving themselves. It is also used by firms who publish false or incomplete information in their environmental performance to create a misleading image that the firm is acting responsibly for the environment (Furlow, 2010). Different areas of an organization can be altered to mislead stakeholders through greenwashing. This ranges from the corporate level, to specific products and even the strategy. Thus, reporting on the environmental performances of firms is not without controversy. This is seen in signaling theory as well, when a signal is easy to reproduce it is not effective at showing consumers which products are of higher quality (Morris, 1987). Thus, the threat is that if it becomes easy for unsustainable companies to publish false and misleading information on the environment, it leads to it becoming nearly impossible to distinguish between those and the actual green firms.

In the academic world, there is not one specific definition of greenwashing, as different researchers approach the topic from different angles. Scholars like Furlow (2010), define greenwashing as the spread of false or incomplete information by a firm to present the image of acting environmentally responsible. This can be seen as the more baseline view of greenwashing with many scholars and other organizations choosing to expand the definition beyond this. Some scholars such as Parguel et. al. (2011) go further with the definition of greenwashing defining it as the act of misleading consumers concerning an organizations' environmental performance or that of their products. This view on greenwashing suggests that firms benefit from consumers perceiving them as green, misleading them to increase sales or improve their public image. However, the "degree of falsehood"(Gatti et. al, 2019) in which the firms purposely misreport their values is not agreed upon among scholars. Gatti, Seele and Rademacher (2019) found this ranges from misleading claims, to unsubstantiated claims, to deliberately choosing to publish information which will create a positive image and leaving out the negative performances. This suggests that there is a discrepancy in the definition based on the role of an organization purposely misleading consumers or whether the information is framed in a way to improve their image.

A significant part of the academic community sees the scope of greenwashing as broader than just relating to environmental concerns. According to Gatti et. al. (2019), 38% of articles state that greenwashing relates to social issues alongside environmental issues as well. Although the majority, 61.8%, of articles only relate greenwashing to environmental issues, it shows that there is still significant ambiguity in the definition and a need for a more widely recognised term to express the same issue in societal circumstances.

Due to the mostly voluntary nature of the disclosure of CSR information, there is a lack of institutional oversight to verify the accuracy of this data. This has led to NGOs and the media stepping in and filling the role of controlling entities in many cases. Most recently, scholars have started looking at greenwashing from a different perspective, looking at it “through the eyes of the beholder” (Seele & Gatti, 2015). This definition states that greenwashing is when there is an “external accusation toward an organization with regard to presenting a misleading green message”(Seele & Gatti, 2015). Thus, it is the NGOs and media reporting on the misleading messaging of firms that will ‘create’ greenwashing, and if the action is not perceived it does not constitute greenwashing. Thus, the perception of greenwashing, whether it is occurring or not, is an integral part of the idea.

Delmas & Burbano (2011) discuss the drivers for greenwashing in their article, showing that it has a negative impact on the confidence of investors and consumers. They state that lawmakers can reduce the prevalence of greenwashing by increasing the availability of information and decreasing the uncertainty about punishment for greenwashing. Sun & Zhang (2019) concur with the findings that government intervention is impactful at reducing the occurrence of greenwashing, with their research in China. The most effective mechanism is a government punishment, however using taxes and subsidies are effective too for firms operating in efficient markets. Gatti et. al. (2019) also finds that government regulation is part of the solution against greenwashing, however the voluntary aspects of CSR reporting are also important as they promote creativity and are efficient. Thus, by creating stricter and mandatory rules, it can reduce greenwashing without hampering the benefits of CSR too much. This shows that the academic community agrees that there is more space for the government to intervene in preventing greenwashing. This would also aid strengthening signaling within CSR as it would make it more costly to create an image that a firm is doing good for the environment when they legally have to disclose certain statistics. The EU taxonomy is a method to increase the availability of relevant information to tackle greenwashing, which should help according to their recommendations.

2.3. EU Taxonomy

The EU Taxonomy has only been implemented recently and almost no literature has been published on its effectiveness in reflecting sustainability measures in the real world. However, there is literature on EU Taxonomy looking at the theoretical impacts there should be. Lucarelli et. al. (2020) looked at scientific publications on EU taxonomy objectives and sectors. They performed multivariate regressions between the number of scientific publications and CO2 emissions per capita and found that there was a statistically significant impact of taxonomy related publications on CO2 emissions. Their main conclusion was that scientific production has a positive impact on society, but also that now the taxonomy is being implemented there should be a positive effect on reducing emissions. Nevertheless, this is purely based on academic research and Lucarelli et. al. accept that there are limitations to this study of the taxonomy as there is an uncertainty how effective the taxonomy will be at impacting a company's strategic choices. There are also accusations that the EU has been lobbied by stakeholders like the governments of Poland and France to include gas and nuclear powered activities and transitional powers which are not purely sustainable power sources but count towards the taxonomy in its current state. This decision has led the European Consumers' Association to state this amounted to institutionalized greenwashing (Reclaim Finance, 2022).

Schütze & Stede (2021) looked at how the EU taxonomy would contribute to the stated ambition of the EU to be climate neutral by 2050. It did this by standardizing information about a company's environmental performances, channeling investments to companies with lower carbon footprints. Up to 80% of EU emissions are classified under taxonomy eligibility, which is a significant amount, but not all. The 20% not covered mainly can be explained by these three scenarios: activities which do not have greener substitutes and are waiting for green technological development (ie. air transport); activities with little to no emissions left out as this would be an administrative burden; and activities which have a green alternative and are being phased out (ie. oil and coal). This shows that although the taxonomy is not all encompassing with its classifications, what it has left out has been done with a specific purpose. Schütze & Stede explain that because of the differences in classifications across sectors, it is only an effective tool to compare companies within their industries. Comparing the data of firms operating in different industries would not be a fair comparison. Nevertheless, Dumrose et. al. (2022) were able to do an initial experiment using the first batch of taxonomy data, comparing them with the environmental ratings of ESG data for firms. They were able to find that in 3 out of 4 cases there was a significant relationship between the taxonomy values and the environmental ratings, which suggests that the EU taxonomy has a role in reducing greenwashing. However, there is a potential for the relationship in this measurement to be stronger, suggesting that the EU taxonomy in its current form is not as effective at this yet. This could mean that through including gas and nuclear power the EU taxonomy measures are less effective at reducing greenwashing.

2.4 Reporting on Greenhouse gas emissions

Globally, many firms choose to (voluntarily) report on their greenhouse gas emissions to share this information with stakeholders. Under the Global Reporting Initiative this disclosure falls under GRI 305. There is not just one single method to calculate and report on a firm's emissions but there are multiple differently defined scopes of emissions. There are scope 1 emissions from resources that a firm owns or controls (Ehlers et. al., 2020). These are emissions under their direct control. Scope 2 emissions are the indirect emissions that are created in the generation of energy (Ehlers et. al., 2020), such as electricity, that a firm uses during its operations. Lastly, there are scope 3 emissions which “include all other indirect emissions that occur in a firm's value chain”(Ehlers et. al., 2020). This goes from employee travel to the transportation of goods in the upstream or downstream segments. Since firms have different abilities to control the different scopes of emissions it will be useful to look at scope 3 emissions separately during the research as the control over this is less direct than compared to the others.

3. Hypotheses

The EU taxonomy was set up to eliminate greenwashing and provide investors with information on the sustainable activities of a company, including its impact on climate change. This suggests that the measures are meant to represent the sustainability of a firm and thus should have a statistically significant relationship with climate change measures like emissions. Thus, it can be expected that the higher the percentage of EU taxonomy-eligible Revenue, CapEx and OpEx a firm has, the lower a firm's carbon emissions are, when compared to a firm in a similar situation with a lower value. However, there will be no impact on scope 3 emissions as these are out of the direct control of a firm.

H1: The higher the percentage of taxonomy-eligibility measures Revenue, CapEx and OpEx, the lower a firm's scope 1 & 2 emissions is.

H1.1:The higher the percentage of taxonomy-eligibility measures Revenue the lower a firm's scope 1 & 2 emissions is.
H1.2:The higher the percentage of taxonomy-eligibility measures CapEx the lower a firm's scope 1 & 2 emissions is.
H1.3:The higher the percentage of taxonomy-eligibility measures OpEx the lower a firm's scope 1 & 2 emissions is.

A firm has direct control over their scope 1 emissions and are indirectly in control of scope 2 emissions, through their electricity usage for example. It is realistic that the more a firm is settled in a strategy in which their KPI's are taxonomy eligible, ie. considered to be potentially green, the lower the emissions from those segments. This is related to the work by Dumrose et. al. (2022) which found that the higher the taxonomy related Revenue, CapEx and OpEx, the better a firm scores in the environmental segment of ESG scores. In this case it can be expected that the taxonomy-eligible CapEx has a smaller relationship with scope 1 and 2 emissions as it is a forward looking measure, looking at how much a firm is investing into more sustainable practices rather than its current performances. Theoretically this would mean that there is only a small impact on current emissions, but this will still be significant. A firm that is investing a lot in greener activities likely has been doing so for a long time, which suggests it probably has lower emissions than similar competitors who do not spend a lot on more sustainable capital.

H2: The percentage of taxonomy-eligible Revenue, CapEx and OpEx has no significant relationship with a firm's scope 3 emissions.

H2.1:The percentage of taxonomy-eligible Revenue has no significant relationship with a firm's scope 3 emissions

H2.2:The percentage of taxonomy-eligible CapEx has no significant relationship with a firm's scope 3 emissions

H2.3:The percentage of taxonomy-eligible OpEx has no significant relationship with a firm's scope 3 emissions

A firm has no direct control over their scope 3 emissions as these are emitted through other (independent) firms in its supply chain. They also have only a very limited indirect control on these emissions. Thus it seems like the taxonomy-eligible Revenue, CapEx and OpEx will have no impact on these emissions, as there is no significant relationship between the firm and the emissions from their supply chain.

4. Data and Methodology

4.1.1 Data

To analyze the impact of EU taxonomy-eligible Revenue, CapEx and OpEx on emissions, data will be collected from the annual reports and sustainability reports published by firms. Firms are required to release these reports detailing a range of financial and nonfinancial data every year, next to which some firms opt to report data about their sustainability voluntarily to the shareholders in a sustainability report. These reports will be published in 2022, which means they are from the 2021 annual reports, as that is the only year in which firms are required to publish data on taxonomy figures, as this became mandatory from February 2022 onwards. However, some firms published their 2020 taxonomy data in their 2021 annual reports as well which will be used in the model. Reports will all be recovered from the websites of the individual companies. This means the data will be on a firm level, which is needed to look at the impact taxonomy reporting has on individual companies.

4.1.2 Sample Selection

To narrow down the data from all possible annual reports to a usable sample, a selection must be made. First firms are only required to report EU taxonomy figures if these firms are large public interest entities with over 500 full time employees on average, as stated by the Non-Financial Reporting Directive (NFRD). This narrows down the amount of firms to approximately 2,000 companies (Glowacki Law Firm, 2022). These firms are from a range of different industries, which cannot be fairly compared unless they are compared within their industry. This can be done using a dummy variable for industry, but to ensure that the sample which is accurately analyzed is as big as possible the focus will be on one industry. The industry chosen is the energy sector. This industry was chosen as this sector has the largest carbon footprint of all sectors (Poolen, 2020) and has been fully reviewed by the technical expert group of the EU taxonomy. This is useful to look at as in the energy sector it has been fully classified what activities enable the transformation from high emissions to low emissions (Poolen, 2020), which means that the classifications will not change soon and the analysis can be valid for a longer period. In the energy sector, 25 different sets of data will be selected to allow for a diverse enough sample to be able to draw valid conclusions. These 25 sets of data do not mean that there are 25 firms selected, some firms may be included twice if they have voluntarily published 2020 taxonomy data in their 2021 annual report. This is done to increase the sample size. The firms will be chosen if they are publicly listed on the European market and a part of the energy sector. These firms will be selected on the basis of being large enough to be able to be required to publish taxonomy data, and next to that they have to voluntarily disclose data on emissions. For this reason companies that are listed in Europe and are a part of the energy sector will have their annual reports looked at to see if they contain the right data, going through the sector descending from largest firm revenue. This of course limits the sample, filtering out some large and small firms which do not publish all the data needed to carry out this analysis, creating a bias.

4.2.1 Methodology

In order to test the hypotheses using the data collected, a regression analysis will be done. This will allow for a conclusion whether or not the taxonomy-eligibility measures have a significant predicting power on greenhouse gas emissions, within the energy sector. To perform this regression the following statistical model has been devised to explain the relationships between the variables.

(1)

$$Scope\ 1\ \&\ 2\ Emissions_i = \beta_0 + \beta_1 Eligible\ Revenue_i + \beta_2 Eligible\ CapEx_i + \beta_3 Eligible\ OpEx_i + \varepsilon_i$$

Model 1 shows a simple explanatory relationship, where the taxonomy-eligible revenue, capital expenditure and operating expenditure are the independent variables that , alongside a constant β_0, are used to predict the combined scope 1 and 2 emissions of that firm. However, this model lacks control variables, as the taxonomy measures are not the only decider of a firm's carbon emission. Firm size is the most important control as larger firms have larger operations and often this leads to larger emissions. Since the taxonomy-eligibility variables are all percentages, it is most useful to use the proper amounts to correct for size differences, as a firm may be significantly greener, but if it is much larger in size it may still have higher emissions. It was considered to include other variables such as total assets or employees to correct for size. Employees were left out, as the paper by Schütze & Stede (2021) found that there is little relation between labor intensity and emissions. The measure for total assets was excluded due to the regulators choosing to leave it out of the taxonomy, suggesting that the impact of total assets on emissions is not as significant as measures like revenue. The adjusted model can be found below.

(2)

$$Scope\ 1\ \&\ 2\ Emissions_i = \beta_0 + \beta_1 Eligible\ Revenue_i + \beta_2 Eligible\ CapEx_i + \beta_3 Eligible\ OpEx_i + \beta_4 Revenue_i + \beta_5 CapEx_i + \beta_6 OpEx_i + \varepsilon_i$$

As said before, Schütze & Stede (2021) found that a fair comparison outside of the sector may not be possible due to the differences in the classification system. Within the energy sector there are differences in the types of firms operating. This includes in the market for fuels like petrol.. Although these operations are covered by the taxonomy classifications for energy, these firms also partially fall under the taxonomy classifications for the chemical sector. That is why a control should be added to take into account the possible effect of companies which are involved in the production of oil. This has been done in model 3, by adding the Oil & Gas variable, $O\&G$. There are other smaller subsectors in the energy sector, however as these all still fall fully under the same taxonomy category the model will not split up the market further. This is done to analyze the firms in the way the EU divided them when creating the taxonomy.

Lastly, to add another variable to adjust more for firm size, the value of the property, plant and equipment, $PP\&E$, a firm is included in model 3. This is partially due to this measure giving a good impression of the size of a firm in the energy sector, as firms here rely on large tangible assets to create revenue in the long term. Although it is not the most effective way to use this variable, PP&E can also partially take into account the effect of the age of the assets used to create energy. As the PP&E of a firm gets older, it gets depreciated over its useful lifetime. When comparing two equally sized firms, one with newer equipment, one with older, the more modern firm will have a significantly higher PP&E than that with the outdated, as this one will have depreciated much of the worth of the assets. It can be useful to add the age of the assets in the model, as a firm with older energy production assets can have higher emissions, even if they may create more renewable energy. However, PP&E is not perfect for this, but there is no better measure with enough data. This variation due to the age of PP&E can be taken out, to ensure that the comparison is fair between the taxonomy measures and emissions, and not just looking at the age of the plant, property and equipment of different firms.

(3)

$$Scope\ 1\ \&\ 2\ Emissions_i = \beta_0 + \beta_1 Eligible\ Revenue_i + \beta_2 Eligible\ CapEx_i + \beta_3 Eligible\ OpEx_i + \beta_4 Revenue_i + \beta_5 CapEx_i + \beta_6 OpEx_i + \beta_7 O\&G_i + \beta_8 PP\&E_i + \varepsilon_i$$

The second hypothesis mentioned in chapter 3 delves into the relationship between scope 3 emissions and the taxonomy-eligibility measures. The makeup of that model and the model for scope 1 & 2 emissions is the same and can be seen below.

(4)

$$Scope\ 3\ Emissions_i = \beta_0 + \beta_1 Eligible\ Revenue_i + \beta_2 Eligible\ CapEx_i + \beta_3 Eligible\ OpEx_i + \beta_4 Revenue_i + \beta_5 CapEx_i + \beta_6 OpEx_i + \beta_7 O\&G_i + \beta_8 PP\&E_i + \varepsilon_i$$

4.2.2 Variable explanation

$Scope\ 1\ \&\ 2\ Emissions_i$ are a dependent variable, measured in tonnes of CO2 equivalent emissions. These emissions are either directly from the firm's production processes or indirectly controlled by the firm's direct operations. This means all greenhouse gas emissions are converted to where they are in one standardized measure of which the impact can be compared more effectively. The other dependent variable is $Scope\ 3\ Emissions_i$, which is likewise measured in tonnes of $CO2$ equivalent emissions. These are the emissions that a firm has little direct control over as they occur in the upstream or downstream production process.

The independent variables in the models are $Eligible\ Revenue_i$, $Eligible\ Capex_i$ and $Eligible\ Opex_i$. $Eligible\ Revenue_i$ is the percentage of taxonomy-eligible revenue firm i has. This percentage represents the fraction of sales a firm has that can be considered eligible. $Eligible\ Capex_i$ is the percentage of taxonomy-eligible capital expenditure firm i has. This percentage represents the fraction of longer term investments into fixed capital a firm has that can be considered sustainable depending on how it is applied. $Eligible\ Opex_i$ is the percentage of taxonomy-eligible operating expenditure firm i has. This percentage represents the fraction of the firm's short term expenditure during its operations that are eligible under the taxonomy classifications.

The control variables for the size of the firm's operations are of course similarly defined as the percentages they are linked to. $Revenue_i$, $CapEx_i$, $OpEx_i$ and $PP\&E_i$ are all expressed in euros and represent the amount of total revenue, total capital expenditures, total operating expenditures and total property, plant and equipment that firm i has. The control variable $O\&G_i$ is a binary variable that takes the value 1 if firm i has significant operations in the production process of oil/fuels, and 0 if it does not.

The other variables in the model represent the coefficient of control or independent variables, β , where β_0 represents the constant in the model. The term ε_i is the error term within the equation.

These variables all make up the statistical models. When looking at the data behind these variables we can understand the sample population of this model and look at a summary of their characteristics.

Table 4.1 Descriptive Statistics of the models dependent, independent and control variables

Variable	Obsv.	Mean	Std. Dev.	Min.	Max.
Scope 1 & 2 Emissions	25	25,900,000	26,800,000	172,793	89,600,000
Scope 3 Emissions	24	124,000,000	307,000,000	2,432,282	1,545,000,000
Eligible Revenue	25	35.23	26.94	0.57	79.50
Eligible CapEx	25	61.41	29.84	8.10	99.00
Eligible OpEx	25	42.54	27.01	5.10	93.10
Revenue	25	48,900,000,000	57,200.000,000	18,800,000	251,000,000,000
CapEx	25	4,560,000,000	5,380,000,000	2,089,999	24,400,000,000
OpEx	25	3,010,000,000	8,070,000,000	725,220	41,100,000,000
O&G	25	0.28	0.46	0	1
PP&E	25	30,200,000,000	39,600.000.000	2,000,000	181,000,000.000

Note: The observations and the specific values of the variables associated with each company can be found in the appendix.

Table 4.1 shows the descriptive of the variables from the model used. It can be seen that the range of the variables is large, suggesting that there is diversity between the firms chosen in the energy sector on the basis of size (Revenue, CapEx, OpEx, PP&E) and types of operations (Eligibility variables. The control variables have a large standard deviation, which reinforces the idea of a spread in the size of firms selected. The same is the case with the dependent variables, which have a high standard deviation. The number of observations are lower than for the other variables, as the company Orlen has chosen not to disclose their scope 3 emissions.

4.2.3 Analytical Technique

The technique used to analyze the model will be regression using the ordinary least squares (OLS) method, to create a linear model with as little residual values as possible. Next to that it needs to be ensured that the statistical test used to check the significance in the model aligns with the characteristics of the data. As there are multiple independent variables in the model, it first needs to be seen if multivariate regression can be used. This would mean there needs to be a linear relationship, the residuals need to be normally distributed, needs to be homoscedastic and there cannot be multicollinearity between the independent variables. This is not the case, as shown by the correlation table 4.2.

Table 4.2 Correlation table for Model Variables

	Variable	1	2	3	4	5	6	7	8	9	10
1	Scope 1 & 2 Emissions	1									
2	Scope 3 Emissions	0.488	1								
3	Eligible Revenue	-0.355	-0.336	1							
4	Eligible CapEx	-0.348	-0.431	0.774	1						
5	Eligible OpEx	-0.465	-0.310	0.731	0.802	1					
6	Revenue	0.704	0.792	-0.430	-0.552	-0.409	1				
7	CapEx	0.600	0.774	0.020	-0.067	-0.039	0.664	1			
8	OpEx	0.178	0.103	-0.182	-0.155	-0.251	0.150	0.190	1		
9	O&G	-0.029	0.390	-0.350	-0.573	-0.435	0.146	0.175	-0.103	1	
10	PP&E	0.586	0.815	-0.151	-0.225	-0.105	0.760	0.860	0.224	0.245	1

Table 4.2 shows the correlation between the variables. The correlation table shows there is a low to moderate negative relationship between taxonomy-eligible Revenue, CapEx, Opex and emissions. This shows that there is some relationship between these variables, which is that the

higher the eligible Revenue, CapEx and Opex, the lower the emissions. However, this is not proven to be statistically significant, thus should be taken with a grain of salt. The more significant finding shown within the table is the strong correlation between taxonomy-eligible Revenue, CapEx and Opex. This means there is multicollinearity, which prevents the use of multivariate regression. Each independent variable has to be regressed individually to see the effects more clearly. This will be done via OLS linear regression. For this to be possible the data needs to be distributed linearly, which can be seen to be the case in figure A.1 and A.2 in the appendix, although this linearity is not very strong which could lessen the predicting power of the model. Next to that the data needs to be normally distributed. This was tested through the creation of quantile-quantile plots, to check the distribution of the variables compared to expected normal distribution they would have. This can be seen in figure A.3 in the appendix, where although the distribution is not perfectly normal it does follow the 45 degree line close enough to allow for OLS to be used. Next to that the regression is done with robust standard errors, to make sure that heteroskedasticity is controlled and to make sure the regression is resistant to outliers.

Moving away from multivariate regression does mean the model changes slightly. In this case, the 3 independent variables have to be worked out in separate models due to their high correlation. To simplify these models, the output variable has been changed to $Emissions_{si}$. This shows the emissions of firm i as before, but the variable is also defined by s, which stands for the scope, which can either be scope 1 and 2, or scope 3 emissions. This means it is used the summarize the two output variables that differ across the two main hypotheses: $Scope\ 1\ \&\ 2\ Emissions_i$ and $Scope\ 3\ Emissions_i$. The new models can be seen below.

(5)

$$Emissions_{si} = \beta_0 + \beta_1 Eligible\ Revenue_i + \beta_2 Revenue_i + \beta_3 CapEx_i + \beta_4 OpEx_i$$
$$\beta_5 O\&G_i + \beta_6 PP\&E_i + \varepsilon_i$$

(6)

$$Emissions_{si} = \beta_0 + \beta_1 Eligible\ CapEx_i + \beta_2 Revenue_i + \beta_3 CapEx_i + \beta_4 OpEx_i$$
$$\beta_5 O\&G_i + \beta_6 PP\&E_i + \varepsilon_i$$

(7)

$$Emissions_{si} = \beta_0 + \beta_1 Eligible\ OpEx_i + \beta_2 Revenue_i + \beta_3 CapEx_i + \beta_4 OpEx_i$$
$$\beta_5 O\&G_i + \beta_6 PP\&E_i + \varepsilon_i$$

5. Results

5.1.1 Scope 1 & 2 Emissions

The hypothesis earlier in the paper stated: the higher the percentage of taxonomy-eligibility measures Revenue, CapEx and OpEx, the lower a firm's scope 1 & 2 emissions is. This was since a firm had more direct control over their scope 1 & 2 emissions. This would mean that if a firm had more taxonomy-eligible operations that they would operate greener, and with relatively lower emissions, than their competitors with lower taxonomy-eligibility in the same sector.

5.1.2 Scope 1 & 2 Taxonomy-eligible Revenue

The initial hypothesis for taxonomy-eligible revenue stated the same as the main, that with a higher taxonomy-eligible revenue a firm would have relatively lower emissions than a competitor in the same sector with a lower taxonomy-eligible revenue.

The findings of the regression can be found in table 5.1. This table shows that there is no significant effect of the value of the taxonomy-eligible revenue of a firm on the scope 1 & 2 emissions in the energy sector. This rejects the hypothesis. It seems taxonomy-eligible revenue can not be seen as a figure that signals whether a firm is actually greener and more sustainable. It can be seen that there is a negative effect, so an increase in taxonomy-eligible revenue should decrease greenhouse gas emission, but again this is not significant. None of the variables are significant in this model, suggesting that there is no relationship between the independent/control variables and the dependent variable. This could mean the wrong control variables were used in the model, or that there is indeed no significant relationship, which would mean that the taxonomy cannot be used to accurately judge a firm's sustainability. The model itself explains 59% of the variation of the scope 1 & 2 carbon emissions between firms. This is significant, but is still missing a lot of the variation, suggesting the model could be expanded.

Table 5.1 Analysis of regressions of taxonomy eligibility measures with scope 1 & 2 emissions

Variable	(5)	(6)	(7)
Eligible	-287,489	-290,657	-582,566*
	(322,440)	(172,856)	(317,660)
Revenue	0.00017	0.00013	0.00005
	(0.00016)	(0.00010)	(0.00016)
CapEx	0.00243	0.00232	0.00207
	(0.00249)	(0.00184)	(0.00141)
OpEx	-0.00006	-0.00008	-0.000494
	(0.00036)	(0.00023)	(0.00045)
O&G	-1.28×10^7	-1.82×10^7	-2.53×10^7*
	(1.28×10^7)	(1.08×10^7)	(1.51×10^7)
PP&E	-0.00006	-0.00002	0.00013
	(0.00027)	(0.0024)	(0.00019)
Constant	2.24×10^7	3.24×10^7**	3.89×10^7*
	(1.95×10^7)	(1.53×10^7)	(1.19×10^7)
Observations	25	25	25
R^2	0.59	0.56	0.68

Note: Standard errors are in brackets; *p<0.1, **p<0.05, ***p<0.01

5.1.3 Scope 1 & 2 Taxonomy-eligible Capital Expenditure

It was predicted that the higher the percentage of taxonomy-eligible capital expenditure would be, the lower emissions of greenhouse gasses. This effect would possibly be smaller than the rest as it is more of a signal of an investment into creating a greener company in the future, but would still be significant enough.

Looking at the findings in table 5.1 this is not the case. There is no significant impact of a company's percentage of taxonomy-eligible capital expenditure on their 1 & 2 emissions. In this case taxonomy-eligibility cannot be seen as a signal of being a more sustainable company. It could be that this variable is more forward looking and in the long term it has a significant effect, but this cannot be tested with the current data available. Even within the energy sector it is clear that even if a firm invests more into capital that could have a significant climate impact, it does not actually mean there are lower emissions. The constant is significant with a p-value of 0.049, although this in itself is not significant as there are no firms which have a value of 0 for all predictor variables. This significance has no real impact on answering the research question. Even without any other significant variables, the model itself explains 56% of the variation of the scope 1 & 2 carbon emissions between firms. However, this does raise the question that if the model is missing important variables which explain greenhouse gas emissions of a firm.

5.1.4 Scope 1 & 2 Taxonomy-eligible Operating Expenditure

The sub hypothesis H1.3 stated that "The higher the percentage of taxonomy-eligibility measures OpEx the lower a firm's scope 1 & 2 emissions is."

In this case there is a significant effect of the percentage of taxonomy-eligible operating expenditure of a firm on the greenhouse gas emissions, as seen in table 5.1. For every percentage point increase of taxonomy-eligible operating expenditure, there is a 582,566 tonnes CO2 equivalent decrease in greenhouse gas emissions. This is not an insignificant decrease either. Thus, within the energy sector in the EU, firms that have higher ongoing business costs that are classified as potentially sustainable are an accurate signal of actually being more sustainable. Unlike the two other taxonomy measures, operating expenditure is related to emissions that can be controlled by a firm and thus the measure can be used by investors to make conclusions about a firm's effort to be sustainable and compare this more accurately across the industry. Next to the constant is significant again, however as before this can be ignored when answering the research question. This model has a higher R^2 value of 0.68, so 68% of the variation in emissions is explained by the model, which is good but could still be higher to be a more comprehensive model that explains as much of the variations as possible.

5.2.1 Scope 3 Taxonomy-eligible Revenue

The hypothesis for taxonomy-eligible revenue stated that it was predicted that there would be no significant relationship between it and scope 3 emissions as a firm has no direct control over these emissions and nor their revenue segments, nor the amount they invest in capital or operating expenditures impacts this.

The regression results which look at this hypothesis can be found in table 5.2. This table shows that there is no significant relationship between the value of the taxonomy-eligible revenue of a firm and its scope 3 emissions. This means the hypothesis is not rejected by the test. However, there are multiple variables which do have a significant relationship with scope 3 emissions. The control variable revenue has a significant relationship. Every euro of revenues extra 0.00173 tonnes of CO2 equivalent greenhouse gas emissions. This is likely due to a firm with larger revenues being of a larger size, which leads to larger supply chains which increase emissions. The capital expenditure variable has tested significantly too, with a one euro increased capital expenditure leading to 0.0201 tonne CO2 eq. increase in emissions. This can be due to multiple reasons, one being larger firms having to invest more into keeping up their fixed capital, these bigger firms have larger supply and distribution chains, therefore having higher emissions. Another reason could be that a firm with high capital expenditure has an older energy infrastructure of which the firm, and its upstream and downstream partners, are forced to pay more to renovate or renew. This means higher capex, but also higher scope 3 emissions than their greener competitors who can spend less on upkeep. Lastly, the variable O&G has a significant impact on emissions. Although this was not seen for scope 1 & 2 emissions, it seems that if an energy company has a significant oil segment in the business, it will lead to increased scope 3 emissions. This suggests that there is no significant difference between the more direct emissions that energy companies that do or do not operate in an oil/fuel business segment, but this difference does exist with indirect emissions. This could be due to the oil/fuel being transported over longer distances to get to the eventual market using emission heavy methods, while electricity travels less, using less emission heavy infrastructure. Next to that, the supply and distribution chains are longer for oil/fuel which results in higher emissions when transporting the (un-)finished product. The model is strong at predicting variations in scope 3 emissions, explaining 81% through the variables with an R^2 of 0.81.

Table 5.2 Analysis of regressions of taxonomy eligibility measures with scope 3 emissions

Variable	(5)	(6)	(7)
Eligible Revenue	-1,319,993	-412,140	-374,718
	(1,572.636)	(1,664,463)	(1,090,171)
Revenue	0.00173*	0.00203	0.00208
	(0.00948)	(0.00130)	(0.00104)
CapEx	0.0201**	0.0175**	0.0168**
	(0.0087)	(0.0087)	(0.0077)
OpEx	-0.00231	-0.00016	-0.00170
	(0.00184)	(0.00244)	(0.00233)
O&G	1.29×10^{8}*	1.44×10^{8}	1.49×10^{8}*
	(6.61×10^{7})	(9.51×10^{7})	(7.78×10^{7})
PP&E	0.00157	0.00155	0.00160
	(0.00132)	(0.00143)	(0.00141)
Constant	-8.13×10^{7}	-1.11×10^{8}	-1.22×10^{8}
	(8.06×10^{7})	(1.54×10^{8})	(8.35×10^{7})
Observations	24	24	24
R^2	0.81	0.80	0.80

Note: Standard errors are in brackets; *p<0.1, **p<0.05, ***p<0.01

5.2.2 Scope 3 Taxonomy-eligible Capital Expenditure

Hypothesis 2.2 predicted that there would be no relationship between the percentage of taxonomy-eligible capital expenditure and emissions of scope 3 greenhouse gasses. Table 5.2 supports this finding. There impact of a company's percentage of taxonomy-eligible capital expenditure is not seen back when trying to predict scope 3 emissions. Due to the lack of control over their scope 3 emissions, capital expenditure which goes according to the EU taxonomy classifications has no real relationship with emissions. The variable CapEx is the only significant variable in this model as well, with similarly sized effect as before. A euro's increase in capital expenditure results in a 0.0201 tonne CO_2 eq. increase. This is a relatively large impact when looking at it, as only 50 euros worth of capital investments are equal to the emissions of the energy consumption of 0.65 households in 1 year (Climate Neutral Group, 2022). This is likely to be significant as it is related to the size of a firm's operations. The model is still strong at predicting the scope 3 emissions of the companies operating in the energy sector, with 80% of the variations explained

5.2.3 Scope 3 Taxonomy-eligible Operating Expenditure

Taxonomy-eligible operating expenditure, just as the other measures, was predicted to have no significant relationship with scope 3 emissions. It was the only measure to have a significant relationship with scope 1 & 2 emissions, but this is not the case with scope 3. This suggests the hypothesis is correct and that none of the taxonomy-eligibility measures signal information to investors about the sustainability of the entire supply and distribution chain of a company. The measures that are significantly related to emissions are again capital expenditure and whether or not the firm operates in the oil segment of the energy sector. These values are again very similar to those in the other regressions of scope 3. A euro worth of capital expenditure leads to 0.0168 tonnes CO_2 equivalent of greenhouse gasses. This similarity is logical as there taxonomy variables have effects which are of the same size and that is the only thing changing between regressions. The impact of operation in the oil/fuel segment is increasing the scope 3 emissions of a firm by 1.49×10^8 tonnes of CO_2 equivalent greenhouse gasses. The model is strong at predicting the regression here as well, with 80% of the variation is scope 3 emissions of firms being explained.This is a lot, but shows that the model could still be expanded upon.

6. Conclusion

6.1 Overall conclusion

The paper initially set out to discuss the central question: *To what extent is there a relationship between the values of taxonomy-eligible Revenue, CapEx and OpEx and the greenhouse gas emissions of firms that operate in the same industry?* The findings show that there is only a very limited relationship between the values of taxonomy-eligibility measures of a firm and its greenhouse gas emissions. This was limited to the taxonomy-eligible operating expenditure of a firm when looking at the European energy sector, only when comparing it to a firm's combined scope 1 and 2 emissions and was not the case if greenhouse gas emissions were defined by scope 3 emissions. EU taxonomy-eligibility is thus to a greater extent not a usable measure for investors to compare and invest into more "green" firms within an industry. If this is not communicated clearly, firms may be able to falsely signal their sustainability and could be used to greenwash their practices. This means the European Union needs to be strict and ensure that investors do not make sustainability decisions based on this, that firms do not use this measure to greenwash their practices and they need to ensure that there is another viable option which investors and firms can use to compare their sustainability.

Nevertheless, within the energy sector taxonomy-eligible OpEx can be used as a tool to judge how sustainable a firm is compared to other firms in that sector. This only considers sustainability in terms of greenhouse gas emissions, those which a firm has a more direct control over, thus should only be seen as a part of the decision whether a firm is sustainable in its industry as it does not contain the full picture of sustainability.

6.2 Scope 1 & 2 Emissions

The results showed that the first hypothesis, the higher the percentage of taxonomy-eligibility measures Revenue, CapEx and OpEx, the lower a firm's scope 1 & 2 emissions is, was not correct. It was only partially correct, as said a one percentage point increase in taxonomy-eligible operating expenditure for a firm in the energy sector leads to a 582,566 tonnes CO_2 equivalent decrease in greenhouse gas emissions. However, revenue and capital expenditure are not proven to have a significant relationship with scope 1 & 2 emissions. This is the case even though they are highly correlated with taxonomy-eligible operating expenditure. This suggests that sustainable investments in the day to day operations have more of an impact on lowering emissions than investing into new capital or being more sustainable on the sales side.The control variables show that a firm's size expressed through its investments in capital did usually relate with its emissions of a firm, likely due to larger firms with more new projects or more upkeep for old projects have higher levels of emissions. There was no significant relationship between taxonomy eligible Revenue, Capital Expenditure and the emissions over which a firm has a more direct control. Thus it seems that the taxonomy needs to be developed further to ensure that these two measures can be used like OpEx to make green investment decisions, or it must clearly be disclosed that these measures do not show whether a firm is greener.

6.3 Scope 3 Emissions

The prediction that there would be no significant relationship between scope 3 emissions and taxonomy-eligibility could not be disproved. This seems to suggest that the criteria of the EU taxonomy that define eligibility do not have any relationship with the emissions within a firm's supply/distribution chain. This makes sense as other parties are in control of this and a firm only has a smaller, indirect power to influence this. Next to that, taxonomy-eligibility is measured within a firm’s direct operations, which is not where the scope 3 emissions are found, making the lack of a relationship logical. Even though this makes sense, the EU should consider requiring companies to disclose that these measures do not represent scope 3 emissions, as uninformed investors could still make the mistake to blindly trust good taxonomy-eligibility figures as an EU stamp of approval for being a green firm. The absolute size of the capital expenditure of a firm is significantly related to scope 3 emissions. This could be due to larger firms which have larger capital expenditure and larger supply and distribution chains, having higher emissions throughout these. In one of the models it was the case that absolute revenue was also significantly related to emissions. This may be due to the firms with larger revenues having larger supply chains and distribution networks to create and get all these products to the end user, which in turn have larger scope 3 emissions.

6.4 Limitations of the Research

As mentioned, there is a significant lack of prior research due to the recency of the establishment of the EU taxonomy and the requirements only going in as of 2022. This is a major limitation.

There is little prior research to build on and compare the findings with, but more importantly a lack of data due to the requirement existing for less than a year. This lack of data is worsened as not all firms publish the taxonomy data in the same way (Bodart et al., 2022), for instance some only publish the percentage of taxonomy-eligibility and not the gross amount, which means that it is not possible to compare all firms. This limited data created a small sample size of 25, which is small to draw significant conclusions from. Further research in the future should find a larger sample size to run this experiment with to be able to draw a more built upon conclusion.

The energy sector is one of the most developed areas for the EU taxonomy, which allowed this paper to delve into it and draw its conclusions from there. This singular focus on this sector however limits this paper's ability to draw conclusions of the taxonomies working on all companies. To fully understand how taxonomy-eligibility works across the economy, a diverse range of sectors should be analyzed in further research and the findings be compared. There may be major differences across these sectors as the way the criteria are constructed vary across sectors (Schütze & Stede, 2021), possibly meaning the taxonomy-eligibility figures across sectors have a range of differing relationships with emissions.

Taxonomy-eligibility is only a part of the EU taxonomy for Sustainable Activities, an essential part of it will be the taxonomy-alignment of firms. As mentioned, this measure expands upon and increases the strictness of what is eligible. This means the definition of what is seen as sustainable is stricter and this measure may thus have a stronger relationship with emissions. Firms and investors will also use alignment faster to compare sustainability within a sector as it is stricter. That is why the analysis applied within this paper should be applied upon taxonomy-alignment, to ensure that this measure has a stronger relationship with emission and does not become a tool to wrongly signal a firm's sustainability within its market and become a tool to greenwash.

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8. Appendix

Table A.1 Overview of the companies used in the analysis

Company name	
EnBW*	Endesa*
Enel Spa*	Vattenfall
Engie	EDP
Verbund	Fortum
Iberdrola	CEZ Group
E.ON	Eni
Orsted	Shell
Naturgy	Acciona
Orlen	RWE Ag
MOL Group	Neste
OMV	Orlen

Note: * Means both the 2021 and 2020 eligibility figures were used in the analysis

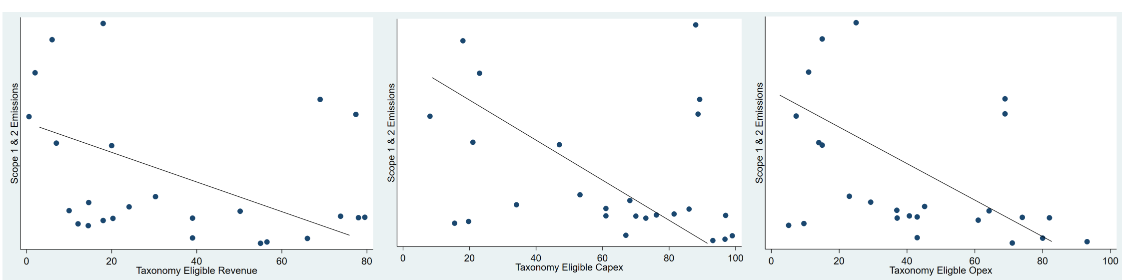

Figure A.1 Linearity of independent variables and scope 1 & 2 emissions

Note: The relationship is not perfectly linear, but there is a negative trend.

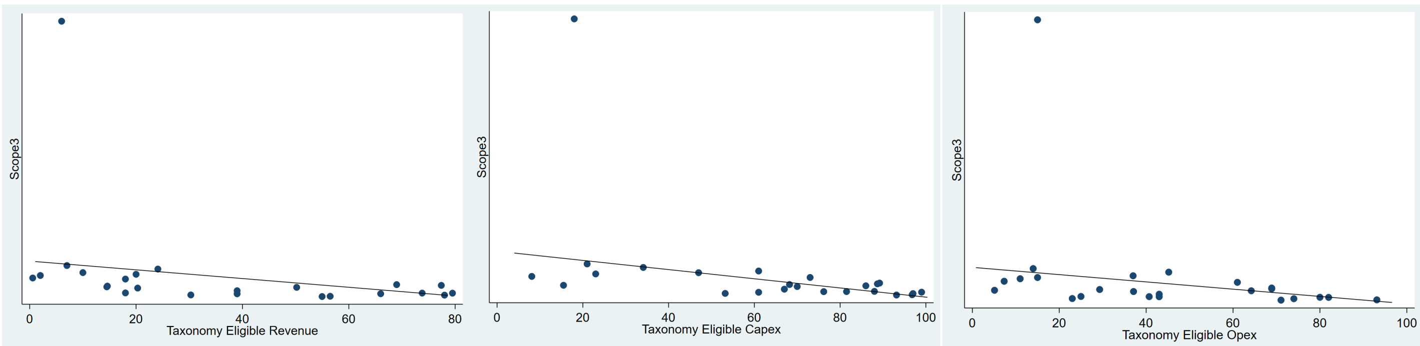

Figure A.2 Linearity of independent variables and scope 3 emissions

Note: The outlier is the company Shell

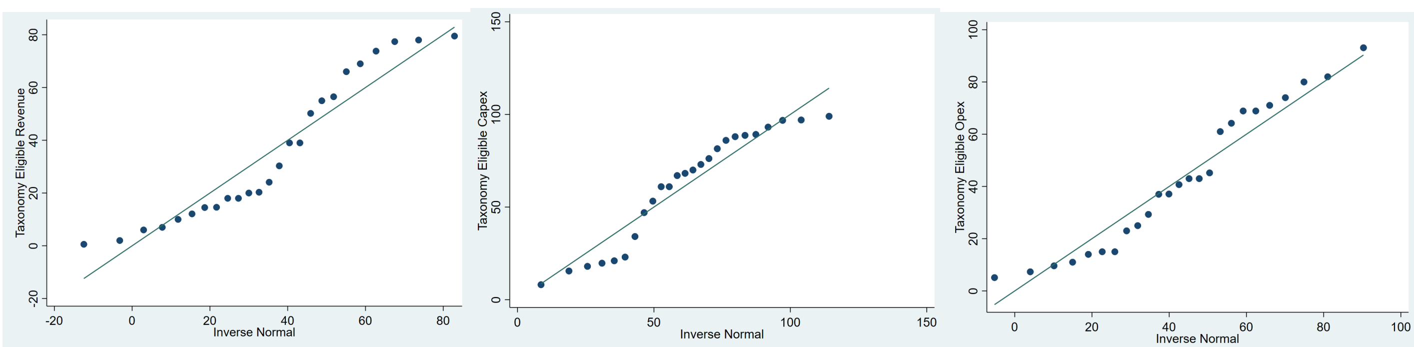

Figure A.3 QQ graphs of all independent variables