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Internal and external factors affecting oil and gas companies' climate change performance

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Abstract

This master thesis investigates the internal and external determinants of oil and gas companies' climate change performance for the period 2019-2021. We use resource-based theory, resource dependence theory and institutional theory as a theoretical framework for our analysis. By conducting a random effect model, we find that internal factors such as financial strength, gender diversity among executives, innovation competency and climate change policy elaboration negatively affect oil and gas companies' GHG emissions. Moreover, this thesis provides evidence of a non-linear relationship between sales growth and GHG emissions – initially, this relationship is negative, but after reaching a critical threshold it becomes positive. As for the external factors, only energy transition regulations appear to be a significant factor, being negatively related to GHG emissions and showing that coercive pressures influence the climate-related performance of this industry. We find a positive correlation between the combined oil and gas reserves of integrated oil and gas companies and their GHG emissions. Furthermore, the results show that the companies that are members of the Oil and Gas Climate Initiative, have on average lower total GHG emissions, Scope 1 emissions and energy consumption than their comparative non-members counterparts. Finally, the difference between the climate-related performance of leaders and laggards of OGCI members is lower than the one of non-members, indicating a possible effect of mimetic isomorphism on oil and gas companies' climate change performance.

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List of abbreviations

BP – British Petroleum
CC – climate change
CCP – climate change performance
CCS – climate change strategy
CSR – corporate social responsibility
ET – energy transition
GHG – greenhouse gas
GI – green investments
FE – fixed effects
IEA – International energy agency
INOC – international oil companies
IRENA – International renewable energy agency
IT – institutional theory
NOC – national oil companies
O&G – oil and gas
OGCI – oil and gas climate initiative
PV – photovoltaics
RBV – resource-based view
RDT – resource dependence theory
RE – random effects model
RE – renewable energy
VRIN - valuable, rare, inimitable and non-substitutable

1. Introduction

Many countries and industries must adapt to the provisions of Paris Agreement.¹ The Parties of this international convention have decided to take measures to drive climate change mitigation and adaptation. These measures should let keep the increase of global average temperature below 2°C, ideally below 1,5°C. As mentioned in the Agreement, the responsibility of countries is common but differentiated, which means that each country elaborates its own climate strategy, being at the same time in accordance with generally accepted measures. In addition, climate change is in the center of the SDG 13² of the U.N. and is closely related to such SDGs as responsible production and consumption (SDG 12) and energy transition (SDG 7).

However, current level of investments in energy transition is far from being enough to meet the established long-term goals. According to IRENA³, the annual level of investment needed by 2050 should be approximately equal to \$797 billion, while the real annual renewable energy investments are approximately equal to \$350 billion. Consequently, the analysts of IRENA warn that the global annual investments in renewables need to triple by the year 2050 (IRENA, 2020b).

In the same report a remarkable difference between investments in fossil fuels (e.g., oil and gas upstream and downstream infrastructure, coal mining and transportation), and renewables is highlighted: *“In 2018, for example, the fossil fuel sector received a total of \$933 billion, almost three times as much as what was invested in renewables in the same year”*⁴. This is the *status-quo* for today – global annual investments in fossil fuels exceed those in renewables.

At the same time, there is a huge variety of RE investment fiscal, regulatory and financial incentives put in place by policymakers. Despite this wide variety of support policies, there is still a wide gap between ambition and action.

¹ “The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at COP 21 in Paris, on 12 December 2015 and entered into force on 4 November 2016”

² U.N. has set 17 goals and 169 targets concerning different dimensions of society and environment. These 17 goals are part of the 2030 Agenda for Sustainable Development of the United Nations. *SDG 13, Climate action: Take urgent action to combat climate change and its impacts*

³ International Renewable Energy Agency, Climate Policy Initiative, “Global landscape of renewable energy finance”, 2020, p.52

⁴ Idem, p.52

These political initiatives are object of close attention not only of governments, but also of private sector entities, local communities and individuals. For businesses, for instance, corporate environmentalism as part of corporate social responsibility is not new, but with Paris Agreement adoption and other derivative legislations dedicated to climate change, corporate CSR⁵ strategies became concretized and tailored for each industry. Yet, despite the important role of governmental measures and environmental policies put in place, these measures are probably still not enough to accelerate action.

The sector that is nowadays faced with particularly high pressure from the entire society, being obliged to make difficult choices and face considerable challenges, is the oil and gas sector. The high social pressure is closely related the energy-intensive and environmentally consequential nature of this industry. McKinsey and Company (2021)⁶ indicated that the oil and gas sector is responsible for 42% of global emissions. In industrialized countries, oil industry is responsible for more than a half of greenhouse gas emissions. Considering recently adopted legislation, oil and gas sector simply cannot operate as before. If there is no answer to this social appeal, there will be possible threats not only the reputation of these companies, but their existence in general.

Also, higher demand in sustainable business practices of oil and gas is due to the increasing awareness of people about the environmental impact of fossil fuels. An example is Climate Action 100+⁷, created in 2017 as an initiative of investors with a mission to push the most polluting companies to move towards decarbonization and a more active sustainability disclosure. There is an increasing number of restrictions of fossil fuel companies' financing from numerous financial institutions, investment funds and credit unions. Thus, inaction can also hinder the access to debt and equity finance for this industry.

As stakeholders are becoming more demanding, not only elaborating energy transition strategies is required, but also concrete actions behind these strategies.

Stakeholders tend to be exigent to the private sector also because of the high potential of private capital. The analysis realized jointly by CPI⁸ and IRENA⁹ shows that private

⁵ “Corporate Social Responsibility – a responsibility among firms to meet the needs of their stakeholders and a responsibility among stakeholders to hold firms to account for their actions.” There is no commonly accepted definition, it varies across cultures (Chandler, 2017)

⁶ [How oil and gas is navigating the energy transition | McKinsey](#)

⁷ [Climate Action 100+](#)

⁸ Climate Policy Initiative

investments (which besides corporate actors also include institutional investors, households, private equity, venture capital and funds) far exceed the public sector investments. For the period 2013-2018, 86% of total investments in renewable energy came from the private sector. As oil and gas is one of the largest and economically important industry in the world¹⁰, its potential contribution to energy transition could be decisive on the global scope.

In response to Paris Agreement requirements, Oil and Gas Climate Initiative¹¹ was created to support the acceleration to carbon neutrality. This Initiative consists of consent-given members-companies whose production represents 30% of global oil and gas production. Common efforts for decarbonization are done by these companies, publicly disclosing their progress on the issue.

However, climate change strategies and performance vary across companies and countries in which they operate. On average, investments in clean energy have been quite modest relatively to the considerable outcomes of oil and gas activities – on average, expenditures in RE represent 4% of their capital expenditures, which is far from being enough to achieve Paris Agreement goals. Some scientists estimate that only Royal Dutch Shell will be capable to reach the zero-emission goal by 2050 (Dietz et al., 2021), which is an explicit long-term goal for most oil majors. On the contrary, the American oil major ExxonMobil has one of the less ambitious climate change strategies, as they anticipate the increase in oil demand for the near future. This lack of initiative from the American company is somehow paradoxical from the historical perspective of its home country, as the U.S was one of the first countries to admit the climate change issue and the necessity to change businesses (Kolk and Levy, 2001).

The question raises not only for the biggest private-owned majors in the industry, but also for national oil companies (NOC's) that, according to IEA (International Energy Agency), *“account for well over half of global production and an even larger share of reserves.”*¹² More precisely, they own two-thirds of global proven-plus-probable oil reserves, and the largest share of natural gas reserves. IEA mentions that for NOCs there are additional challenges in climate change mitigation and adaptation because the states' income highly

⁹ International Renewable Energy Agency, Climate Policy Initiative, “Global landscape of renewable energy finance”, 2020, p.9

¹⁰ [Global oil industry - statistics & facts | Statista](#)

¹¹ The members of this initiative are BP, Petrobras, Chevron, ExxonMobil, Shell, Total, Eni, Equinor, Aramco, Occidental, Repsol and CNPC.

¹² International Energy Agency, The Oil and Gas Industry in Energy Transitions, Insights from IEA analysis, p.16

depends on such natural resources as oil and gas. Hypothetically, there is a negative relationship between the quantity of oil reserves that a company holds and its renewable energy investments (J.Pickl, 2019). This is quite intuitive that companies holding considerable reserves of oil and gas are less likely to invest in clean energy, relying on their natural resources' ownership, despite the fact that on the long-term, these companies risk facing high resources' scarcity due to the limited quantity of these resources.

No matter the type of ownership of oil and gas companies, while making decisions in this important business shift, there are many points that CEOs and managers must take into consideration. The type of ownership may be one of the internal factors of the company that will probably influence the way how a company reacts on climate change. On the one hand, policy implications and rapidly falling costs of renewables due to technological innovations encourage energy transition (Yun Peng, 2019). For example, as Yun Peng highlights, the average price of a PV has fallen by 90% since 2005. Also, there is a progress in terms of efficiency of renewable energy technologies – far less equipment than before is needed for the same energy output in case of wind and solar PV.

On the other hand, one of the challenges O&G decarbonization process may be a lack of expertise and experience of these companies in the field of clean energy sources' deployment, which may have uncertain implications on their profitability. Therefore, some O&G companies focus on geothermal energy, like Equinor, BP and Chevron do – their already existing knowledge in drilling technologies facilitates access to the earth's heat due to similar technology use in geothermal energy. Equinor starts preparing the transition to hydrogen¹³ by acquiring Triton Power. Green hydrogen¹⁴ is becoming frequently promoted for accelerating corporate decarbonization plans.

Consequently, O&G companies would need additional resources in experience accumulation, expertise search and optimal budget allocation, as well as their choice of energy mix both for their operations processes and products. All these challenges that oil and gas companies face, make the process of climate change mitigation and adaptation one of the most complex issues in sustainability transformation. Therefore, the purpose of this master thesis is a deeper understanding of the factors affecting climate change performance of the oil and gas

¹³ [Equinor and SSE Thermal acquire Triton Power and prepare for transition to hydrogen - Equinor](#)

¹⁴ “Green hydrogen – hydrogen produced from renewable energies (i.e. solar and wind), as opposed to black or grey hydrogen obtained from fossil fuels (definition provided by ENGIE Impact”, [Green Hydrogen | ENGIE Impact](#))

companies. The academic literature shows that there is a research gap in the corporate climate change performance assessment, especially for the oil and gas sector.

We will focus on oil and gas companies' GHG emissions as one of the pillars of climate-related performance. By integrating the resource-based view, resource-dependency theory and the institutional theory, both internal and external determinants of oil and gas companies' GHG emissions will be analyzed. We conduct an econometric analysis, notably the random effect model, to examine what internal and external factors influence the oil and gas companies' climate-related performance across different countries. The group of internal factors includes O&G companies' financial performance, gender diversity among executives and board of directors, their innovation competency and a presence of climate change policy. The group of external factors include institutional coercive and normative pressures that could be GHG emissions' determinants. For mimetic pressures, we conduct a separate comparative analysis of the climate change performance for a group of companies-members of the Oil and Gas Climate Initiative compared to their non-members counterparts. In addition, we test for a non-linear relationship between oil and gas companies' sales growth and GHG emissions.

The thesis is structured as follows: first, we present the literature review and the hypotheses formulated. Second, we explain the data collection with descriptive statistics, as well as describe the dependent and independent variables. Then, we present the methodology and the models used for conducting regressions analyses. We show the empirical results, followed by the discussion of results, the limitations of our work and conclusion.

2. Literature review and hypotheses formulation

This section is dedicated to the scientific literature review that allows to identify the existing research gap and formulate the hypotheses. Firstly, we define the concept of climate change performance. Then, we present the different theories with regards to environmental sustainability determinants and their link with the environmental performance of companies in general, and specifically for oil and gas companies. For each sub-group of determinants, we develop hypothetical statements. In the following sections, we construct a theoretical model that will help us to conceptualize our research question, as well as a model of cause-and-effect potential links.

2.1 Definition of corporate climate change performance

Within the framework of this master thesis, we preliminary define the concept of climate change performance and highlight the elements which we will focus on. We will refer to the definition of R. Sullivan (2010) which lists the main constituents of the concept of corporate climate change performance:

- **“Governance:** *whether a firm has assigned board or senior executive responsibility for climate change-related issues.*
- **Policy:** *whether a firm has a clear statement on climate change*
- **Risk assessment:** *whether a firm conducted a detailed analysis of climate change risks and opportunities for the business and is aware of the financial and strategic significance of climate change for the business.*
- **Inventory:** *the quality and the robustness of the GHG emissions data provided by the company.*
- **Targets:** *whether a firm has set climate change targets.*
- **Implementation:** *whether a firm explains how it reduces GHG emissions and estimates the costs related to this reduction.*
- **Leadership and performance:** *whether a firm has participated in any climate change leadership initiatives and reduced its GHG emissions”¹⁵*

These seven aspects constitute the overall climate change corporate performance.

Many other studies (Schojaeddini, 2019; Kolk and Pinkse, 2005; Kolk and Levy, 2002; Pickl, 2019) distinguish the climate change strategy types based on their end goal. Climate change mitigation¹⁶ strategies are oriented to emission reduction practices through the achievement of science-based targets. This type of strategy includes energy efficiency targets and renewable energy use promotion. Climate change adaptation strategies (Dell and Pasteris, 2010), instead of climate change prevention mechanisms, focus on preventing the expected damage caused by climate change. This could be done by assessing the risks and the potential impact of climate change on companies’ financial health, value chain, their buildings and products. Finally, climate change resilience¹⁷ strategies are focused on the research of market

¹⁵ p.41, “An assessment of the climate change policies and performance of large European companies” (R.Sullivan, 2010)

¹⁶ « Climate change mitigation refers to specific actions that reduce greenhouse gas emissions in the atmosphere or enhance greenhouse gas sinks for storing the gases », European Commission

¹⁷ “The ability to withstand and recover rapidly from deliberate attacks, accidents, natural disasters, as well as unconventional stresses, shocks, and threats to the economy and democratic system.” Center for Climate and Energy solutions.

opportunities that appear on the market with regards to climate change. This last type is associated with business case creation with regards to climate change consequences.

In this master thesis, we will not consider the exact type of climate change strategy developed by oil and gas companies due to the low availability of information about the orientation of their CC policies. We will track the presence or not of climate change policies, being part of “*Policy*” pillar of Sullivan’s framework, and the GHG emissions’, being part of “*Leadership and performance*” pillar of this framework. These two pillars are very likely to be interrelated, as GHG emissions reduction is expected to be a result of climate change policy effective implementation. However, companies that develop a climate change policy may not necessarily be those that are more performant in terms of GHG emissions reduction. Similarly, companies that have relatively low emissions, are not necessarily the ones that have developed climate-related policies. For this reason, we will test for the presence of this relationship in our analysis, as well as for other internal and external determinants of GHG emissions of oil and gas companies.

2.2 Oil and gas companies’ climate change strategies

Initially, the O&G sector was very reluctant about climate change and to the reduction of their carbon emissions (Kolk and Levy, 2001; Kolk et al., 2005). As time passed, many of them have developed different strategies to tackle climate change. These strategies vary from emission reduction goals in O&G operations to a radical leave of oil and gas in favor of clean energy (Erikson, 2015). Energy transition strategies, so a more progressive decline of fossil fuels in favor of renewable energy use, was testified as well (Muttitt et al., 2016). The criteria of classification vary across researchers.

For instance, Levy and Kolk use the matrix of Gladwin and Walter (1980) who addressed the possible strategies of O&G response to climate change by creating a matrix with two dimensions – the level of assertiveness with regards to climate change, distinguishing assertive and unassertive strategic responses, and the level of corporate cooperation with external actors, so the “*cooperative/uncooperative*” dimension (Appendix, Figure 1).

Kolk and Pinkse (2005) have elaborated another classification of possible business responses to CC, where other two dimensions are key – the organization of corporate action with regards to external actors (“*internal, vertical and horizontal types of interaction*”) and their end goal (“*innovation or compensation*”). Innovative strategy, for example, would be based

on continuous improvement of business operations and products promoting environmental innovations, whereas the compensation strategy would be based on purchase of carbon credits (Appendix, Figure 2). The authors give an example of Royal Dutch Shell that, according to this classification, follows the innovative strategy by developing innovations in solar and wind energy.

The heterogeneous character of climate change strategies of O&G companies is analyzed by several other academic researchers as well as by many authors of “grey literature”. For instance, Bazilian et al. (2018) classify the low-carbon strategies of O&G and renewable energy investments into four groups: *“integrating low-carbon technologies into oil and gas production/ expanding beyond oil and gas production/ not engaging in low-carbon investments or emissions reduction/ aiming to lower operational emissions”*¹⁸. This classification is based on such criteria as the extent to which the RE investments are linked to IOC’s (international oil companies) resources and the degree of their commercial diversification. The analysis of IRENA (2021)¹⁹ highlights that some IOCs continue to do business traditionally with predominating role of fossil fuels, while others invest in biofuels, blue hydrogen and natural gas, renewables, and focus on emissions reduction.

The instruments that companies use within the same strategy differ too. According to the IRENA climate strategy assessment, European oil and gas companies differ in the way they are involved in clean energy development. For example, Shell, Total and Eni mostly acquire companies specializing in clean energy, while BP and Equinor tend to directly invest in RE projects. Shell has recently acquired such companies as NewMotion, First Utility and Greenlots. On the contrary, British Petroleum (BP) has joint ventures with renewable energy companies as well as with Chevron and Petroleo Brasileiro. BP has partnerships such as the one with DuPont and NIO Capital and stakes in such renewable energy companies as FreeWire and StoreDot. Differences are observed between European and U.S.-based companies, the latter being less active (ExxonMobil and Chevron) in terms of energy transition. Moreover, ExxonMobil is widely known for its criticism of climate change (Jerving et al., 2015). ExxonMobil, Chevron and Petrobras are considered to be laggards in climate change performance in comparison with Equinor, Royal Dutch Shell, Eni and Total

¹⁸ p.2; “Oil and gas company strategies regarding energy transition”, Schoaeddini et al. (2019)

¹⁹ IRENA, International oil companies and the energy transition, pp.15-18

Energies (J. Pickl, 2019). Additionally, J. Pickl finds out a link between majors' proved oil reserves and their renewable energy use:

*“Fig. 6 illustrates that oil majors with smaller levels of proved oil reserves are moving into the renewable space faster, whereas those companies with large pools of oil reserves are rather choosing the strategy to progress at a more limited speed.”*²⁰

Schojaeddini et al. (2019) expand the analysis by including national oil companies (NOCs). In comparison with international oil companies (IOCs), NOCs tend to delegate the production of renewable energy to the electricity sector (ex. ADNOC and its partner, Masdar). As IRENA indicates, NOCs have a significant advantage over IOCs that could give them a possibility to be leaders in the energy transition – they have access to more resources, namely to capital and qualified professionals (IRENA, 2021). However, the latter statement is questionable because NOCs have progressively become structurally very similar to private companies, which significantly reduces their differentiation in climate change strategies development. The divergence becomes more and more related to the individual characteristics of each company than of a particular group of O&G companies (Kolk, 2002).

For some researchers, the ownership type of companies (so, whether they are private or state-owned) is not the decisive factor of their energy transition potential. For example, membership in OGCI unlocks for its members a high potential to become leaders in energy transition according to Bash (2019). The researcher tries to identify the conditions under which the leadership of OGCI is possible, as well as the styles of this leadership. Firstly, structural leadership, as these companies have large material resources to achieve their decarbonization goals. Additionally, members represent a cognitive type of leadership, since they possess knowledge and ideas of a group of companies, and the entrepreneurial leadership as well since this initiative is organized for the whole industry. So, the benefits of synergy could be essential for leadership positions of OGCI members. Finally, the author lists such macro-level factors motivating O&G to commit into energy transition as pressures from external stakeholders and significant divestments from this industry by such big investment funds as Rockefeller Foundation (RFF, 2020)²¹.

In addition, there are some energy transition strategic trends that can be identified among the O&G sector (Yun Peng et al., 2019). Firstly, to reduce carbon emissions, companies tend to

²⁰ “The renewable energy transition strategies of oil majors – From oil to energy?”, 2019, p.6

²¹ The Rockefeller Foundation Commits to Divesting from Fossil Fuels - The Rockefeller Foundation, 2020.

increase the share of natural gas in their portfolios as it is much less carbon intensive in comparison with coal and oil production, Eni being the company with the highest growth rate of gas production (*“its gas share growth was 34.5% in 2005 and moved to 50.7% in 2017”*).²² Secondly, more and more O&G companies elaborate strategies that are either related to renewable energy businesses acquisition, investing in R&D dedicated to low-carbon technologies, or selling assets with high carbon footprint. Thirdly, as already mentioned, there is an increasingly popular strategy of creating collaborations with peers to benefit from synergy effects. This study completes Jerving’s and Pickl’s findings by noticing that European O&G tends to directly invest in renewables while U.S.-based companies focus more on energy efficiency and emissions’ reduction.

Another trend is that the decarbonization process is often accompanied by the rebranding of O&G companies that change the nomenclature of their brands. For example, Equinor, before being known as Statoil, or Total that went Total Energies (Abraham-Dukuma, 2021). So did DONG-Energy that changed its name to “Orsted” and became the only company that made a complete energy transition from coal, oil and gas to renewable energy, focusing on offshore wind. The author argues that other companies could follow this example by using three main success factors of Orsted’s energy transition strategy: organizational steering, technical leverage and synergies.

The analyses of previous scientific articles were mostly dedicated to leading multinational oil companies with high turnover and large geographical extension which is due to their regular and extensive environmental data published, and probably to the fact that less “powerful” companies do not possess enough resources to react to climate change. Our analysis extends beyond oil majors and thus contributes to a deeper understanding of factors affecting the climate performance and strategy not only of large companies, but also for companies of smaller size. The next section of this thesis is dedicated to the theories existing in this field, explaining the environmental sustainability performance of industries in general, and then for the oil and gas companies in particular. Three theories will be presented – resource-based theory, resource dependence theory and institutional theory, each of them bringing light to the complex universe of environmental sustainability of O&G and allowing us to construct the theoretical framework for the analysis.

²² « International oil companies’ low-carbon strategies: confronting the challenges and opportunities of global energy transition”, p.2, Yun Peng et al. (2019)

2.3 Resource-based theory, resource dependence theory and environmental sustainability

While searching for factors that could directly or indirectly explain the way oil and gas companies would react to climate change issues, several theoretical frameworks appear.

The first theory that is often mentioned in the literature is the resource-based theory. It was elaborated by Barney (1991) and Wernerfelt (1984). The basic fundament of this theory is the explanation of corporate performance by its valuable, rare, inimitable and non-substitutable (VRIN) resources that are acquired by a firm in order to gain competitive advantage. Resources are the means whereby firms accomplish their activities. They are seen as the “*basic constitutive elements out of which firms transform inputs into outputs, or generate services*” or “*productive assets of firms, the means through which activities are accomplished*” (Mathews, 2007)²³. The combination of appropriate resources is the key for a company to formulate and implement a value-creating strategy, that will lead to a competitive advantage, thus improving corporate performance. The resources and capabilities are divided into tangible (physical assets, liquidity, investments in R&D) and intangible (patents, knowledge and experience of employees, human capital resources, reputation). Intangible resources are more likely to meet the VRIN conditions by being less substitutable or imitable than tangible ones, but they are much more difficult to measure and monitor. The concept of dynamic capability²⁴ is also key to the resource-based theory.

In the environmental sustainability literature, this theory has been used since 1990's (Hamdoun, 2020). Sustainability is often referred to the resource-based view as, if the concept of performance is extended to the companies' financial, social and environmental dimensions, then the internal corporate resources play a certain role not only in financial outcomes but also in the way that a company (proactively or reactively) deals with social and environmental issues.

2.3.1 Financial performance, lifecycle, size of a company and environmental sustainability

²³ “Resources and activities are two sides of the same coin: duality of the activities- and resource-based views of strategic management”, p.7, Mathews J.(2007)

²⁴ « *Capability of an organization to purposefully adapt an organization's resource base* » (D.Teece, 1997)

Based on the academic literature about RBV, we conclude that each dimension of corporate performance plays a role in shaping the other two dimensions as well. For instance, the financial performance of a company can be a reason why companies possess enough financial resources to invest in sustainable product development or donate and contribute to any social initiatives. Inversely, environmental performance influences the financial performance by creating new opportunities, attracting customers that care about the environmental aspect of a business and willing to pay a premium for the sustainable component of a product or service (Hamdoun, 2020). Sustainability could be valuable not only for customers but also for investors, suppliers and other key stakeholders. Thus, companies' financial and social performance can potentially impact the environmentally sustainable practices put in place in the company.

For example, the study of Hasan and Habib (2017) is dedicated to the relationship between the company's lifecycle and its commitment to overall sustainability. The researchers use a dynamic-based source view that prove that the evolution of companies in time dimension significantly changes its sustainability involvement by a mediating role of "*slack resources*" that a company starts to possess closer to a maturity stage. Moreover, this relationship can be explained by the fact that the closer the company is to its maturity stage, the more financial resources it has, and the more stable these resources become. The risk of losing the resources may be an important determinant of corporate sustainability, which manifests the willingness to invest in sustainable practices when being more mature. McWilliams and Siegel (2004) also argue that the lifecycle of a company has a significant positive impact on its sustainability involvement.

The size, which also reflects the scope of corporate resource base, plays an important role in sustainability commitment. Yunus et al. (2016) and Elefteriadis and Anagnotsopoulou (2017) have identified that large companies possess organizational and financial capabilities to implement climate-related corporate practices. Jūrate Jaraitė (2012) studied industrial firms in Sweden and concluded larger and more profitable firms tend to be more active in environmental issues resolution. Additionnally, carbon-intensive firms such as oil and gas tend to invest more in environmental protection. The study of Haller and Murphy (2012) confirms the results of Jaraitė: larger, energy-intensive firms and exporters invest more in green technologies. On the contrary, the study of Barabanov, Basnet and J.Walker (2020)

claim that more profitable firm²⁵ tend to make fewer green investments. So, we see that there are no convergent results on this question. The studies of Armaz-Crus (2011) and Lee and Rhee (2007) also confirm the absence of consistency in the studies' results.

Such company-specific factors as companies' history of profitability, location, market assessments, degree of centralization, can be key to green corporate investments (Kolk and Levy, 2002).

Considering the financing of companies and their different ways to get funding to accumulate resources, there are some studies providing evidence that there is a relationship between green corporate investments and access to finance. However, we find this link under-studied in the literature because within the framework of RBV - the access to finance would mean access to resources, so it may be related to the capacity of a firm to grab resources for gaining its competitive advantage.

There is a list of studies dedicated to the relationships between lending conditions and firms' innovation capacity. Especially, this relationship raises concern in case of green technologies because it is still new to the lenders and investors to provide an assessment of risks and potential of such projects (e.g., Equator principles²⁶). Falcone (2018) studied the firm-bank relationship to understand the determinants of the environmental commitment of firms. The results suggest that the longer the credit relationship between the firm and its main bank is, the higher is the probability of the firm to make a green investment. Also, the author found that bigger, older, more profitable and more innovative firms tend to make more green investments.

In summary, we see that there is evidence in favor of existing link between companies' financial resources and their environmental performance. In the next section, we present the previous studies' evidence about the possible impact of corporate human capital characteristics of human capital on environmental sustainability.

2.3.2 Human resources' characteristics and environmental sustainability

Human capital is a company's intangible resource and, as explained by the RBV, more likely to be non-substitutable, and thus, more valuable. The characteristics of human capital within a

²⁵ ROA-based analysis

²⁶ "A financial industry benchmark for determining, assessing and managing environmental and social risk in projects" [Home Page - Equator Principles Association \(equator-principles.com\)](https://www.equator-principles.com/)

company shape the uniqueness of this resource. Any features of the executives, the board of directors, the board of management and the employees may constitute the value-creating resource of a company. These features could be age, education levels, experience, tenure, gender.

In this thesis, the human capital characteristics are assumed to be part of the social dimension of the companies' triple bottom line, which is taken as fundamental in our analysis, and we will treat human capital characteristics as being part of company's social performance. The studies that we refer to in this thesis often apply one theory while explaining the link between corporate human capital features and environmental performance – the resource dependence theory (Pfeffer and Salancik, 1978). This theory has similar postulates as the resource-based view, but instead of possessing the internal resources to get a competitive advantage (RBV's legacy), the resource dependence theory focuses on procurement of external resources as a means to minimize the dependence of a company on other organizations. This theory explains the corporate strategic choices from the perspective of uncertainty avoidance and independency maximization. Key actors for the RDT are board directors, because they possess certain features and skills that are necessary for a company to become independent and occupy strong positions on the market (Hilman et al., 2009). Thus, the board of directors are seen as a key external resource that headhunters search for, not only because directors have advanced knowledge and skills, but also because they provide further access to additional external resources for the company by the network of contacts and connections. In addition, the concept of power is key to this theory.²⁷

That is why, resource dependence theory supports the view that companies need large and diverse boards, in order to maximize the connections with the external environment and get resources, and to have diverse knowledge and expertise presented in the company.

Within the framework of this thesis, we will focus on the relationship between gender diversity and the companies' environmental performance. There is some evidence in the scientific literature showing that gender diversity on board is positively related with corporate environmental performance (Lu and Herremans, 2019). The possible explanation of this relationship for the authors is that gender diversity brings a more "*healthy mix of knowledge*" that allows companies to make decisions about optimal financial and environmental performance combination. Other studies confirming this statement are these of Gabaldon et al.

²⁷ Definition from "Resource dependence theory: a review" (Hillman et al., 2009)

(2015) and Kim and Starks (2016) who go even further and argue that women possess advanced sustainability skills, which is why gender-diverse boards of directors perform better in terms of environmental sustainability. Authors argue that balanced gender board is more likely to have heterogeneity of opinions, and thus is keener to conflictual situations and disagreements, but in the long-term, the decisions taken tend to be more optimal and impactful. Similarly, Nadeem et al. (2020) find that board gender diversity has a significant link with environmental innovation of a firm. This relationship seems to be more “*pronounced*” for less profitable firms and for more environmentally sensitive industries, such as the agricultural, energy, and utilities sectors. The study of Jiang et al. (2017) also explain this relationship with same argumentation – diversity allows different perspectives to bring light on complex environmental issues, thus leading to outperforming environmental outcomes. On the contrary, Daniel Kouloukoui et al. (2019) who studied the link between gender diversity and climate change management of a company, do not find a significant relationship between these two metrics. Some studies made stronger statements and concluded that women are more concerned with meeting stakeholders’ expectations and with community connections (Jain & Zaman, 2019). In general, women tend to be more caring about community issues and nature protection (Carlson, 1972).

Hillman et al (2009) claim that for industries with high environmental impact, the relationship between the gender diversity on board and the environmental performance is stronger than for companies with low environmental impact.

The gender diversity not only affects the general environmental performance but has stronger effect on certain aspects of environmental practices than for others. For instance, He and Jiang (2019), have shown that green innovations are related with women representation on board, more influencing green product innovation than greening the company’s own operations. This could be related to the fact that the presence of women is proof of corporate behavior within the social expectations, forcing them to invest in environmental sustainability as well, the product innovation being more “visible” for external stakeholders, which is in line with Jain & Zaman’s conclusion.

In general, we notice a convergence of the results of studies that investigated the link between gender diversity within a company and environmental performance. In the next section, we explain the criticism that resource-based theory and resource-dependence theory are object to.

2.3.3 Criticism of resource-based view and resource dependency theory

The resource-based view has been objected by some researchers. They often highlight that it makes generalization very challenging (Gibbert, 2006), because it is mostly based on the uniqueness of each company. Connor (2002) argues that RBV can be only applied for firms striving for sustainable competitive advantage, therefore those who are satisfied with their market positions, the RBV does not bring much insight. The meaning of competitive advantage itself in this context has been broadly criticized, some authors considering it as a non-achievable goal (Fiol, 2001) due to its temporary nature. However, this critique is under objection that the short-term competitive advantage has its power in the decision-making process of the firms, even in very uncertain constantly changing environments with high risks that imply regular reviewing of the resource base needed to be mobilized.

The critique that is less likely to be objected than others is the statement that the definition of resources in case of RBV is “axiomatic” and “all-inclusive” and thus problematic, for two reasons. Firstly, “the resource-based view does not sufficiently acknowledge the distinction between those resources that are inputs to the firm and the capabilities that enable the firm to select, deploy, and organize such inputs (especially for the notion of “dynamic capability”). Secondly, “*RBV does not address fundamental differences in how different types of resources may contribute in a different manner to a firm’s SCA*”²⁸ (Kraajenbrink et al., 2010). Tangible and intangible resources are two different types of resources, but RBV treats them in the same way. The same logic can be applied to distinguish the definitions of resources, capabilities and action within this framework. In a nutshell, RBV is lacking clear definitions of its fundamentals.

Additionally, the RBV is quite limited when we take into consideration the external factors that have a significant impact on corporate behavior regarding environmental sustainability, which is also its important drawback. As the resource-based theory evolved, Conner (2001), Hart (1995), Collis and Montgomery (1995) argued that the internal resources of a company cannot be considered separately from external factors. They claim:

“Resources cannot be evaluated in isolation, because their value is determined in the interplay with market forces. A resource that is valuable in a particular industry or at a

²⁸ P.359, “The resource-based view: a review and assessment of its critiques”, Kraajenbrink et al. (2010)
[The Resource-Based View: A Review and Assessment of Its Critiques \(sagepub.com\)](#)

particular time might fail to have the same value in a different industry or chronological context”²⁹.

As for the critiques that were addressed to the resource dependency theory, they converge to a lack of explanation of firms’ performance *per se*. Nienhuser (2008) lists other critics generally addressed to RDT: not sufficient justification of viewing companies as political entities and not as economic systems. The concept of power is closer to political power than economic, but the explanation of corporate behavior from RDT perspective tends to be close to economic power in the literature, which challenges the consistency of this theory’s fundamentals. Also, there is not enough differentiation between economic and political power motives (Donaldson, 1995). Some authors (Tolbert, 1985), according to Nienhuser, argue that resource-dependence theory limits the view of resources only to material ones.

Hillman et al. (2009) argue that integrating the resource-based view and resource-dependency theory would be interesting for further research. On the stage of gaining the resources, the resource-dependency theory would be playing a crucial role, and on the stage of making these resources unique, valuable and inimitable, the resource-based view could bring insight to corporate behavior regarding sustainability.

The next sub-section explains how these theories have been used in order to explain the environmental performance of the oil and gas industry in particular and presents the hypotheses formulated based on the literature reviewed.

2.4 Resource-based theory, resource dependence theory and climate change performance of oil and gas industry

2.4.1 Financial performance of oil and gas companies and climate change performance

IRENA’s analysis (2021) shows that financial health of the main IOCs has an impact on the companies’ commitment to renewables: *“In order to invest more radically in green technology, oil companies would need both the financial capacity to allocate enough money, as well as the willingness to hold back more cash from their investors”*.³⁰

The analysts add that crude oil prices play an important mediating role in the financial health affecting green investments of O&G, especially for upstream integrated companies. As crude

²⁹ P.287, “Competing on resources: Strategy in the 1990’s”, Collis and Montgomery (1995)

³⁰ [IRENA Oil Companies Energy Transition 2021 \(1\).pdf](#), p.28

oil prices have been plummeting in the last years, especially due to the demand decrease during the Covid-19 pandemic, the investments in renewables have consequently declined³¹. Moreover, research shows that returns of oil and gas companies have become more sensitive to oil price volatility (BCG, 2020)³².

Weidermars et al. (2014) indicate that the costs for the extraction of hydrocarbon have increased which also does not make the process of energy transition an easy task for O&G, so that they have a modest resource base for “greening” their operations and products. These authors do not find how exactly financial strength affects the climate change performance of oil and gas, making suggestions for future research.

Brancati (2005), Alessandrini et al. (2010) revealed that the availability of financial resources positively affects green investments and, therefore, triggers environmental innovations. However, because of the information asymmetry between investors and managers existing in some markets, financial institutions tend to be risk-averse and constraint the lending conditions. These lending constraints that financial sector implements, are thus barriers to firms’ green investments and innovations (Ghisetti et al., 2016). The nature of oil and gas companies’ activity complexifies the relationship between access to finance and green innovations. On the one hand, oil and gas companies need resources to invest into renewable energy technologies, so access to finance would be necessary for them to shift to more sustainable energy sources for their operations and products. On the other hand, these companies need to sustain their growth and keep their shareholders satisfied with returns, profit being generated mostly from fossil fuels. This is also done through access to finance, creating tension between short and long-term objectives of oil and gas companies. Because the resources for GI come essentially from revenues generated from fossil fuels commerce, the hypothesis formulation is quite challenging. We formulated the hypotheses based on the RBV assumption that O&G financial resources’ availability would allow for climate change initiatives implementation. Thus, the higher sales growth would potentially guarantee more resources and, consequently, lower GHG emissions. As for the debt, we would assume that debt would create a barrier to resources’ availability because of regular repayment obligations. We will assume that debt is essentially oriented to supporting the fossil fuels-related core business of O&G.

³¹ [How the COVID-19 Pandemic Plunged Global Oil Prices - UNC Global](#)

³² [Oil and Gas Investment in the New Risk Environment | BCG](#)
[The Oil Price Shock\(s\) of 2020 | BCG](#)

Based on the resource-based theory assumptions and findings in the literature, we have set two hypotheses to test whether the financial strength has a significant influence on O&G climate change performance:

Hypothesis 1a: There is a significant negative relationship between the oil and gas company's sales growth and its GHG total emissions

Hypothesis 1b: There is a significant non-linear relationship between the oil and gas company's sales growth and its GHG total emissions

Hypothesis 1c: There is a significant positive relationship between the oil and gas company's leverage and its GHG total emissions

The hypothesis 1b is complementary to the hypothesis 1a, bringing additional information about the nature of the link between sales growth and GHG emissions. The hypothesis 1b is based on the study of Schaltenbrand et al. (2015) found out that firms having attained a certain level of financial stability, like ExxonMobil, do not invest much in green technologies since they do not feel the threat for their financial health in case of non-action with regards to CC. So, this study provides evidence of a non-linear relationship between financial strength of a company and its GI.

2.4.2 Gender diversity within the company and the oil and gas companies' climate change performance

Historically, companies with high environmental impact have been male dominated (Lu and Heremans, 2019). Referring to the above-mentioned previous research about gender diversity on boards and environmental outcomes of companies, there may be indeed a significant impact of gender diversity on board of oil and gas companies and their climate-related performance. “*More environmentally impacting industries generally have a more complex impact on the environment, the availability of a greater diversity of skills that a balanced gender board offers can result in a higher quality of environmental policy (Li et al., 2017).*”³³

The study of Post, Rahman, and McQuillen (2014) with a sample of 36 oil and gas companies in the U.S. for the period 2004–2008, provides evidence that renewable energy alliances play

³³ P.1452, “Board gender diversity and environmental performance: An industries perspective”, Lu and Herremans (2019)

a mediating role in the relationship between gender diversity and environmental performance of these companies.

Overall, the relationship between gender diversity in oil and gas firms and their climate change performance is understudied in the academic literature, that is why we will contribute in the research of this link. Besides the hypothesis about gender diversity on board, we find it relevant to test for gender diversity among executives as well, because the long-term character of climate change strategy and implementation would potentially depend on the c-suite level decision-makers.

Based on the previous research and our reflection, we have developed following hypotheses:

Hypothesis 2a: There is a significant negative relationship between the gender diversity level among executives within oil and gas companies and its GHG total emissions

Hypothesis 2b: There is a significant negative relationship between the oil and gas companies' gender diversity on board and their GHG total emissions

The fact that a certain person within the company is part of a certain group (age, gender, experience, tenure, etc.) does not necessarily mean that this group possesses certain inner characteristics, which could be a strong bias. The explanation behind the pattern observed must be carefully thought. For instance, the fact that this person could be him/herself subject to stereotypes and behave in accordance with a certain stereotype about his/her group, can be a possible explanation. For example, some literature has evidence that young people tend to be more easily attracted by the green human resource management (Chaudhary, 2018), but it does not necessarily mean that young people are more concerned by greening HRM than older people. It could be that this stereotype could work as “self-prophecy” for young personnel, making them obliged to behave in a certain way due to the social expectations. Same warning has to be applied for gender, or tenure, or any other characteristics of the executives, board, management or personnel. While analyzing human capital features, we must pay attention to the existing cognitive biases.

2.4.3 Innovation competency and oil and gas companies' climate change performance

In addition, we have decided to develop another hypothesis that is important for the understanding of the behavior of the oil and gas companies – the relationship between innovations' competency and the climate change performance of O&G. Innovations are key

to foster climate change mitigation and adaptation, creating decarbonization pathways and implementing net-zero plans. Innovation competency of a company constitutes one of the main resources that are not easily imitable because most often, they are confidential and protected by patents (Cao and Chen, 2018). Even if green technologies innovations development is an exploratory pathway that does not necessarily guarantee short-term success (Wicki and Hansen, 2019), we consider that the innovation development in the field of CSR may be negatively related to O&G GHG total emissions. On the contrary, we suppose that general innovation competency of O&G, when it is not CSR-oriented, would have a positive effect on its GHG emissions, because otherwise they will be oriented to the innovations' deployment in the field of fossil fuels as it remains the core business of O&G.

Innovation competency would potentially be a driver of climate-related performance of O&G. Therefore, our next hypotheses are formulated as follows:

Hypothesis 3a: There is a significant negative relationship between oil and gas company's CSR innovation competency and its total GHG emissions

Hypothesis 3b: There is a significant positive relationship between oil and gas company's general innovation competency and its total GHG emissions

2.4.4 Climate change policy effectiveness and oil and gas companies' climate change performance

The additional hypothesis that we consider being important is whether the fact of having elaborated climate change policy would affect the climate change performance of O&G. We will test for the effectiveness of O&G climate change policies elaboration, expecting that companies that have such policies, will have lower GHG emissions. This factor does not directly refer to corporate resources, but more to the capacity to mobilize resources to execute this strategy and follow the roadmap towards low-carbon future. In that sense, this hypothesis is closer related to the above-mentioned concept of dynamic capability (RBV). If this hypothesis is supported, we will consider that having climate change policy contributes to a more efficient resources' mobilization. Climate change policy may represent an important enabler of corporate action. For example, the study of Andreassen Saeverud and Birger

Skjaerseth highlight that there are often deviations from climate change strategies and their implementation. Royal Dutch Shell and BP's different implementation approaches (while having very similar climate change strategies) may be explained by internal organizational barriers of Shell and its lack of consensual decision-making in comparison with BP, explaining why BP is more performant in CCS implementation. This example shows that, indeed, having very similar climate change policies developed, does not mean performing similarly. However, we suppose that having elaborated climate change policies gives a company higher chances to lower its GHG emissions.

Hypothesis 4 : Oil and gas companies having elaborated climate change policies have lower total GHG emissions than those who have not elaborated such a policy

The next section provides an overview of institutional theory, which is often invoked in the sustainability literature.

2.5 Institutional theory

2.5.1 Institutional theory and environmental performance

The institutional theory focuses on external factors that have an impact on companies' environmental sustainability engagement. Ahmed, Mubarlik and Shanbaz (2021) acknowledge that the institutional theory is the most frequently applied when investigating the domain of environmental sustainability. This theory is perceived by researchers as both opposite and complementary to the resource-based theory.

The institutional theory (DiMaggio, Pawell, 1983) claims that any particularity of a corporate behavior with regards to sustainability can be explained by the external pressures the company has to deal with. According to the definition of Bansal and Bogner (2002), institutions are structures and activities that provide stability and meaning to social behavior. Oliver (1996) stated that the institutional theory assumes that the company's choices are influenced by its external environment in a form of social norms and habits.

The benefits of conformity, as well as the penalty of non-conformity to the norms and rules predefined by external actors is a fundamental pillar of this theory. The main benefit of this conformity is social acceptance (Oliver, 1992; Berger and Luckman, 1967). It must be noted that these norms are not necessarily explicit.

On the contrast with the inimitable resources that companies use to have a competitive advantage in the resource-based theory, the institutional theory explains the corporate behavior by the necessity of the firms to imitate each other and respond to external impulses. If RBV considers uniqueness as the ultimate objective driver of sustainability, the IT claims that it is the social acceptance that firms progress search for and this proceed with in sustainable practices. Institutional theory differs from resource dependence theory as well, because the resource dependency theory explains corporate conformity to those entities that are the most important resource holders (government, consumers, investors), but for the institutional argument, it is not enough to explain the corporate legitimacy³⁴ phenomena. From the perspective of the institutional theory, the institutions are taken for granted and do not rely on “*utilitarian*” arguments.

Sustainability is part of the corporate response to these pressures (Bansal and Clelland, 2004, Groen et al, 2009). The concept of isomorphism (coercive, normative, mimetic) is the center of the institutional theory (Chaudhry and Amir, 2020). According to this distinction, coercive pressures are political influence of governments and regulations. Normative pressures stand for existing in the external environment social norms. And mimetic pressures mean pressures occurring when competitors adopt practices, incentivizing others to follow the example.

Some of the authors use a slightly different classification (Scott, 2013)³⁵ – regulative (law requirements), normative (social norms’ requirements) and cognitive (taken-for-granted mental requirements).

Thus, every region, country or community has different expectations in terms of sustainable practices depending on their own context, history and current economic, political, social, environmental and cultural background. Schaltenbrand et al. (2015) found out that when resource scarcity is high, German managers, being culturally risk-averse, invest less in green technologies than U.S. managers, but both managers groups decrease their GI when the resources are scarce.

The same study also shows that in developed countries states privilege environmental policies and define sustainability as based primarily on nature protection practices or climate change. On the contrary, in developing countries the privilege tends to be given to the social aspect of

³⁴ “Legitimacy is defined as a generalized perception or assumption that the actions of an entity are desirable, proper or appropriate” p.2 (Suchmam, 1995)

³⁵ Idem, p.2

sustainability, poverty and human rights. Miska et al. (2018) also find out that cultural aspects play an important role in the deployment of clean technologies. Schneider and de Meyer link the managerial perception of the external environment, of the company and the issue itself with the cultural particularities of each country. The cultural aspect plays a role of a prism through which managers look and interpret the governmental pressures regarding climate change. Even the profit-maximization approach, when decision-makers or influencers need to proceed with the cost/benefit calculations while investigating investment opportunities, is often a result of a conventionally-accepted methodology which is shaped by companies' external environment: *"Managers attempt to make rational calculations of the costs and benefits of various strategies, but these calculations are premised upon assumptions and forecasts that are themselves shaped by interactions with competitors, governments, the media, and other institutions"* (Kolk, 2002).³⁶

Schiedschlag and Yan (2021) argue that the geographical extension and learning from peers play an important role in sustainability strategies adoption. In comparison with other studies that almost all observe a positive relationship between the environmental regulation and the corporate CSR, this study does not confirm this hypothesis. Also, this study proves that the companies that are part of large corporate groups tend to invest more in environmental protection and green technologies.

Authors that also apply the institutional theory in their studies are Zajac, Kraatz and Bresser (2020). They argue that firms, while facing external pressures from institutions, align their resources with the external environment. Other researchers are supporters of this theory too - Meyer and Rowan (1977), North (1990), Matten and Moon (2008), Brammer et al (2012), Delmas and Toffel (2008), Ozen and Kuskü (2009), Zhu (2016).

The findings of the environmental sustainability literature from the IT perspective are converging to a group of external factors that are significant in many studies. The above-mentioned notion of mimetic pressure is often identified as a driver of change towards environmentally sustainable initiatives both in product conception and operations. Coercive pressure is also a significant determinant of low-carbon strategies of firms as it can drive sustainability measures in different forms, for instance, regulatory taxation policy for

³⁶ "Strategic responses to global climate change: conflicting pressures on multinationals in the oil industry", Levy and Kolk, 2002, p. 297

sustainability (Busch and Hoffman, 2008). Shibin (2017) also argues that coercive type of pressure has an impact on firms' sustainability.

Caution has to be taken when we consider macroeconomic external factors, as in some studies (Oliver, 1998) these factors are part of RBV view, because the economic prosperity of countries is often seen as a resource of companies headquartered and operating in this country. In other studies (Eyraud et al., 2013) macroeconomic factors are part of institutional theory. Thus, Eyraud et al. (2013) found out a positive relationship between countries' gross domestic product (GDP), economic growth, oil prices, feed-in tariffs and GI, but the authors admitted that the combination of internal and external factors is still understudied. Eyraud also indicates in his study that the presence of qualified human capital and progress in innovation are drivers to GI which are reflected by such metrics as country-level R&D investments and tertiary education expenditures. Interestingly, the authors notice that firms headquartered in countries with larger populations tend to be more concerned about the environment, and countries with a larger surface are less environmentally conscious.

As for the other country-level factors' investigations, Ward et al. (2016) conclude that the GDP growth is strongly linked with higher energy use and higher consumption and use of raw material, which makes green innovation deployment challenging. On the contrary, Grossman and Kreuger (1995) find a non-linear relationship between countries' GDP and the scale of green investments. There is a critical threshold of aggregated income after which countries start to invest more in GI.

Cultural aspects also play an important role in the deployment of clean technologies (Miska et al., 2018): future orientation, gender egalitarianism, uncertainty avoidance, and power distance practices positively affect environmental sustainability practices. On the contrary, performance orientation negatively affects companies' aspiration for sustainable initiatives. Finally, the study of Wang and Sun (2019) provides evidence that the positive effect of institutional pressures on firms, to reduce their carbon footprint, is stronger for non-state-owned firms than for state-owned firms.

2.5.2 Criticism of institutional theory

One of the most frequently encountered critics of the institutional theory is that this theory failed to explain the heterogeneity across firms. DiMaggio and Powell (1983) highlighted that some dimensions of companies might be very homogenous, while others highly diverse. Also,

this theory does not provide any view of a company-level perspective. Institutional pressures is an image of the input that a company must process and transform and provide a certain output, and this processing and transformation stages are often overlooked.

Boden (1994) argues that there are, indeed, external rules and norms conditioning corporate behavior, but these are only a part of the explanation. The variation of institutions and differences between each other are well explained by the IT, but the variation within one institution is not enough elaborated and the notion of institution itself is seen as excessively static.

2.6 Institutional theory and oil and gas companies' climate change performance

Extractive and manufacturing industries are exposed to more institutional pressures to improve environmental performance (Bansal & Clelland, 2004). Shareholders' pressure on O&G could be a considerable driver to the energy transition of the sector (Abraham-Dukuma, 2021). The author lists examples from other scientific articles showing examples of companies that took measures under the raising pressure of shareholders: Royal Dutch Shell being obliged to decrease its GHG emissions because of shareholder's inquiries, British Petroleum (BP) that disclosing its pathway to meet Paris Agreements Goals, ExxonMobil setting a long-term net-zero emissions goal by 2050. Same pattern is observed for the Thailand oil and gas companies (PTT, Thai Oil Group and Bangchak Petroleum), actively investing in renewable energy projects under regulatory pressures (Chaiyapa et al., 2018).

Canadian oil and gas sector was investigated by Cavalcante et al. (2021) who conducted a logit regression analysis showing that pressures from government, customers, suppliers and competitors increase the likelihood of firms' low-carbon strategy adoption. Also, authors identified that firms' perception of resource-scarcity risks is a significant factor as well.

Another study that explains the sustainability commitment of firms from the institutional theory perspective is done by Jaber and Oftedal (2020) who investigated the internal legitimacy³⁷ of sustainability and argued that two pillars have a significant impact on sustainability practices' legitimization in oil and gas companies: the regulative and normative. The cognitive pillar is not so impactful. The authors see legitimacy as a major catalyst of

³⁷ Drori and Honig definition of internal legitimacy: "...the acceptance or normative validation of an organizational strategy through the consensus of its participants, which acts as a tool that reinforces organizational practices and mobilizes organizational members around a common ethical, strategic and ideological vision". p.347, "A process Model of internal and external legitimacy" (Drori and Honig, 2013)

green innovation deployment. The results of this study support the “top-down” approach, the regular pillar being essential in legitimizing sustainability. This study confirms the research of Shibin (2020) who suggested coercive pressures are the main driver of corporate sustainable practices in general. This is evidence that O&G industry reacts to coercive pressures similarly to other industries.

A question of the scope and the geographical extension of institutional pressures is important. There is some evidence that the home countries’ institutional pressures are no longer so impactful for oil and gas companies as before. Kolk (2002) highlights that initially, the pre-existing context of O&G strongly influenced their heterogeneous reactions to climate change. As “the issue matured” and despite that multinational companies still concentrate their senior management in the country of origin, they got decoupled from “*domestic roots*” and became more independent of their initial local context. Their strategies started to converge and be more dependent on the pressure that is generated by a common industry-level field. This extension is well reflected in their collaborative initiatives, strategic joint ventures and alliances. Progressively, this industry-based convergence of O&G, according to Kolk, creates cognitive, normative, and regulative pressures pushing companies to homogeneity in their climate-related actions. In addition, the nature of oil and gas products that are commodities, makes them more exposed to the compliance with international and global regulations and norms, more than national standards. Commodities are more than other products subject to geopolitical conflicting pressures, which makes the international context hypothetically more influential for these companies. Moreover, climate change is a global issue, and the idea the international scope of institutional pressures is even more reinforced by the obligation of all the countries to act in a convergent way in order to prevent climate change, making international pressures more accentuated than the national context.

Despite the progressive broadening of the horizons of oil and gas companies, for many authors home-country cultural and regulatory features, remains impactful to some extent. Kolk observed that European multinational oil companies were more proactive in their climate-related actions than the U.S. companies, and this is for the reason of the security of oil exploration that in Europe is under heavy taxation, while in the U.S. it is supported by government subsidies which does not create much incentive for O&G to switch to greener technologies. Moreover, European consumers are more exigent in terms of environmental compliance than U.S. consumers, therefore oil and gas companies in Europe feel more value in improving their image and reputation.

But overall, the global trade of oil and gas, according to the author, makes the sustainability practices less dependent on the economic level of their home country as they can always use the potential of their subsidiaries situated in more prosperous countries. The institutional dominance of home countries decreases, while the institutional pressure of industry regulations increases, as Kolk highlights that competition in this industry make O&G companies more and more sensitive to each others' behavior.

Things are more complicated with regulations in case of O&G than for other industries. Powerful multinationals, as they have large resources, can themselves impact governments and environmental regulations, as a group of them already did in the past, their denial took different forms from lobbying to financing media campaigns to spread the denial across the society. So, governments can shape their behavior but inversely, oil and gas companies can influence governments and other institutions' pressure.

We suppose that despite the existing evidence about the decreasing impact of home countries, the local pressures are still important determinants of oil and gas companies climate change performance.

Referring to the previous literature findings from the institutional theory perspective, we have formulated the following hypotheses:

Hypothesis 5a: There is a significant negative relationship between the institutional strength of oil and gas companies' home countries, and these companies' GHG total emissions

Hypothesis 5b: There is a significant negative relationship between the energy transition regulatory commitment of oil and gas companies' home countries, and these companies' GHG total emissions

The group of hypotheses 5a and 5b stands for the coercive pressures' importance respectively. The institutional strength as well the regulatory commitment of oil and gas companies' home countries indicate the countries' coercive pressures exerted on the O&G sector with regards to energy transition. We expect that these pressures are negatively related with corporate GHG total emissions of this industry.

The next group of hypotheses will be standing for the normative pressures potentially exerted on oil and gas companies in their home countries' local cultural environment.

Hypothesis 6a: There is a significant negative relationship between the cultural long-term orientation of oil and gas companies' home countries, and these companies' GHG total emissions

Hypothesis 6b: There is a significant positive relationship between the cultural uncertainty avoidance of oil and gas companies' home countries, and these companies' GHG total emissions

Cultural long-term orientation would potentially be an incentive for O&G greening operations and products, leading to the emissions' reduction, as climate change initiatives are long-term oriented actions. In addition, we assume that for the O&G industry climate change mitigation and adaptation imply high risk decisions and uncertain outcomes, and if the culture of these companies' is more risk-averse, there will be less pressure for change, and thus for emissions' reduction initiatives. O&G companies that are headquartered in countries with high uncertainty avoidance, will be potentially more conservative and not proceed with environmental sustainability practices.

The hypothesis that we will test for the presence of the link between mimetic pressures on oil and gas climate-related performance would be the following:

Hypothesis 7: Oil and gas companies that are members of Oil and Gas Climate Initiative have higher climate-related performance than their comparable non-member counterparts

The membership in such partnerships as OGCI, in our view, could exert additional pressure on its members, which would push the OGCI laggards to follow the leaders and create convergent climate change strategies, thus having convergent climate change performance. As for the non-members, we expect that their climate change performance will be lower and the gap between the leaders and laggards will be increasing with time.

Last but not least, we will test for correlation presence between the oil and gas reserves of companies and their GHG emissions. Pickl (2019) has identifies a correlation between oil proved reserves and O&G activity in renewable energy, and our hypothesis will complete this finding.

Hypothesis 8: There is a positive correlation between integrated O&G companies' combined oil and gas reserves, and their GHG total emissions

2.7 Integration of institutional theory, resource-based view and resource-dependency theory

The need to integrate the institutional and the resource-based theories, thus compensating for their drawbacks and reinforcing their strengths was explained by Oliver (1996). The idea behind this suggestion was that both theories, when considered separately, fail considering other dimensions impacting corporate environmental sustainability commitment. The institutional theory suggests that, even if the resources a firm has accumulated are inimitable and “highly productive”, without political support they will be less valuable. Inversely, the RBV view is limited to internal firms’ factors consideration, losing from its view the external forces fostering environmental commitment.

The dynamics of firms’ competition can be framed by RBV which increases heterogeneity, while firms’ common purpose can be framed by IT which, on the contrary, reduces heterogeneity by putting in place support schemes and standards that need to be respected in order to achieve sustainability goals. These two theories can be complementary, even if they have opposite implications for firms (convergence in IT and divergence in RBV). The model proposed by Oliver (1997) is the combination of RBV and IT, as the author highlights: “*The firms’ ability to generate rents from resources and capabilities will depend primarily on the firm’s effectiveness in managing the social context of these resources*”³⁸. Indeed, corporate resources and capabilities, as well as the ability to mobilize these resources in a certain way, never exist outside the social context. The external environment ensures the access of a firm to a certain type of resources and guarantees the ability to multiply these resources. Inversely, even if the conditions for sustainability deployment are put in place by the social context, if a company is not able to get the resources and transform them to VRIN resources, it will be a barrier for sustainability to happen. This is where the resource-dependency theory comes into play, as it explains the way how the board of directors help to gain these resources, “extracting” them from external environment and transforming them into value.

The integration of these three complementary views implies that each of them would come into force at separate stages of corporate actions towards sustainability goals achievement. The external environment in a form of institutions create incentives for companies to get resources that would have a positive environmental impact or impose constraints that would

³⁸ P.711, “Sustainable competitive advantage: combining institutional and resource-based views”, Oliver (1997)

limit the negative externalities of their activities (institutional theory). Companies willing to minimize their resource dependency and uncertainty, would act to gain these resources in a form of connections, tangible and intangible assets, knowledge and experience (resource dependence theory). They will get this strong resource base and transform it valuable, rare, inimitable and non-substitutable resources, in order to create a competitive advantage and get power on the market (resource-based view). The challenge is to explain both the convergent institutional forces that enable firms to act in a similar manner, and the divergent resource-based forces that hinder firms from uniformization. The interaction of these dialectic forces needs deeper understanding.

The moderate effect of general external business environment between the impact of organizational resources and capabilities on proactive environmental strategy was highlighted by Arragon-Correa and Sharma (2003). Lopez-Gamero and Molina-Azorin (2009) also confirm the complementarity of these two theories, as well as Kang and He (2018) who conclude in their study that environmental innovation capacity of firms has a positive moderating effect on the relationship between institutional forces and environmental commitment.

The role of managers and the board of directors is often a challenging question from this perspective. Some authors perceive them as a resource, and some propose to consider them as an intermediary actor between institutional external factors and internal factors of low-carbon strategies and performance. For instance, Hamdoun (2020) proposed a theoretical framework of environmental engagement of firms, and the manager's role is not perceived by the author as a resource of a company, but more as a separate factor, so is the size of the firm (Appendix 3). On the contrary, Tonsinet (2015), uses the concept of environmental management system implementation, which depends on internal and external factors and, in its term, influences the environmental and financial performance of a company. Appendix 4 describes the theoretical framework elaborated by the author, and, in comparison with the previous study, management is perceived as part of the resource base of companies. Overall, the author considers that both internal and external factors should be considered.

Some of the studies not only consider both groups of factors but look at the interactive effects that each of these groups could have on the sustainability. Menguc, Auh and Ozanne (2009) investigated the interactive effect of internal and external factors to the environmental strategy of corporations, constructing a model where external factors play a moderating role in the

internally elaborated strategies and that the elaboration of a proactive environmental strategy would be idiosyncratic, meaning that the top management, when having external pressure in form of environmental policies issued by the state, will make choices based on their own knowledge, their experience, their views and understanding of these issues. The results of their study suggest that environmental regulations and consumers' pressure plays an important mediating role between the internal factors and corporate environmental strategies.

Similarly, in the study of Hart extends the resource-based theory where the author develops an idea that those resources can become valuable only if they respond to stakeholders' expectations. Russo and Fouts (1997) consider that the resource base and the capabilities of firms will depend on the way they react to environmental policies – they will choose between the compliance strategy or the strategy beyond compliance. The authors argue that compliance only requires physical assets to be modified, while going beyond compliance requires the mobilization of intangible resources (human resources, R&D, marketing, reputation), giving the firm a real competitive advantage based on advanced knowledge.

Luis Fernando Escobar and Harrie Vredenburg (2010) investigated the behavior of multinational oil and gas companies regarding sustainability practices affected by both internal and external factors, using both the postulates of the institutional (particularly, mimetic isomorphism) and resource-based theory. In this study the authors argue why it is quite unlikely to privilege such responses to pressures as coercive, normative or mimetic isomorphism. Firstly, there is lack of regulations. Secondly, oil and gas companies massively operate in less developed countries that do not have enough infrastructure or resources to put in place these actions and regulations. Moreover, there exists a high level of heterogeneity of demand and of sustainability understanding in different countries where subsidiaries are located. In addition, no evidence of positive financial outcome of sustainable business strategies exists (no reason for laggards to follow the leaders such as BP or Royal Dutch Shell). Imitating business strategies (*“green consumerism, reduced legal liability, reduced cost, and reduced risk exposure”*) that possibly lead to competitiveness on the market, is not yet something certain for the competitors to realize. So, the authors argue that multinational oil and gas companies, by reason of lack of concrete financial positive outcomes of implementing sustainability strategies, hesitate a lot to follow their sustainability-oriented competitors, thus forming different strategic groups.

The integration of these theories and taking into account both internal and external factors is the main reason why we have developed hypotheses both for internal and external potential determinants. Verifying for only internal or external factors would give a limited image of these relationships.

Our theoretical model, which will be our support for the methodology elaboration, is presented in the following Figures. Figure 1 explains the integration of resource-based, resource-dependency and institutional theories, where the external environment influences the financial, social and environmental performance of companies, thus shaping the triple bottom line. At the same time, the internal environment includes important factors that shape these three pillars of corporate performance as well, which is represented by the bidirectional arrows. These three performance pillars are interrelated with each other, and with the external environment. They are related with each other because each of them separately represents a valuable resource for the development of the other two. It is important to highlight that the boundaries of “Resources” are framed by dotted line, meaning that the financial, social and environmental performance can be resources for firms’ competitive advantage acquisition.

Figure 2 represents the visual support for the formulated hypotheses and the scheme of hypothetical cause and effect relations and correlations between the external and internal environment factors and oil and gas GHG emissions/climate change policy. We did not present any mediating relations between internal and external factors, focusing only direct impacts in order to understand whether internal or external factors are significant and to what extent. We have included factors that are control variables which will be described in the following sections of the thesis.

Figure 1. Theoretical model of institutional, resource-based and resource-dependence theory integration

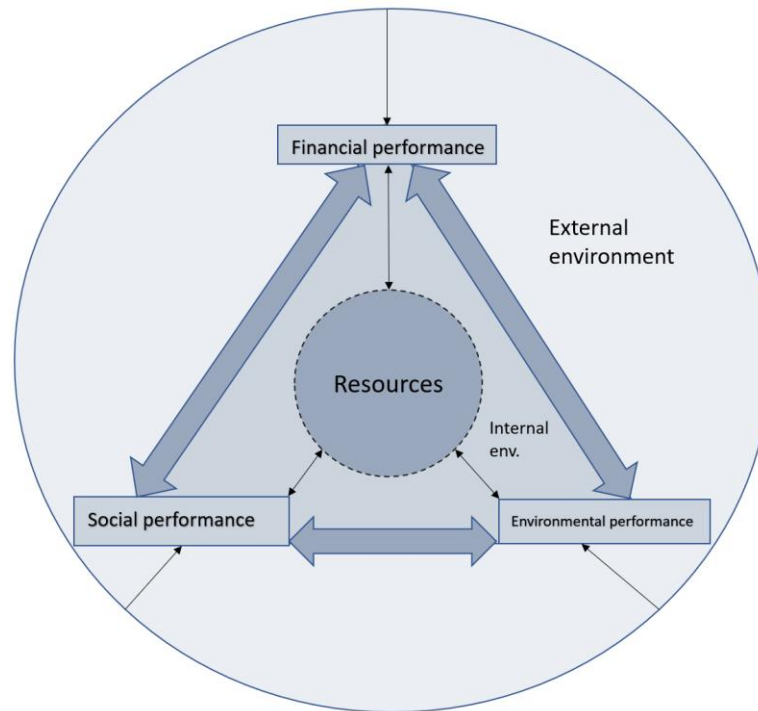
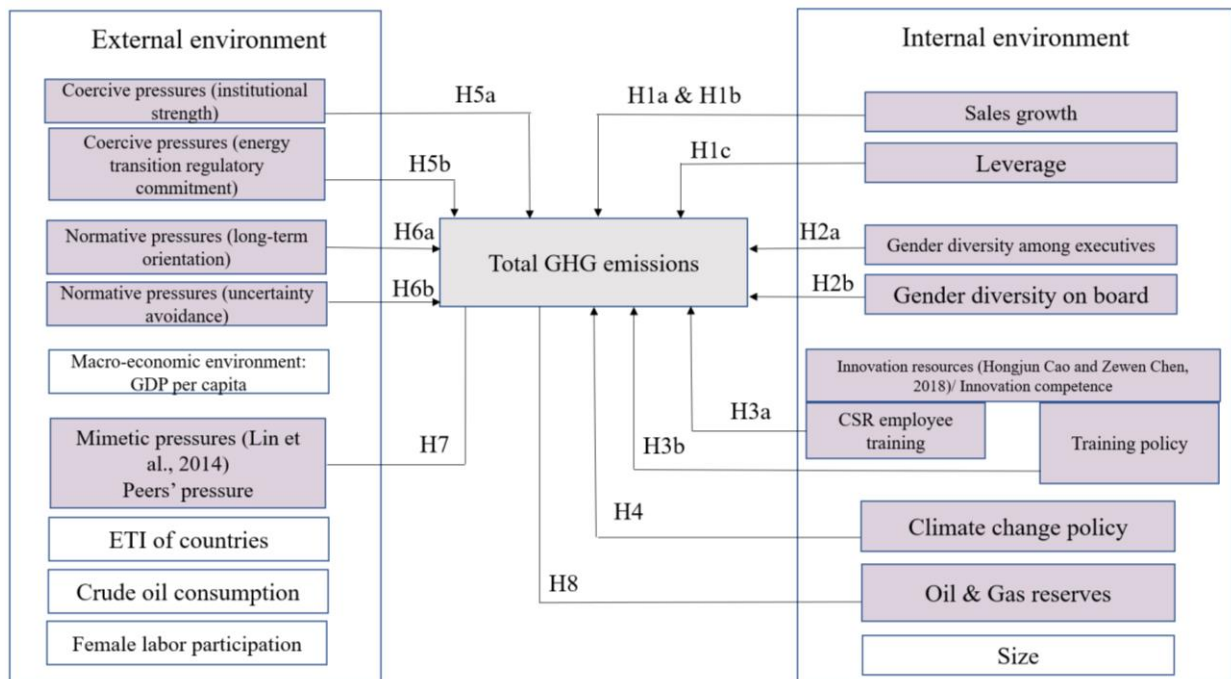


Figure 2. Graphical representation of hypotheses



In the next sections we will describe the data collected for the analysis and the variables we have chosen to test our hypotheses.

3 Data

3.1 Data collection

Our data consists of panel data set for the period of 2019-2021 for 243 companies³⁹. The main criteria for the choice of companies and period were the availability of data and the relevance of independent and dependent variables for these companies.

Bloomberg is the main source for gathering the company-level data. The initial criteria for companies' selection to construct our sample were restrictive, targeting companies from Eastern and Western Europe.

Having faced data unavailability issues, we decided to relax the selection criteria for the regions, instead of targeting only Europe, we widened the sample to all the countries for which environmental, social and financial performance data was available.

The list of companies is presented in the Appendix and consists of 240 companies registered in different regions and operating in different value chain positions. Considering the character and the main functionality of Bloomberg, financial performance data was the most accessible.

The sample consists of companies registered in Europe, Middle East, Africa, Asia, North and Latin America regions. Often the data was limited for the year 2021. The sources of information that we have referred to were Bloomberg ESG, Bloomberg Intelligence, World Bank data, World Economic Forum and Hofstede Insights website. All the countries' governments included in our sample have signed the Paris Agreement, thus announcing their engagement to global climate goals, which gives us the right to compare them. However, the U.S. announced its withdrawal from the Paris Agreement in 2017⁴⁰ and rejoined it in 2021⁴¹. This change might have impacted the oil and gas industry in the U.S. regarding their efforts to reduce emissions, that is why we conduct firstly an analysis including U.S., and then an analysis for non-US countries.

³⁹ The econometric models will often contain less groups, depending on the availability of data for each variable

⁴⁰ BBC, "Climate change: US formally withdraws from Paris Agreement" Matt McGrath, 2020

[Climate change: US formally withdraws from Paris agreement - BBC News](#)

⁴¹ [Paris Climate Agreement | The White House \(archive.org\)](#)

3.2 Choice of variables for the regression analysis

3.2.1 *Dependent variables description*

GHG emissions:

Greenhouse gas emissions (GHG) is one of the most frequently used KPIs for climate change performance within companies. For example, Taylor, Layurova, Vogel and Slocum (2019) prefer using cumulative emissions for the robustness of climate models. Munir Ahmad et al. (2017) consider greenhouse gas, flaring gas, routine flaring and flaring intensity are essential environmental indicators for oil and gas companies.

Scope 1, 2, 3 and sometimes even 4 (for avoided emissions) are used as carbon footprint measures. Energy consumption shows the energy intensity of a business, so when monitoring this indicator, firms can decide how to reduce energy consumption at different levels of the value chain. The investment in alternative sources of energy is a way to know how companies differentiate their energy mix in the operations and in product development in case of utilities, energy companies and O&G.

The climate change KPIs that, for instance, Repsol uses⁴² total GHG emissions, Scope 1, 2 and 3 emissions, hydrocarbons flared, GHG emissions by source, energy consumption (in millions of GJ), renewable energy capacity (GW), GHG intensity (tons of CO₂ per tons of crude oil processed and tons of CO₂ per thousand boe⁴³ produced, both for refining and exploration and production stages), and methane emissions. Indeed, for the oil and gas industry, methane emissions are very meaningful.

If we take the example of BP, which is considered as a leader in climate-related performance, they have fixed 5 areas of net-zero strategy (e.g. net-zero operations, net-zero in their upstream oil and gas production, net-zero sales, reducing methane, more investment in renewable energy, etc)⁴⁴, each category having its own KPIs. For net-zero operations, BP tracks their Scope 1⁴⁵ and 2⁴⁶ emissions. For net-zero production, they use Scope 3⁴⁷

⁴² Repsol's reports and indicators regarding climate change | Repsol

⁴³ Barrel of oil equivalent

⁴⁴ Sustainability report BP, 2021

⁴⁵ "from running the assets within their operational control boundary" (sustainability report BP, 2021)

emissions as an indicator of progress. The net-zero sales means that BP aims to reduce the carbon intensity of the products sold.

In order to get data on climate-related performance of our sample, we used Bloomberg ESG function. It provides insights for investors interested in responsible investment, so those who, while their analysis, assess the environmental, social and governance performance of companies. ESG Ratings are determined and provided to Bloomberg by SAM, MSCI, Sustainalytics, GRI and SCS. Climate-related KPIs of oil and gas companies that we could collect were total GHG emissions, Scope 1, Scope 2, energy intensity per sales, total energy consumption and climate change strategy. Scope 3 emissions, which is the measure of GHG emissions across the company's value chain, were not available⁴⁶. However, Scope 3 emissions account for more than 88% of total emissions of the sector (IHS Markit), so the lacking data about this type of emissions is a limitation to this thesis.

These KPIs were assessed in order to choose the most relevant dependent variable.

Total GHG emissions to tangible assets is considered as our main dependent variable representing climate-related performance of oil and gas companies. GHG emissions in absolute terms seem, in our view, not enough to compare the companies' performance because we lose the size of their assets, making the comparison between companies problematic. Some of the companies historically have more tangible assets than others, and, if they start making efforts to reduce emissions, not taking into consideration their assets' size, may lead to evaluating this company as not performant enough relatively to companies that have less emissions just because of having less assets. To make oil and gas companies object to fair comparison, we calculated this ratio in the following way:

$$GHG \text{ emissions to tangible assets} = \frac{\text{Total GHG emissions}}{\text{Tangible assets}}$$

⁴⁶ “associated with producing the electricity, heating and cooling that is bought in to run those operations” (Sustainability report BP, 2021)

⁴⁷ In case of BP, it is associated with “the CO2 emissions from the assumed combustion of upstream production of crude oil, natural gas or natural gas liquids (Sustainability report BP, 2021)

⁴⁸ “Scope 3 emissions result from activities from assets not owned or controlled by the reporting organization, but that the organization indirectly impacts within its value chain (EPA). Scope 3 can include emissions from upstream activities like purchased goods & services or downstream emissions from the use of sold products” (ENGIE Impact definition, Value Chain & Scope 3 Emissions | ENGIE Impact)

As for the numerator, Bloomberg measures total GHG emissions “in thousands of metric tons of carbon dioxide equivalent (CO₂), using the location-based method. Greenhouse gases are defined as those gases which contribute to the trapping of heat in the Earth’s atmosphere, including *carbon dioxide, methane, nitrous oxide, and others*. Total GHG emissions as defined in this field, equals the total company Scope 1 and Scope 2. It does not include Scope 3 emissions.”⁴⁹

We also define the components of GHG total emissions (Scope 1 and 2 emissions). Scope 1 emissions mean GHG emissions from owned, direct operations of oil and gas companies. As Bloomberg explains: “Scope 1 emissions are those emitted from the emitted from sources that are *owned or controlled by the reporting entity*. Examples of Direct Emissions include emissions from combustion in owned or controlled boilers, furnaces, vehicles, emissions from chemical production in owned or controlled process equipment.” Scope 2 emissions are indirect emissions from the generation of purchased energy. Bloomberg defines Scope 2 as follows: “Indirect greenhouse gas emissions of the company in thousands of metric tons of carbon dioxide equivalent (CO₂), using the location-based method... Scope 2 emissions are those emitted that are a consequence of the activities of the reporting entity but occur at *sources owned or controlled by another entity*. The principal source of the Indirect Emissions is emissions from purchased electricity, steam, heating, or cooling. These emissions physically occur at the facility where electricity/steam/heating/cooling is generated”.

As for the denominator, tangible assets are measured in millions of dollars (USD), as we converted them in one currency. Tangible assets are the result of the following subtraction according to Bloomberg:

$$\text{Tangible assets} = \text{Total assets} - \text{Total intangible assets}$$

Thus, the dependent variable for climate-related performance will be measured in thousands of metric tons of carbon dioxide equivalent (CO₂) per millions of dollars (USD).

Energy consumption:

Another regression model could also look for energy efficiency performance as a robustness test, would be the energy consumption to tangible assets ratio. Energy consumption is also taken from Bloomberg database and is measured in “megawatt-hours (MWh). Bloomberg

⁴⁹ Bloomberg FLDS function, definition of the metrics

indicates: “This includes energy directly consumed through combustion in owned or controlled boilers, furnaces, vehicles, or through chemical production in owned or controlled equipment. It also includes energy consumed as electricity.” For tangible assets, the calculation and units of measure is identical to the previous dependent variable denominator. Thus, the ratio is measured in MWh per millions of dollars (USD) and calculated as follows:

$$\text{Energy consumption to tangible assets} = \frac{\text{Energy consumption}}{\text{Tangible assets}}$$

In the next section, we will describe the independent variables.

3.2.2 Independent variables description

3.2.2.1 Internal determinants

a) financial performance of oil and gas companies

There are many ways to measure the financial health of a company. Indicators that are often used to represent the financial health of O&G companies are their net profits, the revenue growth, return on assets, profit to revenue ratio, cost reduction, adherence to production plan in percentage and improving delivery performance. When choosing relevant metrics, our goal was to collect those metrics that reflect the financial health of a company and the availability of its financial resources for allocating them into climate change mitigation initiatives.

- The debt-to-equity ratio is the leverage metric that we have chosen for the analysis as it represents the availability of resources of a company, in relation to its equity.

We assume that a higher debt-to-equity ratio means that a company is more leveraged and thus has less available resources to allocate them in sustainability, so is expected to have higher GHG emissions. Usually, a high debt-to-equity means that there are higher risks in companies’ financing its investments with debt. It is measured in percentage and calculated as follows:

$$\text{Debt to equity ratio} = \frac{\text{Total liabilities}}{\text{Total Shareholder's Equity}} * 100$$

- 5-year average revenue growth

The second measure of a company's financial strength is the 5-year average revenue growth, which is useful when assessing the overall medium-term trend of a company. Even though this metric does not take into account the compounding, it is still a frequently used indicator for investors to understand the overall long-term trend.

The annual sales growth rate is calculated as follows:

$$\text{Sales growth rate} = \frac{\text{Current period sales} - \text{prior period sales}}{\text{prior period sales}} * 100$$

For the average sales growth calculation, we simply divide the sum of the sequential sales growth rates by the period, so by the 5 years and multiply by 100 in order to get a percentage.

The 5-year average revenue growth of companies is compared based on the performance of the whole industry and considering the size of it, but in general, the higher is the average sales growth, the better company performs.

b) gender diversity level within oil and gas companies'

(Redha M. Elhuni, Munir Ahmad, 2017) consider key social performance indicators being social investment, preventing corruption in the company, workforce diversity and inclusion, workforce engagement, and workforce training and development. We focused on gender diversity because this metric, in our view, gender diversity and more precisely women's inclusion and participation may contribute to green technologies implementation in the company and enable sustainability transformation.

Diversity and inclusion metrics are part of Bloomberg ESG's social performance pillar, containing measures of gender statistics for the employees, management, board of directors and executives. We have chosen the percentage of women on board and the percentage of female executives as metrics reflecting the diversity level on the higher level of the corporate hierarchy, because climate change strategic decisions are usually taken by decision-makers such as directors and c-suites and less by managers, who are mostly influencers. *The percentage of women on board* is defined by Bloomberg as follows: "Percentage of women on the board of directors, as reported by the company. For Europe, where the company has a supervisory board and a management board, this is the percentage of women on the supervisory board." and *the percentage of women executives*: "Number of female executives, as a percentage of total executives, as of the fiscal year end wherever available, otherwise as

of the date of the latest filing. Executives are as defined by the company, or those individuals that form the company executive committee/board of management committee/board or equivalent”.

c) innovation competency of the company

As for the innovation competency, we consider *employee CSR training* and *general training policy* dummies as relevant proxies. There is strong evidence that companies foster their innovation competency by developing the capabilities of its employees (Hargadon and Sutton, 2000)⁵⁰. General training policy would be a good indicator of companies’ willingness to develop employees’ knowledge and skills, making them more likely to innovate and take initiatives in new solutions’ searching. CSR trainings for employees may impact employees’ willingness to invent new ways to make corporate activities more sustainable, including innovative ways to reduce carbon emissions, to decarbonize operations and to purchase more sustainable electricity, or to use energy in a more efficient way. Such trainings enable employee engagement in sustainability and mobilize their ability to learn and to leverage their ungraded knowledge to drive environmental sustainability. This variable is a dummy and indicates whether the company conducts training courses for employees related to CSR.

We do not take R&D expenditures because they are likely to strongly correlate with corporate assets and sales growth, potentially engendering issues for our regression analysis results.

d) climate change policy dummy variable

“Climate change policy” is defined by Bloomberg as follows: “Indicated whether a company has outlined its intention to help reduce global emissions of the greenhouse gases that cause climate change through its ongoing operations and/or the use of its products and services. Examples might include efforts to reduce Greenhouse Gas (GHG) emissions, efforts to improve energy efficiency, efforts to derive energy from cleaner fuel sources, investment in product development to reduce emissions generated or energy consumed in the use of the company’s products etc.” This metric is retrieved from the companies’ annual or corporate social responsibility reports. Even if the conditions for a company to obtain “1” are quite vague, we consider this metric as important for understanding whether the strategy elaboration differs from implementation in terms of internal or external factors affecting these two sustainability pillars.

⁵⁰ “Building an innovation factory”, Harvard Business Review, pp.157-166

3.2.2.2 External determinants

As all the countries in our sample have signed the Paris Agreement, they all are expected to proceed with a certain energy transition strategy and action. However, their initiatives and performance regarding net-zero goals and low-carbon economies are different. For each type of institutional pressure, we have identified a group of variables likely to impact the climate change performance of O&G companies headquartered in these countries.

a) ETI Index and its decomposition – coercive institutional pressures

Energy transition index⁵¹ of a country is a metric composed of indicators that represent different dimensions: the energy systems performance and their transition readiness. The *system performance* provides an assessment of the energy system overall performance across three key dimensions: access to secure and reliable energy supply, the ability to support economic development and growth, and the environmental sustainability across the energy value chain. The *transition readiness* tracks such enabling dimensions as regulations and political commitment, institutions and governance, infrastructure and innovative business environment, human capital and consumer participation and energy system structure.

The *transition readiness* pillar is interesting for our analysis as the dimensions composing it are closer to the institutional theory main concept of “pressure”. The *system performance* pillar is more related to favorable conditions for low-carbon transformation, but its components do not seem to be close to the concept of institutional pressure, according to the definitions of the previous literature.⁵² The main argument to distinguish between these two aspects is the fact that favorable conditions could be foreseen by countries for decarbonization initiatives, but they do not necessarily play the role of pressure for firms. This is the reason why we present several models, one of them including ETI index as an external independent variable, and the other containing only several components of the ETI index, being epistemologically closer to the institutional theory.

Thus, we need to decompose the ETI index and retrieve the transition readiness dimension in order for us to construct external variables that are consistent with institutional theory. Among

⁵¹ “Fostering effective energy transition”, World Economic Forum (2021)

⁵² “Institutional pressure refers to the force that is exerted on firms within the same field to constrain organizational choices and ensure organizational conformity (Colwell & Joshi, 2013)

all components, we have chosen *transition readiness* indicators – “political and regulatory commitment into energy transition” and “institutions and governance”.

- Political and regulatory commitment will be a variable standing for for coercive institutional pressures. It is a score that includes such metrics as:
 - Regulations to support energy transition, renewable energy deployment and access and commitment to international agreements (60% of the total weight total of the sub-indices)
 - Stable policy (20% of the total weight of the sub-indices)
 - Commitment to international agreements (20% of the total weight of the sub-indices)
- Institutions & Governance will be a variable standing for coercive institutional pressure. It is a score and includes such metrics as:
 - Stable finances (33% of the sub-indices)
 - Rule of law (33% of the sub-indices)
 - Transparency and political stability (33% of the sub-indices)

These two variables will be both showing whether coercive institutional pressures impact climate change performance of oil and gas companies.

c) Cultural differences variables – normative institutional pressures

The culture of countries and regions may be an important determinant of public and private action regarding decarbonization. Cultural norms are normative forces. Hofstede’s cultural dimensions theory is used to track cultural differences that shape the business environments in countries (Hofstede and Hofstede, 1980) and their behavior regarding sustainability. We will use the cultural dimensions that seem to be the more adaptable to the oil and gas companies’ commitment to decarbonization. Uncertainty avoidance and long-term orientation were opted as potential normative pressures:

- Uncertainty avoidance

The *uncertainty avoidance index* considers the extent to which an uncertain situation with unknown outcomes is tolerated in a country. It may be a relevant metric to include in the analysis, which may reflect the O&G willingness to commit to renewable energy sources, low-carbon sources, or green products development, which is for them a certain risk as many O&G specialists have advanced knowledge of fossil fuels exploration, extraction

and/or production, but the experience and expertise in green technologies is lacking. Moreover, they can be risk-averse to green technologies because of the uncertainty of the outcome in terms of generating cash flow at least as high as oil and gas products do.

- Long-term orientation

Long- or short-termism is a dimension that measures to what extent the society focuses on the future while making decisions, and takes into consideration the long-term consequences of a certain action. The long-term orientation of a country is a relevant indicator of its willingness to engage in sustainability. Decarbonization, climate change mitigation and adaptation strategies, green products' development are long-term oriented practices as the impact of these activities is aimed to be impactful not only for current generations but also for future ones. Furthermore, the year 2050 is often a frontier year for net-zero strategies of governmental and corporate commitment.

- d) The pressure of peers – mimetic institutional pressures

For mimetic isomorphism and market pressure for the oil and gas industry, we created a small sample of companies that are members of the Oil and Gas Climate Initiative⁵³, and companies that have similar structure and size, but are not members of this organization. Being a member of this partnership would potentially make their GHG emissions, Scope 1 emissions and energy consumption decrease in comparison to companies that are not part of this partnership. These companies have the opportunity to leverage common knowledge and experience of their peers, imitating the leaders and becoming more engaged in decarbonization. If the companies-members have on average better performance and if the difference between the laggards and leaders tends to decrease with time, we would suppose that there is indeed, a relationship between the membership in OGCI and the climate-related performance. This relationship will not be necessarily causal, but it will bring light on the trend of peer's pressure possible link with GHG emissions and energy efficiency.

⁵³ Not all members are presented due to data availability challenge

OGCI members	Non-member counterparts
BP	Ecopetrol
Chevron	YPF SA
Saudi Aramco	Ecopetrol
Eni	Petroleos Mexicanos
Equinor	Gazprom
Shell	Rosneft
Total Energies	Duke Energy
Exxon Mobil	ConocoPhillips
Sinopec	Petrochina
Petroleo Brasileiro	Petronas Chemicals
Occidental Petroleum	Enbridge

e) Oil and gas combined proved reserves

Bloomberg provides data about total oil and gas combined reserves of integrated companies. This metric is measured in billions of barrels oil equivalent.

3.2.2.3 Control variables:

- Log (number of employees) in O&G companies

Companies' size is expected to influence its energy consumption and GHG emissions. Also, it is likely to have an impact on corporate financial performance, and trainings policy because it represents the availability of corporate resources for such activities. The number of employees is one of the most frequently used indicators for the firm size, that is why we have chosen it to be one of the controls. This variable will be used in logarithmic form.

- Log (crude oil consumption) in home countries of O&G companies

Another control variable could be the demand for oil in a home country which directly impacts the prices of oil and gas, on its turn influencing the profitability of this industry and its further strategic decisions. This control variable will be used in logarithmic form as well. We cannot analyze O&G without looking at oil and gas demand and prices – their role is crucial in this industry and determines many decisions taken by their board of directors, senior management and executives. Oil and gas demand and prices condition their operations, their supply chain, their trade agreements and geographical extension levels. Therefore, we expect the impact of these macroeconomic factors on the climate-related performance of these companies to be strong. For example, during significant oil demand decreases, the risks of

these companies increase, potentially increasing the probability of their search for alternative commodities production and commerce. Their willingness to diversify their product portfolio would increase, opening the path for renewables and green technologies and reducing risks. Moreover, the study of Hartmann et al. (2020) suggest for further research to take this perspective into consideration.

The authors highlight: *“Historically, the most critical strategic decision facing international oil and gas companies was vertical integration (Inkpen and Ramaswamy (2017)). Given the long-term energy transition, horizontal diversification beyond oil and gas into renewable energy now represents a strategic opportunity for the established industry players”*.⁵⁴

Moreover, during oil demand decreases oil companies may want to reduce their costs by partially limiting their activities, and thus decreasing their emissions.

So, if we consider O&G companies' climate change strategy as a means to mitigate business risks related to the oil and gas demand fluctuations, these macroeconomic factors should influence their decision on decarbonization. The variable of crude oil consumption in O&G home countries will be taken as a control variable. It will be also taken in logarithmic form.

- Female to male labor participation in home countries of O&G companies

Other control variables will be the gender equality indices on a country level - a relevant control variable for the gender diversity level within the company. It may be that the impact of gender diversity of the board or among executives is related to the fact that the country is more concerned about gender equality issues on a country-level, making it possible for corporate ecosystem to be more gender diverse, and a country that promotes gender equality could also be concerned on environmental issues, thus exerting pressure on companies to act sustainably. For this reason, we use the variable that calculates a ratio of *female to male labor participation* from the World Bank Gender Statistics.

- Innovative business environment in home countries of O&G companies

Another control variable that we use is the innovative business environment variable, that is one of the scores for Energy Transition Index composition. This variable will control for external innovation environment, related to the innovative competency of oil and gas companies. If there is an impact of innovations level within the oil and gas company on its

⁵⁴ p.880, “Different shades of green: global oil and gas companies and renewable energy” (Hartmann et al., 2021)

climate change performance or strategy, it is possible that the home country of the company creates an innovation-friendly environment and promotes green technologies deployment, and not the internal corporate innovations level will be decisive *per se*. To control for this effect, we use this control variable.

- Log(GDP per capita) of home countries of O&G companies

GDP per capita of countries would be a control variable for the economic development of countries where oil and gas companies are headquartered. It may be that the relationship between the financial performance of these companies and their climate-related performance would be related to the fact that in economically developed countries there are in general more favorable conditions for energy transition, thus making it possible for companies to become greener, develop climate change policies and decrease GHG emissions. This indicator is taken from the World Bank database and will be used in logarithmic form.

- Control variable for time shocks

The year (“Year control”) will also be one of our control variables for time dimension. It is important to take into account time periods, because, for instance, such global issues as Covid-19 pandemic could influence all the companies and make their financial, social and environmental performance fluctuate.

- Human capital in home countries of O&G companies

It is possible that there will be a significant relationship between the cultural variables as uncertainty avoidance or long-term orientation and the climate change performance of O&G. However, the link between the uncertainty avoidance in case of taking the risk of investing in renewable energy, for instance, is related to the fact that the government does not put in place conditions favorable for the creation of new jobs related to renewable energy. It may be that it is not the cultural uncertainty avoidance of home countries that hinders the climate-related initiatives in the O&G companies, but the lacking professionals in the renewable energy field (Eyraud, 2013). This lack of specialists can potentially create the climate-change bad performance and reluctant O&G companies’ attitude towards climate change policies elaboration and implementation. Or, it could be that the specialists of renewable energy are available on the labor market, but the quality of home country-level education is not enough for O&G companies to decarbonize their complex value chains. Thus, we control for this

effect of renewable energy specialists' availability on the country-level. This variable is one of the ETI Index components, and it is a score, including the following metrics:

- Jobs in renewable energy sector (50% of the total weight of the sub-indice)
- Quality of education (50% of the total weight of the sub-indice)

After having described the variables that will be used for the analysis, we will present the descriptive statistics for these variables, the correlation matrix and the sample composition, preparing the field for the methodology.

4. Data description

STATA software was used to provide descriptive statistics, as well as the analyses to test our hypotheses. In Table 1 the number of companies per country are presented. Table 1 and 2 present descriptive statistics of firm-level and country-level data. The availability of the data for the GHG emissions is much lower than for other variables, that is why the regression will drop out the observations of dependent variables that cannot be associated with any value GHG emissions. From the tables 1 and 2 we can notice that the 5-year average sales growth variable's minimum value is -34.813 and maximum value is 1794.13, showing that there is a wide range in the level of O&G sales growth in our sample. Similarly, the debt-to-equity ratio minimum value is 0, and the maximum value is 22500, showing an enormous variation between the lowest and highest ratios of leverage of O&G companies. Overall, we notice that the variation for the internal factors is much higher than for the external ones, which may influence the regression results and we may engender insignificant external variables as a result. For the "Climate change policy" dummy variable, the mean is 0.885 indicating that the majority of O&G companies have elaborated climate change policies. Interestingly, the "training policy" dummy variable has a mean of 0.935, but the "CSR employee training" dummy variable is on average equal to 0.381 which shows that in our sample, a much lower proportion of companies envisage CSR employee trainings, focusing on general training policies development.

Control variables "Crude oil consumption", "GDP per capita" and "Number of employees" will be taken in logarithmic form because their high variation, as their effect could be roughly exaggerated. The descriptive statistics with logarithmic form of these variables are presented on the table 2. Table 3 shows the sample composition by country. As may be noted, the

highest number of firms located in the U.S., making our dataset unbalanced. This unbalanced distribution could impact the regression results, that is why we will conduct robustness tests with a sample that does not include the U.S. firms. The remaining observations are also unevenly distributed – for example, we have 25 firms located in Canada and 1 firm located in Argentina.

Table 1. Descriptive Statistics at firm-level

Variable	Obs	Mean	Std. Dev.	Min	Max
(1) GHG emissions	592	.267	.249	0,001	2.058
(2) Regulations	726	71.699	6.274	39.89	87.06
(3) Institutions	726	71.437	12.496	27.21	89.84
(4) Human capital	726	46.267	8.682	26.2	84.99
(5) Crude oil consumption	726	7363.321	7797.019	0	19423.6
(6) Female labor	726	79.52	11.594	26.5	94.6
(7) Long-term orientations	693	46.216	22.459	13	88
(8) Innovative business	726	106.512	516.271	36.53	70.36
(9) GDP per capita	720	41653.53	23751.15	1359.515	89202.75
(10) Number of employees	620	22325.276	64688.047	43	467000
(11) Female executives	701	13.165	13.03	0	60
(12) Women on board	714	20.166	13.114	0	60
(13) CSR employee training	714	.381	.486	0	1
(14) Training policy	706	.935	.247	0	1
(15) Debt-to-equity	715	128.342	848.147	0	22500
(16) Sales growth	698	20.365	120.211	-34.813	1794.13
(17) Climate change policy	712	.885	.319	0	1
(18) ETI Index	678	64.281	6.197	48.4	78.6

Table 2. Descriptive Statistics at firm-level

Variable	Obs	Mean	Std. Dev.	Min	Max
(1) GHG emissions	592	.267	.249	0,001	2.058
(2) Sales growth	698	20.365	120.211	-34.813	1794.13
(3) Female executives	701	13.165	13.03	0	60
(4) CSR employee training	714	.381	.486	0	1
(5) Training policy	706	.935	.247	0	1
(6) Debt-to-equity	715	128.342	848.147	0	22500
(7) Log(number of employees)	620	8.384	1.831	3.761	13.054
(8) Climate change policy	712	.885	.319	0	1
(9) Women on board	714	20.166	13.114	0	60
(10) Female labor	726	79.52	11.594	26.5	94.6
(11) Log(crude oil)	720	8.01	1.552	4.843	9.874
(12) Innovative business	726	106.512	516.271	36.53	70.36
(13) Human capital	726	46.267	8.682	26.2	84.99
(14) Regulations	726	71.699	6.274	39.89	87.06
(15) Institutions	726	71.437	12.496	27.21	89.84
(16) Long-term orientation	693	46.216	22.459	13	88
(17) Log (GDP)	720	10.344	.912	7.215	11.399
(18) ETI index	678	64.281	6.197	48.4	78.6

The variables (7), (11) and (17) are taken in logarithmic form

Table 3. Sample composition

No	Country name	Obs	No	Country name	Obs
1	Argentina	1	22	Japan	1
2	US	67	23	Malaysia	5
3	Australia	5	24	Mexico	1
4	Austria	1	25	Netherlands	3
5	Brazil	7	26	New Zealand	1
6	Canada	25	27	Norway	12
7	Chile	1	28	Pakistan	1
8	China	20	29	Philippines	2
9	Colombia	2	30	Poland	3
10	Croatia	1	31	Portugal	1
11	Denmark	1	32	Romania	2
12	Finland	1	33	Russia	11
13	France	3	34	Saudi Arabia	1
14	Germany	2	35	Singapore	1
15	Greece	2	36	South Korea	4
16	Hong Kong ^a	12	37	Spain	4
17	Hungary	1	38	Sweden	1
18	India	5	39	Thailand	5
19	Indonesia	1	40	Turkey	3
20	Israel	1	41	UAE ^b	1
21	Italy	1	42	UK	9

^a Hong Kong is a special administrative region of China, but in this thesis we consider it separately – institutional data provided by the World Economic Forum treats this region as being apart

^b United Arab Emirates

The correlation matrix presented on the table 4 shows that there is a very strong correlation⁵⁵ between our control variable $\log(\text{GDP})$ and “Institutions”, a strong correlation between $\log(\text{GDP})$ and ETI index. These correlations are acceptable because $\log(\text{GDP})$ is a control variable for external explanatory variables and strong correlation expected between them. All the other variables are very weakly, weakly or moderately correlated with each other, so the risk of multicollinearity⁵⁶ issues is low.

⁵⁵ We assume that 0 – 0.19 is regarded as very weak correlation, 0.2 – 0.39 as weak, 0.4- 0.59 as moderate, 0.60 – 0.79 as strong and 0.8 – 1 a very strong correlation.

⁵⁶ One of our postestimation robustness tests will be the multicollinearity test.

Table 4. Correlation matrix

Pairwise correlations																	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(1) GHG emissions	1.000																
(2) Sales growth	-0.137*	1.000															
(3) Female executives	-0.030*	-0.064*	1.000														
(4) CSR employee training	-0.045*	-0.056*	-0.068*	1.000													
(5) Training policy	0.017	-0.018	0.110*	0.137*	1.000												
(6) Debt-to-equity	0.091*	-0.005	-0.052*	-0.033*	-0.158*	1.000											
(7) Climate change policy	0.020	-0.209*	0.072*	0.099*	0.197*	-0.011	1.000										
(8) Ln(number of employees)	0.157*	-0.022	-0.033*	0.008	0.300*	-0.069*	0.153*	1.000									
(9) Women board	-0.031*	-0.033*	0.316*	-0.043*	0.012	0.089*	0.083*	-0.044*	1.000								
(10) Female labor	-0.038*	0.025	0.140*	-0.018	-0.118*	0.051*	-0.091*	-0.187*	0.288*	1.000							
(11) Ln(crude oil)	0.073*	0.080*	-0.163*	0.101*	-0.088*	-0.044*	-0.122*	-0.067*	-0.128*	0.089*	1.000						
(12) Innovative business	-0.062*	0.043*	0.034*	-0.020	0.017	0.008	0.025	0.031*	0.058*	0.042*	-0.036*	1.000					
(13) Human capital	-0.034*	0.019	0.055*	0.001	-0.070*	0.010	-0.123*	-0.086*	0.171*	0.423*	0.296*	-0.042*	1.000				
(14) Institutions	-0.096*	-0.023	0.128*	-0.044*	-0.159*	0.061*	-0.099*	-0.261*	0.425*	0.655*	0.217*	-0.004	0.473*	1.000			
(15) Regulations	-0.102*	0.041*	-0.056*	-0.002	-0.038*	0.016	0.025	-0.018	0.245*	0.297*	-0.094*	0.122*	0.232*	0.518*	1.000		
(16) Ln(GDP)	-0.115*	-0.069*	0.074*	-0.063*	-0.164*	0.047*	-0.091*	-0.257*	0.355*	0.679*	0.146*	0.015	0.447*	0.891*	0.400*	1.000	
(17) ETINDE	-0.162*	-0.113*	0.236*	-0.158*	-0.134*	0.092*	-0.016	-0.219*	0.521*	0.548*	-0.215*	0.060*	0.477*	0.653*	0.350*	0.714*	1.000
X																	
*** <i>p</i> <0.01, ** <i>p</i> <0.05, * <i>p</i> <0.1																	

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

5. Methodology

As the literature review indicates, the divergence in climate change performance is more and more related to firm individual specific characteristics (Kolk, 2002). Therefore, we apply models that control for individual-specific effects. To identify the determinants of total GHG emissions of oil and gas companies, we first conduct a two-way fixed effect model, then a random-effect model and proceed with tests that allow to choose the appropriate model for our data. Pooled OLS model is conducted as a complementary model, even if it may have biased and inconsistent estimators (Appendix, table 1). We proceed with post-estimation robustness tests, verifying whether our results have an issue of multicollinearity, whether they hold when modifying the sample group and the dependent variables, and whether external factors are significant, when taken separately. Next, we proceed with the random effect model to verify whether there is a non-linear relationship between sales growth and GHG emissions, by adding a quadratic term of sales growth to the set of our variables. To examine the presence or not of a link between corporate oil and gas reserves and GHG emissions, we do a correlation analysis between these two metrics. Finally, we compare the climate-change-related performance of oil and gas companies that are members of the Oil and Gas Climate Initiative (OGCI), to their structurally similar companies that are not members of this organization. All these analyses allow us to have a wide view on the levers and drivers of climate change corporate commitment and performance.

5.1 Two-way fixed effect model

Panel data not only it allows to identify trends between observations in the sample, but also within them. Panel data provides insights both on the cross-sectional and time-series dimension.

Firstly, we apply the fixed-effect model for our analysis to control for unobserved effects that do not change over time (Heiss, 2016):

$$y_{it} = \beta_0 + \beta_1 x_{it1} + \dots + \beta_k x_{itk} + a_i + u_{it} , \quad t = 1, \dots, T ; \quad i = 1, \dots, n \quad (1)$$

where a_i is the unobserved time-invariant variable. The fixed effect estimator uses average values over time:

$$\bar{y}_i = \beta_0 + \beta_1 \bar{x}_{i1} + \dots + \beta_k \bar{x}_{ik} + \bar{a}_i + \bar{u}_i \quad (2)$$

where $\bar{y}_i$ is the average of y_{it} over time for cross-sectional unit i . Such individual-specific effect is likely to be strongly correlated with the independent variables. That is why the within transformation subtracts these individual averages from the observations, so we subtract the equation (2) from the equation (1):

$$\dot{y}_{it} = y_{it} - \bar{y}_i = \beta_1(x_{it1} - \bar{x}_i) + \dots + \beta_k(x_{itk} - \bar{x}_i) + (u_{it} - \bar{u}_i)^{57},$$

Or

$$\dot{y}_{it} = \beta_1 \dot{x}_{it1} + \dots + \beta_k \dot{x}_{itk} + \dots \ddot{u}_{it}, \quad (3)$$

$$\dot{y}_{it} = \beta_1 \dot{x}_{it1} + \dots + \beta_k \dot{x}_{itk} + \dots \ddot{u}_{it}, \quad (4)$$

where $\dot{x}_{it}$ is the time-demeaned variable.

As for the pooled OLS model, we present the results in Appendix, table 1. Even if this model used both the between and within variation, it ignores the nature of panel data and this is the reason why we do not consider it as relevant for this analysis.

5.2 Two-way fixed effect model equation

For presentational clarity of the fixed effect model, we have composed the following equation:

$$\begin{aligned} Emissions_assets_{ict} = & \beta_0 + \beta_1 Financial_strenght_{ict} + \beta_2 Gender_diversity_{ict} + \beta_3 \\ & Innovation_competency_{ict} + \beta_4 Climate_Change_Policy_{ict} + \beta_5 \psi_{ict} + \\ & \beta_6 Coercive_pressures_{ict} + \beta_7 \zeta_{ict} + \delta_t + \lambda_i + \varepsilon_{ict} \end{aligned} \quad (5)$$

where,

β_0 : the constant term

⁵⁷ The individual affect a_i will drop out because it does not change over time

$Emissions_assets_{ict}$: the dependent variable, represents GHG total emissions per tangible assets for firm i , country c and time t .

$Financial_strenght_{ict}$: a vector of variables “sales growth” and “debt-to-equity”, the 5-year average sales growth of company i in country c at time t , and the debt-to-equity ratio of company i in a country c at time t , respectively.

$Gender_diversity_{ict}$: a vector of variables “female executives” and “women on board”, the percentage of female executives within the company i in country c at time t , and the percentage of women on board of a company i in a country c at time t , respectively.

$Innovation_competency_{ict}$: a vector of dummy variables “CSR employee training” and “Training policy”, a dummy variable for presence of CSR training for employees in a company i in a country c at time t , and a dummy variable for the general training policy presence in a company i , in a country c at time t , respectively.

$Climate_change_policy_{ict}$: a dummy variable for presence of a climate change policy in a company i in country c at time t

ψ_{ict} : a vector of control variables for internal factors, including $Innov_business_{ict}$, $Log(number\ of\ employees)_{ict}$, and $Log(Crude\ oil)_{ict}$ and $Female_labor_{ict}$ in a company i in country c at time t

$Coercive\ pressure_{ict}$: a vector of variables “institutions” and “regulations”, the institutional strength score in a company i in a country c at time t , and regulatory quality with regards to energy transition score in a company i in a country c at time t , respectively.

ψ_{ict} : a vector of control variables for external factors, including “human capital” of a company i in country c at time t , $Log(GDP)_{ict}$, the logarithmic form of “GDP per capita” for a firm i in a country c at time t .

δ_t : time-specific effect, allows to control for common time shocks (i.e. during Covid, the demand for crude oil and oil products decreased for all the companies)

λ_i : firm-specific fixed-effect, allows to control for unobserved invariant factors within firms, so for preexistent differences between them

ε_{ict} : error term

Having presented the empirical model and the equation for the fixed-effect estimator, in the section 5.3 we will provide the empirical results of this model.

5.3 Empirical results of two-way fixed-effect model

We perform a series of fixed-effect model regression to examine which factors affect the total GHG emissions of oil and gas companies. Our first model (Model 1) includes the main internal explanatory factors and the associated control variables. The second model (Model 2) includes only the external factors and the associated control variables. The third model (Model 3) includes both internal and external variables, as well as the respective control variables. The fourth Model (Model 4) replaces the components of ETI index by the ETI index itself. We remove the “*innovative business*” control variable, “human capital”, the “institutions” and “regulations” and replace them by the ETI index to look at the impact of the overall home country’s commitment into energy transition on the GHG emissions of the oil and gas companies. Finally, the fifth model (Model 5) represents the output of fixed-effect regression for only the ETI index. We do not keep the Log(GDP) control variable for these models because the ETI index already includes the economic growth of the home country as one its components. Table 5 shows the results of this series of models.

Table 5. Regression results for total GHG emissions per tangible assets

	GHG emissions to tangible assets (Model 1)	GHG emissions to tangible assets (Model 2)	GHG emissions to tangible assets (Model 3)	GHG emissions to tangible assets (Model 4)	GHG emissions to tangible assets (Model 5)
Sales growth	-0.00145*** (0.000499)		-0.00140*** (0.000513)	-0.00166*** (0.000541)	
Female executives^a	-0.00150* (0.000784)		-0.00131 (0.000817)	-0.00149* (0.000802)	
CSR employee trainings	-0.0269 (0.0281)		-0.0374 (0.0295)	-0.0294 (0.0286)	
Training policy	0.148**** (0.0386)		0.138**** (0.0391)	0.145**** (0.0388)	
Debt-to-equity	0.00000720* (0.00000429)		0.00000697 (0.00000432)	0.00000740* (0.00000436)	
Climate change policy	-0.0639*** (0.0235)		-0.0652*** (0.0236)	-0.0720*** (0.0254)	
Log (number of employees)	-0.0100 (0.0123)		-0.00898 (0.0124)	-0.00845 (0.0125)	
Women on board^b	-0.000435 (0.00104)		-0.000705 (0.00110)	-0.000443 (0.00107)	
Female labor ^c	-0.00505 (0.00316)		-0.00534 (0.00338)	-0.00543* (0.00320)	
Log (Crude_oil) ^d	-0.0858 (0.0590)		-0.110 (0.0750)	-0.0948 (0.0800)	
Innovative business ^e	-0.00000549 (0.00000807)		0.000000386 (0.00000892)		
Human capital ^f		-0.00347* (0.00205)	-0.00199 (0.00251)		
Institutions ^g		-0.0000494 (0.00277)	-0.00195 (0.00319)		
Regulations^h		-0.00165 (0.00207)	-0.00286 (0.00302)		
Log (GDP per capita)		-0.111** (0.0541)	-0.0138 (0.0902)		
ETIINDEX				-0.00307 (0.00376)	0.000503 (0.00329)
Year control	-0.00928 (0.00635)	-0.0117** (0.00499)	-0.0104 (0.00814)	-0.00923 (0.00660)	-0.0148**** (0.00408)
<i>Nⁱ</i>	445	585	439	418	558
<i>R²</i>	0.154	0.068	0.172	0.164	0.037
<i>adj. R²</i>	-0.351	-0.422	-0.344	-0.341	-0.458
<i>AIC</i>	-1208.0	-1616.2	-1187.1	-1121.5	-1513.9

BIC	-1154.8	-1590.0	-1117.7	-1069.0	-1501.0
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Standard errors in parentheses
^{*} $p < 0.1$, ^{**} $p < 0.05$, ^{***} $p < 0.01$, ^{****} $p < 0.001$
^a variable name for the percentage of female executives in the company
^b variable name for the percentage of women on board of directors
^c variable name for female-to-male labor participation on the country-level, control variable
^d variable name for crude oil consumption on the country-level, control variable
^e variable name for the innovative business environment on the country-level, control variable, score
^f variable name for the human capital (jobs related to renewable energy) and consumer participation (level of education of the population) with regards to energy transition, country-level control variable, score
^g variable name for the institutional strength of countries where oil and gas companies are headquartered, score
^h variable name for the regulatory commitment with regards to energy transition on the country-level, score
ⁱ number of observations
the highlighted variables are the explanatory variables related to the hypotheses being tested

There is strong evidence that the sales growth variable has a statistically significant impact on GHG emissions of oil and gas companies at a level of 1% for the models 1, 3 and 4 (p-value < 0.001). The “sales growth” variable’s coefficients are negative, meaning that the higher the sales growth rate is, the lower are the emissions with regards tangible assets. As for the debt-to-equity variable, it is positive and significant at the 10% level for the models 1 and 4, providing weak evidence of positive relationship between leverage ratio and GHG total emissions. These two variables’ significance support the Hypothesis 1a and 1c: corporate financial strength is positively affecting the climate change performance of O&G. Better climate-related performance occurs for firms with stronger financial health, possibly reflecting the resources’ availability.

The female executives' percentage has a significant negative effect on emissions for the Model 1 ($\beta = -0.0015$, p-value < 0.1). The higher is the level of gender diversity among executives, the lower are the GHG emissions. However, this variable is no longer significant when we include the external variables (Model 3). The percentage of women on board variable is not significant for any model. The possible interpretation of this results is that the decisions about emission reduction goals and implementation are often taken by the executives in case of oil and gas industry because it requires strategic c-suite decision-making with long-term oriented actions. Thus, gender diversity has a negative impact on GHG emissions only at the c-suit level.

As for the innovation competency, we find that for the CSR training dummy variable, there is no significance for any model. However, the training policy dummy variable has a 0.1% level significantly positive effect on corporate emissions for O&G for all the models, possibly signaling that the character of trainings is oriented to fossil fuels’ deployment rather than low-

carbon technologies development. Fossil-fuels-oriented trainings lead to innovative activities in carbon-intensive projects, consequently increasing the GHG emissions of O&G with regards to tangible assets.

Climate change policy dummy variable is significant and negative for all the models (p-value < 0.01), this result being in favor of the hypothesis 4. This effect can be explained by the fact that having a climate change policy contributes to efficient resources' mobilization and allocation, leading to GHG emissions reduction.

As for the factors that stand for the institutional theory, no variable is significant for any model. This finding may be related to the relatively low variability of external variables in comparison with internal, as mentioned when analyzing the summary statistics. Also, this finding can be related to the fact that the international context is becoming more and more impactful, local institutions and regulations being less important for O&G climate change performance.

5.4 Random-effect model and equation

In our model, we have two time-invariant cultural variables, that the fixed-effect omits and thus we lose the possibility to test for institutional normative pressures' significance. The model that allows for time-invariant variables inclusion, is the random effect model. The condition of empirical homogenous distribution of fixed effects is respected and the Hausman test that we provided in the end of this sub-section, shows that the random effect model is appropriate. Finally, in order to compare the consistency of the pooled OLS and random effect, we did a Breush-Pagan Lagrange multiplier test which showed that random effects is more relevant for this analysis.

The random effect model is based on time-invariant unobserved effects (a_i) model, identically to the equation 1.

$$y_{it} = \beta_0 + \beta_1 x_{it1} + \dots + \beta_k x_{itk} + a_i + u_{it}, \quad t=1, \dots, T; \quad i=1, \dots, n$$

where a_i is the individual-specific effect and u_{it} is the idiosyncratic error term.

The random effect model assumes that the individual specific effect a_i is not correlated with the independent variables (with regressors x_{itk}) for t , so the $cov(x_{itk}, a_i) = 0$.

However, the a_i and the error term are serially correlated, that is why transformation is needed. Wooldridge (2016, Section 14.2) shows that the GLS transformation leads to a “quasi-demeaned specification”:

$$\dot{y}_{it} = y_{it} - \theta \bar{y}_{it} = \beta_0 + \beta_1 (x_{it1} - \theta \bar{x}_{i1}) + \dots + \beta_k (x_{itk} - \theta \bar{x}_{ik}) + (a_i - \theta \bar{a}_i) + (u_i - \theta \bar{u}_i) , \quad (6)$$

or

$$\dot{y}_{it} = y_{it} - \theta \bar{y}_{it} = \beta_0 + \beta_1 \ddot{x}_{1it} + \dots + \beta_k \ddot{x}_{kit} + \ddot{u}_i \quad (7)$$

Where $\ddot{x}_{itk} = x_{itk} - \theta \bar{x}_{itk}$, so we need to subtract the averages over time from the variables, similarly to fixed-effect model within estimator equation.

The equation for this parameter θ is:

$$\theta = 1 - \sqrt{\frac{\sigma_u^2}{\sigma_u^2 + T\sigma_a^2}} \quad (8)$$

Where σ_u^2 is the variance in the idiosyncratic error term and σ_a^2 is the variance in the individual-specific effect. If θ is closer to 0, then the random effect estimators are closer to pooled OLS model, meaning that the individual-specific effect is not important. When it is closer to 1, the model is closer to fixed effect within estimator.

One of the advantages of the random-effect model is that time-invariant variables can be included. In the fixed effect model, the variables standing for normative pressures such as long-term cultural orientation and uncertainty avoidance, are omitted.

We can apply both of these models, but we need to check which of them is more appropriate. Hausman test is usually done to verify which of the two following hypotheses should be rejected:

H_0 : *there is no correlation between individual specific effects and independent variables, fixed effect and random effect coefficients are not significantly different from each other*

H₁: there is correlation between individual specific effects and independent variables, fixed effect and random effect coefficients are significantly different from each other

Conventionally, the validity of the null hypothesis means that random effect is appropriate.

We find that the null hypothesis that supposes that random effects model is appropriate, cannot be rejected because the p-value of the Hausman test is higher than 5%. Thus, we should select the random effect model, as if the H₀ is not rejected, this model is consistent and more efficient than FE.

The results of the Hausman test are showed in the table 6.

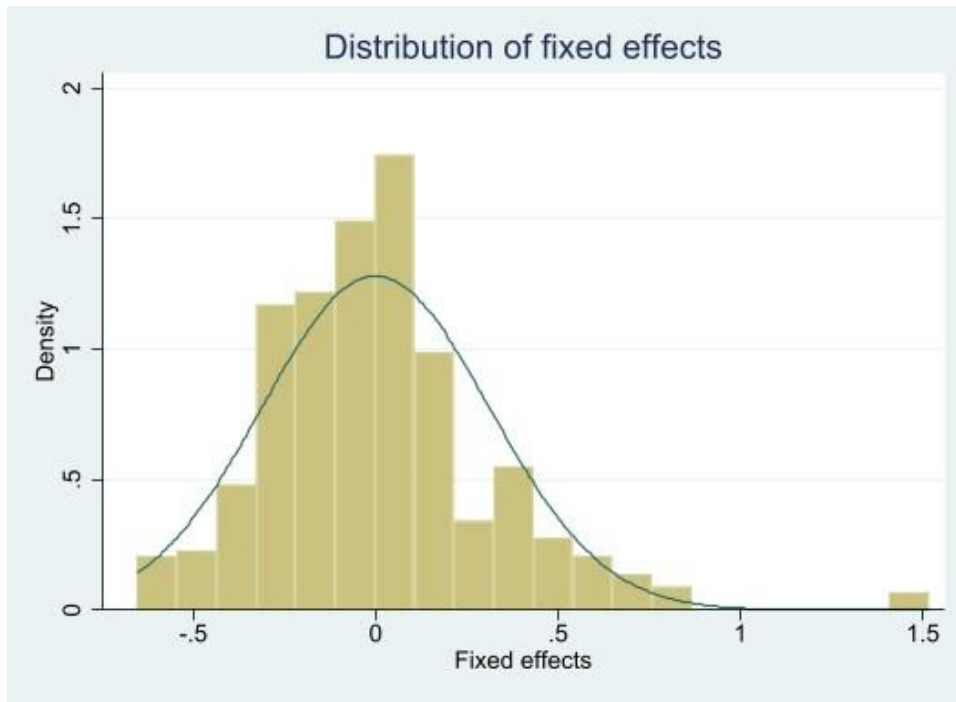
Table 6. Hausman (1978) specification test

	Coef.
Chi-square test value	19.8
P-value	.138

The p-value is equal to 0.138 (higher than 0.05) so we cannot reject the hypothesis that the random-effect model is appropriate, in favor of the alternative hypothesis that the fixed-effect model is appropriate.

Another condition to verify is the empirical homogenous distribution of fixed effects. If the fixed effects are normally distributed, it means that our estimates are efficient, and we can indeed provide a random effect model. This condition is graphically verified in the Figure 3. As may be noted, the fixed effects are indeed close to be normally distributed, only some firms being very different from the others. Thus, we opt for the random effects model in the following analyses and robustness tests.

Figure 3. Distribution of fixed effects



Finally, in order to check for presence of random effects and to know whether we have to reject pooled OLS in favor of random effects model, we have to do a Breush-Pagan Lagrange multiplier test. This test indicated the presence of random effects (the p-value of this test is lower than 1%), so will focus on the random effects model.

Random effect estimator is a weighted average of the pooled OLS and the FE estimator and allows for time-invariant variables to be included in the model. Applying random-effect model would allow to avoid another fixed effect model's drawback – existing random effects are treated as non-random.

As for the equation composed for the random effect model, it is very similar to the equation 5, but we add a vector *Normative_pressures_{ict}* which includes the variables “long-term orientation” and “uncertainty avoidance”. Also, the variable λ_i that represented the firm-specific fixed-effect that allows to control for unobserved invariant factors within firms, will be replaced by the ω_i , which is the unobserved firm-specific random-effect. δ_t is identical to the two-way fixed effect's model time control variable. The equation is transformed as follows:

$$\begin{aligned}
Emissions_assets_{ict} = & \beta_0 + \beta_1 Financial_strenght_{ict} + \beta_2 Gender_diversity_{ict} + \beta_3 \\
& Innovation_competency_{ict} + \beta_4 Climate_Change_Policy_{ict} + \beta_5 \psi_{ict} + \beta_6 Coercive_pressure_{ict} \\
& + \beta_7 Normative_pressure_{ict} + \beta_8 \zeta_{ict} + \delta_t + \omega_i + \varepsilon_{ict}
\end{aligned}$$

(9)

Finally, the random effect model is more efficient than fixed effect model. The results of RE are shown in the table 7 and described in the next chapter.

6. Empirical results

6.1 Empirical results of random effects model

We have conducted 6 Models for the random effect regression. The first three models and the model 6 are very similar to the FE model, the difference is that in the Model 2 and 3, time-invariant variables “long-term orientation” and “uncertainty avoidance” are included. The model 5 includes only these two cultural variables responsible for normative pressures in the home county of an O&G company. The results are presented in the table 7.

Table 7. Random-effect model results

	GHG emissions to tangible assets (Model 1)	GHG emissions to tangible assets (Model 2)	GHG emissions to tangible assets (Model 3)	GHG emissions to tangible assets (Model 4)	GHG emissions to tangible assets (Model 5)	GHG emissions to tangible assets (Model 6)
Sales growth^a	-0.00152**** (0.000406)		-0.00156**** (0.000411)	-0.00172**** (0.000431)		
Female executives^b	-0.00120* (0.000720)		-0.00108 (0.000754)	-0.00111 (0.000747)		
CSR employee training	-0.0372 (0.0238)		-0.0615** (0.0265)	-0.0543** (0.0262)		
Training policy	0.106*** (0.0358)		0.0963*** (0.0360)	0.105*** (0.0359)		
Debt-to-equity	0.00000750* (0.00000427)		0.00000736* (0.00000428)	0.00000772* (0.00000435)		
Climate change policy	-0.0471** (0.0227)		-0.0475** (0.0228)	-0.0583** (0.0246)		
Log (number of employees)	0.00233 (0.00835)		0.00178 (0.00882)	-0.00188 (0.00900)		
Women on board^c	-0.000396 (0.000914)		-0.000801 (0.000988)	-0.000368 (0.000973)		
Female labor ^d	-0.000843 (0.00149)		-0.000256 (0.00196)	0.0000320 (0.00167)		
Log (crude oil) ^e	0.00703 (0.0125)		0.00940 (0.0142)	0.00821 (0.0158)		
Innovative business ^f	-0.00000590 (0.00000800)		-0.000000358 (0.00000858)			
Human capital ^g		-0.00183 (0.00159)	-0.00152 (0.00196)			
Institutions^h		0.00202 (0.00204)	0.00131 (0.00238)			
Regulationsⁱ		-0.00372** (0.00178)	-0.00376* (0.00241)			
Log (GDP per capita)		-0.0321 (0.0285)	-0.0118 (0.0370)			
Long-term orientation		0.00107 (0.000927)	0.00109 (0.00130)	0.000374 (0.00118)	0.000981 (0.000830)	
Uncertainty avoidance		-0.000151 (0.000987)	0.000337 (0.00128)	0.000593 (0.00132)	0.000500 (0.000865)	
ETI Index				-0.00457 (0.00318)		-0.00364* (0.00221)
Year control	-0.00330 (0.00538)	-0.0105** (0.00481)	-0.000531 (0.00632)	-0.00430 (0.00579)	-0.0140**** (0.00395)	-0.0161**** (0.00403)
<i>N</i>	445	555	428	407	561	558
R² (overall)	0.0267	0.0219	0.0567	0.0560	0.0146	0.0286
R (within)	0.1357	0.0537	0.1506	0.1495	0.0323	0.0332
R (between)	0.0209	0.0203	0.0509	0.0490	0.0125	0.0318

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$

^a variable name for the sales growth

^b variable name for the percentage of female executives in the company

^c variable name for the percentage of women on board of directors

^d variable name for female-to-male labor participation on the country-level, control variable

^e variable name for crude oil consumption on the country-level, control variable

^f variable name for the innovative business environment on the country-level, control variable, score

^g variable name for the human capital (jobs related to renewable energy) and consumer participation (level of education of the population) with regards to energy transition, country-level control variable, score

^h variable name for the institutional strength of countries where oil and gas companies are headquartered, score

ⁱ variable name for the regulatory commitment with regards to energy transition on the country-level, score

^j number of observations

the highlighted variables are the explanatory variables related to the hypotheses being tested

The results indicate that the sales growth has a significant negative impact on GHG emissions to tangible assets at a 0.01% significance level for the Model 1, 3 and 4. This result is similar to the FE regression outcome. The higher the sales growth within the oil and gas companies, the lower their total GHG emissions are. The debt-to-equity ratio is significant and positive for all the models. The more a company is leveraged related to its equity, the more GHG emissions it will produce. It is a quite intuitive result, because a higher sales growth and a lower leverage are, according to our assumptions, associated with higher resources' availability to allocate them to greener technologies, consequently leading to emissions' reduction.

Women percentage on board coefficient is not significant for any model, indicating no impact of board gender diversity on GHG emissions. Female executives' percentage coefficient is significant and negatively related to the GHG emissions per tangible assets only in the Model 1 ($\beta = -0.0012$ and $p\text{-value} < 0.1$), demonstrating that a higher diversity among c-suite executive leads to emissions' decrease when we consider only internal factors. For other models, the effect of this variable is not significant.

The presence of CSR training is significant and negatively affects the GHG emissions for the Models 3 and 4, when we include both internal and external factors. However, the presence of general training policy in the company is significant and positive at 0.1% meaning that having foreseen general trainings for employees lead to emissions' increase. This could be an indicator of the nature of trainings and their end goal - they are probably oriented to the fossil fuels' innovations competency development, rather green technologies. These results may indicate that orienting general corporate trainings for employees to CSR could substantially improve oil and gas climate-change performance.

The climate change policy dummy variable is significant at a 5% level and negative, confirming the idea that having a policy dedicated to climate change adaptation, mitigation or resilience would lead to lower GHG emissions than for those companies that do not have any policy.

As for the external variables, the “regulations” variable is statistically significant at a 5% level for the Model 2 and at a 10% level for the Model 3. Its coefficient is negative, meaning that oil and gas companies headquartered in countries with more regulations with regards to energy transition, tend to have lower GHG emissions. Other external institutional variables (institutional strength, and variables responsible for cultural particularities of the O&G firms' home countries) are not significant for any model. When we run the Model 5, including only cultural variables, the outcome indicates no significance. However, for the Model 6, when we run the regression only for the ETI index, its coefficient is significant at 10% level and its impact is negative.

The results of random effect model are similar to those of fixed effect, providing unexpected results about external institutional factors' insignificance, except of regulations with regards to energy transition. However, the results of both fixed and random effects model should be taken with caution as, despite the control variables' inclusion and controlling for company-specific and time-specific effects, we may partially miss out time-invariant unobserved heterogeneity between *countries*. Taking this limitation into account, our results may be not robust enough to reflect the effects of countries' preexisting differences. These unexpected results may be also related to the fact that the institutional scores of “institutions” variable and the cultural factors “uncertainty avoidance” and “long-term orientation” do not vary a lot over time. In addition, there may be endogeneity issues related to the reverse causality. Finally, we did not take into account the international context, which may affect the O&G climate change performance. For instance, the level of internationalization of these companies could be included (Hartmann et al., 2021) as well as the context of *host* countries where O&G companies operate.

If there is no data and variable choice issues, it is possible that the institutional factors do not have an important impact on the GHG emissions with regards to tangible assets. It may be that the implementation and the effectiveness of climate-related initiatives is only conditioned by the internal environment of oil and gas companies, notably the availability of their financial resources, innovation competency, gender diversity among executives and climate

change policy elaboration. Only country-level energy transition regulations seem to be impactful for O&G emissions' reduction.

In the next section, we do several robustness tests to ensure that the outcome of these models is not driven by the choice of the sample or variables.

6.2 Robustness tests

Our models provide expected results for internal factors, and unexpected results for external factors. In order to explore whether there are issues in the choice of the dependent variable or sample composition, we make several robustness tests.

6.2.1 *The Multicollinearity diagnostic of our model*

To detect the multicollinearity issues of our regression, we proceed with the VIF (Variance inflation factor)⁵⁸ test. This test measures the inflation of the regressor's coefficient that is due to the correlation between the regressors. This procedure is done by regressing each independent variable against the other independent variables. The results of this test are shown in table 8. All of our variables' VIF is lower than 10 (see Table 8), which means that there is no much concern about the multicollinearity issues of our regression. The “Institutions” and the logarithmic form of GDP per capita variable have high VIF which indicates that caution has to be taken when interpreting the results of these variables. As the VIF of all our explanatory variables is under 10, we keep all these independent variables in the regression.

⁵⁸ Dodge, Y. (2008). The Concise Encyclopedia of Statistics. Springer.
Everitt, B. S.; Skrondal, A. (2010), The Cambridge Dictionary of Statistics, Cambridge University Press.

Table 8. Diagnostic for multicollinearity of data

Variance inflation factor		
Variable	VIF	1/VIF
Institutions	9.03	.111
Log (GDP per capita)	7.91	.126
Female labor	3.28	.304
Long-term orientation	3.06	0.327
Regulations	2.87	.348
Human capital	1.83	.547
Log (Crude oil)	1.82	.548
Women on board	1.60	.626
Uncertainty avoidance	1.55	.645
Log (number of employees)	1.43	.700
Female executives	1.35	.739
Training policy	1.31	.766
Sales growth	1.19	.839
Innovative business	1.16	.86
CSR employee training	1.16	.865
Year control	1.14	.879
Climate change policy	1.14	.879
Debt-to-equity	1.07	.932
Mean VIF	2.44	

6.2.2 Random-effect models for non-US and US firms

Our analysis may not be robust enough due to the unbalanced character of our data (we have 67 companies from the U.S.). For this reason, we first exclude U.S. firms to provide another model with non-US firms. We use the model that explains the highest percentage of the dependent variable's variation, so with the highest overall R-squared - the model 3 of the random effect regression (table 7), including the external and internal explanatory variables (R-squared = 0.0567). The table 9 provides the results of the random effect model for non-US firms compared to the pooled-OLS outcome and the random effect for the whole sample for easier comparison of the outcomes.

Table 9. Robustness test, random effect model for non-US firms

	Pooled OLS, whole sample (GHG emissions to tangible assets)	Random-effect model, whole sample (GHG emissions to tangible assets)	Random-effect model, non-US (GHG emissions to tangible assets)
Sales growth	-0.00144*** (0.000425)	-0.00156**** (0.000411)	-0.00227**** (0.000496)
Female executives	0.000538 (0.00110)	-0.00108 (0.000754)	-0.00168** (0.000757)
CSR employee training	-0.0712** (0.0270)	-0.0615** (0.0265)	-0.0536* (0.0292)
Training policy	-0.0552 (0.0511)	0.0963*** (0.0360)	-0.0845 (0.0611)
Debt-to-equity	0.0000272** (0.0000115)	0.00000736* (0.00000428)	0.00000759* (0.00000389)
Climate change policy	0.0111 (0.0448)	-0.0475** (0.0228)	0.0376 (0.0326)
Log (number of employees)	0.0182**	0.00178	0.00585
	(0.00769)	(0.00882)	(0.00938)
Women on board	-0.00121 (0.00121)	-0.000801 (0.000988)	-0.000452 (0.00111)
Female labor	0.00224 (0.00187)	-0.000256 (0.00196)	-0.000470 (0.00183)
Log (Crude oil)	0.0191* (0.0101)	0.00940 (0.0142)	-0.00992 (0.0233)
Innovative business	-0.00000539 (0.0000224)	-0.000000358 (0.00000858)	0.00000557 (0.00000810)
Year control	-0.000830 (0.0158)	-0.000531 (0.00632)	-0.00933 (0.00746)
Human capital	-0.00208 (0.00213)	-0.00152 (0.00196)	0.000104 (0.00229)
Institutions	0.00156 (0.00290)	0.00131 (0.00238)	-0.000884 (0.00229)
Regulations	-0.00461 (0.00355)	-0.00376* (0.00241)	-0.00168 (0.00239)
Log (GDP per capita)	-0.0291 (0.0376)	-0.0118 (0.0370)	-0.0121 (0.0374)
Long-term orientation	0.00151 (0.00107)	0.00109 (0.00130)	0.00180 (0.00164)
Uncertainty avoidance	0.000566 (0.000843)	0.000337 (0.00128)	0.000357 (0.00126)
N	428	428	280
R ² (overall)	0.1043	0.0567	0.1121

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$

The results of the regression for non-US companies suggest that the sales growth, female executives' percentage, the dummy for CSR training and the debt-to-equity variables are significant. Sales growth is negatively related to GHG emissions to tangible assets at a significance level of 0.1% which is identical to the random-effect regression with the whole sample. The debt-to-equity ratio variable is less significant than it is in the main regression, but its coefficients' sign is identical.

The CSR employee training variable is negative and significant at 10% level. The training policy dummy variable is not significant, contrary to the whole-sample regression. Climate change policy is not significant in this model, same as the the pooled-OLS result.

Another difference with the whole-sample regression is that the model for non-US firms indicates a significant negative relationship between the female executives' percentage and GHG total emissions (p-value < 0.05), being insignificant for the whole-sample regression. The percentage of women on board is not significant, same result being observed in the whole-sample regression.

As may be noted, the results are partially different for the internal factors. Such internal factors as financial resources' availability (sales growth and debt-to-equity), the innovation competency (CSR training) and the gender diversity among the executives are significant and negatively related to the O&G emissions for the non-US sample. It is possible that the non-US firms' GHG emissions are not sensitive to general trainings for employees and climate policies presence, gender diversity among executives being an important determinant instead.

Both non-US and whole-sample regressions show similar outcomes for external factors (non-significant external institutional variables), and these results are not in line with our hypotheses. Similarly, this outcome could be linked to the fact that external variables do not vary a lot within companies during the 2019-2021 period, or to the fact that the data is not extensive enough to provide more granularity in results. Or, the external factors are indeed not significant for the GHG emissions, showing that the climate-related performance of oil and gas companies is related to their internal characteristics rather than their external pressures. Finally, it is possible that these results would confirm the findings of Kolk (2002), claiming that due to the internationalization process of the oil and gas industry, the local context in form of institutions, regulations and cultural particularities of the home countries may no longer play a significant role in the climate-change performance of these companies.

6.2.3 Test for other dependent variables: Scope 1 emissions and Energy consumption

To know whether our results are conditioned by the choice of the dependent variable, we run two regressions that use Scope 1 emissions and energy consumption of oil and gas companies, instead of GHG total emissions. The Scope 1 emissions variable is one of the components of the GHG total emissions metric and measures company's corporate emissions caused by its own operations. Energy consumption is one of the measures of climate-related performance as well, and more precisely, a measure of corporate energy efficiency initiatives' effectiveness. The outcome of both models is presented in the table 10. It has to be noted that both of these metrics were divided by the tangible assets of O&G companies. So, the units of measure of Scope 1 emissions to tangible assets is thousands of metric tones of carbon dioxide (CO₂) equivalent per million of dollars (USD). The energy consumption to tangible assets is measured in MWh per million of dollars (USD). The table 10 shows the reference model of RE for the whole sample for GHG emissions, Scope 1 and energy consumption.

Table 10. Robustness test, random effect model with Scope 1 and energy consumption

	GHG emissions to tangible assets	Scope 1 emissions ^a to tangible assets	Energy consumption ^b to tangible assets
Sales growth	-0.00156**** (0.000411)	-0.00157**** (0.000415)	-0.00593**** (0.00150)
Female executives	-0.00108 (0.000754)	-0.00124* (0.000683)	-0.00444* (0.00266)
CSR employee training	-0.0615** (0.0265)	-0.0704** (0.0272)	-0.0440 (0.0874)
Training policy	0.0963*** (0.0360)	0.0617* (0.0339)	0.206 (0.136)
Debt-to-equity	0.00000736* (0.00000428)	0.00000107 (0.00000375)	0.0000496**** (0.0000137)
Climate change policy	-0.0475** (0.0228)	-0.0375 (0.0243)	-0.187** (0.0933)
Log (number of employees)	0.00178 (0.00882)	0.00498 (0.00857)	-0.0158 (0.0297)
Women on board	-0.000801 (0.000988)	-0.000583 (0.000904)	0.00522 (0.00324)
Female labor	-0.000256 (0.00196)	0.000527 (0.00182)	0.00191 (0.00654)
Log(Crude oil)	0.00940 (0.0142)	0.0142 (0.0132)	0.0240 (0.0462)
Innovative business	-0.000000358 (0.00000858)	-0.000000390 (0.00000886)	-0.0000183 (0.0000276)
Year control	-0.000531 (0.00632)	-0.00168 (0.00592)	-0.0191 (0.0215)
Human capital	-0.00152 (0.00196)	-0.000956 (0.00181)	0.00725 (0.00645)
Institutions	0.00131 (0.00238)	-0.000576 (0.00220)	-0.00159 (0.00802)
Regulations	-0.00376* (0.00241)	-0.00119 (0.00218)	0.00372 (0.00750)
Log(GDP per capita)	-0.0118 (0.0370)	-0.0287 (0.0349)	0.0123 (0.124)
Uncertainty avoidance	0.00109 (0.00130)	0.000891 (0.00122)	0.00611 (0.00381)
Long-term orientation	0.000337 (0.00128)	0.000118 (0.00126)	-0.0101** (0.00402)
<i>N</i>	428	396	363
R²(overall)	0.0567	0.0890	0.0778
<i>R² (within)</i>	0.1509	0.1405	0.2070
<i>R² (between)</i>	0.0506	0.0935	0.0704

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$

^a “Scope 1 emissions are those emitted from the emitted from sources that are owned or controlled by the reporting entity. Examples of Direct Emissions include emissions from combustion in owned or controlled boilers, furnaces, vehicles, emissions from chemical production in owned or controlled process equipment. Measured in thousands of metric tons of carbon dioxide equivalent (CO₂)” (Bloomberg)

^b “This includes energy directly consumed through combustion in owned or controlled boilers, furnaces, vehicles, or through chemical production in owned or controlled equipment. It also includes energy consumed as electricity. Measured in MWh.” (Bloomberg)

The regression using Scope 1 emissions as dependent variable has similar compared to the GHG total emissions regression results. Sales growth variable is significant at 0.1% level, negatively affecting the Scope 1 emissions of oil and gas companies. However, the debt-to-equity ratio is no longer significant, but the positive sign of the coefficient is held. Female executives’ percentage coefficient is negative and significant a 10% level. Women on board percentage has no significant impact on Scope 1, same as on total GHG emissions.

CSR training and training policy dummies are significant, CSR training for employees being negatively related with Scope 1 emissions ($\beta = -0.0704$, $p\text{-value} < 0.05$), and training policy being positively related with Scope 1 emissions ($\beta = 0.0617$, $p\text{-value} < 0.1$). Climate change policy has no significant impact on Scope 1. Similarly to all the other regressions we applied, the external institutional pressures are not significant for Scope 1 emissions.

In summary, the results show that the sales growth of the O&G, the gender diversity among executives, and the innovation competency play an important role in Scope 1 emissions’ reduction.

As for the energy consumption regression model, the results are similar to the main regression as well, even if the variable represents a different aspect of corporate climate change performance. Sales growth and debt-to-equity variables are significant and confirm our intuition about the availability of financial resources that enable energy consumption reduction, so energy efficiency increase. Female executives’ percentage is negatively related to energy consumption and significant at 10% level. Women on board do not affect energy consumption.

The results indicate that innovation competency is not significant at all for the energy consumption reduction, because neither CSR training nor general training policy are significant.

As for the differences between the two models, the long-term cultural orientation of the home country of oil and gas companies has a negative significant impact on energy consumption (p -value < 0.05). Oil and gas companies that are headquartered in countries with a high level of cultural long-term orientation, are more likely to reduce their energy consumption and contribute to energy efficiency improvement. Other external institutional factors are not significant for this model.

To sum up, the energy consumption depends on O&G financial strength, gender diversity among executives, climate change policy and the long-term orientation of their home country. There is no substantial difference between the results of these regressions, allowing to acknowledge a certain robustness of our results.

6.2.4 Models with external factors exclusively

To verify whether the external factors have an impact on GHG emissions, we take each factor separately and run the random effects model isolated from other factors. We control for time shocks and run 4 series of regressions for each factor. The table 11 presents the regressions results.

Table 11. Random effect model for external institutional factors taken separately

	(1) GHG emissions to tangible assets	(2) GHG emissions to tangible assets	(3) GHG emissions to tangible assets	(4) GHG emissions to tangible assets
Year control	-0.0147**** (0.00380)	-0.0104*** (0.00400)	-0.0140**** (0.00395)	-0.0141**** (0.00395)
Institutions	-0.00187 (0.00118)			
Regulations		-0.00413*** (0.00147)		
Uncertainty avoidance			0.000709 (0.000848)	
Long-term orientation				0.00108 (0.000811)
<i>N</i>	591	591	561	561
<i>R</i> ² (overall)	0.0118	0.0114	0.0059	0.0135

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$

Our findings are the following: the variable “regulations” is significant at a 1% level. The significance of the “regulations” variable was observed in our main random effect model. These findings indicate that the results of RE model are robust enough.

7. Test for a non-linear relationship between sales growth and GHG total emissions

In the literature, evidence exists that there is a non-linear relationship between the corporate resources and the commitment into sustainability practices (Schaltenbrand et al., 2015). This relationship will be tested in this chapter, and we will verify whether there is any non-linear link between the sales growth of O&G companies and their GHG emissions. Firstly, we will add the quadratic term of sales growth in the model with the whole sample (Model 2) and in the model with only non-US companies (Model 4). Model 1 is our reference model of RE for the whole-sample, and the Model 3 is the RE for the non-US firms, so without the quadratic terms. The Hausman test shows that the RE model is appropriate as the p-value is equal to 0.2134 (RE effect is opted), and there are random effects shown by the p-value of the Breush-Pagan Lagrange multiplier (it is lower than 1%), meaning that the RE is more appropriate than the OLS model. The results of these tests are shown in the table 12.

Table 12. Non-linear relationship between sales growth ratio and GHG total emissions

	Whole-sample RE GHG emissions to tangible assets (1)	Whole-sample RE GHG emissions to tangible assets (2)	Non-US companies GHG emissions to tangible assets (3)	Non-US companies GHG emissions to tangible assets (4)
Sales growth	-0.00156**** (0.000411)	-0.00235**** (0.000611)	-0.00227**** (0.000496)	-0.00327**** (0.000712)
Female executives	-0.00108 (0.000754)	-0.000981 (0.000754)	-0.00168** (0.000757)	-0.00158** (0.000753)
CSR employees training	-0.0615** (0.0265)	-0.0619** (0.0265)	-0.0536* (0.0292)	-0.0524* (0.0290)
Training policy	0.0963*** (0.0360)	0.0976*** (0.0359)	-0.0845 (0.0611)	-0.0754 (0.0609)
Debt-to-equity	0.00000736* (0.00000428)	0.00000736* (0.00000426)	0.00000759* (0.00000389)	0.00000757** (0.00000386)
Climate change policy	-0.0475** (0.0228)	-0.0470** (0.0227)	0.0376 (0.0326)	0.0400 (0.0324)
Log(number of employees)	0.00178 (0.00882)	0.00140 (0.00880)	0.00585 (0.00938)	0.00591 (0.00933)
Women on board	-0.000801 (0.000988)	-0.000867 (0.000986)	-0.000452 (0.00111)	-0.000468 (0.00110)
Female labor	-0.000256 (0.00196)	-0.000460 (0.00196)	-0.000470 (0.00183)	-0.000716 (0.00182)
Log(crude oil)	0.00940 (0.0142)	0.0106 (0.0142)	-0.00992 (0.0233)	-0.00611 (0.0233)
Innovative business	-0.000000358 (0.00000858)	-0.00000196 (0.00000860)	0.00000557 (0.00000810)	0.00000338 (0.00000812)
Human capital	-0.00152 (0.00196)	-0.00140 (0.00196)	0.000104 (0.00229)	0.000470 (0.00229)
Institutions	0.00131 (0.00238)	0.00100 (0.00238)	-0.000884 (0.00229)	-0.00122 (0.00228)
Regulations	-0.00376* (0.00241)	-0.00385 (0.00240)	-0.00168 (0.00239)	-0.00178 (0.00237)
Log(GDP)	-0.0118 (0.0370)	-0.00598 (0.0371)	-0.0121 (0.0374)	-0.00430 (0.0374)
Long-term orientation	0.000337 (0.00128)	0.00113 (0.00130)	0.00180 (0.00164)	0.00161 (0.00164)
Uncertainty avoidance	0.00109 (0.00130)	0.0000670 (0.00129)	0.000357 (0.00126)	0.0000435 (0.00127)
Year control	-0.000531 (0.00632)	0.00279 (0.00659)	-0.00933 (0.00746)	-0.00582 (0.00763)
Sales growth²		0.00000665* (0.00000379)		0.00000810* (0.00000418)
<i>N</i>	428	428	280	280
<i>R</i> ² (overall)	0.0567	0.0587	0.1121	0.1212
<i>R</i> ² (within)	0.1509	0.1587	0.1506	0.2685
<i>R</i> (between)	0.0506	0.0524	0.0509	0.1178

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$

The quadratic term is highlighted in blue for a better visibility

The results of this test confirm the presence of a non-linear relationship between sales growth and GHG emissions for both larger and smaller samples. The model 2 does not change the results of the reference model 1, except of the “Regulations” variable, which is no longer significant after adding the quadratic term. We observe a non-linear relationship at a significance level of 10%, showing that initially, the relationship between the sales growth and the GHG emissions is negative, so the higher is the sales growth, the lower the GHG emissions are related to the tangible assets. After reaching a turning point, this relationship becomes positive. This turning point can be calculated by the following formula:

$$Turning\ point = -\frac{\beta}{2a} ,$$

Where a is the coefficient of the quadratic term.

Using this formula, we calculate the turning point for the whole sample model, being equal to 176,7% of the 5-year average sales growth. That is, after reaching 176,7% of sales growth, the relationship between the sales growth and GHG emissions becomes positive.

As for the non-US firms’ sample, the coefficient of the quadratic term is significant at 10% level as well, meaning that, indeed, there is weak evidence of non-linear relationship. The turning point for non-US oil and gas companies’ sample is equal to 201,85% of the 5-year average sales growth. After reaching 201,85% of 5-year average sales growth, the higher is non-US companies’ sales growth, the more they will emit GHG. Other results remain unchanged in comparison with their reference model 3, indicating a certain level of their robustness.

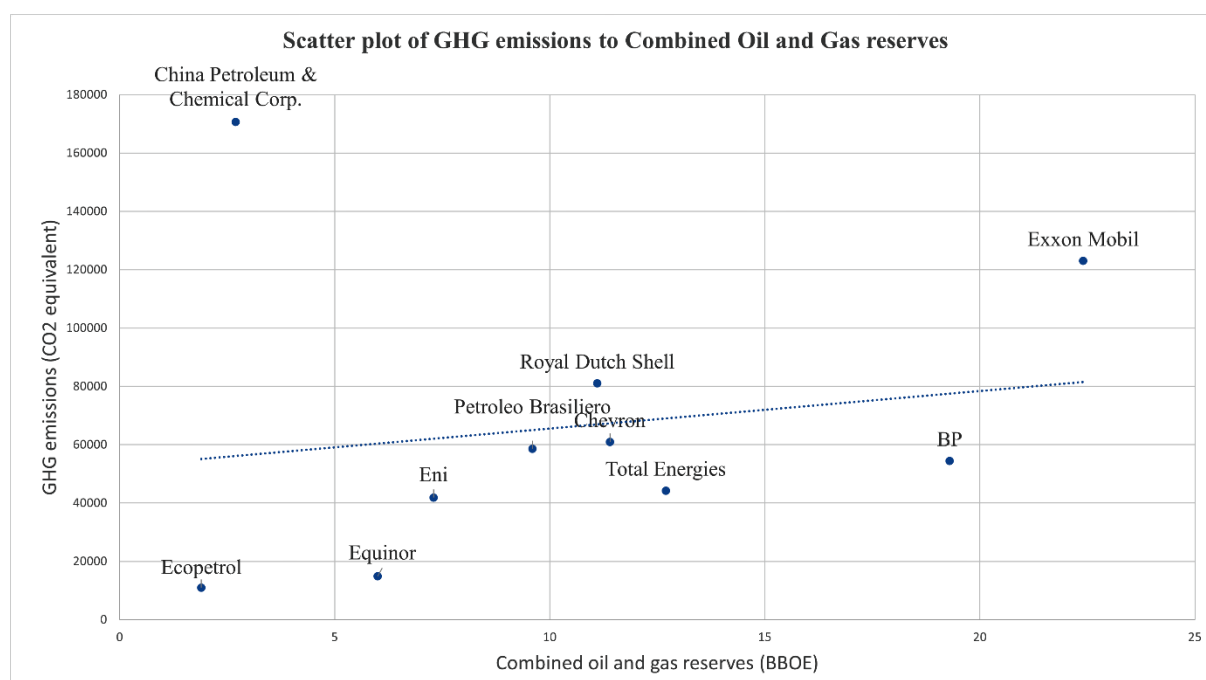
8. Correlation analysis for the link between combined oil and gas reserves and GHG emissions

J.Pickl (2019) verified whether there was any relationship between companies’ oil reserves and its involvement in renewable energy deployment. To complete these findings, we proceed with a very similar type of analysis and provide a correlation scatter plot to see whether oil and gas combined reserves of companies are related to their GHG emissions. Involvement in renewables energy and GHG emissions can be seen as different aspects of the climate change performance. This is quite intuitive that companies holding considerable reserves of oil and gas are less likely to invest in renewable energy, having secured their future.

Bloomberg provided data for some multinational integrated oil and gas companies' combined O&G reserves for the year 2019, measures in BBBOE (billions of barrels of oil equivalent).

When we calculate the correlation coefficient between reserves and GHG emissions with the outlier China Petroleum & Chemical Corporation, it is equal to approximately 0.17 which is not as high. When we drop this outlier, the correlation coefficient is equal to approximately 0.81, which is high enough to deduce that, there is indeed, a positive correlation between the combined oil and gas reserves of these integrated companies and their total GHG emissions. Consequently, higher levels oil and gas proved reserves are associated with higher total emissions. The causality of this relationship is yet to be examined by future research. The visual presentation of this link is shown in the Figure 4, that shows a clear positive correlation and a trend line.

Figure 4. Reserves and GHG emissions scatter plot



9. Comparative analysis for peers' pressure potential presence

To verify whether there is any possible link between the peers' pressure (or mimetic pressure) and the climate-related performance of oil and gas companies, we conduct a comparative analysis between a set of integrated companies that are members of Oil and Gas Climate

Initiative⁵⁹, and their similar⁶⁰ counterparts that are not members of this organization. We compare the average climate-related performance of these two groups (based on their GHG total emissions, Scope 1 emissions and energy consumption) for the year 2021. Then, we compare the difference between the laggard and the leader within each group, for each of these metrics. Finally, we compare the trend of this gap for these two groups, for the period 2019-2021. We suppose that if:

- A) The averages of climate change performance metrics of OGCI members' group is higher than those of the non-members' group,
- B) The gap between the leader and the laggard is lower for the OGCI members' group than for the non-members' group,
- C) This gap decreases with time for the OGCI members' group and it does not for the non-members' group

then we can suppose that there is a relationship between the membership in OGCI and climate-change performance of O&G. This membership represents a likely existing peers' pressure, which, in our view, corresponds to the institutional mimetic pressures exerted on O&G, and potentially impacts their climate-related performance. The causal relationship between these metrics has to be yet investigated by future research. The table 13 shows the results of this comparative analysis.

⁵⁹ Not all members of OGCI are presented in the constructed dataset, for some of them data not being available

⁶⁰ Comparable size and market capitalization of these companies

Table 13. Comparative analysis of OGCI members' and non-members groups

	Year	Members of OGCI	Non-members of OGCI
Companies		BP Chevron Saudi Aramco Eni Equinor Shell Total Energies Exxon Mobil Sinopec Petroleo Brasileiro Occidental Petroleum	Ecopetrol YPF SA Ecopetrol Petroleos Mexicanos Gazprom Rosneft Duke Energy ConocoPhillips Petrochina Petronas Chemicals Enbridge
Average GHG emissions to tangible assets	2021	0,249	0,342
Average of Scope 1	2021	56481,5	57546,2
Average Energy consumption to tangible assets	2021	0,787	1,471
Gap "laggard-leader" GHG emissions to assets ^a	2021	0,253	0,63
Gap "laggard-leader" Scope 1	2021	96000	204630
Gap "laggard-leader" Energy consumption	2021	0,898	2,858
Trend of the gap, GHG emissions	2019-2021	Decrease	Decrease
Trend of the gap, Scope 1	2019-2021	Decrease	Increase
Trend of the gap, Energy consumption	2019-2021	No difference	Increase

^a The laggard-leader difference was calculated by subtracting the GHG emissions of the "best" performing company from the GHG emissions of the "worst" performing company, in order to have a positive value for an easier trend tracking. The same subtraction was done for the Scope 1 and energy consumption metrics.

The results indicate that on average, the GHG emissions of OGCI members group are lower (0.249) than the GHG emissions of non-members group (0.342). The average Scope 1 emissions of OGCI members is lower (56481,5 thousand of metric tons of CO₂ equivalent) than the average Scope 1 emissions of non-members (57546,2 thousand of metric tons of CO₂ equivalent). The average energy consumption of OGCI members is lower than the one of non-members' group. On average, the results suggest that the climate change performance of OGCI members is on average better than the performance of the counterpart group of non-members.

When we compare the difference between the laggard and the leader, the findings show that the gaps between the companies that are members of OGCI are lower than the gaps between those firms that are not members. This may be an indicator of the peers' pressure link with the O&G emissions and energy consumption. This result holds for all the three comparative criteria – for GHG total emissions, for Scope 1 and energy consumption.

Finally, when the trend of these gaps for the period 2019-2021 is analyzed, we acknowledge that the GHG emissions and Scope 1 gaps between the laggard and the leader for the OGCI members decreases, while the energy consumption gap stagnates. The GHG emissions' "laggard-leader" gap for non-members group decreases as well. However, the Scope 1 and energy consumption "laggard-leader" gaps for the non-members group increase. This result is in line with our hypothesis. For the OGCI members' group, the difference between the laggard and the leader decreases with time indicating that the peers' pressure may be an incentive of members' emissions reduction and energy efficiency initiatives' implementation. For non-members, these gaps tend to increase. The exception is only the GHG emissions gap which decreases for both groups during 2019-2021.

In summary, the results of this comparative analysis show that there is a link between the membership in OGCI and the climate-related performance. This relationship is not necessarily causal and a longer time period needs to be assessed for its further investigation, but we observe a clear difference between averages, the existing gaps between laggard and leader and the trend of the gaps across time for OGCI members and non-members.

10. Discussion

The research question of this thesis is what internal and external factors affect oil and gas companies' climate change performance. From the perspective of three complementary theories, the resource-based, the resource dependence, and the institutional theory we formulated hypotheses that were tested by applying fixed effect, random effect models and by making several robustness tests. The robustness tests verified whether the choice of dependent variables and the sample composition influence the findings. Overall, the results appear to be robust. In this section, we will discuss the results with regards to each hypothesis.

Hypothesis 1a: There is a significant negative relationship between the oil and gas company's sales growth and its GHG total emissions

Both the results from our whole sample and from our sample with only non-US firms suggest strong empirical evidence that the sales growth of O&G is negatively related to companies' GHG total emissions. The findings are consistent with the resource-based theory: the financial strength of companies provide necessary resources for climate change mitigation and adaptation initiatives. This finding is in line with previous studies (Hasan and Habib, 2017; Yunus et al., 2016; Elefteriadis and Anagnotsopoulou, 2017; Jūrate Jaraitė, 2012; Falcone, 2018) and supports the Hypothesis 1a.

Hypothesis 1b: There is a significant non-linear relationship between the oil and gas company's leverage and its GHG total emissions

Both the results for the whole sample and for the non-US firms confirm a presence of a non-linear relationship between sales growth and the GHG total emissions. This relationship is initially negative, but when reaching a turning point, it becomes positive. This confirms our idea and is consistent with previous findings of Schaltenbrand et al. (2015) specifically for the O&G industry - when the financial resources of oil and gas companies are under a certain level, it is important for them to diversify their risks and invest in alternative energy sources. However, when they possess a certain level of financial resources, they feel secure enough not to commit into environmental sustainability. This may be also related to the fact that the managerial perception of reputational risks is higher when the financial resources are under a certain level, but when a company is sure about its financial and economic prosperity, the reputational risks do not seem so threatening. After reaching a critical threshold, financial and economic strength may create a rationale for not investing into climate change mitigation and adaptation initiatives, being focused on core business activities. Moreover, high sales growth is a signal for a high demand for fossil fuels on the market, being a strong argument for O&G companies to invest in fossil fuels⁶¹.

Hypothesis 1c: There is a significant positive relationship between the oil and gas company's leverage and its GHG total emissions

The results showed evidence that the debt-to-equity ratio of O&G positively impacts the GHG total emissions. This result was expected because, according to our assumption, higher leverage level with regards to equity would mean lower resources' availability due to regular repayment obligations. The financial strength, from the perspective of the resource-based

⁶¹ When making this conclusion, we assume that the largest part of these companies' revenues come from the trade of oil and gas-related products and services.

theory, is seen as the extent to which a firm possesses available resources (Hasan and Habib, 2017; Yunus et al., 2016; Elefteriadis and Anagnotsopoulou, 2017; Jūrate Jaraitė, 2012; Falcone, 2018, Brancati (2005). However, Alessandrini et al. (2010) argue that lending constraints are barriers to firms' green investments, which is not completely consistent with our result – from the point of view of a firm, the more a company is leveraged, the more it will emit greenhouse gases. This inconsistency can be related to the fact that most of the debt finance goes to fossil fuels projects in case of O&G. This result holds for the non-US firms' sample as well, confirming their robustness. Thus, our findings support the Hypothesis 1b.

Hypothesis 2a: There is a significant positive relationship between the gender diversity level among executives within oil and gas companies and its GHG total emissions

Regarding the relationship between gender diversity among executives and the climate change performance, the results for the whole-sample regression suggest that there is no effect of female executives' percentage on the GHG emissions. However, for the non-US companies this effect is significant, meaning that higher women representation on c-suite level leads to lower GHG emissions. When we test this relationship for Scope 1 emissions and energy consumption, c-suite level gender diversity appears to be impactful and its effect is negative. Therefore, we acknowledge that the results support the Hypothesis 2a and are in line with both RBV and RDT. Resource dependence focuses on the board of directors' role with regards to sustainability and suggests that gender diversity brings a greater variety of skills to the company on boards because of the “*strategic direction to the management of the firm*” (Lu and Herremans, 2018). In this thesis, we assume that executives have even a higher ability to take decisions with regards to climate change than directors, and “grab” external resources for tackling this issue. This result is in line with the studies of Porter & Kramer (2011), Jain & Zaman (2019), Jiang et al. (2017).

Hypothesis 2b: There is a significant negative relationship between the oil and gas companies' gender diversity on board and their GHG total emissions

As for the role of gender diversity among directors for the O&G climate change performance, the results show that it has no impact on GHG total emissions of these companies. This result holds for all the models tested. Even though many studies provide evidence of a positive link

between gender diversity on boards and firms' environmental performance (Jones & Dunlap, 2010; Lu and Herremans, 2018; Gabaldon et al., 2016, Nadeem et al., 2020)⁶², in case of O&G industry, results suggest there is no relationship. It is also possible that for this specific aspect of environmental sustainability, gender diversity of boards has no impact, playing an important role in other dimensions (biodiversity, water and waste management, for instance). Environmental sustainability is a multidimensional concept and needs to be deconstructed to look at each dimension separately. Moreover, we observe that female executives' percentage has a negative impact on GHG emissions, and the possible explanation of these findings could be that for a better climate change performance of O&G, c-suite strategic long-term decision-making is required.

Hypothesis 3a: There is a significant negative relationship between oil and gas company's CSR innovation competency and its GHG total emissions

CSR innovation competency, which was represented by a CSR training policy dummy variable, appears to be negatively related to O&G GHG emissions. Oil and gas companies with CSR trainings perform better in terms of emissions. This result holds when we analyze non-US firms and when we take Scope 1 emissions as a dependent variable. The findings are consistent with the resource-based theory, stating that innovation competency is a critical resource for environmental sustainability deployment in companies. Trainings oriented to CSR bring knowledge and skills to employees, fostering innovations' development in this field. The hypothesis 3a is supported by our results.

Hypothesis 3b: There is a significant positive relationship between oil and gas company's general innovation competency and its GHG total emissions

A positive relationship between general innovation competency and GHG emissions was expected, due to the nature of O&G core business. We supposed that the general training policies, being a proxy for general innovation competency, would positively affect climate change performance when not being specifically CSR oriented. The results support this hypothesis, showing, that the end goal is crucial to the innovations' orientation in this industry. This outcome holds for the random effect model where Scope 1 emissions are taken as dependent variable.

⁶² Jones, R. E., & Dunlap, R. E. (2010). The social bases of environmental concern: Have they changed over time? *Rural Sociology*, 57(1), 28–47. <https://doi.org/10.1111/j.1549-0831.1992.tb00455.x>

Hypothesis 4: Oil and gas companies having elaborated climate change policies have lower total GHG emissions than those who have not elaborated such a policy

This hypothesis was standing apart from the first 3 hypotheses, because it does not directly relate to the notion of resources within the framework of RBV. It is more associated with the concept of “dynamic capability”, addressing factors that affect the ability to efficiently mobilize necessary resources and accomplish the short- and long-term goals predefined by a CC policy. The results suggest that this factor is negatively related to GHG emissions, providing evidence that strategic planning is key for effective climate change performance. Oil and gas companies having elaborated climate change policies, perform better than those that do not have such a policy. However, the results are not robust enough when we test for the non-US sample, and for Scope 1 emissions, as they do not hold for these models. We acknowledge that the results support the Hypothesis 4, however, caution needs to be taken for this outcome.

Hypothesis 5a: There is a significant negative relationship between the institutional strength of oil and gas companies' home countries, and these companies' GHG total emissions

Our main model of random effect does not support this hypothesis. Institutional strength, composed by the stability of the financial system, rule of law, political stability and transparency sub-indices, do not appear to be significant for any of the analyzes conducted. This result is unexpected and is not consistent with the institutional theory implications (e.g. Shibin, 2020). However, the study of Kolk (2002) argues that the actual institutional pressures exerted on the oil and gas companies are extended beyond the home country's local context, in favor of the industry's pressure (mimetic isomorphism becomes a more important determinant). Also, the variable “Institutions” is the one with highest VIF⁶³, which can be the reason of this variable's persisting insignificance. If there is no data issues and no issues related to the choice of variables (specifically, the ETI index of the World Economic Forum), the fact that institutions do not influence O&G climate change performance could be also related to this industry's specific characteristics. For example, oil and gas commodities may be a crucial source of a country's aggregated income, thus not being object to strong institutional pressures for replacing them with clean energy sources.

⁶³ Meaning that this variable is highly correlated with other covariates

Hypothesis 5b: There is a significant negative relationship between the energy transition regulatory commitment of the oil and companies' home countries, and these companies' GHG total emissions

There is weak evidence of the negative relationship between the regulatory commitment of O&G home countries regarding energy transition, and the O&G companies' GHG emissions. The random effect model with the whole sample shows that the “regulations” variable is significant. However, when we conduct the same analysis for the non-US firms, regulatory commitment is no longer significant. Neither it is for the models including Scope 1 emissions and energy consumption as dependent variables. When taking this variable separately and controlling for time shocks, we find that regulations have a significant impact on GHG emissions. Consistently to previous studies (Busch and Hoffman, 2009; Shibin, 2020), regulations with regards to environment in general, and energy transition and climate change specifically, favorably affect environmental and climate change performance of oil and gas industry.

This weak evidence may be also related to the fact that when including the U.S. in the sample, the companies headquartered there have an impact on the overall results. There was a considerable change from 2017 to 2021 in their legislative system with regards to climate change, because during this period, U.S. was no longer a signee of the Paris Agreement after their withdrawal in 2017. In 2021, they rejoined the Agreement and thus, we assume that there was a high variation in the regulations with regards to energy transition and climate change plans, making our results significant, as an important percentage of our sample consists of O&G companies from the U.S.

In addition, we did not examine the *host* countries' regulations' impact, losing the potential effect of the international character of O&G sector's activity and trade. Thus, we still consider that the hypothesis is supported by our findings, but this result has to be taken with caution because it is not robust enough.

Hypothesis 6a: There is a significant negative relationship between the cultural long-term orientation of oil and gas companies' home countries, and these companies' GHG total emissions

We find that long-term orientation of home countries of O&G does not affect their GHG total emissions, meaning that normative pressures do not have any significant impact on climate change performance. Robustness tests show similar results as well, long-term orientation

being significant and negative only for the model where energy consumption is taken as dependent variable. Not being in line with the previous studies (Schaltenbrand et al., 2015; Miska et al., 2018; Schneider and de Meyer, 1991), this unexpected result may be related to the fact that the “long-term orientation” variable does not vary a lot across time, similarly to the institutional strength variable. Also, as already mentioned, we consider only the cultural context of *home* countries, overlooking the international character of O&G activity and trade, so the perspective from the *host* countries cultural context.

Hypothesis 6b: There is a significant positive relationship between the cultural uncertainty avoidance of oil and gas companies’ home countries, and these companies’ GHG total emissions

This hypothesis is not supported by our results, meaning that the cultural uncertainty avoidance does not impact the oil and gas companies GHG emissions. Same results are occurring when we do the robustness tests with non-US firms and different dependent variables, as well as the models with this factor taken separately with control variables for time periods. It may be that for the oil and gas industry, cultural aspects of *home* countries are not determinants of their climate actions.

Hypothesis 7: Oil and gas companies that are members of Oil and Gas Climate Initiative have higher climate-related performance than their comparable non-member counterparts

Our results support this hypothesis when we make a comparative analysis, showing that, on average, the GHG emissions, the Scope 1 emissions and energy consumption of OGCI members’ group are lower than the averages of these metrics for their non-members’ group. This means that there is weak evidence that there is a link between the membership in OGCI and climate change performance of oil and gas firms. The difference between the leader and the laggard, so between the best performing company and the worst performing company, is smaller for OGCI members than for the non-members’ group. Furthermore, this difference tends to decrease for OGCI members with time, which is not the case for the non-members. All these results may indicate a possible link between the membership in OGCI and the improvement of climate change performance, and a possible favorable effect of being in a group, due to the mimetic pressures effect (Schiedshlag and Yan, 2021). These results need to be further investigated in order to examine whether there is a causal relationship, signaling the impact of mimetic pressures on CCP, which would be consistent with the institutional theory

implications. As far, we conclude that the findings, even if they are obtained on the basis of limited number of observations and short time period, support the hypothesis 7.

Hypothesis 8: There is a positive correlation between integrated O&G companies' combined oil and gas reserves, and their GHG total emissions

After having conducted a correlation analysis, we find that there is a positive correlation between the combined oil and gas reserves of integrated companies⁶⁴ and their GHG emissions. The more the company has reserves, the more it will have emissions. This result was expected because we assumed that the reserves are corporate resources providing a guarantee of a secured future, and thus do not incentivize a company to improve its climate change performance. Our findings are consistent with the results of Pickl (2019) who observed a positive correlation between proved oil reserves and O&G activity in renewable energy. The presence or not of causal relationship between these two variables is yet to be tested by the future research, but as far, even if our results are based on a limited number of companies, they support the Hypothesis 8.

11. Limitations

During the data collection process, we encountered many difficulties while searching for data and exporting it from Bloomberg terminals. It was a time-consuming process, requiring many attempts and verifications. This is the main reason why we have a limited number of companies in our sample. At the same time, we have a quite unbalanced sample composed by 67 U.S. oil and gas firms, potentially impacting our results.

When proceeding with the regression, the limitation of this thesis is the fact we had unexpected results for external variables, appearing to be insignificant for many of our models. This unexpected outcome may be related to the fact that our sample was limited, or that there was not enough variation of our variables “Institutions”, “Regulations”, “Long-term orientation” and “Uncertainty avoidance” within countries, due to a relatively stable nature of these dimensions on a country-level. These results can be related to the choice of explanatory variables as well. As for the cultural external factors, Hofstede’s matrix is often object to

⁶⁴ Data provided by Bloomberg ESG function

criticism of other authors (Baskerville, 2003) claiming that measuring culture by numeric values can be problematic. Next, ETI Index components were used to construct institutional strength and regulatory commitment variables, as well as control variables for innovative business environment and human capital, and these variables are scores. It has to be noted that the credibility of using a score strongly depends on the methodology of this score's calculation. As ETI sub-indices are weighted averages of other scores, the relevance and the consistency of each score is difficult to assess. Thus, these variables' coefficients need to be considered with caution.

Even if several robustness tests have been conducted and confirmed a certain robustness of our results, they have to be taken with caution also because of a possible endogeneity issues related to reverse causality. In addition, despite the inclusion of many explanatory variables, control variables, firm-specific fixed effects and time-specific effects, we might have partially lost the effect of unobserved time-invariant heterogeneity among *countries*.

Finally, we did not include the potential effect of the institutional context of *host* countries, which could have been an important contribution due to the international character of oil and gas value chains and trade.

12. Conclusion

The objective of this thesis was to examine the internal and external determinants of climate change performance in the oil and gas industry. This topic brings light on a complex universe of the oil and gas and allows to figure out what actions need to be taken in order to accelerate the decarbonization of this sector, and propose possible solutions for its future in general. From the current context with Covid-19 pandemic and the geopolitical conflict between Russia and Ukraine, we understand how strong the dependence of many countries on oil and gas is, and how crucial it is to understand the dynamics of this sector and its possible transition to clean energy.

Our data consisted of companies of different size from 42 countries for the period 2019-2021. We use resource-based theory, resource dependence theory and institutional theory as a theoretical framework for our analysis. To identify these factors, we used a quantitative analysis, notably, the fixed and random effect models, as well as several robustness tests. We focus on our random effect model which respected the conditions of homogenous fixed

effects' distribution and Hausman test, and appeared to be appropriate for this analysis. We find that internal factors such as financial strength, gender diversity among executives, innovation capacity and climate change policy elaboration negatively affect oil and gas companies' GHG emissions. Moreover, this thesis provides evidence of a non-linear relationship between sales growth and emissions – initially, this relationship is negative, but after reaching a critical threshold, it becomes positive.

As for the external factors, only home countries' regulations with regards to energy transition appear to be a significant factor, being negatively related to corporate GHG emissions and showing that coercive pressures influence the climate-related performance of this industry. These results are unexpected, as extractive and manufacturing industries are proved to be exposed to more institutional pressures to improve environmental performance (Bansal & Clelland, 2004). We find that the institutional strength of home countries, the cultural uncertainty avoidance and long-term orientation are not significant factors.

We observe a positive correlation between combined oil and gas reserves of integrated oil and gas companies and their GHG emissions. Furthermore, the results show that the companies that are members of Oil and Gas Climate Initiative, have on average lower GHG emissions, Scope 1 emissions and energy consumption than their comparative non-members counterparts. The difference between the climate-related performance of leaders and laggards of OGCI members is lower than the one of non-members, indicating a possible effect of mimetic isomorphism on oil and gas companies' climate change performance. This difference tends to decrease for OGCI members, which is not the case for non-members.

Future research can investigate the same relationships with a larger sample, looking for the effects of the corporate position in the value chain and differentiating groups by upstream, midstream, downstream and integrated oil and gas companies. Also, the international context can be considered, reflecting the potential institutional pressures from *host* countries of oil and gas companies' subsidiaries, thus being more representative due to the international nature of oil and gas commodities' production and trade. Also, causal relationships between oil and gas combined reserves and GHG emissions may be tested, as well as causal relationship between mimetic isomorphism and CCP in general. Finally, other scores than ETI index can be used for constructing institutional dimensions' variables.

In conclusion, this thesis made a contribution to the studies dedicated to climate change performance of oil and gas. Despite the limitations of this thesis, we found interesting

relationships between internal and external factors and GHG emissions of oil and gas. Our findings could bring insight for theoretical and practical implications. Executives, directors, and other key actors in this industry may find it beneficial to pay granular attention to financial resources' availability, gender diversity on a c-suite level, innovation competency and climate change policies elaboration to improve the CCP of their companies. Also, joining climate change partnerships, associations and joint ventures could potentially be beneficial for O&G decarbonization. A practical implication for home countries could be to put in place more regulations with regards to CC and ET, potentially enabling O&G to proceed with climate change action. Finally, the positive relationship between leverage and emissions brings insight for financial institutions, who could conduct more methodical and rigorous due diligence to provide debt finance to oil and gas companies. Especially, they could thoroughly track the end goals of the projects which will be financed by this debt.

13. References

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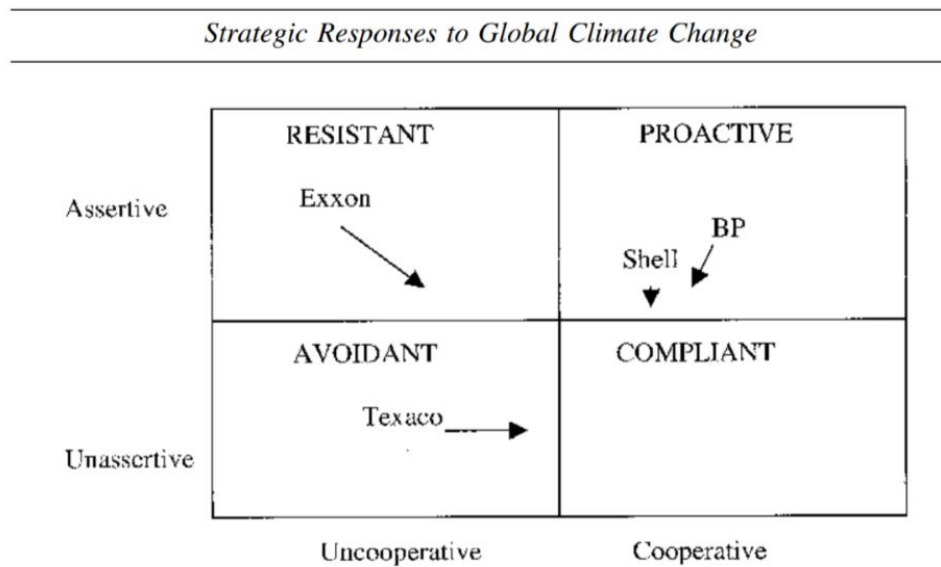
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14. Appendix

Appendix. Figure 1. Strategic responses to climate change (Kolk and Levy, 2002; Gladwin and Walter, 1980)

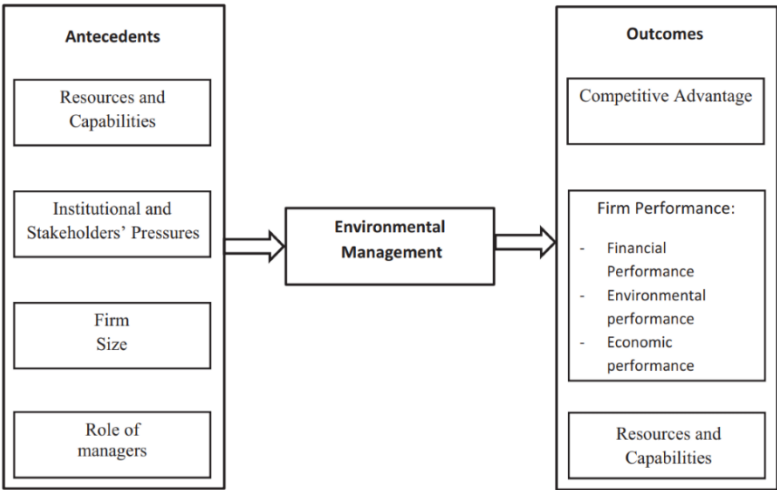


Appendix. Figure 2. Strategic options for climate change. Kolk and Pinkse (2005)

		Main Aim	
		Innovation	Compensation
Organization	Internal (company)	Process Improvement (1)	Internal Transfer of Emission Reductions (2)
	Vertical (supply chain)	Product Development (3)	Supply-Chain Measures (4)
	Horizontal (beyond the supply chain)	New Product/Market Combinations (5)	Acquisition of Emission Credits (6)

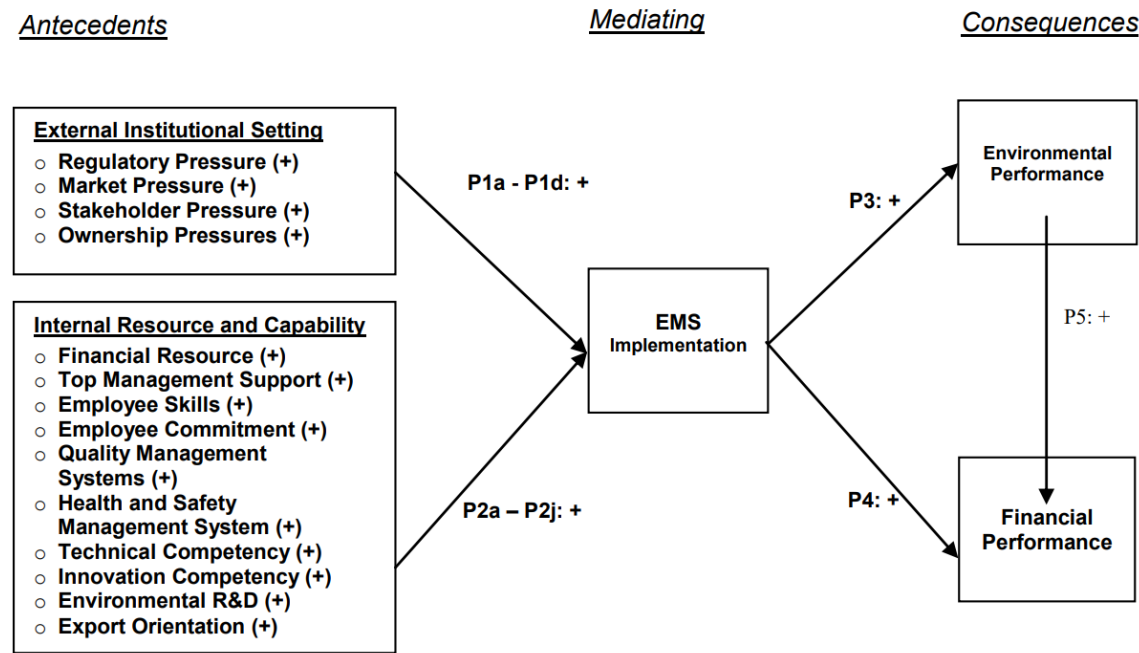
Appendix. Figure 3. Hamdoun, 2020

Figure 6.
Main results of the
systematic literature
review



Appendix. Figure 4. Tonsinet, 2015

FIGURE 1: CONCEPTUAL MODEL OF EMS IMPLEMENTAION



4.1 The Link between External Institutional Setting and EMS implementation

Appendix. Table 1. Pooled OLS Model

	GHG emissions to tangible assets (Model 1)	GHG emissions to tangible assets (Model 2)	GHG emissions to tangible assets (Model 3)	GHG emissions to tangible assets (Model 4)	GHG emissions to tangible assets (Model 5)	GHG emissions to tangible assets (Model 6)
Sales growth	-0.00130*** (0.000430)		-0.00144*** (0.000425)	-0.00157*** (0.000426)		
Female executives	0.000824 (0.00101)		0.000538 (0.00110)	0.00112 (0.00111)		
CSR employee training	-0.0363 (0.0259)		-0.0712*** (0.0270)	-0.0680** (0.0277)		
Training policy	-0.0562 (0.0518)		-0.0552 (0.0511)	-0.0466 (0.0510)		
Debt-to-equity	0.0000266** (0.0000117)		0.0000272** (0.0000115)	0.0000295** (0.0000114)		
Climate change policy	0.0260 (0.0450)		0.0111 (0.0448)	-0.0238 (0.0479)		
LOG(# of employees)	0.0214*** (0.00704)		0.0182** (0.00769)	0.0116 (0.00810)		
Women on board	-0.000810 (0.00107)		-0.00121 (0.00121)	0.000288 (0.00125)		
Female labor	-0.0000741 (0.00108)		0.00224 (0.00187)	0.00276 (0.00174)		
LOG(GDP)	0.0118 (0.00771)		0.0191* (0.0101)	0.00379 (0.0141)		
Innovative business	-0.00000588 (0.0000221)		-0.00000539 (0.0000224)			
Year control	-0.00822 (0.0154)	-0.00884 (0.0130)	-0.000830 (0.0158)	-0.0103 (0.0161)	-0.0161 (0.0126)	-0.0189 (0.0128)
Human capital		0.000424 (0.00155)	-0.00208 (0.00213)			
Institutions		0.00277 (0.00219)	0.00156 (0.00290)			
Regulations		-0.00584* (0.00235)	-0.00461 (0.00355)			
LOG(GDP)		-0.0310 (0.0284)	-0.0291 (0.0376)	0.0215 (0.0365)		
Long-term		0.00168*** (0.000624)	0.00151 (0.00107)	0.000490 (0.000870)	0.00111** (0.000502)	
Uncertainty		0.000121 (0.000678)	0.000566 (0.000843)	0.000697 (0.000838)	0.000424 (0.000518)	
ETI index				-0.0152*** (0.00531)		-0.00685*** (0.00176)
N	445	555	428	401	561	558
R ²	0.069	0.029	0.104	0.115	0.015	0.030
adj. R ²	0.043	0.016	0.065	0.081	0.009	0.026

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix. Figure 5. Pickl (2019) Activity in Renewable energy and the proved oil reserves of oil majors

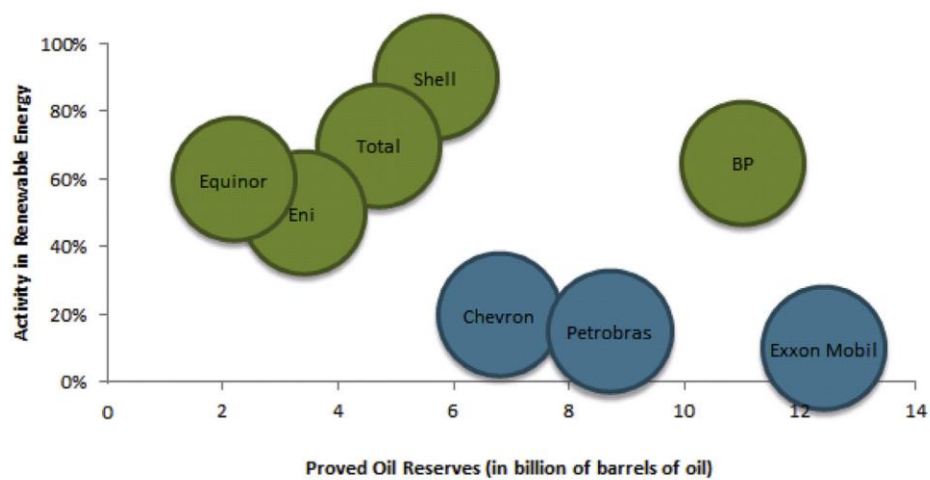


Fig. 6. Linkage of Renewable Energy Activity of Oil Majors with their Proved Oil Reserves [59].

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