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MASTER´S DEGREE
FINANCE

The exposure of European Pension Funds to the Oil&Gas Industry – Before and After the Paris Agreement

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2026

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FEP FACULDADE DE ECONOMIA E GESTÃO UNIVERSIDADE DO PORTO

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Dissertation
Master in Finance

Supervised by
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"All our dreams can come true
if we have the courage to pursue them"

Peter Pan

Acknowledgements

As the author of this work, I would first like to thank my supervisor, Professor Bernardo Vasconcelos e Sousa Paula Marques, for all his advice, availability, and dedication.
To all the teachers who have contributed to shaping the person I am today, both professionally and personally.
To the Faculty of Economics of the University of Porto and Maastricht University, for giving me the opportunity to undertake an international semester in an academic environment completely outside my comfort zone.
To Já T´Explico, for allowing me to tutor lower secondary education students living in disadvantaged family circumstances.
To all colleagues I crossed paths with throughout my first year in audit at Ernst&Young, thank you very much for all your support.
To all my family and friends, particularly my grandparents, for the example they set through their life experiences and stories.
To my brothers, António e Pedro, for all advice, laughter, and occasional arguments.
To my parents, for all their support, love, and trust during my academic journey.

Abstract

Pension funds play a pivotal role in shaping investment norms. As large institutional investors with long-term horizons, they face growing regulatory and societal pressure to integrate climate-related risks into portfolio decisions. The Paris Agreement, signed in 2015, intensified the need to assess how these investors allocate assets to carbon-intensive industries, particularly Oil&Gas (O&G) companies. This Master's Thesis in Finance examines the exposure of European pension funds to major O&G companies worldwide, which are especially exposed to transition risks arising, for instance, from shifts in demand, technological change, and climate policy.

Using a sample 62 O&G companies and 285 European pension funds (exposed and non-exposed) listed in the Investment & Pension Europe (IPE) from 2010 to 2023, this dissertation addresses two research questions: the extent of pension funds ´ exposure to the sector *before* the Paris Agreement (2010-2014) and which features distinguish the exposed and non-exposed pension fund, and the fund- and firm-level determinants of exposure reduction afterwards (2015-2023). The empirical analysis combines descriptive statistics, benchmarks comparisons, pooled t-tests, logit models, and a Two One-Sided Tests (TOST)-based procedure to identify "exit" after the Paris Agreement.

The results show that the exposure of European pension funds to the O&G sector was aligned with benchmark indices before the Paris Agreement, and started to become significantly less exposed only in 2018. Larger funds were more likely to hold O&G shares before the Paris Agreement, while post-Paris exits were associated with smaller funds, located in wealthier countries, and with lower fossil-fuel dependency. At the O&G company level, we find the lack of environmental performance to be a more important determinant of exit than financial underperformance.

Overall, the findings suggest that European pension funds are adopting selective approaches rather than simply abandoning the O&G sector. This is relevant because the climate transition requires coordinated action across sectors to limit the increase in global temperature to 1.5°C above pre-industrial levels, and the role of institutional investors, such as pensions funds, should not be overlooked.

Keywords - European pension funds, oil&gas companies, Paris Agreement, climate change, socially responsible investment (SRI).

Resumo

Os fundos de pensões europeus têm um papel predominante em influenciar decisões de investimento. Sendo investidores institucionais de grande dimensões, assim como de longo prazo estão expostos à crescente pressão regulatória e social de integrar os riscos climáticos nas decisões de carteira. O acordo de Paris, assinado em 2015, veio intensificar a necessidade de perceber como é que os fundos de pensões alocam os seus ativos nas indústrias intensivas em carbono, particularmente de petróleo e gás. Esta dissertação do Mestrado em Finanças analisa a exposição dos fundos de pensões europeus às principais empresas mundiais de petróleio e gás, visto que estão especialmente expostos ao risco de transição, designadamente a alterações na procura, mudanças tecnológicas e das políticas climáticas.

A amostra deste estudo consiste em 62 empresas petróleo e gás e 285 fundos de pensões europeus tanto expostos como não expostos. Estes fundos encontram-se na base de dados da Investment&Pension Europe entre 2010-2023. A investigação consiste primeiramente em avaliar a exposição dos fundos de pensões europeus ao setor *antes* do Acordo de Paris (2010-2014), incluindo a caracterização dos fundos que estão expostos, e, de seguida, avaliar os determinantes da decisão de "saída" *após* o Acordo de Paris (2015-2023) ao nível dos fundos de pensões, bem como das empresas. A análise empírica contem estatísticas discritivas, comparações com índices de mercado, pooled t-tests, modelos logit e usa o procedimento Two One-Sides Tests (TOST) de modo a identificar uma "saída" do período após Acordo de Paris.

Os resultados mostram que, antes do Acordo de Paris, a exposição dos fundos de pensões europeus ao setor de petróleo e gás estava alinhada com os índices de mercado. A partir de 2018 verifica-se uma exposição significativamente inferior face a estas benchmarks. Antes do Acordo de Paris, os fundos de maior dimensão apresentam maior probabilidade de deter acões das empresas do setor de petróleo e gás. No período posterior ao Acordo de Paris, a redução de exposição torna-se mais provável em fundos de menor dimensão, localizados em países com níveis de rendimento mais elevados e com menor dependência de combustíveis fósseis. Ao nível das empresas, o fraco desempenho ambiental revela-se um determinante mais significativo de desinvestimento do que o fraco desempenho financeiro.

Em geral, os resultados sugerem que os fundos de pensões europeus estão a adotar estratégias seletivas. Este resultado é relevante, uma vez que a transição energética exige uma ação coordenada entre setors para que seja possível limitar o aumento da temperatura global a 1.5°C acima dos níveis pré-industriais. Neste contexto, o papel dos fundos de pensões enquanto investidores institucionais não devem ser ignorado.

Palavras-Chave - Fundos de Pensões Europeus, empresas de petróleo e gás, Acordo de Paris, alterações climáticas, investimento socialmente responsável

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1 Introduction

The transition towards a low-carbon economy is reshaping how financial markets, institutional investors, corporations and governments evaluate risk, returns, and long-term value (Bolton & Kacperczyk, 2021).. The Paris Agreement, adopted in 2015 under the United Nations Framework Convention on Climate Change (UNFCCC), marked a major turning point by establishing a global commitment to limit temperature increases and by reinforcing the need to align economic activity and financial markets with decarbonisation objectives (UN, 1992). This transition has created new risks and new opportunities for companies operating in carbon-intensive sectors, such as O&G industry [1]. On one hand, they have a huge presence in the global economy and are among the most exposed to the transition risk, arising, more importantly, from climate regulation, changes in investors preferences, and technological developments (Alessi et al., 2024; Bolton & Kacperczyk, 2021; Ilhan et al., 2021).

European pension funds are especially vital in this context (Bauer et al., 2021). As large institutional investors with short- and long-term liabilities, they manage substantial pools of capital and are expected to act in the best interests of their beneficiaries. From a portfolio management perspective (Fama, 1970; Markowitz, 1952; Sharpe, 1964; Tobin, 1958), pension funds, acting as "universal owners", may hold O&G companies because these firms are included in broad market indices and may contribute to broadly diversified portfolios across sectors, geographies and asset classes (Faller & Knyphausen-Aufseß, 2018; Fichtner et al., 2017; Hoepner et al., 2021).

Nevertheless, the emerging asset-pricing and responsible-investment literature suggest that climate risk and sustainability preferences may affect required financial returns, downside tail risk, and long-term portfolio resilience (Bolton & Kacperczyk, 2021; Eugene F. Fama, 1993; Ilhan et al., 2021; Ross, 1976). Pension funds are increasingly engaging in socially responsible investment (SRI), which shapes their investment allocation (Krueger et al., 2020; Wagemans et al., 2024). Agency theory highlights two potential conflicts of interests between: (i) fund beneficiaries vs fund managers, and (ii) the fund vs the investee company (Jensen & Meckling, 1976). Stakeholder theory suggest that pension funds may respond to pressures from regula-

[1] Since 2015 there is an upward trend in adopting national net zero pledges - Annex A.1

tors, governments, peers, and society (Freeman, 1984), while institutional theory emphasises how similar regulatory, cultural, and normative environments may shape investment behavior (DiMaggio & Powell, 1983).

These theoretical perspectives have encouraged researches to examine SRI strategies, particularly exclusion, norms-based screening, and engagement&voting (Busch et al., 2024; CFA et al., 2023). Existing studies have focused on the financial and environmental consequences of these strategies for investors and investee firms. Exclusion and norms-based screening do not necessarily harm risk-adjusted performance (Hoepner & Schopohl, 2018; Trinks et al., 2018), although their contribution to real-economy decarbonisation remains debated (Boermans & Galema, 2019; Casady & Monk, 2025). Engagement&voting may improve investee companies´ environmental performance, particularly when investors are committed and have a sufficient ownership (blockholder) influence (Dordi et al., 2023; Dyck et al., 2019; Krueger et al., 2020).

Despite this growing literature, less is know about how the exposure of European pension funds to the O&G sector evolved *before* and *after* the Paris Agreement. This dissertation therefore has two main objectives. First, it assesses whether European pension funds were significantly exposed to major O&G companies *before* the Paris Agreement, and which characteristics distinguish between the exposed and non-exposed pension fund. Second, it examines how their investment decisions reacted *after* the signing of the Paris Agreement, and which fund and firm characteristics shape the exit decision.

To address these questions, the dissertation studies the equity exposure of pension funds [2] to O&G companies with a market capitalization above EUR 10bn before the Paris Agreement (2014) and headquartered in OECD or BRICS countries. To do so, the shareholder ownership data are extracted from LSEG and combined with a private Investment&Pension Europe (IPE) dataset to obtain asset under management (AUM) information. This yields a sample of 62 O&G companies and 285 European pension funds (exposed and non-exposed) over 2010-2023. The empirical analysis combines descriptive statistics, benchmarks comparisons, pooled t-tests, and logit models. For the post-Paris period, pension funds are classified as following an exit strategy when their reduction in O&G exposure exceeds the material reduction observed in

[2] Other studies (Blake et al., 2017) analyze also exposure to fixed income instruments. However, for brevity reasons, we decide to focus exclusively on equity exposures.

benchmark indices, using the Two One-Sided Tests (TOST)-based procedure (Lewandowski, 2017).

We find that the exposure of European pension funds to the O&G sector, before the Paris Agreement was generally aligned with European benchmark indices (STOXX 600 and STOXX ESG) and below other reference indices (S&P500 and FTSE 350). Before 2015, larger pension funds were more exposed to these companies. After the Paris Agreement, average exposure declined significantly, but only starting in 2018. Smaller funds and funds with lower share of their portfolio allocated to O&G companies were more likely to reduce exposure. Country-level characteristics also matter: pension funds located in countries with lower fossil-fuel dependency and higher GDP per capita appear more likely to reduce exposure. At the firm level, environmental performance emerges as negative and significant determinant of exposure reduction, while financial indicators such as DPS and ROE are less robust once the environmental variable is included.

Overall, these results contribute to enrich the literature in at least two ways. First, it adds new empirical evidence on how European pension funds adjusted their actual exposure to the major O&G companies *before* and *after* the Paris Agreement. Second, it shows that post-Paris investment behaviour differs depending on pension funds characteristics, O&G company characteristics, and the institutional and economic environments in which these players operate.

The thesis is organized as follows. Chapter 2 reviews the literature on portfolio management theory, agency and institutional theories, and SRI strategies. Chapter 3 analyses the exposure of European pension funds *before* the Paris Agreement by presenting the main data, methodology and results. Chapter 4 analyses the exposure of European pension funds *after* the Paris Agreement by presenting the main data, methodology and results. Chapter 5 concludes the thesis.

2 Literature Review

In this chapter we frame the decisions of European pension funds on whether to invest in Oil&Gas under four main frameworks: Portfolio Management Theory (Eugene F. Fama, 1993; Markowitz, 1952; Tobin, 1958), Agency Theory (Jensen and Meckling, 1976), Stakeholder Theory (Freeman, 1984), and Institutional Theory (DiMaggio and Powell, 1983). Additionally, we analyse the potential SRI strategies that European pension funds may adopt, and presents the main empirical evidence regarding each strategy.

2.1 Conceptual frameworks

2.1.1 Portfolio Management Theory

Markowitz (1952) developed the Modern Portfolio Theory which states that investors should not evaluate securities in isolation, but according to their expected returns and the risk of the portfolio as whole. In this context, portfolio risk depends on the covariance among assets rather than solely on individual volatility. Therefore, diversification allows investors to reduce idiosyncratic risk without necessarily sacrificing expected returns. Pension funds, acting as "universal owners", must diversify their substantial assets across geographies, asset classes, and sectors, including O&G industry (Faller & Knyphausen-Aufseß, 2018; Hoepner et al., 2021). For instance, ABP, a Dutch pension fund for government and education employees, manages around EUR 473bn as of 2023 and allocate these assets in real estate, equities and bonds worldwide (ABP, n.d.). Also, in United Kingdom, the UK Universities Superannuation Scheme, one of the largest domestic private pension schemes managing EUR 86bn in assets as of 2023, invests globally across public and private markets (Universities Superannuation Scheme, n.d.). Hence, the aim of diversification is to mitigate risk and hedge for unexpected changes, which depends on the size of the fund´s assets under management.

Along with Markowitz (1952)´s theory, Tobin (1958) introduced the Separation of Risky Portfolio Selection and Investor´s Risk Preferences, while later Sharpe (1964) presented the

Capital Asset Pricing Model, where expected returns are linked to systematic risk. From this perspective, pension funds may hold Oil&Gas companies because they are included in broad market indices and are part of market reference portfolios. Additionally, the Efficient Market Hypothesis supports this benchmark-oriented view developed by Fama (1970) since asset prices are a reflection of the available information in efficient markets. Indeed, this market-oriented perspective is reinforced by the widespread use of equity benchmarks, index funds and ETFs, which allow investors to replicate broad market portfolios at a relatively low cost (Fichtner et al., 2017). Consequently, deviations from the market portfolio, including both O&G inclusion and exclusion, must be justified to beneficiaries on either financial grounds (such as expected transition risk) or non-financial grounds (for example, sustainability preferences) (Baker et al., 2011; Trinks et al., 2018). Importantly, a strand of the pricing literature has explored the presence of mean reversion in commodities markets. For instance, Bessembinder et al. (1995) found that 44% of energy prices tend to reverse within 8 months.

An alternative perspective, under the Multiple Factor Framework (Eugene F. Fama, 1993; Ross, 1976), is possible to consider climate risk and sustainability preferences as independent risk factor for which investors require additional financial returns. In Europe, this perspective gained traction with the signing of the Paris Agreement, after which investors were increasingly expected to incorporate sustainability practices in their financial decisions. Bauer et al. (2021) show that a medium-sized Dutch pension fund, Pensioenfonds Detailhandel (EUR 24bn AUM as of 2023) prefers investing in firms with stronger ESG performance. Consequently, carbon-intensive firms may offer higher expected returns - a carbon premium - as compensation for climate-related uncertainty (Bolton & Kacperczyk, 2021). Ilhan et al. (2021) also show that such firms are more exposed to downside tail risk under climate policy uncertainty. Prior research shows that stronger corporate social responsibility (CSR) indexes and environmental performance (i.e., including environmental ratings) can affect firm profitability, resilience, and investor preferences. Tzouvanas and Mamatzakis (2021) reported financial benefits from improving environmental scores in S&P 500 firms between 2005 and 2018. During periods of crisis (2008-2009 and Covid-19), CSR may strengthen market confidence (Broadstock et al., 2021; Lins et al., 2017). However, in the carbon-intensive sectors, Trinks et al. (2018) find that fossil fuel exposure does not necessarily generate superior risk-adjusted performance and may provide limited diversification benefits. These mixed findings suggest that pension

funds may value the carbon-intensive sector differently, according to its financial attractiveness and transition credibility. Additionally, as discussed in the next section, the pension funds´ own corporate social responsibility (CSR) profiles.

2.1.2 Agency and Institutional theories

We start by exploring the insights of Agency Theory (Jensen & Meckling, 1976), distinguishing between two types of stakeholder relationships (i.e., sources of potential conflicts of interests): (i) fund´s beneficiaries vs funds managers and (ii) fund vs investee company.

Regarding (i), according to Agency Theory (Jensen & Meckling, 1976), the management of pension funds involves the potential tension between the goals/preferences of beneficiaries and the fund managers. In particular, the beneficiaries are expected to require sound long-term financial returns and potentially demand certain norm-based practices (such as avoiding controversial or sin sectors), while fund managers may have the incentive to pursue short-term performance, private benefits (e.g, related to the size of the fund), or avoiding the effort implicit in following the norm-based practices (Sievänen et al., 2013). This view has gained traction in Europe after the release of the IORP II Directive and the Sustainable Finance Disclosure Regulation, which require pension funds and asset managers to integrate sustainability considerations into their investment decisions (European Parliament and Council of the European Union, 2016). Fiduciary duties are central to pension fund governance, as they require decision-makers to act in the best long-term interests of beneficiaries. Hong and Kacperczyk (2009) find that norm-constrained investors tend to avoid "sin stocks". Also, Tirodkar and Berkman (2023) state that social norms reduce ownership in highly polluting U.S firms, especially in the case of long-term investors. Additionally, Egli et al. (2022) emphasise that public funds are more likely to pursue this strategy. However, as pension funds have to manage both short and long-term liabilities, beneficiaries prioritize stable long-term returns, which can limit their ability to adjust large positions rapidly from these stocks (Atta-Darkua et al., 2022; Jang et al., 2024; McDonnell, 2024).

With respect to (ii), Agency Theory sheds light on the potential tension between the pension fund and the investee company. Consider the case of the Norways´s Government Pension fund, a pension fund with a strong CSR preference, which invests in an O&G company with

the aim of promoting its energy transition. Under this theory, the degree to which the fund can impact the investee company is a function of both its ownership stake in the company and its willingness to pursue costly active monitoring *increased and intensified efforts in active ownership strategies (...) may require more budget to prepare, execute, and monitor these activities* (Bauer et al., 2022: p.82). In line with this, Shleifer and Vishny (1997) argue that large shareholders can play a crucial monitoring role, as their ownership stakes give them both the incentive and the influence to discipline management (blockholder).

Alternatively, according to Stakeholder Theory, fund managers may be compelled to respond to the preferences and needs of stakeholders other than beneficiaries, including regulators, governments, and society (Freeman, 1984). This means that even if beneficiaries do not have a strong CSR preference, the fund managers may opt to pursue responsible investment strategies (Lydenberg, 2014). On the other hand, Institutional Theory suggests that pension funds are embedded in similar regulatory, cultural and normative environments that shape investment preferences and may lead to homogeneous behaviour (DiMaggio & Powell, 1983). Similarly to Stakeholder Theory, this framework suggests that even if beneficiaries do not have responsible investment preferences, fund managers may be tempted to follow the investment strategies of their peers, to avoid standing out of the "herd". In our setting, this implies, for instance, that pension funds may be more willing to invest in geographically proximate stocks, since domestic stocks are easier to understand and monitor, which reduces information asymmetries (Coval and Moskowitz, 1999; Coval and Moskowitz, 2001). Moreover, in carbon-intensive sectors, this may explain to some extent their persistence in holding controversial stocks (Boermans & Galema, 2025).

2.2 SRI strategies and Empirical evidence

2.2.1 SRI strategies

According to Busch et al. (2024) and CFA et al. (2023), there are four key SRI strategies [1]:

[1] As shown in Figure 2.1, there are three additional SRI strategies which are not mentioned due to their reduced relevance, namely (i) Best-in-class (selects companies with the highest ESG scores within each sector), Sustainability themed (allocates capital to funds or portfolios organised around specific environmental or social themes — clean energy, water scarcity, sustainable agriculture), and Impact investing (seeks measurable social or environmental outcomes alongside financial returns) (Busch et al., 2024; CFA et al., 2023)

- **Exclusion**: the fund excludes firms based on their sector of activity, i.e., a firm is excluded based on what it produces or which sector it operates in, irrespective of how well it is managed or how responsibly it behaves. For instance, a best-in-class O&G firm with high quality governance is excluded based on this SRI strategy;

- **Norms-based screening**: the fund excludes firms based on their actual conduct, i.e., a firm in any sector can be excluded if it violates recognised international standards (such as the UN Global Compact, OECD Guidelines for Multinational Enterprises, or ILO core labour conventions);

- **Engagement&Voting**: the fund retains ownership and uses it to influence corporate behaviour, either via direct engagement (e.g., direct dialogue with company management to push for changes in strategy, governance, or ESG practices) or via voting at general meetings (e.g., to support/oppose resolutions on executive pay, board composition, climate transition plans);

- **ESG integration**: the fund incorporates ESG factors into mainstream financial analysis and investment decision-making as financially relevant information. The premise is that ESG risks and opportunities affect cash flows, cost of capital, and long-term firm value. A fund practising ESG integration may still hold O&G firms, but will price in transition risk, regulatory exposure, or governance quality when determining position sizing and valuation.

Note that both exclusion and norms-based screening imply the possibility of funds deciding to exit from a pre-existing stake (based on a new exclusion or norm-based rule), also referred to as "divestment" or "exit" strategy. Alternatively, the engagement&voting strategy can be referred to as "voice" strategy. Additionally, funds may use combined approaches, such as divest-invest (e.g., reallocate capital from brown stocks to greener alternatives) (Busch et al., 2024). In the European pension fund context, as shown in Figure 2.1, exclusion is the most widely used ESG instrument, followed by engagement&voting. Evidence from Sweden illustrates the relevance of these strategies: Första AP-fonden (manage as of 2023 EUR 38mln AUM) and Sjunde AP-fonden (manage as of 2023 EUR 81mln AUM) mainly use engagement&voting and exclusion to manage reputational risk and stakeholders' expectations (Becht et al., 2023; Hamilton &

Eriksson, 2011). In the next section, we will focus on analysing the existing empirical evidence on the choice of exit and voice strategies.

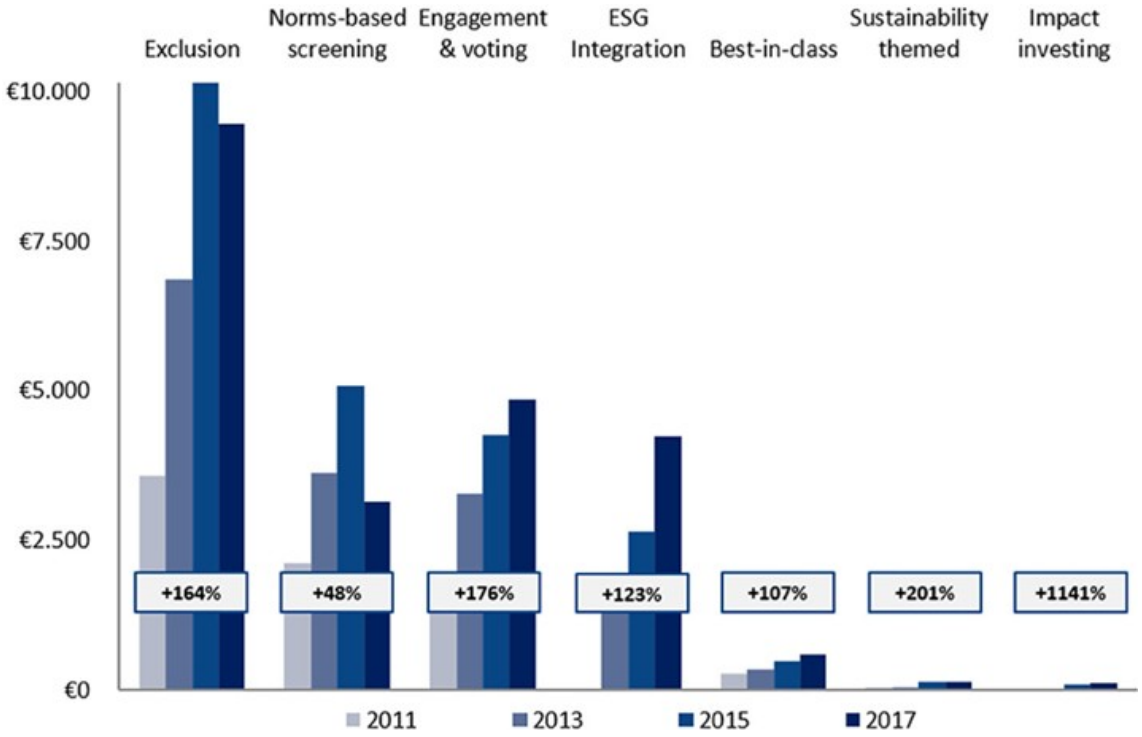

Figure 2.1: ESG instruments in Europe by AUM (EUR bn) (**Gao2023ESGTools**)

2.2.2 Empirical evidence

Exit: Exclusion and norms-based screening strategies

Exclusionary screening is the most longstanding strategy among institutional investors. Evidence from Dutch pension funds shows that such screening is commonly applied to public equity, including the O&G sector, and to corporate bond portfolios (Wagemans et al., 2024), with funds that measure and report their carbon footprint being more likely to follow this approach.

Beyond adoption patterns, a key empirical question concerns the financial consequences of divestment. Several studies suggest that O&G exclusions do not necessarily harm risk-adjusted performance: Hoepner and Schopohl (2018) compare Norway's Government Pension Fund Global and Sweden's AP funds against their benchmark indices over 2001–2015 and find no significant abnormal returns following exclusions. Trinks et al. (2018) and Plantinga and Scholtens (2021) report similar conclusions, showing that exclusions do not seem to imply the sacrifice of

returns or diversification benefits. When exclusion is adopted as part of a divest-invest approach (i.e., reallocating capital towards greener assets) the evidence is comparatively favorable: an analysis of green and non-green energy portfolios over 2008–2020 found that greener portfolios outperformed (Cortez et al., 2022). Similar findings are obtained using fossil-fuel free, clean-energy, and high-environmental-score portfolios (Halcoussis & Lowenberg, 2019; Henriques & Sadorsky, 2018; Hunt & Weber, 2019; Pedersen et al., 2021).

Divestment campaigns may also generate social and reputational pressure on O&G firms (Ouadghiri et al., 2022; Zori et al., 2022), although Monaco (2023) finds that such effects may be only applicable in the short-run. Notably, Boermans and Galema (2019) and Casady and Monk (2025) find no subsequent reduction in portfolio carbon emissions among funds that divest, suggesting that exclusion strategies do not necessarily contribute to real-economy decarbonization.

Voice: Engagement & Voting strategy

With respect to the popularity of voice strategies, Krueger et al. (2020) surveyed 439 long-term investors in Europe between 2017 and 2018, and found that 84% of respondents actively engaged with investee companies about climate-related topics. Dyck et al. (2019) analyse non-US companies worldwide over 2004–2013 and shows that institutional investors are more willing to improve firms' ESG performance (voice) when supported by a favorable home-country environment. Regarding the effectiveness of voice strategies, Broccardo et al. (2022) finds that engagement yields better social outcomes when investors are broadly committed to SRI.

Nevertheless, engagement seems to face significant barriers. For instance, the evidence collected by Lewandowski (2017) indicates that investors remain exposed to transition risk until firms achieve a minimum threshold of carbon performance. Moreover, as expected, smaller ownership stakes are likely to reduce the ability to influence corporate decisions directly (Dordi et al., 2023). The capacity to engage is also shaped by country-level transition readiness. Shen et al. (2024) find that wealthier developed countries have greater capabilities to undertake the energy transition, while resource-constrained economies face higher transition costs. In this study, Nordic countries are shown to perform particularly well, reflecting low fossil-fuel dependency and diversified energy mixes. Similar results are obtained by Semieniuk et al. (2022), Shang et al. (2024) and Cergibozan (2022).

Climate policy seems to further moderate investor behaviour. In this regard, Alessi et al.

(2024) study the impact of the Paris Agreement on the portfolio selection to equities of high-carbon firms, and find that investors operating in BRIC countries are more likely to remain exposed to transition risks. In a similar vein, Fourné and Li (2026) analyse the country-level bilateral holdings across 40 countries, between 2009 and 2019, and find that the stringency of climate policy in the destination country is associated with a higher allocation of portfolio equity and banking investment in that country.

Taken together, the evidence suggests that neither exit nor voice strategies are unambiguously superior. Exclusionary screening is widespread and does not appear to harm risk-adjusted returns (Hoepner & Schopohl, 2018; Plantinga & Scholtens, 2021; Trinks et al., 2018), yet its contribution to real-economy decarbonisation remains limited (Boermans & Galema, 2019; Casady & Monk, 2025). Engagement is broadly practiced (Krueger et al., 2020) and can yield positive outcomes when investors are collectively committed (Broccardo et al., 2022), but its effectiveness is constrained by ownership size (Dordi et al., 2023), country-level institutional capacity (Alessi et al., 2024; Shen et al., 2024), and transition risk exposure (Lewandowski, 2017). The choice between strategies is therefore unlikely to be uniform across funds, and is likely to be driven by fund-level characteristics, regulatory environment, and portfolio composition. This motivates the empirical approach adopted in the following section.

3 RQ1: Exposure of European Pension Funds *Before* the Paris Agreement

Given the relevance of the Paris Agreement for institutional investors (Alessi et al., 2024; Fourné and Li, 2026), we are interested in understanding, firstly, what was the exposure of pension funds *before* the shock, i.e., the approval of the Paris Agreement in 2015. This analysis allows us to answer two unanswered questions in the existing literature: **(RQ1a)** were European pension funds significantly exposed to the fossil fuel sector *before* the Paris Agreement?, and **(RQ1b)** what were the determinants of fossil fuel exposure among European pension funds *before* the Paris Agreement? To achieve these goals, in this section we focus exclusively on the sample period before the Paris Agreement (2010-2014). In the following sub-sections we present the data, methodology, and results for this sub-set of questions.

3.1 Data

The data on European pension funds is retrieved from Investment&Pension Europe (IPE), a well-known monthly publication for institutional investors and pension fund managers in Europe [1], used in recent research (Egli et al., 2022). The dataset is ranked, on a yearly basis, by assets under management (AUM, EUR mn) and includes information about the fund's name, country of headquarters and AUM. This is a key aspect of this dataset, given that conventional databases, such as LSEG, do not provide information on the latter characteristic on a yearly basis [2].

To identify which pension funds are exposed to O&G companies one would ideally search the holdings of each pension fund in a conventional data provider (e.g., LSEG). However, this is not feasible, given that the data for the majority of pension funds is not accessible. To tackle this

[1] The lists were obtained privately. More information can be accessed via: https://www.ipe.com/reports/top-1000-pension-funds

[2] Note, however, that the dataset has some missing AUM values, which we tackle using the growth rate (%) for each country over the full sample period.

issue, we retrieve from LSEG the information about the shareholders for a set of eligible O&G companies, and identify which shareholders are present in our baseline pension funds list. More specifically, first, we find the list of eligible O&G companies by imposing two criteria: market capitalization equal or above EUR 10 bn as of the end of 2014, and headquartered in OECD or BRICS countries. These criteria allow us to handle data quality issues, as well as to incorporate the most dominant O&G companies. Second, we extract the shareholder report of each firm-year for the 2010-14 period, and match the shareholders flagged as pension funds with our IPE list. This resulted in a total of 39 pension funds located in 8 countries [3] with equity stakes in O&G companies in this period, where the latter are specialized in 7 sub-sectors[4]. With respect to the non-exposed pension funds, we retain the funds that are present in the IPE list for at least half of the sample period, yielding a total of 246 pension funds that were not directly exposed to O &G shares. The total sample (exposed and non-exposed) comprises 285 European pension funds.

Additionally, equity indices (RQ1a) were downloaded from LSEG and country fund-level variables (RQ1b) including Gross Domestic Product per capita (GDPpc), Energy Consumer Price Inflation (CPI Energy), Total natural resources rents in % of GDP (Fossil GDP), a proxy for a green country index (Greenness), and Renewable energy consumption in % of total final energy consumption (Renewables) were extracted from World Bank and Germanwatch (see definitions in Table 3.1).

3.2 Methodology

To understand whether European pension funds were significantly exposed to O&G companies before 2014 (RQ1a) we compare the average portfolio exposure of the European pension funds ($\%Portfolio_t$) to the weight of the O&G sector companies in several equity indices ($\%IndexPortfolio_t$), using an annual one-sample t-test, and Welch two sample t-test (Fichtner et al., 2017). These measures are computed in the following way:

[3] The exposed pension funds are located Finland, Ireland, The Netherlands, Norway, Poland, Sweden, Switzerland and the United Kingdom. The top 5 countries in terms of pension funds' portfolio exposure to O &G shares are Norway (3.45%), Ireland (3.30%), the United Kingdom (1.80%), the Netherlands (1.30%), and Sweden (0.91%).

[4] The 7 sectors include the Integrated Oil & Gas (15), Oil & Gas Refining and Marketing (13), Oil & Gas Exploration and Production (10), Oil & Gas Transportation Services (6), Oil & Gas Drilling (1) and Coal (4).

$$\%\text{Portfolio}_t = \left(\frac{\sum_{i=1} \text{Value}_{i,t}}{\sum_{i=1} \text{AUM}_{i,t}} \right) \times 100 \tag{3.1}$$

$$\%\text{IndexPortfolio}_t = \left(\frac{\sum_{j=1} \text{MarketCapitalization}_{j,t}}{\sum_{j=1} \text{MarketCapitalization}_t} \right) \times 100 \tag{3.2}$$

The equity indices used as benchmarks encompass (i) the main European index (STOXX 600), (ii) a sub-set of this index which includes only ESG leaders (STOXX ESG), and (iii) two of the most important international stock indices (FTSE 350 and S&P 500).

To answer RQ1b, i.e., what are the differences between exposed and non-exposed pension funds before 2014, vectors of variables (determinants) are added, namely: pension fund characteristics (PFC), pension funds' country of headquarters (PFCH). We estimate the following binary-dependent variable model using logistic regressions:

$$\text{Exposure}_{i,t} = \beta_0 + \beta_1 \, \mathbf{PFC}_{i,t-1} + \beta_2 \, \mathbf{PFCH}_{i,t-1} + \varepsilon_{i,t} + \theta_t \tag{3.3}$$

The dependent variable is $Exposure_{i,t}$ which equals 1 if the pension fund i is exposed to O&G companies in year t. The independent variables include both macro and micro determinants previously discussed in section 2.2.

All variables are described in Table 3.1 and are lagged one year to mitigate endogeneity concerns (i.e, reverse causality and simultaneity between the dependent and independent variables) (Wooldridge, 2010). Also, it makes the approach more realistic since the current decisions are based on the prior year results. Additional tests are performed, including the use of buckets of AUM, in order to shed further light on the determinants of O&G exposure of pension funds before the Paris Agreement.

Table 3.1: RQ1 - Variable definitions and data sources

Variable	Definition	Data source
Pension fund characteristics (PFC)		
AUM	Logarithm of Assets Under Management in EUR mn	IPE (2010-2023)
AUM bucket	Small (p0.25), medium (p0.50), large (p0.75) and extra-large	Own' definition
Pension fund Country characteristics (PFCH)		
GDPpc	Gross Domestic Product per capita; Proxy of economic development level; Converted USD to EUR (European Central Bank, n.d.)	World Bank (n.d.-a)
CPI Energy	Energy Consumer Price Inflation	**Inflation<empty citation>**
Fossil GDP	Total natural resources rents (% of GDP)	World Bank (n.d.-c)
Greenness	Climate Change Performance Index of country (higher = greener); Range from 0 to 100	Germanwatch et al. (2010)
Renewables	Renewable energy consumption (% of total final energy consumption)	World Bank (n.d.-b)

3.3 Results and Discussion

3.3.1 Were European pension funds significantly exposed to the fossil fuel sector before the Paris Agreement?

Table 3.2 shows that in 2014, i.e., the year before the implementation of the Paris Agreement, 34 pension funds were exposed to O&G companies. They collectively managed EUR 1,540,724 mn, of which approximately 2% was invested in O &G shares (EUR 31,984 mn). Furthermore, Table 3.2 indicates that the number of pension funds varied over the period, ranging from 29 to 34. Moreover, untabulated results show that only 21 out of the 49 pension funds were exposed every year during this period. Over time, the size of the exposed group shows an upward trend, starting at EUR 920,262 mn and ending at EUR 1,540,724 mn, and generally holding more AUM than the non-exposed subset. The amount deployed in this universe ranged from EUR 20,810 mn to 31,984 mn.

Table 3.2: Main features - 2010–2014

Notes: Table 3.2 presents the number of pension funds that are yearly exposed and non-exposed to the fossil fuel sample. The sample of exposed and non-exposed is composed by 285 European Pension funds. Missing observations for the non-exposed group were detected in 2010, 2011, and 2015. The column "O&G Equity Exposure (€mn)" shows the amount of yearly investments in EUR mn in O&G companies.

	Number of pension funds		**Total AUM (€ mn)**		**O&G Equity Exposure (€ mn)**	
Year	**Exposed**	**Non-exposed**	**Exposed**	**Non-exposed**	**Exposed**	**Non-exposed**
2010	30	79	920 262	365 847	20 810	–
2011	29	231	1 029 886	965 844	25 175	–
2012	34	251	1 307 064	1 159 875	29 107	–
2013	31	254	1 304 705	1 377 141	22 930	–
2014	34	251	1 540 724	1 369 076	31 984	–

Secondly, Table 3.3 shows that, on average, all indices reduced their exposure to O&G companies, as their percentages declined. The results suggest that the %Portfolio of exposed pension funds is consistently lower than FTSE 350 and S&P 500 every year during the sample period, while no significant differences emerge when comparing the pension funds with STOXX 600 and STOXX ESG. This is confirmed when observing the period average (2010-2014). Overall these findings suggest that European pension funds exposure to O&G shares was generally aligned with that of European indices prior to the 2015 Paris Agreement, and less exposed when compared to the main UK and US indices. These results confirm the intuition that pension funds tend to follow broad market practices/portfolios (Fichtner et al., 2017), while also exhibiting a tendency for home bias (Coval and Moskowitz, 1999 ; Coval and Moskowitz, 2001).

Table 3.3: Share of Portfolio invested in O&G companies for Exposed European pension funds

Notes: Table 3.3 presents the evolution of the percentage of the average exposed pension funds portfolios allocated to O%G companies, as well as the share of O%G companies' market capitalization in several equity indices, prior to the Paris Agreement. Statistical significance is based on two t-tests that compare the exposed group with each non-exposed and index column: an annual one-sample t-test, and Welch two sample t-test in the last row using the entire period. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Year	Exposed	FTSE 350	S&P 500	STOXX 600	STOXX ESG
2010	2.59%	6.87%	8.19%	2.39%	1.27%
2011	1.95%	7.24%	8.46%	2.67%	1.79%
2012	1.57%	6.07%	7.41%	2.33%	1.59%
2013	1.45%	5.64%	6.92%	1.92%	1.17%
2014	1.45%	4.56%	5.64%	1.53%	1.16%
2010–2014	1.80%	6.07%	7.33%	2.15%	1.39%
Differences between Exposed pension funds and Benchmark Indices (pp)					
2010	–	4.28***	5.61***	-0.19	-1.31*
2011	–	5.29***	6.51***	0.72	-0.17
2012	–	4.50***	5.84***	0.76**	0.02
2013	–	4.19***	5.47***	0.48	-0.28
2014	–	3.11***	4.19***	0.08	-0.29
2010–2014	–	4.27***	5.52***	0.37	-0.41

3.3.2 What differences exist between exposed and non-exposed European pension funds?

The results regarding the differences between exposed and non-exposed European pension funds are presented in Tables 3.4 and 3.5. Namely, the mean comparison results presented in Table 3.4 indicate that the exposed European pension funds tend to be statistically larger than

the non-exposed group, and operate in countries with a lower energy inflation rate and a higher natural-resource rents as share of GDP. The remaining variables (GDPpc, Renewable share, and Greenness) do not show significant differences at conventional significance levels.

Table 3.4: Comparing group means Exposed and Non-Exposed

Notes: Table 3.4 reports a pooled t-test between 2010-2014 of the PFC and PFCH. Variable definitions appear in Table 3.1. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Variable	Exposed	Non-Exposed	Diff
AUM	9.35	7.70	1.65***
CPI Energy	2.16	2.51	-0.35**
Fossil GDP	1.63	0.81	0.82***
GDPpc	39.90	40.30	-0.37
Renewables	18.00	16.70	1.32
Greenness	63.30	62.60	0.73

With respect to the regression results, Table 3.5 confirms that fund size is one of the main characteristics that influence the O&G exposure, in line with the t-test reported in Table 3.2. The coefficient on AUM is always positive and significant at the 0.01 level, with odds ratios above two, implying that a one-unit increase in the natural log of AUM (i.e., which corresponds to the shift from the sample mean AUM of EUR 2.7 bn to EUR 7.4 bn) doubles the odds of being exposed, holding other factors constant. In the same line, Models 2 and 4 provide additional information on the impact of AUM on the likelihood of being exposed. In comparison with the small funds, the extra-large funds (i.e., funds with AUM above EUR 6,021 mn) have a higher probability of investing in major fossil fuels at the 0.01 level. Additionally, Model 4 indicates that large funds (i.e., funds with AUM between EUR 2,191 mn and EUR 6,021 mn) also have a higher likelihood, although at a lower level of statistical significance (equals to 0.01). Furthermore, medium funds show a statistically significant positive effect at the 0.05 level. These findings are in line with the concept of "universal owners" (i.e., those that control large amounts

of capital), since funds with higher AUM diversify more broadly across the entire market, including the O&G sector (Faller & Knyphausen-Aufseß, 2018; Hoepner et al., 2021). Moreover, larger funds have greater capabilities to drive change in companies, as their size increases the likelihood of promoting sustainable investments, which makes them more likely to be interested in such firms (Bauer et al., 2024).

Regarding the impact of macroeconomic variables, we may observe, in Models 3-5, that the only statistically significant determinant is energy price inflation, which has a negative association on the likelihood of being exposed, i.e., when CPI Energy increases by one unit in the previous year, on average, the probability of the pension fund investing in O&G shares decreases, holding the other characteristics constant. This result is aligned with the mean comparison tests, and could be explained by the pension funds strategy to anticipate the mean reversion of O&G shares, following valuation gains obtained from high CPI Energy yearly (Bessembinder et al., 1995). We note, however, that this argument does not seem to align with the long-standing view of pension funds as long-term investors (Serafeim, 2018), and hence should be interpreted cautiously, as it implicitly attributes a degree of short-term tactical rebalancing to institutions typically associated with strategic, long-horizon asset allocation.

Overall, the findings regarding RQ1a and RQ1b before Paris Agreement suggest that fund size, and energy inflation of the previous year are robust determinants of differences between the two groups. The remaining macroeconomic variables (i.e., Fossil fuel dependency, GDPpc, Renewables dependency and Greenness) are not statistically significant.

Table 3.5: Determinants of the Exposure of European pension funds to O &G: Logistic regressions

Notes: Table 3.5 presents the results of logit regressions on the pension funds characteristics and country of headquarters of portfolio exposure ($Exposure_{i,t}$ = 1). All variables were lagged one year. The thresholds of the "AUM bucket" variable are defined as: small (below EUR 991 mn), medium (between EUR 995 mn and EUR 2,191 mn), large (between EUR 2,191 mn and EUR 6,021 mn), and extra-large (above EUR 6,021 mn). The coefficient estimations represent odds ratios. Model (1) and (2) include both year and country fixed effects. Model (3)-(6) include year fixed effects. Variable definitions appear in Table 3.1. Cluster-robust standard errors (by fund) are used, and reported in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Dependent Variable:	$Exposure_{i,t}$				
Model:	(1)	(2)	(3)	(4)	(5)
AUM_{t-1}	2.70***		2.55***		2.61***
	(0.50)		(0.35)		(0.36)
AUM bucket [Medium]$_{t-1}$		1.93		3.70*	
		(1.28)		(2.37)	
AUM bucket [Large]$_{t-1}$		7.31**		15.99***	
		(5.06)		(10.44)	
AUM bucket [Extra-large]$_{t-1}$		20.78***		39.28***	
		(14.23)		(29.75)	
CPI Energy$_{t-1}$			0.90**	0.90**	0.84***
			(0.03)	(0.03)	(0.04)
GDPpc$_{t-1}$					0.98
					(0.01)
Fossil GDP$_{t-1}$					1.15
					(0.09)
Renewables$_{t-1}$					1.00
					(0.02)
Greenness$_{t-1}$					1.02
					(0.04)
Year fixed effect	Yes	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	No	No	No
Observations	588	588	916	916	916
Pseudo R^2	0.28	0.23	0.23	0.19	0.23

4 RQ2: Exposure of European Pension Funds *After* the Paris Agreement

Having examined the exposure of the European pension funds to O&G before the Paris Agreement, in this chapter we are interested in deepening our understanding of what occurred after the Paris Agreement (2015-2023). Namely, we focus on answering the following two questions: how did the exposure of European pension funds to the O&G sector evolve *after* the Paris Agreement? (e.g., how many pension funds reduced/increased exposure? (RQ2a), and what are the determinants of the decision to exit both at the pension fund level (RQ2b) and at the O&G company level (RQ2c). In the following sub-sections we present the data, methodology, and results for this sub-set of questions.

4.1 Data

To answer these questions, we enrich the original data (used for RQ1), with the following information retrieved from LSEG (or when not available from pension funds websites). First, the classification of the pension fund into public (i.e., run by the government) or private (i.e., run by a private company). Second, several features of the O&G companies, namely E_Rating, DPS and ROE. Additionally, we extract information from the World Bank website about the Energy CPI and Fossil fuel share of GDP of the country where the O&G companies are located (Fossil GDP), as well as the Climate Change Performance Index (Grenness), from Germanwatch. The final dataset includes the 49 exposed pension funds (RQ1) and 62 O&G companies.

4.2 Methodology

Our first task is to identify the pension funds that significantly reduced their exposure to O&G companies in the post-Paris Agreement period. To do this, we classify as "exit" those funds whose negative growth of O&G exposure, in a given sub-period, falls below the lower

bound of the confidence interval/range of growth rates observed for a set of benchmark indices. This approach follows the logic of equivalence testing, in particular the Two One-Sided Tests (TOST) procedure, according to which an observed effect can be benchmarked against a pre-specified interval to determine whether it falls within or beyond conventional bounds (Lakens, 2017). In our setting, this approach allows us to identify funds whose divestment behaviour reflects an active and deliberate exit decision rather than a mechanical response to changes in index composition or market valuations. The step-by-step procedures used to classify funds as "exit" are presented in Annex A.2.

Next, to assess the determinants of pension funds' exit from O&G, we run a set of logit regressions, where we iteratively include additional vectors of variables (determinants), namely: pension fund characteristics (PFC), pension funds' country of headquarters (PFCH), O&G companies' characteristics (OGCC) and O&G companies' country of headquarters (OGCCH). The final specification is as follows:

$$\begin{aligned} \text{Exit}_{i,t} = \beta_0 + \beta_1 \, \mathbf{PFC}_{i,t-1} + \beta_2 \, \mathbf{PFCH}_{i,t-1} + \beta_3 \, \mathbf{OGCC}_{i,t-1} + \beta_4 \, \mathbf{OGCCH}_{i,t-1} \\ + \varepsilon_{i,t} + \theta_t \end{aligned} \tag{4.1}$$

The dependent variable is $Exit_{i,t}$, which is a dummy 1 if fund i´s reduction in exposure in the period "2015-year t", relative to the pre-Paris Agreement period (2010-2014), is more significant than the reduction in the benchmark indices, according to the TOST methodology (Lakens, 2017). All variables are described in Table 4.1. The independent variables include both macro and micro determinants previously discussed in section 2.2. All explanatory variables are lagged variables and include year and country fixed effects, to control for time-varying fluctuations. We use cluster-robust standard errors at the fund-level.

Given that each pension fund may be exposed to multiple O&G companies, we follow the literature (Cremers & Petajisto, 2009). More specifically, we compute a ranking aggregation (Lettau et al., 2018) and build a synthetic O&G company per pension fund, using the relative exposure to each company, per year, as the weighting factor. This approach is applied in the regressions using the OGCC and OGCCH variables. Related to this, we use the top holding of each pension fund (Cohen et al., 2008), to identify whether the fund has continent home bias

(i.e, if the yearly largest O&G holding belongs to Europe).

Table 4.1: RQ2 - Variable definitions and data sources

Variable	Definition	Data source
Pension fund characteristics (PFC)		
AUM	Logarithm of Assets Under Management in EUR mn	IPE (2010-2023)
%Portfolio	Logarithm of the % weight of value invested in O&G company in total AUM	Own classification
Years Of Exposure	The average number of years that each pension fund is exposed to O&G companies	Own classification
Public	Dummy = 1 if the pension fund is publicly (state) owned; 0 otherwise	Own classification
Energy Company characteristics (OGCC)		
E_Rating	Environmental pillar score of the energy company; Range from 0 to 100	LSEG Refinitiv ESG
ROE	Earnings before interest and taxes in total equity	LSEG
DPS	Dividend per share	LSEG definition
Pension funds and energy company Country characteristics (PFCH & OGCCH)		
GDPpc	Gross Domestic Product per capita; Proxy of economic development level; Converted USD to EUR (European Central Bank, n.d.)	World Bank (n.d.-a)
CPI Energy	Energy Consumer Price Inflation	**Inflation<empty citation>**
Fossil GDP	Total natural resources rents (% of GDP)	World Bank (n.d.-c)
Greenness	Climate Change Performance Index of country (higher = greener); Range from 0 to 100	Germanwatch et al. (2010)
Continent Home Bias	Dummy = 1 if the pension fund and the highest exposed energy company are European ; proxy of home bias	Own classification

4.3 Results and Discussions

4.3.1 How did the exposure of European pension funds to the O&G sector evolve *after* the Paris Agreement?

When compared with the pre-Paris Agreement period (2010-2014), we identify 10 new pension funds that became exposed to O&G shares and only 5 that exited from O&G, resulting in a net increase of 5 pension funds exposed to O&G. This result is intriguing and would suggest that the majority of European pension funds opted to remain or join the O&G after the Paris Agreement. However, this method of measuring the exposure to a sector may not reflect long-term investment strategies, as it may encompass relatively short-term exposures to a given sector. To mitigate this issue, we count the number of funds that were exposed to O&G for the majority of the pre- and post-Paris Agreement periods (i.e., at least 3 years between 2010-2014 and 5 years between 2015-2023) and find that almost half of the 32 funds exposed to O&G in the majority of the pre-Paris period exited from this sector (15 funds) - a finding that seems aligned with the notion that a significant share of European pension funds divested from the O&G sector after the Paris Agreement.

Panel A of Table 4.2 presents the share of portfolio invested in O&G after the Paris Agreement. Overall, the statistics indicate that all indices, as well as the exposed pension funds, reduced their average exposure to O&G companies in the 2015-2023 period. Next, we check to what extent the reduction in the exposure of pension funds was significantly larger than the mean indices. As shown in Panel B, we can observe that between 2015-2017 the differences between the two groups were similar. However, a significant gap emerges in 2018, when pension funds reduced their exposure to O&G more than the indices. This gap is widened further through the end of 2023, driven mostly by a further decline in pension fund´s mean exposure (with a peak of -57,25% in 2023). Overall these findings suggest that the decrease of O&G exposure by pension funds was (i) driven by broad market movements immediately after the Paris Agreement, and (ii) accelerated, after 2018, when compared to the overall market.

Table 4.2: Share of Portfolio invested in O&G after Paris Agreement

Notes: Table 4.2 presents the share of fossil fuel companies' market capitalization presented in Table 3.3, as well as, the average evolution of the average percentage of the pension funds most of the period portfolios allocated to fossil fuel companies after the Paris Agreement. Statistical significance is based on an accumulated one-sample t-test as explained in Section 4.2. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Year	FTSE 350	S&P 500	STOXX 600	STOXX ESG	Indices	Exposed pension funds
Panel A. %Portfolio						
2010–2014	5.97%	7.08%	2.11%	1.34%	4.12%	1.39%
2015	4.06%	4.19%	1.49%	0.79%	2.26%	0.79%
2015–2016	4.74%	4.51%	1.80%	0.94%	2.59%	0.90%
2015–2017	4.71%	4.28%	1.90%	0.96%	2.56%	0.87%
2015–2018	4.81%	4.01%	1.98%	0.99%	2.55%	0.79%
2015–2019	4.71%	3.65%	1.98%	0.99%	2.47%	0.72%
2015–2020	4.35%	3.08%	1.87%	0.93%	2.23%	0.64%
2015–2021	4.11%	2.72%	1.74%	0.88%	2.07%	0.60%
2015–2022	4.10%	2.85%	1.87%	0.89%	2.12%	0.58%
2015–2023	4.03%	2.82%	1.93%	0.86%	2.10%	0.56%
Panel B. %Portfolio evolution rate from Pre to Post Paris Agreement						
2015	-31.03%	-40.84%	-29.28%	-41.08%	-36.86%	-32.96%
2015–2016	-20.59%	-36.37%	-14.50%	-29.63%	-26.14%	-28.97%
2015–2017	-21.11%	-39.52%	-9.85%	-27.79%	-25.21%	-33.07%
2015–2018	-19.40%	-43.45%	-6.23%	-26.06%	-24.24%	-41.03%*[a]
2015–2019	-21.00%	-48.42%	-5.99%	-25.99%	-25.48%	-45.29%**[b]
2015–2020	-27.11%	-56.49%	-11.42%	-30.16%	-31.07%	-51.45%**[c]
2015–2021	-31.05%	-61.59%	-17.62%	-34.04%	-35.67%	-55.16%**[d]
2015–2022	-31.34%	-59.82%	-11.46%	-33.66%	-33.99%	-56.64%***[e]
2015–2023	-32.45%	-60.16%	-8.30%	-35.44%	-34.36%	-57.25%***[f]

Confidence intervals:

[a] CI = [-0.64, -0.23]; [b] CI = [-0.69, -0.27]; [c] CI = [-0.73, -0.36];

[d] CI = [-0.76, -0.41]; [e] CI = [-0.77, -0.43]; [f] CI = [-0.79, -0.43].

To further solidify the abovementioned results we compare the evolution of each pension fund´s exposure individually with the confidence intervals shown in Table 4.2. Untabulated

results show that 24 pension funds permanently divested from O&G since 2018, while 11 pension funds maintained a significant exposure. For the purposes of the next section, we will label the former pension funds as "exit".

4.3.2 What are the key drivers of exit strategies from the perspective of the *pension funds*?

In this section we explore two levels of drivers of exit strategies, both linked to the pension funds: (i) pension fund features (e.g., size, exposure, persistant of exposure, type of fund) and (ii) characteristics of the fund's country of headquarters (e.g., Fossil and renewables dependence, GDP per capita, greenness, and CPI energy).

At the fund-level, Table 4.3 reports the regression coefficients of the logistic regression on the likelihood of pension funds assuming an exit strategy. The results show that the funds that exited are significantly smaller (i.e., have lower AUM), and had a smaller portfolio exposure to O&G companies before the exit (% Portfolio). These findings, which are confirmed by mean comparison tests (untabulated), are aligned with the literature and suggest that smaller funds are more flexible (Atta-Darkua et al., 2022; McDonnell, 2024) and hence are in a better position to eliminate carbon-related risks, such as stranded assets or reputational risks (Becht et al., 2023; Egli et al., 2022) by exiting from brown sectors. Importantly, in line with Agency Theory, active engagement with investee companies may be infeasible due to the high fixed cost of active monitoring (Bauer et al., 2022). On the other hand, funds with a relatively funds with high portfolio exposure may face difficulties unwinding their positions (blockholders), and are more inclined to pursue voice strategies, as they have greater exposure (Jang et al., 2024). We do not find statistically significant differences between the two groups in terms of the number of years that pension funds are exposed to O&G companies or the likelihood of being a public pension fund - contrary to the findings by Egli et al. (2022).

Table 4.3: Key drivers of the exit strategy: pension funds characteristics

Notes: Table 4.3 presents logistic regression results on the fund determinants of portfolio reduction ($Exit_{i,t}$ = 1) vs non-reduction group ($Exit_{i,t}$ = 0). All explanatory variables are lagged by one year. Coefficients are reported as odds ratios, with cluster-robust standard errors (by fund) in parentheses. All models include year fixed effects, and country fixed effects. Multicollinearity was assessed using the variance inflation factor (VIF). There are no concerns with multicollinearity (VIF<5). Variable definitions appear in Table 3.1. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Dependent Variable:			$Exit_{i,t}$		
Model:	(1)	(2)	(3)	(4)	(5)
AUM_{t-1}	0.30				0.20**
	(0.26)				(0.15)
$\%Portfolio_{t-1}$		0.87			0.67*
		(0.32)			(0.13)
$Years\ of\ Exposure_{t-1}$			0.94		1.05
			(0.05)		(0.08)
$Public_{t-1}$				1.07	1.72
				(0.78)	(1.38)
Year & Country FE	Yes	Yes	Yes	Yes	Yes
Robust errors	Yes	Yes	Yes	Yes	Yes
Observations	264	280	280	264	280
Pseudo R^2	0.265	0.242	-0.028	-0.044	0.099

With respect to the country-level features, the results presented in Table 4.4, Model (1) and (6) indicate that fossil fuel dependency of the country where the fund is located has a negative effect on the likelihood of exit (Model 3 and 5). This result suggests that pension funds are less likely to reduce exposure to Oil&Gas companies when the fund is located in a country that is more economically dependent on fossil fuels. This is consistent with institutional theory (DiMaggio & Powell, 1983), as fossil-fuel dependence may create path dependence, political constraints, and stronger local legitimacy for carbon-intensive industries. It also supports the findings of Alessi et al. (2024), which show that investors remain more exposed to transition risks in economies where climate transition is more difficult.

Additionally, renewable energy dependency is also negatively associated with exit (Models 2 and 6). Under the previously discussed SRI strategies, this result could be interpreted as indi-

cating that funds with greater renewable energy consumption do not necessarily follow a pure exclusion strategy. Instead, they may combine green reallocation with continued ownership of O&G companies, which is consistent with ESG integration and divest-invest approaches discussed by Busch et al. (2024). This interpretation also seems aligned with portfolio management theory (Eugene F. Fama, 1993; Markowitz, 1952; Tobin, 1958), since pension funds may retain some Oil&Gas exposure for diversification, benchmark, or fiduciary reasons.

Table 4.4: Key drivers of the exit strategy: pension funds' country of headquarters

Notes: Table 4.4 reports a logistic regression for the macro determinants of portfolio reduction ($Exit_{i,t} = 1$). All regressors are lagged one year. Coefficients are odds ratios with cluster-robust SEs (by fund) in parentheses. All models include year and fund fixed effects (no country fixed effects). Fund controls used were AUM, Portfolio, and Years of Exposure. All variables present VIF values below 3, which do not indicate relevant multicollinearity concerns. Variable definitions in Table 3.1. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Dependent Variable:	$Exit_{i,t}$					
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Fossil GDP$_{t-1}$	0.58**					0.68**
	(0.13)					(0.12)
Renewables$_{t-1}$		0.95**				0.94***
		(0.03)				(0.02)
GDPpc$_{t-1}$			1.01			1.10**
			(0.04)			(0.04)
Greenness$_{t-1}$				1.01		1.06
				(0.05)		(0.04)
CPI Energy$_{t-1}$					1.03	1.00
					(0.02)	(0.03)
Funds controls	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	No	No	No	No	No	No
Observations	280	280	280	280	280	280
Adj. Pseudo R^2	0.150	0.214	0.095	0.094	0.098	0.275

Interestingly, the findings reported in Model 6 show that GDP per capita (GPCpc) is positively and significantly associated with exit from O&G, suggesting that pension funds are more likely to reduce O&G exposure in wealthier countries. This finding is consistent with the idea that developed economies have greater institutional, financial, and technological capacity to absorb the costs of the energy transition (Semieniuk et al., 2022; Shen et al., 2024).

Conversely, the pension funds´ country greenness score remains insignificant in the post-Paris Agreement. This result is somewhat intriguing and could be driven by a substitution between investor discipline vs the institutional setting. Namely, if a country's environmental laws are able to effectively push O&G companies toward transition, institutional investors located in these countries may feel less pressured to actively avoid the O&G sector (Dyck et al., 2019). Finally, in our setting energy inflation does not appear to influence portfolio reduction after the Paris Agreement, which could be explained by the commodity-pricing literature that suggests that energy prices may exhibit mean reversion, reducing the relevance of short-term energy inflation for strategic divestment decisions (Bessembinder et al., 1995).

4.3.3 What are the key drivers of exit from the perspective of the *O&G companies*?

In this section we explore two levels of drivers of exit strategies, both linked to O&G companies: (i) O&G features (e.g., E_Rating, ROE, and DPS) and (ii) characteristics of the O&G companies' country of headquarters (e.g., Fossil dependence, greenness, CPI energy, and continent home bias).

Table 4.5 shows the results regarding the analysis of which features of the invested O&G companies significantly influence the likelihood of pension funds´ exit. Overall, the findings presented in Models 1-3 indicate that, when studied in isolation, both the environmental performance (E_Rating) and financial performance metrics (ROE and DPS) influence the exit decision, with the expected sign. Namely, pension funds are more likely to exit from O&G companies with a lower environmental and financial performance. These results are confirmed by untabulated mean comparison tests. However, Model 4 shows that, when considering both types of variables, only the environmental rating remains significant. This result is novel in the literature and highlights the increasing relevance of ESG performance for companies in brown

sectors, as they are seen to strengthen market confidence (Broadstock et al., 2021; Lins et al., 2017).

Table 4.5: Key drivers of the exit strategy: O&G companies characteristics

Notes: Table 4.5 presents logistic regression results on O&G company determinants of portfolio exit ($Exit_{i,t}$ = 1). All explanatory variables are lagged by one year. Coefficients are reported as odds ratios, with cluster-robust standard errors (by fund) in parentheses. All models include year fixed effects, but no country fixed effects. Variable definitions appear in Table 4.1. Fund controls are used namely AUM, %Portfolio, Years of Exposure, CPI Energy, Fossil GDP, Greenness and Renewables. GDPpc of the fund is not included since VIFs are higher than 5. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Dependent Variable:	$Exit_{i,t}$			
Model:	(1)	(2)	(3)	(4)
E_Rating$_{t-1}$	0.98***			0.97***
	(0.01)			(0.01)
ROE$_{t-1}$		0.04**		0.57
		(0.06)		(1.40)
DPS$_{t-1}$			0.63*	1.58
			(0.17)	(0.69)
Funds controls	Yes	Yes	Yes	Yes
Country fixed effects	No	No	No	No
Observations	280	280	280	280
Adj. Pseudo R^2	0.271	0.237	0.240	0.264

With respect to the features of O&G countries of headquarters, the results presented in Models 1-4 of Table 4.6 show that pension funds are less likely to exit from O&G companies located in countries with higher energy inflation (Model 2) or greater levels of greenness (Model 4). These results are consistent with untabulated mean differences tests. Regarding the energy inflation, it seems intuitive that O&G companies are likely to directly benefit from higher revenues when energy inflation is high domestically. A similar relationship is not observed when studying the energy inflation at the pension funds´ country of headquarters, as shown in Table 4.4, given that the revenues of pension funds are not directly tied to the domestic energy CPI,

but those of O&G companies are.

Interestingly, when including all country-level variables in Model 5, we observe that the level of greenness is the only variable to retain significance. This result contrasts with the absence of significance of greenness of the pension funds' country as a determinant of exit (Table 4.4). This finding suggests that investors may consider the level of greenness of the invested country as a complementary or reinforcing signal, similarly to what was discussed regarding the environmental performance. Namely, a pension fund investing in an O&G company operating in a country with a high greenness score is likely to feel less tempted to use exit as a disciplining mechanism - in line with Bauer et al. (2022), Broadstock et al. (2021), and Lins et al. (2017). Our results suggest that exit strategies are not materially influenced by GDP per capita or home bias.

Table 4.6: Key drivers of the exit strategy: O&G companies' country of headquarters

Notes: Table 4.6 reports a logistic regression for the macro energy company determinants of exit ($Exit_{i,t}$=1). All regressors are lagged one year. Coefficients are odds ratios with cluster-robust SEs (by fund) in parentheses. All models include year and fund fixed effects (no country fixed effects). Fund controls used were AUM, %Portfolio, Years of Exposure, GDPpc of the pension fund, CPI Energy, Fossil GDP, Greenness and Renewables. Additionally, energy company controls were used: ROE and DPS. Multicollinearity issues were reported. E_Rating, and GDPpc of O&G company are not included since VIFs are higher than 5. Variable definitions in Table 4.1. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Dependent Variable:	$Exit_{i,t}$				
Model:	(1)	(2)	(3)	(4)	(5)
CPI Energy$_{t-1}$	0.62**				0.81
	(0.14)				(0.20)
Greeness$_{t-1}$		0.96**			0.96*
		(0.01)			(0.02)
Fossil GDP$_{t-1}$			0.89		0.94
			(0.18)		(0.19)
Continent Home Bias$_{t-1}$				1.49	2.57
				(0.14)	(0.20)
Funds controls	Yes	Yes	Yes	Yes	Yes
Energy company controls	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Country fixed effects	No	No	No	No	No
Observations	280	280	280	280	280
Adj. Pseudo R^2	0.247	0.270	0.232	0.231	0.258

5 Conclusions

The dissertation examined whether and how European pension funds adjusted their equity exposure to major O&G companies *before* and *after* the Paris Agreement. The analysis was motivated by the growing relevance of climate-related risks for institutional investors and by the debate on whether investors should respond to carbon-intensive sectors through "exit" or "voice" strategies (Broccardo et al., 2022; Krueger et al., 2020). More specifically, the dissertation address two research questions: (i) whether European pension funds were significantly exposed to major O&G companies *before* the Paris Agreement, and which differentiate the exposed group from the non-exposed group and (ii) how this exposure evolve afterwards and which characteristics explain the decision to reduce it.

The empirical evidence shows that European pension funds were already exposed to the O&G sector before the Paris Agreement, although they underweighted the sector relative to equity benchmarks (STOXX 600, STOXX ESG, FTSE350, and S&P 500). Additionally, larger pension funds were more likely to hold O&G companies, which is consistent with the concept of "universal owners" that invest across broad market portfolios (Faller & Knyphausen-Aufseß, 2018; Hoepner et al., 2021). Furthermore, larger pension funds may also have more tools to promote sustainable investments practices within investee companies, which can create stronger incentives to remain invested and engage (Bauer et al., 2024).

After the Paris Agreement, the results indicate that average exposure to O&G companies declined. However, the reduction in comparison with the equity benchmarks was not immediate. The decline became more pronounced from 2018 to 2023, suggesting that pension funds responded to the low-carbon transition gradually and selectively. At the fund level, smaller pension funds and funds with lower exposure were more likely to reduce their holdings. These findings suggest that smaller funds may face lower adjustment costs and stronger incentives to divest, while larger funds may have stronger incentives to remain invested and potentially use engagement&voting in O&G companies (Bauer et al., 2022; Dordi et al., 2023; Jang et al., 2024).

Country-level characteristics help explain exit decisions. Pension funds located in more developed economies and in countries with lower fossil fuel dependency were more likely to reduce exposure. This is aligned with Alessi et al. (2024), Dyck et al. (2019), and Shen et al. (2024) who show that institutional and economic environment in which investors operate may shape their ability and willingness to adjust portfolios. At the company level, pension funds appear increasingly likely to retain or exit O&G companies depending on perceived transition credibility, measured by greenness.

Overall, these findings suggest that European pension funds are not simply abandoning the O&G sector. Rather, they seem to reallocate capital selectively across companies and countries. This contributes to the literature by showing that post-Paris investment behaviour is driven by both financial and non-financial goals, as well as by country-level transition environment.

This dissertation has some limitations. Firstly, the analysis focuses exclusively on equity exposure and does not consider the role of fixed income instruments as an investment tool. Secondly, the sample is restricted to large O&G company in 2014 and to European pension funds for which ownership and AUM could be matched. Thirdly, the classification of divestment is based on changes relative to market benchmarks and does not directly explore the internal motivations behind each fund´s decisions.

Future research could extend this analysis by exploring the "voice" sub-group, examining whether funds engage through board representation, shareholder voting, or direct dialogue, and assessing whether portfolio constraints make exit difficult. In addition, to complement the existing literature, it would be useful to examine the impact of the "exit" strategy on the carbon emissions of the O&G company, as a measure of their transition towards a net-zero carbon economy.

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A Appendix

A.1 National net zero pledges and share of global CO_2 emissions covered

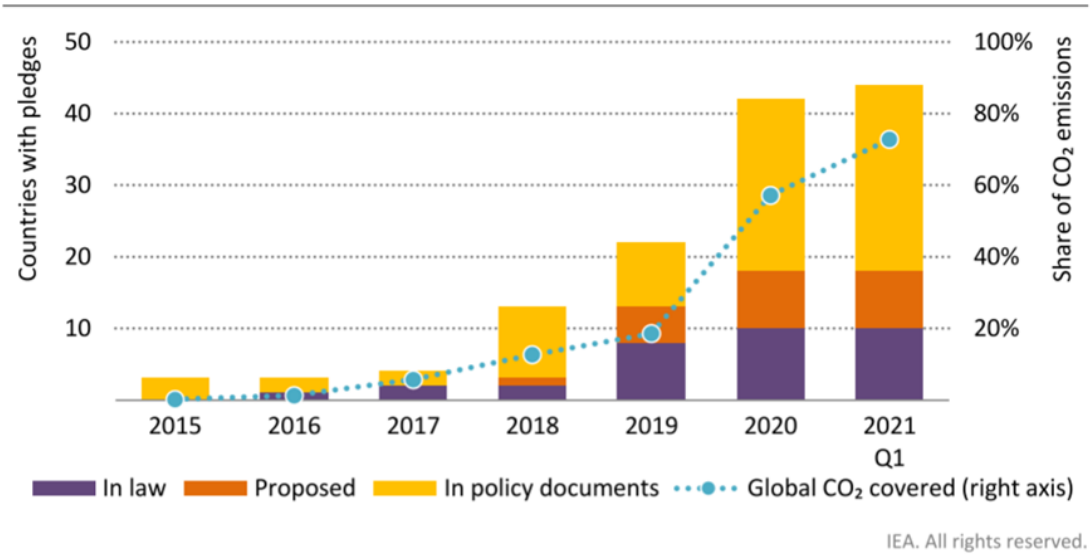

Figure A.1: Number of national net zero pledges and share of global CO_2 emissions covered (**IEA33**)

Note: "In law = a net zero pledge has been approved by parliament and is legally binding. Proposed = a net zero pledge has been proposed to parliament to be voted into law. In policy document = a net zero pledge has been proposed but does not have legally binding status."

A.2 Classification of Exit pension funds

To classify pension funds strategies into "Exit", we take the following steps[1]:

1. Compute the weight of the O&G exposures in the funds' portfolios for the period *before* the Paris Agreement:

[1] However, due to (RQ2a) findings and oppositely from (RQ1), it was used only the pension funds which comply with the "most of the period" criteria (35 pension funds). In this way, we can prevent from short-lived or sporadic exposures making the sample more selectively to the ones that really were persistently exposed

$$\overline{\%\text{Portfolio}}_{2010-2014} = \left(\frac{\sum_{j=1} \text{Value}_{2010-2014}}{\sum_{j=1} \text{AUM}_{2010-2014}} \right) \times 100 \tag{A.1}$$

2. Compute the weight of the O&G exposures in the equity indices for the period *before* the Paris Agreement:

$$\%\text{EquityPortfolio}_{2010-2014} = \left(\frac{\sum_{j=1} \overline{\text{MarketCapitalization}_{2010-2014}}}{\sum_{j=1} \text{MarketCapitalization}_{2010-2014}} \right) \times 100 \tag{A.2}$$

3. Compute the weight of the O&G exposures in the funds' portfolios for the period *after* the Paris Agreement:

$$\overline{\%\text{Portfolio}}_{t,2010-2014} = \left(\frac{\sum_{j=1} \text{Value}_{t,2010-2014}}{\sum_{j=1} \text{AUM}_{t,2010-2014}} \right) \times 100 \tag{A.3}$$

4. Compute the weight of the O&G exposures in the equity indices for the period *after* the Paris Agreement:

$$\%\text{EquityPortfolio}_{t,2010-2014} = \left(\frac{\sum_{j=1} \overline{\text{MarketCapitalization}_{t,2010-2014}}}{\sum_{j=1} \text{MarketCapitalization}_{t,2010-2014}} \right) \times 100 \tag{A.4}$$

5. Compute the portfolio pension funds evolution rate from the period *after* and *before* the Paris Agreement:

$$g_{t,2010-2014} = \frac{\overline{\%\text{Portfolio}}_{2010-2014,t} - \overline{\%\text{Portfolio}}_{2010-2014}}{\overline{\%\text{Portfolio}}_{2010-2014}} \times 100 \tag{A.5}$$

6. Compute the equity portfolio evolution rate from the period *after* and *before* the Paris

Agreement

$$g_{t,2010-2014} = \frac{\%\text{EquityPortfolio}_{2010-2014,t} - \%\text{EquityPortfolio}_{2010-2014}}{\%\text{EquityPortfolio}_{2010-2014}} \times 100 \quad \text{(A.6)}$$

7. Compare the simple mean of portfolio pension funds evolution rate (Exposed pension funds) with equity portfolio evolution rate (Indices) performing a one-sample t-test - see Table 4.2

8. For the cases that the one-sample t-test is statistically significant, the threshold was based on the minimum "material" variation measured by the confidence interval of the one sample t-test (i.e, the point at which indices began reducing their portfolio exposure beyond the "natural" decrease). That means that, when the t-test significantly supports that the share of pension funds portfolio holdings differ from the benchmark index holdings, hence, the pension fund is having a statistically different behaviour compared with the market [2].

[2] For the insignificant intervals, it was used the most recent information (eg, for the periods 2015, 2015-2016 and 2015-2027 was used the information regarding period 2015-2018, assuming that pension funds took longer time to incorporate the Paris Agreement in their decisions.

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