Divestment From Fossil Fuels: Evidence From Ownership Data

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Abstract

There is a lot of talk about fossil divestment. Is there any action? We built a new database on investor divestment based on ownership data. Instead of focusing on prices, we look at the actual ownership of investors. Our database contains 30 million investor positions in the 312 largest fossil fuel companies. We show that certain religious organizations, universities and public organizations divested from fossil fuel. Looking at all large investors, we find a heterogeneous behavior between short- and long-term divestment. Using a Structural Vector Autoregression (SVAR) and a Vector Error Correction model (VECM) both resulting from behavioral assumptions, we find that commodity price returns are the major drivers of short-term divestment and environmental and climate policy likelihood exhibit a cointegration relationship with long-term divestment. It shows that investors react strongly to fluctuations in the market energy prices in the short term. Only very few investors adjust their fossil fuel holdings in the long term, considering the risk of climate and environmental policy implementation.

Keywords: Divestment, Climate finance, Ownership structure, Stock market
JEL Classification: G11, G32.

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1 Introduction

Harvard, the Vatican, and the London Borough of Hackney Pension Fund have something in common. They have all divested from fossil fuel companies. They, along with 1670 other institutions, took a public divestment commitment (Global Fossil Fuel Divestment Committement database, 2024). While the number of institutions seems impressive, it is unclear if large investment managers followed suit. There is indeed a lot of talk of fossil fuel divestment. But is there any action? Here, we look at hard evidence from investor portfolios to determine whether fossil fuel divestment is gaining traction, as the climate crisis worsens.

Divestment is a way for investors to shun stocks they do not like, for moral or other reasons. There have been divestment campaigns in the context of the South African Apartheid or for tobacco companies. While there is some evidence that divestment impacts share prices in the short run (Dordi and Weber, 2019), the impact in the long run seems limited. With management compensation being linked to long-term share prices, short-term price shocks are unlikely to change the course of action of fossil fuel companies (Bolton and Kacperczyk, 2023). But while there may only be a short-term price effect, divestment can still lead to change. Divestment creates anti-fossil fuel norms (Green, 2018), which can eventually lead to a change in the mode of energy production. The point of divestment is, therefore, not to impact share prices directly, but rather to progressively ban fossil fuel assets from the list of "socially acceptable" investment vehicles. (Braungardt et al., 2019).

Divestment campaigns work in steps: Ansar et al. (2013) argue that successful divestment has three phases. It starts with religious organisations, then universities, followed by public investors. Finally, once these three early investors had divested, the broader investment community will follow. In this paper, we proceed in two steps. First, we start by looking into micro evidence of divestment in these three classes of investors (religious, academic and public). Then, we take a macro approach and try to see if there is a global divestment movement from all large investors. For the macro approach, we take a short-term and long-term lens. Building a database of 30 million fossil investment positions, we find that in the short term, investors mostly sell their fossil shares in the wake of a recession or when the oil price drops. But not for climate-related reasons. Taking a longer time horizon, we see some weak evidence of climate uncertainty (or transition risk) having an impact. Overall, we find that apart from religious, academic and public investors, divestment is not widespread yet, despite the worsening of the climate crisis.

Our paper, despite the data limitations discussed in the methodology, makes a significant contribution to the literature by being the first to directly examine investors' portfolios, rather than relying solely on proximate indicators of divestment such as price movements or news announcements.

Investors who do not want to divest can voice their concerns through shareholder engagement, which has generated a large literature (Dyck et al., 2019; Azar et al., 2021; Lewellen and Lewellen, 2022; Kakhbod et al., 2023). They can talk directly or indirectly to the boards of the companies in which they invested. This approach is outside of the scope of this paper, where we focus exclusively on divestment, even if both policy can be used jointly (Kölbel et al., 2020; McDonnell and Gupta, 2024) . Also, in the context of the climate crisis, there is doubt whether this approach is effective. Blackrock has been a major investor in ExxonMobil since the investment fund was established(Li et al., 2022; Lim, 2021). Yet, despite constant engagement from Blackrock, ExxonMobil is still not aligned with Paris compliant scenarios (Supran and Oreskes, 2017). So, while it might be useful for minor issues, it is unclear if engagement with fossil fuel companies will yield the change needed to reach IPCC climate targets.

Dewenter et al. (2010) show that divestment announcements by sovereign wealth funds have an impact on share returns. Other studies have taken various approaches, including establishing theoretical foundations for understanding these movements (Ansar et al., 2013; Ayling and Gunningham, 2017; Green, 2018), examining the impact of divestment on the stock market valuations of fossil fuel companies (Dordi and Weber, 2019; Halcoussis and Lowenberg, 2019; Bassen et al., 2021; Becht et al., 2023), and assessing the implications for portfolio performance among investors adopting divestment strategies (Boermans and Galema, 2019). Other research seems to also show that fossil fuel investments are not essential in a diversified portfolio. Trinks et al. (2018) show portfolios excluding fossil fuel investments that do not under-perform others, and that including fossil fuels provided limited diversification benefits, though it might depend on the speed of divestment (Marupanthorn et al., 2024). Another concern is the timing of the sample of these studies in regards to the performance of fossil fuel companies. But according to Plantinga and Scholtens (2021), the performance of fossil free portfolios holds even under market conditions benefiting fossil fuel companies.

To get an overview of the literature, Braungardt et al. (2019) offer a review of the arguments on whether fossil fuel divestment has an impact on climate issues. In a more recent review, Plantinga and Scholtens (2024) that fossil fuel divestment debates focus on justification, impact, and agency, highlighting the 'carbon shield' that protects firms from accountability, while noting the growing range of perspectives but limited environmental and financial effects. But our question here is not whether the policy is effective, but rather if large investment managers have started divesting. And why.

In addition, with an approach close to ours, Egli et al. (2022) conducted a study focusing on the factors influencing divestment announcements by European pension funds. While their study is insightful and thorough, it is limited to European pension funds and the data only comes from official divestment announcements, not investors' portfolio data as we explore. This is true of many empirical studies on this subject, which examine divestment announcements rather than the actual act of divestment itself. Here, we look at actual portfolio data, not announcements. We aim to understand investors' actions, not only their communications. And we focus only on the world's largest investors, not all investors or institutions.

Thus, while considerable research has been devoted to understanding various aspects of divestment, there is still much to explore regarding the underlying factors driving divestment decisions and the actual outcomes of divestment strategies. Addressing these gaps will improve our understanding of the effectiveness and implications of divestment. So we ask: Can we identify global divestment movements? And what factors contribute to their emergence?

In terms of methods, we study the determinants of fluctuations in this divestment, whether in the short or long-term. We pose two hypotheses: one that describes the behavior of divestment as being subject exclusively to fluctuations in the energy market, and another that describes the behavior of divestment as resulting from the risk of implementing an environmental policy. We then test these two hypotheses by modeling divestment behavior using an SVAR and a VECM. We find that both hypotheses are verified, and there is heterogeneity in divestment behavior depending on our formal definition of divestment.

2 Fossil Fuel ownership data

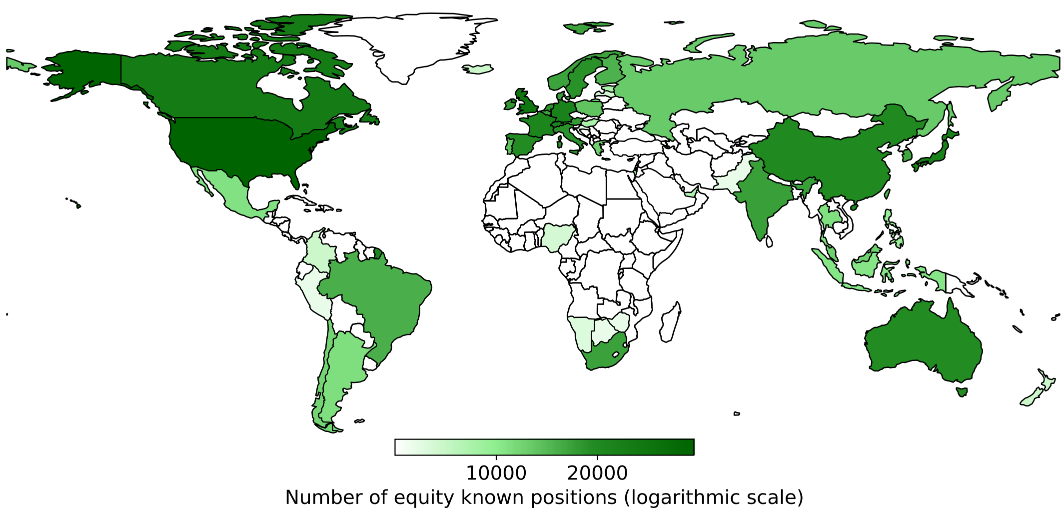
We rely on data provided by Fossil Free Index Solutions (FFI Solutions) through "Carbon Underground 200" database.[1] It contains a registration of the 100 largest publicly-listed coal reserves owners and the 100 largest publicly listed Oil and Gas reserves owners. The time period includes 2004Q1 to 2021Q4. This dataset is a good source of information as it tracks 98% of proven and probable coal reserves, 97% of proven gas reserves and 98% of oil reserves owned by publicly listed companies. We focus on these companies because keeping this potential CO2 underground remains one of the biggest challenges we face in limiting global warming. We extract all the fossil fuel producers included in this dataset and build two novel databases, one using Bloomberg data and the other using Refinitiv data, both comprising all equity investors reported by the data providers. The reporting scheme is supported by regulatory bodies such as the Securities and Exchange Commission in the US (SEC). Investors are required to maintain an equity position exceeding $100 million dollars in order to trigger mandatory reporting

[1] See https://www.ffisolutions.com/

obligations. It is a threshold, meaning we select only investors that hold enough assets. This ensure we cover the largest investment managers.

Figure 1 shows the geographical spread of the different investors in the database. The coverage is global with more data for OECD countries and an over-representation of the United States and United Kingdom. Despite this OECD focus, the database still shows investors from many high and middle income countries, with low income countries being underrepresented.

Figure 1: Geographic spread of investors



Note: Average number of investor position in fossil fuel companies over the years 2004-2022, based on Refinitiv. This is an overview of our sample.

On Refinitiv, we collected data as a percentage of ownership in a fossil fuel company. On Bloomberg, we collected data on the number of shares held.

We build these databases by combining manual and automated (using API) data extraction from Refinitiv and Bloomberg. The creation of these databases required powerful computing to both extract and merge the multiple datasets. Extracting data from Bloomberg required a surprising amount of manual work, potentially explaining why such a project had not been done before.[2] We choose to rely on two different sources

[2]Extracting the data from Bloomberg involved over 100 hours of copy-pasting from the terminal by a research assistant and one of the authors. The issue remained even after contacting Bloomberg customer service and consulting several Bloomberg experts .

because Bloomberg allows us to explore smaller investors and Refinitiv turned out to be more robust for larger investors.

This results in two databases encompassing over 12 million (Bloomberg) and 21 million (Refinitiv) data entries. The data is at quarterly frequency, showing all the largest investors into the 200 largest fossil fuel companies over time (or 312 companies in total).

Table 1 shows the characteristics of the two databases. This makes it possible to assess their strengths and weaknesses in order to determine their usefulness.

Table 1: Bloomberg and Refinitiv databases features

	Nb. entries	Time length	Nb. Companies	Nb. Investors	Nb. Countries	Investors type	Av. %
Refinitiv	21 100 752	2004Q1-2021Q4	312	26 871	107	23	60%
Bloomberg	12 647 100	2004Q1-2021Q4	100	31 147	N/A	N/A	N/A

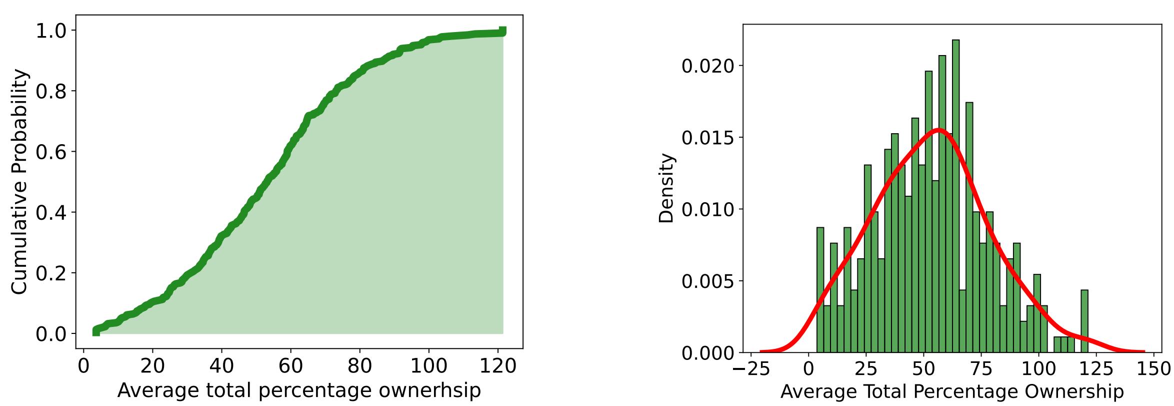
As shown, the Refinitiv database contains over 20 million observations, including 312 fossil fuel companies and over 26,000 unique investors gathered in 23 investor-type classifications. They are located in over 100 countries around the world and span a period from 2004Q1 to 2021Q4. These metrics demonstrate a rich database that captures an average of 60% of positions in each company. Moreover, Refinitiv also offers the advantage of listing either 0, when it is known that an investor has no stake in a company, or N/A, when no data is available, which is fundamental when trying to capture any divestment decision.

On the other hand, Bloomberg contains over 12 million observations, including 100 oil and gas companies and over 31,147 unique investors spanning from 2004Q1 to 2021Q4. Unfortunately, in our database, Bloomberg does not provide information on countries and types of investors, and it is limited to 100 companies due to the extremely time-consuming manual extraction process.

Unlike Refinitiv, Bloomberg lists 0 for both cases when no data is available or when the company has divested. This is problematic and could lead to some false positives, and this is why we use the Refinitiv database in the statistical analysis. However, as the Bloomberg database lists more investors, we use that additional richness in our descriptive presentation of divestment statistics.

Another argument in favor of Refinitiv is that in around 60% of companies, we capture more than 50% of their capital ownership structure. This can be seen in Figure 2a, which shows the cumulative distribution function, and Figure 2b, which displays the distribution density. Note that some errors in reporting timing have led to numbers above 100%. For example, reports of a merger being poorly captured in the database could lead to two companies owning 60% of a company, leading to ownership levels above 100%. This is a major limitation of the data, yet as we focus on divestment, it affects our study less. We are mostly interested in investors going from some position (no matter how much), to zero as we will show. Yet, the figure shows that Refinitiv enables the exploration of data at a more aggregated level, whereas Bloomberg is more effective at zooming in on smaller investors.

Figure 2: Average total percentage ownership distribution (Refinitiv data)



(a) Cumulative density function

(b) Probability density function

Database limitations

As far as we know, the data set we present in this paper is the first of its kind in its long time frame and breadth of ownership of fossil fuel companies. It also presents the distinct advantage of looking at actual ownership data and not relying on the communication by the institutions themselves. This ensures that the actors we analyze have completely divested from fossils and not just made an announcement. It is also coming from two distinct sources, allowing for cross checking. Yet, despite these advantages, this data set comes with limitations.

First, we might miss investments if they pass the threshold to be reported to government financial supervisors. This might also involve some investors becoming smaller over time and disappearing while they have divested. This means we might think a company has divested when its investment simply became too small to be reported. This is an important issue with the dataset.

In the analysis, we show how we mitigate these concerns, but our approach is far from bulletproof. Another way to phrase this is that the data set is precise for very large investors. So, Blackrock's positions are likely reported precisely. For smaller investors, the data becomes noisier.

To summarize, the data quality is far from perfect, and we do our best to take this into account. Yet using this dataset remains interesting for researchers, as it is the only way to know for sure when investors sold a position, instead of simply trying to guess from the price. These limits prevent us from directly entering the analysis and modeling the raw data. It is advisable to operate transformations to be able to extract the rich quantity of information that this base offers us.

3 Micro level: Identifying Divestment Trends Among Selected Religious, Academic and Public Investors

3.1 Investor Selection

To gain an initial understanding of divestment, we examine the areas where the literature suggests divestment is most likely to occur. This exploration is purely descriptive and relies on our databases. Drawing on divestment theory (Ansar et al., 2013) and the key actors historically associated with it, we focus on identifying the largest number of investors within three categories often linked to divestment: religious organisations, universities, and public investors. The methodology for identifying investors in these categories is detailed in the following paragraph. A key limitation of our dataset is its focus on the world's largest investors, as they are more likely to report to regulatory agencies or make their data publicly available. As a result, universities, which often do not fall into the largest investor category, may be underrepresented. This initial assessment only analyses part of our dataset, the main contribution in the macro approach uses the full dataset.

Religious organizations

On the Refinitiv data set, we did not find many religious investors except for the Methodist Church and the American Bible Society. We found more religious organizations on Bloomberg and performed a systematic search detailed here.

The search was done by looking for religion-related keywords in investors' names. Most keywords did not yield anything. The most frequent keywords in the chosen investors were "church "(21), "catholic" (16), "union" (8), "Jewish" (8) and "holy" (7). The sample is likely biased toward the Global North, explaining the larger representation of the Catholic religion. Islamic finance might also limit investments to companies that follow the Sharia principle, which might not be true for many companies in our sample.

Universities

For universities, we started with the 100 largest North American universities by endowment as listed by the National Association of College and University Business Officers in 2022. Because of their large portfolios, these are likely to appear in our Bloomberg and Refinitiv investors dataset. The majority of universities with over $1 billion in endowments are in North America, but we also added to the list some of the other largest universities in the world with over $1 billion endowment.

As the largest universities do not always invest in their own name, we tried to match each university with an investment fund. For example, the Massachusetts Institute of Technology has MIT Investment Management Company (MITIMCo) as an investor name. We also searched our database for any investor with the term "university" or "college" in their Refinitiv and Bloomberg investor names. We excluded Universities Superannuation Scheme Limited (USS) as it is not a university but a pension fund.

One of the limitations of our approach is that it does not offer a comprehensive view of the universities' portfolios, but only shows the ownership shares, that are large enough to be reported to regulators and, therefore, are in our database. Others have searched for divestment announcements, offering a broader data set but not offering objective reporting on the behavior of the actors, only what they communicated.

Public investors

Finally, "public investor" is the most loosely defined of our three categories. We searched for investors with the keywords "state", "region", "Republic", "national", "county" or "public" in their name. We then manually removed investors that were not public, such as "State Street" for example, which contains the keyword "state" but is not public.

We added the largest public investors: sovereign wealth funds and public pension funds. We focused on the 100 largest public pension funds compiled by the Sovereign Wealth Fund Institute (SWFI) and available online. We also added any investor listed as "government" by the Refinitiv classification. This classification is not ideal, but it offers a starting point.

Table A1 (in the Appendix) summarizes the number of unique investors and investor positions our database offers. While there are limited unique investors, these are all existing large investors of that category for which we have publicly available information. In the next section, we will isolate the investment behavior of these actors to see if they divested from fossil fuels as expected by the literature.

3.2 Empirical divestment on selected investors

The next few paragraphs analyze evidence of divestment from the most likely candidates identified above: religious organizations, universities and public investors. Spotting divestment in our dataset is a bit like spotting a snow leopard in Mongolia: a very rare occurrence.

Note that both these representations are imperfect, because the sample has investors coming in and out of the sample. Still, survival rates and overall divestments offer some insight into divestment. We now turn to some significant case studies of divestment in the next section.

3.2.1 Religious organizations

Is there evidence of divestment by religious organizations at large? Looking at our datasets, we found two noteworthy investors to analyze in terms of divestment. Catholic investors divested after an appeal by the Pope and the Methodist Church sold fossil investments. Religious organizations are known for their responsible investment practices (Williams, 2007) and they are often presented as pioneers in this field (Goodman, 2015).

Catholic divestment in 2015

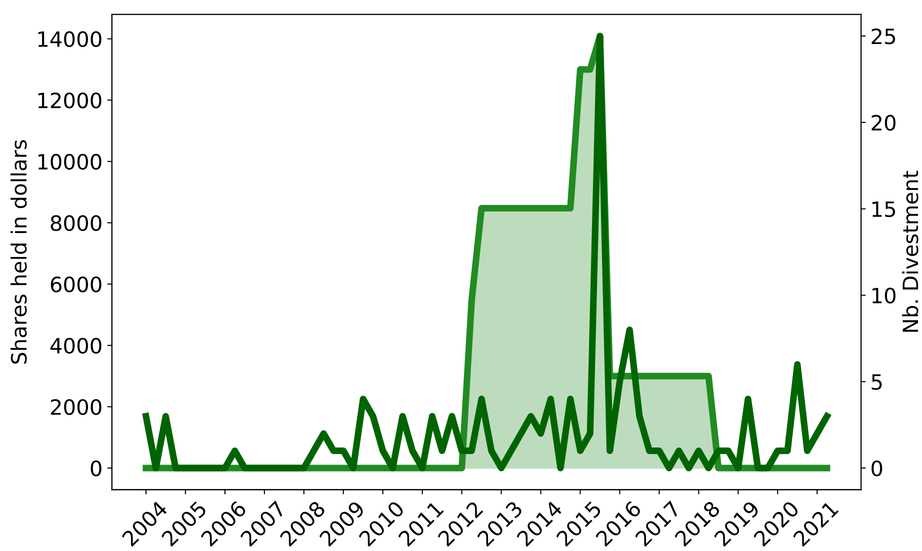
In May 2015, Pope Francis issued an encyclical (or doctrinal document) on climate. The appeal specifically targeted fossil fuel companies (Schiermeier, 2015). The appeal from Pope Francis starts by noting the failure of international finance: "The failure of global summits on the environment make it plain that our politics are subject to technology and finance." There are "too many special interests" blocking true progress on climate. The solution is to replace fossil fuel companies: "We know that technology based on the use of highly polluting fossil fuels – especially coal, but also oil and, to a lesser degree, gas – needs to be progressively replaced without delay."

In the quarter following the appeal, 16 Catholic investors in our database divested from fossil fuel companies. The database shows divestment out of 128 positions in fossil fuels. These are only the investors for which we have data, but it is likely that other Catholic investors divested at the time. As Figure 3 shows, there was a spike in divestment among religious organizations during the quarter after the appeal by Pope Francis.

While the Methodist Church is a decentralized entity, we have information on its British branch. We know the movements of the Central Finance Board of the Methodist Church which manages the British investments of the church. As an investor, the Central Finance Board of the Methodist Church "seeks both superior returns and improved ethical standards" according to its website. It also has an approach "of avoiding investments in particular businesses and encouraging better practices". They are clearly an active ethical investor.

Looking at the Methodist Church, there seems to be evidence of divestment for that particular institution. It is hard to broaden this finding to other religious organizations. In 2013, the church sold a position in Chevron. In 2015, the church sold some more fossil holdings. And finally, in 2019, it sold its share in BP, Rio Tinto, Anglo American and Centrica. It only kept its investments in Satoil and TotalEnergies, perhaps because these companies have a more open approach to the climate transition or higher ecological standards.

Figure 3: Religious organization vs Methodist Church divestment



Note: This figure illustrates the divestment within the religious organizations and the Methodist Church. The dark green line represents religious organizations divestment according to the case 3 of the divestment filter (right y-axis). The light green area represents Methodist Church evolution of shares held (left y-axis). Source Bloomberg.

3.2.2 Universities

There is a large literature on universities and their divestment campaigns (Deeks, 2017; Maina et al., 2020). Here we present some aggregate data and look at Harvard as a case study. We also look at all universities that still have fossil positions and compare this to their divestment claims. In 1987, Harvard University was already involved in debates around divestment linked to the Apartheid (Hartman, 1987). More recently, Harvard was the theater of a large divestment campaign.

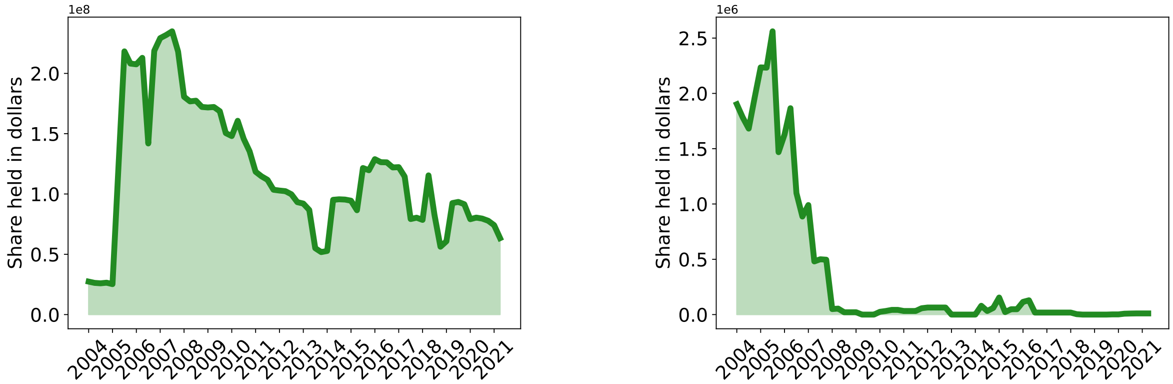
We start by presenting the data for all universities we found before focusing on specific cases.

Looking at our dataset, based on the data collection methodology explained in the data section, we found investment data for 27 universities globally. Figure 4a shows that the number of shares held by universities in the fossil fuel sector has fallen sharply since the mid-2000s, although there was an increase in 2015. Dynamics are more pronounced when looking at the Harvard-specific case.

Harvard

In the dataset we built, Harvard is the university with the most data entries because it has the largest endowment of any university in the world. In our limited dataset, which captured only large investments, Harvard had invested in 38 different fossil fuel companies over time. Figure 4b below reports the number of shares held by Harvard University from 2004Q1 to 2021Q4. It seems that Harvard was a forerunner in divesting from the fossil fuel sector. They liquidated almost all their position by 2008. This could also be influenced by the global financial crisis but it is noteworthy that the institution began to divest in 2006.

Figure 4: Universities vs Harvard divestment



(a) Universities

(b) Harvard

Note: This figure illustrates the evolution of shares held by universities over time (right side) and the same evolution specifically for Harvard University (left side). Source Bloomberg.

3.2.3 Public investors

Pension funds

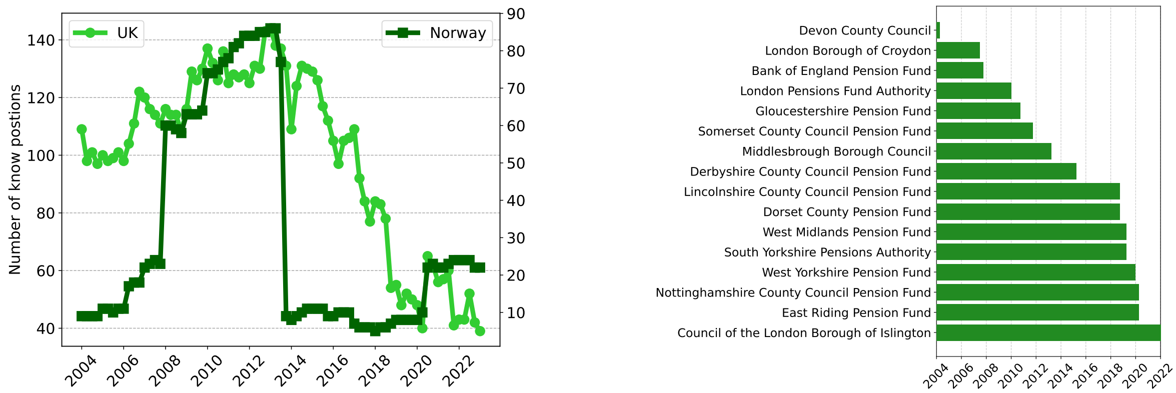
We identify the investment of 240 pension funds in 29 countries. Most of these pensions funds are public, but not all. We start by looking at the common behavior of all pension funds. Looking at pension funds by country, two countries stand out in their number of fossil fuel ownership positions in our dataset. As Figure 5a shows, Norway experienced a massive drop in the number of investments because one pension fund, Kommunal Landspensjonskasse, divested. The fund manages the pensions of municipal employees in Norway. It drastically reduced the number of its investments in fossil fuel companies, though it still has some fossil fuel positions to date.

There was also evidence of divestment in the UK. We find that 84% of UK publicly owned pension funds in our dataset have divested from fossil fuel companies. Figure 5b below lists these pension funds and their divestment dates.

Other public actors

While companies related to public activities, such as public pension funds, are starting to show signs of divestment, things are different when looking at the balance sheet of sovereign investors. States in both high-income and medium-income countries own majority shares in fossil fuel companies.

Figure 5: Public investors divestment



(a) Norwegian vs UK pension funds

(b) UK pension funds divestment date

Note: The figure displays the evolution of equity position held by Norwegian and UK pension funds over time (left-hand side), and the date when UK pensions funds completely divested from fossil fuel companies (right-hand side). For the left-hand side figure, the left y-axis is assigned to Norwegian pension fund holdings, and the right y-axis for the UK pension funds.

Looking at sovereign wealth funds, there is little evidence of divestment. Ireland Strategic Investment Fund seems to have dropped all of its 143 positions in fossil fuel companies in late 2016. Another potential divestor is Temasek Holdings Private Limited, the sovereign wealth fund of Singapore. It had invested in up to 19 fossil fuel companies but is fossil free in our dataset since July 2022. Beyond these two exceptions, there is no evidence of divestment by sovereign wealth funds. Many governments still have strategic investments in fossil fuel companies: The Polish government has a majority share in three large Polish fossil fuel companies, Italy owns a third of the fossil fuel company Eni, France owns 23% of Engie, India has several majority shares in Indian fossil fuel companies, Norway owns 69% of Equinor as well as a majority share in other companies and Saudi Arabia owns over 94% of Saudi Aramco. These large majority shares show that many governments are still largely involved in the business of fossil fuel extraction. Our dataset only covers publicly listed fossil fuel companies and excludes unlisted large state-owned fossil fuel companies, as is the case in Venezuela or Iran, for example.

We find that religious organizations, universities and public investors divested. But what about other investors? In the next section, we bunch together all the observed divestment movements and try to explain potential explanations for this divestment.

4 Macro level: Investor Behavior in Divesting from Fossil Fuel Companies

4.1 Divestment Detection Algorithms

In this section, we explain our divestment detection methodology. This methodology is then used in the quantitative section. Considering the strengths and weaknesses of our databases, we decide to filter using an 'if' condition procedure. Moreover, we create four divestment cases ranging from the most general to the most restrictive definition. We present each case below:

Case 1: Short-term divestment targeted

We define the short-term divestment targeted as the liquidation of all positions in a firm at a given point in time. It gives the following condition:

$$d1_{i,t}^{j} = \begin{cases} 1 & \text{if } Y_{i,t-1}^{j} \neq 0 \ \ \& \ Y_{i,t}^{j} = 0 \\ 0 & \text{otherwise} \end{cases}$$

Case 2: Short-term divestment widespread

We define the short-term divestment widespread as liquidating all positions in all firms at a given point in time.

$$d2_{i,t}^{j} = \begin{cases} 1 & \text{if } Y_{i,t-1}^{j} \neq 0 \ \ \& \ \sum_{j=1}^{M} Y_{i,t}^{j} = 0 \\ 0 & \text{otherwise} \end{cases}$$

Case 3: Long-term divestment targeted

We define the long-term divestment targeted as the liquidation of all positions in a firm permanently.

$$d3^j_{i,t} = \begin{cases} 1 & \text{if } Y^j_{i,t-1} \neq 0 \ \ \& \ \ \sum_{t=1}^{T} Y^j_{i,t} = 0 \\ 0 & \text{otherwise} \end{cases}$$

Case 4: Long-term divestment widespread

We define the long-term divestment targeted as the liquidation of all positions in all firms permanently.

$$d4^j_{i,t} = \begin{cases} 1 & \text{if } Y^j_{i,t-1} \neq 0 \ \ \& \ \ \sum_{t=1}^{T} \sum_{j=1}^{M} Y^j_{i,t} = 0 \\ 0 & \text{otherwise} \end{cases}$$

where $Y^j_{i,t}$ = percentage ownership for the investor i in the asset j at time t, and the set of divestment variables $d_{i,t} \in \{d1^j_{i,t}, d2^j_{i,t}, d3^j_{i,t}, d4^j_{i,t}\}$ with the investor i in the asset j at time t.

We developed a formalization called the "divestment detection algorithm," which creates a binary variable to identify divestment behaviors in accordance with our definition. However, these variables alone are not suitable for analysis, which is why we perform an aggregation by period, as shown in Equation 1 below.

$$D_t = \frac{1}{P_t} \sum_{i=1}^{N} \sum_{j=1}^{M} d^j_{i,t} \tag{1}$$

where P_t is the number of known positions at each date t, and $D_t \in \{D1_t, D2_t, D3_t, D4_t\}$ which is an element of the set of the four different divestment cases defined above.

By aggregating the binary variable, we create a time series of divestment counts that can be utilized to analyze trends and patterns in divestment behavior over time. This approach provides a more accurate and insightful view of divestment activity, facilitating the identification of factors that contribute to divestment decisions.

To avoid issues of clear identification of divestment over time, we choose to divide the divestment count by the number of known positions at each instant. This eliminates the potential trend induced by differences in open positions between each period. We call this variable the "divestment rate". The resulting divestment rate time series are displayed in Figure A1 in the Appendix.

4.2 Behavioral assumptions

We posit two hypotheses to understand the factors influencing fossil fuel divestment. First, we show how energy market specific shocks affect short-term divestment, using a framework that considers the interactions between equity and commodity markets. Second, we hypothesize that as the likelihood of environmental policy implementation increases, it pushes investors incorporate transition risks into their decision-making processes.

Hypothesis 1: Shocks on the energy market influence short-term divestment

Let us set up a conceptual framework based on contemporary financial theory. We have two types of agents: (i) firms and (ii) investors. We assume two markets: (i) the equity market, and (ii) the commodity market. The price on the commodities market is fixed outside the model; it is exogenous and changes every period. The quantities traded on this market are assumed to be constant and equal to unity. Firms are producers of fossil fuels and are price takers.

Investors have no other purpose than to invest in fossil fuel companies and seek to get the highest return on their equity investments through dividends and price movements. An important point is that investors can invest without additional costs. We get:

$$\Pi_t = f(P_{c,t}Q_{c,t}, C_t) = f(P_{c,t}, C_t) \tag{2}$$

where $P_{i,t}$ is the profit of the fossil fuel producing firm at date t, $P_{c,t}$ the selling price of commodity c (oil, gas and coal) at date t, $Q_{c,t}$ the quantity of commodity c sold and C_t the production costs. The firm will make a profit from the sale of these fossil fuels. This profit will be (i) reinvested, (ii) redistributed to shareholders and/or (iii) placed in the cash account to prevent future negative events. A positive relationship between profit and dividends paid to shareholders can therefore be deduced. As a result, we define dividends as follows:

$$d^i_{j,t} = a_t \Pi_t = a_t f(P_{c,t}, C_t) = d(P_{c,t}) \tag{3}$$

where $d^i_{j,t}$ represents the dividends paid by firm j to investor i at date t, which is a fraction a_t of the profit, and $d(.)$ is the function resulting from $a_t f(.)$. Also, we determine the fundamental value of each asset, which is the expectation of future dividends discounted. This gives:

$$V_{j,t} = \sum_{t=1}^{T} \frac{\mathbb{E}[d^i_{j,t}]}{(1+r)^t} = \sum_{t=1}^{T} \frac{\mathbb{E}[d(P_{c,t})]}{(1+r)^t} = v(P_{c,t}) \tag{4}$$

where $V_{j,t}$ is the fundamental value of asset j at date t, r is the interest rate, and $v(.) = \sum_{t=1}^{T} \frac{1}{(1+r)^t} \times d(.)$.

We assume a semi-strong form efficiency à la Fama (1970), the market value can be approximated to the fundamental value, we deduce:

$$S_{j,t} \approx V_{j,t} \tag{5}$$

where S_{j_t} is the stock price of firm j at date t.

Stock prices can be expressed as asset returns. We derive:

$$r_{j,t} = \frac{S_{j,t}}{S_{j,t-1}} - 1 = \frac{V_{j,t}}{V_{j,t-1}} - 1 \tag{6}$$

We assume that investors modify their shareholding in firm j on the basis of the variation in their expected returns of the asset, which is the following:

$$D^j_{i,t} = D(\Delta R_{i,t}) \tag{7}$$

where $D^j_{i,t}$ is the divestment decision of an investor i in firm j at date t, and $D(.)$ is the divestment decision function.

Then, the variation of expected returns is expressed as follows:

$$\Delta R_{j,t} = \frac{1}{T}\sum_{t=1}^{T} r_{j,t} - \frac{1}{T-1}\sum_{t=1}^{T-1} r_{j,t} = \delta(r_{j,t}) \tag{8}$$

where $\Delta R_{j,t}$ is the variation of expected returns of the asset j at time , and $r_{j,t}$ is the return of asset j at time t.

Finally, we have :

$$\begin{cases} r_{j,t} = \frac{d(P_{c,t})}{(1+r)^t} \times \frac{1}{v(P_{c,t-1})} \\ D^j_{i,t} = D_1(r_{j,t}) \end{cases} \tag{9}$$

where $D_1(x)$ is the composite function $\delta \circ D$.

The system derived from the behavior of the firm and the investor highlights that the stock market valuation of a company producing fossil fuel depends on the price of this fuel exchanged on the wholesale market. This is done through the profit channel which impacts the distribution of dividends to shareholders. This stock market valuation impacts the behavior of the firm's investors since at each period, they evaluate the evolution of the expected returns of their portfolio composed of fossil fuel producing companies. Finally, this evolution determines their choice to maintain their shareholding in each of the firms making up their portfolio.

Hypothesis 2: The likelihood of environmental policy implementation influences long-term divestment.

We expect that investors consider the environmental policy likelihood as a transition risk. Let us assume the transition risk $T_{c,t}$ as a stochastic process with memory following a unknown distribution $F(\theta)$ with at least its first moment m_t (expectation) that exists:

$$T_{c,t} \sim F(\theta) \tag{10}$$

$$m_t = E_t(T_{c,t}|T_{c,t-1}, ..., T_{c,t-k}) \tag{11}$$

As an implication of recent findings on the relationship between transition risks and financial performances of firms (Reboredo and Ugolini, 2022), we can assume based on the hypothesis 1 mechanism that an integration of a climate transition risk would have the following consequences:

$$\Pi_t = f(P_{c,t}, C_t, m_t)) \tag{12}$$

We can compare this transition risk cost to a regulation or a tax that would be implemented within the fossil sector, and it forces the firm to invest more in the transformation in of its activity.

Without demonstrating the underlying mechanisms again, the incorporation of a transition risk leads us to the following system:

$$\begin{cases} r_{j,t} = \frac{d(P_{c,t}, m_t)}{(1+r)^t} \times \frac{1}{v(P_{c,t-1}, m_t)} \\ D^j_{i,t} = D_1(r_{j,t}) \end{cases} \tag{13}$$

Referring to financial theory on the transmission of information, we can interpret that investment decisions are made directly after the release of an environmental policy risk news. This suggests that investors directly integrate the transition risk into their choice of divestment, knowing the causal chain that follows, which will be used in the structural VAR.

4.3 Empirical results

4.3.1 Short-term divestment behavior

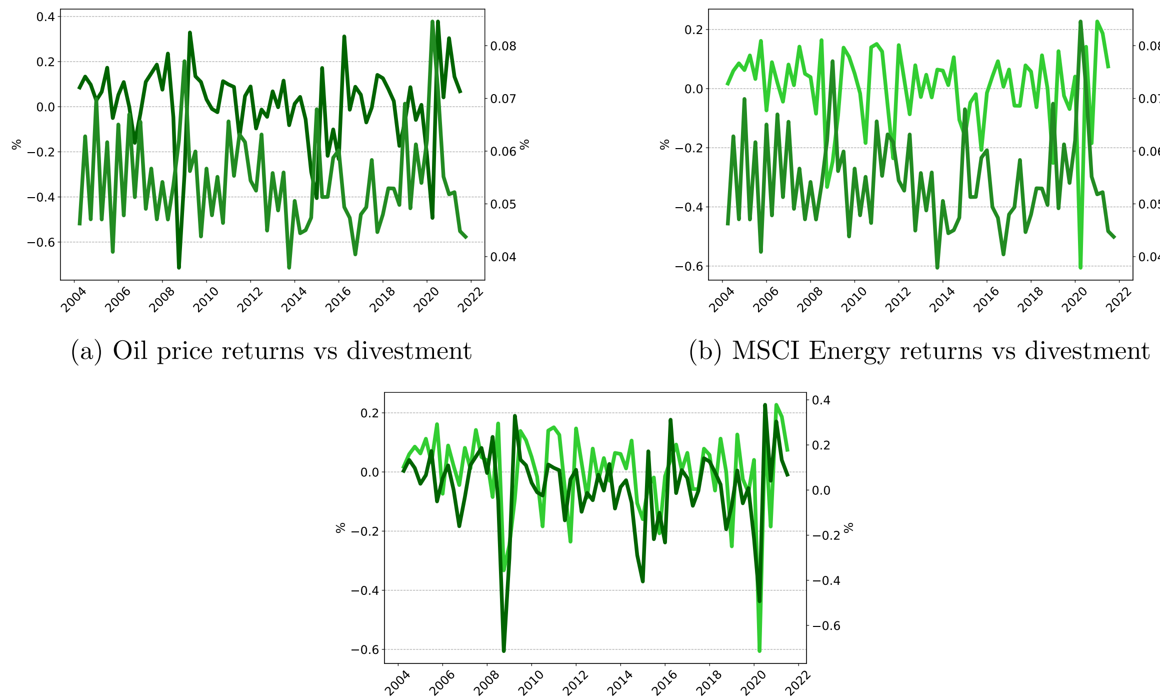
Do investors divest when the oil price drops? The objective is to assess whether the short-term divestment behavior derived from the model is empirically verified or whether there are components of this behavior that are not justified by contemporary financial theory. We use exclusively the short-term divestment from Case 1: that is, an investor selling all shares of a fossil fuel company for a short time. This would be, for example, a hedge fund selling all of their ExxonMobil shares for three quarters.

In order to model the interactions within the model illustrated by Equation 9, we choose three variables: (i) for the divestment behavior: the series constructed in Section 1, which determines the divestment rate in the fossil sector for each period (the number of investors selling one of the 312 fossil fuel companies for a period). (ii) for the price of fossil fuels: WTI crude oil, which represents the price of oil on the US market. As WTI crude oil is the price that influences the price of fossil fuels at the global level, this variable, therefore, includes the price dynamics of the three fossil fuels (oil, gas and coal) at a global level. Using an alternative oil price would yield similar results. These data come from the St. Louis Fed (FRED) on a quarterly basis and are not adjusted for seasonality. As for the divestment rate, the period used is 2004Q1-2021Q4. (iii) for fossil fuel stock prices: the MSCI Energy Index, which tracks the price dynamics of fossil fuel companies worldwide. These data come from the provider Eikon Refinitiv and are also unadjusted for seasonality over the period 2004Q1-2021Q4 at a quarterly frequency.

Table A2 in the Appendix lists the descriptive statistics of the three variables considered. The variables are correlated contemporaneously, as shown in Table A3 the correlation matrix in the Appendix. We can see that the divestment rate is negatively correlated with MSCI Energy Return and Oil Price Return. Also, MSCI Energy and Oil Price Return are positively correlated (see Figure 6). These correlations highlights that a contemporaneous relationship between the three variables is possible, which is consistent with the system derived in Hypothesis 1 (Section 4.2).

Yet, the relationships between the variables may be subject to reverse causality and time-delayed effects. This is why we use an SVAR modeling. It allows us to take into account both contemporaneous and lagged interactions between variables.

Figure 6: Variables co-movements



(a) Oil price returns vs divestment

(b) MSCI Energy returns vs divestment

(c) Oil price returns vs MSCI Energy returns

Note: This figure shows the fluctuations variables taken from Hypothesis 1 in Section 4.2.

We impose short-term restrictions on structural relationship following the system derived behavioral assumptions in Hypothesis 1. The structural decomposition equation looks as follow:

$$\begin{bmatrix} a_{11} & 0 & 0 \\ a_{21} & a_{22} & 0 \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{bmatrix} u_{1t} \\ u_{2t} \\ u_{3t} \end{bmatrix} = \begin{bmatrix} \epsilon_{1t} \\ \epsilon_{2t} \\ \epsilon_{3t} \end{bmatrix} \tag{14}$$

where $\epsilon_{i,t}$ is the structural shock for variable i in time t, and $u_{i,t}$ the reduced-form errors for the variable i in time t.

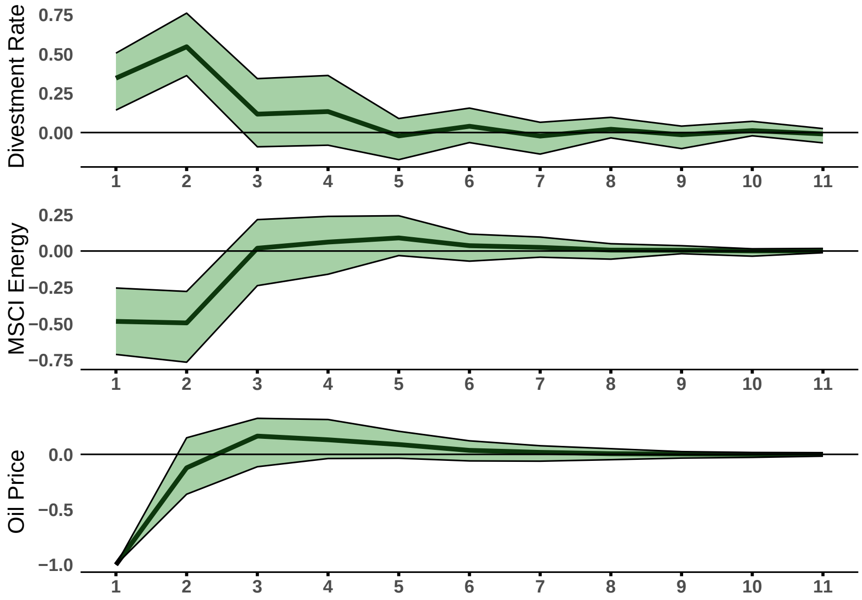
In this structural form, a_{ij} represents the contemporaneous effect of the structural shock from variable j on variable i. Specifically, a_{1j} captures the influence of oil price return shocks on the other variables. This structure assumes that oil price returns ($j = 1$) directly influence MSCI Energy returns ($j = 2$) and the divestment rate ($j = 3$), but are not contemporaneously affected by them. MSCI Energy returns, in turn, are influenced by both oil price returns and their own idiosyncratic shocks, but not by the divestment rate within the same period. Lastly, the divestment rate is contemporaneously impacted by both oil price returns and MSCI Energy returns. This hierarchy reflects the assumed causal ordering of the system reflecting the Hypothesis 1 (see Section 4.2).

Figure 7 shows the impulse response functions following a negative shock to oil and coal price returns. For the oil/gas sector: stock price returns in the fossil fuel sector decrease on average by half a standard deviation over a two-quarter period, spreading to investors and having an instantaneous positive impact on the sector's divestment rate over a two-quarter period. For the coal sector, the implications remain the same but the magnitude of the responses to the coal price shock is smaller. The average responses are lower than those for the oil sector and the confidence interval bands are close to 0. Nevertheless, the effects remain significant at the 95% confidence level. We also run additional Granger test in Table A4 and Table A5 in the Appendix.

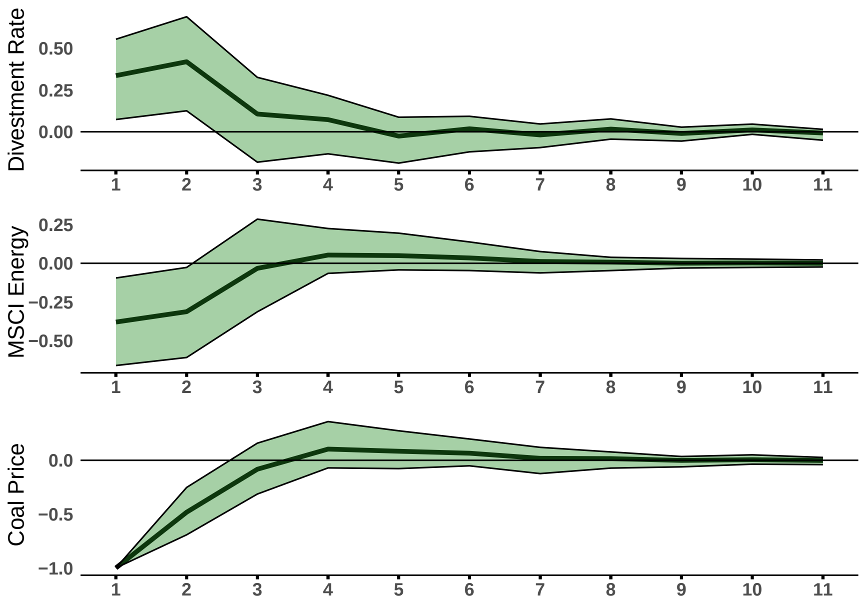
Coal investors are less sensitive to fossil fuel price shocks compared to oil and gas investors. This difference may be attributed to the ownership structure of coal companies, as many in our sample are predominantly state-owned. Consistent with Hypothesis 1, governments and parent companies represent a larger share of investors in the coal sector than in the oil and gas sector. Unlike return-seeking investors, these entities prioritise ownership to maintain decision-making power rather than solely to maximise returns. As a result, their investment behaviour is less influenced by market dynamics, making them less responsive to shocks in energy commodity prices.

A final implication of the models is the stability of the coefficients over time (Figure A2a and Figure A2b in the Appendix). This is true for both models. This reinforces the argument that no break in the relationship occurred during the study period. The relationship between the variables is stable throughout the period.

Figure 7: SVAR Impulse response function



(a) Oil price returns shock



(b) Coal price return shock

Note: We set the number of lags at 2 according to AIC, HQ, SC and FPE criteria. Confidence intervals are calculated at a 95% confidence level using the bootstrap method.

4.3.2 Long-term divestment behavior

Environmental policy variables

To evaluate how climate change influences investor behaviour, we use climate risk indicators. These text mining indicators aim to capture the perceived risk associated with the implementation of policies designed to combat climate change, offering insights into how uncertainty in this domain affects investment decisions. We use the following indicators: the climate policy uncertainty indicator (Gavriilidis (2021)), the climate and environmental policy uncertainty indicator (Noailly et al. (2022)), and the climate change indicator (as identified in media sources).

The climate policy uncertainty indicator constructed by Gavriilidis (2021) reports the appearance of words related to climate change or the implementation of future climate policies in eight US newspapers with international visibility. It is also negatively correlated with CO2 emissions at the US level, demonstrating its robustness in the perception of climate change.

The second indicator constructed by Noailly et al. (2022) scans more than 80,000 US press articles in 10 US newspapers. They identify the appearance of terms related to the “ecological transition”, “energy”, the “environment” and “climate change”, as well as terms related to the implementation of climate policy. Then, they build the indicator by classifying the terms identified in the different articles (via a support vector machine method) according to whether they are in favor or against climate action.

The third indicator measures the perception of climate change in the world through news in the press. It is constructed by MeCCO (Media and Climate Change Observatory) and records the appearance of terms related to climate policy implementation in newspapers around the world (Hayakawa et al., 2024). However, the interpretation as an indicator of climate policy uncertainty at the global level is rather weak. Its ability to capture the perception of climate change in all countries, especially the most important ones, is rather weak. For example, it includes only two Chinese newspapers.

Cointegration relationship with divestment

We choose the divestment indicator showing investors that have permanently (at the time of measure) sold all their fossil fuel positions (Case 4 above). The goal is to see if they see a transition risk and have decided to completely abandon the sector. Environmental policy uncertainty and divestment variables are order 1, so we analyse their interactions at level.

Cointegration allows testing for long-run relationships among variables of the same order, which applies to our case. To test cointegrating relationships, it is common to perform a Johansen test. Table Table A7 in the Appendix reports the results of this test for the six models posed above. By comparing the statistics calculated from the trace and the critical values (5% risk), we can see that all our models present one cointegrating relationship, except the model that links the coal divestment and the climate policy uncertainty variable.

Table 2: Model definitions

	Variable 1	Variable 2
Model 1	Divestment Oil & Gas	MeCCO
Model 2	Divestment Oil & Gas	Environmental Policy Index
Model 3	Divestment Oil & Gas	Climate Policy Uncertainty
Model 4	Divestment Coal	MeCCO
Model 5	Divestment Coal	Environmental Policy Index
Model 6	Divestment Coal	Climate Policy Uncertainty

The presence of these cointegration relationships supports our Hypothesis 2, which states that there is a relationship between transition risk and divestment. To verify this intuition, it is essential to model the dynamics between our variables. To do this, we opt for a vector error correction model that takes into account the cointegration relationships between the variables as well as short-term adjustments.

This type of modeling also allows us to assess the impact of shock on the variables and their change in long-term equilibrium. It is defined as follows:

$$\Delta y_t = \beta_0 + \Pi Y_{t-1} + \sum_{i=1}^{K} \beta_i \Delta y_{t-i} + u_t \tag{15}$$

with $\Pi = \alpha\beta'$ where α is the short run adjustment coefficient vector and β the cointegrating vector (long run relationship). Imposing restrictions on the order of the variables allows us to clearly identify the two vectors making up the Π matrix. In fact, the long-run coefficient vector β gives us the strength of the long-run relationship between the variables. Table A6 lists the long-term coefficients for the models. We can see that the long-run relationship between divestment and environmental policy risk is quite strong. This is corroborated by Table 3, which lists the results on the divestment equation for the estimation of each VECM model. We can see that the error correction term, which measures the speed of adjustment between the divestment variable and the environmental policy risk, is significant at the 5% threshold and is fairly strong. Its values range from -0.31 to -0.65. This indicates that when environmental policy uncertainty varies by 1 standard deviation in the following period, divestment varies by around -0.5 standard deviations for the oil and gas sector and by around -0.3 standard deviations for the coal sector. As in the case of short-term divestment, the greater sensitivity of the oil and gas sector can be explained by the greater involvement of investors subject to the laws of the financial markets in their financing structure.

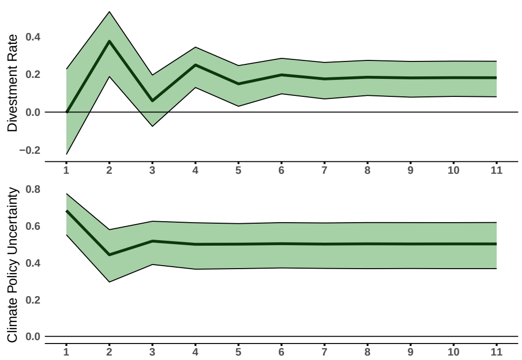
Table 3: VECM divestment results

	Model					
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-0.0624	-0.1929.	-0.0580	0.0097	-0.3407	0.0243
ECT	-0.5857**	-0.6579**	-0.6357**	-0.3130**	-0.1519	-0.3493**
Divestment OG_t-1	-0.9021**	-0.8970**	-0.9343**			
Divestment Coal_t-1				-0.7203**	-0.6704**	-0.7634**
MeCCO_t-1	0.3744			0.4104.		
Env. Policy_t-1		0.4029*			0.3407	
Climate Policy Un._t-1			0.4935**			0.1958

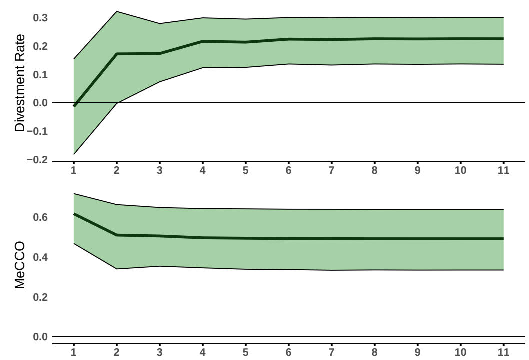
Note: Signif. Codes: ***: 0.01, **: 0.05, *: 0.1. *Abbreviations*: ECT stands for Error Correction Term.

To illustrate these results, we analyze the impulse response functions from the VECM shown in Figure 8. The divestment rate (for oil and gas and coal gathered) responses is positive and significant following either a shock from Climate Policy Uncertainty or MeCCO index. Note that the Environmental Policy Index, unlike the two others, is not significant at a 5% level. It shows the same sign however and is significant at a 10% level. These IRFs support our estimates. Following a positive shock from environmental policy uncertainty variables, long-term divestment, whether oil and gas or coal, reacts positively and with a permanent effect (except for the Environmental Policy Index). In other words, the increasing risk of environmental policy implementation, particularly in the fossil fuel sector, leads to an increase in long-term divestment according to the data used in this paper. The increased transition risk is linked to some of the long-term divestment by investors.

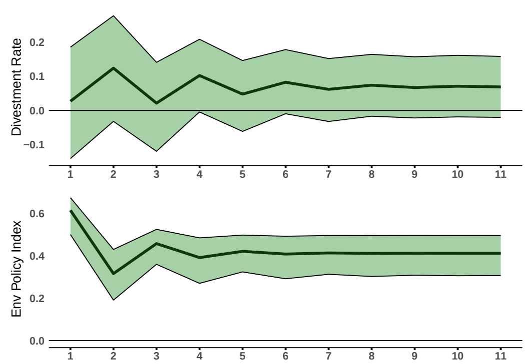
Figure 8: VECM Impulse response functions



(a) Climate policy uncertainty shock



(b) MeCCO shock



(c) Environmental Policy Index shock

Note: The confidence intervals are calculated at a 95% confidence level using the bootstrap method.

5 Conclusion

Fossil fuel divestment remains fringe behaviour among large investors. Most investors, and especially large ones, still own fossil fuels, this despite the numerous public announcements by many institutions on divestment. So while there is a lot of talk of fossil fuel divestment, among large investors there is little action. This does not mean that they might not reduce some holdings, something this study does not analyse. When investors do divest from fossil fuel shares, it is because of shocks to the fossil fuel price, and not other considerations.

With the most pragmatic approach possible, we build two large databases that would allow us to extract divestment behavior and show that divestment behavior exists among targeted investors (religious, academic and public investors). Our study is, to our knowledge, the first to look at divestment from an investor portfolio angle, and not from public announcements. This allows to see what large asset managers are actually doing, not just what investors are saying. As stressed in the paper, the approach is limited by data quality issues. Despite these issues, we still offer a credible identification to find new elements about fossil fuel divestment.

We identify two hypotheses that have been justified by a conceptual framework and test their relevance using an SVAR and a VECM. We find that short-term divestment is influenced mostly by variables specific to the energy markets. Long-term divestment is influenced by news on climate uncertainty or transition risk in the fossil fuel sector. Investors decide to adjust their long-term behavior accordingly.

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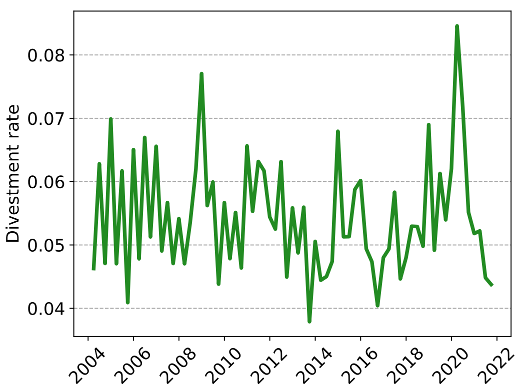
A Appendix

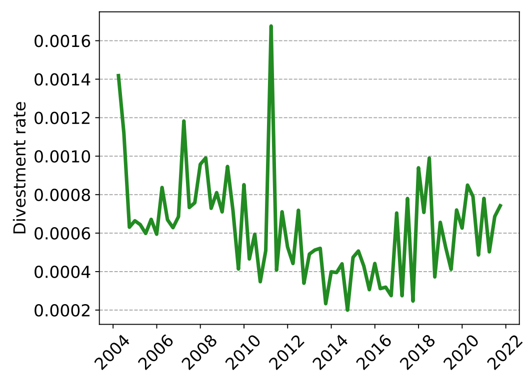
Table A1: Investors selection features

	Source	Number of investment positions	Number of unique investors
Religious organizations	Bloomberg	144	49
	Refinitiv	110	10
Universities	Bloomberg	170	73
	Refinitiv	85	23
Public investors	Bloomberg	1492	234
	Refinitiv	1968	87

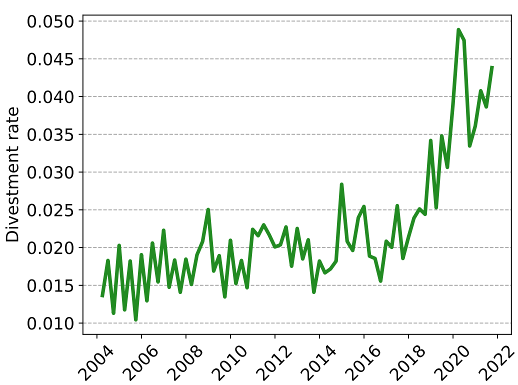
Figure A1: Global divestment movements



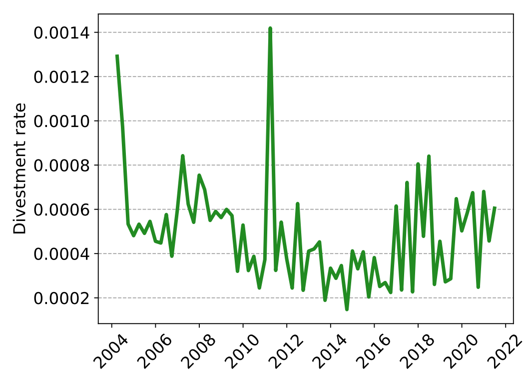
(a) Short-term divestment targeted



(b) Short-term divestment widespread



(c) Long-term divestment targeted



(d) Long-term divestment widespread

Table A2: Summary Statistics

	Divestment Rate	MSCI Energy return	Crude Oil prices return	Coal prices return
Min	0.04	-0.61	-0.71	-0.56
Max	0.08	0.26	0.38	0.43
Mean	0.06	0.01	0.01	0.02
Std. Dev.	0.01	0.14	0.18	0.16
Variance	0.00	0.02	0.03	0.03
Median	0.05	0.03	0.05	-0.00

Table A3: Correlation Matrix

	Divestment Rate	MSCI Energy return	Oil price return
Divestment Rate	1	-0.610	-0.389
MSCI Energy return	-0.610	1	0.596
Oil price return	-0.389	0.596	1

Note: Pearson correlation test is performed. All correlation are significantly different from 0 at 95% confidence.

Table A4: Granger Causality Test for Oil & Gas Sector

Null Hyphothesis : x do not cause y	Res.Df	F	Pr(>F)
Oil Price Return on Divesmtent Oil & Gas	66	11.15	0.0001
Oil Price Return on MSCI Energy Return	66	20.69	0.0000
MSCI Energy Return on Divesmtent Oil & Gas	66	0.15	0.8623
MSCI Energy Return on Oil Price Return	66	2.80	0.0685
Divesmtent Oil & Gas on Oil Price Return	66	0.41	0.6651

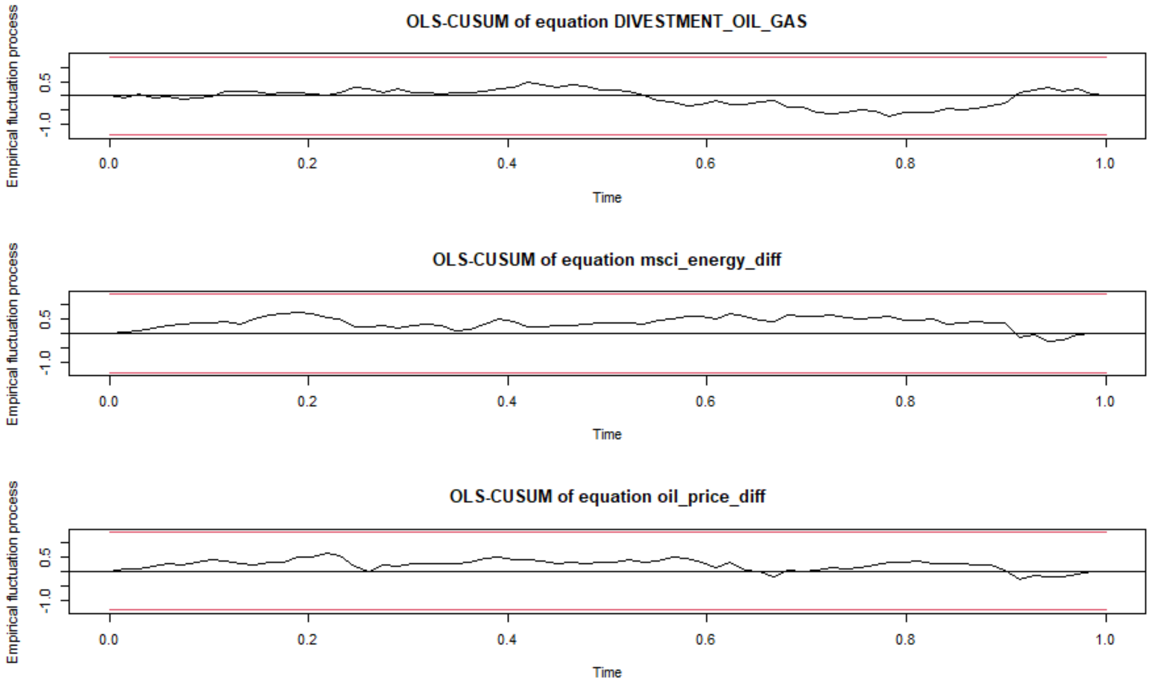
Note: The Granger test tests whether the inclusion of information on an exogenous variable better predicts fluctuations in the variable of interest. The return on the oil price causes, in the sense of Granger, the divestment in the oil and gas sector and the MSCI Energy Return with an error threshold of 5%.

Table A5: Granger Causality Test for Coal Sector

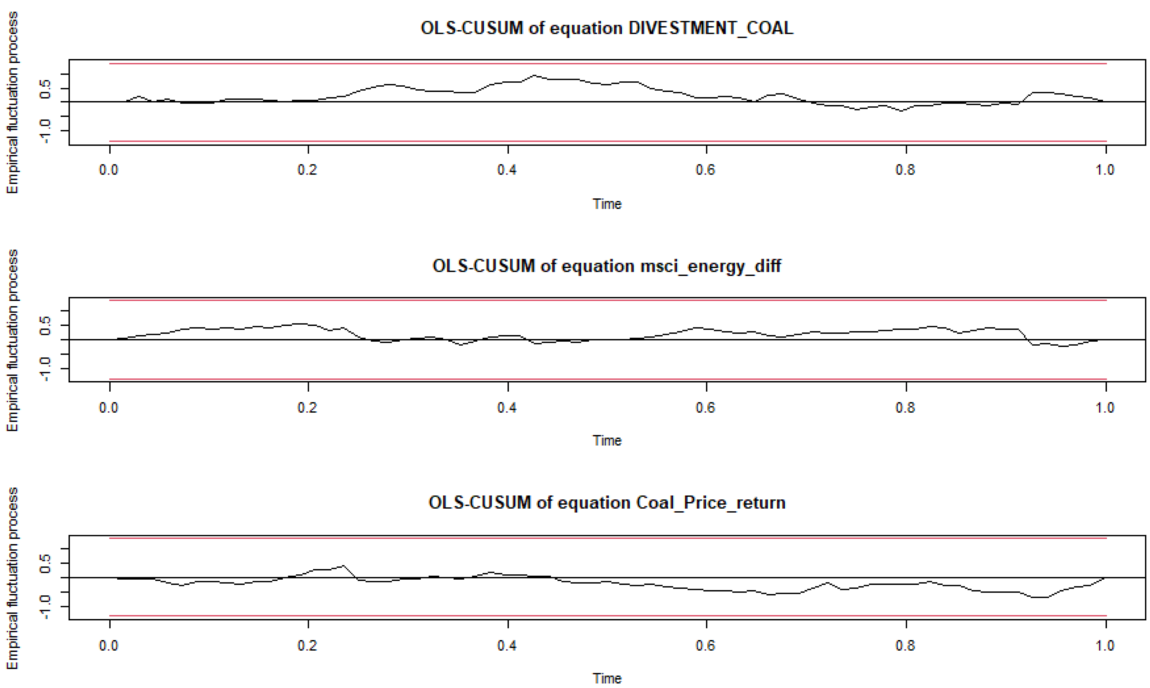
Null Hyphothesis : x do not cause y	Res.Df	F	Pr(>F)
Coal Price Return on Divestment Coal	65	2.73	0.0729
Coal Price Return on MSCI Energy Return	65	3.77	0.0284
MSCI Energy Return on Divestment Coal	65	0.10	0.9017
MSCI Energy Return on Coal Price Return	65	0.13	0.8800
Divestment Coal on MSCI Energy Return	65	0.58	0.5633

Note: The Granger test tests whether the inclusion of information on an exogenous variable better predicts fluctuations in the variable of interest. The return on the coal price causes, in the sense of Granger, the divestment in the coal sector and the MSCI Energy Return with an error threshold of 5%.

Figure A2: SVAR coefficients stability



(a) Coefficients Stability Test for Oil & Gas



(b) Coefficients Stability Test for Coal

Table A6: Long run vector coefficients from VECM

		Model					
		(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Long run coefficients	Divestment	1	1	1	1	1	1
	Env. variable	-0.574	-0.235	-0.535	-0.872	-0.822	-0.591

Note:"Env. variable" refers as either "Climate Policy Uncertainty", "MeCCO", or "Environmental Policy Index" depending on the model.

Table A7: Johansen cointegration tests

Model	$\mathbf{H_0}$	**Trace statistics**	**Critical values 5%**
Model 1	None	31.79	17.95
	At most 1	1.89	8.18
Model 2	None	36.13	8.18
	At most 1	7.18	17.95
Model 3	None	27.44	15.67
	At most 1	3.85	9.24
Model 4	None	18.99	17.95
	At most 1	3.51	8.18
Model 5	None	22.07	8.18
	At most 1	10.27	17.95
Model 6	None	10.08	20.20
	At most 1	3.94	11.65

Note: We define the null hypothesis as the absence of a cointegrating relationship and the alternative hypothesis as the presence of at least 1 cointegrating relationship bounded by $K-1$ (K is the number of variables in the model).