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Finance Working Paper N° 900/2023
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Abstract

A common argument against divestment is that it discards voting power and has a small effect on stock prices. We argue that divestment is a statement of disapproval that aligns actions with words for effectiveness. We show that the Go Fossil Free divestment movement is a narrative with impact. Viral divestment pledges depressed the share prices of all high carbon emitters, including those with no divestment. Peak virality coincided with a concurrent rise in the carbon premium and preceded net-zero commitments. The introduction of these commitments effectively recast divestment from a moral statement to a strategic exercise in risk management.

Keywords: Divestment, fossil free, carbon budget, shareholder engagement, responsible investment, climate change, carbon premium, economic narratives, net-zero commitments, social preferences, Twitter as data

JEL Classification: D23, K22, G32, G34

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1 Introduction

It has been argued that the financial impact of divestment is small because there are too many willing buyers on the other side of the trade, and that therefore engagement is a better approach to addressing environmental, social and governance (ESG) issues (Heinkel, Kraus, and Zechner (2001), Broccardo, Hart, and Zingales (2022)). Yet, divestment is the preferred tactic of climate campaigners and many responsible investors (Global Sustainable Investment Alliance (2020)), with *go fossil free* becoming the fastest-growing divestment movement in history (Howard (2015)). This paper argues that there is no contradiction between divestment and engagement when divestment pledges contribute to changing social preferences. Go fossil free is part of a wider movement that seeks to denounce coal, oil and gas companies. Its success is reflected in the net-zero commitments of many countries, regions, cities, and companies. Divestment has a much larger impact than is reflected in the reduction in shares held by responsible investors because it increases reputation and regulatory risk for fossil fuel companies and high carbon emitters; its effect goes far beyond the negative price pressure on the stock. Divestment pledges are statements of disapproval echoed through social media and the press, which is heard by policy makers, customers, employees, and boards. Through its impact on social preferences and policy, the divestment movement begets further divestment by rational risk averse investors, even those who have no ethical imperative against coal, oil, gas, carbon emissions and climate change. Net-zero commitments from governments have made it riskier to invest in high-carbon emitters, making it rational to decarbonize portfolios.

We show how the fossil fuel divestment campaign has achieved mass-media coverage. The movement has deliberately targeted university endowments, religious groups, foundations, and other renowned institutions with a stock portfolio. Pledges from pension funds and asset managers followed. The number of institutions that have joined the movement grew from 181 in 2014 to 1,591 in 2023 (Global Divestment Commitments Database). In many instances, divestment pledges became viral and preceded net-zero commitments by countries, regions or cities where the divesting institutions have social influence or came from state and private entities that had divested. Moreover, the impact of these divestments is not confined to fossil fuel companies but extends to all high-level carbon emitters, for example the cement industry.

Divestment can be defined as the action or procedure of withdrawing from investments.[5] Divestment pledges are the first stage in the divestment process. They are a verbal censure reinforced by action. Research in behavioral psychology suggests that active commitments, or declarations backed by actions, are more influential in shaping behavior than mere verbal pronouncements. This is particularly true when these actions echo specific values (Isenberg and Brauer (2022), Cioffi and Garner (1996), Cialdini and Trost (1998)).

To illustrate this broader significance of divestment, consider the case of Ireland. The Republic of Ireland was one of the first countries to divest from fossil fuel companies in 2018. In April 2016, Trōcaire, a humanitarian organization established by the Bishops of Ireland and actively involved in ending apartheid, launched a "Burning Question" campaign urging the Irish Strategic Investment Fund (ISIF) to divest (CatholicIreland.net (2016)). Trinity College Dublin, Ireland's most prestigious university, pledged to divest in December of the same year. On January 26, 2017, the Irish parliament voted in favor of passing a Fossil Fuel Divestment Act. The Act was adopted on July 12, 2018, and instructed the ISIF to fully divest from companies that derive more than 20% of their revenue from the exploration, extraction and/or refinement of fossil fuels. On 16 July there was a report that ISIF would pull out from carbon-producing companies (Peters (2018)). At the time, ISIF had positions in 38 fossil fuel companies with a portfolio value of Euro 72 million. The shares were sold in December 2018 and in early January 2019 (ISIF Annual Report 2018, pg. 26). The two announcements went viral on Twitter, with the number of retweets vastly exceeding the number of tweets. On 12/13 July there were over 21,000 tweets and retweets that were seen by up to 264 million followers (Figure 1).

The divested amounts were negligible when compared to the market capitalization of fossil fuel majors.[6] For example, at the end of 2017 the fund only held 21,350 shares in Exxon Mobil valued at 1.5 million Euro million (1.25 million $); Exxon had 4.256 billion shares issued and outstanding with a market capitalization of 354 billion dollars. Yet, there were negative abnormal returns of -3.4% and -4.1% for the 40 U.S. companies with the largest coal, oil, and gas reserves summing up to losses of 31 billion and 21 billion dollars over a

[5] The Oxford English Dictionary defines divestment as investments that "are judged not to meet required ethical standards or criteria relating to environmental sustainability." In the climate finance literature "divestment" is also used as a synonym for "defunding", especially by banks (Green and Vallee (2023)).

[6] The number of shares held was also very small in terms of voting; engagement and voting were outsourced to Hermes EOS, an equity ownership service (ISIF RI Transparency Report filed with PRI, 2018). Hermes continued to engage, also on behalf of ISIF, with fossil fuel companies.

seven-day window around the events, on 26 January 2017 and 12 July 2018, respectively (Table 1).[7] It is inconceivable that the anticipation of ISIF's sale caused this price reaction, especially since ISIF only held 16 of these 40 stocks. On the second (viral) day of Ireland's divestment announcement there were negative abnormal returns for fossil fuel companies more generally (-2.7%) and for all high carbon emitters (-1.7%). This is not consistent with a pure price pressure effect because cement stocks, for example, were not divested; it is consistent, however, with the market changing its estimate of stranded asset risk. In sum, the Irish divestment pledge was a lead indicator of social and political change.

In 2019 Ireland published a comprehensive report of its path to net-zero. In 2020 the country passed a law committing to net-zero by 2050 (Government of Ireland (2020)) and signed a Climate Act into law in July 2021. *Inter alia* the law contained a commitment to end the issuing of new licenses for the exploration and extraction of oil and gas. The Act commits the Irish government to "adopt carbon budgets that are consistent with the Paris agreement and other international obligations" and to "determine […] how to apply the carbon budget across the relevant sectors".[8] The initial reduction will be 51% by 2030 relative to a baseline of 2018. Crucially, the Act will affect all carbon emitters, not just fossil fuel companies. Accordingly, ISIF has committed to decarbonize its portfolio by 50% by 2025 and will ensure that "investee companies and third-party managers are considering potential climate risks and opportunities".[9] The fossil fuel divestment decision was a principle-based decision and gave impetus to Ireland's net-zero commitment. The decarbonization decision was a risk-based decision and reflects the new social and political environment. This Irish example illustrates how voice through divestment has been an effective strategy significantly affecting the valuations of all high carbon emitters.

Finance scholars and practitioners usually consider divestment as an exclusionary investment strategy aimed at screening out socially irresponsible investments (Heinkel, Kraus, and Zechner (2001)). In these models selling the stock of dirty companies lowers the market value of these companies, raises the cost of capital and induces value-maximizing corporate

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[7] Cumulative abnormal returns over a seven-day window around the two announcement dates using a market model based on the MSCI AC World US$ index. Over a narrower three-day window, the losses were 11 and 14 billion dollars respectively. For the second event the window was constructed around 12 July.

[8] Irish Government, Department of the Environment, Climate and Communications, Press Release, 23 July 2021 "Ireland's ambitious Climate Act signed into law" (https://www.gov.ie/en/press-release/9336b-irelands-ambitious-climate-act-signed-into-law/).

[9] ISIF Press Release, "ISIF publishes first-ever Annual Climate Report", 25 November 2021 (https://isif.ie/news/isif-publishes-first-ever-annual-climate-report).

leaders to switch to "pro-social" strategies. In equilibrium, the price impact of divestments is mitigated by value-oriented agents with weaker "pro-social" preferences who will take advantage of lower prices to purchase more shares, bonds or goods; or to supply more labour. Therefore, the impact on stock price is limited and the incentive for management to change strategy is small.[10] The effect on the cost of capital is also predicted to be small (e.g., Berk and van Binsbergen (2021)).[11]

If downward price pressure was the only economic channel, the small amount divested by Ireland would necessarily have no measurable impact on the share price of target companies or their cost of capital. The argument could be taken even further to argue that the impact on the divested companies is negligible, but the impact on portfolio returns of the divesting institutions would be large. The singular channel logic is clearly flawed, but this line of argument is actively used by the fossil fuel industry to lobby against divestment, especially by university endowments.[12]

Divestment is also criticized because it prevents responsible investors from engaging with the company (using "voice"), pursuing an active communication and voting policy, which has been shown to be effective in influencing corporate decisions (Dimson, Karakaş, and Li (2015), Krueger, Sautner, and Starks (2020), Hartzmark and Shue (2023)).[13] Comparing the relative strengths of divestment and engagement, Broccardo, Hart, and Zingales (2022) thus conclude that voice is the preferable strategy to push firms to act in a socially responsible manner.[14] The argument is also used by some of the largest and most engaged responsible

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[10] This view is also echoed by leading practitioners. For example, in 2019 Bill Gates said: "Divestment, to date, probably has reduced about zero tonnes of emissions. It's not like you've capital-starved [the] people making steel and gasoline." Larry Fink, the chief executive officer of BlackRock put forward a similar argument in his 2022 letter to CEOs: "Divesting from entire sectors – or simply passing carbon-intensive assets from public markets to private markets – will not get the world to net zero. And BlackRock does not pursue divestment from oil and gas companies as a policy."

[11] The application of exclusionary screening is also predicted to result in lower returns for pro-social shareholders (Heinkel, Kraus, and Zechner (2001), Luo and Balvers (2017), Zerbib (2022)).

[12] A leading example is the "Divestment Facts" campaign of the Independent Petroleum Association of America (IPAA). See *infra*, Section 3.3.

[13] Edmans, Levit, and Schneemeier (2022) argue that divestment is inferior to "tilting" or "best in class" strategies; they argue that once divestment has occurred the target company no longer has a financial incentive to change behaviour.

[14] The authors acknowledge the potential impact of divestment campaigns on raising awareness about an issue and social preferences. Divestments ("exits") are a continuous source of news while shareholder votes tend to be singular events. They also acknowledge peer pressure inciting institutions to divest because they want to be part of a "growing and potentially successful movement (Thaler and Sunstein 2008)." The authors question the legitimacy of the divestment campaigns: "There is no guarantee that the ability of an exit strategy to succeed is linked to the social desirability of its goal. Thus, extending the model to incorporate information and social pressure is unlikely to change the fundamental result that voice is more aligned to social incentives than exit." In

investors to justify why they oppose divestment (Stausboll (2015)), but it was also co-opted by the fossil fuel industry, including the Independent Petroleum Association of America (IPAA), suggesting that the industry prefers engagement to divestment.[15]

On the other hand there is growing evidence that markets have started to price in carbon emissions and demand higher returns from firms with higher total CO_2 emissions (Bolton and Kacperczyk (2021)).[16] This finding is not consistent with the traditional view of divestment and downward sloping demand curves for stocks, since the carbon premium is not limited to the divestment targets in the fossil fuel sector, but is proportional to carbon emissions across all industries. Bolton and Kacperczyk (2021) also find that the carbon premium has increased significantly around 2015. Our view of divestment is consistent with this pricing evidence because the divestment narrative potentially affects all carbon emitters. We also provide a rationale for the observed timing: the initial peaks in virality around divestment pledges coincide with the observed increases in the carbon premium.

We argue that the financial impact of the divestment movement is best understood through the lens of an economic narrative, even if narratives are not always easy to delineate empirically (Shiller (2017)). We overcome this empirical challenge by using Twitter data.

Narratives have been defined as "stories people tell themselves, and each other, to make sense of human experience that is, to organize, explain, justify, predict and sometimes influence its course" (Bénabou, Falk, and Tirole (2018)). They are central to our cultures and social science has long recognized their role in shaping public opinion. Economists, however, have only recently turned to the study of narratives: traditionally economic theory has focused on individual decision making subject to constraints and beliefs (Akerlof and Snower, (2016)). However, individual aspirations are often shaped by the stories people tell themselves, in other words social and economic narratives (Bénabou, Falk, and Tirole (2018)).

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the case of fossil free it is likely that the movement is more aligned with social incentives than shareholder voting; we shall return to this question below.

[15] See DivestmentFacts.com blog-post, "Experts say company engagement drives change. Will divestment groups get the memo?", 22 January 2022. The argument also overlooks that engagement is a parallel activity to voting and beneficial owners like ISIF pay equity ownership services with multiple clients to engage (Becht et al. (2021)); engagement continues after divestment.

[16] A recent paper found a contradictory result, identifying a "greenium" – a premium on stocks of green companies – rather than a carbon premium (Pástor, Stambaugh, and Taylor (2022)). Yet, the authors caution that the outperformance of "sin" stocks by "clean" stocks is likely to reflect an unanticipated increase in environmental concerns, representing an ex-post realization rather than being indicative of the true expected return.

"Narrative economics" seeks to understand how popular narratives spread and can influence economic fluctuations (Shiller (2017)). The form of the narrative can vary greatly, but the ones that are successful share a critical social-contagion element, and when they "go viral" they affect economic behavior and have economic consequences (Shiller (2019)).[17] More specifically Shiller (2017, at 968) defines "the term narrative to mean a simple story or easily expressed explanation of events that many people want to bring up in conversation or on news or social media because it can be used to stimulate the concerns or emotions of others, and/ or because it appears to advance self-interest. To be stimulating, it usually has some human interest either direct or implied."

We show that *go fossil free* closely fits this economic narrative definition. Its declared goal goes beyond exclusionary screening. Indeed, the movement has been described as "a transnational advocacy network that uses a range of strategies to shame, pressure, facilitate, and encourage investors in general, and large institutional investors in particular, to relinquish their holdings of fossil fuel stocks in favour of climate-friendly alternatives" (Ayling and Gunningham (2017)). It calls into question the social license to operate dirty businesses: "Cut off the social license and financing for fossil fuel companies — divest."[18] Moreover, the Fossil Free campaign explicitly sees itself as creating a "story": "Campaigns aren't just about winning a "yes" on divestment. They're about telling the story of people power against the fossil fuel industry. Getting a "yes" on divestment is a big part of that, but creating tension around a city pension system that might be reluctant to divest tells that story, too."[19] In this broader view, the main goal of the movement is to target dirty companies' reputation and standing in society. Because it is a story aiming at teaching a moral,[20] the divestment movement might be defined not just as a narrative, but as a finance "parable."[21]

We show that widely publicized divestment commitments (that are part of a broader campaign) put pressure on companies that goes well beyond stock prices, the cost of equity and the loss of shareholder voting power. Our results reveal that Ireland is no isolated case.

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[17] For example, Roe and Shapira (2021) have argued that "stock-market-driven short-termism damages the economy" is a narrative that had a substantial impact on law-making, although the supporting empirical evidence is inconclusive and contested.

[18] 350.org, About 350, https://350.org/about/.

[19] Fossil Free, About, https://gofossilfree.org/about/.

[20] The Oxford English Dictionary define "parable": "A (usually realistic) story or narrative told to convey a moral or spiritual lesson or insight."

[21] As pointed out by Eliot in Middlemarch: "[W]hatever has been or is to be narrated ... may be ennobled by being considered a parable" (Eliot (1930)).

We use the event study to examine the impact of viral divestment campaigns on stock returns in four different groups: (1) the Carbon Underground 200 (CU 200) companies that were specifically targeted by the Fossil Free divestment movement; (2) fossil fuel companies not included in the CU 200 list; (3) high carbon emitting companies in other sectors, such as cement or airline companies; (4) a placebo group of best-in-class CDP Climate A-List companies that should be unaffected.

Our results show significant negative cumulative average abnormal returns (CAAR) around viral divestment pledges for all three groups. The largest negative CAARs are for group (1), the CU200 companies, amounting to a -0.9% loss for a three-day event window (for US companies), which corresponds to market value losses of 87 billion dollars in total (over the 25 most viral days). However, we observe negative and significant CAARs (-0.2% in a three-day event window) also for group (3), other high carbon emitters, like cement companies, which suggests a broader effect from the divestment campaign. There is no significant impact for group (4), the CDP A-List companies.

Why does "voice through divestment" have a measurable impact on stock prices? One possibility is raised awareness; prior to the most viral divestment pledges markets had not priced in all relevant information about climate risk. This explanation is plausible and emphasized by Bolton and Kacperczyk (2021), but requires bounded rationality. Another possibility is that markets are pricing in a change in regulatory risk; they (correctly) anticipated that future regulation will adversely affect fossil fuel companies, for example through net-zero commitments. This view is consistent with the outsized impact of Ireland's divestment pledge. This, in turn, makes it rational for risk averse investors to go beyond fossil fuels and divest all high-carbon emitters, resulting in initiatives like the UN convened Net-Zero Owner Alliance (NZAOA), set up in 2019 (United Nations Environmental Programme Finance Initiative (2023)). The divestment movement started with an emphasis on values, in the moral sense; today it is also about value (Starks (2023)).

Our paper builds on the theoretical work on narrative economics (Shiller (2017), Shiller (2019)) and more broadly on the importance of "stories" in the formation of economic behavior (Akerlof and Snower (2016), Bénabou, Falk, and Tirole (2018), Akerlof (2020)). Our work relates to a large literature investigating green-versus-brown returns, generally for stocks. Examples include (Litterman (2011), Bansal, Ochoa, and Kiku (2016), Daniel, Litterman, and Wagner (2016), Painter (2020), Ilhan, Sautner, and Vilkov (2021), Ramelli et al. (2021), Pástor, Stambaugh, and Taylor (2022), Bolton and Kacperczyk (2021), Aswani,

Raghunandan, and Rajgopal (2023), Hsu, Li, and Tsou (2023)). Finally, our empirical evidence adds to the literature on the role of the media in affecting corporate governance (Dyck and Zingales (2002), Burke (2022)) and corporate investment decisions (Schiller (2021), Gantchev, Giannetti, and Li (2022)), and social media in finance (Campbell et al. (2022)).

2 A Simple Model

To illustrate how "voice through divestment" differs from the standard framing in economics and finance consider the following, very simple model. In the selling price pressure model of divestment there are two types of investors: responsible investors (*R*), and opportunistic investors (*C*) that focus exclusively on maximizing returns. The market value is V_{RC} when both types are invested, and V_C when only *C* is invested. When *R* divests *C* type investors readily replace *R*. As a result, V_{RC} is only slightly larger than V_C and the difference in market value (ΔV) is small, where $V_{RC} > V_C$ and $\Delta V \equiv V_{RC} - V_C$.

As a result, divestment puts little or no pressure on target companies through stock prices and thus the cost of capital. The absence of price pressure also means that there is no "threat of exit" Admati and Pfleiderer (2009). On the contrary, investors *R* transfer voting power to *C*, and thereby lose "voice" in corporate decision making (Broccardo, Hart, and Zingales (2022)).

This paper distinguishes between three classes of investors: responsible investors that are "notable" (R_N); a second group of investors H that pay heed to the actions of R_N; and a third group C that disregard or dismiss the actions of R_N.[22] We argue a pledge from notable responsible investors to divest induces *H* sell to *C*. The holding of R_N is often small, but the holding of H is relatively large. When both R_N and *H* are invested, the market value is $V_{RHC;}$ when only C is invested the market value is V_C. The difference in market value is relatively large, where

$V_{RHC} > V_C$ and $\Delta V \equiv V_{RHC} - V_C$.

We show which institutions command R_N status and their degree of influence. Notable institutions might act on their own accord (e.g. the Vatican) or respond to engagement by the fossil free divestment campaign (e.g. Harvard University). It is also possible that notable

[22] We deliberately denote the second group H and not R because it contains responsible investors and risk averse investors that pay attention to transition and stranded asset risk.

institutions make no divestment pledges, although they were targeted by the fossil free movement (e.g. Imperial College, MIT, the Nobel Foundation). In these cases, there is no action by R_N to which H investors respond, but the campaigns raise general awareness about climate change.

There are several reasons why investors H might heed the actions of R_N. A purely risk-based interpretation suggests that H believe that R_N has the power to influence the regulatory environment; if the divestment pledge from R_N threatens the license to operate it increases transition and stranded asset risk. Alternatively, the awareness of H could be increased through the actions of R_N, or the divestment campaign targeting R_N. It is also possible that H investors start to share the moral stance voiced by R_N through divestment, like in the conversion narratives of Paul and Augustine (Fredriksen (1986)).

We use this simple model as a framework for examining how the fossil free divestment effects stock prices. We map the movement that identified notable investors R_N and sought to prod them into acting. This includes potential R_N investors that have not divested. Divestment pledges are recorded in a global database. We use twitter to identify viral pledges, those that were most likely to have an impact on H investors. Finally, we test if viral pledges are associated with movement in the stock price of fossil fuel companies and other high emitters. In the next section we describe the narrative that the movement used to spur R_N investor into action.

3 The Go Fossil Free Narrative

3.1 The Carbon Budget

For decades climate experts have been alerting about the catastrophic climate consequences that would come if carbon dioxide (CO_2) emissions are not slashed. In 2008, a group of NASA scientists guided by James Hansen identified 350 parts per million (ppm) CO_2 as the safe upper bound for atmospheric concentration of carbon dioxide Hansen et al. (2008): "If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, paleoclimate evidence and ongoing climate change suggest that CO_2 will need to be reduced … to at most 350 ppm." Today, the level of CO_2 in the atmosphere is 419 ppm and projected to reach 450 ppm by 2040, with average temperatures rising to over 1.5ºC above pre-industrial levels (Intergovernmental Panel on Climate Change (IPCC), 2022).

The IPCC estimates that the total carbon budget we have left (the total amount of CO_2 that can still be accumulated in the atmosphere while keeping temperatures from rising by more than 1.5ºC) is around 300Gt of CO_2 as of 2020. Under any scenario the carbon budget is almost depleted and emitting the carbon from all known fossil fuel reserves would vastly exceed the allowable CO_2 emission budget for staying below 1.5ºC.

In 2011, the Carbon Tracker Initiative (CTI) – an NGO formed by a group of financial analysts and environmentalists – translated the carbon budget constraint into financial terms, applying the concept to listed companies. The CTI's first "Unburnable Carbon" report identified a balloon in the valuation of oil and gas companies tied to stranded fossil fuel proven reserves of listed firms, the extraction of which is incompatible with a 2°C global carbon budget (Campanale, Leggett, and Leaton (2011)). Their analysis estimated that the remaining global carbon budget until 2050 is 565Gt, while known fossil fuel reserves amount to 2795Gt, which is equivalent to nearly 5 times the carbon budget for the next 40 years. The title of the report refers to the difference between the carbon budget and the fossil fuel reserves that are "unburnable." The analysis implies that to stay below 2°C these known reserves will need to remain in the ground. This means that fossil fuel companies should drastically reduce production and immediately stop the expansion of existing projects and exploration.

The CTI report also pointed out that the fossil fuel reserves held by the top 100 listed coal companies and the top 100 listed oil and gas companies represented potential emissions of 745Gt, while the remaining reserves were owned or by government controlled or state energy firms. If the 20% use limit is applied uniformly, then only 149Gt of the 745Gt held by listed companies could be used unabated, implying that 80% of declared reserves owned by the world's largest coal, oil and gas firms would be subject to impairment as these assets become "stranded." Yet, valuations of the oil and gas sector still assumed that all known reserves could be taken out of the ground and sold. If the assumption is wrong, the report argued, there is a "carbon bubble" in financial markets.

This science-backed financial analysis provided a new conceptual foundation to the climate justice movement. The "carbon budget" and "carbon bubble" concepts were used by climate activists to shape a new strategy: divestment from the fossil fuel industry. The thinking was that if the movement was able to persuade policy makers to force fossil fuel companies to "keep it in the ground," the carbon bubble would burst. If enough market participants believed in the implosion of the bubble, carbon divestment would be transformed from a

statement of principle to a rational investment decision. The same logic applied to other industries that would be affected by restrictions on carbon emissions or taxation. Thus, the fossil free divestment movement viewed itself as a catalyst for a broader reassessment of stranded asset and other risks associated with fossil fuel-based companies.

A key breakthrough for the movement was the publication of an article by climate activist Bill McKibben's in the Rolling Stone Magazine 2012 edition called "Global Warming's Terrifying New Math", in which he advocated cutting the supply of financial capital to fossil fuel companies. The article prominently refers the "carbon budget" and "carbon bubble" notions, asking readers "to do a little math" and focusing on "three simple numbers" (McKibben (2012)).[23] Carbon reserves that would take us past two degrees had to stay in the ground. The article further argued that "working through the political system had proved ineffective to achieve this goal, but the moral outrage arising from this terrifying math could lead to a transformative challenge to fossil fuel. There is one example in recent corporate history when anger was effectively able to force an industry to make changes: the South Africa divestment movement of the 1980s" (McKibben (2012)).

The Rolling Stone article was heavily promoted on social media by 350.org, an organization co-founded in 2008 by McKibben and named after the Hansen et al. (2008) 350 ppm paper (Hestres (2014)). The main goal of 350.org was to build a global grassroots movement using internet-enabled organizing strategies to increase the intensity of political activism among the segment of the public already alarmed about climate change (Nisbet (2015)). The organization sought to generate headlines and to draw media attention, and it was able to obtain more than 170,000 online comments on the Rolling Stone article and social media posts, making it the most widely read in the magazine's history at the time (Hestres (2014)).

Along with this article, McKibben and 350.org organized a university campus "Do the Math Tour," traveling around the country to explain the math behind climate change and carbon emissions; they also produced a movie. The tour then led to the launch of a global "Go Fossil Free: divest from fossil fuels" campaign. This is the genesis of the fossil free divestment movement (Hopke and Hestres (2017)).

3.2 The Fossil Free Divestment Movement

[23] The argument was picked up subsequently by mainstream publications (e.g. The Economist (2013)).

Fossil Free (also "FF") is a campaign of 350.org started in 2012 to push institutions to divest from fossil fuels.[24] FF later developed into a loosely affiliated network of independent grassroot campaigns. FF considers fossil fuel companies a crucial target for its campaign to stay within the limits of the carbon budget. By calling on leading institutions to divest from the fossil fuel industry, the aim is to turn public opinion against the fossil fuel sector and to hold it accountable. In short, the goal of FF is to strip the veneer of fossil fuel companies' social acceptability, which is essential for the industry to continue to benefit from government subsidies.

FF records divestment pledges in a Global Divestment Commitments Database (GDCD), which collects fossil fuel divestment commitments made by institutions globally. The first Go Fossil Free campaign was launched in November 2012. In keeping with the "unburnable carbon" narrative, the campaign focused on divestment from 100 listed companies with the largest coal reserves and 100 companies with the largest oil and gas reserves. The names of the companies had been published by Carbon Tracker (2011) in its report. In 2014 the list became the Carbon Underground 200™ compiled by Fossil Free Indexes℠ (today, FFI Solutions), ranking companies by carbon emissions embedded in their reported reserves.

The divestment targets were the Carbon Underground 200, but the campaign was directed at investors. In 2012 the campaigns recruited college students in the U.S. and the U.K. to press universities to divest endowment assets (Nisbet, 2015)). In November 2012, Unity College (Maine) became the first institute of higher learning to commit to fossil fuel divestment supported by the FF movement (350.org (2018)). Between 2012 and 2014, student movements at more than two hundred universities pressured their institutions to divest from fossil fuel companies.

On September 21, 2014, the People's Climate March called by the global advocacy human rights group Avaaz and 350.org gathered more than three hundred thousand people in New York City, becoming the largest climate change march in history (Foderaro (2014)). Following the March, the Divest-Invest Philanthropy organization – a coalition of endowments and individuals committed to divesting from fossil fuels and investing in clean energy – announced that 70 organizations were divesting $50 billion from the fossil fuel sector (Candid (2014)). Remarkably, among the new signatories was the Rockefeller Brothers

[24] The first fossil fuel divestment campaign begun on the campus of Swarthmore College in Pennsylvania in 2011, but the movement started to gather force only after the first Go Fossil Free campaign was launched by 350.org in November 2012.

Fund, heirs of Standard Oil founder John D. Rockefeller (Schwartz John (2014)). At the same time, Naomi Klein – writer and member of the board of 350.org – published her best-selling book, "This Changes Everything: Capitalism Versus the Climate", advocating for divestment from fossil fuel companies. The book debuted on the New York Times bestseller list at number five on 5 October 2014, and it appeared on the best-seller list for several weeks, generating considerable media attention (Nisbet (2015)).

By 2015 thousands of divestment campaigns were underway, earning support well beyond college campuses, with 436 institutions and 2,040 people committed to divesting from fossil fuels companies (Arabella Advisors (2015)). In March 2015, the Guardian (in partnership with 350.org and its Go Fossil Free Campaign) launched a "Keep It in the Ground" campaign, at the behest of outgoing editor-in-chief Alan Rusbridger. Within its first year, the digital campaign garnered support from more than a quarter million online petitioners and won the "campaign of the year" at the Press Gazette's British Journalism Awards (The Guardian Press Office (2015)). On December 15, 2021, 196 parties signed the Paris Agreement at the UN Climate Change Conference. This was followed by a new cascade of divestment pledges, providing further impetus to the campaign (Arabella Advisors (2016)).

The movement spread beyond universities, and by 2016 the largest share of divestment commitments had been made by faith-based organizations. In 2014, the University of Dayton was the first Catholic institution to divest. In June 2015 Pope Francis published an encyclical letter called *Laudato Si': On Care for Our Common Home*. He explicitly called world leaders to action, underscoring that "highly polluting fossil fuels – especially coal, but also oil and, to a lesser degree, gas – needs to be progressively replaced without delay" (The Holy Father Francis (2015)). The next month the World Council of Churches – which includes more than 350 denominations comprising more than 500 million Christians worldwide – made divestment pledges and encouraged its members to do the same (World Council of Churches (2014)). In August 2015, Islamic leaders from 20 countries announced the Islamic Declaration on Global Climate Change, which not only calls on the 1.6 billion Muslims around the world to phase out greenhouse-gas emissions but also specifically calls "upon corporations, finance, and the business sector to (…) [assist] in the divestment from the fossil fuel driven economy" (UNFCCC (2015)). The faith community support is important to understand how the divestment movement makes a strong case for the moral responsibility to act on climate change divesting from the fossil fuel industry (Arabella Advisors (2016)). Yet

the divestment pledges were relatively small in monetary terms and unlikely to have any direct price impact.

By 2018, the FF divestment movement extended its reach to private companies and major pension, sovereign wealth, and insurance funds. Many high profile individuals such as Archbishop Desmond Tutu (350.org (2015)) – the Nobel Peace Prize winner who worked to liberate South Africa from Apartheid –, the former secretary-general of the United Nations Ban Ki Moon, and actor Leonardo DiCaprio (Rowling (2015)) also started supporting the FF divestment movement.

From early 2018 FF entered a new phase of the campaign, "expanding beyond divestment", and introduced new tactics and tools with "the goal of stopping all new fossil fuel projects by 2020." But the divestment movement continued to grow, and the total number of recorded divestment pledges now stand at 1591.

3.3 Is Fossil Free Divest a Narrative?

As the description in the previous section shows, the FF divestment movement has some critical features of an economic narrative. Narratives usually have an ethical dimension that trumps hard-nosed economic calculations (Bénabou, Falk, and Tirole (2018)). In its early days the FF divestment movement was not primarily focused on the financial implications of shifting money away from the fossil fuel industry, but rather on "highlighting the moral dimensions of climate change". Divestment was seen as a way of ending fossil fuel companies' social license to operate and of breaking their hold over economy and governments at a global level.

Second, popular narratives have an underlying "us versus them" theme, a Manichaean tone of clear right and wrong, black or white behavior (Shiller (2019)). The FF movement identifies the fossil fuel industry as the enemy of a sustainable planet, painting the whole sector with a broad brush. Klein advanced the idea that to avoid a climate catastrophe "It's them or us" (Klein (2014)). McKibben in his influential article is even clearer, explaining that "enemies are what climate change has lacked. But what all these climate numbers make painfully, usefully clear is that the planet does indeed have an enemy (…). Climate change operates on a geological scale and time frame, but it's not an impersonal force of nature; the more carefully you do the math, the more thoroughly you realize that this is, at bottom, a moral issue; we have met the enemy and they is Shell" (McKibben (2012)).

Third, stories can have a core contagious element that makes them go viral and cause economic changes. The viral elements of the FF divestment campaign were the underlying science, 350 ppm, and the carbon budget. In the empirical section we list the main hashtags used by the campaign and show how they propagated. We also establish which elements went viral.

Finally, economic narratives mutate, and mutations might change their contagiousness. Mutations in a narrative can renew its economic message by tying it better to economic decisions (Shiller (2017)). In the next sections we will show how the FF divestment narrative has morphed from a "moral outrage" narrative to a more mainstream risk-management issue supported by a shift in the narrative towards more financial considerations related to stranded assets risk and the "carbon bubble".[25] There are signs that the narrative might be shifting from fossil fuel divestment to the decarbonization of portfolios.

4 The Fossil Free Movement on Twitter

This section documents the growth of the Fossil Free movement and its accompanying narrative on social media. Section 4.1 reports the Twitter handles associated with the movement and descriptive statistics on tweets, hashtags, and followers. Section 4.2 details network analysis that treats the movement's Twitter handles as nodes. Section 4.3 presents a time series of the movement's Tweet volumes.

4.1 Data and Methodology

FF has its dedicated website (gofossilfree.org) which provides information about the campaigns and makes material available to activists. Local movements can register with 350.org to get listed on the gofossilfree.org website. We accessed the Twitter archive through its API and created a dataset containing all handles associated with the 350.org and the Fossil Free Project, including tweets, hashtags, followers, and users.

The main Twitter account is run by 350.org in the United States with the handle @350. Local campaigns typically use handles that are composed of @350 plus the country, city, or region, for example @350Australia, @350Montana, @350Sacramento, @350Deutschland or

[25] Consistently, Krueger, Sautner, and Starks (2020) shows how institutional investors strongly agree that the two most important motives for incorporating climate risk into investment decisions are: the protection of their reputation; and a moral/ethical obligation to consider climate risks.

@350Canada. However, it is also possible that 350 is used at the end of the handle or in the descriptor, for example @SanDiego350. There are also individuals who affiliate themselves with the movement and use #350.org or 350.org in their profile text, for example @GreenGregDennis[26] or the @350 founder, @billmckibben.[27]

The FF project has its own Twitter handle (@gofossilfree), but it was only created in February 2020, has few followers (116 in November 2022), and only one tweet. The local campaigns typically use @FossilFree and a location, for example @FossilFreeCA for California or @FossilFreeYale. They also use @Divest plus the target institution, for example @DivestHarvard, @DivestMIT or @DivestEast, a campaign to divest the East Sussex Pension Fund.

We identified the handles associated with both networks 350 and FF. For 350 we required the handle to contain the substring "350" and the description to contain "fossil" or "climate". We also selected accounts that mentioned "350.org" in the description. For FF we required the handle to contain "fossilfree" or "divest" in combination with "fossil" in the description. Through the latter, we excluded the handles of unrelated divestment campaigns. We combined the two sets of handles into one list and eliminated duplicates; the result is a combined dataset containing 504 handles.

4.2 Network Analysis

We performed basic network analysis to assess the overall integration of the movement (Grund (2015)). We found that the network is directional, and that the nodes are well connected. There are 4,842 singular and 2,741 mutual connections, meaning that followership of these nodes is reciprocal. Transitivity is a high 40%, meaning that almost half the nodes are connected directly or through one other node. The nodes are also relatively close to each other: the length of the longest shortest path between two nodes is 5; the average length of the shortest path is 2.8.

We further identify the most connected nodes, those with the highest network centrality. We calculate degree centrality of a node by the number of its connections, and betweenness

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[26] Greg Dennis's Twitter biography reads "Writer, Vermonter, #ClimateChange activist, #ThirdAct, son of USAF colonel. #350.org #vtpoli #Skiing. Life is a carnival." See @GreenGregDennis, TWITTER, https://twitter.com/GreenGregDennis.

[27] Bill McKibben's Twitter biography reads "Author, Educator, Environmentalist and founder of http://350.org and http://ThirdAct.org." See @billmckibben, TWITTER, https://twitter.com/billmckibben.

centrality by "the number of shortest paths among all other nodes that pass through this node" Grund (2015). Since the absolute number is hard to interpret, it is customary to standardize the betweenness measure with the length of the shortest path. We use the standardized betweenness measure to rank nodes (Table 2).

The nodes with the highest degree of centrality are @nyudivest, @DivestHarvard, @350 itself, @FossilFreeMIT and @divesthackney. These nodes were created around campaigns at specific institutions (NYU, Harvard, MIT, and the London Borough of Hackney) but morphed into central connectors in the movement; @DivestUK, @DivestDE (divest Germany) and @350Australia are not linked to an institution specific campaign but seek to influence policy in a country.

4.3 FF Hashtags and Tweets

We extracted all tweets and retweets from each of the 504 handles. Not surprisingly, the most frequently used hashtags by fossil free nodes were #divest and #divestment, while #keepitintheground is used by both movements (Table 3). Also, 350.org often used hashtags with some variations on climate, consistent with its broader scope. In addition to fossil free, 350 also participates in campaigns targeted at specific pipeline or mining projects.[28]

Table 4 reports the evolution of the Fossil Free movement over time. In 2008, when 350.org was founded, there was only one tweet, which did not receive any kind of attention or interaction on the platform. In 2012, McKibben's article went viral and after the first FF campaign was launched in 2013 the number of tweets, retweets and replies grew exponentially. Not surprisingly in 2015, the year of the adoption of the Paris Agreement and of the related "Keep It in the Ground" campaign, the Twitter interaction about the FF movement reached its peak. In the following years, the number of tweets, replies, retweets, and quotes remained steadily high, in line with the overall growth of the movement (Table 4, Panel A).

The size and the relevance on Twitter of the Fossil Free movement can be better appreciated through a comparison with "Divestment Facts," a counter campaign launched by the Independent Petroleum Association of America (IPAA) with the goal "to educating the

[28] For instance, #nokxl refers to the Keystone XL Pipeline project in the United States, while #StopAdani seeks to stop the Indian Adani Group from expanding its coal operations.

public and institutions alike on the facts about divestment".[29] IPAA members would be hardest hit from a ban on exploration and production restrictions. The IPAA employed the economic consultancy Compass Lexecon to calculate the alleged cost of divesting for university endowments, created a dedicated website (https://divestmentfacts.com), a Twitter account (@DivestmentFacts) and promoted the hashtag #divestmentpenalty (DivestmentFacts.com (2022)). As Panel C of Table 4 shows, the campaign was never able to garner media attention, and by 2021 its activity on Twitter has almost completely disappeared. Ironically, the tweet from Divestment Facts with the highest level of engagement – reporting a study commissioned by the IPAA that shows the negative effects of divestment – received essentially only critical comments and quote retweets, underlining the conflict of interests behind the study and the importance of fighting climate change.[30]

5 The Divestment Campaign

This section tracks the pledges from divesting institutions and divestment campaigns, and it measures their broader impact using Twitter data. Section 5.1 and 5.2 present the dataset and sample descriptive statistics for divesting institutions and divestment campaigns respectively. Section 5.3 measures the virality of the divestment pledges.

5.1 Divesting Institutions and Divestment Pledges

The FF divestment campaigns targeted institutions with investment portfolios and asked them to divest from fossil fuel companies. Because the main objective of the movement was to remove the social license of the fossil fuel industry, the ideal targets were prestigious and high reputation institutions. If successful, a divestment pledge would publicize that the institution distances itself from the fossil fuel industry; if unsuccessful on divestment, the campaign might still be a success because it raises awareness. An example of the latter is the FF divestment campaign aimed at the Nobel Foundation in Sweden, that awards the Nobel Prizes. The campaign is explicitly motivated by the fact that the Foundation "is seen by the public, and politicians (and us!), as a guiding light, showing the way forward for

[29] In its website, the association is described as the "voice for the exploration and production segment of the industry" representing independent producers that "develop 91 percent of the nation's oil and natural gas wells" in the United States (https://www.ipaa.org/about/).
[30] Divestment Facts (@DivestmentFacts), TWITTER (Aug. 8, 2018, 10:34 AM), https://twitter.com/DivestmentFacts/status/1027201476899291136.

humanity."[31] Likewise, both Go Fossil Free website display the logos of "Notable Divestment Commitments," a selection of pledges from a Global Divestment Commitments Database (GDCD) with 1,591 individual entries. The selected logos are government sponsored financial institutions (La Banque Postale, the Norwegian Sovereign Wealth Fund, the New York City Pension Fund), leading Universities (Harvard, Oxford), the State of Maine, the Ford Foundation, the Rockefeller Brothers Fund, the UK Royal Family, and the Vatican. The selection criteria are not the size of the divestment but the perceived social influence of the institution, or its proximity to governments and policy makers.

To estimate the power of the divestment campaigns that involved these divesting institutions, we construct a database that draws on the 1,591 entries in the FF Global Divestment Commitments Database (GDCD). For each pledge we record the name of the divesting institution, the institution type, the country, a link to the institution's website, the type of divestment (full, partial, coal only, coal and tar sand etc.) and a link to the information source that led to inclusion. In the background, the GDCD also tracks the total assets under management by the divesting institution (i.e., the market value of its portfolio). The value of the fossil fuel divestment is not reported, and often not available.

We have downloaded the publicly available data in July 2021 and again in December 2021. We further augmented the database by adding a field with the information source (press release, Twitter post, news article), the date of the first announcement, the value of the divestment pledge (when available) and the Twitter handle of the divesting institution. For the latter we first performed a Google search for the respective institution's name and the word "twitter" (for example, "Archdiocese of Malta AND twitter"). We verified the description to ensure that we had found the correct institution. We found 845 unique handles in our sample of 1,477 institutions (after duplicate removal).

Table 5 – which lists the first ten divesting institutions who committed to divest from fossil fuel companies – demonstrates how at the beginning of the movement the pledges came mainly from educational and faith-based organizations.

5.2 Fossil Free Divestment Campaigns

[31] Fossil Free, #DivestNobel, https://gofossilfree.org/se/divest-nobel/#blog.

We also collected tweets from divesting institutions or tweets that mention the divesting institutions in the context of the fossil free campaign. To retrieve all relevant tweets, we employed the Twitter Academic Research application programming interface (API) v2[32] that we accessed through Twarc2.[33] We ran three queries. The first query contains tweets from divesting institutions with reference to fossil fuel; the second query are tweets about the divesting institutions; the third query searched for all tweets that mention fossil fuel divestment.

For the first query we extracted the tweet history of the 845 divesting institutions with a Twitter handle if they contained the words divest, divestment, fossilfree, fossilfuel, fossilfuels or the hashtag keepitintheground.[34]

For the second query we searched the text of all tweets in the Twitter archive for mentions of one or more of the 845 divesting institution handles.[35] Multiple mentions were fairly common, and we eliminated the resulting duplicates. Since we wanted to track the mention of institutions *targeted* by 350 and not made by 350 itself, we also eliminated tweets mentioning @350 and @350Australia. After these exclusions, we retained 127,929 fossil fuel divestment tweets mentioning at least one of the divesting institutions. The strategy underestimates the total impact of the divestment pledges, because we could not search for mentions of 714 divesting institutions that have no twitter handle.[36] However, we could be certain that the bulk of the tweets we retained were directly related to the divestment pledges of institutions in the fossil free divestment database.

The third query captured all fossil free divestment related tweets, retweets, replies and quotes.[37] It is more general than the previous queries and captured the full impact of the fossil free divestment movement. We retained 418,901 tweets and 945,016 retweets; there were

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[32] Twitter Development Platform, Getting Started with the Twitter API, https://developer.twitter.com/en/docs/twitter-api/getting-started/about-twitter-api.
[33] Twarc Project, twarc2, https://twarc-project.readthedocs.io/en/latest/twarc2_en_us/.
[34] The exact search expression was "*from:username (divest OR divestment OR fossilfree OR fossilfuel OR fossilfuels OR keepitintheground OR fossil)*".
[35] The exact expression was *"@username (divest OR divestment OR fossilfree OR fossilfuel OR fossilfuels OR keepitintheground)*".
[36] We also tried a string search using the names of these institutions but without success; there were too many duplicates, and it was not possible to narrow down the search with accuracy.
[37] The exact search query was: *twarc2 search --archive --start-time --end-time '(divest OR divestment OR divesting OR divestnow) (fossil OR fossils OR fossilfree OR fossilfuel OR fossilfuels OR keepitintheground OR climate OR climatechange OR actonclimate OR climatestrike OR climateaction OR climateemergency OR coal OR greennewdeal OR 350ppm OR fridaysforfuture OR cop21 OR cop26)'*.

also 40,927 replies and 33,557 quotes (Table 4, Panel B). Figure 2 Panel A shows cumulative count of tweets and retweets from the beginning to the end of the sample period.

For the third query we also computed an upper bound for the number of views. To obtain this estimate we multiplied the number of tweets and retweets with the number of follows of the author. This provides an upper bound for the number of views because not all tweets or retweets are viewed, and the number of followers changes over time.[38] Our estimate of the upper bound for the cumulative number of views of the fossil fuel divestment campaign on Twitter is approximately 20 billion (Figure 2, Panel B). Figure 3 shows the monthly intensity of the number of tweets, retweets, and views. The greatest intensity was around the time of the Paris agreement in 2015, but there are distinct peaks in later years. We use these peaks to find days when tweets went viral.

Table 6 lists the thirty authors that made the largest contribution to the campaign when ranked by the potential number of views. The total is the product of the number of times an author tweeted or retweeted and the number of followers in March 2023. The most important contributor has been The Guardian newspaper tweeted 143 times and had almost 11 million followers in March 2023 making it the top contributor with up to 1.5 billion views. The New York Times tweeted less often but has more followers, putting it in second place. Potential views provide an approximate measure of how many people were made aware about the fossil fuel divestment narrative and the key contributors play a central role in fostering viral divestment pledges on twitter.

5.3 FF Divestment Virality

We next examine the propagation of the divestment campaigns on Twitter, define "virality", and identify the points in time when divestment-related tweets "went viral".[39] The term "viral marketing" goes back to the late 1990s and refers to a marketing technique where users help to spread the advertiser's message to other users; more recently the virality concept has been applied to the spread of information among social media users (Campbell et al. (2022)). The term is also used to characterize the strength of contagion in economic narratives (Shiller (2017)).

[38] The Twitter archive does not contain the number of followers of the author at the time of the tweet, but with an archive search writes out the number of followers at the time the query was run. The number of followers can go up or down.
[39] We focus on Twitter because it has the largest impact on journalists, politicians, and senior decision makers.

We construct two time-specific measures of divestment campaign virality. The first measure captures the potential number of users who view the tweets (Campbell et al. (2022)). It combines the number of tweets (including retweets)[40] (*#tweets*) per day and the number of followers (in thousands) for users that tweeted about divesting institutions (*#followers*). Concretely, we define a *Virality Dummy* taking the value one in days when both variables *#tweets* and *#followers* are in the top decile, and zero otherwise.[41] The *Virality Dummy* identifies important days at any point in the campaign but is not directly related to the announcement day of an investment pledge. In contrast, the second measure, the *Combined Virality Dummy*, is explicitly tied to the investment pledges. It is only set equal to one if a tweet-based viral day was preceded by at least one divestment announcement in the previous 30 days. There were 323 such "viral" days.

Table 7 reports the top-20 most viral dates for all fossil fuel related divestment tweets from the third query. As the table shows, the divestment campaigns that went viral on Twitter had different scopes. While the majority announced or reported a divestment pledge, others aimed at drawing attention to eminent organizations to pressure them into divesting from fossil fuels, for example Harvard, Oxford and the Bill & Melinda Gates Foundation. Harvard University went viral several times. Significantly, two of the most viral days out of 20 involved the Irish divestment law that we documented in the introduction.

6 Event Study: Impact on Stock Prices

In this section we test if viral tweets associated with divestment campaigns and pledges had an impact on stock returns. We consider three different groups of companies: (1) the Carbon Underground 200 that were specifically targeted by the FF divestment movement; (2) fossil fuel companies not included in the CU 200 list; and (3) high carbon emitting companies in other sectors, such as cement or airline companies. If the impact of divestment is primarily driven by selling pressure and downward sloping demand curves for stocks, then we would expect to see the largest impact on the first group, the FF movement's declared divestment targets. We would also expect some impact on the second group because many institutions pledged to divest from all fossil fuel companies.

[40] Campbell et al. (2022) at 15: "the concept of retweeting, or resharing in general, is part of what fuels the speed and depth of dissemination on social media."
[41] Campbell et al. (2022) use a similar approach for their *Viral Earnings* variable.

Note that the events we identify mark divestment announcements, not actual sales, that could follow much later.[42] If the market expects the sale to be delayed or uncertain, we would observe no impact on prices, even for the first group. In any case, we would expect an insignificant impact on the third group because the divestment pledges do not cover cement companies or airlines.

In contrast, if the FF movement is an economic narrative reaching companies that fit the narrative even if they are not directly targeted for divestment, then viral carbon divestment pledges should have a much broader impact. The effect of stigmatization of some fossil-fuel companies is not limited to those companies but may extend to all high-carbon emitters, if the narrative shifts social preferences, and if transition risk increases for all high-carbon emitters. In this case we expect to observe negative abnormal returns for all three groups.

6.1 Data and Methodology

To perform the event study, we identify potential targets of the FF movement and classify them into the three groups described above: (1) the Carbon Underground 200 (CU 200); (2) other coal, oil and gas companies; (3) other high carbon emitters (Scope 1, 2 and 3).

We combine two datasets for the time-series variable of the CU 200 sample. First, we use the original list of Top 200 listed companies by estimated carbon reserves – 100 coal companies and 100 oil & gas companies - published by Carbon Tracker in 2011 (Carbon Tracker (2011)). We update this list with a seven-year history of CU 200 companies (Q4 2014-Q4 2020), provided by FFI Solutions. The result is a list with 1200 observations. There were 27 duplicates and 113 companies with only one or two years of data; we excluded these observations. The resulting CU 200 unbalanced panel contained 1060 firm-year observations for 218 unique firms. We have annual observations between 2011 and 2014, and quarterly observations between 2014 and 2020. For the event study we require daily observations, so that we define a daily dummy set to one if a company was on the CU 200 at the beginning of the year or quarter and zero otherwise. There were 113 firms that were on the CU 200 list on all days during the observation period.

To identify the second group, we used the Global Industry Classification Standard (GICS) industry group 101020 “Oil, Gas & Consumable Fuels”, an industry taxonomy developed by

[42] In the case of Harvard, for example, the Harvard Crimson note that “Fossil fuels make up less than 2 percent of the University’s endowment — but they won’t disappear overnight” (Goodman and Griffin (2021)).

MSCI and S&P and widely used by the global financial community. We retrieved the relevant companies and excluded those that were already on the combined CU 200 list.

Finally, the third group includes companies in other high carbon emission sectors. We used the top ten industries in terms of average Scope 1, 2 and 3 emissions as reported by Bolton and Kacperczyk (2021). Companies already included in the CU 200 or "Oil, Gas & Consumable Fuels" industry group were excluded.

In addition we performed a placebo test, an event study on an auxiliary cohort of corporations that should be least affected by the viral divestment pledges: U.S. companies from the CDP Climate A-List.[43] CDP, a non-profit charity, performs annual evaluations of companies and cities, assigning grades from A to D- based on their transparency in environmental disclosure, their management of environmental risks, and adherence to best practices regarding environmental leadership.[44] Consequently, the firms that comprise the A list are purported to represent the apex of environmental leadership.

We hypothesize that these firms are less susceptible to the influence of divestment campaigns due to their demonstrated commitment to environmental stewardship. For this subgroup, we identified U.S. corporations that were on the CDP A-List at least once during the interval from 2012 to 2022. This identification process resulted in a compilation of 94 corporations, of which 12 concurrently belong to group (3). This occurrence does not defy plausibility given that sectors with high emissions often contain both high- and low-emissions companies.

We calculate cumulative average abnormal returns for the four different groups around viral days. We use the MSCI AC World US$ Price Index for the baseline model. As a robustness test, we also calculate abnormal returns for each of the countries with the largest number of sample companies, namely Australia, Canada, China, and the US, using local market indices.[45] We use two short event windows, [-1, +1] and [-3, +3], to limit potential confounding effects. The cumulative average abnormal returns (CAAR) are tested for significance using a simple *t* test. All results are qualitatively similar if we use alternative parametric and non-parametric tests, or alternative event windows (e.g. [-2, +2], [0, +1], or [0, +3]).

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[43] CDP, Companies Scores, https://www.cdp.net/en/companies/companies-scores.
[44] CDP, CDP Scores Explained, https://www.cdp.net/en/scores/cdp-scores-explained.
[45] This robustness test is done using the event study tool in WRDS.

The initial set of dates to consider are the 323 viral days (with the *Combined Virality Dummy* equal to one) described in Section 5.3. We restrict this further to most viral divestment campaign dates. In particular, we select only the top 1 percentile of dates according to the number of daily tweets and retweets and exclude the dates that overlap with other (earlier) viral days within the [-3, +3] interval. The final sample consists of 25 viral divestment campaign dates between 2014 and 2021.[46]

As an additional placebo test, we use a similar approach to determine the days with the lowest number of mentions of the divestment campaign on Twitter. We select the dates in the bottom 10th percentile according to the daily number of tweets and followers, and without any divestment pledge made in the previous 7 days. On these days there were less than three tweets and retweets a day. After excluding weekends and dates that overlap within the (-3, +3) interval, we get a sample of 18 low Twitter activity days.

We extract stock price data for Canadian and US companies from Compustat North America and for all other countries – from Compustat Global. MSCI AC World US$ Index returns, and daily currency rates are obtained from Refinitiv.

6.2 Results

Tables 8 and 9 present our main results. Table 8 shows the CAARs around viral divestment pledges for US companies for the subsample groups. Table 9 presents the same analysis for non-US (and Canadian) companies and three individual countries with the largest number of sample companies (besides the US), namely, Australia, Canada, and China.

Panel A of Table 8 reports significant negative cumulative average abnormal returns for all the three groups. We find the largest negative CAARs for group (1), the carbon underground companies targeted by the FF movement. For the narrower three-day window [-1,+1] there is a -0.9% loss that is significant at the one percent level; in terms of market value this sums up to losses of 3.5 billion dollars on average and 87 billion dollars in total. For the wider window [-3,+3] the losses are larger; 4.8 billion on average and 121 billion dollars in total. This finding is consistent with the negative price pressure and stigmatization hypothesis.[47]

[46] Two viral dates were public holidays. In these cases, we chose the next trading day.
[47] Price pressure would require relatively large amounts to be divested or expected to be divested; many of the institutions in our sample have relatively small holdings in Carbon Underground 200 companies, but we do not have systematic data on this point across all divesting institutions.

For group 2, coal, oil and gas companies that are not included in group (1) we also find negative CAARs, -0.4% in a three-day event window; again, this finding is consistent with the price pressure and stigmatization hypothesis because some divesting institutions do not distinguish between the Carbon Underground 200 and fossil fuel companies in general. However, we further observe negative and significant CAARs (-0.2% in a three-day event window) for group (3) (albeit significantly smaller than for group 1), which suggests a broader effect from the divestment campaign. A similar pattern holds for a sample of global firms (excluding Canada and US) in Panel A of Table 9 and a sample of Canadian and Chinese firms in Panels C and D of Table 9.

In Panel B of Table 8, we perform a placebo test using days with hardly any Twitter activity as event days. None of the CAARs, except for those of group (2) in the [-3, +3] event window, are significant, and there is no significant difference between the returns of groups (1) and (3). The results are consistent across countries except for Australia (in Panel B of Table 9). We do not observe any negative effect from divestment campaigns on Australian companies in all three samples. On the contrary, results show a positive effect for group (2) and (3) companies.

It is conceivable that in Australia divestment pledges have had no impact because of the unique political context driven by the powerful Australian fossil fuel lobby (Wright, Nyberg, and Bowden (2021), Crowley (2021)). If investors expect the power of this lobby to persist, they may price in an Australian exception for fossil fuel companies. The sample is too small to draw definite conclusions, but this Australian exception is striking.

Finally, Table 10 reports the CAARs around viral divestment pledges for US companies in the CDP A List sample, distinguishing between companies that are not included also in group (3) (82 firms) and companies that instead do overlap with group (3) (12 firms). We find that in both the event windows the A List companies that are not in high carbon emission sectors did not experience any significant effect from divestment campaigns (-0.03% in the three-day window and -0.08% in the seven days window). The results of the placebo test are consistent with the negative price pressure and stigmatization hypothesis, showing that companies who are transparent about their carbon emissions, demonstrate to have a climate transition plan in place, and are not highly polluting, were not impacted by the viral divestment campaigns. The 12 A list companies that are also included in group (3) of high-carbon emitters, CAARs are higher (albeit significant only for the wider window [-3, +3]). This finding is consistent with the coarse sector hypothesis; investors attach greater carbon risk to all companies in

certain sectors, irrespective of the individual company risk or profile (Bolton and Kacperczyk (2021)).

As a robustness test, we investigated whether the stock price reversal occurred within one month after the event (i.e., within +20 trading days). Our (unreported) findings indicate that we do not observe a reversal (in the [-3, +20] or [0, +20] event windows) in all subsamples, except for category (3) in the top 25 viral day sample for US companies. These results further support the notion that the viral divestment campaigns had a lasting impact rather than a temporary fluctuation in stock prices. Overall, the general finding – negative CAARs in all the three sample groups (in all countries except Australia) – suggests that there is more to the prevalent finance hypothesis that divestment primarily operates through selling pressure on stock prices. The effects of divestment are far broader than simply through selling pressure; they also work by shifting social preferences. To be sure, our results are consistent with the hypothesis that the FF divestment movement influences public opinion in general through its economic narrative. It has a broader impact that goes beyond the fossil fuel industry and affects all the high carbon emitters. Our findings are also consistent with the temporal and cross-section distribution of the "carbon premium" documented by Bolton and Kacperczyk (2021). They rationalize their finding with increased investor awareness since the signing of the Paris agreement in 2015. Our findings are consistent with this general explanation, but we highlight the special role of a particularly powerful social agent raising awareness, the Carbon Underground 200 divestment movement.

7 Divestment Pledges and Net-Zero Commitments

One of the most viral divestment pledges in our sample is the 2018 divestment pledge of Ireland. In the introduction we indicated how Ireland's principle-based divestment pledge preceded its broader net-zero commitment and the subsequent announcement of the decarbonization of the Irish strategic investment fund. In this section we explore whether the effects of this net zero commitment extend to the full sample of viral pledges. In this view markets interpret viral divestment pledges as a lead indicator for credible net-zero commitments tied to the carbon budget. These commitments from cities, regions, companies, and countries increase the risk of investing in high-level carbon emitters.[48]

[48] Net-zero refers to "cutting greenhouse gas emissions to as close to zero as possible".

To test the lead indicator hypothesis, we constructed a database of net-zero commitments using data from Net Zero Tracker (NZT). NZT tracks all commitments from United Nations Framework Convention on Climate Change (UNFCCC) member states, regions in the 25 highest emitting countries, cities with population greater than 500,000, and the 2,000 largest publicly-listed companies (Lang et al. (2022)). Table 11 Panel A shows the earliest pledges from entire countries and Panel B the most important pledges when in terms of real GDP. The earliest commitment from a high-GDP country enshrined in law was from Sweden in 2018. The commitments from the largest 20 economies date to 2020/21. We matched this data to our divestment pledges database using the geographic location of the divesting institutions.

If divestment pledges are lead indicators for net-zero commitments, we expect to find a correlation between the geographic location of the divesting institutions and net zero-commitments from entities in the same jurisdiction.[49] Table 12 compares the mean number of divestment pledges for countries that had made net-zero commitment by the end of 2021 with those that had not. The difference is large and statistically significant at the 10% level.

For the United States we conduct a more detailed analysis considering all the net-zero commitments by states, cities and companies and match these to the divestment pledges from U.S. institutions that went viral between 2010 and 2021. Figure 4 shows a clear temporal pattern. The number of viral divestment pledges increased sharply from 2014 onwards, while net-zero commitments only started in 2017. Although we do not provide empirical evidence to establish causality, we do observe that viral divestment campaigns preceded and likely pushed the net-zero commitments. The political mechanism that links divestment pledges to net-zero commitment could be explored in future research, for example by investigating the influence of divesting institutions on voter opinion and the campaign on political careers.[50]

8 Conclusion

In conclusion, the Go Fossil Free divestment movement has successfully induced notable investors to make a statement through action. It relies on a finance parable that conveys a moral principle in a simple story that people can understand. Voice through divestment had a

[49] We are assuming that the prominence of the divesting institutions is greatest in the city, region, or country where the institutions is located. This is not unreasonable even for institutions with global influence like the Holy See because divestment pledges usually came from local churches, not from the Vatican itself.
[50] There is anecdotal evidence that some participants in the fossil free movement successfully transitioned into politics (Murray (2022)).

measurable impact on the share prices of high carbon emitters that is consistent with a higher carbon premium, raised awareness and increased transition risk. Voice through divestment could be effective for other environmental, social or governance issues, but only if it is linked to a broader social movement around a compelling economic narrative.

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Table 1

Abnormal Returns Around Ireland's Divestment Announcements

The table shows abnormal returns around Ireland's divestment announcements on 26 January 2017 and 12 July 2018 for US companies. The two announcements went viral on Twitter, but the degree of virality was significantly higher for the latter. The Ireland Strategic Investment Fund (ISIF) divested from 38 global fossil fuel companies in December 2018 and January 2019; the total value of the divestment was €72m. The cumulative abnormal returns (CARs) are relative to the MSCI AC World US$ index and they are reported for three groups: The Carbon Underground 200 targeted by the fossil free divestment movement [1]; other fossil fuel companies [2] and a third group of high-carbon emitters that are not fossil fuel companies (e.g. cement) [3]. Fossil Fuel companies are from GIC Industry 101020 (Oil, Gas & Consumable Fuels). High Carbon Emitters are from GIC Industries 551050, 551010, 203020, 551030, 151040, 203010,151020, 151050, and 151010, as in Bolton and Kacperczyk (2021). CARs are winsorized at the 99th percentile. We also report inflation-adjusted (base January 2023) dollar returns in millions calculated by multiplying the market capitalization of the sample firm the day before the respective event window with the cumulative abnormal returns in the three (and seven) days around the announcement. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. CARs for US companies on 26 January 2017

		[1]	[2]	[3]	(1)-(2)	(1)-(3)	(2)-(3)
CAR (-1,+1)	Mean	-1.02%*	-0.44%	-0.53%***	*0.577*	*0.472*	*0.868*
	Median	-1.48%*	-0.53%	-0.72%***	*0.211*	*0.267*	*0.311*
Dollar returns	Mean	-289.7*	3.4	-13.7	*0.000*	*0.000*	*0.422*
($ millions)	Median	-50.1***	-0.2	-6.3***	*0.000*	*0.016*	*0.000*
Sum of values ($ millions)		*-10,718*	*638*	*-3,158*			
CAR (-3,+3)	Mean	-3.37%***	-1.39%***	0.24%***	*0.130*	*0.000*	*0.012*
	Median	-3.65%***	-0.67%**	0.12%	*0.001*	*0.000*	*0.016*
Dollar returns	Mean	-840.0**	4.7	-8.4	*0.000*	*0.000*	*0.695*
($ millions)	Median	-305.0***	-1.0	0.6*	*0.000*	*0.000*	*0.055*
Sum of values ($ millions)		*-31,077*	*879*	*-1,938*			
Number of unique firms		40	177	214			

Panel B. CARs for US companies on 12 July 2018

		[1] Carbon Underground 200	[2] Fossil Fuel Companies	[3] High Carbon Emitters	(1)-(2)	(1)-(3)	(2)-(3)
CAR (-1,+1)	Mean	-3.11%***	-0.94%***	-0.38%*	*0.001*	*0.000*	*0.093*
	Median	-2.37%***	-0.56%***	-0.26%***	*0.000*	*0.000*	*0.223*
Dollar returns	Mean	-352.6**	-10.6	-20.4	*0.000*	*0.000*	*0.638*
($ millions)	Median	-125.0***	-1.0**	-2.3**	*0.000*	*0.000*	*0.651*
Sum of values ($ millions)		*-14,104*	*-1,883*	*-4,360*			
CAR (-3,+3)	Mean	-4.06%***	-2.66%***	-1.74%***	*0.214*	*0.000*	*0.122*
	Median	-3.11%***	-2.36%***	-1.71%***	*0.103*	*0.008*	*0.233*
Dollar returns	Mean	-521.2***	-56.0***	-86.8***	*0.000*	*0.000*	*0.249*
($ millions)	Median	-171.1***	-5.6***	-18.7***	*0.000*	*0.000*	*0.079*
Sum of values ($ millions)		*-20,849*	*-9,990*	*-18,490*			
Number of unique firms		40	177	214			

Table 2

Nodes with Highest Degree of Centrality

The table shows the twenty nodes that are most central to the 350/Go Fossil Free Twitter network when ranked by their normalized "between" factor. The between factor is calculated by dividing the number of shortest paths that pass through a node by the total number of shortest paths. Shortest path is the shortest path between any two nodes. The table also reports the "in" and "out" connections for any one node.

RANK	@HANDLE	OUT	IN	BETWEEN	RANK	@HANDLE	OUT	IN	BETWEEN
1	nyudivest	171	144	4.4%	11	BestToDivest	50	132	1.2%
2	DivestHarvard	91	119	3.2%	12	FossilFreeSWK	56	94	1.1%
3	350	99	92	2.1%	13	divestumass	84	101	1.0%
4	FossilFreeMIT	155	89	2.1%	14	DivestVU	103	82	1.0%
5	divesthackney	81	131	2.0%	15	350Australia	60	60	0.9%
6	DivestDE	30	139	2.0%	16	massdivest	50	61	0.9%
7	DivestFund	93	98	1.9%	17	350Vermont	73	62	0.9%
8	divestinvestorg	88	72	1.6%	18	DivestMcGill	137	82	0.8%
9	DivestSmith	113	76	1.5%	19	DivestNobel	34	57	0.8%
10	UKDivest	31	55	1.4%	20	MPDivest	55	46	0.7%

Table 3

Main Hashtags

The table shows the hashtags that were used most frequently by 350.org and the Go Fossil Free project. They were extracted from the collection of tweets from all 504 nodes. Some hashtags are not completely self-explanatory: #auspol refers to Australian Politics; #nokxl is the collective term use by the opposition movement to the Keystone Oil Pipeline in the United States; #StopAdani is the hashtag of the @stopadani campaign in Australia that opposes the expansion of coal mines controlled by the Adani Group; #NoDAPL opposition to the Dakota Access Pipeline; #StopLine3 opposition to the Line 3 Pipeline; #MAPoli refers to Massachusetts politics.

	350.org		**Go Fossil Free**	
Rank	Hashtag #	Obs.	Hashtag #	Obs.
1	climate	19,105	divest	10,867
2	climatechange	18,191	divestment	7,095
3	actonclimate	8,620	fossilfree	5,741
4	keepitintheground	7,267	climatechange	3,339
5	climatestrike	6,916	climate	3,327
6	auspol	6,619	fossilfuels	2,133
7	fossilfree	6,602	fossilfuel	1,946
8	nokxl	6,502	keepitintheground	1,893
9	coal	5,992	divestnow	1,730
10	divest	5,871	mapoli	1,230
11	stopadani	5,294	actonclimate	1,121
12	climateaction	4,569	fracking	910
13	greennewdeal	4,106	coal	902
14	divestment	4,041	cop21	853
15	nodapl	3,956	climateemergency	809
16	stopline3	3,797	nodapl	797

Table 4

Tweets and Retweets by Year

The table shows the number of fossil fuel divestment tweets, replies, retweets and quotes. Panel A shows the tweets associated with the 350.org and the go fossil free movement between 2008 and 2021; Panel B shows the number of tweets mentioning divestment in the context of fossil fuels and climate change; Panel C shows the number of tweets from the @DivestmentFacts handle sponsored by the Independent Petroleum Association of America (IPAA).

Panel A. Number of Tweets from 350 and the Go Fossil Free Campaign

Year	Total	Retweets	Tweets	of which:	
				Replies	Quotes
2008	1	0	1	0	0
2009	0	0	0	0	0
2010	127	19	108	1	0
2011	285	109	176	1	0
2012	591	144	447	14	0
2013	10,880	3,556	7324	665	0
2014	14,856	6,311	8545	821	1
2015	28,312	12,923	15,389	1,298	929
2016	27,324	14,330	12994	767	2,138
2017	18,283	9,438	8845	594	1,757
2018	14,734	7,421	7313	696	1,399
2019	15,977	8,314	7,663	1,387	1,620
2020	17,255	8,209	9,046	2,140	2,039
2021	26,861	11,655	15,206	5,750	2,853
Total	175,486	82,429	93,057	14,134	12,736

Panel B. Number of Tweets mentioning Divestment from Fossil Fuels

Year	Total	Retweets	Tweets	of which:	
				Replies	Quotes
2008	1	0	1	0	0
2009	27	0	27	2	0
2010	300	4	296	5	0
2011	134	9	125	2	0
2012	8887	3882	5005	85	0
2013	54,605	23,189	31416	1,318	2
2014	137,090	70,948	66142	2970	27
2015	293,506	162,077	131,429	5,704	2808
2016	149,248	100,272	48976	1,507	2,620
2017	163,773	123,804	39969	2,539	3,513
2018	173,683	129,889	43794	3,717	4,270
2019	151,289	111,786	39,503	8,084	6,869
2020	164,689	118,939	45,750	7,228	6,727
2021	140,706	100,217	40,489	7,766	6,721
Total	1,437,938	945,016	492,922	40,927	33,557

Panel C. Number of Tweet from the @DivestmentFacts handle sponsored by the Fossil Fuel Industry

Year	Total	Retweets	Tweets	of which:	
				Replies	Quotes
2015	412	103	309	26	10
2016	523	50	473	12	7
2017	177	16	161	3	6
2018	198	17	181	1	6
2019	284	1	283	2	0
2020	116	5	111	29	0
2021	21	1	20	6	1
Total	1,731	193	1,538	79	30

Table 5

Earliest Divestment Pledges

The table shows the first ten of 1,591 pledges recorded in the global divestment database. They came from educational institutions, cities and faith institutions.

Divesting institution	Type of organization	Announcement date
Hampshire College	Educational Institution	01-Dec-11
City of Oakland, CA	Government	14-Jun-12
Unity College	Educational Institution	01-Nov-12
Massachusetts United Church of Christ	Faith-based Organization	10-Dec-12
City of Santa Monica, CA	Government	26-Feb-13
United Church of Christ, Minnesota Conference	Faith-based Organization	05-Mar-13
Trinitarian Congregational United Church of Christ, Warwick, MA	Faith-based Organization	10-Mar-13
Uniting Church, New South Wales & ACT, Australia	Faith-based Organization	16-Apr-13
City of Richmond, CA	Government	07-May-13
First Parish Church UU, MA	Faith-based Organization	02-Jun-13

Table 6

Tweet and Retweet Authors with Most Potential Views

The table ranks institutions or individuals who tweeted or retweeted about fossil fuel divestment between January 2008 and December 2021 by an upper bound estimate of the potential number of views. Column 1 shows the rank, Column 2 the potential number of views, Column 3 the sum of tweets and retweets and Column 5 the number of followers the author had during the latest Twitter archive search (March 2023). Column 6 shows the authors Twitter handle. The list is dominated by newspapers and new services like The Guardian, The New York Times, Bloomberg, CNN, Reuters, HuffPost, CNBC, ABC News, The Wall Street Journal, The Financial Times (with three handles), The Independent, and magazines like The Nation, The New Yorker and TIME. From the movement itself, 350.org and Bill McKibben were the most visible authors. The most visible external contributor is the American actor Mark Ruffalo; Leonardo DiCaprio has more followers but tweeted less often. @climatehawk1 and @johnlundin are climate activists. @YourAnonNews is part of nerdculture.de, a decentralized social network. Greenpeace and the Sierra Club environmental NGOs. @democracynow is the handle of an independent news service. @mashable is a blog platform. @ClimateReality is a project set up by former U.S. Vice-president Al Gore.

Rank	Potential Views Total	Tweets and Retweets Total	Name	Number of Followers	Handle (@)
1	1,677,677,386	154	The Guardian	10,894,009	guardian
2	769,909,560	14	The New York Times	54,993,540	nytimes
3	731,772,238	1,913	350 dot org	382,526	350
4	636,204,512	76	Mark Ruffalo	8,371,112	MarkRuffalo
5	597,487,410	65	Bloomberg	9,192,114	business
6	438,488,928	1,104	Bill McKibben	397,182	billmckibben
7	386,153,705	203	Greenpeace International	1,902,235	Greenpeace
8	384,366,910	6,445	climatehawk1	59,638	climatehawk1
9	334,969,392	4,724	John Lundin	70,908	johnlundin
10	306,289,360	5	CNN	61,257,872	CNN
11	231,752,808	9	Reuters	25,750,312	Reuters
12	214,147,604	11	TIME	19,467,964	TIME
13	212,906,400	19	HuffPost	11,205,600	HuffPost
14	179,133,812	143	CNBC-TV18	1,252,684	CNBCTV18Live
15	169,892,832	136	The Nation	1,249,212	thenation
16	158,952,784	304	Guardian Environment	522,871	guardianeco
17	158,386,608	41	Guardian news	3,863,088	guardiannews
18	150,817,953	19	Anonymous	7,937,787	YourAnonNews
19	148,807,890	394	Sierra Club	377,685	SierraClub
20	125,633,312	14	The New Yorker	8,973,808	NewYorker
21	124,745,096	7	ABC News	17,820,728	ABC
22	123,060,240	6	The Wall Street Journal	20,510,040	WSJ
23	112,975,800	15	Financial Times	7,531,720	FinancialTimes
24	106,448,260	19	Financial Times	5,602,540	FT
25	102,549,402	162	Climate Reality	633,021	ClimateReality
26	102,281,960	11	Mashable	9,298,360	mashable
27	100,225,140	5	The Washington Post	20,045,028	washingtonpost
28	97,606,440	5	Leonardo DiCaprio	19,521,288	LeoDiCaprio
29	95,613,600	120	Democracy Now!	796,780	democracynow
30	94,331,380	26	The Independent	3,628,130	Independent

Table 7

Top-20 Fossil Fuel Divestment Viral Dates

The table lists the 20 most viral dates, which identify the days when tweets mentioning fossil fuel divestment reached the highest virality. Most of the tweets refer to divestment campaigns and coincide with the more restrictive sample that required specific reference to a divesting institution. The table confirms that the raw counts for the restrictive sample vastly understate their visibility. The viral tweets in this table capture the impact of the pledges but also the impact of the campaigns, for example the Harvard and Yale campaigns that were central to the movement. The last column shows a selection of the most viral tweets on the day.

Viral Date	Tweets and Retweets per Day	Views per Day (Upper Bound)	Type of Campaign	Example of Divestment/Campaign Tweet
Jan 11, 2018	13,367	121,212,192	Divestment Pledge	@thenation: “Flanked by Nation contributors Naomi Klein and Bill McKibben, Bill de Blasio just announced that New York City would divest from and sue fossil fuel companies”
Jul. 12, 2018	11,060	114,591,624	Divestment Pledge	@guardian: “Ireland becomes world's first country to divest from fossil fuels”
Jul. 13, 2018	10,301	149,153,664	Divestment Pledge	@Davos: “Ireland becomes the 'world's first' country to commit to divesting from fossil fuels”
Nov. 24, 2019	9,509	89,922,920	Push to divest	@billmckibben: “Not just Harvard--Here's one of Yale footballs leaders with the same message: Climate is an emergency. Divest now.”
Jan. 10, 2018	9,286	148,385,664	Divestment Pledge	@MarkRuffalo: “NYC’s move to sue and divest from Big Oil is a huge step in curbing the impact of climate change and creating a more responsible financial future for the city. #stopfundingfossils”
Sep. 22, 2014	8,937	324,948,032	Divestment Pledge	@MSNBC: “Rockefellers announce plans to divest fossil fuel assets following largest climate march in history”
Nov. 23, 2019	8,193	139,887,712	Push to divest	@nytimes: “Climate change activists stormed the field at the Yale-Harvard football game on Saturday afternoon, disrupting the game at halftime to call for the universities to divest their investments in fossil fuels”
Apr. 1, 2015	7,303	103,977,312	Divestment Pledge	@guardian: “Guardian Media Group to divest its £800m fund from fossil fuels”
Feb. 13, 2015	7,220	203,305,360	Push to divest	@MarkRuffalo: “Today is Global Divestment from Fossil Fuel day. I will be sending out tweets today on that topic. Please RT”
Sep. 10, 2021	5,533	150,992,912	Divestment Pledge	@algore: “After years of activism from students, faculty & alums, Harvard is finally divesting from fossil fuels. Thank you to @DivestHarvard and all those who pushed to make this happen. Let this be a strong signal to other institutions that the era of fossil fuels is coming to a close.”
Sep. 23, 2014	5,044	192,843,136	Divestment Pledge	@Slate: “The Rockefeller Family made billions from oil. Now they're divesting over climate change”
Jun. 5, 2015	4,903	166,872,976	Divestment Pledge	@thinkprogress: “Norway will divest from coal”
Feb. 14, 2015	4,716	73,720,992	Push to divest	@ClimateReality: “For Valentine’s Day, break up with fossil fuels & fall in love with renewables http://gofossilfree.org #divest”
Jan. 23, 2020	4,524	150,847,344	Push to divest	@AP: “U.S. Treasury chief says it's "a joke"' when asked about climate activist Greta Thunberg's recommendation that the public and private sectors should divest from fossil fuels. He says she can't give economic advice until she gets a college degree.”
Mar. 16, 2015	4,479	94,914,800	Push to divest	@tveitdal: “Oxford University Fossil Free Divestment Campaign: Group of Oxford alums in occupation!”; @guardian: “"The argument for divesting from fossil fuels is becoming overwhelming" – @arusbridger”
Apr. 16, 2015	4,111	95,375,728	Push to divest	@democracynow: “Harvard Students Expand Blockade Calling for School to Divest from Fossil Fuels”; @guardianeco: “Dear @gatesfoundation @wellcometrust : here's 180,000 reasons why you shd #divest #fossilfuels”
Dec. 13, 2016	4,025	62,746,928	Push to divest	@LeoDiCaprio: “As the hottest year in history concludes it's time for NY to act on climate & divest from fossil fuels http://divestny.org #DivestInvest”
Dec. 9, 2020	3,843	64,258,032	Divestment Pledge	@billmckibben: “Truly staggering win in New York this a.m.: the state will divest its $226 billion pension fund from fossil fuels. That's the biggest pension fund yet, it comes after a decade of great activism, and it underlines the weakening power of Big Oil”
Dec. 27, 2021	3,834	13,481,942	Push to divest	@FastCoImpact: “Was 2021 the tipping point for fossil fuel divestment?”
Dec. 20, 2017	3,715	50,638,452	Divestment Pledge	@350: “NY state and city are moving to divest their pension funds from fossil fuels. With combined assets over $390 billion, these are the largest ever pension fund commitments to freeze and divest from oil, gas and coal in the world.”

Table 8

Abnormal Returns around Viral Divestment Pledges for U.S. Companies

The table shows cumulative abnormal returns around the announcement dates of divestment pledges that went viral on Twitter. The sample is confined to U.S. companies. The cumulative abnormal returns (CARs) are relative to the MSCI AC World US$ index and they are reported for three groups: Carbon Underground 200 companies targeted directly by the divestment movement [1]; other fossil fuel companies [2] and other high carbon emitters that are not directly targeted by the divestment movement (e.g. cement companies) [3]. Panel A reports abnormal returns around the top viral days. We also report inflation-adjusted (base January 2023) dollar returns in millions calculated by multiplying the market capitalization of the sample firm the day before the respective event window with the cumulative abnormal returns in the three (and seven) days around the announcement. Panel B reports results around low Twitter activity dates. Fossil Fuel companies are from GIC Industry 101020 (Oil, Gas & Consumable Fuels). High Carbon Emitters are from GIC Industries 551050, 551010, 203020, 551030, 151040, 203010,151020, 151050, and 151010, as in Bolton and Kacperczyk (2021). CARs are winsorized at the 99th percentile. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. CAARs for US companies during top viral days (25 event days)

		[1] Carbon Underground 200	[2] Fossil Fuel Companies	[3] High Carbon Emitters	[1]-[2]	[1]-[3]	[2]-[3]
CAAR [-1,+1]	Mean	-0.94%***	-0.41%***	-0.18%***	*0.014*	*0.000*	*0.029*
	Median	-0.85%***	-0.37%***	-0.25%***	*0.004*	*0.000*	*0.094*
Dollar returns	Mean	-92.7***	-4.6	-15.1***	*0.000*	*0.000*	*0.078*
($ millions)	Median	-11.4***	-0.2***	-0.6***	*0.000*	*0.000*	*0.214*
Sum of values ($ millions)		*-86,963*	*-19,643*	*-82,881*			
CAAR [-3,+3]	Mean	-1.03%***	-1.01%***	-0.24%***	*0.927*	*0.001*	*0.000*
	Median	-0.99%***	-0.88%***	-0.44%***	*0.960*	*0.001*	*0.000*
Dollar returns	Mean	-128.7***	-10.9***	-24.2***	*0.000*	*0.000*	*0.106*
($ millions)	Median	-9.0***	-0.8***	-0.9***	*0.000*	*0.002*	*0.945*
Sum of values ($ millions)		*-120,550*	*-46,976*	*-132,772*			
N		937	4,294	4,497			
Number of unique firms		60	257	288			

Panel B. CAARs for US companies during low activity days (18 event days)

Sample	CAAR [-1,+1]	Significance	CAAR [-3,+3]	Significance	Number of firms
Carbon Underground 200 [1]	0.09%		-0.16%		53
Fossil Fuel Companies [2]	-0.08%		-1.03%	***	228
High Carbon Emitters [3]	0.09%		-0.05%		260
[1] vs. [2] (p-value)	*0.561*		*0.004*		
[1] vs. [3] (p-value)	*0.985*		*0.515*		
[2] vs. [3] (p-value)	*0.270*		*0.000*		

Table 9

Abnormal Returns Around Viral Divestment Pledges for Global Companies

The table reports similar result to Table 7 but for global companies. The cumulative abnormal returns (CARs) for global companies are relative to the MSCI AC World US$ index. Panel A includes all global companies, excluding Canada and the United States. Panel B show results for Australia, a country with a large number of fossil fuel companies and governments that were considered firmly in the hand of the fossil fuel industry. Panel C and D shows the same results for Canada and China. Fossil Fuel companies are from GIC Industry 101020 (Oil, Gas & Consumable Fuels). High Carbon Emitters are from GIC Industries 551050, 551010, 203020, 551030, 151040, 203010,151020, 151050, and 151010, as in Bolton and Kacperczyk (2021). CARs are winsorized at the 99th percentile. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. CAARs for Global companies (excluding Canada and US) during top viral days (25 event days)

Sample	CAAR [-1,+1]	Significance	CAAR [-3,+3]	Significance	Number of firms
Carbon Underground 200 [1]	-0.16%	***	-0.63%	***	82
Fossil Fuel Companies [2]	-0.21%	***	-0.80%	***	395
High Carbon Emitters [3]	0.15%	***	-0.38%	***	2699
[1] vs. [2] (p-value)	*0.714*		*0.413*		
[1] vs. [3] (p-value)	*0.009*		*0.193*		
[2] vs. [3] (p-value)	*0.000*		*0.000*		

Panel B. CAARs for Australian companies during top viral days (25 event days)

Sample	CAAR [-1,+1]	Significance	CAAR [-3,+3]	Significance	Number of firms
Carbon Underground 200 [1]	-0.36%		0.27%		8
Fossil Fuel Companies [2]	0.22%		1.19%	***	27
High Carbon Emitters [3]	0.28%	***	1.54%	***	144
[1] vs. [2] (p-value)	*0.368*		*0.316*		
[1] vs. [3] (p-value)	*0.289*		*0.158*		
[2] vs. [3] (p-value)	*0.842*		*0.487*		

Table 9 (continued)

Panel C. CAARs for Canadian companies during top viral days (25 event days)

Sample	CAAR [-1,+1]	Significance	CAAR [-3,+3]	Significance	Number of firms
Carbon Underground 200 [1]	-0.85%	***	-1.31%	***	25
Fossil Fuel Companies [2]	-0.48%	***	-1.03%	***	85
High Carbon Emitters [3]	0.01%		-0.14%		174
[1] vs. [2] (p-value)	*0.285*		*0.579*		
[1] vs. [3] (p-value)	*0.010*		*0.023*		
[2] vs. [3] (p-value)	*0.006*		*0.001*		

Panel D. CAARs for Chinese companies during top viral days (25 event days)

Sample	CAAR [-1,+1]	Significance	CAAR [-3,+3]	Significance	Number of firms
Carbon Underground 200 [1]	-0.21%	*	-1.62%	***	18
Fossil Fuel Companies [2]	0.65%	***	-1.90%	***	35
High Carbon Emitters [3]	0.49%	***	-0.64%	***	811
[1] vs. [2] (p-value)	*0.001*		*0.490*		
[1] vs. [3] (p-value)	*0.002*		*0.012*		
[2] vs. [3] (p-value)	*0.299*		*0.000*		

Table 10

Abnormal Returns around Viral Divestment Pledges for CDP A List Companies

The table shows cumulative abnormal returns around the viral divestment pledges for companies that were included in the CDP A List at least once between 2012 and 2022. The sample is confined to U.S. companies. The cumulative abnormal returns (CARs) are relative to the MSCI AC World US$ index and they are reported for two groups: CDP A List companies that are not within high carbon emitters in group [3]; and CDP A List companies that do overlap with high carbon emitters in group [3]. High Carbon Emitters are from GIC Industries 551050, 551010, 203020, 551030, 151040, 203010,151020, 151050, and 151010, as in Bolton and Kacperczyk (2021). CARs are winsorized at the 99th percentile. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

		A List (not in [3])	A List (overlap with [3])
CAAR [-1,+1]	Mean	-0.03%	-0.15%
CAAR [-3,+3]	Mean	-0.08%	-0.46%**
Number of firms		82	12

Table 11

Country Net Zero Commitments

The table shows net-zero commitments by country, the end target, the target year, the target status at the end of 2022 and the country's real GDP in billion U.S. dollars. Panel A shows the earliest net-zero commitments; Panel B ranks the countries that have made a commitment by real GDP. The data comes from Net Zero Tracker (https://zerotracker.net); see Lang et al. (2022). Net-zero (emissions) and climate neutral implies that all greenhouse gases released by human activity are absorbed or removed; carbon neutral is similar but confined to carbon; reduction v. BAU means a reduction against a "business as usual" scenario.

Panel A - Earliest Net-Zero Commitments by Countries

Status Year	ISO	Country Name	End Target	Target Year	Target Status	Real GDP
2014	SUR	Suriname	Net zero		Achieved (self-declared)	10B
2015	LIE	Liechtenstein	Emissions reduction target	2030		
2015	FIN	Finland	Climate neutral	2035	In policy document	305B
2015	VEN	Venezuela	Emissions reduction target	2030	In policy document	
2015	KGZ	Kyrgyzstan	Other	2050	In policy document	35B
2015	FSM	Micronesia	Net zero	2050	Proposed / in discussion	less than 1B
2015	SMR	San Marino	Emissions reduction target	2030	In policy document	2B
2015	TKM	Turkmenistan	Other	2030	In policy document	76B
2016	DMA	Dominica	Emissions reduction target	2030	In policy document	1B
2016	DJI	Djibouti	Reduction v. BAU	2030	In policy document	6B
2016	BWA	Botswana	Emissions reduction target	2030	In policy document	42B
2017	EGY	Egypt	Other	2030	In policy document	1,388B
2017	SRB	Serbia	Emissions reduction target	2030	In policy document	117B
2017	AZE	Azerbaijan	Emissions reduction target	2030	In policy document	161B
2018	GNQ	Equatorial Guinea	Emissions reduction target	2050	In policy document	26B
2018	ERI	Eritrea	Net zero	2050	Proposed / in discussion	
2018	SWE	Sweden	Net zero	2045	In law	618B

Panel B – Top-20 Net-Zero Commitments by Countries by GDP

Status Year	ISO	Country Name	End Target	Target Year	Target Status	Real GDP
2020	CHN	China	Carbon neutral(ity)	2060	In policy document	27.3E+12
2021	USA	United States of America	Net zero	2050	In policy document	23.0E+12
2020	XXX	European Union	Climate neutral	2050	In law	21.7E+12
2021	IND	India	Net zero	2070	Declaration / pledge	10.2E+12
2021	JPN	Japan	Net zero	2050	In law	5.4E+12
2021	RUS	Russian Federation	Carbon neutral(ity)	2060	In law	4.8E+12
2021	DEU	Germany	Climate neutral	2045	In law	4.6E+12
2021	IDN	Indonesia	Net zero	2060	Proposed / in discussion	3.6E+12
2020	BRA	Brazil	Carbon neutral(ity)	2050	Declaration / pledge	3.4E+12
2020	FRA	France	Net zero	2050	In law	3.4E+12
2020	GBR	United Kingdom	Net zero	2050	In law	3.3E+12
2021	ITA	Italy	Climate neutral	2050	In policy document	2.7E+12
	MEX	Mexico	Carbon neutral(ity)	2050	Proposed / in discussion	2.6E+12
2021	TUR	Turkey	Net zero	2053	In policy document	2.6E+12
2021	KOR	South Korea	Net zero	2050	In law	2.3E+12
2021	CAN	Canada	Net zero	2050	In law	2.0E+12
2021	ESP	Spain	Climate neutral	2050	In law	1.9E+12
2021	SAU	Saudi Arabia	Net zero	2060	In policy document	1.8E+12
2021	AUS	Australia	Net zero	2050	In policy document	1.4E+12
	POL	Poland	Emissions reduction target	2030	In policy document	1.4E+12

Table 12

Divestment Pledges and Country Net Zero Commitments

The table test the mean difference in the number of divestment pledges between countries that have made a net-zero commitment by the end of 2021 and countries that have not. Note that the sample only includes countries with at least one divestment pledge. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

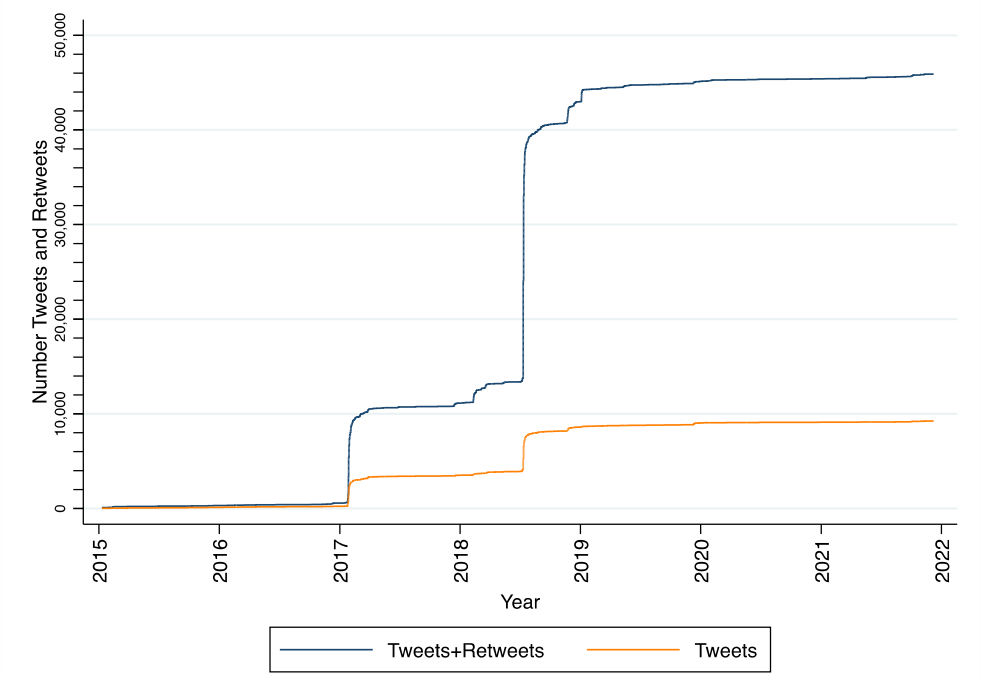
	Countries WITH Net Zero pledges	Countries WITHOUT Net Zero pledges	Difference (p-value)	Significance
Divestment pledges (mean)	36.91	5.40	*.0736*	*
Number of countries	23	15		

Figure 1

Number of Tweets and Retweets around Ireland's Divestment Announcements

The figure shows the number of tweets and retweets containing the word "Ireland" in tweets and retweets mentioning fossil fuel divestment. To be included the tweet needs to contain the words "divest", "divestment", "divesting" or "divestnow" in combination with fossil, fossils, fossilfree, fossilfuel, fossilfuels, keepitintheground, climate, climatechange, actonclimate, climatestrike, climateaction, climateemergency, coal, greennewdeal, 350ppm, fridaysforfuture, cop21 or cop26. Panel A shows the number daily tweets and retweets over time. There are discrete jumps on the days of the Irish divestment announcement: 26 January 2017, 12 and 16 July 2018. Panel B shows an upper bound estimate on the number of views defined by the sum of the followers of the tweeting and retweeting individuals and institutions. The estimated total reach was more than 300 million.

Panel A. Number of Fossil Fuel Divestment Related Tweets and Retweets mentioning "Ireland"



Panel B. Number of Daily Views of Ireland related Divestment Tweets - Upper Bound in Million (10^6)

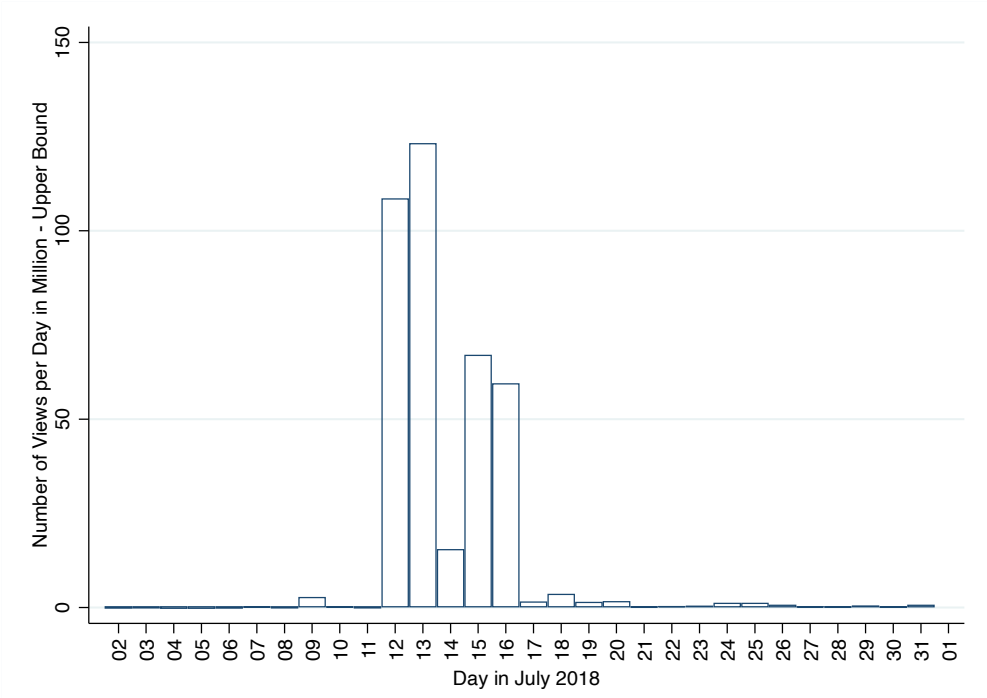
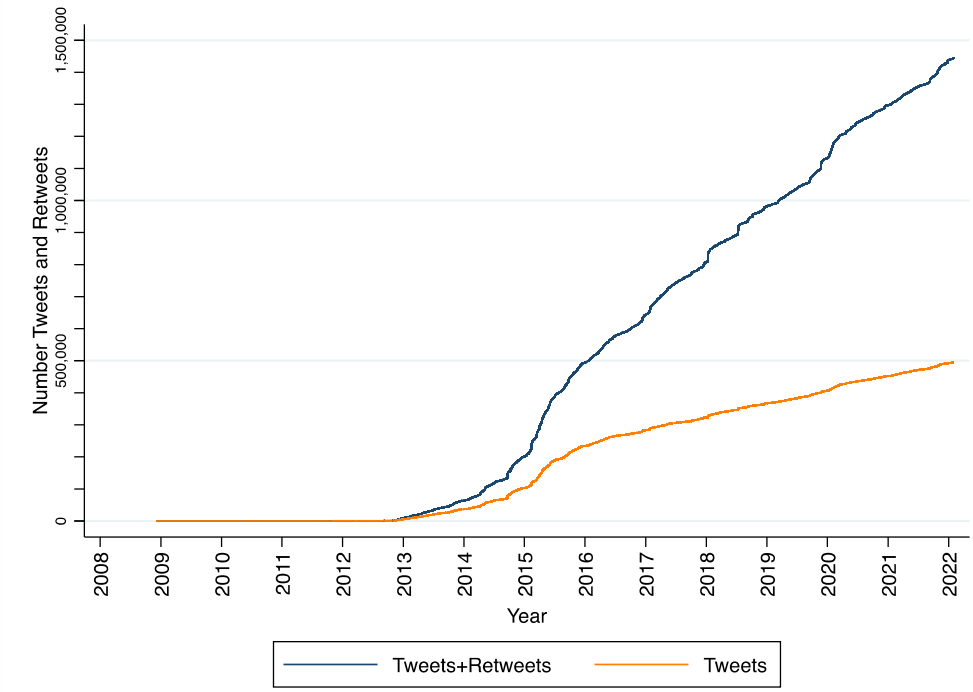


Figure 2

Number of Tweets and Retweets Mentioning Fossil Fuel Divestment

The figure shows the evolution of the number of tweets and retweets mentioning fossil fuel divestment. To be included the tweet needs to contain the words "divest", "divestment", "divesting" or "divestnow" in combination with fossil, fossils, fossilfree, fossilfuel, fossilfuels, keepitintheground, climate, climatechange, actonclimate, climatestrike, climateaction, climateemergency, coal, greennewdeal, 350ppm, fridaysforfuture, cop21 or cop26. Panel A shows the evolution in the number of tweets and retweets overt time. Panel B shows the upper bound of the number of views measured by the number of followers of authors of the tweet or retweet in March 2023.

Panel A. Evolution of the Number of Tweets and Retweets over Time



Panel B. Evolution of the Number of Views over Time - Upper Bound in Billions (10^9)

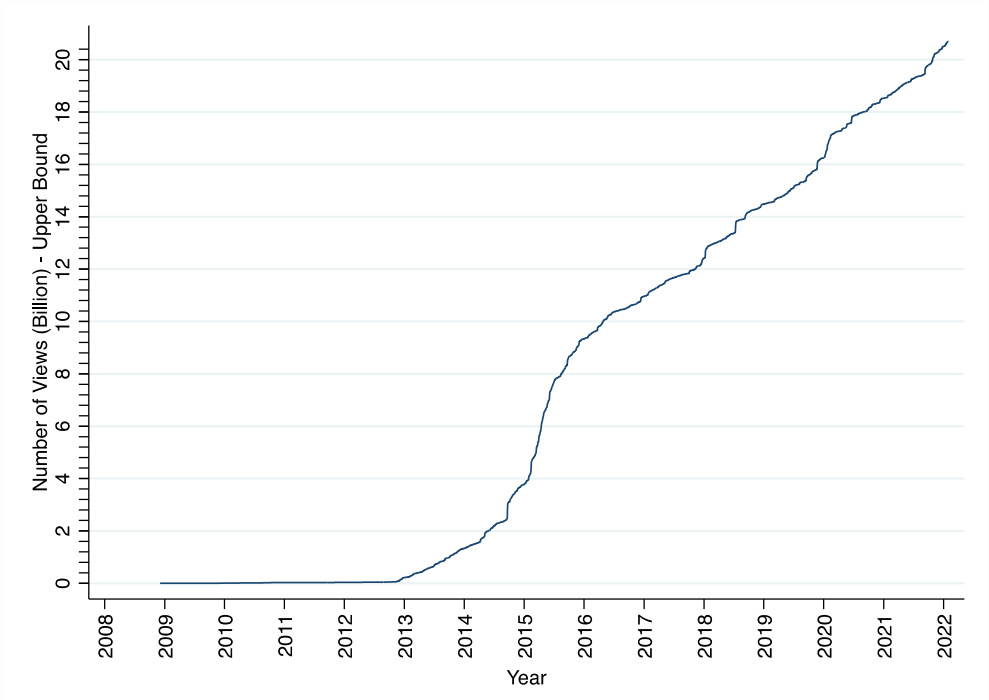
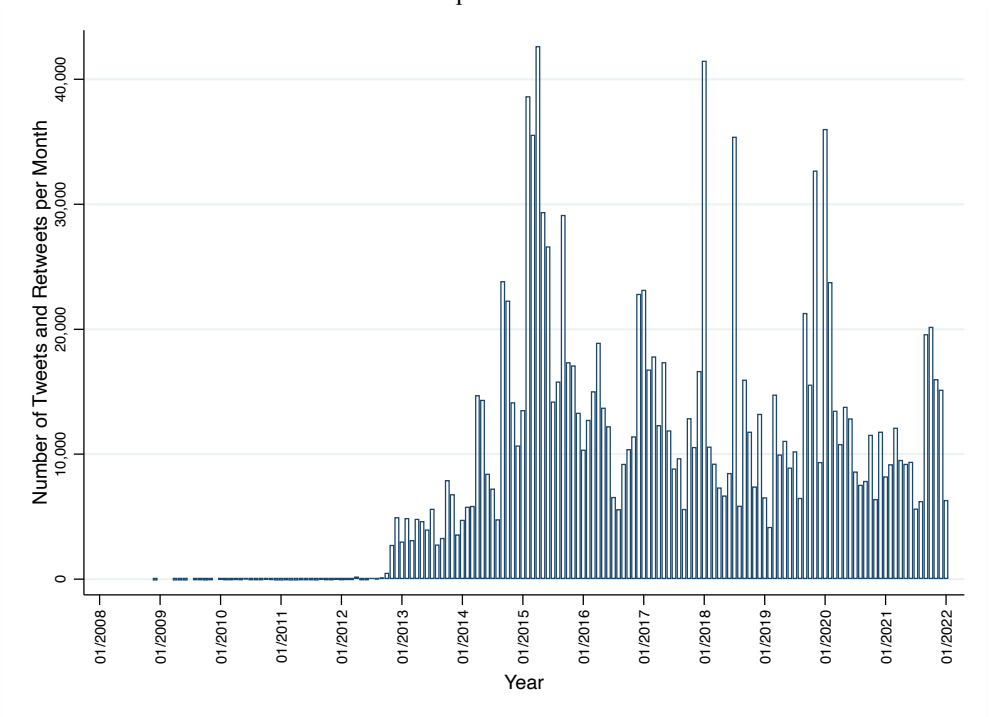


Figure 3

Monthly Frequency of Tweets and Retweets Mentioning Divestment

The figure shows tweets and retweets per month relating to divestment pledges from any source. There is an initial peak in 2015 around the Paris Agreement (COP21). There are further peaks in later years around significant divestment announcements. Panel A shows the number of tweets and retweets per month. Panel B shows the upper bound of the number of views per month.

Panel A. Number of Tweets and Retweets per Month



Panel B. Number of Views per Month in Millions – Upper Bound

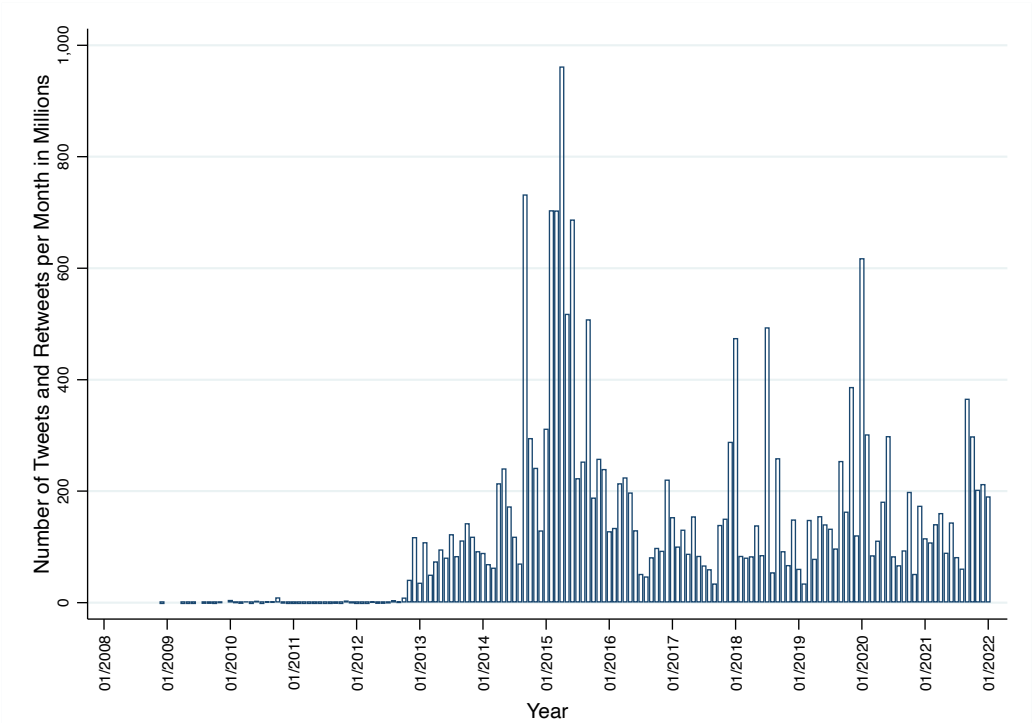
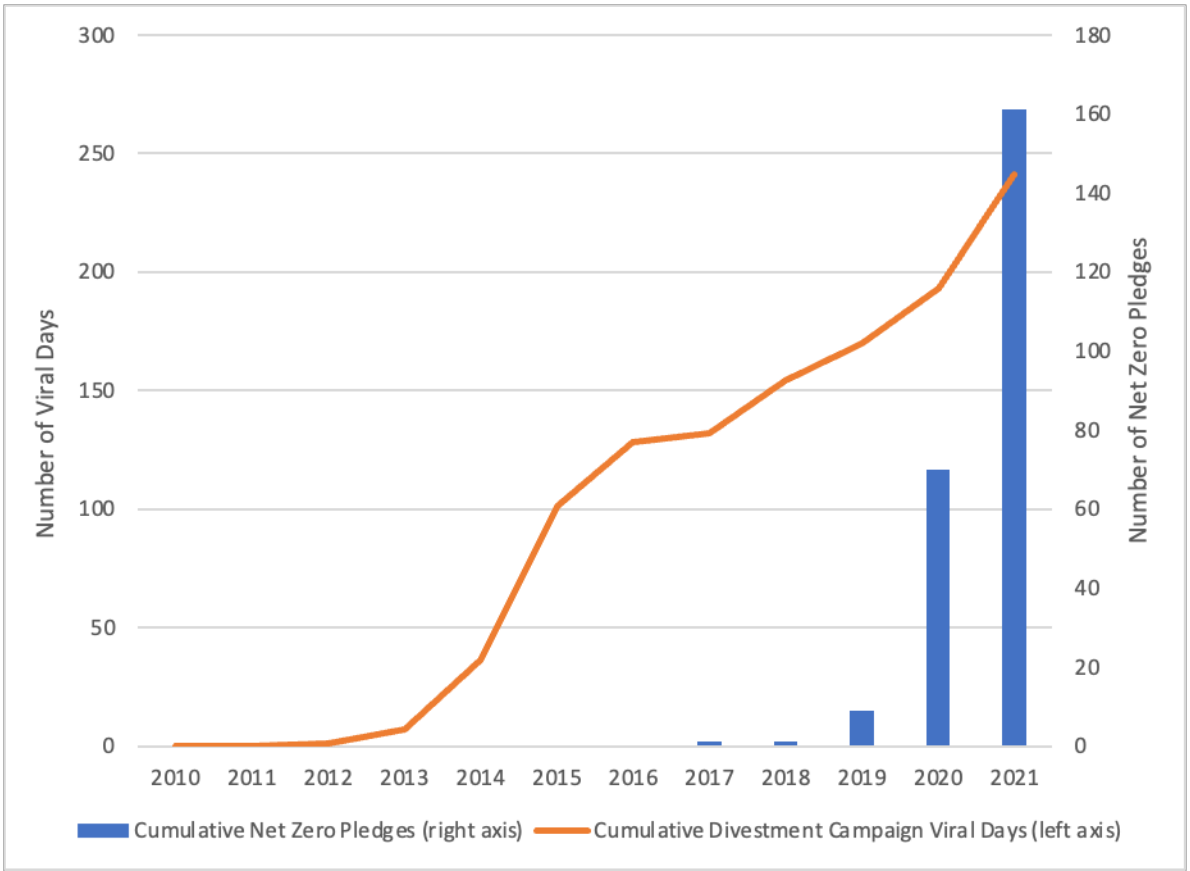


Figure 4

Divestment Pledge Virality vs. Net Zero Pledges (U.S. Case)

The figure shows the cumulative number of viral days (orange, left axis) against the number of net-zero pledges by the country, cities, states, and companies (right axis, blue bar chart).



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