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Rethinking carbon risks in the (post)-pandemic landscape: a perspective from the financial markets

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Abstract

This paper investigates whether the coronavirus outbreak has led to a de-carbonization of the financial markets by analyzing the fund flows of US and European equity mutual funds. Using a carbon risk measure to categorize funds, this paper finds support for such a de-carbonization effect, with investors allocating significantly more capital toward low-carbon risk funds following the outbreak of the virus. Aside from the greater transition risks and opportunities imposed by the pandemic, these capital movements can be explained by the financial performance of equity mutual funds during the pandemic-induced market crash. That is, the higher risk-adjusted returns of low-carbon risk funds during the pandemic-induced market crash indicate that these funds can serve as a valuable hedge during periods of market turmoil. Overall, these findings demonstrate the impact of the pandemic on the financial markets, thereby highlighting the more prominent role of carbon risk in the (post)-pandemic landscape.

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1 Introduction

Climate change has moved from the merely predicted to noticeable consequences, making it one of the most pervasive and pressing issues of this century. As highlighted by the Intergovernmental Panel on Climate Change (IPCC), these climate-related consequences are becoming more catastrophic if global greenhouse gas emissions (GHG) are not reduced substantially in the upcoming thirty years (IPCC, 2018). Consequently, authorities have established mondial climate change agreements to reduce overall GHG emission levels. The Paris Agreement of 2015, in particular, is one of the leading treaties to realize these mondial climate change objectives. An essential element of this agreement is the mobilization of climate capital, which facilitates the transition to a low-carbon economy[1]. However, this necessitates the mobilization of both public and private capital, as public capital alone is insufficient to close the current investment gap (see EU, 2019). The recent outbreak of the COVID-19 virus has enabled an unique opportunity to accelerate the mobilization of public climate capital, as the impact of the virus has resulted in unprecedented capital needs to restructure the global economy. Indeed, authorities worldwide have devoted substantial amounts of stimulus funds to climate change objectives in order to accelerate the transition to a low-carbon economy (see EU, 2022, e.g.). However, a thorough understanding of private capital flows is needed to determine whether the COVID-19 crisis has mobilized climate capital in aggregate (i.e., public and private capital). This is particularly relevant given the imperative role of private capital in closing the investment gap in order to completely facilitate a low-carbon transition. This study aims to investigate the impact of the COVID-19 crisis on private capital flows by analysing the financial markets, answering the following research question:

Research Question: *Does the COVID-19 crisis de-carbonize the financial markets?*

For two reasons, the COVID-19 crisis is expected to have a de-carbonization effect—that is, increased capital flows to investment vehicles with low-carbon risk exposure—on the financial markets[2]. First, these type of investment vehicles provide downside protection during times of market turmoil. Namely, the high environmental standards of the underlying companies that are tied to these investment vehicles ensure that essential stakeholders (e.g., customers) are more likely to remain loyal during periods of economic downturn. This results in operational resilience, making these companies less sensitive to adverse market shocks. Similarly, this mechanism of resilience may also stem from investor loyalty, reducing the negative implications of fire sales during periods of market turmoil. Given the volatile financial markets after the outbreak of the coronavirus, it is thus expected that investors will gravitate toward these investment vehicles to hedge against downside risks. Second, the economic role of authorities is generally more pronounced during crisis periods,

[1] See Article 2 of the Paris Agreement, which states: "Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development."

[2] Note that carbon risk exposure is a measure of the risks associated with the transition to a low-carbon economy. This implies that low-carbon risk funds are adequately positioned for this transition, whereas high-carbon risk funds are not.

as is their public spending. Therefore, authorities can bring about long-term structural changes to economies and hence accelerate a low-carbon transition. This imposes greater transition risks and opportunities in the near future and is likely to be reflected in the capital movements of investors.

Using data on fund flows and returns in the equity mutual fund industry, this study establishes two main results[3]. First, low-carbon risk funds experience greater fund flows after the outbreak of the coronavirus, in line with the expected de-carbonization effect. Second, during the pandemic-induced market crash, low-carbon risk funds outperform other funds in terms of risk-adjusted returns. This finding is consistent with the notion that these assets provide more resilience during times of market turmoil, and provides a financial explanation for the observed capital movements.

These results are developed in two main steps and are based on a sample that consists of US and European domiciled funds over the period from July 1, 2019 to March 1, 2021[4]. The first step examines capital movements to funds across heterogeneous carbon risk classes using a difference-in-difference framework. The results indicate that low-carbon risk funds experience significantly higher net flows than average-rated funds after the onset of the pandemic, as compared to before. Next, the second step examines the performance of funds in terms of their risk-adjusted returns during the market crash. This analysis makes use of a multi-factor model to compute the risk-adjusted returns. These risk-adjusted returns are then used as a dependent variable in a (OLS) regression analysis to examine the relationship between fund performance and heterogeneous carbon risk classes. The results indicate that risk-adjusted returns are positively related to funds with low-carbon risk and negatively related to funds with high-carbon risk.

In addition to the main results, this study conducts a comparative analysis and additional robustness checks that exploit the broader ESG rating and its individual environmental, social and governance sub-components. This has two purposes. First, it sheds light on the commonalities and disparities between different sustainability factors along with their influence on fund flow dynamics during the pandemic. Second, it highlights the importance of carbon risk and alleviates concerns about the main results being driven by other sustainability factors.

This paper contributes to two streams of literature: (1) investor behaviour and (2) investment performance. As for (1), this study adds to the literature that studies whether investors prefer to invest in socially responsible investment vehicles (see Barber et al., 2021; Bassen et al., 2019; Bollen, 2007; Döttling and Kim, 2021; Hartzmark and Sussman, 2019; Pástor et al., 2021; Renneboog et al., 2011; Riedl and Smeets, 2017, e.g.). This study contributes to the existing literature by demonstrating investor behaviour at various stages of the pandemic, shedding light on investors' responsible asset allocations in the face of changing economic

[3]Note that this study focuses on equity mutual funds to examine the behaviour of investors throughout the pandemic. Unlike other investment classes, fund flows accurately reflect the demand for responsible assets as arbitrageurs are not able to counter the trades (i.e., short-selling is absent) (Wang and Young, 2020).

[4]Note that this study focuses on the US and Europe, as these are the two major regions in the equity mutual fund industry, accounting for approximately 63% and 24% of the total industry, respectively. These statistics are derived from The International Investment Funds Association and are based on the total net assets in the first quarter of 2021.

and financial market conditions. As for (2), this study contributes to the literature on the performance of socially responsible investments during periods of market turmoil (see Lins et al., 2017; Nofsinger and Varma, 2014, e.g.). The use of the pandemic-induced market crash sheds more light on this relationship due to the exogenous nature of the crisis[5]. Unlike most of the extant literature on investor behaviour and investment performance, this study takes an alternative measure of social responsibility. Namely, this study focuses on carbon risk, whereas the majority of the literature focuses on the broader ESG rating[6]. By doing so, this study argues that the salient carbon risk component is not accurately reflected by the broader ESG rating, albeit essential for the mobilization of climate capital and the transition to a low-carbon economy. Despite the imperative role of carbon risk in the transition to a low-carbon economy, the field of research in this domain remains scarce and the relationship between carbon risk and equity mutual funds throughout the course of the pandemic has not been studied to the best of found knowledge[7].

This paper is informative from a strategic standpoint for both financial intermediaries and policy-makers. First, the findings inform financial intermediaries about the pertinence of carbon risk. In particular, they show that low-carbon risk investment vehicles can provide a competitive advantage in terms of capital flows. Second, the findings are informative for policy-makers that seek to mobilize climate capital. In particular, they highlight the more prominent role of carbon risk on asset allocations, making mandatory carbon risk disclosure a valuable policy-instrument to re-orient capital flows toward a low-carbon economy. Namely, mandatory carbon risk disclosure would increase transparency in the financial markets, with potential to enlarge the current shift in capital flows to low-carbon risk investments.

The remainder of this paper is organized as follows. Section 2 provides an overview of the existing literature on responsible investing as well as the hypothesis. Section 3 introduces the data and outlines the empirical methodology. Section 4 presents the sample overview and preliminary results. Section 5 presents the main results of the empirical analysis. Section 6 provides additional robustness checks. Section 7 summarizes and concludes the paper. Finally, Section 8 provides a discussion of the paper and outlines potential avenues for future research.

[5]Note that former crises (e.g., the 2008-2009 financial crisis) are generally complex and endogenous in nature, making it difficult to establish direct causality between social responsibility and investment performance.

[6]Note that only a nascent body of literature focuses on carbon risk in the financial markets, which relate to the same streams of literature: 1) investor behaviour (see Ceccarelli et al., 2019; Kuang and Liang, 2020, e.g.) 2) investment performance (see Bolton and Kacperczyk, 2021; Monasterolo and De Angelis, 2020, e.g.). However, these works are unrelated to the pandemic.

[7]Note that four studies have been found that relate carbon risk with other type of investment classes throughout the course of the pandemic. First, the work by Sun and Small (2022) who examine the relationship between returns and carbon risk for exchange-traded funds (ETFs). Next, the work by Jacob and Nerlinger (2021), Koçak et al. (2022) and Mukanjari and Sterner (2020) who examine the relationship between returns and carbon intensity or efficiency for stocks. The results on risk-adjusted returns in this paper are complementary to their work given that this paper focuses on equity mutual funds. Moreover, the behaviour of investors in terms of capital flows is the primary focus in this paper, making it fundamentally different from their work.

2 Literature Review

2.1 Responsible Investing

For many years, the financial industry has remained silent on social issues, adhering to the belief that these issues were not meant to be of concern to the financial markets. On the one hand, this was due to the neoclassical view on investing, where the integration of social issues was perceived as a "luxury", leading to a deterioration of financial wealth. On the other hand, this was led by the fear of becoming embroiled in ethical debates. Financial institutions, who invest on behalf of a large number of individuals, were particularly concerned about this (Chenet, 2021; Richardson, 2009). This has changed significantly in recent decades, as social issues have moved to the forefront in the investment industry. Consequently, there have emerged socially conscious investment strategies and financial institutions have started to market investment vehicles as "sustainable". This movement—wherein financial institutions and investors integrate social issues in their investment policies and decisions—is commonly referred to as "socially responsible investing" or "responsible investing". However, responsible investing remains an open concept without an univocal definition, which leads to heterogeneous interpretations (Sandberg et al., 2009). It is for this reason that it can be particularly complex to determine which investments are or should be regarded as responsible. To elucidate this matter and provide more context to the concept of social responsibility, it is essential to consider the evaluation criteria that underpin responsible investing, as well as the investment strategies that are used to incorporate these criteria.

2.1.1 Evaluation Criteria

Evaluation criteria are used to deliniate the concept of social responsibility. These criteria were initially based on moral standards. More specific, revenue streams derived from human vice—such as companies active in the tobacco and weapons industry—were and continue to be widely regarded as unethical. These companies are labeled as "sin-stocks" in the investment universe, and they serve as the initial criteria for assessing social responsibility. However, these criteria are subject to conflicting views, as these criteria are hard to quantify and assess from an objective standpoint (Blitz and Fabozzi, 2017). In spite of this, sin-stocks convey an important insight. That is, they highlight that going against moral standards or engaging in unethical practices can result in significant risks. For instance, the tobacco industry has faced numerous legal repercussions and unfavorable tax policies. Such consequences can have a direct impact on companies and their ability to generate long-term profits. Looking at responsible investing through this lens, it comes down to a fundamental aspect of investing: risk.

Over time, investors have started to include a broader spectrum of social issues in their investment decisions. In particular, issues such as labor conditions, diversity, eco-efficiency and waste-management have been increasingly considered. As a result, one particular prevalent assessment framework has emerged that incorporates considerations along the lines of environmental, social and governance (ESG) criteria (Martini, 2021; Purvis et al., 2019). These criteria comprise a wide domain of social issues and are not exclusive to companies that derive revenue from human vice. In the financial industry, there appears to be some level of agreement that these criteria define the concept of social responsibility (Sandberg et al., 2009). Indeed, the United Nations Principles for Responsible Investments (UNPRI), defines socially responsible investing as "a strategy and practice to incorporate environmental, social and governance (ESG) factors in investment decisions and active ownership" (UNPRI, 2021). These criteria can be measured and integrated in the investing process by looking at them through the lens of risk—i.e., how the risks associated with ESG issues can affect enterprise value. Inequitable labour standards, for example, can have a direct impact on enterprise value through litigation processes, brand damage or labor productivity (Edmans et al., 2014; Wright, 2016).

Environmental risks, in particular, have received much attention in recent decades. These risks were once regarded as an afterthought, but environmental issues such as natural resource scarcity, extreme weather events and rising sea levels are now posing a threat to society. These environmental consequences are largely attributable to human-induced climate change. To mitigate these environmental consequences, it is therefore imperative to move away from the current fossil-fuel-based economy and transition to a low-carbon economy. The risks associated with the transition to this low-carbon economy are captured by the so-called "carbon risks" (Kuang and Liang, 2020). For instance, specific carbon risks include regulatory initiatives aimed at reducing greenhouse gas emissions (e.g., carbon taxes), switching costs to de-carbonize operating processes and shifting consumer preferences. The extent that a company is exposed to these carbon risks is not accurately reflected by the prevalent ESG criteria. This is because ESG criteria cover a broad domain of social issues that range from labour standards to physical climate risks, with carbon risk being only one component of these evaluation criteria. It is for this reason that companies can perform well on the overall ESG domain while having a negative impact on environment in terms of climate change (Ceccarelli et al., 2019). In other terms, companies with high greenhouse gas emissions may still obtain a low-ESG risk rating when performing well on other dimensions (e.g., social risks, governance risks or physical climate risks). As a result, one may argue that the current climate crisis necessitates a less holistic approach to responsible investing, but rather one that prioritizes carbon risk in the overall ESG domain (Bolton et al., 2021).

2.1.2 Investment Strategies

The strategic dimension of responsible investing outlines how evaluation criteria can be factored into the investment process. Similar to evaluation criteria, this is an evolving domain in the social responsibility landscape; however, these investment strategies can be broadly categorised into three groups: negative screening, positive screening and engagement.

The oldest and most commonly adopted strategy is negative screening, which as the name implies, screens out investments that are determined as socially irresponsible. Investors may incorporate these negative screens by excluding companies that operate in certain "a-social" sectors. However, negative screening is not limited to the exclusion of certain sectors, as investors can extend negative screening to the company's value chain and hence conduct screens at a more granular level (Junkus and Berry, 2015). Positive screening, on the other hand, is a strategy that deliberately seeks to invest in socially responsible companies. Investors incorporate this approach by selecting companies that meet their social responsibility standards. However, this approach may limit the universe of eligible investments, especially when combined with a negative screening approach. For this reason, positive screening is generally used in conjunction with a "best-in-class" approach. This approach evaluates companies on their social responsibility practices within each sector, rather than on a market-wide basis. A market-wide comparison would exclude companies due to the nature of their sector, as certain sectors may be better positioned in terms of social responsibility than others. Hence, this approach allows to incorporate positive screening, without restricting the investment universe significantly (Martini, 2021). The final investment strategy is engagement. This strategy involves active engagement in company behavior along the lines of social responsibility. Investors can actively engage in the behavior of their portfolio companies by exercising their voting rights or proposing formal motions. Another, more informal way to influence company behavior, is through direct dialogue with the portfolio companies. The ability to influence behavior in these formal or informal ways is generally proportional to the amount of equity an investor holds in a given company (Renneboog et al., 2008).

2.2 Investment Motives

As responsible investing has grown over the past decades, it has become particularly interesting to examine the underlying motives behind this growth. The existing literature provides support for either financial or non-financial motives, or a combination of the two.

2.2.1 Financial Motives

One of the motives to invest in responsible assets stems from a financial standpoint. Specifically, investors may seek to hedge their overall investment position against risks that are associated with social issues. Indeed, Pollard (2018) state that these issues form risk factors, and that being exposed to them can lead to financial losses when these risks materialize.

An important body of academic research has emerged to explore whether these issues are perceived as risk factors by investors. To do so, various studies explore whether these risks are priced by the financial markets. For instance, Bolton and Kacperczyk (2021) find supporting evidence that carbon risks are priced in the financial markets. The authors examine whether investors in the equity market demand a carbon premium for companies that emit high levels of carbon dioxide. After controlling for a wide variety of risk factors, the authors conclude that there is a relationship between carbon emissions and equity returns, lending support to the existence of a carbon premium. Kruttli et al. (2021) contribute to this domain of research by demonstrating how extreme weather risks affect the price of equity options. The authors find that investors demand a risk premium when exposed to greater levels of extreme weather risks. Moreover, the authors argue that price efficiency increases after investors become more sophisticated with the risks of extreme weather events. Bernstein et al. (2019) approach this subject from the real estate market and explore the relationship between sea-level rise risk and property purchase prices. The authors find that property purchase prices are inversely related to sea-level rise risk, lending support to the existence of a risk premium. These findings underpin the fact that investors are aware of climate risks and require some form of compensation to bear the additional risk. Aside from climate risks, other types of social-related risks have been investigated. For instance, Jiang et al. (2020) explore whether investors price risks associated with data protection and system security[8]. These risks are becoming increasingly important in digitized economies, and inadequate risk management can have serious consequences, such as increased vulnerability to cyber attacks. This is reflected by the equity markets as the authors find support for a risk premium.

As supported by the risk premia, investors perceive social issues as risk factors. It is for this reason that investors may seek to hedge against these type of risks by investing in responsible assets (Engle et al., 2020). Moreover, Hoepner et al. (2018) and Nofsinger and Varma (2014) argue that these assets do not only hedge against social-related risks but function as an effective hedge against downside risk in general. Lins et al. (2017) support this from a company-level perspective, arguing that high social responsibility standards ensure the loyalty of key stakeholders such as customers and employees during times of economic downturn. This results in both revenue and operational resilience, reducing the negative consequences of economic downturns. Overall, the demand for responsible assets can be explained from this financial standpoint, where these assets serve as a hedge against social specific or overall downside risk.

2.2.2 Non-financial Motives

According to Friedman (1970), the sole social responsibility of companies is to maximize shareholder value, where optimal resource allocation and engagement in value-adding activities should underlie business operations. From a financial perspective, shareholder value is equivalent to financial wealth, expressed in dividends and equity value. In line with this, investors should base their investment decisions on risk and return considerations, maximizing their financial utility. Yet, a wide domain of academic literature argues that investors do not solely trade off financial considerations. Indeed, Hart and Zingales (2016) state that investors consider non-financial factors such as social issues. Accordingly, the authors broaden Friedman's argument to maximizing "shareholder welfare". This objective encompasses both financial and social properties, making it more aligned with the utility function of an investor in general. These pro-social properties in the investor's utility function provide a non-financial motive to invest in responsible assets.

[8] Note that risks related to customer and employee data protection fall under the "social" pillar in the ESG domain.

Fama and French (2007) contribute to this strand of academic literature and present a model where investors view assets as consumption goods. The authors state that investors, like consumers, can have “tastes” for certain assets. These tastes, such as pro-social preferences, may come at the expense of financial returns. This suggests that investors are willing to forego financial returns in order to accommodate their non-financial preferences. Benson and Humphrey (2008) and Bollen (2007) provide empirical evidence for these pro-social preferences by examining mutual fund flow dynamics. The authors compare responsible funds to conventional funds and find that fund flows of the former are less sensitive to negative returns. This contradicts the conventional wisdom that fund flow dynamics are highly sensitive to returns, implying that investors derive non-financial utility from holding responsible assets. Riedl and Smeets (2017), also find support for these pro-social preferences in the mutual fund industry. The authors use data on investor holdings in combination with behavioral experiments and survey responses. The results indicate that intrinsic social preferences and social reputation concerns lead to higher responsible equity holdings. Furthermore, the survey results show that some investors are willing to forego financial returns in order to accommodate equity holdings that match their social preferences. Moreover, Brodback et al. (2019) argue that high returns on responsible assets can even lead to divestment. The rationale behind this behaviour is that extrinsic incentives can undermine intrinsic motivations, resulting in a crowding-out effect. This notable result, however, is only observed for investors with very strong social beliefs. Overall, there is a general consensus that pro-social motives can influence investor behavior and drive demand for responsible assets.

2.2.3 Combination of both Motives

The existing literature indicates that demand for responsible assets stems from financial and non-financial motives. Indeed, Pástor et al. (2021) present a theoretical model that encompasses both motives. The authors show that responsible assets are priced at a premium in excess of pro-social preferences. This price premium stems from the financial motive, where investors use responsible assets as a hedge against social specific or downside risk. Moreover, the authors argue that investors derive non-financial utility from holding assets with greater social impact, in line with the non-financial motive. This non-financial component drives up the price premium for responsible assets, as investors are willing to pay a higher price to accommodate their social preferences. Hence, financial and non-financial motives coexist in the financial markets and drive up the price premium on responsible assets. Given this premium, responsible assets are expected to earn lower long-term returns than irresponsible assets. Yet, the authors show that unexpected shocks may cause responsible assets to outperform irresponsible assets in the short-term. These unexpected shocks—such as climate-related events—may alter consumer and investor demand for responsible products and assets, respectively. For instance, climate regulations may stir investors away from irresponsible assets and towards responsible assets. Due to such a demand shift, responsible assets may outperform irresponsible assets, despite their lower expected returns. Alternatively, Pedersen et al. (2021) argue that responsible assets may outperform their conventional counterparts when investors are unaware of social-related information and therefore fail to accurately bid up the price of these assets[9]. As such, investors may seek to exploit these short-term developments or information inefficiencies with their responsible asset allocations.

Furthermore, Pástor et al. (2021) argue that the rising demand for responsible assets is important from a socio-economic standpoint. In particular, the authors indicate that demand for responsible assets, whether driven by financial or non-financial motives, leads to favorable social consequences. The reason for this is twofold. First, the demand for responsible assets encourages companies to become more socially responsible. This stems from the objective that companies should aim to maximize shareholder welfare instead of shareholder value. However, becoming more socially responsible is still desirable when the sole objective of the company is to maximize shareholder value. This is because investors are willing to pay a higher price for responsible assets, thereby raising the market value of companies with high social responsibility standards. Second, it lowers the cost of capital for responsible companies and increases the cost of capital for irresponsible companies (see El Ghoul et al., 2011, e.g.). This is desirable from a socio-economic standpoint, as the cost of capital is directly related to the investments of a company. As a result, irresponsible companies will reduce their investments, whilst responsible companies will increase their investments.

2.3 COVID-19 Pandemic

The coronavirus has brought an unprecedented shock to the world, resulting in a global health crisis that has progressed to a disruption of the global economy and financial markets. The initial outbreak of the virus was reported in Wuhan, China, on January 1, 2020. The virus has spread throughout China since the initial outbreak, eventually leading to infections on a global scale. These global infections increased at an unprecedented rate, straining public health care systems and leading to economic deterioration. This led to high levels of uncertainty and distress in the financial markets, resulting in a stock market crash on February 20, 2020 (Ramelli and Wagner, 2020b). This period of financial downturn was followed by government interventions, with stimulus packages announced on March 23, 2020, to reinvigorate the economy. After these stimulus announcements, the financial markets rebounded, while economic and public health conditions continued to deteriorate. Numerous studies have examined these implications from an economic and financial standpoint, providing important insights on the changing market conditions following the onset of the pandemic.

The pandemic-induced market crash is notable from a financial standpoint, as it resulted from a health crisis whereas former financial crises (e.g., the 2008-2009 financial crisis) originated from inside the financial sector. In other words, the pandemic-induced market crash is exogenous in nature whereas former crises

[9] Both these theories help to explain the inconclusive work on the performance of responsible assets. See (Badía et al., 2021; Derwall et al., 2005, e.g.) for evidence of responsible asset outperformance, (Brammer et al., 2006; El Ghoul et al., 2011, e.g.) for evidence of responsible asset underperformance, or (Bauer et al., 2005; Hamilton et al., 1993, e.g.) for evidence of no discernible difference in the performance of responsible assets and their conventional counterparts.

originated from endogenous factors. As such, Croce et al. (2020) and Zhang et al. (2020) find that the volatility levels in the financial markets are closely related to the contagion levels and developments of the virus. These volatility levels peak during the market crash and fall sharply in response to the stimulus announcements (Altig et al., 2020). However, Giglio et al. (2020) find that the pandemic has lasting effects on the perception of investors. According to the authors, investors have become more pessimistic about future outcomes and the pandemic has heightened their concern of economic and financial disasters.

Another important implication of the pandemic is the direct impact on the real economy, driven by the public health effects in combination with the intervention policies. According to Baldwin and Tomiura (2020), this results in both supply and demand shocks in terms of the aggregate economy. In particular, lockdown measures and rising contagion levels dampen the production of goods and services, and cause a halt to the movement of humans and goods (Barua, 2021). This results in a disruption of supply chains, with global spillover effects (Grida et al., 2020). These supply shocks have negative implications on labour demand and expenditures, resulting in rising unemployment levels and sharp demand reductions for non-essential goods and services (Baker et al., 2020b; Cajner et al., 2020).

In response to the economic downturn, authorities have engaged in recovery policies and stimulus-packages to reinvigorate the economy. These recovery instruments address economic concerns while simultaneously accelerate the transition to a low-carbon economy. Indeed, Steffen et al. (2020) argue that the pandemic emerged at a time when existing climate concerns where gaining momentum. It is for this reason that authorities have integrated climate objectives into their recovery instruments and devote substantial amounts of financial resources to environmental transition levers. For instance, the recovery and resilience facility in the EU has devoted 40% of its financial resources to climate measures (EU, 2022). Overall, there is a general consensus that the pandemic opens a window of opportunity to de-carbonize the global economy (Pianta et al., 2021).

2.4 Hyptheses Development

There are several distinct phases of the pandemic that are expected to have an impact on the fund flows of heterogeneous funds in terms of carbon risk. First, the incubation phase (i.e., January 1, 2020 - February 19, 2020), starting after the first formal announcements of the virus outbreak[10]. The outbreak was exogenous and unprecedented in nature, thereby in stark contrast with initial market conditions. The market conditions following this shock are marked by rising levels of distress due to information diffusion about the severity of the virus and its potential economic implications (Ramelli and Wagner, 2020a). These market developments—i.e., increasing volatility levels as a result of fear and panic among investors—are consistent with former market reactions to fear-inducing tail events, such as terrorist attacks or former epidemics (see Nikkinen et al., 2008;

[10] Note that this study sets an uniform starting date for the incubation period. This is due to the vast information diffusion and spillover effects across financial markets, making it rather complex or inaccurate to set nonuniform starting dates for the incubation period in the US and Europe.

Nippani and Washer, 2004, e.g.). However, unlike most tail events, the market implications unfolded on a global scale[11]. While these market developments are related to the number of infected cases by region, Corbet et al. (2021) and Wang et al. (2021) find that bidirectional spillover effects across financial markets are an important contributing factor to global rising volatility levels. The rising instability during the incubation phase eventually resulted in a crash of the global financial markets. The subsequent market crash phase (i.e., February 20, 2020 - March 23, 2020) is characterized by panic sell-offs, resulting in steep market declines and volatility levels that surpass those of former financial crises and epidemics (e.g., 2008-2009 financial crisis or SARS epidemic) (Baker et al., 2020a). Both the incubation phase and the market crash are expected to influence capital allocations across heterogeneous carbon risk funds. In particular, in response to the volatile market conditions during the incubation phase, investors are expected to re-allocate capital to funds that hedge against downside risks, resulting in higher capital flows to low-carbon risk funds. Similarly, investors are expected to seek shelter in these funds during the actual market crash to mitigate downside losses. This leads to the following hypothesis:

H1: *Low-carbon risk funds receive relatively higher fund flows than high-carbon risk funds during the incubation phase and market crash.*

The financial markets rebound significantly after the stimulus announcements on March 23, 2020. This rebound in the financial markets distinguishes the market crash from the subsequent recovery phase (i.e., March 24, 2020 - March 1, 2021). While market conditions have become less volatile during this phase, it is expected that investments to low-carbon risk funds will continue to rise. The reason for this is twofold. First, intervention policies and stimulus funds may accelerate the transition to a low-carbon economy, imposing greater transition risks and opportunities in the near future. In particular, the intervention policies may result in long-term behavioural and structural changes. For instance, human mobility patterns changed significantly as a result of lockdown measures, potentially resulting in a long-term behavioral shift that could reduce human transportation patterns (Zhang and Zhang, 2021). Moreover, these behavioral and structural changes are accompanied by fiscal stimulus measures that lend direct support to environmental transition levers, such as investments in clean energy development or binding environmental conditions on bailouts, thereby advancing transition developments (Kuzemko et al., 2020; Pianta et al., 2021). These heightened transition risks and opportunities are expected to influence the capital allocations of investors, causing them to gravitate toward low-carbon funds in the recovery phase. Second, the virus outbreak and the market crash may have lasting effects on the risk aversion of investors. Indeed, Malmendier and Nagel (2011) find evidence that economic or financial shocks heighten the perceived salience of negative outcomes over prolonged periods

[11] Note that former tail events, such as the SARS epidemic, had a more regional impact on the financial markets, primarily affecting the financial markets of the regions that were most affected by the virus (see Nippani and Washer, 2004).

of time[12]. This is supported by the heightened concern about financial disasters and the pessimistic outlook among investors following the pandemic-induced market crash (Giglio et al., 2020). Given the heightened risk aversion among investors in the recovery phase, it is expected that investors will gravitate toward funds that have fared better during the market crash, resulting in higher capital flows to low-carbon risk funds. This leads to the following hypothesis:

H2: *Low-carbon risk funds receive relatively higher fund flows than high-carbon risk funds during the recovery phase.*

Low-carbon risk funds are expected to provide more resilience in terms of risk-adjusted returns during periods of market turmoil, providing a financial justification for the capital flows to these funds. In particular, there are two mechanisms that ensure the resilience of low-carbon risk funds during bear markets. First, essential stakeholders such as customers or suppliers are more inclined to support companies with high environmental standards during periods of downturn, making these companies and thus funds more resilient to negative shocks (Lins et al., 2017). Second, Bollen (2007) argue that some investors make investment decisions on the basis of a multi-attribute utility function that does not solely encompass optimal risk-return considerations, but also pro-social preferences. On the basis of these pro-social preferences, investors are more likely to retain their investment positions during periods of market turmoil, thereby reducing the negative price pressure implications of fire sales (Coval and Stafford, 2007; Nakai et al., 2016). Given these stakeholder and investor resilience mechanisms, it is expected that low-carbon risk funds fare better during the market crash. This leads to the following hypothesis:

H3: *Low-carbon risk funds have relatively higher risk-adjusted returns than high-carbon risk funds during the market crash.*

3 Data and Method

3.1 Data

The data set used in this study is obtained from the survivorship-bias-free database Morningstar Direct and consists of open-end equity mutual funds domiciled in the US and Europe. The main sample covers the period from 1 July, 2019 to 1 March, 2021 and consists of 2,734 US and 7,149 European funds.

[12]Note that the effect of adverse shocks on investor behaviour is more pronounced in the short-term; however, Malmendier and Nagel (2011) find that these experiences could continue to influence investor behavior after several decades.

3.1.1 Fund Flows

The fund universe in this study is constructed by obtaining daily share class level data on dollar net flows and total net assets. These share class level values are then aggregated to weekly fund level values in order to reduce noise in the data[13]. This aggregation procedure is performed in two steps. First, the data is aggregated from daily to weekly values by summing dollar net flows over the week and retaining the week's last total net asset value[14]. Next, the data is aggregated to the fund level by summing dollar net flows and total net assets across share classes. These variables are then used to construct the main variable of interest—net flow (%)—which is computed by dividing the weekly dollar net flows by the total net assets of the previous week.

3.1.2 Fund Performance

Throughout the study, daily net returns are used to evaluate fund performance. Morningstar discloses these daily net return movements as return indices at the share class level. For comparative purposes, these return indices are first converted to daily net returns:

$$Return_{i,t} = \frac{RI_{i,t} - RI_{i,t-1}}{RI_{i,t-1}},$$

where $RI_{i,t}$ represents the daily net return index for share class i at day t. These daily net returns are then aggregated from the share class level to the fund level to derive the value-weighted returns, weighted by the lagged total net assets. Finally, these value-weighted returns are factor adjusted by adopting the Fama and French six-factor model. This model adjusts returns based on daily risk factors, which are derived from Kenneth French's data library. More details on the Fama and French six-factor model are presented in the methodology section.

3.1.3 Fund Characteristics

A variety of fund characteristics are retrieved, which may impact fund flows or performance. One essential characteristic is the carbon risk score, which is a measure of the portfolio-level carbon risk exposure based on the weighted-average of the underlying company-level carbon risk scores. These carbon risk scores are used to categorize funds into five quantiles, which range from low-carbon risk (i.e., lowest quantile) to high-carbon risk (i.e., highest quantile). Additionally, the broader ESG risk rating is retrieved, along with the risk rating of the individual environmental, social and governance sub-components.

Other fund characteristics consists of the fund's age, domicile, cash position, expense ratio and turnover ratio. In addition, monthly returns are obtained to compute the 12-month returns on a rolling window basis.

[13]The reason that aggregation takes place at the week and fund level is twofold. First, week level values still allow for a semi-granular segmentation of distinct time periods. Second, equity funds offer multiple share classes in order to provide a variety of fee structures. However, these share classes are tied to the same underlying assets and hence have equivalent investment objectives and responsibility ratings. It is for this reason that all analyses are performed at the fund level throughout this study.

[14]Note that the financial markets in the US and Europe are opened on trading days, which solely consist of weekdays. Accordingly, a business calendar is constructed that runs from Monday to Friday.

Moreover, data on the fund's global category and industry net investment position are obtained to account for the fund's investment style, geographical orientation and industry exposure[15]. As before, data on fund characteristics are provided at the share class level and aggregated to the fund level. These fund level values are computed by taking the mean of the 12-month returns, expense ratio's and turnover ratio's. Fund age is determined by the oldest share class and other fund level information is based on the largest share class. A complete overview of the variable descriptions is reported in Appendix C.

3.1.4 Screens

A variety of screens are used to arrive at the primary sample. First, only equity funds are retained by excluding other types of investment classes with the Morningstar global broad category. Second, the sample is restricted to funds that have received a carbon risk score[16]. Third, an incubation bias screen is applied to the data, which excludes funds with less than $5 million dollars in total net assets[17]. Fourth, only funds that exist throughout the complete sample period are retained[18]. Fifth, all continuous variables are winsorized at the 1st and 99th percentiles to remove the influence of outliers[19].

3.2 Econometric Approach

3.2.1 Fund Flows

A difference-in-difference approach is used to investigate the impact of the pandemic on investor behaviour in the US and Europe. This is a quasi-experimental approach that estimates the causal effect of a treatment or shock—that is, the pandemic—on the outcome for units in the treatment group. The causal effect of the shock is inferred from the difference between the treatment group outcomes and an approximation of the unobserved counterfactual outcomes. These unobserved counterfactual outcomes are based on the difference between units in the treatment and control group in the period preceding the shock. To ensure the internal validity of the difference-in-difference approach, this difference is assumed to be constant, implying that both groups exhibit parallel trends (Lechner, 2011). In this study, low- and high-carbon risk funds function as the treated groups, whereas average-rated funds serve as the control group. Both these treatment and control groups are exposed to the pandemic as the shock is exogenous in nature and not exclusive to particular investment classes. In this setting, the difference-in-difference approach estimates if low- and high-carbon risk

[15] Note that global categories and industry net investment positions are not mutually exclusive, but are two ways to account for the industry exposure of a given fund (Vorsatz, 2021).

[16] Note that Morningstar uses company-level carbon risk scores from Sustainalytics to compute the portfolio-level carbon risk scores. Sustainalytics relies on corporate disclosures to assess carbon risks of a given company and uses a variety of estimation models to fill in information gaps. Using these estimation techniques, Sustainalytics is able to determine carbon risk scores for companies that do not disclose carbon-related information. Yet, it is not possible to refute that this screen may still result in a selection effect, and more information is required from Sustainalytics to determine why certain companies did not receive a carbon risk score.

[17] Note that incubation is a method for developing new fund offerings; however, it results in an inaccurate representation of flows and returns during the incubation period (Evans, 2010).

[18] Note that this screen screen is not applied to the fund performance sample to avoid survivorship bias (Elton et al., 1996).

[19] Note that this winsorize procedure is in line with the work of El Ghoul and Karoui (2017) and Hartzmark and Sussman (2019); however, the results continue to hold without it.

funds are disproportionately affected by the pandemic relative to average-rated funds, as compared to the period preceding the pandemic[20]. The accompanying model is specified as:

$$\begin{aligned} Flow_{i,t} = {} & \alpha + \beta_1 \cdot LowCR_i + \beta_2 \cdot HighCR_i + \beta_3 \cdot LowCR_i \times Incubation_t + \beta_4 \cdot HighCR_i \times Incubation_t \\ & + \beta_5 \cdot LowCR_i \times Crash + \beta_6 \cdot HighCR_i \times Crash_t + \beta_7 \cdot LowCR_i \times Recovery_t \\ & + \beta_8 \cdot HighCR_i \times Recovery_t + \gamma' \cdot X_{i,t} + \delta \cdot Y_{j,t} + \theta_{y,t} + \kappa_{z,t} + \varepsilon_{i,t}, \end{aligned} \quad (1)$$

where $Flow_{i,t}$ indicates the net flows for fund i at week t. The variables $Incubation_t$, $Crisis_t$ and $Recovery_t$ are time dummies, corresponding to the incubation, crash and recovery period, respectively. $LowCR_i$ and $HighCR_i$ are dummies that take the value one if the fund is classified as a low- or high-carbon risk fund[21]. Particularly interesting are the coefficients β_3 to β_8, which capture the interaction between the time dummies and the carbon risk classes. Moreover, $X_{i,t}$ is a vector controlling for fund level characteristics that could affect fund flows. These fund level controls consists of the past 12-month returns, (log) total net assets, age, cash position, expense ratio and turnover ratio. In addition, $Y_{j,t}$ is a vector that controls for industry effects, capturing the fund's net investment position in a given industry. Lastly, $\theta_{y,t}$ and $\kappa_{z,t}$ are style-week and country-week fixed effects, respectively.

In addition, the difference-in-difference regressions are complemented with regression analyses for each sub-period. These regression analyses shed more light on the relative fund flow dynamics across heterogeneous carbon risk classes in each sub-period. Following the same notation as introduced earlier, the regression model is specified as:

$$\begin{aligned} Flow_{i,t} = {} & \alpha + \beta_1 \cdot LowCR_i + \beta 2 \cdot BelowAvgCR_i + \beta 3 \cdot AboveAvgCR_i + \beta_4 \cdot HighCR_i \\ & + \gamma' \cdot X_{i,t} + \delta \cdot Y_{j,t} + \theta_{y,t} + \kappa_{z,t} + \varepsilon_{i,t}, \end{aligned} \quad (2)$$

where, the dummy variables $LowCR_i$ to $HighCR_i$ correspond to the different carbon risk classes. As before, $X_{i,t}$ and $Y_{j,t}$ represent vectors that capture fund and industry controls, while $\theta_{y,t}$ and $\kappa_{z,t}$ represent the style-week and country-week fixed effects, respectively.

3.2.2 Fund Performance

A two-stage regression technique is used to examine fund performance. This technique has two benefits. First, it allows to adjust returns for risk factors in the first stage of the analysis, providing a more accurate

[20] Note that this alternative difference-in-difference setting is used in multiple fields of economics. For instance, Couch et al. (2021) and Fairlie et al. (2020) use this setting to indicate the effect of the pandemic on unemployment gaps between genders or ethnic groups. Alternatively, Lins et al. (2017) use this setting to examine the returns of heterogeneous firms in terms of social responsibility during the 2008-2009 financial crisis.

[21] Note that this classification is based on the carbon risk score from December 2019, before the onset of the pandemic. These carbon risk scores are updated on a quarterly basis and based on a moving average of a 12-month trailing period. Consistent with Hartzmark and Sussman (2019), these scores are "sticky" and the results are robust to using carbon risk scores that are lagged by one or two quarters, or by taking the mean of the carbon risk scores over the complete sample period.

representation of fund performance. Second, it allows to link the estimated fund performance with low- and high-carbon risk classes in the second stage of the analysis, while accounting for a variety of fund controls.

In the first stage, a multi-factor model is used to compute risk-adjusted returns for the market crash period. This study follows Fama and French (2018) and uses the Fama and Frech six-factor model to compute risk-adjusted returns[22]. The model is specified as:

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + w_i WML_t + \varepsilon_{i,t}, \quad (3)$$

where R_{it} indicates the value-weighted return on fund i at day t and R_{ft} the risk-free rate at day t. Besides, let $R_{mt} - R_{ft}$ be the market excess return, SMB_t (small-minus-big) the size factor, HML_t (high-minus-low) the value factor, RMW_t (robust-minus-weak) the profitability factor, CMA_t (conservative-minus-aggressive) the investment factor and WML_t (winners-minus-losers) the momentum factor. Of particular interest is the intercept term α_i, which captures the return on fund i while accounting for the specified risk factors, thereby representing the factor- or risk-adjusted return.

In the second stage, a regression model is used to examine the relationship between fund performance and carbon risk. Here, the estimated risk-adjusted return is regressed on the low- and high-carbon risk classes, as well as a variety of fund controls. The model is specified as:

$$Performance_{i,t} = \alpha_i + \beta_1 \cdot CR_i + \gamma' \cdot X_{i,t} + \delta \cdot Y_{j,t} + \theta_{y,t} + \kappa_{z,t} + \varepsilon_{i,t}, \quad (4)$$

where, $Performance_{i,t}$ denotes the risk-adjusted returns and CR_i is a dummy variable that takes the value one if the fund is classified as a low- or high-carbon risk fund. As before, $X_{i,t}$ is a vector controlling for fund level characteristics, consisting of the past 12-month returns, (log) total net assets, age, cash position, expense ratio and turnover ratio. Furthermore, $Y_{j,t}$ is a vector that controls for industry effects, capturing the fund's net investment position in a given industry. Finally, $\theta_{y,t}$ and $\kappa_{z,t}$ represent style and country fixed effects, respectively.

4 Sample Overview and Preliminary Results

4.1 Sample Overview

Appendix A presents an overview of the descriptive statistics, with statistics for the US and Europe in Tables A1 and A3, respectively. It's worth noting that the main variable of interest, net flow, has a negative mean in the US while being only slightly positive in Europe. These negative or marginal flows across equity mutual funds are the result of a long-term trend that began prior to the pandemic's onset, driven by a shift toward

[22] Note that funds may strategically use mismatched self-designated benchmarks to provide an exaggerated view of risk-adjusted returns. Using a factor model avoids the potential bias associated with these self-designated benchmarks (Sensoy, 2009).

other types of investment products (e.g., ETFs) that have grown in popularity among investors (Moussawi et al., 2020)[23]. Tables A2 and A4 add more detail to the net flow dynamics by segmenting average net flows by period and carbon risk class. The aggregate net flows (i.e., average net flows across all funds) reveal that the pandemic has not accelerated fund outflows, apart from the considerable outflows during the market crash. In fact, aggregate net flows in Europe have even increased during the incubation and recovery phase when compared to pre-COVID levels, while aggregate net flows have extended their pre-COVID levels in the US. Considering the segmentation by carbon risk class, it is apparent that inflows are primarily driven by lower-rated carbon risk funds, whilst outflows are predominantly due to higher-rated carbon risk funds, across all periods in both the US and Europe.

4.2 Graphical Evidence

Figure 1 graphically illustrates the average net flows to low-, average- and high-carbon risk funds, with the fund flow dynamics on the left- and right-hand side for the US and Europe, respectively. Notice that the different carbon risk classes demonstrate a monotonic relationship in the pre-COVID period for both the US and Europe, where low-carbon risk funds demonstrate the highest average fund flows and high-carbon risk funds the lowest average fund flows. Despite the fact that fund flows are noisy, all classes appear to illustrate roughly similar fluctuations throughout this period, lending support to parallel pre-trends. However, there appear to be disparities between the US and Europe when comparing absolute levels across carbon risk classes. That is, low-carbon risk funds display greater absolute levels as compared to other classes in Europe, whereas this level difference is marginal in the US. This disparity suggests that, prior to the pandemic, carbon risk was a more prominent determinant of fund flows in Europe than in the US.

Next, the incubation phase illustrates that investors gravitate toward low-carbon risk funds across both the US and Europe. This effect is particularly interesting since it may indicate that investors seek shelter in low-carbon risk funds during times of heightened market uncertainty, consistent with the notion that these funds function as a hedge against downside risk. Furthermore, financial distress is evident during the market crash, as fund flows hit an all-time low. While all carbon risk classes experience negative flows during this period, the relative relationships to one another do not deviate significantly from pre-COVID patterns in the US. In contrast, while flows across carbon classes appear to be more polarized in Europe prior to the crash, they tend to converge during the crash. This may indicate that investors primarily use low-carbon risk funds as a hedge prior to the crash, but not during the market downturn.

During the recovery period, low-carbon risk funds experience relative higher flows in both the US and Europe as compared to the pre-COVID dynamics. This is especially noticeable for the US, where absolute level differences between carbon risk classes are marginal in the pre-COVID period, which augments the relative

[23]Note that equity mutual funds still remain one of the leading investment vehicles in economic terms, with approximately 7.1 and 18.8 trillion dollars in total net assets in the US and Europe, respectively. These statistics are derived from The International Investment Funds Association and are based on the total net assets in the first quarter of 2021.

recovery to pre-COVID pattern. Overall, these preliminary results suggest that the pandemic has accelerated the transition to low-carbon financial markets, with investors allocating more capital to low-carbon risk funds.

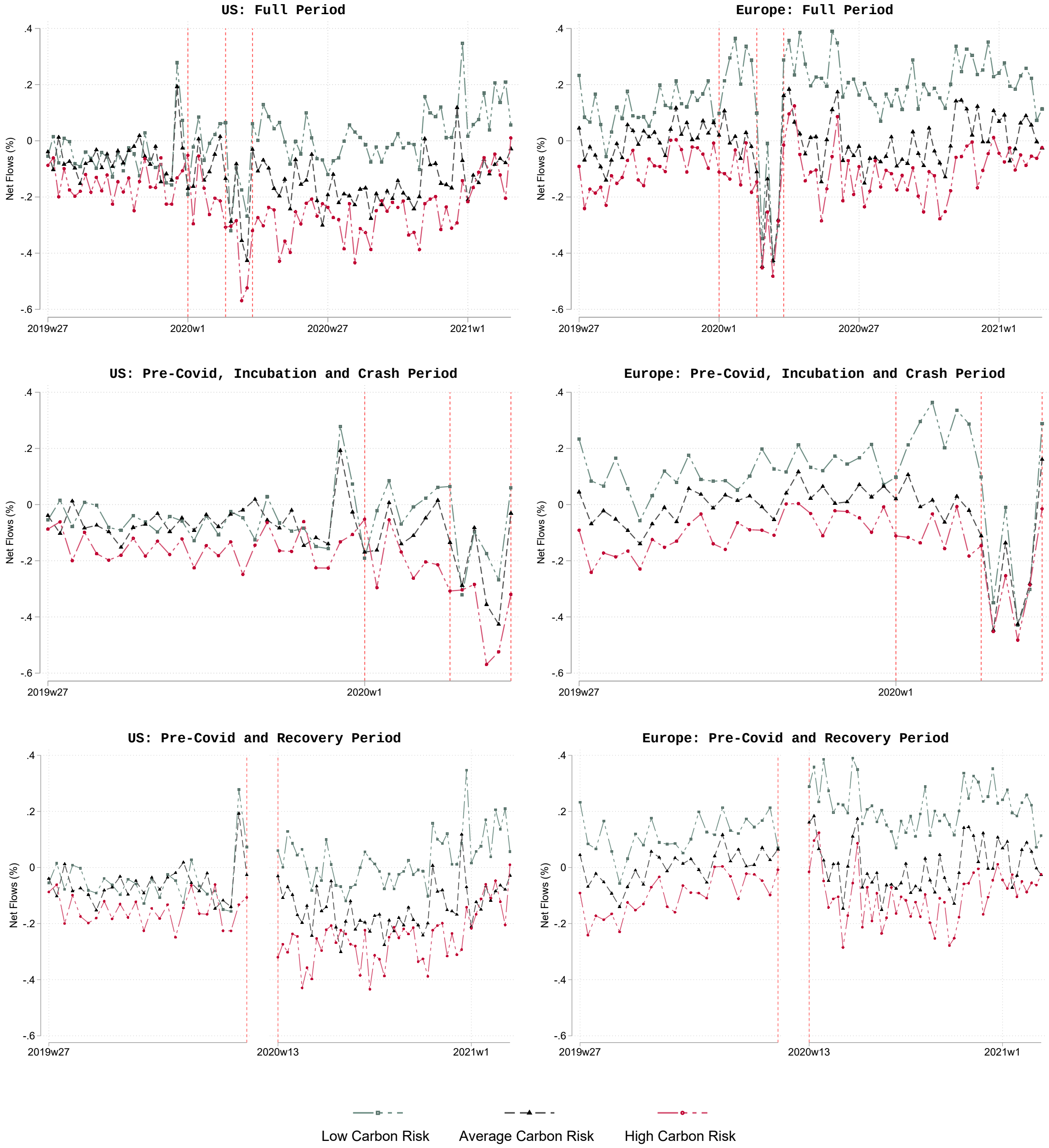

Figure 1: This figure plots the average weekly net flows of low-, average and high-carbon risk funds for the US (left-hand side) and Europe (right-hand side). The top panel presents the average net flows over the full sample period (i.e., July 1, 2019 - March 1, 2021), where the first dotted line indicates the beginning of the incubation period, the second dotted line indicates the beginning of the market crash and the last dotted line indicates the beginning of the recovery period. The middle panel presents the pre-COVID period (July 1, 2019 - December 31, 2019), the incubation period (January 1, 2020 - February 19, 2020) and the crash period (February 20, 2020 - March 23, 2020). The bottom panel present the pre-COVID period (July 1, 2019 - December 31, 2019) and recovery period (March 24, 2020 - March 1, 2021).

5 Main Results

5.1 Fund Flows

The preliminary results indicate that net flows across different carbon risk classes are disproportionately affected by the pandemic. These results are formally tested using the difference-in-difference regression model specified in Equation (1). The estimation results are presented in Table 1. First, consider the results of the full sample in column 1. This column shows a positive and statistically significant coefficient on the interaction term *CRS Low* × *Incubation*, implying that low-carbon risk funds experience higher net flows during the incubation period as compared to the relative pre-COVID dynamics. Yet, the coefficients of the interaction terms *CRS Low* × *Crash* and *CRS High* × *Crash* are both statistically insignificant. These results suggest that investors use low-carbon risk funds as a mechanism to hedge against downside risk prior to, but not during, the market crash, thereby partly supporting the first hypothesis.

Furthermore, the interaction term *CRS Low* × *Recovery* is positive and statistically significant. This indicates that investors allocate relatively more capital to low-carbon risk funds during the recovery period as compared to the period preceding the pandemic. This supports the de-carbonization effect during the recovery period, in line with the second hypothesis. This effect is substantial in economic terms, as net flows are computed on a weekly basis as the percentage of total net assets. For instance, low-carbon risk funds experience relatively higher net flows of 0.11 percentage points during the recovery period. When this effect is compounded over the forty-nine weeks in the recovery period, this leads to a cumulative increase of 5.5% in assets under management. Alternatively, this can be quantified to an asset increase of approximately 108 million and 24 million dollars for median-sized funds in the US and Europe, respectively.

Next, column 2 shows that the prior results are not driven by other factors such as the past 12-month returns or net assets, which may be important determinants of fund flow dynamics (see Sirri and Tufano, 1998; Vorsatz, 2021, e.g.)[24]. In addition, column 3 includes industry controls to account for the fund's industry exposure. These industry controls consist of the fund's net investment position in a variety of industries such as utilities, financial services and healthcare (a complete overview of the industries is presented in Appendix C). The results show that the interaction terms remain significant after the inclusion of these industry controls.

Finally, the results of the US and European sub-samples are presented on the right-hand side of Table 1, in columns 4-5 and 6-7, respectively. Across sub-samples, the main results continue to hold—that is, low-carbon risk funds experience relative higher net flows during the incubation and recovery period. Yet, there are some disparities between US and Europe. For instance, high-carbon risk funds experience relatively lower net flows during the market crash in the US, whereas no such effect is found in Europe. Furthermore, the coefficient magnitudes on most of the interaction terms are higher in the US than in Europe, implying a greater shift

[24] Note that the control variables *Turnover Ratio* and *Expense Ratio* are excluded from the full sample as well as the European sample. This is due to missing data on these variables for European-domiciled funds, as it is not mandatory to disclose this information in Europe. Hence, including these variables would limit the sample size considerably.

in net flows as compared to the relative pre-COVID dynamics. Arguably, these disparities between the US and Europe can be partly explained by the relative flow dynamics prior to the pandemic—that is, the impact of the pandemic may be weaker if low-carbon risk funds already experience higher net flows prior to the pandemic.

Table 1: Fund Flows

	Dependent Variable: Net Flow						
	Full Sample			US		Europe	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CR Low × Incubation	0.10***	0.10***	0.11***	0.15**	0.15**	0.09**	0.10**
	[0.03]	[0.03]	[0.03]	[0.06]	[0.06]	[0.04]	[0.04]
CR High × Incubation	-0.01	-0.04	-0.05	-0.01	-0.01	-0.05	-0.05
	[0.04]	[0.05]	[0.05]	[0.07]	[0.07]	[0.06]	[0.06]
CR Low × Crash	0.02	-0.01	0.00	-0.00	0.01	-0.00	0.01
	[0.05]	[0.05]	[0.05]	[0.06]	[0.06]	[0.07]	[0.07]
CR High × Crash	0.04	0.04	0.04	-0.14*	-0.15*	0.08	0.07
	[0.04]	[0.05]	[0.05]	[0.08]	[0.08]	[0.06]	[0.06]
CR Low × Recovery	0.11***	0.08***	0.08***	0.14***	0.15***	0.06**	0.06**
	[0.02]	[0.02]	[0.02]	[0.04]	[0.04]	[0.03]	[0.03]
CR High × Recovery	-0.01	-0.01	-0.01	0.04	0.03	-0.02	-0.02
	[0.02]	[0.02]	[0.02]	[0.04]	[0.04]	[0.03]	[0.03]
CR Low	0.08***	0.09***	0.10***	0.06*	0.06	0.10***	0.11***
	[0.02]	[0.02]	[0.02]	[0.03]	[0.03]	[0.03]	[0.03]
CR High	-0.09***	-0.07***	-0.07***	-0.04	-0.04	-0.06**	-0.06**
	[0.02]	[0.02]	[0.02]	[0.03]	[0.04]	[0.03]	[0.03]
Return (12Mths)		0.13***	0.13***	0.22***	0.22***	0.12***	0.12***
		[0.01]	[0.01]	[0.03]	[0.03]	[0.01]	[0.01]
Net Assets (log)		0.01***	0.01***	-0.01	-0.01	0.01*	0.01**
		[0.00]	[0.00]	[0.01]	[0.01]	[0.01]	[0.01]
Age		-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***
		[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Cash		0.01***	0.01***	0.03***	0.03**	0.01***	0.01***
		[0.00]	[0.00]	[0.01]	[0.01]	[0.00]	[0.00]
Turnover Ratio				-0.00**	-0.00**		
				[0.00]	[0.00]		
Expense Ratio				-0.19***	-0.20***		
				[0.04]	[0.04]		
Constant	-0.04***	-0.19**	0.31	0.32**	1.18***	-0.13	0.41*
	[0.01]	[0.09]	[0.20]	[0.16]	[0.41]	[0.12]	[0.24]
Style-Week FE	Y	Y	Y	Y	Y	Y	Y
Country-Week FE	Y	Y	Y	Y	Y	Y	Y
Industry Controls	N	N	Y	N	Y	N	Y
Observations	360,970	288,974	288,704	63,354	63,336	223,351	223,104
R-squared	0.037	0.051	0.053	0.078	0.081	0.054	0.057

Note. This table reports the estimates from the difference-in-difference regressions of weekly net flows on the low- and high-carbon risk classes and their interactions with the dummy variables indicating the incubation (January 1, 2020 - February 19, 2020), crash (February 20, 2020 - March 23, 2020), and recovery (March 24, 2020 - March 1, 2021) periods. Fund-level controls include the fund's prior 12-month returns, total net assets (TNA) in logs, age in years, cash position (as a percentage of TNA), turnover ratio, expense ratio, as well as style-week and country-week fixed effects. Industry controls include the fund's net investment position (as a percentage of TNA) in basic materials, communication services, consumer cyclical, consumer defensive, energy, financial services, healthcare, industrials, real estate, technology and utilities. Standard errors are reported in the parentheses, and are clustered by fund and style-week levels. *, ** and *** indicate significance at a 10%, 5% and 1% significance level, respectively.

5.2 Sub-period Fund Flows

The difference-in-difference results are complemented with sub-period analyses using the regression model specified in Equation (2). The estimation results are presented in Table 2, with the results for the US and Europe in Panel A and B, respectively. First, the estimation results of the pre-COVID period show that, compared to average rated funds, none of the carbon risk classes experience significantly higher or lower net flows in the US. Low- and high-carbon risk funds in Europe, on the other hand, experience relatively higher and lower net flows during this period, consistent with the patterns in Figure 1.

Next, the relative net flows to low-carbon risk funds become more pronounced during the incubation period in Europe, as reflected by the increase in coefficient magnitude (i.e., 0.10 versus 0.21 percentage points). In addition, the below-average carbon risk class shows a positive and statistically significant coefficient, highlighting the shift to lower-rated carbon risk classes during this period. A similar result is obtained in the US, as illustrated by the positive and statistically significant coefficient on the low-carbon risk class.

Focusing on the market crash period, the results show that carbon risk is still a significant determinant of net flows in both the US and Europe, as reflected by the coefficient estimates on the low-carbon risk class. That investors retain their focus on carbon risk during periods of high market uncertainty suggests that investors have come to perceive this attribute as a "necessity" rather than a "luxury", thereby in stark contrast with the neoclassical view on responsible investing[25].

The recovery period shows that the extreme edges—low- and high-carbon risk funds—are highly significant in Europe, with a positive and negative point estimate, respectively. Similarly, this result also holds for the low- and below-average carbon risk class in the US. Overall, these results show that the pandemic accelerates the transition to low-carbon financial markets, in line with the previous findings of the difference-in-difference setting. Additionally, these sub-period analyses show that this effect primarily stems from relative net flow movements in the lowest carbon risk class. This is consistent with prior research of Hartzmark (2015), who show that investors generally focus on extreme ranks when making investment decisions. Knowing that this applies to carbon risk considerations is particularly relevant for financial intermediaries that seek to attract capital with their investment offerings.

[25] Note that the neoclassical perspective regards responsible investments as a "luxury good" (see Baumol and Oates, 1979, e.g.). Accordingly, this perspective predicts that demand for such luxury goods should decline as market conditions deteriorate. The results show the opposite and suggest that investors perceive responsible investments as a necessity, consistent with the notion that these investments form a hedge against downside risk.

Table 2: Sub-period Fund Flows

D.V. = Net Flow	(Pre-COVID)	(Incubation)	(Crash)	(Recovery)
	Panel A: US			
CR Low	0.02	0.18**	0.13*	0.19***
	[0.03]	[0.07]	[0.07]	[0.04]
CR Below Avg	0.01	0.05	0.09	0.08***
	[0.03]	[0.05]	[0.06]	[0.03]
CR Above Avg	-0.04	0.00	-0.01	-0.02
	[0.03]	[0.06]	[0.06]	[0.03]
CR High	-0.03	-0.02	-0.16*	-0.01
	[0.03]	[0.07]	[0.09]	[0.04]
Constant	1.25***	0.84	1.69***	0.96**
	[0.29]	[0.68]	[0.57]	[0.38]
Observations	36,754	7,468	7,411	62,224
R-squared	0.060	0.084	0.090	0.073
	Panel B: Europe			
CR Low	0.10***	0.21***	0.19***	0.18***
	[0.03]	[0.04]	[0.07]	[0.02]
CR Below Avg	0.02	0.07*	0.05	0.03
	[0.02]	[0.04]	[0.06]	[0.02]
CR Above Avg	-0.01	0.01	0.01	-0.01
	[0.02]	[0.04]	[0.06]	[0.02]
CR High	-0.05**	-0.10*	-0.06	-0.07***
	[0.03]	[0.06]	[0.06]	[0.02]
Constant	0.49**	-0.10	0.26	0.27
	[0.23]	[0.39]	[0.44]	[0.21]
Observations	118,044	30,151	22,376	210,185
R-squared	0.036	0.045	0.068	0.047
Style-Week FE	Y	Y	Y	Y
Country-Week FE	Y	Y	Y	Y
Fund Controls	Y	Y	Y	Y
Industry Controls	Y	Y	Y	Y

Note. This table reports the estimates from the OLS regressions of weekly net flows on the low-, below average-, above average- and high-carbon risk classes for each sub-period, consisting of the pre-COVID (July 1, 2019 - December 31, 2019), incubation (January 1, 2020 - February 19, 2020), crash (February 20, 2020 - March 23, 2020), and recovery (March 24, 2020 - March 1, 2021) periods. Fund-level controls include the fund's prior 12-month returns, total net assets (TNA) in logs, age in years, cash position (as a percentage of TNA), turnover ratio, expense ratio, as well as style-week and country-week fixed effects. Industry controls include the fund's net investment position (as a percentage of TNA) in basic materials, communication services, consumer cyclical, consumer defensive, energy, financial services, healthcare, industrials, real estate, technology and utilities. Standard errors are reported in the parentheses, and are clustered by fund and style-week levels. *, ** and *** indicate significance at a 10%, 5% and 1% significance level, respectively.

5.3 Fund Performance

The performance of equity mutual funds during the pandemic-induced market crash may be an important explanatory factor for the observed fund flow dynamics. Accordingly, the performance of equity mutual funds is examined by using the regression model in Equation (4). The estimation results are presented in Table 3 for the US and Europe. Column 1 and 3 show a positive and statistically significant coefficient estimate on the low-carbon risk term, implying that these funds perform better during the market crash as compared to other funds. Extending this analysis with fund controls in Column 2 and 4 decreases the coefficient estimates in both the US and Europe, but the estimates remain statistically significant. These findings indicate that low-carbon risk funds serve as a valuable hedge during periods of market turmoil.

Columns 5-8 repeat this analysis using the high-carbon risk class. In contrast to the prior results, the coefficient estimates on the high-carbon risk term are negative and statistically significant in both the US and Europe. This implies that high-carbon risk funds underperform as compared to other funds during the market crash. Overall, these findings are in line with the third hypothesis and may help to explain the behaviour of investors throughout the pandemic. That is, investors may gravitate towards low-carbon funds during periods of increased market volatility, knowing that these funds provide more resilience during periods of market turmoil. Alternatively, fear-inducing events such as the market crash may influence the risk preferences of investors, causing them to gravitate toward funds that fared better during the crash.

Table 3: Fund Performance

	Dependent Variable: Fama & French 6-factor adjusted Alpha							
	US		Europe		US		Europe	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CR Low	0.074***	0.033***	0.043***	0.029*				
	[0.02]	[0.01]	[0.02]	[0.02]				
CR High					-0.105**	-0.056***	-0.057***	-0.042**
					[0.04]	[0.02]	[0.01]	[0.02]
Return (12Mths)	0.077***	0.062***	0.017***	0.017***	0.073***	0.060***	0.017***	0.017***
	[0.02]	[0.02]	[0.00]	[0.00]	[0.02]	[0.02]	[0.00]	[0.00]
Net Assets (log)	-0.012***	-0.011***	0.003	0.003	-0.013***	-0.011***	0.002	0.003
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Age	0.000	0.000	0.001*	0.001**	0.000	0.000	0.001*	0.001**
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Cash	0.003	0.003	0.002*	0.001	0.003	0.004*	0.002*	0.001
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Turnover Ratio	-0.000	-0.000			-0.000*	-0.000*		
	[0.00]	[0.00]			[0.00]	[0.00]		
Expense Ratio	-0.053***	-0.043***			-0.037***	-0.036***		
	[0.01]	[0.01]			[0.01]	[0.01]		
Constant	-0.947***	-0.933***	-1.386***	-1.355***	-0.911***	-0.923***	-1.357***	-1.347***
	[0.08]	[0.10]	[0.09]	[0.12]	[0.08]	[0.09]	[0.09]	[0.12]
Style FE	Y	Y	Y	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	Y	Y	Y	Y	Y
Industry Controls	N	Y	N	Y	N	Y	N	Y
Observations	1,922	1,922	3,880	3,867	1,922	1,922	3,880	3,867
R-squared	0.517	0.556	0.457	0.473	0.522	0.558	0.458	0.474

Note. This table reports the estimates from the OLS regressions of Fama & French 6-factor adjusted alphas on dummy variables that indicate the low- and high-carbon risk classes. The FF-6 factor performance measure is estimated using simple net returns and reported in percentage terms. Fund-level controls include the fund's prior 12-month returns as of December 2019, the log of total net assets (TNA) as of December 31, 2019, age in years as of December 2019, cash position (as a percentage of TNA) as of December 2019, turnover ratio as of December 2019, expense ratio as of December 2019, as well as style and country fixed effects. Industry controls include the fund's net investment position (as a percentage of TNA) as of December 2019 in basic materials, communication services, consumer cyclical, consumer defensive, energy, financial services, healthcare, industrials, real estate, technology and utilities. Standard errors are reported in the parentheses, and are clustered by fund and style. *, ** and *** indicate significance at a 10%, 5% and 1% significance level, respectively.

6 Robustness Checks

6.1 Longer Pre-treatment Period

The pre-treatment period is extended to ensure that the results are not driven by seasonal trends or longer-term developments. Appendix B.1 presents the results from this estimation, where the pre-treatment period of the difference-in-difference setting is extended to January 1, 2019. Again, the estimation results indicate that low-carbon risk fund experience greater net flows during the incubation and recovery period, leaving the main results unaltered.

6.2 Parallel Trend

The plausibility of parallel pre-trends is examined by means of visual inspection in Section 4.2. A more formal examination is used in addition to this by following Autor (2003). Here, the authors make use of "leads" to demonstrate parallel pre-trends. These leads are interactions between the treatment group and pre-treatment time dummies, and capture the difference in pre-treatment dynamics between the treatment and control group. Appendix B.2 presents the results of this pre-trend analysis using monthly leads[26]. The coefficient estimates on the leads are statistically insignificant and hence provide additional support for parallel pre-trends.

6.3 Normalized Flow

Net flows are used to examine the behaviour of investors around the COVID-19 shock and during the subsequent recovery period. However, flows are noisy and systematic heterogeneities in flows may be driven by the size of a fund. To ensure that the results are not driven by such size properties, a normalized flow variable is constructed. Following Hartzmark and Sussman (2019), this normalized variable is constructed by dividing funds into weekly size-based deciles. Each fund is then assigned to a percentile rank based on the flows in its given size decile. These computed percentile ranks equate to the normalized flow variable.

The difference-in-difference specification in Equation (1) is re-estimated using this normalized flow variable. Appendix B.3 presents the results from this estimation. The results are robust to this alternative measure of net flows, with one exception. That is, the coefficient estimate on the interaction term *CRS High* $\times$ *Crash* becomes insignificant in the US. Moreover, this interaction term becomes positive and statistically significant in Europe. This notable result can be explained by "buying the dip" behaviour among investors. Buying the dip, as the name suggests, is the practice of purchasing funds that have fallen substantially in value in the expectation of higher future returns (Pagano et al., 2021). This explanation is supported by the underperformance of high-carbon risk funds during the market crash, as well as the disappearance of significant flows to this class during the recovery phase.

[26] By using monthly leads, this analysis allows for some degree of deviation in the weekly series, lending support to "approximate" rather than "exact" parallel pre-trends.

6.4 ESG vs Carbon Risk

As discussed before, ESG accounts for a broader range of risk factors than the carbon risk measure. Even the "environmental" pillar in the ESG domain is a more holistic measurement of climate-related risks, accounting for factors such as physical climate risks (e.g., extreme weather events). Due to these disparities, funds can be assigned to the lowest carbon risk class while also being positioned in the highest ESG risk class, and vice versa (Ceccarelli et al., 2019). This highlights the distinction between the two measures. Moreover, it shows that carbon risk provides additional information to investors, information that cannot be distilled from the broader ESG risk rating. However, it may also be that funds score similar on ESG and carbon risk ratings. For instance, funds that are positioned in the lowest ESG risk class, while also being assigned to the lowest carbon risk class. It is therefore imperative to shed more light on the two ratings and examine if the prior results on investor behaviour are influenced by other factors in the broader ESG domain. This is addressed through a comparative analysis and by directly controlling for individual environmental, social and governance sub-components in Appendix B.4.

6.4.1 Comparative Analysis

First, the comparative analysis uses the broader ESG risk classes to examine fund flow dynamics throughout the pandemic. Appendix B.4.1 presents the results from this comparative analysis. The results are comparable to previous findings in the US, but not in Europe. In particular, the results in Tables B4 and B5 show that there is no significant shift in net flows to low- or high-ESG risk funds during the recovery period, as compared to relative pre-COVID dynamics. The composition of the ESG rating—which includes a wide range of factors that may dampen or offset the carbon risk component—may explain this disparity.

6.4.2 Accounting for Environmental, Social and Governance Sub-components

Next, it is possible that other factors in the broader ESG domain have an impact on capital allocations and hence may influence the prior results. The robustness checks in Appendix B.4.2 attempt to address this issue. First consider Table B6, which presents the correlation between the carbon risk rating and the ESG sub-components. The correlation coefficients indicate that carbon risk is only marginally correlated with social and governance risk. Moreover, the correlation with environmental risk is higher (i.e., 0.485 and 0.5), but not complete. This confirms that carbon risk is only a part of the broader environmental risk component.

The marginal correlation with the social and governance sub-components allows for the inclusion of these factors in the difference-in-difference regression model. As shown in columns 1 and 2 of Table B7, the inclusion of these sub-components does not subsume the main results. Furthermore, columns 3 and 4 restrict the sample to funds that are positioned in the upper three environmental risk classes (i.e., average, above average and high environmental risk) to account for low-environmental risk properties[27]. Even in this more stringent

[27]Note that the direct inclusion of the environmental risk factor may result in inaccurate estimates due to the higher correlation

setting the main results continue to hold. Overall, these results emphasize the pertinence of carbon risk and alleviate concerns about the prior results being driven by other sustainability factors.

7 Conclusion

This paper analyses the fund flows and returns of equity mutual funds during the COVID-19 pandemic. The main purpose of this analysis is to establish if the outbreak of the coronavirus has led to a de-carbonization of the financial markets. Based on capital flows in both the US and Europe this study finds support for such a de-carbonization effect, with investors allocating more capital to low-carbon risk funds after the onset of the pandemic. However, this de-carbonization effect holds to varying degrees throughout the pandemic, as evidenced by exploiting different stages of the pandemic.

In particular, this study finds that low-carbon risk funds experience higher net flows during the incubation phase, as compared to the average fund before the pandemic. However, this increase in net flows does not persist during the pandemic-induced market crash. Furthermore, the capital re-allocations to low-carbon risk funds are particularly noticeable during the recovery period, when the financial markets have rebounded. The capital re-allocations during this period highlight the more prominent role of carbon risk, and are likely to be the result of the greater transition risks and opportunities.

The performance of equity mutual funds during the pandemic-induced market crash provides another explanation for the observed capital movements. In particular, the results show that low-carbon risk funds tend to outperform other funds in terms of risk-adjusted returns, indicating that these funds provide more resilience during periods of market turmoil. As such, investors may allocate more capital to low-carbon risk funds prior to the market crash in order to hedge against downside risk. Alternatively, the market crash may have influenced the risk preference of investors, causing them to gravitate toward funds that fared better during the market crash.

In conclusion, the results accentuate the importance of carbon risk on capital flows after the onset of the pandemic. This has implications for financial intermediaries and policy-makers. First, the results alert financial intermediaries about carbon risk. In particular, the results show that financial offerings with low-carbon risk can provide a competitive advantage in terms of capital flows. Second, the results show that mandatory carbon risk disclosure could be a valuable policy-instrument for mobilizing climate capital, as it would increase transparency in the financial markets, with potential to enlarge the current shift in capital flows to low-carbon risk investments. Thereby, this study argues that policy-makers should prioritize carbon risk in the broader context of ESG, as this measure is more in line with the objective of making financial flows consistent with the pathway to a low-carbon economy.

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with carbon risk. As a result, columns 3 and 4 account for environmental risk in an alternative manner by excluding funds in the low and below average environmental risk classes.

8 Discussion

This study is subject to several limitations that should be acknowledged, while it also provides potential avenues for future research. First, the research design in this study uses an alternative difference-in-difference framework, in which the control group is exposed to the treatment effect (i.e., the pandemic). Thereby, this study is unable to isolate the treatment effect and one may argue that other economic and financial developments influence the results. Nonetheless, given the severity of the pandemic and its economic (stimulus) implications, this seems unlikely. However, one may seek to improve the reliability of the main conclusions by exploiting economic markets that are unaffected by the pandemic. As it is rather challenging to find such a market—due to the mondial reach of the coronavirus and financial spillover effects—one may seek to exploit different treatment intensities by developing indexes for pandemic-induced factors that influence capital allocations across heterogeneous carbon risk funds (e.g., heightened transition risks).

Second, this study is unable to directly examine the underlying motives that drive the capital movements, and instead argues that (downside) risks and opportunities related to the pandemic are the primary drivers behind the observed capital movements. Yet, it is not possible to refute that the results are also influenced by non-financial motives, such as pro-social preferences. Accordingly, future studies may build on this research and deepen our understanding of the investment motives during the course of the pandemic.

Third, direct controls for the social and governance risk factors alleviate concerns that the results are driven by other sustainability properties. Excluding the lowest environmental risk quantiles does also not offset the main results. Nonetheless, it is not possible to directly control for other environmental risk factors—i.e., environmental risk aspects other than carbon risk—as this requires more disaggregated sustainability data. As a result, it is not possible to refute that the main results are influenced by other environmental risk factors. More explicit data on environmental factors would thus be useful for future research from an explanatory standpoint.

Fourth, this study focuses on the equity mutual fund industry in the US and Europe, leaving room to further investigate the impact of the pandemic on other investment classes and nations. Furthermore, whether the observed capital movements are driven by changing investor compositions in the equity mutual fund industry or by re-allocations of existing investors is an important question for future research, and requires more disaggregated data on investor or holding compositions.

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Appendix A Descriptive Statistics

Table A1: Descriptive Statistics: US

Variable	Mean	Std. Dev.	p10	p25	p50	p75	p90
Net Flows (%)	-0.1	1.16	-0.78	-0.33	-0.11	0.07	0.57
Normalized Net Flows	50.24	28.87	10	25	50	75	90
FF 6-Factor Alpha (%)	-1.2	0.26	-1.55	-1.32	-1.14	-1.02	-0.94
Total Net Assets (billion)	1.97	4.61	0.03	0.1	0.41	1.5	4.89
Prior 12-Month Return (%)	0.33	0.59	-0.16	0	0.18	0.51	1.06
Age	18.59	12.59	4.13	9.01	17.34	25.22	33.01
Cash (%)	0.59	1.95	0	0	0	0.17	1.85
Turnover Ratio	55.37	52.87	10	22	41	71	114
Expense Ratio	0.99	0.46	0.32	0.75	1.02	1.25	1.5
Basic Materials (%)	4.25	8.08	0	0.97	2.74	5.44	8.25
Communication Services (%)	7.42	6.73	0	3.05	6.92	10.66	14.06
Consumer Cyclical (%)	10.77	7.9	1.29	6.75	10.55	13.75	17.66
Consumer Defensive (%)	6.85	6.6	0	3.11	6.46	9.19	12.61
Energy (%)	3.71	8.12	0	0	2.29	4.67	7.71
Financial Services (%)	14.32	10.43	0.36	8.94	14.25	18.53	23.43
Healthcare (%)	12.2	11.32	0	7.12	12.56	15.26	18.61
Industrials (%)	10.24	8.38	0.9	5.51	9.57	13.73	17.76
Real Estate (%)	6.2	17.87	0	0.28	2.3	4.02	8.04
Technology (%)	17.47	12.69	1.65	9.01	16.51	23.83	31.99
Utilities (%)	3.23	8.55	0	0	1.56	3.58	6.35
Carbon Risk	2.85	1.33	1	2	3	4	5
ESG Risk	2.94	1.37	1	2	3	4	5
Environmental Risk	3	1.41	1	2	3	4	5
Social Risk	2.99	1.41	1	2	3	4	5
Governance Risk	3	1.42	1	2	3	4	5

Note. This table reports the summary statistics of the continuous variables in the US sample over the period from July 1, 2019 until March 1, 2020. Summary statistics include the mean, standard deviation, 10th, 25th, 50th, 75th, and 90th percentiles.

Table A2: Fund Flow Breakdown: US

	Average Net Flow			
	All Funds	Low CR	Average CR	High CR
Pre-COVID	-0.09	-0.05	-0.06	-0.15
Incubation	-0.09	-0.02	-0.09	-0.18
Crash	-0.26	-0.16	-0.26	-0.40
Recovery	-0.09	0.03	-0.14	-0.25

Note. This table reports the average net flows by sub-period for the US sample. The average net flows are reported in aggregate and for the low-, average-, and high-carbon risk sub-samples. The sub-periods consist of the pre-COVID (July 1, 2019 - December 31, 2019), incubation (January 1, 2020 - February 19, 2020), crash (February 20, 2020 - March 23, 2020), and recovery (March 24, 2020 - March 1, 2021) periods.

Table A3: Descriptive Statistics: Europe

Variable	Mean	Std. Dev.	p10	p25	p50	p75	p90
Net Flows (%)	0.04	1.64	-0.83	-0.22	0	0.21	0.97
Normalized Net Flows	50.09	28.87	10	25	50	75	90
FF 6-Factor Alpha (%)	-1.33	0.46	-1.99	-1.66	-1.26	-1	-0.79
Total Net Assets (billion)	0.44	0.84	0.02	0.05	0.14	0.43	1.14
Prior 12-Month Return (%)	0.36	1.02	-0.32	-0.04	0.12	0.48	1.28
Age	14.8	9.66	3.66	6.69	13.58	20.92	27.7
Cash (%)	1.89	3.54	-0.04	0	0.75	2.57	5.55
Turnover Ratio	56.18	81.21	-5.99	6.81	33	80	151.26
Expense Ratio	1.26	0.63	0.34	0.89	1.28	1.61	1.92
Basic Materials (%)	5.96	7.52	0	2.41	4.85	7.66	10.91
Communication Services (%)	7.16	5.61	0	3.21	6.72	10.16	13.61
Consumer Cyclical (%)	10.34	6.47	2.46	6.46	10.11	13.33	17.38
Consumer Defensive (%)	8.66	6.89	0.49	4.59	7.66	11.5	16.31
Energy (%)	3.75	6.32	0	0	2.46	5	8.33
Financial Services (%)	14.46	9.02	1.73	9.59	14.62	18.59	24.11
Healthcare (%)	12.09	11.76	0.98	5.55	11.29	15.13	20.25
Industrials (%)	11.97	8.45	2.7	6.77	10.61	15.41	21.86
Real Estate (%)	4.35	13.85	0	0	1.72	3.36	6.22
Technology (%)	14.1	10.46	1.37	6.58	13.6	19.91	25.37
Utilities (%)	3.28	5.81	0	0	2.09	4.11	7.16
Carbon Risk	2.87	1.39	1	2	3	4	5
ESG Risk	2.72	1.35	1	2	3	4	5
Environmental Risk	2.99	1.41	1	2	3	4	5
Social Risk	2.99	1.41	1	2	3	4	5
Governance Risk	3	1.41	1	2	3	4	5

Note. This table reports the summary statistics of the continuous variables in the European sample over the period from July 1, 2019 until March 1, 2020. Summary statistics include the mean, standard deviation, 10th, 25th, 50th, 75th, and 90th percentiles.

Table A4: Fund Flow Breakdown: Europe

	Average Net Flow			
	All Funds	Low CR	Average CR	High CR
Pre-COVID	0.02	0.12	0.00	-0.10
Incubation	0.07	0.26	0.01	-0.11
Crash	-0.25	-0.20	-0.28	-0.32
Recovery	0.07	0.22	0.01	-0.10

Note. This table reports the average net flows by sub-period for the European sample. The average net flows are reported in aggregate and for the low-, average-, and high-carbon risk sub-samples. The sub-periods consist of the pre-COVID (July 1, 2019 - December 31, 2019), incubation (January 1, 2020 - February 19, 2020), crash (February 20, 2020 - March 23, 2020), and recovery (March 24, 2020 - March 1, 2021) periods.

Appendix B Robustness Checks

B.1 Longer Pre-treatment Period

Table B1: Longer Pre-treatment Period

	Dependent Variable: Net Flow						
	Full Sample			US		Europe	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CR Low × Incubation	0.10***	0.10***	0.11***	0.14**	0.14**	0.09**	0.10***
	[0.03]	[0.03]	[0.03]	[0.06]	[0.06]	[0.04]	[0.04]
CR High × Incubation	-0.03	-0.06	-0.07	-0.02	-0.02	-0.07	-0.07
	[0.04]	[0.05]	[0.05]	[0.07]	[0.07]	[0.06]	[0.06]
CR Low × Crash	0.02	-0.01	0.00	-0.01	0.00	-0.01	0.01
	[0.05]	[0.05]	[0.05]	[0.06]	[0.06]	[0.07]	[0.07]
CR High × Crash	0.01	0.02	0.02	-0.15**	-0.16**	0.06	0.05
	[0.04]	[0.05]	[0.05]	[0.08]	[0.08]	[0.06]	[0.06]
CR Low × Recovery	0.11***	0.08***	0.08***	0.13***	0.14***	0.05**	0.06**
	[0.02]	[0.02]	[0.02]	[0.04]	[0.04]	[0.03]	[0.03]
CR High × Recovery	-0.04*	-0.03	-0.03	0.03	0.02	-0.04	-0.05
	[0.02]	[0.02]	[0.02]	[0.03]	[0.04]	[0.03]	[0.03]
CR Low	0.08***	0.09***	0.10***	0.07**	0.06**	0.10***	0.11***
	[0.02]	[0.02]	[0.02]	[0.03]	[0.03]	[0.02]	[0.02]
CR High	-0.06***	-0.05**	-0.04**	-0.03	-0.02	-0.04*	-0.04
	[0.02]	[0.02]	[0.02]	[0.03]	[0.03]	[0.02]	[0.02]
Return (12Mths)		0.14***	0.13***	0.23***	0.24***	0.13***	0.13***
		[0.01]	[0.01]	[0.03]	[0.03]	[0.01]	[0.01]
Net Assets (log)		0.01**	0.01***	-0.01	-0.01	0.01	0.01*
		[0.00]	[0.00]	[0.01]	[0.01]	[0.01]	[0.01]
Age		-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***
		[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Cash		0.01***	0.01***	0.03***	0.02***	0.01***	0.01**
		[0.00]	[0.00]	[0.01]	[0.01]	[0.00]	[0.00]
Turnover Ratio				-0.00**	-0.00**		
				[0.00]	[0.00]		
Expense Ratio				-0.20***	-0.20***		
				[0.04]	[0.04]		
Constant	-0.04***	-0.12	0.33*	0.39***	1.15***	-0.07	0.45*
	[0.01]	[0.08]	[0.19]	[0.15]	[0.34]	[0.11]	[0.23]
Style-Week FE	Y	Y	Y	Y	Y	Y	Y
Country-Week FE	Y	Y	Y	Y	Y	Y	Y
Industry Controls	N	N	Y	N	Y	N	Y
Observations	458,764	365,605	365,214	80,360	80,326	282,509	282,157
R-squared	0.035	0.049	0.051	0.076	0.079	0.053	0.055

Note. This table reports the estimates from the difference-in-difference regressions of weekly net flows on the low- and high-carbon risk classes and their interactions with the dummy variables indicating the incubation (January 1, 2020 - February 19, 2020), crash (February 20, 2020 - March 23, 2020), and recovery (March 24, 2020 - March 1, 2021) periods. Fund-level controls include the fund's prior 12-month returns, total net assets (TNA) in logs, age in years, cash position (as a percentage of TNA), turnover ratio, expense ratio, as well as style-week and country-week fixed effects. Industry controls include the fund's net investment position (as a percentage of TNA) in basic materials, communication services, consumer cyclical, consumer defensive, energy, financial services, healthcare, industrials, real estate, technology and utilities. Standard errors are reported in the parentheses, and are clustered by fund and style-week levels. *, ** and *** indicate significance at a 10%, 5% and 1% significance level, respectively.

B.2 Parallel Trend

Table B2: Parallel Trend

	Dependent Variable: Net Flow			
	US		Europe	
	L	H	L	H
t = -12	0.03	0.08	0.04	0.05
	[0.11]	[0.09]	[0.07]	[0.07]
t = -11	0.08	-0.06	0.02	0.02
	[0.08]	[0.07]	[0.07]	[0.07]
t = -10	-0.01	-0.01	-0.00	0.06
	[0.05]	[0.06]	[0.07]	[0.06]
t = -9	0.06	-0.02	0.01	0.01
	[0.06]	[0.05]	[0.06]	[0.07]
t = -8	0.05	0.02	0.02	0.03
	[0.06]	[0.05]	[0.06]	[0.07]
t = -7	-0.04	-0.03	0.02	0.03
	[0.05]	[0.07]	[0.08]	[0.07]
t = -6	0.08	0.08	0.11	-0.02
	[0.06]	[0.07]	[0.07]	[0.06]
t = -5	0.05	-0.00	0.03	0.08
	[0.07]	[0.08]	[0.07]	[0.07]
t = -4	0.01	0.04	-0.02	-0.05
	[0.06]	[0.05]	[0.07]	[0.06]
t = -3	0.01	-0.09	0.04	0.05
	[0.06]	[0.12]	[0.06]	[0.07]
t = -2	0.03	0.09	0.02	0.04
	[0.08]	[0.07]	[0.06]	[0.06]
Constant	1.97***	1.63***	0.85***	0.41
	[0.49]	[0.61]	[0.27]	[0.30]
Style-Month FE	Y	Y	Y	Y
Country-Month FE	Y	Y	Y	Y
Fund Controls	Y	Y	Y	Y
Industry Controls	Y	Y	Y	Y
Observations	6,831	5,704	21,855	19,805
R-squared	0.127	0.120	0.084	0.088

Note. This table reports the regression estimates from the monthly net flows interacted with dummy variables that indicate the months January (i.e., t = -12) to November (i.e., t = -2) of 2019. The baseline period is the month before the onset of the pandemic (i.e., December 2019), and "L" and "H" indicate the interaction with the low- and high-carbon risk classes, respectively. Fund-level controls include the fund's prior 12-month returns, total net assets (TNA) in logs, age in years, cash position (as a percentage of TNA), turnover ratio, expense ratio, as well as style-week and country-week fixed effects. Industry controls include the fund's net investment position (as a percentage of TNA) in basic materials, communication services, consumer cyclical, consumer defensive, energy, financial services, healthcare, industrials, real estate, technology and utilities. Standard errors are reported in the parentheses, and are clustered by fund and style-week levels. *, ** and *** indicate significance at a 10%, 5% and 1% significance level, respectively.

B.3 Normalized Fund Flows

Table B3: Normalized Fund Flows

	Dependent Variable: Normalized Net Flow						
	Full Sample			US		Europe	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CR Low × Incubation	1.71***	1.49**	1.72***	2.62**	2.74**	1.21*	1.52**
	[0.51]	[0.58]	[0.59]	[1.29]	[1.27]	[0.67]	[0.69]
CR High × Incubation	0.05	-0.05	-0.15	-0.30	-0.45	-0.03	-0.15
	[0.49]	[0.57]	[0.58]	[1.55]	[1.55]	[0.61]	[0.62]
CR Low × Crash	-0.10	-1.00	-0.70	-1.18	-0.68	-1.16	-0.82
	[0.68]	[0.80]	[0.79]	[1.39]	[1.38]	[0.97]	[0.96]
CR High × Crash	2.36***	2.52***	2.36***	0.19	-0.09	2.84***	2.71***
	[0.63]	[0.76]	[0.75]	[1.47]	[1.51]	[0.86]	[0.86]
CR Low × Recovery	3.04***	2.20***	2.47***	4.46***	4.67***	1.29**	1.66***
	[0.50]	[0.52]	[0.53]	[1.05]	[1.06]	[0.60]	[0.61]
CR High × Recovery	-0.57	-0.31	-0.51	0.26	-0.53	-0.44	-0.58
	[0.53]	[0.57]	[0.57]	[1.23]	[1.25]	[0.63]	[0.64]
CR Low	2.56***	2.70***	2.65***	2.93**	3.13**	3.07***	2.58***
	[0.59]	[0.60]	[0.62]	[1.32]	[1.36]	[0.67]	[0.69]
CR High	-3.22***	-2.73***	-2.45***	-2.04	-1.96	-2.57***	-2.06***
	[0.63]	[0.63]	[0.64]	[1.44]	[1.60]	[0.69]	[0.70]
Return (12Mths)		3.28***	3.03***	8.10***	8.56***	3.01***	2.68***
		[0.29]	[0.29]	[1.00]	[1.02]	[0.30]	[0.30]
Net Assets (log)		0.27*	0.31**	0.12	0.15	-0.10	-0.04
		[0.15]	[0.15]	[0.32]	[0.32]	[0.17]	[0.17]
Age		-0.41***	-0.40***	-0.35***	-0.34***	-0.43***	-0.42***
		[0.02]	[0.02]	[0.05]	[0.05]	[0.03]	[0.03]
Cash		0.34***	0.22***	0.64**	0.46	0.31***	0.19***
		[0.06]	[0.07]	[0.27]	[0.29]	[0.06]	[0.07]
Turnover Ratio				-0.03***	-0.03***		
				[0.01]	[0.01]		
Expense Ratio				-8.17***	-8.30***		
				[1.37]	[1.35]		
Constant	49.56***	48.49***	62.54***	60.90***	85.43***	55.13***	70.19***
	[0.33]	[2.87]	[5.10]	[6.66]	[12.33]	[3.28]	[5.66]
Style-Week FE	Y	Y	Y	Y	Y	Y	Y
Country-Week FE	Y	Y	Y	Y	Y	Y	Y
Industry Controls	N	N	Y	N	Y	N	Y
Observations	361,312	289,257	288,987	63,489	63,471	223,500	223,253
R-squared	0.057	0.089	0.094	0.114	0.121	0.099	0.105

Note. This table reports the estimates from the difference-in-difference regressions of weekly normalized net flows on the low- and high-carbon risk classes and their interactions with the dummy variables indicating the incubation (January 1, 2020 - February 19, 2020), crash (February 20, 2020 - March 23, 2020), and recovery (March 24, 2020 - March 1, 2021) periods. Fund-level controls include the fund's prior 12-month returns, total net assets (TNA) in logs, age in years, cash position (as a percentage of TNA), turnover ratio, expense ratio, as well as style-week and country-week fixed effects. Industry controls include the fund's net investment position (as a percentage of TNA) in basic materials, communication services, consumer cyclical, consumer defensive, energy, financial services, healthcare, industrials, real estate, technology and utilities. Standard errors are reported in the parentheses, and are clustered by fund and style-week levels. *, ** and *** indicate significance at a 10%, 5% and 1% significance level, respectively.

B.4 ESG vs Carbon Risk

B.4.1 Comparative Analysis

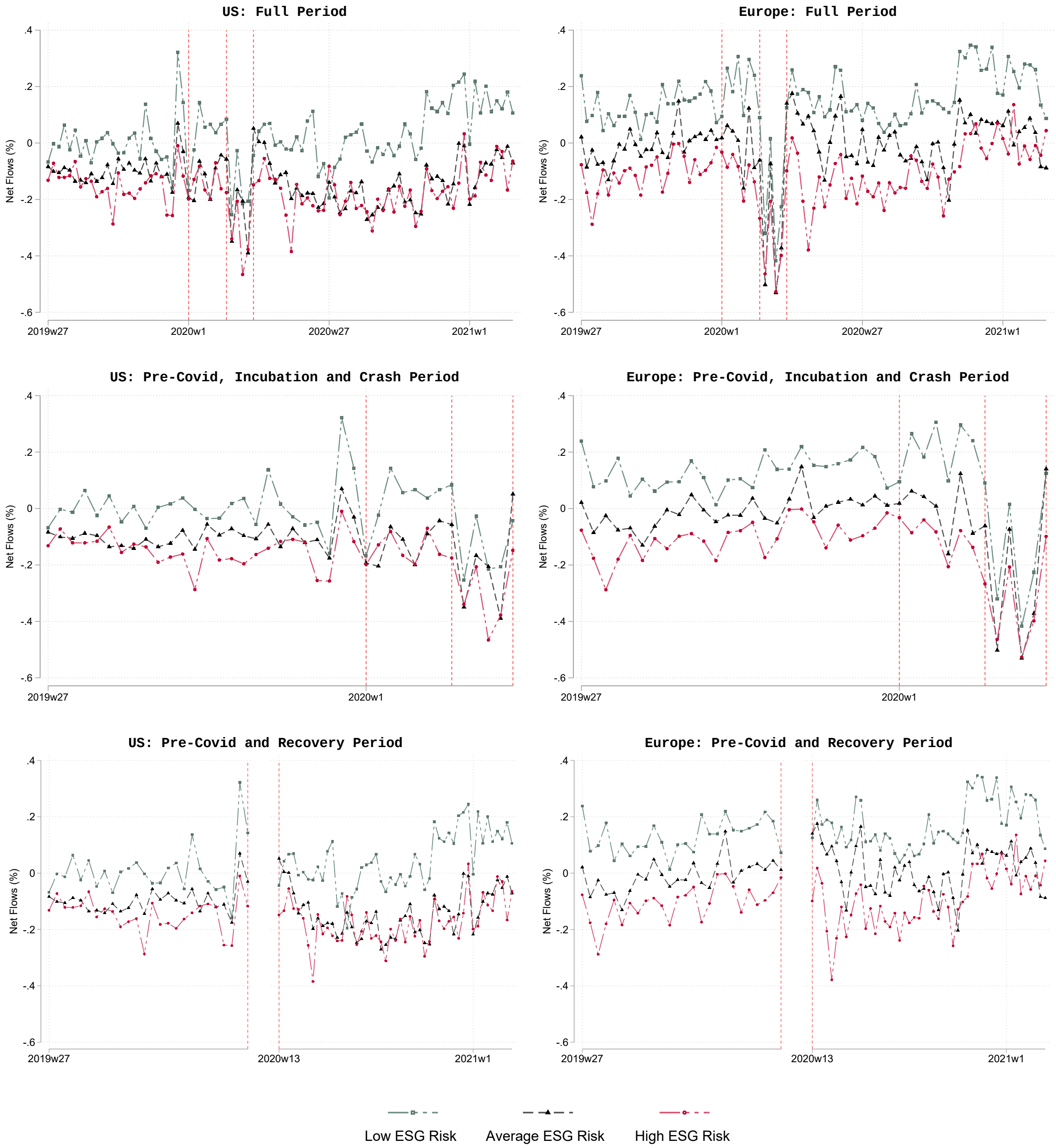

Figure B1: This figure plots the average weekly net flows of low-, average and high-ESG risk funds for the US (left-hand side) and Europe (right-hand side). The top panel presents the average net flows over the full sample period (i.e., July 1, 2019 - March 1, 2021), where the first dotted line indicates the beginning of the incubation period, the second dotted line indicates the beginning of the market crash and the last dotted line indicates the beginning of the recovery period. The middle panel presents the pre-COVID period (July 1, 2019 - December 31, 2019), the incubation period (January 1, 2020 - February 19, 2020) and the crash period (February 20, 2020 - March 23, 2020). The bottom panel present the pre-COVID period (July 1, 2019 - December 31, 2019) and recovery period (March 24, 2020 - March 1, 2021).

Table B4: Fund Flows

	Dependent Variable: Net Flow						
	Full Sample			US		Europe	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ESG-R Low × Incubation	0.07**	0.09***	0.10***	0.14***	0.14***	0.07*	0.08*
	[0.03]	[0.03]	[0.04]	[0.05]	[0.05]	[0.04]	[0.04]
ESG-R High × Incubation	0.02	0.03	0.03	0.01	0.01	0.03	0.03
	[0.03]	[0.03]	[0.03]	[0.05]	[0.05]	[0.04]	[0.04]
ESG-R Low × Crash	0.03	0.04	0.04	-0.02	-0.01	0.04	0.05
	[0.05]	[0.05]	[0.05]	[0.07]	[0.07]	[0.06]	[0.06]
ESG-R High × Crash	-0.02	0.04	0.04	-0.08	-0.08	0.06	0.06
	[0.04]	[0.04]	[0.04]	[0.07]	[0.07]	[0.05]	[0.05]
ESG-R Low × Recovery	0.03	0.02	0.03	0.11***	0.12***	-0.00	-0.00
	[0.02]	[0.02]	[0.02]	[0.04]	[0.04]	[0.03]	[0.03]
ESG-R High × Recovery	0.01	0.04	0.04	0.03	0.02	0.04	0.04
	[0.02]	[0.02]	[0.02]	[0.04]	[0.04]	[0.03]	[0.03]
ESG-R Low	0.13***	0.12***	0.12***	0.08**	0.07*	0.14***	0.13***
	[0.02]	[0.02]	[0.02]	[0.03]	[0.03]	[0.02]	[0.02]
ESG-R High	-0.08***	-0.08***	-0.07***	-0.05*	-0.05	-0.08***	-0.06***
	[0.02]	[0.02]	[0.02]	[0.03]	[0.03]	[0.02]	[0.02]
Return (12Mths)		0.15***	0.15***	0.23***	0.23***	0.15***	0.14***
		[0.01]	[0.01]	[0.03]	[0.03]	[0.01]	[0.01]
Net Assets (log)		0.01***	0.01***	-0.01*	-0.01*	0.01**	0.02***
		[0.00]	[0.00]	[0.01]	[0.01]	[0.01]	[0.01]
Age		-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***
		[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Cash		0.01***	0.01***	0.03***	0.03***	0.01***	0.01***
		[0.00]	[0.00]	[0.01]	[0.01]	[0.00]	[0.00]
Turnover Ratio				-0.00	-0.00*		
				[0.00]	[0.00]		
Expense Ratio				-0.17***	-0.18***		
				[0.04]	[0.04]		
Constant	-0.05***	-0.20**	0.20	0.43**	1.61***	-0.23**	0.11
	[0.01]	[0.08]	[0.18]	[0.17]	[0.42]	[0.11]	[0.20]
Style-Week FE	Y	Y	Y	Y	Y	Y	Y
Country-Week FE	Y	Y	Y	Y	Y	Y	Y
Industry Controls	N	N	Y	N	Y	N	Y
Observations	375,478	302,833	302,662	65,431	65,422	234,936	234,779
R-squared	0.038	0.054	0.055	0.085	0.091	0.058	0.060

Note. This table reports the estimates from the difference-in-difference regressions of weekly net flows on the low- and high-ESG risk classes and their interactions with the dummy variables indicating the incubation (January 1, 2020 - February 19, 2020), crash (February 20, 2020 - March 23, 2020), and recovery (March 24, 2020 - March 1, 2021) periods. Fund-level controls include the fund's prior 12-month returns, total net assets (TNA) in logs, age in years, cash position (as a percentage of TNA), turnover ratio, expense ratio, as well as style-week and country-week fixed effects. Industry controls include the fund's net investment position (as a percentage of TNA) in basic materials, communication services, consumer cyclical, consumer defensive, energy, financial services, healthcare, industrials, real estate, technology and utilities. Standard errors are reported in the parentheses, and are clustered by fund and style-week levels. *, ** and *** indicate significance at a 10%, 5% and 1% significance level, respectively.

Table B5: Sub-period Fund Flows

D.V. = Net Flow	(Pre-COVID)	(Incubation)	(Crash)	(Recovery)
		Panel A: US		
ESG-R Low	0.08**	0.21***	0.13*	0.19***
	[0.03]	[0.06]	[0.08]	[0.04]
ESG-R Below Avg	0.01	0.17***	-0.13**	-0.01
	[0.03]	[0.05]	[0.06]	[0.03]
ESG-R Above Avg	-0.00	0.03	-0.06	0.01
	[0.03]	[0.04]	[0.06]	[0.03]
ESG-R High	-0.04	0.02	-0.08	-0.02
	[0.03]	[0.05]	[0.09]	[0.04]
Constant	1.31***	0.49	1.72***	0.97**
	[0.31]	[0.52]	[0.59]	[0.39]
Observations	36,323	7,457	7,399	62,078
R-squared	0.063	0.086	0.091	0.074
		Panel B: Europe		
ESG-R Low	0.13***	0.20***	0.20***	0.13***
	[0.02]	[0.04]	[0.06]	[0.02]
ESG-R Below Avg	0.02	0.11***	0.09	-0.00
	[0.02]	[0.04]	[0.06]	[0.02]
ESG-R Above Avg	-0.01	0.02	-0.01	-0.02
	[0.02]	[0.04]	[0.05]	[0.02]
ESG-R High	-0.08***	-0.03	-0.06	-0.01
	[0.02]	[0.04]	[0.06]	[0.03]
Constant	0.55***	-0.19	-0.06	0.10
	[0.20]	[0.32]	[0.42]	[0.20]
Observations	121,573	31,091	23,113	217,265
R-squared	0.037	0.058	0.069	0.048
Style-Week FE	Y	Y	Y	Y
Country-Week FE	Y	Y	Y	Y
Fund Controls	Y	Y	Y	Y
Industry Controls	Y	Y	Y	Y

Note. This table reports the estimates from the OLS regressions of weekly net flows on the low-, below average-, above average- and high-ESG risk classes for each sub-period, consisting of the pre-COVID (July 1, 2019 - December 31, 2019), incubation (January 1, 2020 - February 19, 2020), crash (February 20, 2020 - March 23, 2020), and recovery (March 24, 2020 - March 1, 2021) periods. Fund-level controls include the fund's prior 12-month returns, total net assets (TNA) in logs, age in years, cash position (as a percentage of TNA), turnover ratio, expense ratio, as well as style-week and country-week fixed effects. Industry controls include the fund's net investment position (as a percentage of TNA) in basic materials, communication services, consumer cyclical, consumer defensive, energy, financial services, healthcare, industrials, real estate, technology and utilities. Standard errors are reported in the parentheses, and are clustered by fund and style-week levels. *, ** and *** indicate significance at a 10%, 5% and 1% significance level, respectively.

B.4.2 Accounting for Environmental, Social and Governance Sub-components

Table B6: Variable Correlations

	US			
Variable	1	2	3	4
1. Carbon Risk	1			
2. Environmental Risk	0.485***	1		
3. Social Risk	-0.074***	-0.175***	1	
4. Governance Risk	0.005*	0.077***	0.425***	1
	Europe			
Variable	1	2	3	4
1. Carbon Risk	1			
2. Environmental Risk	0.500***	1		
3. Social Risk	0.008***	0.043***	1	
4. Governance Risk	0.143***	0.178***	0.492***	1

Note. This table reports the correlations between the carbon risk score, environmental risk score, social risk score, governance risk score over the period from July 1, 2019 until March 1, 2020. *, ** and *** indicate significance at a 10%, 5% and 1% significance level, respectively.

Table B7: Accounting for Environmental, Social and Governance Sub-components

	Dependent Variable: Net Flow			
	US		Europe	
	(1)	(2)	(3)	(4)
CR Low × Incubation	0.12**	0.15**	0.10***	0.14*
	[0.05]	[0.07]	[0.04]	[0.07]
CR High × Incubation	-0.05	-0.03	0.00	0.02
	[0.06]	[0.06]	[0.04]	[0.04]
CR Low × Crash	0.03	0.15	0.02	0.02
	[0.06]	[0.12]	[0.07]	[0.10]
CR High × Crash	-0.16**	-0.12	0.05	0.01
	[0.08]	[0.08]	[0.06]	[0.07]
CR Low × Recovery	0.15***	0.22***	0.06**	0.12**
	[0.04]	[0.06]	[0.03]	[0.05]
CR High × Recovery	0.01	0.01	-0.04	-0.04
	[0.04]	[0.04]	[0.03]	[0.03]
CR Low	0.05	-0.07	0.10***	0.08*
	[0.03]	[0.06]	[0.03]	[0.04]
CR High	-0.02	-0.09**	-0.04*	-0.06**
	[0.04]	[0.04]	[0.03]	[0.03]
Social Risk × Incubation	0.00	0.04	0.01	-0.01
	[0.03]	[0.04]	[0.02]	[0.03]
Social Risk × Crash	0.01	0.03	-0.01	-0.07**
	[0.03]	[0.05]	[0.03]	[0.03]
Social Risk × Recovery	-0.00	-0.01	0.00	-0.00
	[0.02]	[0.03]	[0.01]	[0.02]
Governance Risk × Incubation	-0.01	-0.02	-0.00	-0.00
	[0.03]	[0.03]	[0.02]	[0.02]
Governance Risk × Crash	0.06**	0.07*	0.01	0.02
	[0.03]	[0.04]	[0.02]	[0.03]
Governance Risk × Recovery	-0.00	0.02	-0.00	-0.00
	[0.02]	[0.02]	[0.01]	[0.02]
Social Risk	0.02	0.02	-0.01	0.00
	[0.02]	[0.02]	[0.01]	[0.02]
Governance Risk	-0.03*	-0.03	-0.01	-0.00
	[0.02]	[0.02]	[0.01]	[0.02]
Constant	1.22***	1.38***	0.43*	0.35
	[0.43]	[0.45]	[0.23]	[0.30]
Style-Week FE	Y	Y	Y	Y
Country-Week FE	Y	Y	Y	Y
Fund Controls	Y	Y	Y	Y
Industry Controls	Y	Y	Y	Y
Observations	63,067	35,730	222,348	127,977
R-squared	0.081	0.083	0.061	0.071

Note. This table reports the estimates from the difference-in-difference regressions of weekly net flows on the low- and high-carbon risk classes and their interactions with the dummy variables indicating the incubation (January 1, 2020 - February 19, 2020), crash (February 20, 2020 - March 23, 2020), and recovery (March 24, 2020 - March 1, 2021) periods. Fund-level controls include the fund's social risk score, interactions between the social risk score and period dummies, governance risk score, interactions between the governance risk score and period dummies, prior 12-month returns, total net assets (TNA) in logs, age in years, cash position (as a percentage of TNA), turnover ratio, expense ratio, as well as style-week and country-week fixed effects. Industry controls include the fund's net investment position (as a percentage of TNA) in basic materials, communication services, consumer cyclical, consumer defensive, energy, financial services, healthcare, industrials, real estate, technology and utilities. Standard errors are reported in the parentheses, and are clustered by fund and style-week levels. *, ** and *** indicate significance at a 10%, 5% and 1% significance level, respectively.

Appendix C Variable Descriptions

Table C1: Variable Descriptions

Variable	Definition
Net Flow	The fund's weekly dollar net flows as a percentage of the TNA of the previous week
Normalized Net Flow	The fund's weekly percentage ranking of the net flows in its given size decile
FF 6-factor Alpha	The fund's Fama & French 6-factor adjusted alpha during the market crash period
Carbon Risk Classes	The five quantile-based carbon risk classes are derived from the portfolio-level carbon risk rating, which is the weighted-average of the underlying company-level carbon risk scores. These company-level scores capture unmanaged carbon risks, such that companies with better carbon policies obtain a lower risk score
ESG Risk Classes	The five quantile-based ESG (sub-component) risk classes are derived from the portfolio-level ESG risk rating, which is the weighted-average of the underlying company-level ESG risk scores. These company-level scores capture unmanaged ESG risks, such that companies with better ESG policies obtain a lower risk score
Incubation Period	The weeks in the period between January 1, 2020 and February 19, 2020
Crash Period	The weeks in the period between February 20, 2020 and March 23, 2020
Recovery Period	The weeks in the period between March 24, 2020 and March 1, 2021
Return (12Mths)	The fund's return of the previous twelve months
Net Assets (log)	The fund's total net assets (TNA) at the end of the previous week in logs
Age	The fund's age in years since the inception date of the oldest share class
Cash	The fund's monthly cash position as a percentage of the TNA
Turnover Ratio	The fund's monthly turnover ratio
Expense Ratio	The fund's yearly expense ratio
Global Category	The fund's Global Category consisting of the following categories: Africa Equity, Asia Equity, Asia ex-Japan Equity, Australia & New Zealand Equity, Canadian Equity Large Cap, Communications Sector Equity, Consumer Goods & Services Sector Equity, Energy Sector Equity, Equity Miscellaneous, Europe Emerging Markets Equity, Europe Equity Large Cap, Europe Equity Mid/Small Cap, Financials Sector Equity Flexible Allocation, Global Emerging Markets Equity, Global Equity Large Cap, Global Equity Mid/Small Cap, Greater China Equity, Healthcare Sector Equity, India Equity, Industrials Sector Equity, Infrastructure Sector Equity, Japan Equity, Korea Equity, Latin America Equity, Long/Short Equity, Malaysia Equity, Mexico Equity, Miscellaneous, Moderate Allocation, Natural Resources Sector Equity, Precious Metals Sector Equity, Real Estate Sector Equity, Technology Sector Equity, Thailand Equity, UK Equity Large Cap, UK Equity Mid/Small Cap, US Equity Large Cap Blend, US Equity Large Cap Growth, US Equity Large Cap Value, US Equity Mid Cap, US Equity Small Cap, Utilities Sector Equity
Country	The fund's domicile consisting of the following countries: Andorra, Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Greece, Guernsey, Ireland, Isle of Man, Italy, Jersey, Liechtenstein, Luxembourg, Malta, Monaco, Netherlands, Norway, Portugal, Slovenia, Spain, Sweden, Switzerland, United Kingdom and the United States
Industry Controls	The fund's net investment position, as a percentage of the total net assets, in the following industries: basic materials, communication services, consumer cyclical, consumer defensive, energy, financial services, healthcare, industrials, real estate, technology, and utilities