Regulating ESG Disclosure

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Abstract

We use new data on the ownership of mutual funds in Europe to estimate how investors respond to regulations on the disclosure of Environmental, Social and Governance (ESG) performance. We find that the introduction of ESG disclosure rules for mutual funds led to strong flows into funds categorized as green. We show that investor rebalancing takes place through an uncertainty channel where investors value the lower uncertainty, and a greenness channel where funds respond to disclosure rules by increasing their greenness to attract flows. We find empirical support for both channels: green funds for which investors had little information before the regulation experience the strongest flows, and green funds that had a low ESG rating before the regulation decrease their emissions most under the new rules.

Keywords: Mutual funds; Disclosure Regulation; Environmental preferences; ESG ratings.

JEL Codes: G11; G15; G23; Q56.

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Corporations, investors and rating agencies disagree on how to assess Environmental, Social and Governance (ESG) performance. The correlation of ESG indicators across rating agencies has been found to be as low as 38% (Chatterji et al. 2016; Berg et al. 2022b). The methodologies of data providers are opaque and arbitrary (Berg et al. 2021; Billio et al. 2024), and green credentials of firms and intermediaries are often overstated (Liang et al. 2022; Parise and Rubin 2023; Giannetti et al. 2023; Sastry et al. 2024; Duchin et al. 2024; Pastor et al. 2024, among others).

In this context, regulators are increasingly focusing on the issue of ESG disclosure, introducing rules targeting both corporations (such as the SEC's climate-related disclosure rules) and financial intermediaries (through e.g. bank climate stress tests or mutual fund reporting rules). These rules are important - the assets of sustainable investors have been estimated at $ 103 trillion in 2020 by the United Nations Principles for Responsible Investment -, but they are also controversial. In the United States, ten states sued the SEC shortly after it announced the climate disclosure rule. In Europe, the design of the green classification of activities ("the taxonomy") was contentious. While the arguments are diverse, one point is clear: we lack evidence on how ESG disclosure rules impact financial markets and the allocation of capital by investors.

In this paper, we provide theoretical and empirical evidence on how the regulation of ESG disclosure by mutual funds impacts (1) investors' asset allocation across funds, and (2) fund managers' portfolio choice. For this, we focus on the case of the European Sustainable Finance Disclosure Regulation (SFDR). The regulation, introduced in 2021, requires mutual funds to choose between a 'brown' (Article 6), a 'light green' (Article 8) or a 'dark green' (Article 9) category, where greener categories are subject to stricter reporting requirements. The SFDR applies to all regulated funds in the European Union (EU), a market representing more than €9 trillion of assets, equivalent to more than 50% of the EU's GDP.

The SFDR provides an ideal setting to study disclosure regulation. While some studies have compared the impact of disclosure regulation across countries (Krueger et al. 2024), a natural concern is that the decision to regulate is related to country-level preferences. In our case, a common regulation is imposed on 27 countries with different market structures and investor preferences. To estimate the impact of the regulation, we rely on granular portfolio data that provide, for each mutual fund, the investors in the fund at the country and financial sector level (for instance: French banks, Spanish insurance companies or German households). Our data

thus provides rich variation across both markets and investors whereas existing studies have typically focused on a single market (Hartzmark and Sussman 2019) or a subset of investors (Giglio et al. 2023a).

We show that more than 46% of funds by assets chose to categorize themselves as green funds (Article 8 or 9) at the launch of the regulation. In the following quarters, green funds experienced positive flows representing 10.2% of their assets versus a growth of 1.9% for brown (article 6) funds. This result is consistent with Hartzmark and Sussman (2019), Pastor et al. (2022) and Bolton and Kacperczyk (2021) who found in other settings that investors respond to signals on asset greenness. To highlight the potential transmission channels of ESG disclosure regulation, we introduce a model of fund choice with uncertainty about the greenness of funds. We show that disclosure regulation leads investors to rebalance their portfolio through two channels: (1) an uncertainty channel where investors value the lower risk with disclosure (as in Avramov et al. 2022), and (2) a greenness channel where funds endogenously increase their greenness to attract flows. We find empirical support for both channels in the data, showing for instance that funds without an ESG rating that chose a green status experienced higher flows than funds that already had a high ESG rating before the regulation. The analysis illustrates the role of investor preferences, with e.g. institutional investors being more responsive to environmental preferences of their country than retail investors.

The SFDR was adopted in November 2019 by the Council and the Parliament of the European Union, and came into force in March 2021. The regulation requires financial intermediaries to publish data on the ESG risks of their investments. In its sixth article, the SFDR requires all funds to explain how sustainability risks are taken into account in their investment process and how they could affect the funds' returns. Article 8 defines additional reporting requirements for funds that "promote environmental or social characteristics". Article 9 then imposes further requirements on funds that "have sustainability as an objective".

Our main dataset, the Securities Holding Statistics (SHS), covers more than 80% of the European mutual funds (UCITS) market from Q4 2018 to Q3 2022. The total holdings range from €8 to 10 trillion across quarters. Among domestic investors, the retail (household) sector is the largest holder of fund shares, accounting for around a third of the holdings. The 'insurance

companies and pension funds' (ICPF) sector and the mutual fund sector are second and third, with around 25% of the holdings each. Equity funds are the largest fund category (€2.5 trillion of assets), followed by fixed income funds (€1.8 trillion) and allocation funds (€1.2 trillion). We merge this data with the environmental preferences of countries compiled by the Eurobarometer survey, and we also complement the holdings data with fund characteristics from Morningstar.

At the launch of the SFDR, Article 8 funds accounted for the bulk of ESG funds, with €4.2 trillion of assets versus €0.3 trillion for Article 9 funds. After the introduction of the SFDR, the green funds (article 8 and 9) experienced higher transaction flows of €459 billion relative to €88 billion for brown (article 6) funds, representing flows of 10.2% of 2020 Q4 AUM for green funds and 1.9% for brown funds. We also document a positive correlation between the share of the funds that are green and the environmental preferences of the different countries in our sample. The flows to green funds were stronger in countries with lower environmental preferences, suggesting a 'catch-up' of these countries in terms of the share of green funds in the market.

We construct a model of fund choice under uncertainty to highlight the potential tranmsission channels. Investors have a preference for greenness (as in Pástor et al. 2021) and choose how to allocate their assets across mutual funds. The funds are characterized by an expected return and greenness, but the greenness of each fund is uncertain (as in Avramov et al. 2022). Fund managers then choose the greenness of their portfolio relative to a target (determined for instance by the fund manager's skills), where deviations from the target greenness are costly. A higher fund greenness thus allows the manager to attract flows from investors, at the cost of deviating from the target greenness level. In our model, we interpret ESG disclosure regulation as a reduction in the greenness uncertainty of the funds. We show that disclosure rules affect investor demand through an 'uncertainty channel', where investors value the lower uncertainty risk regarding the greenness of funds, and a 'greenness channel', whereby funds endogenously increase their greenness in order to attract investor flows under disclosure regulation.

We test these predictions by comparing flows across mutual funds and investors in the aftermath of the regulation (2021 Q1 to 2022 Q3). While existing work on ESG disclosure and investment funds relied on aggregate fund data (Hartzmark and Sussman 2019; Gantchev et al. 2024), our analysis allows to compare the reaction of investors with different environmental preferences (using e.g. values surveys) or risk preferences (focusing for instance on institutional and

versus retail investors). Our first specifications explore how flows vary across funds depending on the information shock brought by the regulation. To proxy for investors' information on the ESG performance of funds, we compare the regulatory status of the fund with the sustainability rating of Morningstar. Around 60% of the funds in our data already had an ESG rating before the reform. Funds that do not have an ESG rating and choose to be regulated as green funds arguably experience a larger reduction in uncertainty after the reform. In line with the model's prediction, we find that positive flows to funds without an ESG rating are entirely driven by the funds that opt for the green disclosure status. Similarly, positive flows to funds with a high ESG rating are also entirely driven by those funds that choose the green status.

We then expand the analysis to consider investor heterogeneity, focusing on differences between retail investors (the household sector) and institutional investors (the other sectors, excluding the foreign sector). In the debate on ESG disclosure rules, Cunningham (2022) have argued that the distinction between institutional and retail investors is key as only the institutional investors would respond and demand ESG disclosure, and Trebbi and Zhang (2022) similarly emphasized that the costs of regulation can be unevenly distributed across market participants. In our case, institutional investors are more averse to ESG risk (due to e.g. reputational concerns as in Jagannathan et al. 2023) and regulatory considerations. A large literature has also documented that institutional investors tend to drive ESG performance (Dyck et al. 2019; Chen et al. 2020; Ferreira and Matos 2008). Our regressions confirm this hypothesis: institutional investors respond more strongly to the green status offered by the regulation than retail investors. This holds in particular for the funds without ESG rating that attract significant flows from institutional investors. Interestingly, within funds with green status, we find that institutional investors rebalance out of 5 globe funds (with high ESG rating) and into 1 globe funds (with low ESG rating), consistent with regulatory arbitrage or with a 'greenness channel' where these funds rebalance more actively towards green assets (a point we document in later regressions). We also find that investors in countries with strong environmental preferences react to the regulation by moving capital from high globe funds with green status to low globe funds with green status. This is consistent with the idea that the green classification served as a positive information shock for funds that were previously thought to be brown.

Finally, we find that managers of green funds that had a relatively low ESG rating improved

the environmental performance of their portfolios, particularly when their fund's investors have strong environmental preferences. This finding applies to all funds that are in scope of SFDR, but the magnitude of the effect is larger for funds that choose the green status.

Overall, our results show how investor preferences shape the impact of sustainability disclosure rules in financial markets. While prior work has focused on aggregate reaction of investors in a single market, the use of granular cross-country data on holdings of investment fund shares allows to confirm the importance of investor preferences emphasized by the models of ESG investing (Pástor et al. 2020; Berk and van Binsbergen 2021; Avramov et al. 2022). The different responses of financial sectors to the regulation is also a novel insight which we aim to further explore in future work.

Related Literature

While there is limited evidence on the regulation of ESG disclosure[1], a number of authors have studied ESG ratings and voluntary initiatives. Hartzmark and Sussman (2019) and Rzeźnik et al. (2021) show that investors respond to ESG ratings by Morningstar, and Gantchev et al. (2024) emphasize how mutual funds adjust their portfolio in response to the ratings. Ceccarelli et al. (2022) and Kim and Yoon (2022) similarly show that investors respond to the adoption of the Principles for Responsible Investing (PRI) by mutual funds - although Kim and Yoon (2022) suggests that signatories do not improve their ESG scores while exhibiting lower returns. Focusing on banks, Sastry et al. (2024) and Giannetti et al. (2023) find that sustainability commitments do not translate in actions by lenders, although Green and Vallee (2024) do find an impact of bank exit policies for the coal industry. Our contribution is to focus on ESG disclosure regulation (instead of commitments), providing evidence on the role of fund investors as well as the response of fund managers.

Our model of the impact of ESG disclosure regulation combines investors with a preference for green assets (Pástor et al. 2020; Pedersen et al. 2020) with uncertainty on the actual greenness of the assets (Avramov et al. 2022; Berg et al. 2022a). In the spirit of Berk and Van Binsbergen (2015), we endogenize the greenness of the funds to highlight the transmission channels of ESG

[1] Becker et al. (2022) and Ferriani (2022) study fund flows and ESG profiles of funds in the first months of the implementation of the SFDR using fund-level aggregated data, and Krueger et al. (2024) compare ESG disclosure regulations across countries.

disclosure regulation. Gupta and Starmans (2024) also model disclosure regulation, focusing instead on the dynamics of the regulatory process and showing that a gradual implementation is optimal.

Beyond ESG labels and signalling of commitments, a broader literature has studied whether investors respond to ESG factors. Bolton and Kacperczyk (2021) show that investors require higher returns from companies with higher emissions and document exclusionary policies of institutional investors. Pastor et al. (2022), van der Beck (2023) and Koijen et al. (2023) find that flows driven by ESG investors affect the returns of green assets. Jagannathan et al. (2023) shows that institutional investors such as mutual funds are particularly sensitive to the risk of ESG scandals and many authors have documented that firms that are owned by institutional investors tend to exhibit better ESG performance (Ferreira and Matos 2008; Dyck et al. 2019; Chen et al. 2020). Our contribution is to provide new evidence on the sensitivity of institutional investors to ESG regulation and country preferences, documenting in particular a stronger response of institutional investors to ESG disclosure regulation relative to retail investors. Our data covers the full mutual funds market in 24 different countries, improving on e.g. surveys of preferences of a subset of investors (Riedl and Smeets 2017; Giglio et al. 2023b).

Last but not least, our work relates to a literature studying how culture and values shape markets (see e.g. Guiso et al. 2004 and Aghion et al. 2010). Gennaioli et al. (2022) show that trust is a key determinant of the costs of insurance premiums across countries. Aghion et al. (2023) show that incentives to innovate are higher in markets with strong environmental preferences. The share of ESG investors in financial markets plays a key role in determing the allocation and prices in Berk and van Binsbergen (2021) and Pástor et al. (2020), and our work further underscores how differences in environmental preferences across markets determine the impact of ESG disclosure regulations.

I. The Sustainable Finance Disclosure Regulation

Following the work of the Task Force on Climate Related Disclosures initiated by the Financial Stability Board, many regulators have introduced ESG disclosure requirements for non-financial corporations, such as the Standardized Climate-Related Disclosures in the United States, or the

Corporate Sustainability Reporting Directive in Europe. The SFDR differs from these initiatives in that it is the first ESG disclosure regulation targetting financial intermediaries, and more specifically mutual funds. The SFDR was enacted on November 27, 2019 and came into effect on March 10, 2021.[2] As a regulation, the SFDR is directly applicable to all EU countries (in contrast to e.g. EU directives which must be transposed in national law and are often modified to include local considerations).

The SFDR was a substantial development for the European mutual funds market. In its Article 6, the regulation requires all funds to explain how sustainability risks are integrated into their investment decisions and how these risks might affect their returns. Article 8 then imposes additional reporting requirements on funds that "promote environmental or social characteristics". These funds must also explain how they meet these characteristics. Finally, Article 9 of the SFDR imposes specific reporting requirements on funds that "have sustainable investment as objective". These funds must indicate how their investments contribute to achieving the stated sustainability objective and how this differs from a traditional market objective. Under SFDR, all fund managers therefore have to choose whether their fund falls under Article 6, Article 8 or Article 9. A common interpretation of these categories is that Article 6 funds are 'brown', Article 8 funds are 'light green' while Article 9 funds are 'dark green'.

When the SFDR was introduced, the definition of what constitutes a sustainable investment was left relatively open, and the burden of proof regarding sustainability was mostly left to the fund manager. The legislator then tasked the European supervisory authorities to design regulatory technical standards to further determine measures and definitions of sustainability.

The introduction of the regulation was done in two phases, or 'levels'. Level 1 covered the reporting year 2022. Over that period, the rule was to 'comply or explain': funds had to publish ESG statistics or to explain why they were not publishing them. Level 2 came into effect in January 2023. From this date, funds faced more detailed guidance on how to report their exposure to sustainability risks, including with 18 mandatory principle adverse impact (PAI) statements to assess the sustainable impact of their investments.[3] Funds also have to prove their alignment to one of six environmental objectives in the Taxonomy regulation.

[2]The legal text is available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32019R2088.

[3]Environmental PAIs include greenhouse gas emissions (scope 1, 2 and 3), the carbon intensity of trustee companies or the share of investment in companies active in the fossil fuel sector. Social PAI include board diversity, exposure to controversial weapons or violations of UN Global Compact principles by firms in the portfolio.

II. Data

To study the impact of the SFDR on financial markets, we combine data on the holdings of investment fund shares from SHS, fund characteristics from Morningstar, fund holdings from Factset, firm-level emissions from Trucost and environmental preferences from the Eurobarometer. Our data covers most of the mutual funds market in Europe, and we provide additional details on the merge of the datasets in appendix A.

II.A. Investor Holdings

The Securities Holding Statistics-Sector data (SHS-S) reports the holdings of securities by the different financial sectors for 24 countries in the European Union. The reporting countries include all E.U. members except Sweden, Hungary and Poland. The financial sectors are banks (Monetary and Financial Institutions), Insurance Companies and Pension Funds (ICPF), Mutual Funds, the household sector and other sectors (including for instance the government sector). For each sector and country (the investor), the SHS report the market value in euros of the all securities held by the investor as well as the 'transaction flows', or active purchases or sales of the security by the investor. As in Koijen et al. (2021), we use the information on the total value of each security outstanding to compute the holdings of the foreign sector, defined as the residual between the total value of a share issued and the holdings that we observe in SHS.

The holdings and flows are reported at the security (ISIN code) level, and we focus on UCITS investment fund shares. UCITS, or Undertakings for Collective Investment in Transferable Securities, are regulated investment fund shares that are also available to retail investors. UCITS account for around 60% of investment fund shares in Europe. UCITS funds are more regulated than other funds such as alternative investment funds, and they are also subject to stronger disclosure rules so that better data is generally available for these funds.

The SHS also include security characteristics downloaded from the Centralised Securities Database of the Eurosystem which combines data from various providers (see e.g. Koijen et al. 2021 and Beck et al. 2023 for further description of the SHS dataset). We use in particular the issuer country, the price as well as the total amount of shares issued for each security, which we use to compute foreign holdings.

II.B. Fund ESG Ratings

We complement the SHS data with fund characteristics data from Morningstar. The data includes the Morningstar Sustainability Rating, which is computed using data on the sustainability of the holdings of the funds. For each holding, Morningstar collects a number of indicators of ESG performance and computes a weighted average of the different indicators, which are then aggregated at the level of the fund. The funds are then ranked and split into five sustainability categories, also know as globes. Funds in the top decile for instance receive a "High" (5 globes) rating, and funds in the bottom decile receive a "low" (1 globe) rating (Hartzmark and Sussman 2019). Morningstar has computed the sustainability ratings since 2016 and our data covers the period 2018 Q4 to 2021 Q4. In case of missing data, we use the last rating available.

We also use information on the classification of the fund under the SFDR, documenting whether the fund is an Article 8 or 9 ESG fund, or whether the type is Article 6 or missing. We downloaded the current SFDR type for all European funds as of December 2022. We thus do not observe the date at which the fund declared its SFDR status and extrapolate the status to the earlier periods.

II.C. Fund Portfolio and Emissions

To analyze the response of mutual funds to the regulation, we combine Factset holdings data with Trucost carbon emissions data. For each fund, Factset provides the list of securities in the portfolio. We then merge the securities to data on corporate carbon emissions from Trucost. We restrict the sample to fund-year pairs in which at least 67% of the fund's holdings (as measured by market value) have available emissions data in Trucost. The restricted sample contains 6,113 funds. We focus on Scope 1 CO2 emissions, which are those generated directly by the firm's operations.

II.D. Environmental Preferences

We use the Eurobarometer to measure the environmental preferences of investors. The Eurobarometer is a Survey conducted regularly by the European Commission in all countries of the European Union, covering a broad range of topics. We focus on the 2020 survey, before

the introduction of the SFDR rules, and use the answers to the question "How important is protecting the environment to you personally?" Respondents choose between 5 answers ranging from 'Very important', 'important', neutral, 'not important' and 'not at all important'.

For each country, we use the net share of households who consider that protecting the environment is important, computed as

$$\text{Net Agreement} = \frac{\#(\text{'Very' or 'fairly' important})\text{-}\#(\text{'Not very' or 'Not at all' important})}{\text{Total respondents}}$$

This measure is similar to the one used by Gennaioli et al. (2022) and Aghion et al. (2023) to proxy for country level preferences. Our proxy of environmental preferences is in line with other surveys such as the European Values Survey (EVS), which also includes a question on the environment. Figure 1 illustrates this, focusing on answers to the question 'Would you agree or disagree with the following statement: "Many of the claims about environmental threats are exaggerated." As for the Eurobarometer, we compute the share of respondents who disagree with that statement. The correlation between the two measures is high, and we choose the Eurobarometer data because it includes all the countries in our sample.

[Insert Figure 1 about here]

In order to better understand our measure of environmental preferences, we explore which other country-level characteristics are correlated with it. We focus on characteristics falling into four categories: (1) responses to other environment-related survey questions, (2) responses to trust-related survey questions, (3) macroeconomic and financial and (4) climate risk exposure. Table 1 shows a selection of these variables and their correlation with our primary measure of environmental preferences.

[Insert Table 1 about here]

III. Stylized Facts on SFDR

III.A. Overview of the European mutual funds market

The focus of our analysis is on European regulated mutual funds, known as UCITS (for "undertaking for collective investment in transferable securities"). As of 2020 Q4, before the

introduction of the SFDR, the total size of the market is around €9 trillion. As shown in Table 2, equity funds are the largest category, with €2.7 trillion of holdings, followed by fixed income (bond) funds and allocation funds with €1.9 trillion and €1.3 trillion respectively. Domestic (European) investors represent 62% of the market, while the rest are foreign investors located outside the 24 countries in our sample. Among domestic investors, the household (retail) sector accounts for €1.9 trillion of holdings, representing roughly a third of domestic investors. Within institutional investors, mutual funds and Insurance Companies and Pension Funds (ICPF) account for the bulk of the investment while banks and other investors such as governments are less important.

[Insert Table 2 about here]

Before the SFDR, the release and creation of information on the ESG performance of funds was left to market intermediaries. Morningstar was one of the leading fund rating agencies to provide information on the ESG performance of funds. The company has a long history of collecting and distributing data on the financial performance of funds, and in 2016 also introduced an ESG rating for funds. As shown in Figure 2, Morningstar covered around 44% of funds at the introduction of SFDR. The coverage however varied widely across investor countries in 2020 Q4. For some countries, only 10% of the holdings had a sustainability rating, while other countries had a coverage of close to 60%.

[Insert Figure 2 about here]

III.B. The mutual funds market after the SFDR

Given the relatively low coverage of Morningstar's sustainability ratings, the SFDR represented a substantial information shock to market participants as all funds now had to choose an ESG category.[4] Figure 3 shows the distribution of funds into Article 6 (brown) and Article 8 and 9 (green) categories in 2020 Q4. The figure distinguishes funds without an ESG rating, funds with a low rating (one, two or three globes) and funds with a high rating (four or five globes). A number of facts stand out from the figure. First, there was a large pick-up of the greener

[4]It is possible that other ratings agencies publish ratings for funds that Morningstar does not cover, Morningstar is (to our knowledge) the largest provider of ESG ratings for mutual funds. For example, as of 2021, MSCI covered approximately 53,000 funds, whereas Morningstar covered over 158,000.

categories (Articles 8 or 9) by mutual funds. In total, 46% of funds by AUM chose to classify as Article 8 or 9.[5] Second, the SFDR categories chosen by the funds are correlated with the pre-existing ESG rating of the funds. In general, funds without ESG rating were more likely to choose the Article 6 category (brown). Funds with low ESG rating were roughly equally likely to choose the Article 6 or Article 8 or 9 category; and funds with a high ESG rating were the most likely to choose an Article 8 or 9 category. Third, despite the overall positive correlation in the signals of SFDR and pre-existing ratings, there were still substantial differences between SFDR and the ESG ratings. For instance, among funds with a high Morningstar ESG rating, a third of the funds (€500 billion) took the Article 6 status.

[Insert Figure 3 about here]

Figure 4 then considers the flows to mutual funds, broken down into the same groups - by SFDR category and ESG rating. The flows consist of transaction flows, i.e. active rebalancing by investors net of returns. The flows are computed over all quarters following SFDR, from Q1 2021 to Q3 2022, and are normalized by the holdings before SFDR, in Q4 2020. The figure shows that Article 8 and 9 funds experienced higher flows relative to Article 6 funds, with flows representing around 10% of initial assets while the flows to Article 6 funds only represented around 1% of assets. Within the SFDR categories, funds that had no ESG rating available and chose to become Article 8 or 9 experienced a much stronger growth than Article 6 funds without rating. Similarly, funds that had a high ESG rating and chose Article 8 or 9 experienced strong flows (representing close to 15% of assets), while the funds that chose Article 6 experienced negative flows.

[Insert Figure 4 about here]

Appendix Table A4 provides further evidence on the growth of funds after the SFDR, distinguishing transaction flows, returns and other flows. In the period considered, the returns were negative for both Article 6 and Articles 8-9 funds which lost around €300 billion in value each. The transaction flows were however positive, and Article 8 and 9 funds experienced larger

[5] Appendix Table A3 shows that the share of the portfolio invested in SFDR (Article 8 or 9) funds was broadly similar across the different financial sectors, except for banks where it was lower at 32 %. Article 8 funds were much more common than Article 9, with Article 8 funds accounting for €4.2 trillion of assets while Article 9 funds amounted to €0.3 trillion.

inflows over the period (€280 billion versus €131 billion for non-SFDR funds). The household sector, ICPF and mutual funds were particularly active in rebalancing their portfolio to SFDR funds.

III.C. Investor preferences and fund SFDR choice

We next explore to how the development of Article 8 and 9 funds varies across countries, and how it correlates with the environmental preferences of countries. Figure 5 shows for each investor country the share of the funds (weighted by assets) that are Article 8 or 9, plotted against the environmental preference of each country (i.e. the net share of respondents who answer that protecting the environment is important or very important). The shares are computed in 2020 Q4, before the launch of the SFDR. The figure suggests a positive correlation between environmental preferences and the share of Article 8 and 9 funds in a market.

[Insert Figure 5 about here]

Figure 6 then explores the correlation between the flows into Article 8 and 9 funds and environmental preferences. The flows are the total for the post-SFDR period (2021 Q1 to 2022 Q3), normalized by the total size of the mutual fund portfolio of each country. The figure suggests a mild negative relationship between flows and environmental preferences. The figure suggests that countries with weak preferences were more likely to have experienced stronger growth in Article 8 and 9, probably also as these investor countries had a less developed market for ESG funds.

[Insert Figure 6 about here]

To examine whether there is empirical evidence that investor preferences play a role in SFDR choice, we compute a holdings-weighted environmental preference measure for each fund. Using holdings as of Q4 2020 (pre-SFDR), we compute:

$$\bar{d}_f = \sum_{i \in I_f} \frac{(q_{if} \times p_f)_{2020\ \text{Q4}}}{\text{AUM}_{f,2020\ \text{Q4}}} \times d_{c(i)},$$

where the first term is the share of fund f owned by investor i in Q4 2020 and the second term is the environmental preferences of the country of investor i. We run a multinomial logit

regression of SFDR classification on $\bar{d}_f$, with Article 6 as the baseline category. Column (1) of Table 3, shows that, relative to Article 6, a fund whose investors are ten percentage points greener are two percent more likely to choose Article 8. Similarly, the second column shows that, relative to Article 6, a fund whose investors are ten percentage points greener are eight percent more likely to choose Article 9. Importantly, the results control for Morningstar Globes rating, which is our measure of observable greenness, as well as fund category and issuer country fixed effects.

[Insert Table 3 about here]

III.D. Convergence of SFDR and ESG ratings

Given the large shift to Article 8 and 9, a reasonable question is whether the SFDR category truly reflected a better ESG profile or whether the move was driven by a marketing desire to project a 'green image' given the relatively loose initial regulatory constraints. Table 4 shows that Article 9 funds had better Morningstar sustainability ratings than Article 8 funds, which in turn had better ratings than other funds. However the consensus between the Morningstar ratings and the SFDR category is relatively weak: close to 10% of Article 9 funds are still rated 'Low' or 'Below average' by Morningstar, and this figure rises to 20% for Article 8 funds.

[Insert Table 4 about here]

Table 4 shows that funds whose Morningstar Globe rating and SFDR status appear to be misaligned account for a substantial portion of assets under management. In particular, funds with 4 or 5 Globes that choose Article 6 account for €468 billion of assets, funds with 1 or 2 Globes that choose Article 8 account for €418 billion and funds with 1 or 2 Globes that choose Article 9, account for €17 billion - around 7% of all Article 9 holdings.

From the regulator's perspective, it is important to understand whether funds that choose an incorrect label ultimately change their portfolios to conform with their chosen label. If the regulator's objective is to increase the amount of capital invested in green firms, then his ideal outcome is that: (1) green funds who choose the brown label (brownwashers) maintain their high levels of portfolio greenness and (2) brown funds who choose the green label (greenwashers) conform to their chosen classification by increasing their greenness. The worst-case scenario for

a regulator with such an objective would be that the brownwashers become less green and the greenwashers remain brown.

Table 4 provides some first evidence on the changes in fund greenness by comparing Q1 2021, when the SFDR was launched, with Q4 2021 which is the last quarter for which we observe the Morningstar ratings. Panel B of the Table suggests that there was some alignment between Morningstar and the SFDR categories, with 47% of one globe funds being Article 6 initially, versus 67% at the end of the year. The alignment between the two measures thus improved for the lowest rated funds.

The third panel of Table 4 then provides additional evidence using the funds' carbon intensity to measure greenness, instead of the Morningstar ratings. The Table confirms that Article 8 funds typically have a lower carbon intensity than Article 6 funds, while the carbon intensity of Article 8 and 9 funds seems similar. There does not seem to be an improvement in the carbon intensity of Article 8 and 9 funds after the regulation. The change in the carbon footprint of funds differs somewhat depending on the indicator used. In Figure 7, we instead consider the change in carbon emissions by funds after SFDR. All fund categories reduced their emissions, and funds with a low rating that chose to be categorized as Article 8 or 9 had the largest fall in emissions.

IV. A model of ESG disclosure regulation

The stylized facts from the previous section suggested a number of dimensions to analyze the impact of disclosure, such as preferences, uncertainty and fund portfolio decisions. We now introduce a model that combines these elements to illustrate the mechanism through which the SFDR is likely to affect portfolio choice of funds and investors. Our model has two components. On the demand side, investors have a preference for green assets (as in Pástor et al. 2021), but they are also uncertain about the actual greenness of the funds (as in Avramov et al. 2022). The disclosure regulation then reduces the uncertainty by providing additional information on funds' true greenness. On the supply side, funds can choose the expected greenness of their portfolio. Fund managers aim to maximize the size of their fund, and thus respond to the preferences of investors who care about fund greenness. The implementation of the regulation

affects both investors' capital allocation across funds and funds' allocation to green assets. The magnitudes of these effects depend on investor preferences.

IV.A. Investor demand

There is a single period and F risky investment funds, indexed by $f = 1, ..., F$.[6] The $F \times 1$ vector of returns is $r \sim (\mu_r, \Sigma_r)$. Investors do not have perfect information about asset greenness. Instead, they only know the distribution of the greenness of funds, $g^{prior} \sim \mathcal{N}(g, \Sigma_g)$, where g is the $F \times 1$ vector of the greenness of the funds and Σ_g is the covariance matrix of greenness across funds. A high value of g_f indicates that fund f has positive social impact, whereas a low value indicates the opposite. Many studies have shown, both theoretically and empirically, that greenness and returns are related. However, in order to emphasize the direct impact of greenness itself on asset allocation, we assume that returns are exogenous and unaffected by greenness, $\Sigma_{rg} = 0$. We also assume that the matrices Σ_r and Σ_g are diagonal.

There are I investors, indexed by $i = 1, ..., I$ who trade the F risky assets and a riskless asset, which is in zero net supply. Investor i has initial wealth W_{0i} and chooses an $F \times 1$ vector of portfolio weights in the risky assets X_i. Investors have utility:

$$V(W_{1i}, X_i) = -e^{-A_i W_{1i} - d_i g' X_i}, \tag{1}$$

where A_i is investor i's absolute risk aversion, d_i is his environmental preference and $W_{1i} = W_{0i}(1 + \tilde{r} + X_i' r)$ is his wealth at time 1, which depends on the risk free rate $\tilde{r}$. Thus, investor i solves:

$$\max_{X_i} \quad \mathbb{E}\left[-e^{-a_i(1+\tilde{r}+X_i' r) - d_i g' X_i}\right], \tag{2}$$

where $a_i \equiv A_i W_{0i}$ is the investor's relative risk aversion.

IV.B. Fund greenness choice

Consider now the supply side and the investment decisions of funds. A large literature has discussed how investor demand shapes the size of mutual funds or their financial returns (Berk

[6]The model can be easily extended to the case where some assets are funds that are affected by the SFDR and others are stocks that are not.

and Green 2004; Berk and Van Binsbergen 2015; Barras et al. 2022). Here, we focus on the choice of greenness g_f by mutual funds. In our model, g_f could be interpreted as the share invested in a green asset, with $g_f \in [0,1]$. To focus on the choice of greenness, we assume here that the returns on the green and the brown assets are identical and perfectly correlated so that the choice of g_f does not affect the return properties of the fund. We present a version of the model that relaxes this assumption in appendix C.

Each fund f earns a profit by setting a fee η on its assets under management. Each fund also has an exogenous target greenness $\overline{g}_f$. Intuitively, this could represent the manager's own non-pecuniary preference for greenness or his knowledge about green assets. The fund manager then chooses a greenness level g_f to maximize the fund's AUM minus a penalty for deviating from $\overline{g}_f$:

$$\max_{g_f} \quad \pi_f\left(g_f\right) = \eta W_f\left(g_f\right) - \left(g_f - \overline{g}_f\right)^2, \tag{3}$$

where $W_f\left(g_f\right)$ is the total wealth invested in fund f, i.e. the f^{th} element of $W_F = \sum_i X_i\left(g\right) W_{0i}$. The portfolio weights X_i are determined by the investors' demand. Each fund manager takes the equilibrium greenness choices of the other funds as given.

IV.C. Equilibrium and transmission channels

In equilibrium, investors maximize utility and funds maximize their profits. The outcome is summarized in the following proposition.

Proposition 1 (Equilibrium)**.** *The portfolio weights of investor i are given by*

$$X_i^* = \frac{1}{a_i}\left(\Sigma_r + \frac{d_i^2}{a_i^2}\Sigma_g\right)^{-1}\left(\mu_r + \frac{d_i}{a_i}g^*\right), \tag{4}$$

and the greenness of fund f is determined by

$$g_f^* = \overline{g}_f + \frac{\eta}{2}\sum_{j=1}^{I} W_{0j}\frac{d_j}{a_j^2}\left[\left(\Sigma_r + \frac{d_j^2}{a_j^2}\Sigma_g\right)^{-1}\right]_{ff}. \tag{5}$$

Proof. See appendix B.A. □

Equation (4) expresses the demand of investors as a function of the risk and return properties

of the fund. This includes in particular the uncertainty surrounding the funds' greenness, Σ_g, and their greenness levels g^*. Equation (5) then summarizes the supply response of funds and their choice of greenness g^* given investor demand.

In the absence of uncertainty ($\Sigma_g = 0$), the portfolio weights of investors are exactly as in Pástor et al. (2021). Given that investors are risk averse, the uncertainty about the true greenness of funds Σ_g leads to an overall reduction in the capital allocated to funds, and funds for which less information on greenness is available (so their variance σ_{gf} is high) are affected most.

When the average investor has a taste for greenness ($\sum_i W_{0i} d_i > 0$), funds will choose a greenness g_f above their target level $\overline{g}_f$. This 'tilting to green' is however weaker when uncertainty is high (i.e. Σ_g is large). In this case, the demand of investors is relatively insensitive to the ESG performance of funds. As the available information increases with disclosure, the variance Σ_g falls and funds respond by increasing their greenness levels. The shift of funds to higher greenness is larger when investors have stronger environmental preferences.

A fall in the uncertainty following the introduction of disclosure rules leads to a rebalancing of portfolios through two channels: a direct, 'uncertainty channel', and an adjustment of funds' greenness - the 'greenness channel'. To see this, let σ_{rf} and σ_{gf} indicate the f^{th} element of the diagonal of (respectively) Σ_r and Σ_g. A fall in the uncertainty σ_{gf} leads to the following portfolio flow by investor i:

$$\frac{\partial x_{if}^*}{\partial \sigma_{gf}} = \underbrace{\frac{1}{a_i} \frac{\partial \left(\sigma_{rf} + \frac{d_i^2}{a_i^2}\sigma_{gf}\right)^{-1}}{\partial \sigma_{gf}} \left(\mu_r + \frac{d_i}{a_i} g^*\right)}_{\text{Uncertainty channel}} + \underbrace{\frac{1}{a_i} \left(\sigma_{rf} + \frac{d_i^2}{a_i^2}\sigma_{gf}\right)^{-1} \frac{d_i}{a_i} \frac{\partial (g^*)}{\partial \sigma_{gf}}}_{\text{Greenness channel}}.$$

The first term is the uncertainty channel: the investor values the fall in uncertainty σ_{gf} and increases its allocation to the fund. While greener funds tend to benefit more from the uncertainty channel, note that brown funds also attract positive flows when their uncertainty falls. The second channel operates through the endogenous response of funds to the increased disclosure. As σ_{gf} falls, this sharpens the sensitivity of investor flows to the greenness of the fund. The fund then responds by increasing its greenness further beyond its target $\overline{g}_f$. In turn, investors then respond to the higher greenness by increasing their allocation to the fund. The next proposition summarizes the two transmission channels of disclosure.

Proposition 2 (Transmission Channels). *A fall in the greenness uncertainty σ_{gf} of a fund f leads to positive flows into the fund through two channels: an uncertainty channel where investors value lower risk and a greenness channel where higher greenness choice by the fund attracts flows.*

The uncertainty channel reflects the fact that, even if fund greenness stayed constant, the regulation would still lead to changes in investor portfolio weights. In other words, funds benefit from the regulation because risk averse investors are willing to increase the size of their positions as a result of the reduction in uncertainty caused by the regulation. The greenness channel then describes the change in investor portfolio weights resulting from funds endogenously adjusting their greenness. The reduction in uncertainty will lead fund greenness to become more sensitive to investor preferences, but the greenness channel highlights that this change in greenness will itself lead investors to adjust their portfolio weights. All else equal, a fund that increases its portfolio greenness will receive inflows.

IV.D. Discussion

Our stylized model simplifies the interaction of fund returns and their level of greenness. As in Pástor et al. (2021), the demand for greenness creates a wedge in the return of green and brown funds. All else equal, investors are willing to accept a lower return for funds that are greener. Bolton and Kacperczyk (2021) and Engle et al. (2020) have shown that green assets also tend to have lower returns, so that the funds' returns could also be affected by their portfolio composition (instead of solely by investor demand). In that case, increasing the greenness of the fund g_f will lead to lower expected returns μ_{rf}. We derive such a model in appendix C and show that the main results remain. The reasons for this is that the interaction of returns and fund greenness choice does not fundamentally alter the trade-off that fund managers face: when investors have a preference for greenness, a higher expected greenness leads to higher flows, but it is costly.

The mutual funds market in our model is perfectly competitive, and fund managers respond to the aggregate demand of investors. The disclosure rule then creates a new dimension of competition. In the extreme, if uncertainty is infinite, funds do not take their greenness into account. Disclosure regulation then increases the salience of fund greenness and creates an incentive for them to compete and increase their greenness. An extension of the model could

consider whether the disclosure rules lead to market segmentation, where some funds decide to specialize on returns while others offer a high greenness to their investors. As in Aghion et al. (2023), this could increase the market power of funds that would be able to discriminate across investors.

Our model focuses on the choice of the greenness g_f by the fund. In practice, the fund could influence both its greenness and the associated uncertainty, Σ_g. The uncertainty in particular could be determined by a signalling game where the disclosure rule would be equivalent to a signal sent by the funds. In such an asymmetric information framework, the equilibrium signals may be separating (so that investors are able to 'see through' the signalling strategies of funds) or pooling. The latter case arises when funds face discrete costs of choosing a specific category. In our framework, the greenness g_f could be loosely interpreted as the 'separating signal' of the fund while the uncertainty Σ_g reduces the precision of the signal, as in a pooling equilibrium.

Ultimately, the objective of our theory is to guide the empirical analysis. In the model, we argue that the SFDR can be interpreted as a shock to the expected greenness of funds g and their variance Σ_g. One way to interpret the SFDR shock is to consider the ESG rating provided by rating agencies before the regulation with the choice of SFDR status by the funds (Article 6, 8 or 9). The impact on expected greenness g is potentially ambiguous. If a fund has a low ESG performance before the SFDR according to rating agencies, the choice of Article 8 or 9 status could represent a positive shock to the expected greenness of the fund. On the contrary, if a fund has a high ESG rating and chooses Article 6 status, this will likely lead to a downgrade of investors' expectations of greenness of this fund.

The pre-existing ESG rating and the SFDR status will also interact to change the uncertainty regarding the greenness of the funds, Σ_g. If a fund has a high ESG rating (e.g. 5 Morningstar globes) and chooses Article 8 or 9 status, this will confirm that the greenness is high and help reduce uncertainty. Similarly, a fund with low ESG rating (say, one globe) that chooses Article 6 status will confirm its low greenness, which also lowers the uncertainty. An intermediate case however occurs if a high ESG rated fund chooses Article 6 (brown) status (or conversely, a low rated fund chooses Article 8 or 9). In that case the investors would receive conflicting signals on the greenness of the fund. This would probably lower the potency of the 'uncertainty channel'

for those funds.

A second empirical challenge is to measure the environmental preferences of investors. One indicator, which we introduced earlier, is the survey responses to the question: 'how important is protecting the environment to you personally?' from the Eurobarometer. Beyond the cross-country dimension of our data, investors also differ across sectors. An important distinction in this respect is that of institutional versus retail investors, where the latter would correspond to the household sector while other sectors such as bank or insurance companies and pension funds would be institutional investors. In general, institutional investors could be expected to be more risk averse than retail investors, in particular when it comes to ESG risk where scandals could tarnish their reputation (which would be less relevant for retail investors).

Thirdly, when considering the response of funds, an empirical challenge is to determine an appropriate measure of their greenness. To do so, we will combine data on the holdings of the funds with data on the carbon emissions of security issuers in order to compute different indicators of greenness and track their evolution over time, as we will explain in section V below.

V. Investor rebalancing and transmission channels

V.A. Aggregate fund flows

We first explore to what extent Article 8 and 9 funds experienced higher flows than other funds after the introduction of the SFDR. The analysis is conducted at the fund level, aggregating flows across all investors for a given fund. While this ignores the heterogeneity across investors, it allows us to replicate the empirical specification of Hartzmark and Sussman (2019). For each fund f and quarter t, we compute the aggregate transaction flows into the fund as a share of Total Net Assets. As Hartzmark and Sussman (2019), we then regress the flows against the SFDR category after the introduction of the new disclosure rules. We control for the Morningstar globe rating, past flows and returns of the fund and also include fund category - quarter interaction effects.

Table 5 shows the fund-level summary statistics. The average quarterly flows represent 0.86% of the total net assets. This is broadly similar in magnitude to Hartzmark and Sussman

(2019) who had average monthly flows of -0.41%. The average size of funds in our sample is €336 million, somewhat smaller than the $ 2,184 million of Hartzmark and Sussman (2019). This can be explained by the relatively larger number of funds included in the analysis: we include around 13,500 while Hartzmark and Sussman (2019) focus on around 3,000 funds. The average fund in our data has a Morningstar rating of 3.27 globes. One of the main findings of Hartzmark and Sussman (2019) is that highly rated, five globe funds experienced higher inflows than other funds in 2016. While our sample is quite different from theirs, we also find in panel B that five globe funds experienced larger flows than the other funds (1.24% relative to an average of 0.47% for all funds).

[Insert Table 5 about here]

Table 6 shows the results of the regression of aggregate fund flows on SFDR status and Morningstar Globe rating. In specifications (1) and (2), we omit the SFDR category of the fund and focus on the role of the sustainability ratings. Specification (1) suggests that funds with higher Morningstar globe rating experience higher flows over our sample period. In specification (2), we use separate dummy variables for each globe category. Consistent with the summary statistics, the regressions confirm that five globe funds experienced higher flows than other funds. In specifications (3) and (4), we then explore the role of the SFDR categories, controlling for the sustainability rating. We find that Article 8 and 9 funds experienced higher flows than other funds, even when controlling for their sustainability rating. The results suggest that Article 8 and 9 funds experienced 1.2 percentage point higher flows than their peers, which is relatively sizeable given the average flow of 0.47% in Table 5.

[Insert Table 6 about here]

V.B. Fund flows and ESG ratings

We next expand the data to study the full sample of funds and the holdings and flows at the investor country and sector level. Our model predicts that the investor response will depend on the reduction of uncertainty associated with the disclosure. A first step is thus to explore how investor flows differed across funds depending on their prior Morningstar sustainability rating and their choice of SFDR classification.

We thus consider the following regression:

$$F_{ift} = \beta_1 SFDR_f \times MSR_{ft} + \beta_2 MSR_{ft} + \alpha_i + \alpha_f + \alpha_t + \epsilon_{ift},$$

where F_{ift} is the transaction flow (i.e. active rebalancing, net of returns) by investor (country and sector) i in fund f in quarter t. The dependent variables include the Morningstar sustainability rating (MSR_{ft}) and the SFDR category of the fund $SFDR_f$, where we group Articles 8 and 9 in one category (so $SFDR_f$) is a dummy equal to one if the fund is Article 8 or 9. We consider two sets of fixed effects: in one set of specifications, we include fund controls such as fund category fixed effects and fund issuer country fixed effects. In a second set, we instead include directly a fund fixed effects, effectively absorbing all fund and time invariant confounders. The sample includes all quarters following the introduction of SFDR, from Q1 2021 to Q3 2022. We do include the foreign sector in our analysis.

The regression results are shown in Table 7. Within each Morningstar rating category, we observe striking differences in flows to Article 8 and 9 funds relative to other funds. In specifications (1) and (3), we consider the flows by Morningstar rating irrespective of their SFDR classification. We see in these specifications that on average five globe funds and funds without ESG rating attracted positive flows (with the latter effect being less statistically significant with fund fixed effects). When we further interact these variables with the SFDR category of the fund, we see that the positive flows were mostly driven by Article 8 and 9 funds. For instance, for funds without a Morningstar rating, it is the funds that chose the Article 8 or 9 category that attracted relatively strong flows. This is consistent with the model, where the SFDR creates new information that reduces the uncertainty regarding the fund's true greenness.

[Insert Table 7 about here]

We observe a similar pattern for five globe funds. While they generally attracted positive flows (specifications (1) and (3)), these flows are driven by funds that chose Article 8 and 9. This is intuitive: for funds that were deemed to be green and did not choose Article 8 or 9 status, the SFDR signal is relatively negative for investors regarding the ESG performance of the fund. The Article 8 and 9 funds with 5 globes however benefit from two consistent signals on the ESG performance of the fund, triggering the positive flows.

Funds with low ESG rating experienced relatively negative flows, although the coefficients are not statistically significant.

We then explore the role of the investor sector: how did the response to the ESG ratings and SFDR vary across types of investors? For this, we focus on one dimension of heterogeneity: institutional versus retail investors. The tolerance for ESG risk is likely to be starkly different across the two investor categories. Institutional investors are for instance legally bounded regarding their ESG performance so that for instance ESG scandals at a company are a much more serious risk for institutional than for retail investors.

To test this, we further interact in Table 8 the different fund rating and SFDR categories with a dummy equal to one if the investor is an institutional investor. Within our data, institutional investor sectors thus include banks, insurance companies and pension funds (ICPF), governments and mutual funds - essentially all sectors except the household and foreign sectors. The Morningstar ratings and interactions with SFDR category are included and indicated in the bottom of the table for brevity.

[Insert Table 8 about here]

The results further illustrate the role of institutional investors in the previous results. In particular, institutional investors seemed relatively active in directing flows to funds that did not have an ESG rating and that chose the Article 8 or 9 category. As regarding the Morningstar globes, institutional investors seem to have responded somewhat differently from average investors. While average investors increased their exposure to 5 globe funds with Article 8 or 9 status, institutional investors seem to have particularly increased their exposure to one globe funds that chose the Article 8 or 9 status, i.e. funds that had a relatively positive information shock regarding the ESG performance. They however decreased their exposure to the five globe funds that were Article 8 or 9, potentially illustrating an arbitrage of funds on ESG performance across funds.

V.C. Role of environmental preferences

The model emphasizes the importance of environmental preferences in shaping the response of investors to increased ESG disclosure by funds. Table 9 suggests that, on average, Article 8 and

9 funds experienced relatively lower flows in countries with high environmental preferences, in specifications (1) and (3). When we further consider the correlation for institutional investors specifically in specifications (2) and (4), we observe however that the investment response was markedly different for institutional investors, whose flows were positively correlated with country environmental preferences. All else equal, institutional investors invested more intensely in Article 8 and 9 funds in countries with stronger environmental preferences.

[Insert Table 9 about here]

In Table 10, we further explore how the flows across ESG rating categories differed for countries with strong and weak environmental preferences. To this end, we interact the different components of the specifications in table 7 with the countries' environmental preferences. These specifications further illustrate the importance of country preferences. For instance, we saw that funds that did not have pre-existing ESG ratings and chose to become Article 8 or 9 attracted stronger flows. The interaction term then further emphasizes the importance of investor preferences, as the flows to the funds that were revealed to be green were stronger in countries with strong environmental preferences.

[Insert Table 10 about here]

As in the specification with institutional investors (Table 8), we find that greener countries were more likely to rebalance their portfolios out of 5 globe Article 8 and 9 funds and into 1 globe funds Article 8 and 9 funds.

VI. Fund responses

To measure the response of mutual funds to the disclosure rules, our main outcome of interest is the change in the weighted average Scope 1 emissions (measured in tons) of the fund's holdings between 2019 (pre-SFDR) and 2021 (post-SFDR):

$$\Delta\mathcal{E}_f = \left(\sum_{n=1}^{N} X_{fn}^{2021}\mathcal{E}_f^{2021}\right) - \left(\sum_{n=1}^{N} X_{fn}^{2019}\mathcal{E}_f^{2019}\right), \tag{6}$$

where $\mathcal{E}_n^t$ is the Scope 1 emissions of firm n in year t and X_{fn}^t is fund f's portfolio weight in firm n in year t. We decompose this change into two pieces, which we call the active and passive

changes in emissions:

$$\Delta\mathcal{E}_f^{ACT} = \underbrace{\left(\sum_{n=1}^{N} X_{fn}^{2021}\mathcal{E}_f^{2021}\right)}_{\text{2021 Portfolio Emissions}} - \underbrace{\left(\sum_{n=1}^{N} X_{fn}^{2019}\mathcal{E}_f^{2021}\right)}_{\text{2021 Emissions of 2019 Portfolio}} \tag{7}$$

$$\Delta\mathcal{E}_f^{PASS} = \underbrace{\left(\sum_{n=1}^{N} X_{fn}^{2019}\mathcal{E}_f^{2021}\right)}_{\text{2021 Emissions of 2019 Portfolio}} - \underbrace{\left(\sum_{n=1}^{N} X_{fn}^{2019}\mathcal{E}_f^{2019}\right)}_{\text{2019 Portfolio Emissions}} \tag{8}$$

This allows us to isolate the change in portfolio emissions resulting from a change in portfolio composition from the change in emissions driven by changes made by the firms themselves.

Using the changes in portfolio emissions (constructed as described in equations 6 and 7), we explore how fund greenness changed following the SFDR and how these changes depend on investor environmental preferences. We begin by comparing funds affected by the regulation (regardless of the Article classification that they choose) with funds that are not required to choose a classification. To this end, we regress changes in emissions on the interaction between preferences, Morningstar Globe indicator variables and an indicator variable for whether the fund has an SFDR classification:

$$\Delta\mathcal{E}_f = \alpha_f + \sum_{j\in\{0,1,2,4,5\}} \beta_j \bar{d}_f \times \mathbb{1}\{\text{HasSFDR}_f\}\mathbb{1}\{\text{Globe}_f = j\} + \varepsilon_f, \tag{9}$$

where $\Delta\mathcal{E}_f$ is the change in Scope 1 emissions of fund f's holdings between 2019 and 2021, α_f are fund category fixed effects, $\bar{d}_f$ is the holdings-weighted average environmental preferences of fund f's investors (measured in 2019 Q3) and $j \in \{0, 1, 2, 4, 5\}$ indicates that we use 3 Globes as the baseline category. We also include each of the three variables in the interaction term on its own, as well as each pairwise interaction. Table 11 shows the results. In column 1, we show that that high environmental preferences lead funds with 1, 2 and 4 globes to reduce their portfolio emissions following the regulation. Columns 2 and 3 confirm that this effect is driven by funds changing their portfolio allocation (active changes). In fact, in column 3, we see that if these funds had kept their portfolio weights fixed at 2019 levels, 1, 2 and 4 globe funds with high preference investors would have actually *increased* their emissions (passive changes). Another interesting finding in this table is that funds without a Morningstar globe rating increased their

portfolio emissions if they had green investors. Recall from Table 10 that high environmental preference investors also flowed into these funds. These two findings are not necessarily at odds with each other and in fact highlight the important role that the SFDR played in reducing uncertainty about fund greenness.

Our next specification examines whether these effects vary depending on the SFDR classification chosen by the fund. We replace the indicator, HasSFDR above with indicators for the SFDR categories. Because of the small number of funds who choose Article 9, we combine Articles 8 and 9. The baseline category is funds with no SFDR classification. Specifically, we run the following regression:

$$\Delta\mathcal{E}_f = \alpha_f + \sum_{\text{ART}\in\{6,8/9\}} \sum_{j\in\{0,1,2,4,5\}} \beta_{j,ART}\bar{d}_f \times \mathbb{1}\{\text{SFDR}_f = \text{ART}\}\mathbb{1}\{\text{Globe}_f = j\} + \varepsilon_f. \tag{10}$$

Table 12 shows the results. The results are quite similar to those in the previous specification. First, low globe SFDR funds reduced their portfolio emissions if their investors had strong environmental preferences. The decomposition into Article 6 and Article 8/9 reveals that this pattern applies to both green and brown funds, although the magnitude of the effect is larger for Article 8/9 than for Article 6. Second, for both Article 6 and Article 8/9 funds, the changes in emissions are due to changes in the funds portfolio allocation (column 2). Finally, the finding that funds without a Morningstar globe rating increased their portfolio emissions if they had green investors also holds for both Article 6 and Article 8/9 funds.

[Insert Tables 11 and 12 about here]

VII. Conclusion

How do ESG disclosure rules impact mutual funds and financial markets, and how do investor preferences shape the impact of disclosure? While a number of papers have studied ESG disclosure, progress on these questions has generally been limited by two constraints: the regulation or information shock was for a single market, and the data did not allow to study the different responses of investors within the market. In this paper, we use new data to study these questions, using the introduction of the SFDR in Europe as a natural experiment. Our setup provides us with an ideal vantage point for two reasons. First, the SFDR is a common

regulation affecting 24 countries at the same time; countries that differ substantially across the preferences of investors and their market characteristics. Second, our data provides us, for each fund, with a breakdown of investors across the different countries affected by the regulation.

A first exploration of the data provides a number of interesting facts on the impact of SFDR. First, the market response was strong, with 46% of funds choosing to be regulated under Article 8 and 9 of the SFDR, the 'greener' categories. The SFDR was a substantial information shock as many funds that did not have an ESG rating chose the Article 8 and 9 category. We then show that Article 8 and 9 funds experienced higher flows after SFDR than their browner Article 6 peers. We also document some response of investment funds, with the worst rated Article 8 and 9 funds subsequently improving their ESG rating.

To highlight the potential transmission mechanisms, we propose a model of fund selection where investors face uncertainty on the greenness of funds. We show that in such a framework, ESG disclosure rules affect investor demand through two channels: the 'greenness channel', where investors reallocate their portfolio from funds that are revealed brown to funds that are revealed green; and the 'uncertainty channel', where the fall in greenness uncertainty leads investors to increase their holdings of all funds - whether green or brown. On the supply side, we endogenize the greenness of the fund. The trade-off is that a higher greenness allows to attract more flows from investors, at the cost of deviating from a target greenness level (determined for instance by the fund manager skills). In this setup, increased ESG disclosure sharpens the incentive of funds to increase their greenness.

We then empirically test these transmission mechanisms. Our strategy is similar to that of Hartzmark and Sussman (2019): we study how the flows to mutual funds after the policy change (in the quarters 2021 Q1 to 2022 Q3) vary across funds and investors. Our results are broadly consistent with the predictions of the model. We show for instance that funds that did not have an ESG rating before the regulation and chose a green category (Article 8 or 9) experienced higher flows, consistent with the idea that additional information reduces uncertainty and increases investment. We also show that institutional investors tend to be particularly responsive to the regulation, with higher flows to Article 8 and 9. In addition, they also seem to respond more to the environmental preferences of their country of origin.

Our work opens a number of fruitful avenues for future research, such as studying whether

the sectoral allocation of fund portfolios changed with the reform and whether the reallocation of investment ultimately affects the real economy.

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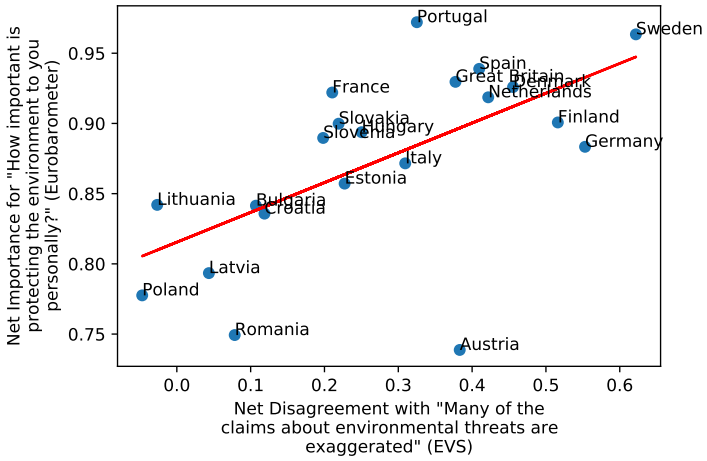

Figure 1. Scatter plot and fitted line for EVS and Eurobarometer environmental concerns measures.

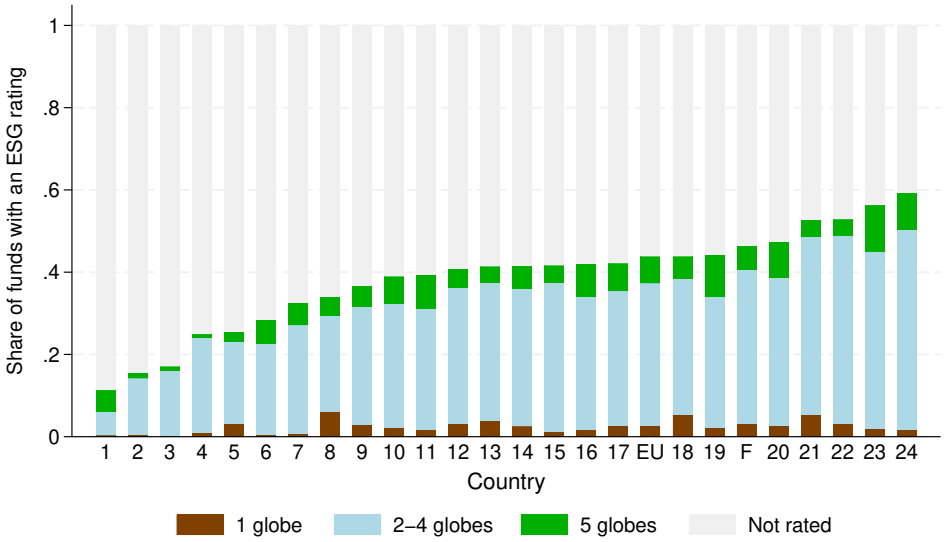

Figure 2. Share of funds that have an ESG rating by investor country (value-weighted)

This figures shows for each of the 24 investor countries in our sample the share of funds held that have 1 globe, 2 to 4 globes, 5 globes or no Morningstar ESG rating. 'EU' is for all EU countries in the sample and 'F' for foreign (non-EU) investors. The quarter is 2020 Q4.

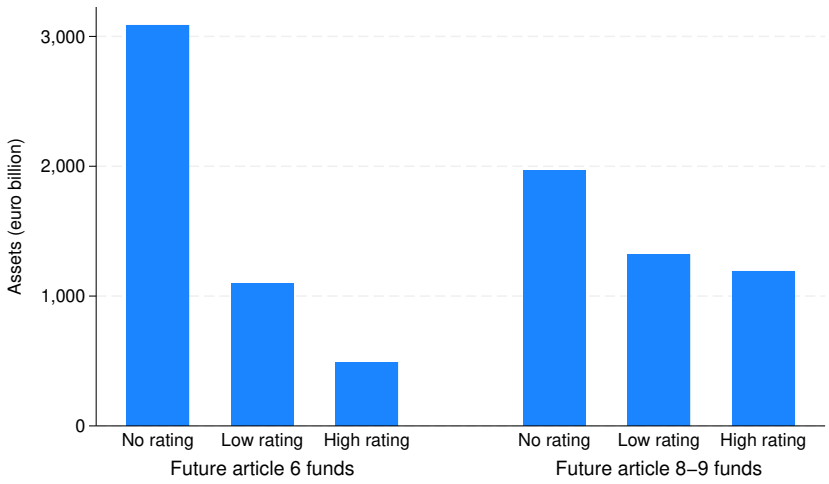

Figure 3. Assets of funds by ESG rating group and SFDR status

This figure shows the assets of funds before the introduction of SFDR, in Q4 2020. The funds are broken down by SFDR category (Article 6 or articles 8 and 9) and by Morningstar sustainability rating. A low rating corresponds to one, two or three globes while a high rating corresponds to four or five globes.

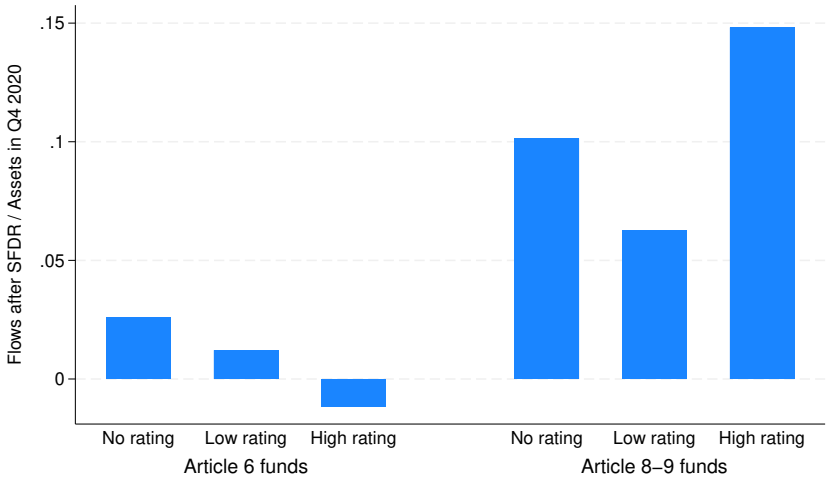

Figure 4. Flows ESG rating group and SFDR status from Q1 2021 to Q3 2022, normalized by holdings in Q4 2020.

This figure shows for the different SFDR and sustainability rating groups the ratio of the total flows into the funds from Q1 2021 to Q3 2022, normalized by the total assets in Q4 2020 (before the introduction of SFDR).

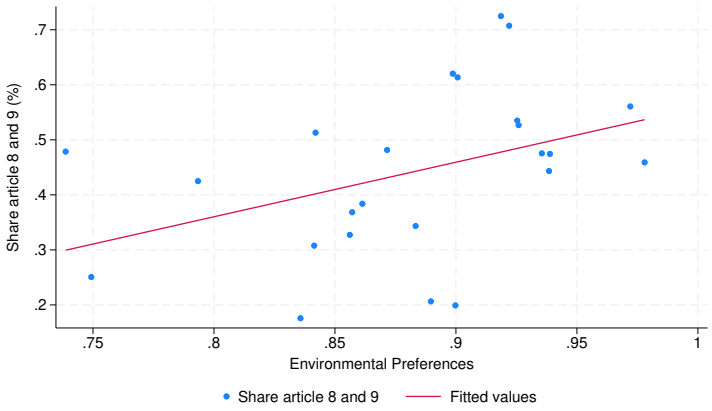

Figure 5. Share of Article 8 and 9 funds (value weighted) and environmental preferences by investor country in 2020 Q4.

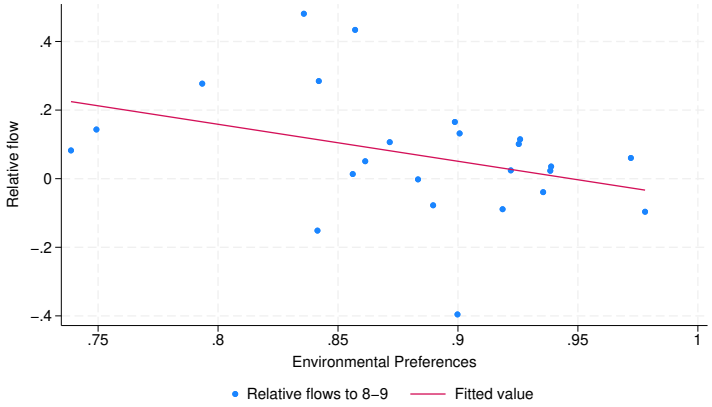

Figure 6. Flows to Article 8 and 9 funds from 2021 Q1 to 2022 Q3 and environmental preferences by country

The flows are normalized by total holdings of mutual fund shares by investor country in 2020 Q4.

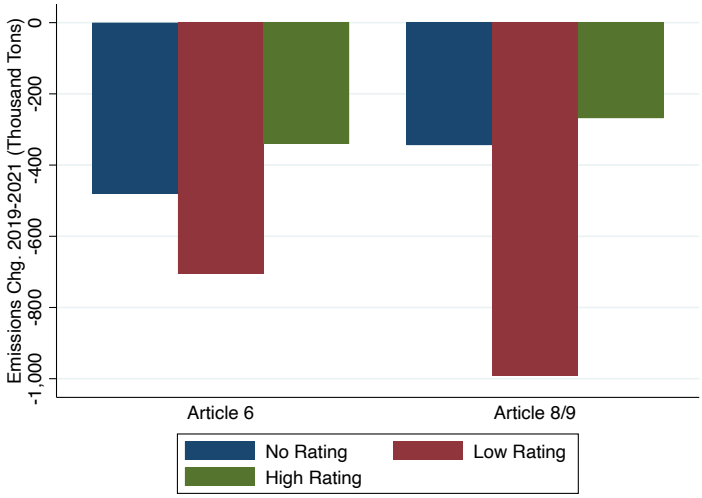

Figure 7. Change in emissions after SFDR by ESG rating group and SFDR category

Change in Scope 1 portfolio emissions (measured in 1,000 tons of CO2) from 2019-2021. Low rating refers to funds with 1-3 globes and high rating refers to those with 4-5 globes. Globe categories are as of Q4 2019 (pre-SFDR).

Table 1. List of country characteristics

In the data source column, EB refers to the Eurobarometer survey and EVS to the European Values Study. All variables described as "Agree..." are computed in the same manner as our main variable of interest: $\frac{\#\text{Agree or Strongly Agree} - \#\text{Disagree or Strongly disagree}}{\#\text{Respondents}}$. # Obs. refers to the number of SHS countries for which the variable is available (out of a maximum of 24). $\rho(x, d_i)$ refers to the correlation between each variable and our main measure of environmental preferences.

Source	Variable Description	# SHS Countries	Category	$\rho(x, d_i)$
EB	Agree that E.U. environmental legislation is necessary for protecting the environment	24	Env. Survey	0.60
EB	Agree that making the banking and insurance systems more environmentally friendly can help protect the environment	24	Env. Survey	-0.47
EVS	Agree with "I would give part of my income if I were certain that the money would be used to prevent environmental pollution"	17	Env. Survey	-0.12
EVS	Agree with "It is just too difficult for someone like me to do much about the environment"	17	Env. Survey	-0.22
EVS	Agree with "Many of the claims about environmental threats are exaggerated"	17	Env. Survey	-0.47
???	Trust in health and medical staff	24	Trust Survey	0.57
???	Trust national government	24	Trust Survey	0.25
ECB	Share of households that invest in risky assets	20	Macro/Fin	0.42
IMF	2019 GDP Per Capita	24	Macro/Fin	0.21
IMF	Climate risk and hazard exposure (2018)	24	Clim. Risk	-0.53
IMF	Environmental protection expenditures as a percentage of GDP (2018)	24	Clim. Risk	0.37
IMF	Percent of total electricity generating capacity that is from renewable sources (2019)	24	Clim. Risk	-0.40
IMF	Change in surface temperature between 2015 and 2022	24	Clim. Risk	-0.37

Table 2. Holdings by fund category

This table shows the holdings of investment fund shares broken down by fund category and investor sector, in billion euro. The figures are for 2020 Q4.

Sector	Fund Category					Total
	Equity	Bond	Money M.	Allocation	Other	
Banks	9	19	27	7	94	155
Mutual Funds	437	424	217	91	458	1,628
ICPF	405	299	148	227	450	1,529
Household	538	381	28	633	342	1,922
Other	74	93	111	44	97	419
Foreign	1,198	687	719	260	646	3,509
Total	2,661	1,903	1,249	1,261	2,087	9,162

Table 3. Investor preferences and fund SFDR choice

This table shows the results from a multinomial logit regression of each fund's SFDR choice on the holdings-weighted environmental preferences of its investors, $\bar{d}_f$. The baseline category is Article 6. All specifications control for Morningstar Globe rating, fund category and issuer country fixed effects.

	Art. 8	Art. 9
Weighted green pref.	0.21296***	0.82730***
	(0.07236)	(0.19604)
1 Globe	-0.45895***	-0.80616***
	(0.08033)	(0.28001)
2 Globes	-0.16082***	-0.45201**
	(0.05498)	(0.18258)
4 Globes	0.30016***	0.89905***
	(0.04800)	(0.12822)
5 Globes	0.70590***	2.07507***
	(0.06577)	(0.13815)
Fund Category	Yes	
Issuer Country	Yes	
Fund	No	
Observations	13692	

Standard errors in parentheses

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

Table 4. Convergence of SFDR and ESG Ratings

This table shows the 2021 Q1 and Q4 holdings of funds across all combinations of SFDR categories and Morningstar Globe ratings. Panel A shows the holdings in billion euro, and panel B shows the share of holdings within each Sustainability rating.

Panel A: Holdings by sustainability rating (billion euro)

Globes	Q1 2021				Q4 2021			
	SFDR			Total	SFDR			Total
	Art. 6	Art. 8	Art. 9		Art. 6	Art. 8	Art. 9	
One globe	91	96	6	192	111	62	2	175
Two globes	291	322	11	623	456	430	11	897
Three globes	678	796	64	1,539	1,149	1,177	88	2,414
Four globes	344	697	70	1,111	594	1,031	121	1,746
Five globes	124	397	89	610	185	510	109	804
Not rated	3,614	1,881	32	5,526	3,132	1,449	26	4,607
Total	5,141	4,188	271	9,600	5,627	4,660	357	10,644

Panel B: Share of holdings by sustainability rating

Globes	2021 Q1				2021 Q4			
	SFDR			Total	SFDR			Total
	Art. 6	Art. 8	Art. 9		Art. 6	Art. 8	Art. 9	
One globe	0.47	0.50	0.03	1.00	0.64	0.36	0.01	1.00
Two globes	0.47	0.52	0.02	1.00	0.51	0.48	0.01	1.00
Three globes	0.44	0.52	0.04	1.00	0.48	0.49	0.04	1.00
Four globes	0.31	0.63	0.06	1.00	0.34	0.59	0.07	1.00
Five globes	0.20	0.65	0.15	1.00	0.23	0.63	0.14	1.00
Not rated	0.65	0.34	0.01	1.00	0.68	0.31	0.01	1.00
Total	0.54	0.44	0.03	1.00	0.53	0.44	0.03	1.00

Panel C: Carbon intensity by SFDR category

SFDR	Percentile	Quarter			
		2019 Q4	2020 Q4	2021 Q4	2022 Q3
Article 6	p10	10.8	9.5	9.8	11.9
	p50	17.6	16.3	16.0	17.3
	p90	23.7	22.6	22.4	23.3
Article 8	p10	6.9	6.2	6.9	8.4
	p50	15.6	14.4	14.3	15.8
	p90	22.4	21.9	20.9	21.8
Article 9	p10	10.0	9.2	9.9	11.1
	p50	16.4	15.8	16.1	16.3
	p90	20.2	21.2	22.1	21.5

Table 5. Fund level summary statistics

This table shows the summary statistics of flows aggregated across investors at the fund-level. *Flow* is the total transaction flows to the fund f in quarter t, in % of Total Net Assets. *Size* is the size of the fund in €million. *MSR* is the Morningstar Sustainability Rating, ranging from 1 Globe (low) to 5 Globes (high). Panel B shows the average size, flow and globes (rating) in the quarters following the introduction of SFDR, broken down by globe rating.

Panel A: Full sample summary stats (2018q4-2022q3)

	Mean	SD	p10	p25	p50	p75	p90
Flow	0.86	15.69	-9.26	-2.80	0.00	3.30	12.15
Size	335.68	676.34	10.17	29.20	94.77	302.97	860.91
MSR	3.27	1.08	2.00	3.00	3.00	4.00	5.00

Panel B: Post SFDR statistics by Globe (2021q2-2022q3)

	Obs	Size	Flow	Globes
All	80,822	350.06	0.47	3.29
One globe	4,133	291.81	-0.28	1.32
Two globes	10,411	333.62	-0.38	2.24
Three globes	21,033	389.07	-0.01	3.08
Four globes	17,414	357.24	0.42	3.94
Five globes	9,106	387.60	1.24	4.75

Table 6. Fund-level transaction flows and SFDR category

The dependent variable is the quarterly total transaction flows to a fund in % of total net assets. The sample includes the quarters after the introduction of the SFDR (2021 Q2 to 2022 Q3). Other controls include the lagged return and flow of the fund.

	Transaction Flow			
	(1)	(2)	(3)	(4)
Sustainability score	0.432***		0.299***	
	(0.051)		(0.053)	
Article 8 or 9			1.254***	1.249***
			(0.113)	(0.113)
One globe		-0.331		-0.120
		(0.253)		(0.255)
Two globes		-0.676***		-0.590***
		(0.157)		(0.157)
Four globes		0.184		0.036
		(0.130)		(0.131)
Five globes		1.160***		0.836***
		(0.168)		(0.170)
Observations	80,826	80,826	80,826	80,826
Fund Cat.x quarter	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes
R^2	0.015	0.015	0.017	0.017

Standard errors in parentheses

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

Table 7. Flows by ESG rating and SFDR Status

The dependent variable is the quarterly flows (active rebalancing) by an investor sector and country into investment funds in the quarters after SFDR (Q1 2021 to Q3 2022). *Article 8 or 9* is a dummy for a fund having article 8 or 9 status. *No ESG rating* is a dummy indicating that the fund does not have a Morningstar sustainability rating. *globe* indicates the ESG rating of Morningstar. All specifications include investor country, quarter, investor sector fund category and fund issuer country fixed effects. Specifications (3) and (4) further interacts each fixed effects with quarters.

	Flows			
	(1)	(2)	(3)	(4)
Article 8 or 9	0.250***	0.114***	0.244***	0.113***
	(0.016)	(0.033)	(0.016)	(0.033)
No ESG rating	0.081***	-0.029	0.060**	-0.045
	(0.026)	(0.029)	(0.026)	(0.030)
No ESG rating × Art. 8-9		0.227***		0.217***
		(0.040)		(0.040)
Five globes	0.140***	0.073*	0.137***	0.070
	(0.033)	(0.044)	(0.033)	(0.044)
Five globes × Art. 8-9		0.125**		0.124**
		(0.061)		(0.061)
Four globes	0.060**	-0.028	0.058**	-0.030
	(0.024)	(0.029)	(0.024)	(0.029)
Four globes × Art. 8-9		0.157***		0.157***
		(0.045)		(0.045)
Two globes	-0.038	-0.058*	-0.037	-0.056*
	(0.026)	(0.031)	(0.026)	(0.031)
Two globes × Art. 8-9		0.027		0.027
		(0.051)		(0.051)
One globe	-0.006	-0.051	-0.014	-0.057
	(0.036)	(0.040)	(0.036)	(0.040)
One globe × Art. 8-9		0.059		0.057
		(0.077)		(0.077)
Observations	1,887,696	1,887,696	1,887,696	1,887,696
Investor country	Yes	Yes	Yes	Yes
Quarter	Yes	Yes	Yes	Yes
Investor sector	Yes	Yes	Yes	Yes
Fund Category	Yes	Yes	Yes	Yes
Issuer Country	Yes	Yes	Yes	Yes
Quarter interactions	-	-	Yes	Yes
R^2	0.004	0.004	0.007	0.007

Standard errors in parentheses

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

Table 8. ESG ratings and SFDR: Role of Institutional Investors

The dependent variable is the quarterly flow (active rebalancing) by an investor sector and country into an investment fund after SFDR (Q1 2021 to Q3 2022). *Instit. inv.* is a dummy equal to 1 if the investor is not a retail investor (household sector). *Art. 8-9* is a dummy for a fund having article 8 or 9 status. *No ESG rating* is a dummy indicating that the fund does not have a Morningstar sustainability rating. *globe* indicates the ESG rating of Morningstar. All specifications include fixed effects for investor country, sector, quarter, fund category, fund issuer country, the ESG rating (globes) of the fund interacted with SFDR status. Specifications (4), (5) and (6) further include fund fixed effects.

	Flows					
	(1)	(2)	(3)	(4)	(5)	(6)
Instit. inv. × Art. 8-9	0.053***	0.103***	0.129***	0.043**	0.088***	0.037
	(0.019)	(0.020)	(0.040)	(0.018)	(0.018)	(0.038)
Instit. inv. × No ESG rating		0.214***	0.220***		0.128***	0.078***
		(0.024)	(0.032)		(0.023)	(0.030)
Instit. inv. × No ESG rating × Art. 8-9			0.001			0.120**
			(0.050)			(0.047)
Instit. inv. × Five globes		-0.050	0.164***		-0.092**	0.054
		(0.038)	(0.054)		(0.038)	(0.047)
Instit. inv. × Five globes × Art. 8-9			-0.296***			-0.184***
			(0.073)			(0.069)
Instit. inv. × Four globes		0.013	0.088**		-0.016	-0.001
		(0.030)	(0.042)		(0.029)	(0.040)
Instit. inv. × Four globes × Art. 8-9			-0.122**			-0.016
			(0.059)			(0.056)
Instit. inv. × Two globes		0.093***	0.096**		0.080***	0.040
		(0.032)	(0.042)		(0.030)	(0.037)
Instit. inv. × Two globes × Art. 8-9			-0.004			0.074
			(0.064)			(0.060)
Instit. inv. × One globe		0.115**	0.054		0.091**	0.010
		(0.046)	(0.055)		(0.042)	(0.050)
Instit. inv. × One globe × Art. 8-9			0.174*			0.189**
			(0.097)			(0.089)
Observations	1,887,696	1,887,696	1,887,696	1,887,696	1,887,696	1,887,696
Investor country	Yes	Yes	Yes	Yes	Yes	Yes
Investor sector	Yes	Yes	Yes	Yes	Yes	Yes
Quarter	Yes	Yes	Yes	Yes	Yes	Yes
Globe x Art. 8-9	Yes	Yes	Yes	Yes	Yes	Yes
Fund Category	Yes	Yes	Yes	-	-	-
Issuer Country	Yes	Yes	Yes	-	-	-
Fund	-	-	-	Yes	Yes	Yes
R^2	0.004	0.004	0.004	0.059	0.059	0.059

Standard errors in parentheses

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

Table 9. Environmental preferences, SFDR and Institutional investors

The dependent variable is the quarterly flow (active rebalancing) by an investor sector and country into an investment fund after SFDR (Q1 2021 to Q3 2022). *Env. pref.* is the net share of respondents in a country that report that 'the protection of the environment is important or very important' (Eurobarometer survey). *Instit. inv.* is a dummy equal to 1 if the investor is not a retail investor (household sector). *Art. 8-9* is a dummy for a fund having article 8 or 9 status. *No ESG rating* is a dummy indicating that the fund does not have a Morningstar sustainability rating. *globe* indicates the ESG rating of Morningstar. All specifications include investor country, sector, quarter, fund category, fund issuer country and ESG rating (globes) fixed effects. Specifications (3) and (4) further include fund fixed effects.

	Flows			
	(1)	(2)	(3)	(4)
Article 8 or 9	0.357***	1.099***		
	(0.127)	(0.148)		
Art. 8-9 × Env. pref. × Instit. inv.		1.619***		1.529***
		(0.228)		(0.246)
Art. 8-9 × Env. pref.	-0.120	-0.962***	-0.274**	-0.969***
	(0.143)	(0.161)	(0.121)	(0.151)
Instit. inv. × Art. 8-9		-1.428***		-1.320***
		(0.203)		(0.220)
Instit. inv. × Env. pref.		0.219		0.235
		(0.143)		(0.155)
Observations	1,887,696	1,887,696	1,887,696	1,887,696
Investor country	Yes	Yes	Yes	Yes
Investor sector	Yes	Yes	Yes	Yes
Quarter	Yes	Yes	Yes	Yes
Fund Category	Yes	Yes	-	-
Issuer Country	Yes	Yes	-	-
Globes	Yes	Yes	Yes	Yes
Fund	-	-	Yes	Yes
R^2	0.004	0.004	0.059	0.059

Standard errors in parentheses

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

Table 10. Sustainability ratings and environmental preferences

The dependent variable is the quarterly flow (active rebalancing) by an investor sector and country into an investment fund after SFDR (Q1 2021 to Q3 2022). *Env. pref.* is the net share of respondents in a country that report that 'the protection of the environment is important or very important' (Eurobarometer survey). *Article 8 or 9* is a dummy for a fund having article 8 or 9 status. *No ESG rating* is a dummy indicating that the fund does not have a Morningstar sustainability rating. *globe* indicates the ESG rating of Morningstar. Specifications (1) and (2) include fund characteristics (fund category, issuer country) while specifications (3) and (4) include fund fixed effects.

	Flows			
	(1)	(2)	(3)	(4)
Article 8 or 9	-0.051	0.101		
	(0.130)	(0.302)		
Env. pref. × Art. 8-9	0.185	0.015	0.009	-0.369
	(0.145)	(0.343)	(0.121)	(0.238)
Env. pref. × No ESG rating	0.533***	0.403*	0.644***	0.371*
	(0.192)	(0.238)	(0.181)	(0.203)
Env. pref. × No ESG rating × Art. 8-9		0.291		0.568*
		(0.395)		(0.299)
Env. pref. × One globe	0.315	-0.791*	0.296	-0.637
	(0.368)	(0.468)	(0.329)	(0.395)
Env. pref. × One globe × Art. 8-9		2.872***		2.177***
		(0.746)		(0.637)
Env. pref. × Two globes	0.012	-0.281	0.073	-0.274
	(0.266)	(0.348)	(0.254)	(0.307)
Env. pref. × Two globes × Art. 8-9		0.568		0.630
		(0.527)		(0.453)
Env. pref. × Four globes	-0.215	-0.201	-0.197	-0.555**
	(0.237)	(0.308)	(0.222)	(0.262)
Env. pref. × Four globes × Art. 8-9		0.003		0.594
		(0.458)		(0.366)
Env. pref. × Five globes	-1.143***	0.150	-0.961***	-0.127
	(0.354)	(0.495)	(0.324)	(0.403)
Env. pref. × Five globes × Art. 8-9		-1.652**		-0.973*
		(0.673)		(0.551)
Observations	1,887,696	1,887,696	1,887,696	1,887,696
Investor country	Yes	Yes	Yes	Yes
Investor sector	Yes	Yes	Yes	Yes
Quarter	Yes	Yes	Yes	Yes
Globes x Art. 8-9	Yes	Yes	Yes	Yes
Fund Category	Yes	Yes	-	-
Issuer Country	Yes	Yes	-	-
Fund	-	-	Yes	Yes
R^2	0.004	0.004	0.059	0.059

Standard errors in parentheses

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

Table 11. Portfolio emissions (measured in 1,000 tons of CO2), investor preferences and SFDR coverage.

The dependent variable is the change from 2019-2021 in scope 1 emissions of the firms in a fund's portfolio, weighted by the size of the fund's holdings. See equations 7 and 8 for the definition of active and passive changes. Has SFDR is an indicator variable for whether the fund is in scope of SFDR. This variable is interacted with indicator variables for the fund's Morningstar Globe rating and the environmental preferences of its investors as of 2019. We also include two-way interactions and the three variables on their own. All specifications include fund category fixed effects.

	(1) Scope 1 Chg.	(2) Scope 1 Chg. (Active)	(3) Scope 1 Chg. (Passive)
HasSFDRx(Miss. Globe)xPref	6384.039***	1850.479***	-1752.969***
	(17.874)	(9.180)	(-8.357)
HasSFDRx(1 Globe)xPref	-10134.654***	-19200.220***	9708.801***
	(-66.462)	(-230.731)	(94.056)
HasSFDRx(2 Globe)xPref	-3834.450***	-10575.490***	4778.059***
	(-7.430)	(-22.488)	(18.596)
HasSFDRx(4 Globe)xPref	-1412.362***	-12324.879***	2533.142***
	(-11.740)	(-69.911)	(33.671)
HasSFDRx(5 Globe)xPref	2204.090***	-2470.116***	1708.880***
	(16.864)	(-11.370)	(15.280)
Const.	-5294.879***	-2092.564***	-1065.828***
	(-39.226)	(-22.012)	(-11.497)
Globe FE	Yes	Yes	Yes
Fund Cat. FE	Yes	Yes	Yes
HasSFDR FE	Yes	Yes	Yes
HasSFDRxGlobe FE	Yes	Yes	Yes
Pref. Controls	Yes	Yes	Yes
Pref.xGlobe Controls	Yes	Yes	Yes
Pref.xHasSFDR Controls	Yes	Yes	Yes
Obs.	6113	6187	6166

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

Table 12. Portfolio emissions (measured in 1,000 tons of CO2), investor preferences and SFDR category.

The dependent variable is the change from 2019-2021 in scope 1 emissions of the firms in a fund's portfolio, weighted by the size of the fund's holdings. See equations 7 and 8 for the definition of active and passive changes. Art 8/9 is an indicator variable for whether the fund is Article 8 or 9. This variable is interacted with indicator variables for the fund's Morningstar Globe rating and the environmental preferences of its investors as of 2019. We also include two-way interactions and the three variables on their own. All specifications include fund category fixed effects.

	(1) Scope 1 Chg.	(2) Scope 1 Chg. (Active)	(3) Scope 1 Chg. (Passive)
Art8/9 x Miss. Globe x Pref	6740.469***	3118.795***	-2621.203***
	(18.626)	(15.324)	(-12.371)
Art8/9 x 1 Globe x Pref	-22293.276***	-35166.244***	13643.156***
	(-145.660)	(-416.389)	(136.737)
Art8/9 x 2 Globe x Pref	-4013.092***	-8289.415***	3449.125***
	(-7.601)	(-17.327)	(13.208)
Art8/9 x 4 Globe x Pref	634.946***	-9834.237***	1752.956***
	(4.918)	(-53.285)	(22.731)
Art8/9 x 5 Globe x Pref	4120.453***	1090.313***	-164.877
	(31.432)	(4.776)	(-1.512)
Globe FE	Yes	Yes	Yes
Fund Cat. FE	Yes	Yes	Yes
SFDR Cat. FE	Yes	Yes	Yes
SFDRxGlobe FE	Yes	Yes	Yes
Pref. Controls	Yes	Yes	Yes
Pref.xGlobe Controls	Yes	Yes	Yes
Pref.xSFDR Controls	Yes	Yes	Yes
Obs.	6113	6187	6166

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

Appendix to "The Effect of Environmental Preferences on Investor Responses to ESG Disclosure"

A. Data coverage and merge overview

Our data covers most of the UCITS market in Europe. This point is illustrated in Figure A3 which compares the total holdings of investment fund shares in our data with publicly available data on the issuance of UCITS funds from the European Fund and Asset Management Association (EFAMA), an industry group. The coverage of the EFAMA is larger than that of SHS as it also include issuances in non-EU countries such as Switzerland, the United Kingdom and Turkey. The SHS data however covers around 80% of the UCITS market, and follows closely the evolution of the broader market.

The total holdings in our sample increased from around €7.5 trillion at the end of 2018 to €9 trillion in late 2022. Table A1 in appendix provides a breakdown of the average holdings of fund shares across the different financial sectors. Domestic investors own about 62% of the UCITS market in our data, i.e around €5.5 trillion worth of investment fund shares. Among domestic investors, the household sector is the largest investor with a portfolio of €1.9 trillion worth of assets. ICPF and Mutual Funds are also large investors while banks or other investors are relatively smaller.

In the empirical analysis of sections III and V, we restrict the sample to funds that are also present in Morningstar. As shown in the third column of Table A1, we match 81% of the SHS holdings to Morningstar. The match rate is broadly similar across investors, except for banks where it is smaller at 40%.

In an additional check to the quality and relevance of the holdings data, we also explored whether the identity of the investor's country seems to correspond with the ultimate owner of the asset. Given that the European investment fund industry is highly concentrated in Ireland and Luxembourg, one concern could be that the investment fund shares are held by entities located in these countries, which are themselves held by investors in other countries. To explore this, we break down the holdings of investment fund shares by investor country and issuer country. We then consider three country groups in appendix Table A2: Ireland and Luxembourg,

other SHS countries, and foreign (non-SHS) countries. The table confirms that Ireland and Luxembourg have a leading role in the issuance of investment funds, with 61% of funds in our data being domiciled in these two countries. However, investors from these two countries hold a relatively small fraction of these funds (9%). Most of the domestic holders of investment fund shares are in fact located in other SHS countries, and a look at the identity of the countries confirms that the size of the holdings are in line with the size of the countries with e.g. Germany, France, Spain and Italy being the largest holders of investment fund shares. In the analysis, we will mostly focus on the country of the investor.

B. Proofs

B.A. Proof of proposition 1

Proof. The demand of investors in equation (4) follows Avramov et al. (2022). Consider then the fund's problem. The size of fund f is

$$W_f = \sum_{j=1}^{I} W_{0j} x_{jf}^* = \sum_{j=1}^{I} W_{0j} \frac{1}{a_j} \left(\Sigma_r + \frac{d_j^2}{a_j^2} \Sigma_g \right)^{-1} \left(\mu_{rf} + \frac{d_j}{a_j} g_f \right)$$

where x_{if}^U is the share of investor i's portfolio invested in fund f. The total investment into fund f is a linear and increasing function of g_f. Let ξ_{if} be the f^{th} element of the diagonal of $\left(\Sigma_r + \frac{d_i^2}{a_i^2} \Sigma_g \right)$. By increasing g_f by one unit, the fund receives inflows of

$$\frac{\partial W_f}{\partial g_f} = \frac{\sum_j W_{0j} \partial \left(x_{jf}^* \right)}{\partial g_f} = \sum_j W_{0j} \frac{1}{a_j} \xi_{jf}^{-1} \left(\frac{d_j}{a_j} \right). \tag{11}$$

Consider now the fund's problem in (3). Given (11), the FOC yields:

$$\eta \sum_j W_{0j} \frac{1}{a_j} \xi_{jf} \left(\frac{d_j}{a_j} \right) - 2 \left(g_f - \overline{g}_f \right) = 0$$

so that optimal greenness is given by (5). □

C. Model with endogenous returns

To illustrate the mechanism through which the SFDR affects portfolio choice of both funds and investors, we present a model with three key features. First, investors have a preference for green assets, as in Pástor et al. (2021). Second, funds act as intermediaries, through which investors can purchase equity assets. Third, prior to the regulation, investors are unable to observe the true greenness of the funds and instead form a prior. This generates uncertainty about fund greenness, as in Avramov et al. (2022). The SFDR eliminates this uncertainty by allowing investors to observe funds' true greenness.[7] The implementation of the regulation affects both investors' capital allocation across funds and funds' allocation to green assets (which we call fund greenness). The magnitudes of these effects depend on investor preferences.

There is a single period and two risky equity assets (green and brown) in fixed supply. The endogenous expected excess returns of the green and brown assets are denoted μ_g and μ_b, respectively. There are I investors, indexed by $i = 1, ..., I$. Investors cannot invest in the equity assets directly, but invest in mutual funds, who in turn invest in equities. Each investor i has access to a single fund (fund i) and a riskless asset.[8] Fund greenness g_i is the weight of the green asset in fund i's portfolio. The expected excess return of fund i is given by:

$$\mu_i = g_i \mu_g + (1 - g_i)\mu_b. \tag{12}$$

For simplicity, we assume that fund i's return is normally distributed with exogenous variance $\sigma^2_{r,i}$. Investor i has wealth W_{0i} and chooses a portfolio weight in fund i fund, x_i.[9]

C.A. *Investors*

Investors have utility:

$$V(W_{1i}, x_i) = -e^{-A_i W_{1i} - d_i g_i x_i}, \tag{13}$$

[7] The intuition holds in a more general model where investors are Bayesian and the SFDR serves as a signal that the investors use to update their priors. For simplicity, we focus on the case where the SFDR leads to full resolution of uncertainty about greenness.

[8] This one-to-one mapping between funds and investors allows us to ignore the effects of competition across funds. These effects are very interesting to study, but complicate the model substantially. Intuitively, the one-to-one mapping is equivalent to a case of full segmentation, where each investor can invest in one fund and investors in the model are representative of all investors in the fund.

[9] Implicitly, $1 - x_i$ is i's weight in the riskless asset.

where A_i is i's absolute risk aversion, d_i is his environmental preference and W_{1i} is his wealth at time 1, given by $W_{1i} = (1 + r_f + x_i r_i)$. Thus, investor i solves:

$$\max_{x_i} \quad \mathbb{E}\left[-e^{-a_i(1+r_f+x_i r_i)-d_i g_i x_i}\right], \tag{14}$$

where $a_i \equiv W_{0i} A_i$ is his relative risk aversion.

C.B. Funds

Fund i has exogenous target greenness $\overline{g}_i$. Intuitively, this could represent the manager's own non-pecuniary preference for greenness or his knowledge about green assets. Manager i chooses his portfolio weight in the green asset, g_i, to maximize the fund's AUM minus a penalty for deviating from $\overline{g}_i$. Specifically, fund i's problem is:

$$\max_{g_i} \quad W_{0i} x_i(g_i; \mu_g, \mu_b) - (g_i - \overline{g}_i)^2, \tag{15}$$

where $x_i(g_i; \mu_g, \mu_b)$ is determined by investor i's maximization problem. We assume that funds are small enough to take equity returns as given and not consider the price impact of their asset allocation decision.

C.C. Prior to the Disclosure Regulation

Prior to the regulation, the investors cannot perfectly observe fund greenness. Instead, they only know the distribution of the greenness of funds, $g_i^{prior} \sim \mathcal{N}(g_i, \sigma^2_{g,i})$, where $\sigma^2_{g,i}$ is the uncertainty about fund greenness. Note that the distribution of g_i^{prior} is centered at true greenness g_i.

As derived in Appendix D.A and as in Avramov et al. (2022), the solution to this maximization problem gives the following portfolio weights under uncertainty:

$$x_i^U = \frac{g_i^U \mu_g^U + (1 - g_i^U)\mu_b^U + \frac{d_i}{a_i} g_i^U}{a_i \left(\sigma^2_{r,i} + \frac{d_i^2}{a_i^2}\sigma^2_{g,i}\right)}, \tag{16}$$

Fund i's choice of greenness prior to the regulation will be the solution to:

$$\max_{g_i} \quad W_{0i} \frac{g_i \mu_g^U + (1-g_i)\mu_b^U + \frac{d_i}{a_i} g_i}{a_i \left(\sigma_{r,i}^2 + \frac{d_i^2}{a_i^2} \sigma_{g,i}^2 \right)} - (g_i - \overline{g}_i)^2 \quad \text{s.t. } 0 \leq g_i \leq 1, \tag{17}$$

where the constraint imposes no short selling of either asset and μ_g^U and μ_b^U denote the equilibrium expected returns of the two equity assets prior to the regulation. Fund f's first order condition implies that:

$$g_i^U = \overline{g}_i + \frac{W_{0i} \left(\mu_g^U - \mu_b^U + \frac{d_i}{a_i} \right)}{2a_i \left(\sigma_{r,i}^2 + \frac{d_i^2}{a_i^2} \sigma_{g,i}^2 \right)} \tag{18}$$

when this quantity is between 0 and 1. If it is less than 0, then $g_i^U = 0$ and if it is greater than 1, then $g_i^U = 1$.

C.D. After the Disclosure Regulation

The disclosure regulation is unanticipated by both managers and investors. It requires funds to disclose their portfolio greenness. This disclosure is viewed as credible by investors and thus $\sigma_{g,i}^2$ goes to zero for all funds. In response to the regulation, both managers and investors can reallocate capital. Investor i's weight in the fund becomes:

$$x_i^* = \frac{g_i^* \mu_g^* + (1-g_i^*)\mu_b^* + \frac{d_i}{a_i} g_i^*}{a_i \sigma_{r,i}^2}, \tag{19}$$

The manager's problem becomes:

$$\max_{g_i} \quad W_{0i} \frac{g_i \mu_g^* + (1-g_i)\mu_b^* + \frac{d_i}{a_i} g_i}{a_i \sigma_{r,i}^2} - (g_i - \overline{g}_i)^2 \quad \text{s.t. } 0 \leq g_i \leq 1, \tag{20}$$

where μ_g^* and μ_b^* denote the equilibrium expected returns of the two equity assets after the regulation. Then, fund i's green portfolio weight will be:

$$g_i^* = \overline{g}_i + \frac{W_{0i} \left(\mu_g^* - \mu_b^* + \frac{d_i}{a_i} \right)}{2a_i \sigma_{r,i}^2} \tag{21}$$

when this quantity is between 0 and 1. As above, if this quantity is less than 0, then $g_i^* = 0$ and if it is greater than 1, then $g_i^* = 1$.

C.E. *Effects of the Disclosure Regulation*

By comparing equations 16 and 18 to equations 19 and 21, we can see that the regulation has three effects:

1. **Uncertainty Channel:** $\sigma^2_{r,i} + \frac{d_i^2}{a_i^2}\sigma^2_{g,i}$ is replaced by $\sigma^2_{r,i}$ in the denominator of equations 16 and 18. This means that, all else equal, funds increase their greenness and investors increase their weight in the funds. Intuitively, this is because investors are risk averse with respect to greenness, so that when $\sigma^2_{g,i} > 0$, the dependence of investor portfolio weights, x_i on fund greenness, g_i is weakened.[10] When $\sigma_{g,i} = 0$, the relation between x_i and g_i becomes stronger, which is then reflected in the funds' portfolio choice, leading to an increase in g_i.

2. **Greenness Channel:** g_i^U is replaced with g_i^* in equation 16. Intuitively, this reflects the fact the investors adjust their portfolios based on the change in fund greenness that results from the regulation.

3. **Return Channel:** μ_g^U and μ_b^U in equations 16 and 18 are replaced by μ_g^* and μ_b^*. This is because, in equilibrium, the regulation will affect expected returns of the equity assets. In particular, the increase in demand for risky assets as a result of the reduction in uncertainty will lead to lower expected returns. See Appendix D.B for details.

The magnitude of each of the three channels varies with investor environmental preferences, d_i, and with fund target greenness $\overline{g}_i$. Figure A1 depicts the change in investor portfolio weights driven by each of the three channels.[11] In Panel A, we can see that the uncertainty channel leads to inflows for both fund types.[12] The magnitude of the inflows being driven by the uncertainty channel is increasing in environmental preferences for both fund types. This is because investors with high d_i also dislike uncertainty about greenness, so the resolution of such uncertainty benefits brown funds as well. In Panel B, we can see that the greenness channel leads to inflows for brown funds with high d_i. This is consistent with our empirical finding that

[10] In fact, d_i is the Arrow-Pratt coefficient of absolute risk aversion with respect to portfolio greenness, $G_i \equiv g_i x_i$.

[11] Note that in this figure and all other figures where we illustrate the effects of the model, we use the following parameterization: d_i ranges from 0.5 to 3.5 in increments of 0.1 (which implies that $I = 62$ because for each level of d_i, we have one investor with access to a high $\overline{g}_i$ fund and one with access to a low $\overline{g}_i$ fund), $a_i = 2\forall i$, $W_{0i} = 1\forall i$, $Q_g = Q_b = 31$ (so that $Q_g + Q_b = \sum_i W_{0i}$), $\sigma^2_{g,i} = 0.1\forall i$, $\sigma^2_{r,i} = 0.15\forall i$, brown funds have $\overline{g}_i = 0$, green funds have $\overline{g}_i = 1$.

[12] In this section, we refer to green and brown funds and those with high and low target greenness ($\overline{g}_i$), respectively.

low Morningstar globe funds that choose Article 8 or 9 experience inflows from investors with strong environmental preferences. Panel C shows that the return channel leads to outflows for all funds. This is because, by reducing uncertainty, the regulation leads to increased demand and thus lower expected returns. While returns are not the main focus of our paper, we believe that this channel would be interesting to test empirically in future work. Finally, in Panel D, we match the empirical finding that investors with strong environmental preferences increase capital allocated to funds that were previously brown. The model analog is that when d_i is high, investors increase their portfolio weight in funds with low $\overline{g}_i$.

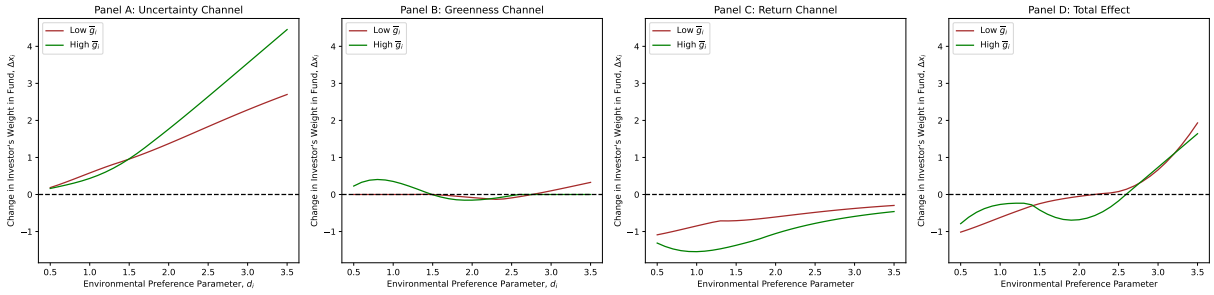

Figure A1. Change in investor portfolio weights driven by each of the three channels.

This figure shows the contribution of each of the three channels to the overall change in investor portfolio weights as a function of investor environmental preferences. The green and brown lines indicate a fund with high and low target greenness $\overline{g}_i$, respectively. In Panel A, we fix portfolio greenness and equity expected returns at their pre-SFDR levels and compute the change in investor portfolio weights when $\sigma^2_{g,i}$ goes to zero. In Panel B, we fix $\sigma^2_{g,i}$ and equity expected returns at their pre-SFDR levels and compute the change in investor portfolio weights when fund greenness changes from g_i^U to g_i^*. In Panel C, we fix $\sigma^2_{g,i}$ and g_i at their pre-SFDR levels and compute the change in investor portfolio weights when equity returns change from μ_g^U and μ_b^U to μ_g^* and μ_b^*. Panel D shows the combined effect of all three channels.

The second set of model implications relate to fund portfolio greenness. In the empirical section of the paper, we found that brown (low Morningstar Globe) funds whose investors have strong environmental preferences reduce their portfolio emissions following the regulation. In Figure A2, we show that this is also an implication of our model. Specifically, note that in Panel C, low $\overline{g}_i$ funds become greener following the regulation. Simply put, when uncertainty about greenness is eliminated, investors become more responsive to changes in fund portfolio greenness, motivating funds to align better with the preferences of their investors. For the low $\overline{g}_i$ funds, this means that the benefit of increasing g_i (more AUM) outweighs the cost (being penalized for deviating from $\overline{g}_i$). This was not the case prior to the regulation because the response of investor portfolio allocation to fund greenness was muted by $\sigma_{g,i} > 0$.

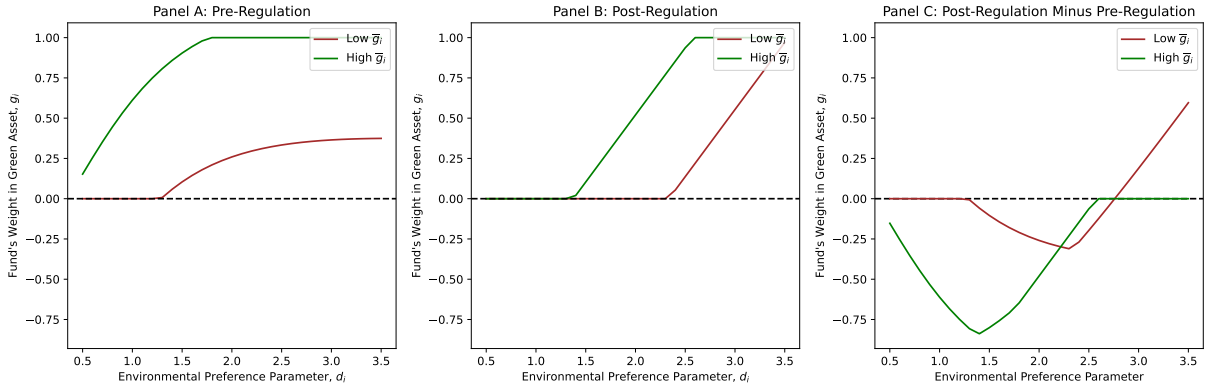

Figure A2. Fund greenness as a function of investor preferences.

D. Derivations and Proofs

D.A. Derivation of Pre-SFDR Portfolio Weights

Recall that the investors' problem is:

$$\begin{aligned} &\max_{X_i} \quad \mathbb{E}_0\left[-e^{-a_i(1+r_f+X_i'r)-d_iX_i'g}\right] \\ \iff &\max_{X_i} \quad -e^{-a_i(1+r_f)}\mathbb{E}_0\left[e^{-a_iX_i'\left(r+\frac{d_ig}{a_i}\right)}\right] \end{aligned} \tag{22}$$

Assume that g and r are jointly normal. Under this assumption, the exponentiated term inside the expectation, $-a_iX_i\left(r+\frac{d_ig}{a_i}\right)$, follows a normal distribution with mean $-a_iX_i'\left(\mu_r+\frac{d_i\mu_g}{a_i}\right)$ and variance $a_i^2X_i'\left(\Sigma_r+\frac{d_i^2}{a_i^2}\Sigma_g+2\frac{d_i}{a_i}\Sigma_{rg}\right)X_i$. This means that the term inside the expectation follows a lognormal distribution, so we can rewrite the investor's problem:

$$\max_{X_i} \quad -e^{-a_i(1+r_f)}e^{-a_iX_i\left(\mu_r+\frac{d_i\mu_g}{a_i}\right)+\frac{1}{2}a_i^2X_i'\left(\Sigma_r+\frac{d_i^2}{a_i^2}\Sigma_g+2\frac{d_i}{a_i}\Sigma_{rg}\right)X_i} \tag{23}$$

The FOC is:

$$[X_i]: a_i\left(\mu_r+\frac{d_i\mu_g}{a_i}\right)=a_i^2\left(\Sigma_r+\frac{d_i^2}{a_i^2}\Sigma_g+2\frac{d_i}{a_i}\Sigma_{rg}\right)X_i, \tag{24}$$

which implies that the portfolio weights of investor i are given by:

$$X_i=\frac{1}{a_i}\left(\Sigma_r+\frac{d_i^2}{a_i^2}\Sigma_g+2\frac{d_i}{a_i}\Sigma_{rg}\right)^{-1}\left(\mu_r+\frac{d_i\mu_g}{a_i}\right) \tag{25}$$

D.B. *Equilibrium Expected Returns*

Let Q_g and Q_b denote the supply of the green and brown equity asset, respectively. Then, the equilibrium expected equity returns will be determined by market clearing:

$$Q_g = \sum_{i=1}^{I} g_i AUM_i \tag{26}$$

$$Q_b = \sum_{i=1}^{I} (1 - g_i) AUM_i, \tag{27}$$

where AUM_i is the assets under management of fund i, $AUM_i = W_{0i} x_i$.

Substituting in the expressions for x_i^U and g_i^U from equations 16 and 18 gives:

$$Q_g = \sum_{i=1}^{I} W_{0i} \left[\left(\overline{g}_i + \frac{W_{0i}\left(\mu_g^U - \mu_b^U + \frac{d_i}{a_i}\right)}{2a_i\left(\sigma_{r,i}^2 + \frac{d_i^2}{a_i^2}\sigma_{g,i}^2\right)} \right) \frac{\left(\overline{g}_i + \frac{W_{0i}\left(\mu_g^U - \mu_b^U + \frac{d_i}{a_i}\right)}{2a_i\left(\sigma_{r,i}^2 + \frac{d_i^2}{a_i^2}\sigma_{g,i}^2\right)} \right)\left(\mu_g^U - \mu_b^U + \frac{d_i}{a_i}\right) - \mu_b^U}{a_i\left(\sigma_{r,i}^2 + \frac{d_i^2}{a_i^2}\sigma_{g,i}^2\right)} \right] \tag{28}$$

$$Q_b = \sum_{i=1}^{I} W_{0i} \left[\left(1 - \overline{g}_i - \frac{W_{0i}\left(\mu_g^U - \mu_b^U + \frac{d_i}{a_i}\right)}{2a_i\left(\sigma_{r,i}^2 + \frac{d_i^2}{a_i^2}\sigma_{g,i}^2\right)} \right) \frac{\left(\overline{g}_i + \frac{W_{0i}\left(\mu_g^U - \mu_b^U + \frac{d_i}{a_i}\right)}{2a_i\left(\sigma_{r,i}^2 + \frac{d_i^2}{a_i^2}\sigma_{g,i}^2\right)} \right)\left(\mu_g^U - \mu_b^U + \frac{d_i}{a_i}\right) - \mu_b^U}{\left(\sigma_{r,i}^2 + \frac{d_i^2}{a_i^2}\sigma_{g,i}^2\right)} \right], \tag{29}$$

which implicitly determine the equilibrium equity returns prior to the regulation, μ_g^U and μ_b^U.

Similarly, substituting the expressions for x_i^* and g_i^* from equations 19 and 21 gives implicit definitions for equilibrium equity returns after the regulation, μ_g^* and μ_b^*:

$$Q_g = \sum_{i=1}^{I} W_{0i} \left[\left(\overline{g}_i + \frac{W_{0i}\left(\mu_g^U - \mu_b^U + \frac{d_i}{a_i}\right)}{2a_i\sigma_{r,i}^2} \right) \frac{\left(\overline{g}_i + \frac{W_{0i}\left(\mu_g^U - \mu_b^U + \frac{d_i}{a_i}\right)}{2a_i\sigma_{r,i}^2} \right)\left(\mu_g^U - \mu_b^U + \frac{d_i}{a_i}\right) - \mu_b^U}{a_i\sigma_{r,i}^2} \right] \tag{30}$$

$$Q_b = \sum_{i=1}^{I} W_{0i} \left[\left(1 - \overline{g}_i - \frac{W_{0i}\left(\mu_g^U - \mu_b^U + \frac{d_i}{a_i}\right)}{2a_i\sigma_{r,i}^2} \right) \frac{\left(\overline{g}_i + \frac{W_{0i}\left(\mu_g^U - \mu_b^U + \frac{d_i}{a_i}\right)}{2a_i\sigma_{r,i}^2} \right)\left(\mu_g^U - \mu_b^U + \frac{d_i}{a_i}\right) - \mu_b^U}{a_i\sigma_{r,i}^2} \right]. \tag{31}$$

E. Appendix Tables and Figures

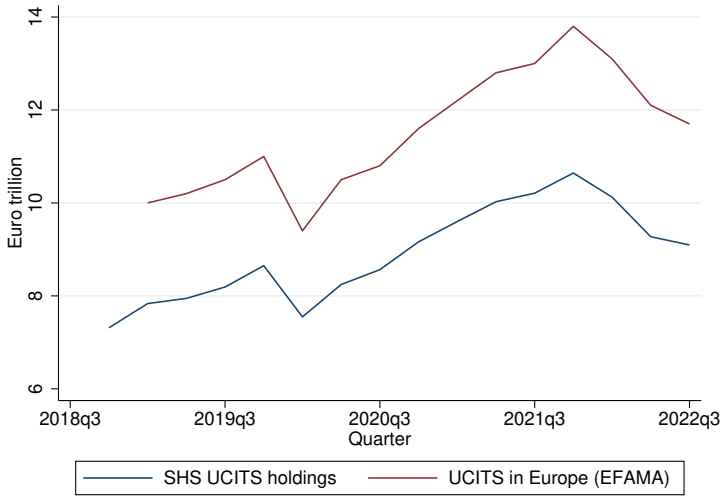

Figure A3. UCITS investment fund shares outstanding for SHS and EFAMA

This figure compares the total value of UCITS fund shares in SHS with the statistics published by the EFAMA. The EFAMA data is for all Europe including countries such as the United-Kingdom, Sweden, Switzerland and Turkey which are not included in SHS.

Table A1. Holdings of UCITS fund shares and match to Morningstar

This table shows in column 2 the holdings of investment shares by financial sector, averaged over the period 2018 Q4 to 2022 Q3. Column 3 shows the share of holdings that are matched to Morningstar.

Sector	Holdings (euro bn)	Matched to MS (%)
Banks	150	40
Mutual Funds	1,585	75
ICPF	1,473	75
Household	1,922	85
Other	397	79
Foreign	3,376	85
Total	8,902	81

Table A2. Distribution of fund shares by issuer and holder country

We consider 3 country groups: Luxembourg and Ireland; the other SHS countries (excluding Luxembourg and Ireland) and Foreign (non-SHS) countries. The columns indicate the amount of investment fund shares by issuer country, and the rows the owner of the fund shares.

		Issuer Country			Total	Share of
		Lux. and Irl.	Other SHS	Foreign		Total
Holder country	Lux. and Irl.	705	89	40	834	9
	Other SHS	2,258	2,421	13	4,692	53
	Foreign	2,507	400	469	3,376	38
	Total	5,470	2,910	522	8,902	.
	Share of total	61	33	6	.	100

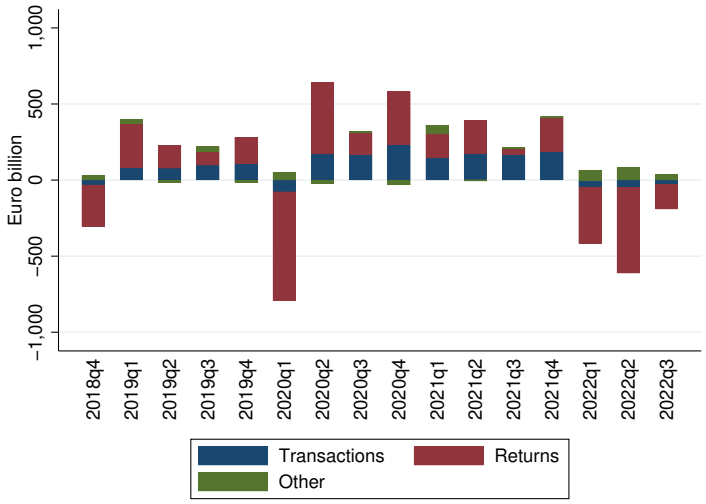

Figure A4. Decomposition of capital flows to investment funds

This figure decomposes the changes in holdings of investment fund share into (1) Transaction flows initiated by investors; (2) Returns from assets under management and (3) Other flows, including foreign exchange revaluations.

Table A3. Holdings by fund SFDR category at the introduction of the SFDR

This table shows the holdings of investment fund shares in 2021 Q1, at the launch of the SFDR. Figures in euro billion.

Investor	SFDR Category			Total	Share
	Art. 8	Art. 9	Other		art. 8 and 9
Banks	51	1	111	162	32%
Mutual Funds	781	69	853	1,702	50%
ICPF	670	53	855	1,577	46%
Household	908	70	1,061	2,038	48%
Other	239	11	179	429	58%
Foreign	1,540	67	2,083	3,690	44%
Total	4,188	271	5,141	9,600	46%

Table A4. Flow decomposition by fund SFDR category

This table decomposes capital flows in investment fund shares for the different investor sectors. Capital flows are broken down into transaction flows, returns of assets and other flows; and by fund SFDR type (articles 8 and 9, or non stated). Figures are computed over the post-SFDR period, from 2021 Q2 to 2022 Q3. Figures in euro billion.

Sector	Flows		Returns		Other		Total
	Other	Art. 8 or 9	Other	Art. 8 or 9	Other	Art. 8 or 9	
Banks	6	-12	-9	-1	2	0	-15
Mutual Funds	-3	46	-52	-61	42	20	-8
ICPF	-9	20	-68	-59	5	18	-94
Household	93	139	-108	-123	43	34	78
Other	18	3	-15	-19	9	5	1
Foreign	27	85	-50	-36	-9	10	27
Total	131	280	-302	-299	92	87	-11