

INVESTMENT FUNDS: FOSTERING THE TRANSITION TO A GREEN ECONOMY— ONLINE ANNEXES

Online Annex 3.1 Data Sources and Fund Sample Description

Online Annex Table 3.1.1. Data Description and Sources		
Variable	Description	Source
Fund variables		
Fund flow	Fund flow as percentage of fund total net assets of the previous quarter. The original flow data are trimmed by 1 percent on the left and right tails.	Morningstar
Fund return	Fund assets' performance as percentage of fund total net assets of the previous quarter. Original returns data are trimmed by 25 bps on the left and right tails.	Morningstar
Fund size	Volume of fund assets in USD.	Morningstar
Fund age	Fund age reported in number of days since the inception date divided by 365.	Morningstar
Fund expense ratio	Percentage of fund assets used to pay for operating expenses and management fees, including 12b-1 fees, administrative fees, and all other asset-based costs incurred by the fund, except brokerage costs. Sales and redemption charges are not included in the expense ratio. The original fund expense ratio data are trimmed by 5 bps on the right and left tails.	Morningstar
Fund style	Global Broad Category, a classification of funds into groups according to their primary asset class orientation, including equity, fixed income, money market, etc.	Morningstar
Fund cash ratio	Percentage of the fund's assets in cash and/or cash equivalents (long positions minus short positions). The original cash ratio data are trimmed by 50 bps on the left and right tails.	Morningstar
Fund carbon management score	The asset-weighted average of the carbon management score for the fund's portfolio holdings with Sustainalytics carbon research. It evaluates a company's preparedness and track record in managing carbon operations and products and services risks that are considered manageable. The management assessment includes carbon-reduction and overall environmental management policies and systems. It also considers a firm's track record of reducing carbon intensity. In their Products & Services, companies managing carbon risk more effectively are reducing the reliance of their products and services on fossil fuels and placing a greater emphasis on developing "greener" products and services. The management assessment includes carbon-reduction goals for products, design and development of sustainable products, and the carbon intensity trend in the use of a firm's products and services.	Morningstar
Fund carbon intensity- MS	Asset-weighted average carbon intensity of funds' portfolio holdings based on emissions data from the Carbon Disclosure Project or estimated values from Sustainalytics. Carbon Intensity is computed for each holding as Total Emissions (metric tons of Co2) / Revenue (Mil USD) and aggregated at the fund level. Sustainalytics looks at the latest reported scope 1 (direct emissions from owned or controlled sources) and scope 2 (indirect emissions from the generation of purchased energy). More than 100 different estimation models are used for non-reporting companies.	Morningstar
Carbon Solutions Involvement	Carbon Solutions Involvement is the percentage of the portfolio's assets involved in carbon solutions, including those related to renewable energy, energy efficiency, green buildings, and green transportation.	Morningstar
Carbon Risk Score	The Carbon Risk Score is the asset-weighted Sustainalytics carbon-risk score of companies held in a portfolio. The score indicates the risk that companies face from the transition to a low-carbon economy. At least 67 percent of portfolio assets must have a carbon-risk rating for a score to be calculated.	Morningstar
Support Climate	The percentage of votes cast in favor of shareholder resolutions that are classified as Climate Change in the Morningstar Shareholder Resolution First Category. Shareholders can vote 'for', 'against', or 'abstain' on each ballot item. A shareholder resolution is a ballot item proposed by one or more shareholders instead of by management of the company.	Morningstar
Passive	A fund is flagged as passive if it is an ETF or an index fund.	Morningstar
Fund innovation score	Asset-weighted average of the environmental innovation category score for a fund's portfolio holdings with Refinitiv. This score reflects a company's capacity to reduce the environmental costs and burdens for its customers, thereby creating new market opportunities through new environmental technologies and processes or eco-designed products. A portfolio is only assessed if data exist for at least 67 percent of the portfolio's assets.	FactSet, Refinitiv, IMF staff calculations
Fund carbon intensity - Refinitiv	Asset-weighted average of holdings with actual emissions data as reported by Refinitiv. Carbon Intensity is computed for each holding as Total Emissions (metric tons of Co2 and Co2 equivalents) / Revenue (Mil USD) and aggregated at the fund level. Emissions include scope 1 and scope 2 emissions. A portfolio is only assessed if data exist for at least 67 percent of the portfolio's assets.	FactSet, Refinitiv, IMF staff calculations
Fund ESG score	Asset-weighted average of holdings of firms' ESG score which is an overall company score based on the self-reported information in the environmental, social, and corporate governance pillars. A portfolio is only assessed if data exist for at least 67 percent of the portfolio's assets.	FactSet, Refinitiv, IMF staff calculations
Fund Environmental pillar score	Asset-weighted average of holdings of firms' environmental pillar score which is the weighted average relative rating of a company's Refinitiv resource use, emissions, and innovation scores. A portfolio is only assessed if data exist for at least 67 percent of the portfolio's assets.	FactSet, Refinitiv, IMF staff calculations

Fund Portfolio Sustainability Score	A weighted average of the trailing 12 months of Morningstar Portfolio Sustainability Scores which are themselves asset-weighted averages of the ESG scores of companies included in a portfolio. A portfolio is only assessed if data exist for at least 67 percent of the portfolio's assets. When averaging across the 12 trailing months, recent observations are weighted more heavily	Morningstar
Fund fused carbon intensity	A fusion of the variable fund carbon intensity - MS and the variable fund carbon intensity - Refinitiv described above. The variable is constructed by rescaling the quarterly cross-sectional distributions of fund carbon intensity - MS to the quarterly cross-sectional distributions of fund carbon intensity - Refinitiv using z-score methodologies. Fund carbon intensity data reported by Refinitiv are preferred for the fused variable and replaced only if there are no values available, or, if the values of the rescaled Morningstar measure exceed the original data based on Refinitiv. ¹	FactSet, Morningstar, Refinitiv, IMF staff calculations
Fund fused transition opportunity score	Variable fusing the fund carbon management score (from Morningstar) and the fund ESG innovation score (from Refinitiv) described above. The variable is constructed by rescaling the quarterly cross-sectional distributions of fund carbon management score to the quarterly cross-sectional distributions of fund the ESG innovation score using z-score methodologies. Fund E-innovation scores are preferred for the fused variable and only replaced if there are no values available, or if the values of the rescaled Morningstar measure exceed the original value based on Refinitiv data.	FactSet, Morningstar, Refinitiv, IMF staff calculations
Fused Sustainability Score Dummies	Indicator variables identifying funds with high sustainability scores. They are based on Morningstar's fund portfolio sustainability score and the fund's ESG score using matched FactSet and Refinitiv data. The fused indicator variables are constructed as a union of the indicators identifying the funds with the highest sustainable scores (e.g., the top decile) from each source.	FactSet, Morningstar, Refinitiv, IMF staff calculations
Fund sustainability label	A fund is labelled as sustainable if it has a sustainability-related fund name or if it is flagged as sustainable by Bloomberg, Lipper, or Morningstar. The following words are considered sustainability-related: sustainable, ESG, social, responsible, SRI, impact, ethic, green, environment, earth, water, waste, climate, renewable, clean, and carbon. The labels by third-party data providers rely on self-declared information from fund prospectuses and mandates.	Bloomberg Finance L.P., Lipper Refinitiv, Morningstar, IMF staff calculations
Fund environment label	A fund is labelled as environment-themed if it has an environment-related fund name or if it is flagged as environment-themed by Bloomberg, Lipper, or Morningstar. The following words are considered environment-related: green, environment, earth, water, waste, climate, renewable, clean, and carbon. The labels by external data providers rely on self-declared information from fund prospectuses and mandates.	Bloomberg Finance L.P., Lipper Refinitiv, Morningstar, IMF staff calculations
Fund climate label	A fund is labelled as climate-themed if it has a climate-related fund name or if it is flagged as climate-themed by Bloomberg, Lipper, or Morningstar. The following words are considered climate-related: climate, renewable, clean, and carbon. The labels by external data providers rely on self-declared information from fund prospectuses and mandates.	Bloomberg Finance L.P., Lipper Refinitiv, Morningstar, IMF staff calculations
Climate news shocks		
WSJ news index	Climate change news index based on textual analysis of Wall Street Journal articles.	Engle and others (2020)
NYT CC news index	Index produced using the same methodology as the WSJ news index but applied to New York Times articles.	Brian Reis and Bob Engle (V-Lab)
NYT Tag news index	The proportion of articles in the New York Times that are classified as being on Climate Change or Global Warming	Brian Reis and Bob Engle (V-Lab)
Google news search	Google Trend worldwide news search on "climate change" related topics	Google Trend
Climate news event	A quarter in which the value of one of the four above-listed news index is in the top decile of the index's distribution.	IMF staff calculations
Macro-financial variables		
VIX	Chicago Board Options Exchange's Volatility Index	Bloomberg Finance L.P.
Term spread	10-year US treasury yield minus 3-month US treasury yield	Bloomberg Finance L.P.
Credit risk spread	US corporate BBB/Baa index yield minus 10-year US treasury yield	Bloomberg Finance L.P.

¹ The distribution of carbon intensity changes only marginally if instead the Morningstar data is preferred when it is lower than the Refinitiv data.

US interest rate level proxy	US 3-month treasury yield	Bloomberg Finance L.P.
US dollar exchange rate basket	Index tracking the performance of a basket of ten leading global currencies versus the U.S. Dollar.	Bloomberg Finance L.P.
Market total return index	Total market index representing all the stocks trading in a country's stock market	Refinitiv
Short-term risk-free rate	3-month government bond yield	Refinitiv
Security issuance variables		
Bonds deal total face value	Total value offered of all bond tranches regardless of eligibility	Dealogic
Equity share offered	Total shares including overallocation offered in all tranches	Dealogic
Firm-level variables		
ESG score	Overall company ESG score based on the self-reported information in the environmental, social and governance pillars.	Refinitiv
E score	Weighted average relative rating of a company based on reported environmental information.	Refinitiv
Transition Opportunity score	Refinitiv's Innovation score. A company's capacity to reduce the environmental costs and burdens for its customers, and thereby creating new market opportunities through new environmental technologies and processes or eco-designed products	Refinitiv
Carbon intensity	Total CO ₂ and CO ₂ equivalents emission in tons divided by net sales or revenue in million US dollars.	Refinitiv
Market capitalization	Stock price multiplied by the total number of outstanding shares	Refinitiv
Leverage ratio	The ratio of the book value of debt to the book value of equity	Refinitiv
Market-to-book ratio	The ratio of the market value of equity to the book value of equity	Refinitiv
Return on assets	The ratio of operating income before depreciation to total assets	Refinitiv
Short-term debt to asset ratio	The ratio of debt in current liabilities to total assets	Refinitiv
Tangibility	The ratio of property, plants, and equipment to total assets	Refinitiv
Stock return	The cumulative return of an issuer's equity during the previous 12 months	Refinitiv
Stock total return index	The return index for a stock expressing the theoretical growth in value of a shareholding over a specific period, assuming that dividends are re-invested to purchase additional units of the stock	Refinitiv
Source: IMF Staff		

Investment fund sample description

The investment fund dataset comprises 52,880 open-ended funds sourced from Morningstar. Of those, 36,535 were in existence at the end of 2020. The sample period extends from 2010:Q1 to 2020:Q4. In the chapter's regression analyses, funds are included only if assets under management exceeded \$500 million at least once over the entire sample period. There were 18,500 such funds in existence at the end of 2020. Their aggregate assets under management amounted to about \$45 trillion versus \$49 trillion in the full sample. The sample investment funds are domiciled in 71 countries, which are grouped into the following 5 regions: China, European Union, United States, Other Advanced Economies, and Other Emerging Markets.² They can also be grouped into the following nine global broad category groups: allocation, alternative, commodities, convertibles, equity, fixed income, miscellaneous, money market, and property.

² The United Kingdom is included in the "Other Advanced Economies" region over the entire sample period.

Online Annex 3.2. Additional Stylized Facts

This annex provides additional stylized facts on the sample funds' transition-related scores by label, on industry-level ownership shares by fund label, and on the decomposition of the yearly change in the sample's transition opportunity score and carbon intensity.

Transition-related score distributions

Panels 1 and 2 of Online Annex Figure 3.2.1 compare the distributions of sustainable funds' transition opportunity score and carbon intensity with those of their conventional peers. By contrast with the climate-themed funds discussed in the chapter, sustainable funds do not tilt toward assets with higher transition opportunity scores, but they do hold assets with lower levels of carbon intensity. Panels 3 and 4 of the same figures show the distributions of climate funds' for two additional transition-related metrics, namely Morningstar's Carbon Solutions Involvement score and Carbon Risk Score, and compares them with that of their conventional peers. Consistent with the evidence presented in the chapter, climate themed funds are heavily exposed to firms considered involved in developing carbon solutions. Panel 5 of the same figure shows the distribution of a transition-opportunity score constructed only with raw metrics that are directly related to greenhouse gas emissions. The results are similar compared to those with the baseline transition-opportunity score further supporting the chapter's finding that climate themed funds tilt their portfolios toward firms engaged in the transition, even though the sample size is reduced.

Industry-level ownership by fund label

Online Annex Figure 3.2.1 panel 6 shows the ownership share of an industry by each of three mutually exclusive fund labels (sustainable ex. environment, environment ex. climate, and climate) as of end-2020. For each fund category, ownership is calculated first for each firm as the total amount of equity holdings by funds in that category divided by total market capitalization of the firm; it is then aggregated to the industry level using weights based on firm-level market capitalization. Industries are defined using the North American Industry Classification System (NAICS) at the two-digit level. The transition-sensitive industries are defined similarly to the "climate-policy-relevant sectors" in Battiston and others (2017). Industries that are not transition-sensitive, apart from finance, are included in the "Other" category.

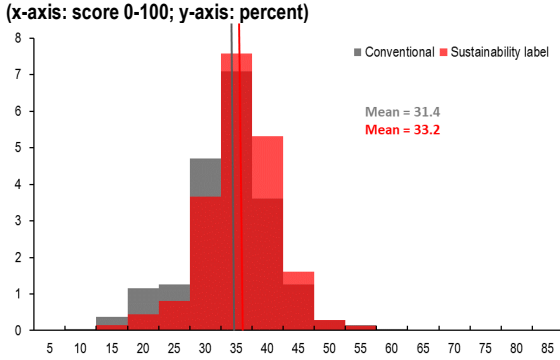
Decomposition of the yearly change of transition opportunity score and carbon intensity

Panels 1 and 2 of Online Annex Figure 3.2.2 show the yearly change in sample funds' transition opportunity score and carbon intensity vis-à-vis the contributions to these changes from changes in individual firm scores (as opposed to changes in portfolio weights). The yearly change is calculated as the four-quarter difference in fund portfolio transition opportunity score and carbon intensity at the end of each year. The contributions to the fund-level changes in scores driven by changes in firm-level scores is calculated as the difference in fund-level scores between a hypothetical scenario where funds' current holdings are matched with firm-level scores of the previous year and the actual scenario, where current fund holdings are matched to current firm-

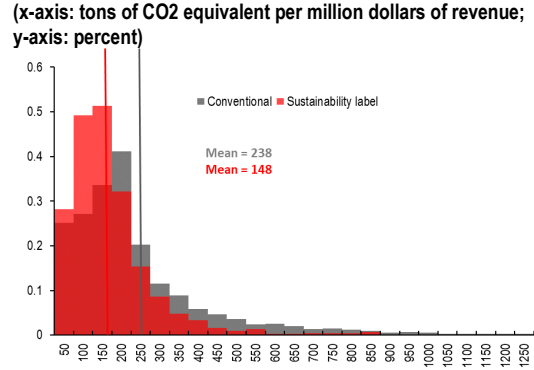
level scores. Calculations are performed first at the individual fund level and then aggregated, weighted by fund size.

Online Annex Figure 3.2.1. Additional Stylized Facts -Distribution of Transition-related Scores and Firm Ownership Composition

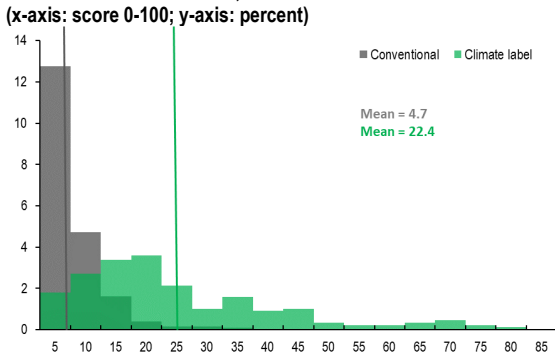
1. Transition-Opportunity Score Distribution, Sustainable versus Conventional Funds, 2020:Q4



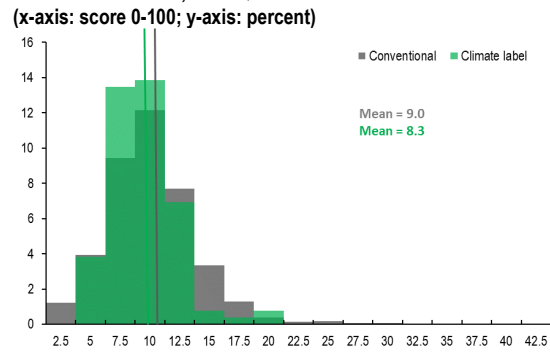
2. Carbon-Intensity Score Distribution, Sustainable versus Conventional Funds, 2020:Q4



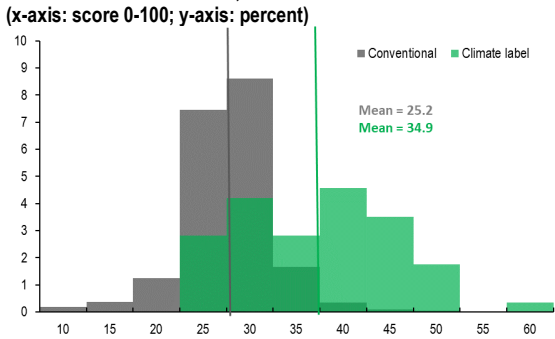
3. Morningstar Carbon Solutions Involvement Distribution, Climate versus Conventional Funds, 2020:Q4



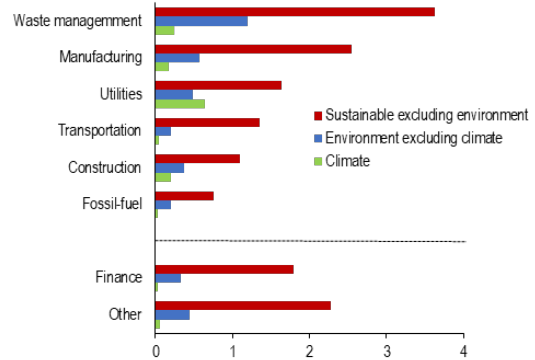
4. Morningstar Carbon Risk Score Distribution, Climate versus Conventional Funds, 2020:Q4



5. Alternative Transition-Opportunity Score Distribution, Climate versus Conventional Funds, 2020:Q4



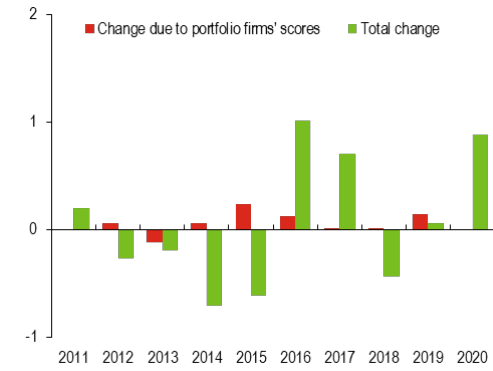
6. Ownership of Firms by Type of Fund, Various Industries (Percent of total market capitalization)



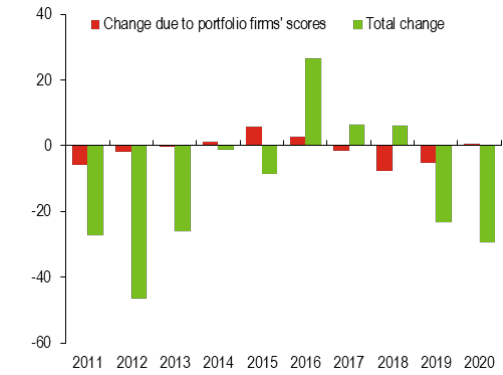
Sources: Morningstar; Bloomberg Finance L.P.; Lipper; FactSet; Refinitiv; and IMF staff.

Online Annex Figure 3.2.2. Decomposition of the Sample Funds' Yearly Change in Transition Opportunity Score and Carbon Intensity

1. Yearly Change in Transition Opportunity Score
(Change in index; index takes values between 0 and 100)



2. Yearly Change in Carbon Intensity
(Tons of CO2 equivalent emissions per million dollars of revenue)



Sources: FactSet; Morningstar; Refinitiv; and IMF staff calculations.

Online Annex 3.3. Fund Labels and Sustainability Scores as Drivers of Fund Flows and of Proxy Voting Decisions

Fund Flow Analysis

The following model is estimated to examine the relationship between fund sustainability labels, sustainability scores, and fund flows:

$$Flow_{i,c,r,t} = \beta_1 Label_{i,c,r,t} + \beta_2 Sustainability_{i,c,r,t} + \beta_3 Scores_{i,c,r,t} + \beta_4 Controls_{i,c,r,t} + \nu_{c,y} + \delta_{r,y} + \varepsilon_{i,c,r,t} \quad (1)$$

where i is a fund, c is a Morningstar global broad category, r is a domicile region, t is a quarter, and y is the year corresponding to quarter t . $fFow_{i,c,r,t}$ is the net flow into the fund, $Label_{i,c,r,t}$ is a vector of dummies capturing the fund sustainability label, environment label, and climate label. $Sustainability_{i,c,r,t}$ is a dummy indicating that the fund belongs to the top decile of funds sorted by the chapter's broad sustainability rating, and $Scores_{i,c,r,t}$ is a vector including the transition opportunity and carbon intensity scores. $Controls_{i,c,r,t}$ is a vector of fund-level control variables including lagged flows, lagged returns, the logarithm of fund size, expense ratio, and fund age. $\nu_{c,y}$ and $\delta_{r,y}$ are category-year fixed effects and region-year fixed effects. Standard errors are clustered at the fund-level. The dataset contains 6,454 funds from 33 countries, and the sample period extends from 2010:Q1 to 2020:Q4.

Proxy Voting Analysis

The following model is estimated to examine the relation between fund sustainability labels, sustainability scores, and proxy voting decisions:

$$SupportClimate_{i,c,r,y} = \beta_1 Label_{i,c,r,y} + \beta_2 Sustainability_{i,c,r,y} + \beta_3 Scores_{i,c,r,y} + \beta_4 Controls_{i,c,r,y} + \nu_{c,y} + \delta_{r,y} + \varepsilon_{i,c,r,y} \quad (2)$$

where notations are as in Equation (1) except that $Label_{i,c,r,y}$ does not include the climate label separately because of the very small number of observations, and $Controls_{i,c,r,y}$ now include a dummy that indicates whether the fund is a passive fund, the logarithm of fund size, expense ratio, and fund age. $SupportClimate_{i,c,r,y}$ is the percentage of votes on climate resolutions by the fund that were cast in favor of the resolution. The dataset contains 1,521 funds from the United States, and the sample period extends from 2015 to 2020.

Online Annex 3.4. Sustainable Fund Flows as Drivers of Firm-Level Security Issuance and Stock Returns

Issuance Analysis

The analysis covers both bond issuances and seasoned equity offerings (SEOs). The regression analysis is focused on a sample of firms in transition-sensitive sectors that issued bonds or SEOs at least once during the period 2010:Q1-2021:Q1. The total number of firms is 6449, of which 5446 issued equity and 3722 issued bonds.³

The empirical analysis considers first the intensive margin (the issuance amount conditional on issuance), and second the extensive margin (the likelihood of issuance). In each analysis, the following fixed-effect panel regression specification is estimated:

$$Issuance_{i,t}^{X,Type} = \alpha_s + \rho_t + \beta_1 Green_{i,t-1} + \beta_2 Flow_sust_{i,t}^{Type} + \beta_3 Flow_conv_{i,t}^{Type} + \beta_4 Green_{i,t-1} \times Flow_sust_{i,t}^{Type} + \beta_5 Green_{i,t-1} \times Flow_conv_{i,t}^{Type} + \gamma Controls_{i,y-1} + \varepsilon_{i,t}, \quad (1)$$

where $X \in \{intensive\ margin, extensive\ margin\}$ and $Type \in \{bonds, equities\}$. The dependent variable is defined as $Issuance_{i,t}^{X,Type} = Issuance_amount_{i,t} / Total_assets_{i,t-1}$ in the intensive margin analysis, and $Issuance_{i,t}^{X,Type} = Dummy(Issuance_amount_{i,t} > 0)$ in the extensive margin analysis. There are four firm-level “Green” indicators (ESG score, E score, transition opportunity score, and - carbon intensity), which all take a higher value if a firm is considered “greener”. The quarterly values of these variables are obtained through linear interpolation of the yearly values. $Flow_sust_{i,t}^{Type}$ and $Flow_conv_{i,t}^{Type}$ are two variables capturing a firm’s securities’ exposure to net inflows to sustainable investment funds and to conventional funds respectively. The two flow variables are defined as in Zhu (2021) as the weighted average of net flows into funds that hold a firm’s outstanding securities. For instance, when looking at bond issuance, firm i ’s exposure to sustainable fund inflows is

$$Flow_sust_{i,t}^{Bonds} = \sum_j \frac{(SustainableFlow_{j,t} * Holding_{j,i,t-1})}{Outstanding\ Bonds_{i,t-1}}, \quad (2)$$

where $SustainableFlow_{j,t}$ is the net inflow to lagged total net assets ratio of investment fund j in quarter t . Similarly, the exposure to conventional funds’ net inflows is defined as

$$Flow_conv_{i,t}^{Bonds} = \sum_j \frac{(ConventionalFlow_{j,t} * Holding_{j,i,t-1})}{Outstanding\ Bonds_{i,t-1}}, \quad (3)$$

The exposure variables in the equity issuance analysis are defined similarly but with lagged market capitalization in the denominator. The regressions control for sector fixed effects α_s and quarter fixed effects ρ_t , as well as market capitalization, leverage ratio, market-to-book ratio,

³ To identify transition-sensitive sectors, SIG codes in Dealogic are hand-matched with the 4-digit NACE Rev2 sector codes of climate-policy-relevant sectors in Battiston et al. (2017) Annex Table 3 (https://static-content.springer.com/esm/art%3A10.1038%2Fnc1climate3255/MediaObjects/41558_2017_BFnc1climate3255_MOESM272_ESM.pdf). The housing sector is excluded.

ROA, tangibility, short-term-debt-to-asset ratio, and stock returns, measured at the end of the first lag of quarter t 's calendar year (denoted by y).⁴

Stock return analysis

The second section of this annex analyzes the relationship between a flow-based equity price pressure measure and abnormal returns. The price pressure measure is constructed as in Khan et al. (2012). It is the difference between buying pressure on shares of firm i due to high-net-inflow investment funds and the corresponding selling pressure due to high-net-outflow investment funds:

$$Pressure_{i,t} = [\sum_j (\max(0, \Delta holding_{i,j,t}) | Flow_{j,t} > 90th\ percentile) - \sum_j (\max(0, -\Delta holding_{i,j,t}) | Flow_{j,t} < 10th\ percentile)] / SharesOutstanding_{i,t-1}, \quad (4)$$

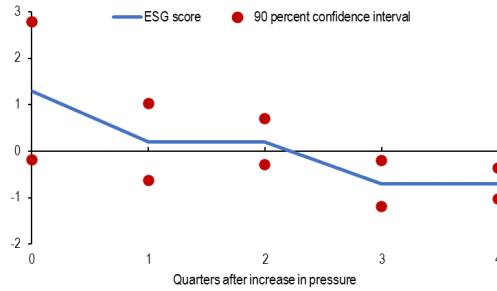
where $holding_{i,j,t}$ is the US dollar amount of shares of firm i held by fund j in quarter t and $SharesOutstanding_{i,t-1}$ is US dollar amount of shares of firm i outstanding. Price pressure measures are constructed using the subsample of sustainable funds and of conventional funds respectively. The econometric analysis consists in regressing firm i 's h -quarter-ahead CAPM-based abnormal returns on the price pressure from flows to sustainable funds in the current quarter, the $Green_{i,t-1}$ variable, and their interaction. The set of explanatory variables includes the same control variables as in Equation (1) plus the price pressure from flows to conventional funds and its interaction with $Green_{i,t-1}$. The analysis shows that a one percentage point increase in price pressure leads to a significantly larger contemporaneous increase in abnormal returns for firms with a higher ESG score or E score (Online Figure 3.4.1). However, there is almost no difference in price impact for firms with higher transition opportunity score or lower carbon intensity.

⁴ There are 220 sectors according to Dealogic's Specific Industry Groups (SIG) classifications.

Online Annex Figure 3.4.1. Impact of Increase in Price Pressure from Sustainable Fund Flows on “Greener” Firms’ Abnormal Equity Returns

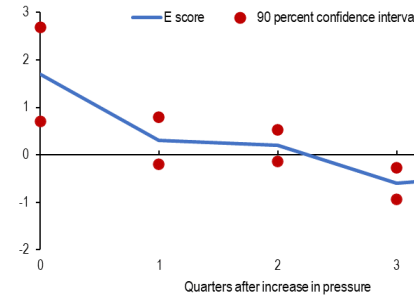
Price pressure from sustainable fund flows has a contemporaneous impact on equity returns of firms with higher ESG scores ...

1. Impact of an increase in sustainable funds’ price pressure on equity returns of firms with high ESG scores relative to firms with low ESG scores
 (Percentage points change in quarter-on-quarter abnormal returns h quarters after a one percentage point increase in price pressure)



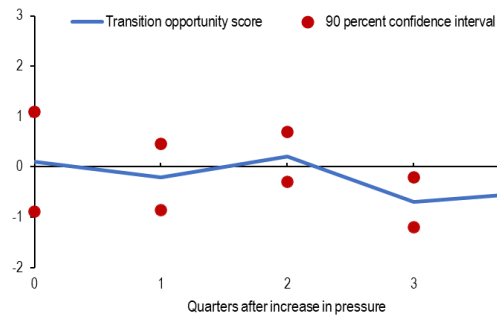
... and of firms with higher E scores.

2. Impact of an increase in sustainable funds’ price pressure on equity returns of firms with high E scores relative to firms with low E scores
 (Percentage points change in quarter-on-quarter abnormal returns h quarters after a one percentage point increase in price pressure)



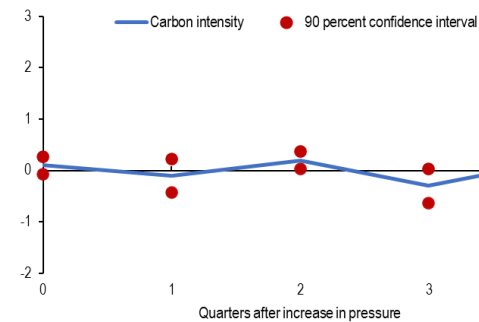
However, price pressure from sustainable fund flows does not affect equity returns of firms with higher Transition Opportunity scores ...

3. Impact of an increase in sustainable funds’ price pressure on equity returns of firms with high Transition Opportunity scores relative to firms with low Transition Opportunity scores
 (Percentage points change in quarter-on-quarter abnormal returns h quarters after a one percentage point increase in price pressure)



... or lower carbon intensity.

4. Impact of an increase in sustainable funds’ price pressure on equity returns of firms with low carbon intensities relative to firms with high carbon intensities
 (Percentage points change in quarter-on-quarter abnormal returns h quarters after a one percentage point increase in price pressure)



Sources: Datastream; Refinitiv; Factset; Morningstar; and IMF staff calculations.

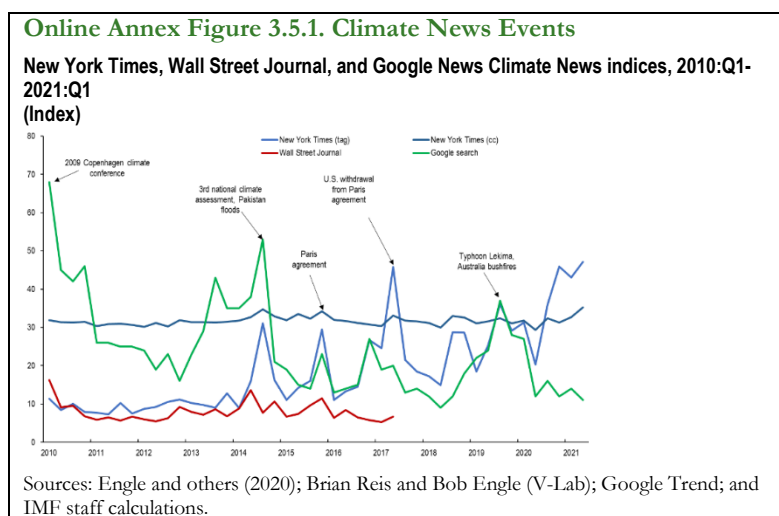
Note: The cross-firm difference of the equity return impact of a one percentage point increase in sustainable funds’ price pressure, calculated based on trading pressure of high inflow sustainable investment funds. The dependent variable is the firm-level h-quarter ahead CAPM-based quarter-on-quarter equity abnormal returns. The firm sample is restricted to those in transition-sensitive sectors. The blue lines represent the mean difference in the equity return impact on firms with one-unit higher ESG scores, higher E scores, higher transition opportunity scores, and one-unit lower carbon intensity. The red dots indicate 90 percent confidence intervals

Online Annex 3.5. Climate Change News, Fund Performance, and Liquidity Analysis

This annex provides additional information on the chapter’s analysis relating climate-change-related news events to fund flows and returns, as well as to changes in funds’ carbon intensity and transition opportunity scores.

Climate Change News

Climate-change-related news events are identified based on existing climate-change-related news indices, starting in 2010. The analysis is based on four indices which reflect the occurrence of climate-change-related phrases, articles, or search queries across three major news sources, namely the New York Times, the Wall Street Journal, and Google News (see Online Annex Table 3.1.1. for details on the four indices). The raw indices are aggregated from monthly to quarterly frequency and dummies are constructed based on the top decile of the quarterly distribution of each news index. The union of these dummies results in nine quarters where attention to climate change in news outlets is heightened (“climate news events”). A few of the identified quarters can be matched to significant transition-related events, such as the Paris Agreement in 2015:Q4, or the announcement of the US withdrawal from the Paris Agreement in 2017:Q2 (Online Annex Figure 3.5.1).



Climate change news and fund performance

The following model is estimated to evaluate the impact of climate-change-related news events on investment funds’ performance, net flows as well as changes in transition-related scores:

$$Y_{i,c,r,t} = \beta_1 News_{t-1} + \beta_2 Carbon_{i,c,r,t} + \beta_3 News_{t-1} \times Carbon_{i,c,r,t} + \beta_4 Opportunity_{i,c,r,t} + \beta_5 News_{t-1} \times Opportunity_{i,c,r,t} + \beta_6 ControlVariables_{i,c,r,t} + v_{c,y} + \delta_{r,y} + \epsilon_{i,c,r,t}, \quad (1)$$

where $Y_{i,t}$ is either the return, the net inflow, the change in carbon intensity, or the change in transition opportunity score of fund i in quarter t , $News_t$ is a climate change news dummy—as described above—taking the value 1 if quarter t belongs to the union of top deciles of the distributions of the four news indices, $Carbon_{i,t}$ is the carbon intensity measure for fund i , and

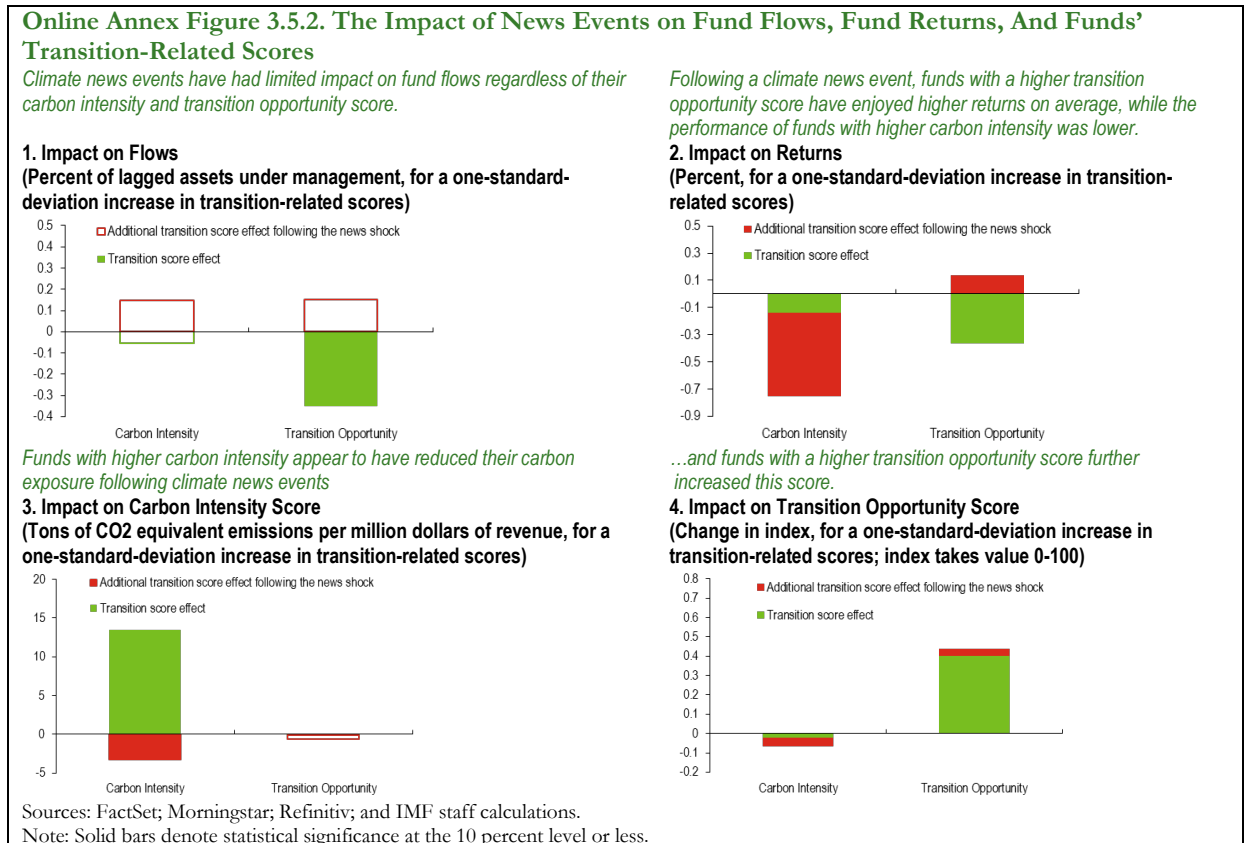
$Opportunity_{i,t}$ is the transition opportunity score. $ControlVariables_{i,t}$ are lagged flows, lagged returns, natural logarithm of fund size, fund’s age, fund’s expense ratio. $v_{c,y}$ and $\delta_{r,y}$ are category-year fixed effects and region-year fixed effects with c , r , and y denoting fund category, region, and year respectively. The panel is estimated for each climate news event separately in the baseline.

Robustness analysis

To control for additional factors that might have played a role in the impact of news events on fund performance and scores, the following robustness checks were implemented:

- estimating a panel regression with all nine news events as the source of shock.
- using an alternative specification with fund-year fixed effects.
- examining the effect of carbon intensity and transition opportunity in two separate equations
- using individual news index series as the source of climate news events.

The result for the estimation with all events included as a source of news shock are reported in Online Annex Figure 3.5.2. In line with the baseline analysis, the results remain mixed for fund flows and returns, and point to limited portfolio adjustments following climate news events. The results are also robust with the alternative fund and year fixed effects, and with using only the carbon intensity or the transition opportunity score variable in the estimation, with the union of news events and with individual news events. Finally, using individual news indices gives mixed results in the panel estimation, confirming the limited impact of climate news events on fund flows and returns so far.



The Effect of Transition-Related Scores on Funds' Cash Balances

The chapter estimates the following model to assess the impact of transition opportunity score and carbon intensity on fund cash balances:

$$Cash_{i,c,r,t} = \beta_1 \begin{pmatrix} Label_{i,c,r} \\ Carbon_{i,c,r,t} \\ Opportunity_{i,c,r,t} \end{pmatrix} + \beta_2 \begin{pmatrix} Label_{i,c,r} \times Carbon_{i,c,r,t} \\ Label_{i,c,r} \times Opportunity_{i,c,r,t} \end{pmatrix} + \beta_3 FundControls_{i,c,r,t} + \beta_4 ETF_{i,c,r,t} + \beta_5 MacroFinancialControls_t + v_{c,y} + \delta_{r,y} + \epsilon_{i,c,r,t}, \quad (2)$$

where *Cash* denotes fund *i*'s net liquidity buffers held as cash or cash equivalents in quarter *t*, *Label* is a dummy variable indicating whether the fund is sustainable or not, *Carbon* is the carbon intensity, *Opportunity* is the transition opportunity score, and control variables include two specific sets of variables. First, fund-specific controls that include fund *i*'s lagged flows, its log size, and its annual expense ratio, all in quarter *t*. In addition, the specification includes an ETF dummy. Second, a set of macro-financial controls comprised of the Chicago Board Options Exchange VIX, the term spread between 10-year and 3-month US treasuries, the credit risk spread between the yield on the CSI BBB/Baa corporate debt index and the 10-year treasury yield, the yield on 3-month US treasuries and the Bloomberg index for a basket for the US dollar exchange rate versus ten leading global currencies, all in quarter *t*. Moreover, the specification also includes fixed effects for the combinations of domicile regions and years ($\delta_{r,y}$) and the combinations of fund categories and years ($v_{c,y}$). Models are estimated separately using OLS and unconditional quantile models to generate mean as well as quantile coefficients, with a view to test for potential heterogeneous effects across the distribution of cash buffers.

Robustness analysis

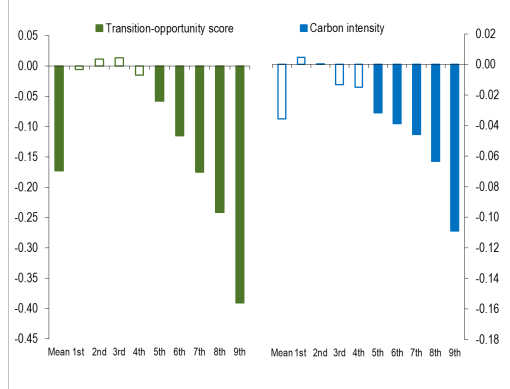
Results remain robust when switching to pooled panel models (Online Annex Figure 3.5.3, panel 1) and partially robust for a substitution of the sustainability label by a variable indicating funds in the highest 32.5 (or, alternatively, ten) percentiles of the distribution of a sustainability score observed for funds of the same fund style in a given quarter (Online Annex Figure 3.5.3, panel 2). The alternative sustainability identifier merges Morningstar and Refinitiv data and follows the idea of the Morningstar globe categories, identifying the highest sustainability score part of the fund sector for a given cut-off value separately in each data source and subsequently forming the union of the dummies constructed in the first step. For this replacement, however, the coefficients for the interactions with the sustainability variable become positive and significant, offsetting for some deciles the coefficients obtained for the transition opportunity and carbon intensity variables almost completely. The inclusion of news events and their interactions with transition opportunities and carbon intensities do not change the results presented in the main text. The results, however, do not prove robust for the replacement of the fixed effects specification detailed above by fund and year fixed effects.

Online Annex Figure 3.5.3. Sensitivity of Funds' Cash Buffers to Changes in Transition-Related Scores

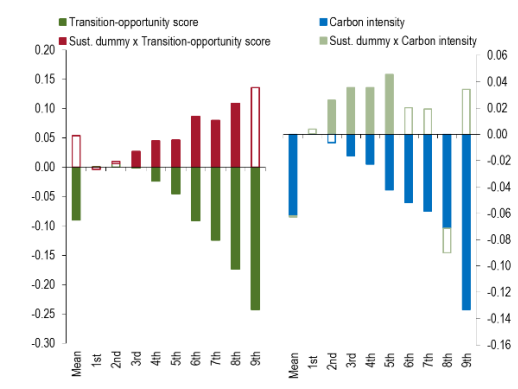
Results remain qualitatively similar in a pooled panel model...

...or when replacing the sustainability label by an identifier based on high sustainability scores.

1. Sensitivities to One Standard Variation Shocks, Various Deciles of the Cash Buffer Distribution (Percent of Fund Assets)



2. Sensitivities to One Standard Variation Shocks, Various Deciles of the Cash Buffer Distribution (Percent of Fund Assets)



Sources: Bloomberg Finance L.P; FactSet, Morningstar; Refinitiv; and IMF staff calculations.

Note: Solid bars denote statistical significance at the 10 percent level or less. In panel 2, the high sustainability score is based on the top 32.5 percentiles.

Online Annex 3.6. Flow-Performance Analysis

The flow-performance relationship is evaluated using the following model specification:

$$Y_{i,c,r,t} = \beta_1 \left(\frac{flow_{i,c,r,t-1}}{return_{i,c,r,t-1}} \right) + \beta_2 Label_{i,c,r} + \beta_3 Label_{i,c,r} \times \left(\frac{flow_{i,c,r,t-1}}{return_{i,c,r,t-1}} \right) + \beta_4 Controls_{i,c,r,t} + v_{c,y} + \delta_{r,y} + \epsilon_{i,c,r,t} \quad (1)$$

where the dependent variable is either fund i 's contemporaneous flows or its returns. The right-hand side of the equation includes lagged flows and returns, a dummy indicating whether fund i has a sustainable label, the interactions of this variable with lagged returns and flows, a set of fund-specific controls and fixed effects. Fund-specific controls include fund i 's log size, its age, and its annual expense ratio, all in quarter t . The fixed effects capture the combined effects of domicile region r and year y as well as the combined effects of fund category c and year y .

As explained in Online Annex 3.1, sustainability labels are constructed based on the union of labels from four sources, namely Bloomberg, Lipper, Morningstar and a textual analysis of fund names. Models are estimated separately using OLS and unconditional quantile models to generate mean as well as quantile coefficients (the latter by using the recentered influence function regression methodology discussed in Rios-Avila 2020), with a view to test for potential heterogeneous effects across the distribution of the endogenous variable of interest.

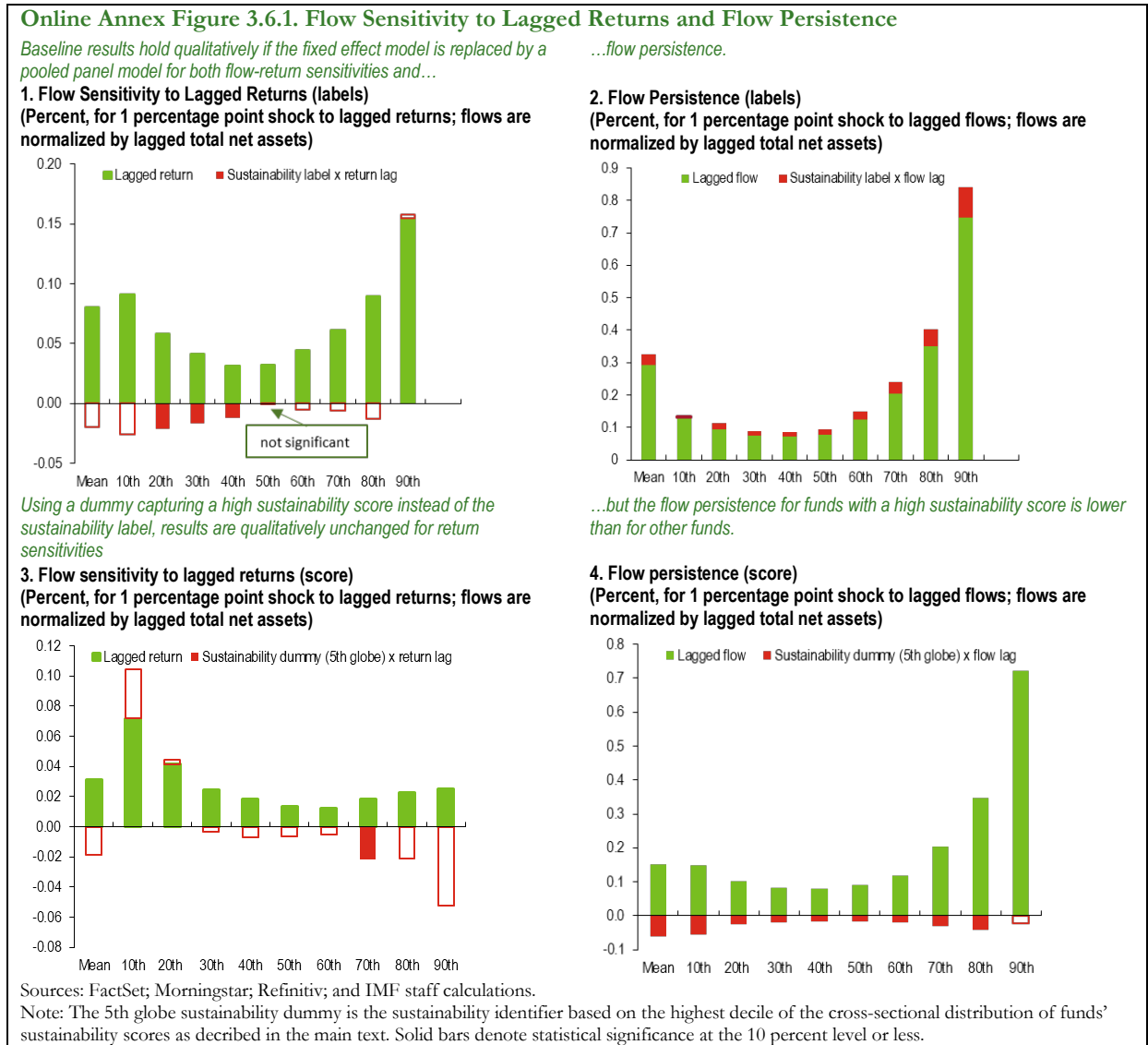
Robustness analysis

The following robustness checks were performed:

- Pooled panel estimation with no fixed effects. In the mean regressions results remain robust for flow persistence, but not for the lower sensitivity of sustainable fund flows to past returns. However, the results remain robust for the quantile regressions (Annex Figure 3.6.1, panels 1-2)
- An alternative specification of fixed effects by replacing the two sets of joint fixed effects with fund-year fixed effects. Results for both mean and quantile regressions are robust to this specification, although the magnitude of the persistence is reduced in the mean regression and for higher flow deciles.
- Replacing the sustainability label by an identifier for sustainability based on the highest quantiles of respective funds' portfolio sustainability scores (top 10 percentiles). In this specification flows are not significantly less sensitive to past performance for sustainable funds, and the reinforcements of the flow persistence for sustainable funds also flips to a marginal moderation of this feature (Online Annex Figure 3.6.1, panels 3 and 4)
- Controlling for strong versus weak past performance and for high and low volatility in financial markets for the mean regression model. Equation (1) is augmented by a triple interaction of a dummy indicating whether return in previous quarter has been negative, past returns, and sustainability indicator. Raw return as well as alpha as a measure of excess return in a Fama-French three-factor (FF3) model are used in separate estimations. Results using the FF3 alpha point to lower sensitivity of sustainable funds to past poor performances, while these results do not hold for raw returns. The analysis also replaced the dummy for past negative return with high-volatility dummy, constructed as the top one-third quantile of the

VIX distribution. Results suggest that the sensitivity of sustainable funds has not differed from that of conventional funds during high volatility episodes.

- Restricting the sustainability labels to each of the four sources of labels within mean regression models. Lower sensitivity of flow to past performance, and persistence of flows for funds whose name include a sustainability term are confirmed. The same conclusion cannot be drawn for funds with climate-related terms in their names.



Online Annex 3.7. Box on Survey of Asset Managers

A short survey of portfolio managers, asset manager representatives, and asset owner representatives was conducted through a series of calls during July 21-August 16, 2021. Survey answers were collected from 26 respondents representing 11 large and very large asset managers, and 1 asset owner. These respondents had accepted an invitation to participate in the survey, which leading asset management trade associations had kindly sent to their members. Representatives of the asset owner were contacted directly by the chapter team. Surveyed institutions were based in the United States, Advanced Europe, Australia, and Japan. Surveyed portfolio managers managed equity funds, fixed income funds, private debt funds, or infrastructure funds. The following multiple-choice questions were covered:

1. How do you integrate climate change mitigation in your investment strategy for funds with a sustainability/environment/climate label (select all that apply)?

- | | | |
|---|--|---|
| <input type="checkbox"/> Negative/exclusionary screening | <input type="checkbox"/> ESG/Climate change risk integration | <input type="checkbox"/> Positive/best-in-class screening |
| <input type="checkbox"/> Sustainability/climate-themed investment | <input type="checkbox"/> Impact investing | <input type="checkbox"/> Other: _____ |

2. Which tools/heuristics do you use to incorporate risks and opportunities related to the transition to a low-carbon economy in your investment decisions (select all that apply)?

- | | | |
|--|--|---|
| <input type="checkbox"/> Sector/industry classification | <input type="checkbox"/> ESG-type score | <input type="checkbox"/> Carbon footprint related to securities in your portfolio |
| <input type="checkbox"/> Expected carbon reduction related to securities in your portfolio | <input type="checkbox"/> Valuation model / scenario analysis | <input type="checkbox"/> Other |

3. Which obstacles do you face in integrating risks and opportunities related to the transition to a low-carbon economy in your investment decisions? (1=most severe to 4=less severe).

1 2 3 4

- Lack of current data
- Lack of forward-looking data
- Lack of a commonly accepted taxonomy
- Multiplicity of disclosure standards

4. Looking specifically at climate-change-related risks and opportunities, please rank the three most important factors for your portfolio decisions over the **next 3 years** (1 = most important to 3 = least important)

1 2 3

Risks related to

- Increase in intensity/severity of climate-change-related physical events
- Increase in carbon taxation and emissions-related regulation
- Technological change

Changes to consumer preferences towards green products and services
Litigation

1 2 3

Opportunities related to

Climate change mitigation

Climate change adaptation

Technological change

Changes to consumer preferences towards green products and services

Box Figure 3.1.1. shows the survey results by institution for the first two questions, and for every individual respondent for the third and fourth questions.

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