HONG KONG MONETARY AUTHORITY

Research Memorandum 01/2024

18 January 2024

AN ASSESSMENT OF THE EXPOSURE OF ASIA-PACIFIC INVESTMENT FUNDS TO CLIMATE-RELATED RISKS

Key points:

- *The exposure of investment funds to climate-related risks could be a significant source of financial stability risks. This is increasingly relevant to the Asia-Pacific region, where investment funds have witnessed significant growth in their assets under management in recent years. However, possibly due to greater data gaps on climate-related financial risks in emerging market economies (EMEs), there have been limited studies on the climate risk exposure of investment funds domiciled in the Asia-Pacific region.*

- *To shed light on this issue, this study analyses the climate risk exposure of investment funds in Asia-Pacific by using both historical and forward-looking metrics of climate risks for companies held in the funds' portfolios. We find that the climate risk exposure of investment funds varies noticeably across economies in the region, and is generally higher for funds domiciled in EMEs.*

- *In addition, we find that funds with high climate risk exposure are likely to face larger outflow pressures when investors perceive an increase in climate-related risks. This means that in the event of a perceived surge in climate risks, such as an abrupt change in global climate transition policies, funds that are more exposed to climate risks may need to meet potentially large redemptions through a fire sale of assets. Our results suggest that the impacts of climate shocks on fund outflows could be one transmission channel through which climate transition risks affect financial stability, apart from the asset price channel.*

- *Finally, we find that several features of Asia-Pacific investment funds could influence funds' climate risk exposure. Our findings provide support for several policy measures that would be helpful in reducing investment funds' exposure to climate transition risks:*

    - *encourage investment funds to take into account sustainability factors in their investment approach and decision-making process;*

- *encourage fund managers to make a public commitment to applying responsible investment principles to their investment portfolios; and*

- *greater public awareness of climate-related financial risks through education and training, and facilitate the sharing of data on climate-related financial risks among investors and the public.*

Prepared by: Victor Leung, Alexander Ying, Joe Wong and Wilson Wan

Market Research Division, Research Department

Hong Kong Monetary Authority

The views and analysis expressed in this paper are those of the authors, and do not necessarily represent the views of the Hong Kong Monetary Authority.

* The authors would like to thank Lillian Cheung and Eric Wong for their helpful comments and suggestions.

1. INTRODUCTION

Climate change is widely regarded as one of the key challenges facing the world economy today. Climate-related shocks may arise from the physical effects of climate change, such as extreme weather events, as well as from an abrupt transition towards a low-carbon economy, such as sudden shifts in policies designed to mitigate and adapt to climate change. The impacts of such shocks on financial institutions, asset markets and the real economy could be a significant source of financial stability risks.

Investment funds present one notable channel through which climate-related shocks may affect financial stability. These shocks can trigger a shift in investors' perception about climate-related risks, which may lead to a repricing of securities issued by companies that are exposed to climate-related risks. Funds with material investments in these companies may face lower returns and larger outflows, and may have to sell assets at a discounted price to meet redemptions. Moreover, funds can amplify shocks if they have common exposures to companies vulnerable to climate risks and react to shocks in similar ways, such as liquidating assets simultaneously, which would depress asset prices further. Funds with global investment portfolios can also transmit shocks across borders if they react to shocks in one region by selling assets in another.

This source of financial stability risk is increasingly relevant to the Asia-Pacific region. This is because investment funds domiciled in Asia-Pacific have witnessed substantial growth of late, with their assets under management (AUM) rising by 77% from 2017 to 2022.[1] However, possibly due to greater data gaps on climate-related financial risks in emerging market economies (EMEs),[2] there have been limited studies on the climate risk exposure of investment funds in Asia-Pacific.[3]

Against this backdrop, this study aims to shed light on the climate risk exposure of Asia-Pacific investment funds by investigating the following questions:

[1] Based on EPFR data on a sample of nine Asia-Pacific economies from 2017 to 2022. For comparison, funds domiciled in the United States (US) and Europe grew by 39% and 27% respectively over the same period.

[2] FSB (2021) noted that many of the data gaps concerning climate-related risks to financial stability are more acute in emerging market and developing economies than in advanced economies.

[3] There are some relevant studies on funds in Europe and the US. Some find that investment funds are more exposed to climate-sensitive sectors than banks, insurers and pension funds (ESRB (2020)). Others find that climate risks can negatively impact fund flow (Reboredo and Otero (2022), Ceccarelli et al. (2023), and Kuang and Liang (2022)).

1. To what extent are Asia-Pacific investment funds exposed to climate-related risks?
2. Are investment funds with a greater climate risk exposure more sensitive to increases in investors' perception of climate-related risks? In particular, do these funds face a negative impact on fund flows?
3. What features of Asia-Pacific funds may help reduce their climate risk exposure?

The rest of this study proceeds as follows: sections 2, 3 and 4 discuss the above questions in turn; and section 5 concludes and draws out policy implications.

2. CLIMATE RISK EXPOSURE OF ASIA-PACIFIC INVESTMENT FUNDS

2.1 Data and methodology

This study focuses on the exposure of investment funds to climate-related risks associated with the transition to a low-carbon economy. To assess their exposure to transition risks, we utilise two measures available from the data provider Morningstar[4] - carbon intensity and carbon risk score.

Morningstar's carbon intensity measure (hereafter "emissions intensity") is the asset-weighted average scope 1 and scope 2 greenhouse gas (GHG) emissions intensity for the companies in an investment fund's portfolio. GHG emissions intensity measures the magnitude of GHG emissions in metric tons of carbon dioxide (CO_2) equivalent normalised by revenue in millions of US dollars (tCO_2e/US$m).[5] A higher emissions intensity means that a company uses more carbon-intensive processes per unit of revenue and is thus more likely to be at a higher risk of experiencing business disruptions or profitability deterioration in the event of an abrupt climate transition shock.

However, there are limitations to emissions intensity as a climate risk indicator. It is a backward-looking historical indicator of transition risk and does not capture how companies in which a fund has invested are managing such risks or the financial impact that a low-carbon transition may have on these companies.

[4] Morningstar's data providers do not guarantee the accuracy, completeness or timeliness of any information provided by them and shall have no liability for their use.
[5] Scope 1 emissions are from directly emitting sources that are owned or controlled by a company, and scope 2 emissions are from the consumption of energy generated from a company's direct operations.

Therefore, in addition to emissions intensity, we also analyse Morningstar's carbon risk score measure, which is the asset-weighted carbon risk score of companies held in a fund's portfolio. For individual companies, the carbon risk score indicates the risk that a company faces from the transition to a low-carbon economy. This score is forward-looking, as it takes into account (i) the extent to which a company's activities and products align with a low-carbon economy, and (ii) a company's management activities that can mitigate carbon risk exposure. In other words, the carbon risk score measures a company's unmanaged carbon risk.[6]

2.2 Key observations

This section presents key observations on the emissions intensity and the carbon risk scores of investments funds domiciled in nine Asia-Pacific economies.

First, the average emissions intensity of investment funds varies notably across Asia-Pacific economies. Specifically, investment funds domiciled in EMEs exhibit higher average emissions intensity, ranging from 400 to 500 tCO_2e/US$m, compared to investment funds domiciled in advanced economies (AEs), which typically range from around 100 to 400 tCO_2e/US$m (**Chart 1**).[7]

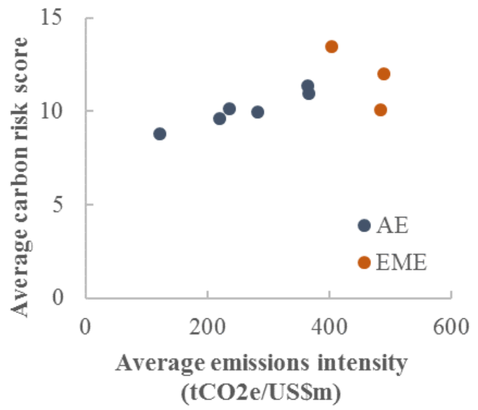
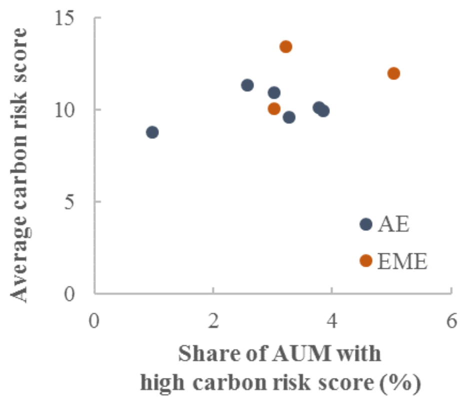
Second, the average carbon risk scores of investment funds in Asia-Pacific are in the low (0-10) or medium (low) (10-15) categories (**Chart 1**). Similar to emissions intensity, funds in EMEs also tend to have higher carbon risk scores than counterparts in AEs. However, while funds with higher emissions intensity tend to also have higher carbon risk scores, the correlation is not always perfect. Therefore, to conduct a more robust and comprehensive climate risk assessment of funds, it may be beneficial to complement historical measures with forward-looking metrics.

In addition to the average overall carbon risk score, we also examined the share of AUM invested in companies with a high carbon risk score (30+). We find that this is generally low (5% or lower) across Asia-Pacific economies (**Chart 2**). While a higher average carbon risk score tends to be associated with a greater share of AUM with a high score, this relationship is also not perfect.

[6] The score is available for (long) equity and corporate bond holdings of a fund. At least 67% of these holdings must have a carbon risk score in order for a fund-level score to be calculated. The score considers a company's carbon intensity, fossil fuel involvement, stranded assets exposure, mitigation strategies and green solutions. Further details can be found in Morningstar Research (2018).

[7] For context, based on an analysis of Hong Kong domiciled funds' portfolios, the average emissions intensity of the high-emitting utilities, materials and energy sectors are 2,500, 1,750 and 700 tCO_2e/US$m respectively.

Therefore, it is useful to take into account the size of a fund's high-risk exposures, in addition to the average risk level.

Chart 1: Emissions intensity and carbon risk score of Asia-Pacific investment funds, by domicile, 2022	**Chart 2**: Carbon risk score of Asia-Pacific investment funds and share of AUM with high carbon risk score, by domicile, 2022
	

Notes: Each data point represents an advanced economy (AE) or an emerging market economy (EME); figures are AUM-weighted averages of the relevant metric for funds domiciled in an economy in Q3 2022; the sample consists of 6,655 funds. Morningstar's carbon risk score ranges from 0 to 100 and has five risk categories: low (0-10), medium (low) (10-15), medium (15-20), medium (high) (20-30) and high (30+).
Sources: Morningstar Direct and HKMA staff estimates.

3. Sensitivity of Fund Flows to Investors' Perception of Climate-Related Risks

This section investigates the extent to which the climate risk exposure of Asia-Pacific investment funds presents risks to financial stability. In particular, we focus on assessing whether fund flows are sensitive to changes in investors' perception of climate-related risks. In the event of large abrupt outflows, investment funds may react in ways that have severe financial stability implications, as discussed in section 1.

3.1 Proxy for investors' perception of climate-related risks

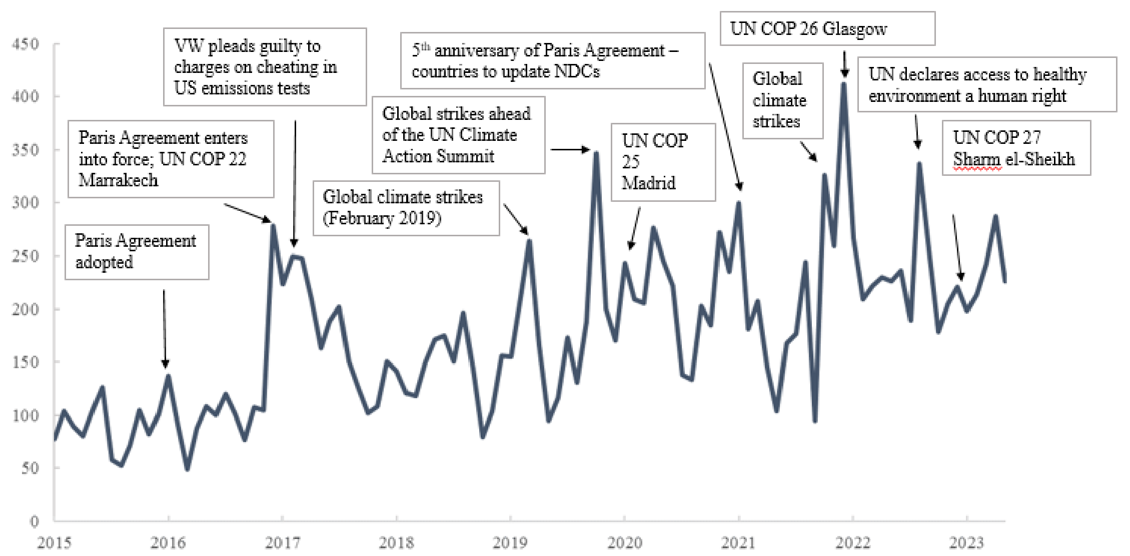
To proxy for investors' perception of climate-related risks, we first consider the Climate Policy Uncertainty (CPU) index constructed by Gavriilidis (2021) (**Chart 3**). The CPU index is a news-based index. In the existing literature, news-based indices have been commonly used as tools to proxy for public perceptions of climate-related risks.[8] Since climate risks are a relatively new

[8] Please refer to Ho (2022), Kuang and Liang (2022) and Zhang (2021). Other publicly available news-based indices of climate-related risks – mostly based on US newspapers – are not updated to the period during which Morningstar's climate risk metrics are available, e.g. Ardia et al. (2020) and Engle et al. (2020).

concern for investors, news coverage can play a pivotal role in shaping their attitudes towards the severity and urgency of the risks. In instances where the media reports on relevant information, intensified news coverage may further increase the perceived relevance of climate risks.[9]

To construct the CPU index, Gavriilidis (2021) conducted searches of eight leading US newspapers[10] for articles that contain terms related to climate change, uncertainty and regulations.[11] For each newspaper, the number of relevant articles per month was scaled by the total number of articles published during the same month. Next, these eight series were standardised to have a unit standard deviation and then averaged across newspapers by month. Finally, the averaged series were normalised to have a mean value of 100 over the sample period.[12]

Chart 3: The Climate Policy Uncertainty (CPU) Index



Notes: VW=Volkswagen; NDC=nationally determined contributions; UN=United Nations; COP=Conference of the Parties.
Sources: Gavriilidis (2021) and HKMA staff annotations; index is retrieved from https://www.policyuncertainty.com/climate_uncertainty.html where the index is hosted and updated.

[9] Other proxies of climate-related risks that have been proposed in the academic literature include climate change phenomena such as temperature indicators and event studies of climate policy actions. However, these methods may be less effective in capturing the multifaceted and evolving nature of climate-related risks than news-based indices.
[10] The eight newspapers are *The New York Times*, *The Wall Street Journal*, the *Chicago Tribune*, *The Boston Globe*, the *Los Angeles Times*, the *Miami Herald*, the *Tampa Bay Times* and *USA Today*.
[11] The search terms include {"uncertainty" or "uncertain"} and {"carbon dioxide" or "climate" or "climate risk" or "greenhouse gas emissions" or "greenhouse" or "CO2" or "emissions" or "global warming" or "climate change" or "green energy" or "renewable energy" or "environmental"} and ("regulation" or "legislation" or "White House" or "Congress" or "EPA" or "law" or "policy"}.
[12] The sample period is from April 1987 to April 2023.

Although the CPU index is based on US newspapers, it is important to note that these major US newspapers have a global readership, and thus are more likely to cover news of global significance as compared to local newspapers in Asia-Pacific. Given the worldwide nature of climate change and the importance of multilateral efforts in driving climate-related transition policies, these newspapers are more likely to report notable developments on climate issues that are more likely to influence investors' perception of climate-related risks. As a result, it is reasonable to use these US newspapers to proxy for changes in investors' perception on climate-related risks.[13]

Chart 3 shows the evolution of the CPU index from January 2015 to April 2023. Each spike in the index represents a surge in intensity of news coverage on topics related to climate policy uncertainty. Throughout this period, we observed multiple spikes coinciding with significant events related to climate change. For instance, in January 2017, there was a spike when Volkswagen pled guilty to charges related to cheating in US emissions tests. Another spike occurred in September 2019 when global climate strikes took place prior to the United Nations (UN) Climate Action Summit. Additionally, in September 2021, there was a spike in coverage due to the global climate strikes preceding the UN Climate Change Conference (COP26) held in Glasgow in November 2021.

Furthermore, we noticed that, since 2015, the CPU index has remained generally above its long-term average of 100, and has exhibited an upward trend with larger and more frequent spikes. This implies that news coverage on climate change has become more intense compared to the historical average. Important events related to climate change are also reported more frequently and with greater intensity, which should make investors become more sensitive to climate-related risks.

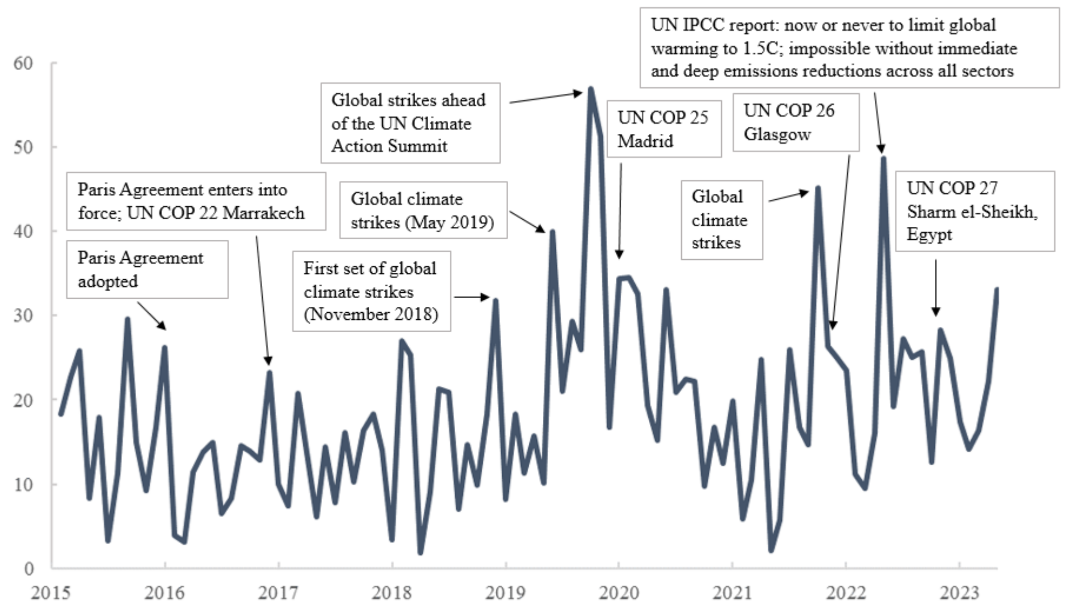
To ensure the robustness of our analysis, we used another indicator, internet search volume intensity (SVI) from Google Trends, to serve as a proxy for investors' perception of climate risks. This data, available by location, has been used in academic research as a proxy for investor attention to specific topics.[14] For a given topic, Google SVI aggregates online search queries related to specific keywords in different languages, calculating the percentage of searches for a topic as a proportion of all searches during a given time and location. The resulting index is scaled from 1 to 100, where 100 represents the maximum search interest for the selected time period and location. For our

[13] The CPU index has also been used in the existing literature, for example to help estimate the impact of climate policy uncertainty on global stock prices (Bouri et al. (2022)), and crude oil market volatility (Salisu et al. (2023)).
[14] For example, Ho (2022) uses it as one of the proxies for investor concern of climate change.

purpose, we selected the Google SVI on the topic "climate change" in the news search category for the Asia-Pacific economies in our regression sample, covering the period from January 2015 to April 2023.[15] The final index used is an average of the indices for each of the economies in our sample (**Chart 4**).

The CPU index and the Google SVI index can be considered as complementary, as they provide different perspectives on how investors perceive climate-related risks. Specifically, the CPU index can be seen as a proxy for the extent to which the public is *receiving* climate-related news, while the Google SVI index is a proxy on how much attention the public is *giving* to climate-related concerns. While there are similarities between the two indices, such as the spikes in September 2019 and September 2021 during the global climate strikes, there are also differences. For example, the Google SVI index had a noticeable spike in November 2018 during the first set of global climate strikes, whereas the CPU index did not. This may be because the largest number of strikes that took place outside of Sweden was in Australia, one of the Asia-Pacific economies in our sample, whereas the number of strikes in North America and other European countries was lower.[16]

Chart 4: Google news Search Volume Intensity (SVI) index on the topic "climate change", average of selected Asia-Pacific economies



Notes: UN=United Nations; COP=Conference of the Parties; IPCC= Intergovernmental Panel on Climate Change. This series is the average of the Google news SVI indices for eight of the nine Asia-Pacific economies in our sample.
Sources: Google Trends and HKMA staff annotations.

[15] This covered eight of the nine economies in our regression sample. The SVI for Mainland China is unavailable due to insufficient search data.
[16] Statistics from Fridays For Future – a youth-led global climate strike movement – show that on 30 November 2018, 30 strikes took place in Australia, 96 in Sweden, and five each in Germany and the US (which both had the most strikes after Australia).

3.2 Data and methodology

We hypothesise that Asia-Pacific investment funds with a high climate risk exposure experience a decline in fund flows compared to other funds when investors' perception of climate-related risks increases. To test this hypothesis, we estimate the following panel regression:

$$Flow_{i,t+1} = \beta_1 \Delta index_t + \beta_2 CR_{i,t}^h + \beta_3 \Delta index_t * CR_{i,t}^h + Control_{i,t} + FE_i + FE_y + \varepsilon_{i,t+1} \quad (1)$$

where $Flow_{i,t+1}$ is the net flow into fund i in quarter t+1 as a percentage of the size of fund i in quarter t. $\Delta index_t$ is the percentage change (expressed in decimal terms) of the CPU or the Google SVI index, which are our proxies for investors' perception of climate-related risks. $CR_{i,t}^h$ is a dummy variable that equals 1 if fund i at quarter t has a high climate risk exposure, which we identify as either having an average emissions intensity that is in the top fifth percentile, or a carbon risk score in the high carbon risk category as considered by Morningstar (i.e. above 30). $\Delta index_t * CR_{i,t}^h$ is an interaction term between the two variables. If our hypothesis is correct – i.e. that funds with a high climate risk exposure (i.e. $CR_{i,t}^h$ equals 1) face lower fund flows relative to other funds when investors' perception of climate-related risks increases (i.e. $\Delta index_t$ is positive) – then the estimate for β_3 should be negative.

$Control_{i,t}$ is a set of control variables; following literature practice, we include fund i's lagged flow, size (in logarithmic form), age, quarterly return, expense ratio, volatility of returns and the VIX index.[17] We exclude new funds that have existed for less than one year in each quarter. We include fund fixed effects (FE_i) to control for any time-invariant fund characteristics that could be correlated with climate risk exposure and fund flows, as well as year fixed effects (FE_y).[18] To mitigate potential reverse causality concerns, explanatory and control variables are lagged by one quarter. We use robust standard errors clustered at the fund level. The regression sample consists of 7,299 funds from nine Asia-Pacific economies, and covers the period from the fourth quarter (Q4) of 2018 to Q3 2022. See Annex Table A1 and Annex Table A2 for summary statistics and details about the variables used.

[17] The flow, return, return volatility and expense variables are winsorised at the 1% and 99% levels to control for the effect of outliers.

[18] We cannot include quarter fixed effects as the index and VIX variables change over time and are fund invariant.

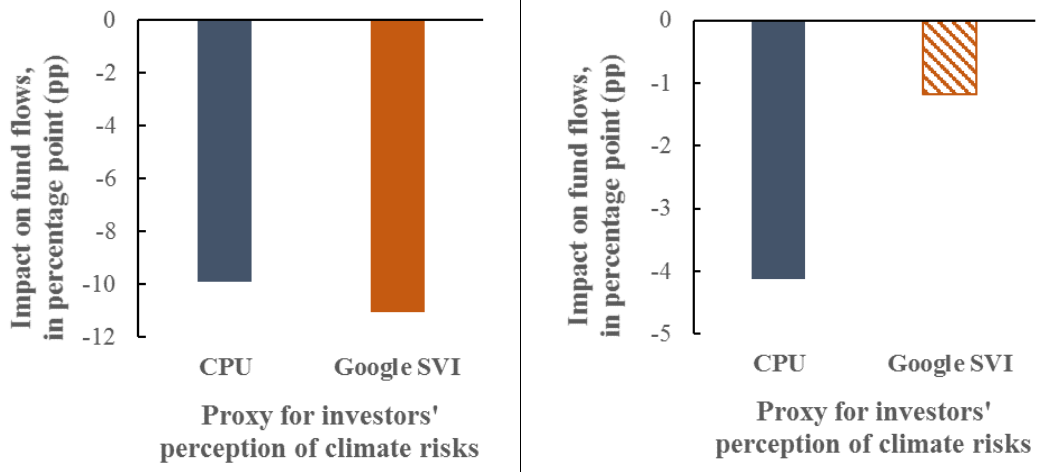
3.3 Findings

Our findings suggest that investment funds with a high climate risk exposure would face more significant outflow pressures compared to other funds when investors perceive an increase in climate-related risks. Using a forward-looking measure of climate risk, the carbon risk score, we find that funds with a high score are estimated to experience an around 10 percentage point (pp) and an 11pp reduction in fund flows relative to other funds, after a doubling in the CPU and the Google SVI indices respectively in the previous quarter (**Chart 5A**).[19] Our analysis using historical climate risk measures also showed similar results (**Chart 5B**). It is worth noting that there have been a couple of times in the sample period when the indices have more than doubled from the prior quarter,[20] implying that investors' perception of climate risks could indeed rise sharply and lead to large flow impacts.

Chart 5: Sensitivity of Asia-Pacific investment fund flows to increases in investors' perception of climate-related risks: funds with a high climate risk exposure vs others

Panel A: Estimated impact on funds with a high carbon risk score vs other funds

Panel B: Estimated impact on funds with a high emissions intensity vs other funds



Notes: The solid bars denote 5% level of statistical significance. These are the estimates for β_3 in equation (1), set out in Annex Table A3. The estimates denote the impact of a doubling in a climate risk index (i.e. a 100% increase, which is when $\Delta index_t$ equals 1) on fund flows (relative to fund assets) in percentage points (pp) in the subsequent quarter for a fund with a high climate risk exposure compared to other funds. Funds with a high emissions intensity are funds whose average emissions intensity is in the top fifth percentile. Funds with a high carbon risk score are those with a score above 30, as per Morningstar's classification.
Sources: HKMA staff estimates.

[19] To set our estimates in the context of the historical evolution of the indices, a one standard deviation increase from the mean of the CPU and Google SVI indices was 31% and 53% respectively. These would lead to a respective 3pp and 6pp fall in fund flows in the next quarter for funds with high carbon risk scores relative to others.

[20] For example, the CPU and Google SVI indices saw a 100% and 170% quarterly increase in Q3 2019 respectively. The Google SVI index also increased by 104% in Q4 2020.

So far, our analysis focuses on investment funds that have a *high* climate risk exposure. As an extension, we investigate, more generally, whether the negative impact on fund flows becomes more severe as the *overall* climate risk exposure of an investment fund increases. To do this, we replace the *high* climate risk dummy variable ($CR_{i,t}^{h}$) in equation (1) with a continuous measure of climate risk exposure, i.e. a fund's emissions intensity and carbon risk score. Consistent with our previous results, we find that an increase in investors' perception of climate risk would lead to outflows if a fund's climate risk exposure is sufficiently large, and that the flow impact would be more severe if a fund has a higher climate risk exposure (Annex Table A4).

Our results suggest that the impact of climate shocks on fund outflows could be one transmission channel through which climate transition risks affect financial stability, apart from the asset price channel.[21] Since we controlled for fund returns in the regression model, our findings suggest that changes in investors' perception of climate risk have an impact on fund flows independent of any impact that they may have on the prices of the assets held by funds.[22]

4. WHAT FEATURES OF INVESTMENT FUNDS MAY HELP REDUCE THEIR CLIMATE RISK EXPOSURE?

4.1 Features of investment funds

In section 3, we find that funds with a high climate risk exposure would experience a negative impact on fund flows when investors perceive an increase in climate-related risks. This could have significant implications for financial stability, if investment funds react to large outflows in ways that amplify the initial shocks, such as through a fire sale of assets. In section 4, we examine three features of investment funds that may reduce their level of climate risk exposure, as summarised in **Chart 6**.

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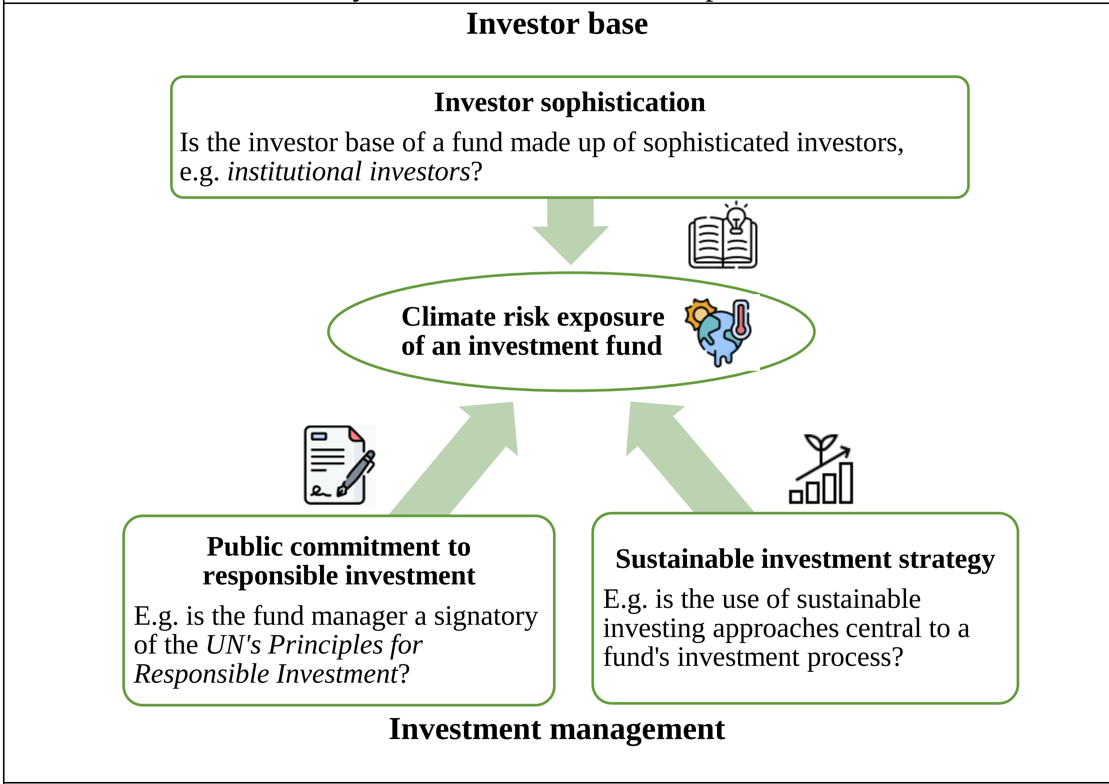
[21] ECB and ESRB (2022) outline that redemptions may appear when climate risk shock affects investment fund assets, or as a reflection of evolving investor preferences, e.g. investors may become increasingly concerned about climate-related factors and include them more systematically and consistently in their investment decisions.

[22] Our finding is in line with Kuang and Liang (2022). They find that, after controlling for fund performance, funds with higher carbon risk exposure have lower fund flows and that investors react to mutual fund carbon risk more negatively when social sentiment on climate change is extremely high. The authors argue that the findings suggest that investors respond negatively to fund carbon risk.

Chart 6: Features that may reduce the climate risk exposure of investment funds



Source: images from Flaticon.com.

One important feature that can influence the climate risk exposure of investment funds is whether a fund has adopted a sustainable investment strategy. These funds should incorporate sustainability factors in their investment process and make them a central part of their investment strategy, such as environmental, social and governance (ESG) funds. As a result, they should be more likely to invest in companies with a lower exposure to climate risks.[23] However, alongside the notable growth in ESG and climate-themed funds, there have been increasing concerns that some funds that advertise as adopting a sustainability strategy may not consider sustainability factors in their investment strategies. Such “greenwashing” acts may help these funds attract capital flows from climate-conscious investors without having to allocate investments according to a sustainability strategy. It is therefore worth investigating the extent to which Asia-Pacific funds that claim to have a sustainable investment strategy have a lower climate risk exposure.

Another feature that may affect the climate risk exposure of investment funds is whether fund managers have publicly committed to applying responsible investment principles to all their investment analysis and decisions (irrespective of whether their funds are focused explicitly on ESG factors). While fund

[23] This is in line with findings in the literature. For instance, Reboredo and Otero (2021) in their study on US equity funds find that the socially responsible focus of a fund reduces fund portfolio exposure to carbon risk.

managers can voluntarily commit to doing so, making such a commitment publicly can help foster market discipline and hold managers accountable for their undertaking. A common avenue through which fund managers can declare their commitment publicly is by becoming a signatory to the UN Principles for Responsible Investment (UNPRI). Established in 2006, the UNPRI now boasts an extensive network of nearly 4,000 signatories across the world. Signatories voluntarily commit to incorporating ESG factors into their decision-making, assuming an active ownership role by integrating ESG concerns into their ownership policies, and providing reports on their progress towards implementing the UNPRI.[24]

Apart from the two features related to investment management, the composition of a fund's investor base may also influence its climate risk exposure. Specifically, if a fund's investor base is comprised primarily of sophisticated investors, the fund manager may face more pressure to consider climate risks when making investment decisions. This is because sophisticated investors are more likely to have the ability and expertise to analyse climate risks. Analysing climate risks and their effects on the financial system is challenging as it is subject to substantial uncertainty; as a result, historical measures may not be a good guide, and forward-looking metrics are still in the early stage of development. Sophisticated investors may also be more likely to adopt a longer-term horizon when carrying out risk assessments – this means they may be more likely to consider the financial risks arising from climate change since its effects are spread over long time horizons. In this study, we identify funds that target sophisticated investors as those whose share classes that are sold to institutional investors account for more than 75% of fund assets for all periods (referred to as "institutional funds").[25] Following Morningstar's approach for the US market, we assume that a share class is aimed at institutional investors if its minimum initial purchase amount is US$100,000 or more. Institutional investors, as opposed to retail investors, are more likely to be experienced investors who have the resources and specialised knowledge to research and understand the risks that their investments may face, including climate-related risk. The existing literature also suggests that institutional investors take account of climate change in their investment decisions.[26]

[24] The six principles under the UNPRI are as follows: "(i) we will incorporate ESG issues into investment analysis and decision-making processes; (ii) we will be active owners and incorporate ESG issues into our ownership policies and practices; (iii) we will seek appropriate disclosure on ESG issues by the entities in which we invest; (iv) we will promote acceptance and implementation of the Principles within the investment industry; (v) we will work together to enhance our effectiveness in implementing the Principles; and (vi) we will each report on our activities and progress towards implementing the Principles."

[25] We follow Kuang and Liang (2022), which identify a fund as an institutional (retail) fund if more than 75% of the fund's assets are held in an institutional (retail) share class.

[26] For example, see Ilhan et al. (2020) and Bolton and Kacperczyk (2021).

4.2 Data and methodology

To test whether the features outlined in section 4.1 lead to a lower climate risk exposure of investment funds, we estimate the following panel regression model:

$$CR_{i,t+1} = \boldsymbol{\beta_1 Inst_i} + \boldsymbol{\beta_2 UNPRI_{i,t}} + \boldsymbol{\beta_3 Sust_{i,t}} + Control_{i,t} + FE_{fc} + FE_t + \varepsilon_{i,t+1} \tag{2}$$

where $CR_{i,t+1}$ is a measure of climate risk, which is fund i's emissions intensity (in logarithm) or carbon risk score in quarter $t+1$. $Inst_i$ is a dummy variable that equals 1 if a fund is aimed at institutional investors. $UNPRI_{i,t}$ is a dummy variable that equals 1 if a fund's manager is a UNPRI signatory in quarter t. $Sust_{i,t}$ is a dummy variable that equals 1 if a fund in quarter t is identified by Morningstar as having a "sustainable investment" strategy. Morningstar identifies these funds by looking at their prospectuses or regulatory filings and assessing whether they intentionally incorporate sustainability features into their investment process, and whether the use of one or more approaches to sustainable investing is central to that process. If our hypothesis is correct, the estimated values for β_1, β_2 and β_3 should be negative.

$Control_{i,t}$ is a set of control variables and includes fund i's flow, size (in logarithmic form), age, quarterly return, expense ratio, and volatility of returns.[27] We excluded new funds that have existed for less than a year. We include time fixed effects, and also fund category fixed effects to control for any time-invariant characteristics of funds of the same type[28] that could be correlated with climate risk exposure and the features being explored.[29] To mitigate the potential reverse causality concerns, explanatory and control variables are lagged by one quarter. We use robust standard errors clustered at the fund type category level. The regression sample consists of 7,124 funds from nine Asia-Pacific economies during Q4 2018 to Q3 2022. See Annex Table A1 and Annex Table A2 for summary statistics and details about the variables used.

[27] The flow, return, return volatility and expense variables are winsorised at the 1% and 99% levels.

[28] We use Morningstar's fund classification, which sorts funds into peer groups based on their region of domicile and portfolio characteristics such as their asset allocation and/or sectoral or geographical focus.

[29] We are not able to include fund fixed effects because doing so would crowd out the time-invariant dummy variable for institutional funds, which is one of our variables of interest.

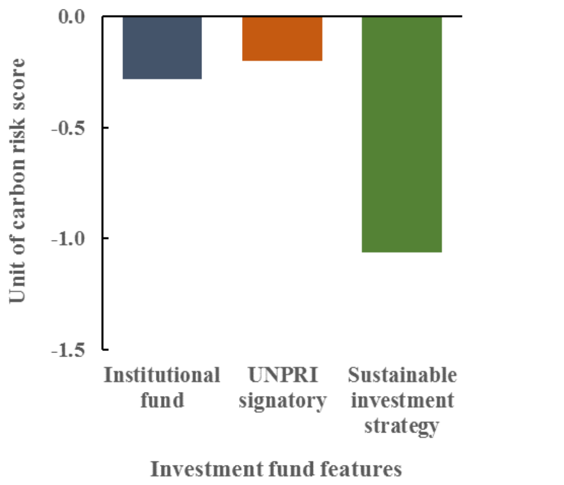
4.3 Results

We find that the three aforementioned features would contribute to a decrease in the climate risk exposure of Asia-Pacific investment funds. By adopting sustainable investment strategies, these funds are estimated to have a lower carbon risk score by around 1 unit, which translates into a 9% reduction in the average carbon risk score in 2022 (**Chart 7A**). Meanwhile, investment funds with an institutional investor base are found to have a lower carbon risk score by 0.3 units, while funds managed by UNPRI signatories show an average score reduction of 0.2 units. These translate into a 2% reduction in the average carbon risk score in 2022. Among the three features examined, the adoption of a sustainable investment strategy has the largest impact on climate risk exposure.

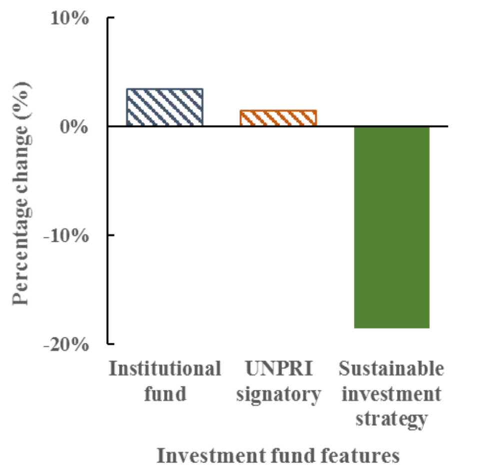
We find similar results in our analysis using a historical measure: emissions intensity (**Chart 7B**). Funds that adopt sustainable investment strategies are estimated to have a reduction of nearly 20% in emissions intensity on average. Other features, however, do not appear to have a statistically significant impact on emissions intensity. One potential reason is that fund managers and institutional investors assess climate risks holistically and on a forward-looking basis,[30] whereas emissions intensity only measures a single aspect of climate risk and is a backward-looking historical indicator.

Chart 7: Estimated impact of Asia-Pacific investment fund features on climate risk exposure

Panel A: Estimated impact on carbon risk score



Panel B: Estimated impact on emissions intensity (percentage change, %)



Notes: The solid bars denote 10% level of statistical significance. See Annex Table A5 for full estimation results. Sources: HKMA staff estimates

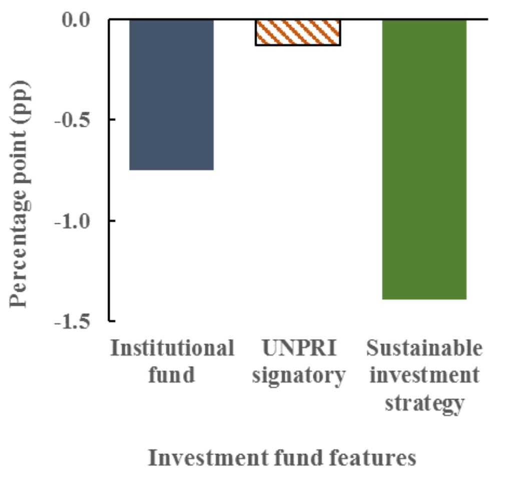
[30] Recent survey evidence from Hong Kong's financial services industry suggests that asset managers use a range of climate risk metrics from a variety of sources to conduct climate risk assessments. Some asset managers use forward-looking metrics such as carbon value-at-risk (which measures the impacts of rising carbon costs on a company's profitability) and emissions reductions (which account for the impacts of a company's mitigating plans). Scenario-based analyses are also used. See HKIMR (2022).

The analysis so far focuses on the impact of these features on the *average* climate risk exposure of an investment fund. However, as noted in section 2, the *average* climate risk exposure of an investment fund does not correlate perfectly with the exposure to companies with a high climate risk. As an extension, we estimate whether the features also lead to a smaller exposure to companies with a high carbon risk score, and greater investments in companies with a low carbon risk score.

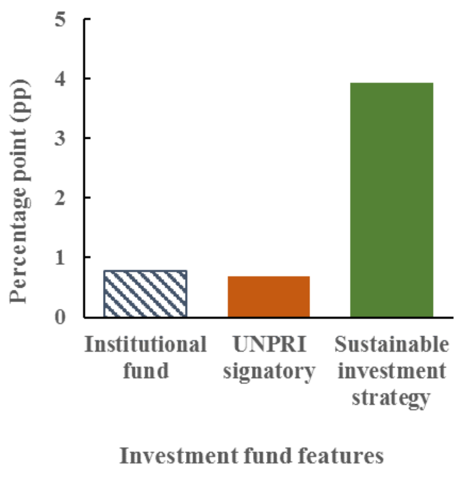
The estimation results confirm our hypothesis. Investment funds that implement sustainable investment strategies exhibit a nearly 1.5pp lower allocation of AUM to companies with a high carbon risk score (**Chart 8A**), and an around 4pp higher allocation of AUM to companies with a low carbon risk score (**Chart 8B**). Meanwhile, institutional funds and funds managed by UNPRI signatories also have somewhat smaller investments in high climate risk firms, and slightly greater investments in low climate risk companies than other funds. Similar to our baseline results, the adoption of a sustainable investment strategy appears to be the most effective approach in increasing investments in environmentally friendly assets and reducing investments in environmentally harmful assets by funds.

Chart 8: Estimated impact of Asia-Pacific investment fund features on the share of AUM invested in companies with a high or low carbon risk score

Panel A: Estimated impact on the share of AUM with high carbon risk score (pp)



Panel B: Estimated impact on the share of AUM with low carbon risk score (pp)



Notes: The solid bars denote 10% level of statistical significance. See Annex Table A5 for full estimation results.
Sources: HKMA staff estimates

5. CONCLUSION

We carried out an assessment of the exposure of Asia-Pacific investment funds to climate-related risks. Using both historical and forward-looking metrics, we find that the climate risk exposure of investment funds varies noticeably across regions in Asia-Pacific, and is generally higher for funds domiciled in EMEs.

The exposure of investment funds to climate-related risks could be a significant source of financial stability risks. We find that funds with a high climate risk exposure could face larger outflow pressures when investors perceive an increase in climate-related risks. This means that, in the event of a perceived surge in climate risks, such as an abrupt change in global climate transition policies, funds that are more exposed to climate risks may need to meet potentially large redemptions through a fire sale of assets. Our findings suggest that the impacts of climate shocks on fund outflows could be one transmission channel through which climate transition risks affect financial stability, apart from the asset price channel.

We examine several features of Asia-Pacific investment funds that could influence their climate risk exposure. Our findings provide support for several policy measures that would be helpful in reducing investment funds' climate risk exposure.

First, policy measures that encourage investment funds to consider sustainability factors such as ESG elements in their investment strategy could help reduce funds' climate risk exposure. For example, asset managers could design investment funds that are specifically focused on ESG themes. To guard against the risk of greenwashing, efforts to promote sustainability-themed funds would need to be accompanied by the development of relevant standards as well as an enhancement of investor knowledge of green and sustainable investment products.

Second, policy measures that encourage fund managers to publicly commit to responsible investment principles and apply them to their portfolios could also help reduce funds' climate risk exposure. Fund managers could be encouraged to become a signatory of well-established responsible investment principles, such as the UNPRI, or principles developed by policymakers themselves. The Hong Kong Monetary Authority (HKMA), as a major global asset owner and manager, is also a signatory of the UNPRI.

Lastly, we find that institutional funds have a lower climate risk exposure than retail funds. This is likely to reflect that institutional investors are more sophisticated, and so are more likely to have the ability to analyse climate risks and adopt a longer-term horizon in risk assessments. As a result, they are likely to put greater pressure on their fund managers to take into account climate risks. Therefore, policy measures that enhance investor sophistication in climate-related risks could help reduce funds' climate risk exposure, e.g. raising public awareness of climate-related financial risks and the public's knowledge of sustainable investment by promoting education and training initiatives. Other measures could include allocating resources to the research of climate-related risks and the development of relevant databases, and facilitating the sharing of such information among investors and the public. An example is the establishment of the Centre for Green and Sustainable Finance in Hong Kong by the Green and Sustainable Finance Cross-Agency Steering Group, co-chaired by the HKMA. This centre has created repositories on data sources and training opportunities to support the financial sector and related sectors in accessing useful data and learning materials on green and sustainable finance.[31]

This study presents an initial assessment of the climate risk exposure of Asia-Pacific investment funds. Future research can build on this study by investigating and quantifying the potential transmission and amplification channels of climate-related shocks by Asia-Pacific investment funds. This may include the extent to which funds have common holdings of investments in companies with a high climate risk exposure, and the possibility of cross-border transmission by funds with global investment portfolios. Expanding the research in these areas would contribute to a more comprehensive understanding of the implications of climate risks on financial stability in Asia-Pacific.

[31] For further details, please see the latest HKMA Sustainability Report (HKMA, 2023).

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ANNEX

Table A1: Summary statistics of variables used in the regression analyses set out in Sections 3 and 4

Variables	Obs	Mean	Median	St. Dev.
Climate risk data				
Emissions intensity (tCO_2e/US$m)	41,399	286	169	468
Carbon risk score	41,399	11.2	10.8	4.8
Share of AUM with high carbon risk score (%)	40,465	2.9	1.1	5.9
Share of AUM with low carbon risk score (%)	40,465	49.8	51.1	23.4
$\Delta index$ (percentage change in decimal terms) – CPU index	41,399	0.05	-0.14	0.41
$\Delta index$ (percentage change in decimal terms) – Google SVI index	41,399	0.07	0.05	0.59
Investment fund data				
Quarterly flow (%)	41,399	1.4	-0.9	23.9
Size (US$m)	41,399	330	40	3,033
Age (years)	41,399	10.4	8.4	7.8
Quarterly return (%)	41,399	-0.92	0.04	12.06
Quarterly expense ratio (%)	41,399	0.34	0.35	0.17
Volatility of return (%)	41,399	5.9	5.5	2.1
Inst (1/0)	40,465	0.06	-	-
UNPRI (1/0)	40,465	0.61	-	-
Sust (1/0)	40,465	0.06	-	-
Market data				
VIX index	41,399	24.1	22.8	8.1

Table A2: Details on data item and sources

Variable	Description	Source
Climate risk data		
Emissions intensity	Asset-weighted scope 1 and scope 2 GHG emissions intensity for the companies in a fund's portfolio, in metric tons of CO_2 equivalent normalised by revenue in millions of US dollars (tCO_2e/US$m).	Morningstar Direct
Carbon risk score	Asset-weighted carbon risk score of companies held in a fund's portfolio. Ranges from 0 to 100; sorted into five risk categories: low (0-9.99), medium (low) (10-14.99), medium (15-19.99), medium (high) (20-30) and high (30+).	Morningstar Direct
$\Delta index$	Quarterly percentage change (in decimal terms) of the CPU index or the Google SVI index.	Gavriilidis (2021); Google Trends
CR^h	A dummy variable that equals 1 if a fund in a quarter has a 'high' climate risk exposure, or zero otherwise. This is defined as having an average emissions intensity that is in the top 5th percentile in our sample, or alternatively if a fund has a carbon risk score above 30.	Morningstar Direct

Investment fund data		
Flow	Quarterly net flow into a fund expressed as a percentage of fund size in the previous quarter (in percentage terms), winsorised.	Morningstar Direct
Size	Log of quarterly fund size in terms of total net assets under management.	Morningstar Direct
Age	Quarterly fund age (in years).	Morningstar Direct
Return	Quarterly fund net return (in percentage terms), winsorised.	Morningstar Direct
Expense ratio	Quarterly ratio of a fund's expenses e.g. operating expense, management fees and administrative fees, relative to size (in percentage terms), winsorised.	Morningstar Direct
Volatility of return	Standard deviation of the past 12 monthly returns (in percentage terms), winsorised.	Morningstar Direct
Inst	A dummy variable that equals 1 if a fund is identified as an institutional fund, i.e. one that is sold to institutional investors, or zero if it is a retail fund. We identify an institutional (retail) fund as a fund where its share class(es) sold to institutional (retail) investors account(s) for more than 75% of a fund's size. An institutional (retail) share class is where a minimum investment amount is at or above (below) US$100,000.	Morningstar Direct
UNPRI	A dummy variable that equals 1 if the investment manager of a fund is or has become a signatory of the United Nations Principles for Responsible Investment (UNPRI) in that quarter, or zero otherwise.	UNPRI signatory directory[32]
Sust	A dummy variable that equals 1 if the fund has a Sustainable Investment strategy as identified by Morningstar in that quarter, or zero otherwise.	Morningstar Direct
Market data		
VIX index	The Chicago Board Options Exchange Volatility Index	Federal Reserve Bank of St. Louis

[32] See https://www.unpri.org/signatories/signatory-resources/signatory-directory.

Table A3: Regression results of model (1) in Section 3.2

Dependent variable	$Flow_{i.t+1}$			
Climate risk measure	High emissions intensity dummy ($CR_{i,t}^{h}$=1 if in top 5th percentile)		High carbon risk score dummy ($CR_{i,t}^{h}$=1 if score is above 30)	
Index used	CPU	Google SVI	CPU	Google SVI
$\Delta index_t$ (β_1)	1.05**	-1.71***	0.88**	-1.72***
$CR_{i,t}^{h}$ (β_2)	0.45	0.40	-1.35	1.06
$\boldsymbol{\Delta index_t * CR_{i,t}^{h}}$ **($\boldsymbol{\beta_3}$)**	**-4.12*** **	**-1.18**	**-9.89** **	**-11.05** **
$Flow_{i,t}$	-0.01	-0.01	-0.01	-0.01
$Log(size)_{i,t}$	-18.75***	-18.78***	-18.75***	-18.77***
$Age_{i,t}$	0.53	2.21***	0.52	2.23***
$Return_{i,t}$	0.15***	0.17***	0.15***	0.17***
$Expense\ ratio_{i,t}$	1.53	1.19	1.42	1.21
$Return\ volatility_{i,t}$	-0.65***	-0.48***	-0.64***	-0.48***
Vix_t	-0.02	0.04	-0.02	0.04
Fund fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
No. of funds	6,108	6,108	6,108	6,108
Observations	31,388	31,388	31,388	31,388

Note: ***, ** and * denote 1%, 5% and 10% level of statistical significance

Source: HKMA staff estimates.

Table A4: Regression results of an amended version of model (1) in Section 3.2

$$Flow_{i,t+1} = \beta_1 \Delta index_t + \beta_2 CR_{i,t} + \beta_3 \Delta index_t * CR_{i,t} + Control_{i,t} + FE_f + FE_y + \varepsilon_{i,t+1}$$

where we replace the high climate risk exposure dummy variable ($CR^h_{i,t}$) in (1) with a continuous measure of climate risk (i.e. a fund's emissions intensity, or carbon risk score).

Dependent variable	$Flow_{i.t+1}$			
Climate risk measure (as a continuous variable)	Emissions intensity		Carbon risk score	
Index used	CPU	Google SVI	CPU	Google SVI
$\Delta index_t$ (β_1)	1.32***	-1.75***	2.40***	-1.41*
$CR_{i,t}$ (β_2)	0.00018	0.00028	0.22	0.24
$\boldsymbol{\Delta index_t * CR_{i,t}}$ **($\boldsymbol{\beta_3}$)**	**-0.0018****	**-0.00010**	**-0.14****	**-0.04**
$Flow_{i,t}$	-0.01	-0.01	-0.01	-0.01
$Log(size)_{i,t}$	-18.74***	-18.78***	-18.76***	-18.80***
$Age_{i,t}$	0.50	2.19***	0.59	2.36***
$Return_{i,t}$	0.15***	0.17***	0.15***	0.18***
$Expense\ ratio_{i,t}$	1.50	1.22	1.68	1.38
$Return\ volatility_{i,t}$	-0.65***	-0.48***	-0.66***	-0.48***
Vix_t	-0.02	0.04	-0.03	0.04
Fund fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
No. of funds	6,108	6,108	6,108	6,108
Observations	31,388	31,388	31,388	31,388

Note: ***, ** and * denote 1%, 5% and 10% level of statistical significance

Source: HKMA staff estimates

Table A5: Regression results of Equation (2) from Section 4.2

Dependent variable	$CR_{i,t+1}$			
	Log (emissions intensity)	Carbon risk score	Share of AUM (in %) with:	
			High carbon risks core	Low carbon risk score
$\boldsymbol{Inst_i}$ **($\boldsymbol{\beta_1}$)**	**0.034**	**-0.28****	**-0.75*****	**0.78**
$\boldsymbol{UNPRI_{i,t}}$ **($\boldsymbol{\beta_2}$)**	**0.014**	**-0.20****	**-0.13**	**0.69***
$\boldsymbol{Sust_{i.t}}$ **($\boldsymbol{\beta_3}$)**	**-0.20*****	**-1.06*****	**-1.39*****	**3.94*****
$Log(size)_{i,t}$	-0.031***	-0.14***	-0.13***	0.56***
$Age_{i,t}$	0.0064***	0.02***	0.04***	-0.06**
$Flow_{i,t}$	-0.00054**	0.00	0.00	0.00
$Return_{i,t}$	0.0028***	0.02***	0.05***	-0.06***
$Expense\ ratio_{i,t}$	-0.25***	-0.57*	-0.93**	1.70
$Return\ volatility_{i,t}$	-0.0031	0.26***	0.28***	-0.90***
Fund category fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
No. of funds	5,959	5,959	5,959	5,959
Observations	30,666	30,666	30,666	30,666

Note: ***, ** and * denote 1%, 5% and 10% level of statistical significance

Source: HKMA staff estimates.