EXECUTIVE BOARD MEETING

SM/22/225

September 9, 2022

To: Members of the Executive Board

From: The Secretary

Subject: **October 2022 Global Financial Stability Report—Chapters 2 and 3 and Online Annexes**

Board Action:	Executive Directors' **consideration** (Formal)
Tentative Board Date:	**Thursday, September 29, 2022**
Publication:	Yes, it is intended that the full set of the October 2022 Global Financial Stability Report documents will be released to the public at the time of the Global Financial Stability Report press conference, tentatively scheduled for **Tuesday, October 11, 2022**. The analytical chapters will be made available to the public on the IMF website in advance of the publication of the full document.
Questions:	Mr. Suntheim, MCM (ext. 39084) Ms. Qureshi, MCM (ext. 38942) Mr. Ehlers, MCM (ext. 38224) Ms. Gardes-Landolfini, MCM (ext. 34474) Mr. Prasad, MCM (ext. 37737)
Additional Information:	The paper will be revised for publication in light of the Executive Board discussion. If Executive Directors have additional comments, they should notify Mr. Ehlers and Ms. Gardes-Landolfini for Chapter 2 and Mr. Suntheim for Chapter 3 by **5:30 p.m. on Wednesday, September 28, 2022.**

Chapter 2

SCALING UP PRIVATE CLIMATE FINANCE IN EMERGING MARKETS: CHALLENGES AND

Chapter 2 at a Glance

- Emerging market and developing economies account for two-thirds of global carbon emissions, and many are highly vulnerable to climate hazards. These economies will need significant climate financing in the coming years to reduce their greenhouse gas emissions and to adapt to the physical effects of climate change.
- Private finance is the key to achieving these objectives. Public budgets are strained in the wake of the COVID-19 crisis, and borrowing conditions for emerging market sovereigns have tightened (see Chapter 1).
- Establishing the right climate policies, including carbon pricing, remains crucial. Climate policies and finance are complementary—better policies incentivize private investment, which helps achieve policy objectives.
- The market for sustainable finance in emerging market and developing economies is developing fast, particularly in Asia, as private investors increasingly look for investments with a positive climate impact.
- Significant challenges complicate efforts to scale up private climate finance in a decisive and timely manner, including a shortage of investable green projects. At the same time, fossil fuel investments remain high. Effective carbon pricing and a strong climate information architecture (data, taxonomies, disclosures) are often lacking.
- Environmental, social, and governance (ESG) investments have grown rapidly, but their climate impact is unclear. Emerging market and developing economies continue to be at a disadvantage from such investments because of systematically lower ESG scores and low investment allocations from ESG funds.
- Despite these challenges, there are various opportunities to scale up private climate finance. Harnessing them will require improvements on various fronts, as well as public support within overall budget constraints.
- Innovative finance instruments, such as emerging market green bond funds, can attract the necessary private investors. Outcome-based debt instruments, such as sustainability-linked bonds, can also benefit emerging market issuers—if the key contractual aspects are set appropriately.
- Multilateral development banks and development finance institutions are crucial to help set up climate projects in low-income countries. They can also help design and implement new financial instruments to leverage private investment and provide risk absorption capacity. A larger share of equity finance by these institutions, combined with greater risk appetite and additional resources, would help achieve these objectives.
- Sovereign issuers have been latecomers to sustainable debt markets, but they can provide an important impetus for the development of private markets.
- Beyond shared principles for sustainable finance alignment approaches, the development of transition taxonomies allows emerging market issuers to send a clear signal of climate benefits to private investors—including in industries whose emissions are hard to abate. These are complementary to a stronger climate information architecture.
- The IMF supports its members through policy advice, identification of financial stability risks, capacity development, attention to data gaps, and advocacy for disclosure. Financing from the new Resilience and Sustainability Trust can help members address longer-term structural challenges, including climate change.

Introduction*

1. Emerging market and developing economies will need significant climate financing in coming years to reduce greenhouse gas emissions (mitigation finance) and adapt to the current and predicted physical effects of climate change (adaptation finance). The investment needs of these economies solely in renewable energy could reach $1 trillion a year by 2030 if they are to stay on track to achieve net-zero greenhouse gas emissions by 2050 (IEA 2021a). Developing economies alone will require up to $300 billion a year by 2030 to adapt agriculture, infrastructure, water supply, and other parts of their economies to counterbalance the physical effects of climate change (UNEP 2021). If efforts to reduce emissions fall short of global objectives set by the Paris Agreement,

* The authors of this chapter are Kay Chung, Torsten Ehlers (co-lead), Charlotte Gardes-Landolfini (co-lead), Esti Kemp, Peter Lindner, and Yanzhe Xiao, under the supervision of Ananthakrishnan Prasad (unit chief, Climate Finance Policy) and Fabio Natalucci (deputy director).

the need for adaptation financing will rise sharply for emerging market and developing economies. Estimates range from $520 billion to $1.75 trillion annually after 2050 depending on the emission pathway (Chapagain and others 2020).

2. **The magnitude of emerging market and developing economy climate finance needs will require significant scaling up of private sources of finance.** The public sector response to the COVID-19 pandemic has placed a burden on public finances in many of these economies, and borrowing costs are rising as central banks worldwide tighten policy to tackle high inflation (see Chapter 1). The issuance of private sustainable finance instruments in emerging market and developing economies thus far has held up relatively well, reflecting continued strong investor appetite. Yet private investment must at least double within this decade to cover the investment needs (Bhattacharya and others 2022).

3. **Underinvestment in climate change mitigation and adaptation in emerging market and developing economies may lead to global financial stability risks through greater exposure to systemic climate-related financial risks.** These economies already account for two-thirds of global emissions (IEA 2021b). Yet greater use of and investment in fossil-fuel-based energy systems from delayed decarbonization (carbon lock-in) may lead to cross-border and global spillover effects as a result of the negative externalities on global climate change and contagion effects along value chains.[1] In addition, because emerging market and developing economies include the majority of megadiverse countries, the loss of ecosystems strongly contributes to the impairment of carbon sinks, necessary to achieve global temperature objectives (NGFS 2022a). Many of these economies are also very vulnerable to climate hazards, with global hot spots in Africa, South Asia, Central and South America, and small island developing states. These vulnerabilities are amplified by poverty, governance challenges, violent conflicts, and a high share of livelihoods sensitive to climate change.

4. **Scaling up private climate finance raises other fundamental challenges beyond the difficulties emerging market and developing economies already face in raising private finance more generally.** These economies face a complex set of interwoven challenges to raise financing that have become more difficult to tackle since the COVID-19 pandemic—including the rise in government debt burdens, higher costs of capital, and underdeveloped banking sectors and capital markets (Prasad and others 2022). Climate finance, in particular adaptation finance, faces an even more fundamental problem: despite its significant benefits for society, it often does not generate sufficient private financial returns. Even if investors are comfortable with a higher level of credit risk, they often face an information asymmetry problem: ascertaining the potential climate benefits of their investments may not be possible with sufficient precision without robust climate data and disclosures. As a result, the risks associated with investing in emerging market and developing economy assets are often deemed too high, deterring otherwise reportedly strong investor interest in sustainable assets. It is unclear whether the very large and quickly growing environmental, social, and governance (ESG) investment flows could play an important role in scaling up private climate finance. In addition to the still uncertain climate benefits of ESG investing, emerging market and developing economy firms' ESG scores are systematically lower than those for firms from advanced markets, and investment funds with an ESG focus allocate significantly fewer funds to emerging market assets.

[1] Carbon lock-in is a specific type of path dependence that occurs when fossil-fuel-intensive systems delay or prevent the low-carbon transition. It is driven by a complex interaction of persistent institutional, market, and policy failures that inhibit the diffusion of low-carbon technologies despite their apparent climate, environmental, and economic advantages.

5. At the same time, there are various opportunities to scale up private climate finance beyond generally improving the investment environment in emerging market and developing economies. Harnessing these opportunities will require improvements on several fronts. Innovative types of structured finance and outcome-based financial instruments that can overcome some of the challenges will need to be deployed on a larger scale and improved where necessary. Transition finance taxonomies, which determine whether and how assets are aligned with emission reduction goals, would benefit emerging market and developing economy issuers by better signaling current and future climate benefits—even for industries with currently high emissions. The climate information architecture—comprised of data, disclosures, and taxonomies to align investments with climate goals—requires strengthening (IMF 2021b; NGFS 2022b). The public sector, including multilateral development banks (MDBs), development finance institutions (DFIs), and other international financial institutions—such as the IMF—must play a key role in crowding in private climate financing in emerging market and developing economies, including by placing more emphasis on equity rather than debt financing. Sovereign issuers have been latecomers—and even absent—from sustainable finance markets, but they can boost market development. The United Nations Framework Convention on Climate Change (UNFCCC) carbon markets could generate significant investment flows to emerging market and developing economies for mitigation purposes, if they are fully implemented. At the same time, specialized vehicles, such as the Green Climate Fund, will need sufficient funding to support adaptation finance.[2]

6. The International Monetary Fund (IMF) can also play an important role, including through its new Resilience and Sustainability Trust (RST). The IMF can help strengthen the climate information architecture and support emerging market and developing economies with the design and implementation of supportive climate policies, including carbon pricing. RST financing could help eligible and qualifying emerging market and developing economies tackle longer-term structural challenges from climate change by providing affordable long-term financing and helping catalyze (public and) private financing. The RST could also be tapped to develop a conducive investment climate by promoting reform measures to improve the regulatory environment and increase the resilience of the infrastructure needed to address climate change.

7. Although this chapter focuses on financial markets and instruments as ways to overcome existing challenges for climate finance in emerging market and developing economies, implementing the necessary and appropriate climate policies remains crucial. Climate policies and finance are complementary—climate policies are a prerequisite for enabling private finance, which in turn contributes to the achievement of climate policy goals.[3] Carbon pricing is an effective tool to make high emitters pay for the climate costs they cause and thereby channel investment toward projects that emit less.[4] More generally, climate policies and commitments, such as the Nationally Determined Contributions under the Paris Agreement, send a strong signal to investors. This can help direct investment flows to support the transition to a low-carbon economy.

[2] The Green Climate Fund was established in 2010 under the UNFCCC framework to limit or reduce greenhouse gas emissions in developing economies. The fund maintains a 50/50 balance between mitigation and adaptation finance.

[3] The recently legislated U.S. Inflation Reduction Act is an example of a policy that incentivizes private investments in carbon-neutral energy production through tax credits.

[4] The IMF's October 2019 *Fiscal Monitor* emphasizes the importance of carbon taxes and pricing to the implementation of carbon mitigation strategies. The IMF's October 2020 *World Economic Outlook* argues that steadily rising carbon prices in combination with a green investment push can deliver the needed emission reductions at reasonable cost. See also www.imf.org/en/Topics/climate-change/climate-mitigation.

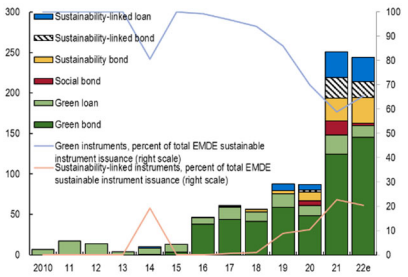
The Market for Private Climate Finance in Emerging Market and Developing Economies: Moving toward the Mainstream

8. Sustainable finance markets in emerging market and developing economies, particularly in Asia, have become progressively more mainstream, and 2021 was a breakout year. Although green bonds are still the main instrument in the sustainable finance ecosystem in emerging market and developing countries (60 percent in 2022 to date), other sustainable finance debt instruments (social, sustainability, and sustainability-linked loans and bonds) have gained prominence since 2018, especially outside of China (Figure 2.1, panel 1).[5] Variation is notable across regions (Figure 2.1, panel 2). The Asia-Pacific region has dominated emerging market and developing economy debt issuance, with 60 percent of sustainable issuance in 2021 and 72 percent in 2022 to date, in line with the region's large share of emissions—about 60 percent of emerging market and developing economies' total territorial emissions. While China remains a significant player, other emerging market and developing economies—especially Chile, India, Mexico, and Türkiye—have seen a sharp pickup in the issuance of sustainable debt as a share of GDP since 2016.

Figure 2.1. Momentum for Sustainable Finance Remains Strong in Emerging Market and Developing Economies (EMDEs), with Notable Differences in Instruments and Regional Composition

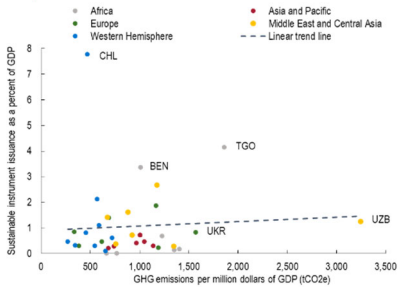
Sustainable debt issuance in EMDEs grew strongly in 2021, with a notable rise in sustainability-linked instruments.

1. Sustainable Instrument Issuance in EMDEs, by Type
(Billions of US dollars; percent)



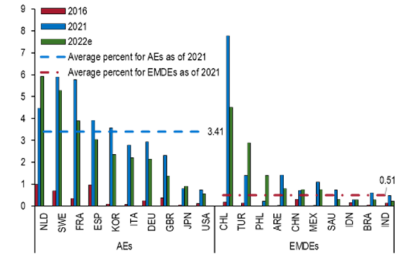
Much of this growth has been driven by issuance in the Asia-Pacific region.

2. Share of Sustainable Instruments in EMDEs and Territorial Greenhouse Gas Emissions by Region, 2021
(Percent of GDP; metric tons of CO_2 equivalent per million US dollars of GDP)



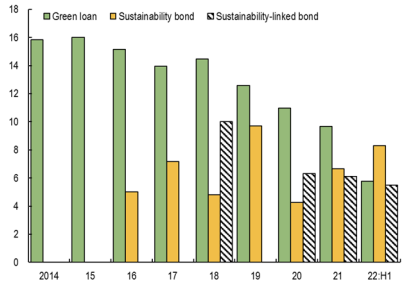
Despite recent increases, sustainable debt issuance remains limited in EMDEs, with some exceptions.

3. Issuance of Sustainable Instruments as a Percent of GDP
(Percent)



Maturities vary substantially across instruments.

4. Sustainable Instrument Initial Maturity in EMDEs by Type
(Year)



Sources: Bloomberg Finance L.P.; IMF, *World Economic Outlook;* and IMF staff calculations.
Note: Data for 2022 in panels 1 and 3 are annualized based on the first half of 2022 (2022e). Panel 3 shows countries filtered by sustainable instrument issuance amounts in 2022 among AEs and EMDEs separately. Panels 2 and 3 use International Organization for Standardization (ISO) country codes. AE = advanced economy; e = estimate; EMDE = emerging market and developing economy; GHG = greenhouse gas; tCO_2e = metric tons of carbon dioxide equivalent.

[5] Green finance instruments are regular financial instruments whose proceeds are used to finance projects that benefit the environment (such as solar energy projects). Social bonds must be used to finance social projects (such as affordable housing), while sustainability bonds finance a combination of green and social projects. All three are "use-of-proceeds" instruments. For sustainability-linked instruments, the issuer sets a contractual target for the borrower to achieve sustainability goals (such as reducing carbon emissions), with free use of proceeds.

9. However, the issuance of sustainable debt in emerging market and developing economies remains a small share of GDP and lower than that of advanced economies (Figure 2.1, panel 3). Maturities vary across instrument types and have shrunk as issuance has grown—except for sustainability bonds (Figure 2.1, panel 4)—due to headwinds in emerging market debt markets more generally.

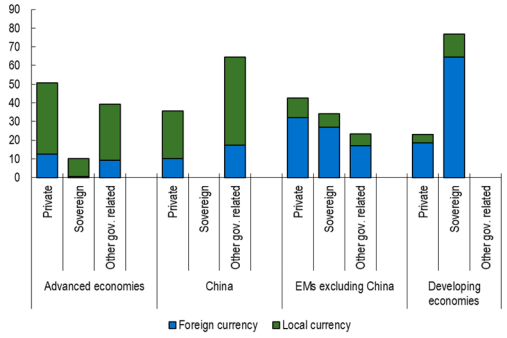
10. Issuance of sustainable bonds follows very different issuer patterns across regions. Sovereign issuance has been absent in China and accounted for only 11 percent of all issuances (since 2008) in advanced economies (Figure 2.2, panel 1). The share has been much larger in emerging markets excluding China (34 percent) and developing economies (77 percent). Issuance by other entities—mainly government agencies and local authorities—has totaled 64 percent in China and 39 percent in advanced economies. These shares are much larger than in other emerging market and developing economies, reflecting greater reliance on public institutions at the local level in the financing of green infrastructure projects in China and the United States. While the share of private sector issuance in other emerging markets, at 43 percent, is comparable to the share in advanced economies and China, it is much lower in developing economies at 23 percent.

Figure 2.2. The Development of Private Climate Finance Comes with a Series of Challenges

China, emerging markets excluding China, and developing economies have followed very different patterns in sustainable bond issuance.

1. Cumulative Issuance of Sustainable Bonds in Foreign and Local Currency

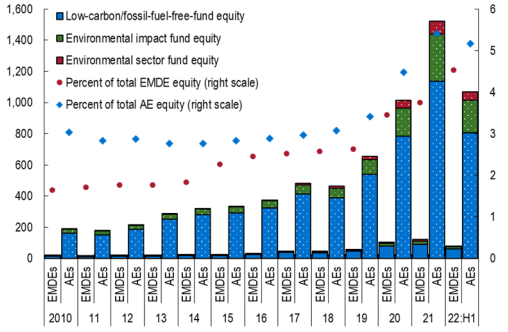
(Percent, since 2008)



Despite recent increases, sustainable equity investments remain small.

2. Sustainable Equity Assets under Management for Selected Climate Fund Types

(Billions of US dollars; percent)



Sources: Bloomberg Finance L.P.; Morningstar Direct; and IMF staff calculations.
Note: Data in panel 2 are as of the first half of 2022. Panel 1 includes only sustainable bonds (excluding US municipal bonds). "Private" includes bonds issued by financial institutions as well as industrial, renewable energy, and utilities bonds. "Sovereign" includes bonds issued by central governments. "Other gov. related" includes bonds issued by agencies and local authorities, as well as covered bonds (debt instruments secured by a cover pool of mortgage loans or public sector debt on which investors have a preferential claim in the event of default). Country classifications in panel 1 are mutually exclusive. Detailed definitions of variables in panel 2 can be found in Online Annex 2.1. AE = advanced economy; EM = emerging market; EMDE = emerging market and developing economy.

11. The low share of private sector issuance in developing economies and the high share of foreign currency issuance in emerging market and developing economies may be explained by a lack of depth in domestic capital markets, including the small scale of local currency bond markets, and high credit risk. The high share of foreign currency issuance in emerging market and developing economies appears to reflect demand for sustainable bonds driven largely by investors based in advanced economies who prefer hard currency over local currency debt. For developing economies, another significant factor is the relative lack of corporations large enough to issue bonds, especially in the global markets.

12. Sustainable equity investments in emerging market and developing economies remain small in terms of assets under management, despite recent increases. As a share of total equity assets under management, however, the difference between advanced and emerging market and developing economies is much smaller (Figure 2.2, panel 2, blue diamonds and red circles). Investor choices in emerging market and developing economies also appear limited in terms

of investment strategies, except those aimed toward companies with small or decreasing carbon footprints or low carbon risk or through avoidance of, or reduced exposure to, fossil fuels.

Challenges for Scaling Up Private Climate Finance in Emerging Market and Developing Economies

13. Despite the increasing momentum behind private climate finance in emerging market and developing economies, several challenges remain when it comes to significantly scaling up financing. These include the complexities of matching the supply and demand of financing, various institutional and informational constraints holding back projects and financing, a lack of effective carbon pricing, still-strong fossil fuel investment, an underdeveloped climate information architecture, and features of ESG scores and funds that put these economies at a disadvantage.

The Climate Financing Gap Remains Large, and Matching the Sources of Supply with Demand is Complex

14. The mismatch between emerging market and developing economies' climate financing needs and current investment flows has produced a large financing gap. For purposes of climate mitigation, infrastructure financing—mainly in the transport and energy sectors—falls short of needs across all regions (Figure 2.3, panel 1). The financing gap is even greater for adaptation purposes, particularly for water and sanitation, irrigation, and flood protection, where investment is almost nonexistent (Figure 2.3, panel 2). It is even more concerning that the more important a region's aggregated vulnerability to climate change (measured by its exposure, sensitivity, and ability to adapt), the greater the financing gap. Financing needs for mitigation and adaptation purposes are also large relative to GDP across all regions (Figure 2.3, panel 3). At the same time, carbon pricing initiatives, still nascent in those economies, offer only limited price signals to support climate financing (Figure 2.3, panel 4).

15. Addressing this mismatch is challenging given the current structure of climate finance markets. In terms of instruments, sustainable finance markets remain largely dominated by debt, which has about twice as large a share as equity financing (60 percent versus 32 percent of total climate finance; see Online Annex 2.2). With respect to sources of financing and types of intermediaries, the private sector—commercial financial institutions, funds, households, and corporations—account for about half of the flows. All types of financing instruments and investors, with different investment horizons, needs for scale, risk profiles, and funding sources, need to be mobilized for mitigation and adaptation purposes. For instance, renewable energy infrastructure and low-carbon technologies (such as carbon capture and storage, batteries, low-carbon hydrogen) will largely require equity finance (IEA 2021a).

16. At the same time, several constraints hold back projects and financing on the supply and demand sides. Investors have noted various reasons for gaps in financing needs related to lack of investable projects (Ehlers 2014; Fouad and others 2021). They point to bottlenecks in project preparation and development. Deficiencies in policy and regulatory frameworks and weaker institutional capacity (related to contract enforcement, property rights, and management of fiscal risks and public investment) make it hard to manage the long-term investments needed in sustainable infrastructure. In addition, investors point to a need for high-quality, reliable, and comparable data.

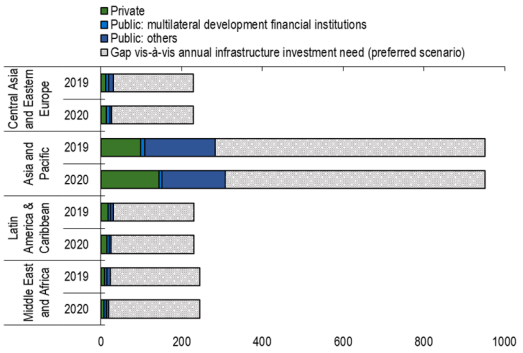
The Triple Challenge: The Lack of Carbon Pricing and Fossil Fuel Investment and an Underdeveloped Climate Information Architecture

17. Currently, emerging market and developing economies lag advanced economies in their implementation of carbon pricing. Nascent initiatives—mainly carbon taxes—fall short of targets both in emission coverage and prices when compared with advanced economies (Figure 2.3, panel 4). Consumption subsidies for fossil fuels in some emerging market and developing economies are essentially a persistent form of negative carbon pricing, which makes for an uneven playing field for investments in low-carbon technologies.

Figure 2.3. A Deep-seated Financing Gap for Climate Change Mitigation and Adaptation: Limited Fiscal Capacity and Carbon Pricing Strategies in Emerging Market and Developing Economies

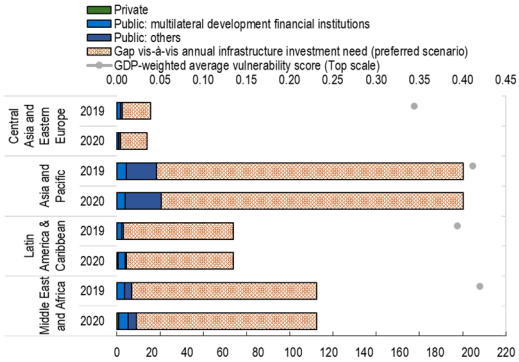
The overall gap vis-à-vis mitigation needs is high across regions…

1. Global Climate Finance Flows in Mitigation and Infrastructure Investment Needs by Region
(Billions of US dollars)



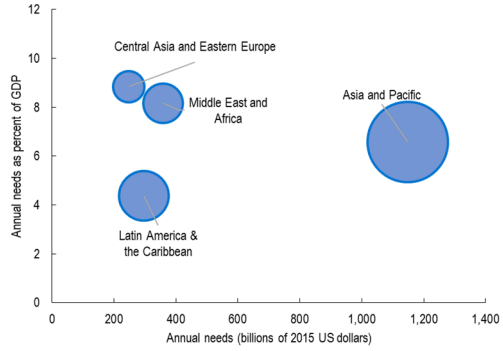
…and even more so for adaptation finance, despite the high level of vulnerabilities to climate change.

2. Global Climate Finance Flows in Adaptation, Infrastructure Investment Needs, and Vulnerability Score by Region
(Billions of US dollars, bottom; score, top)



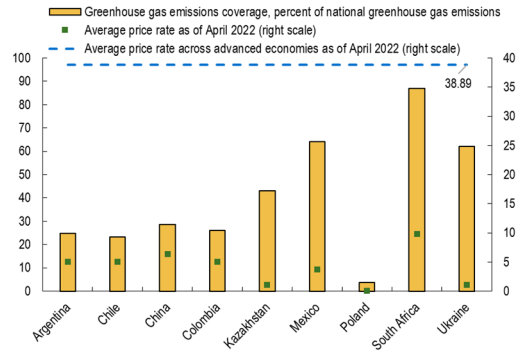
Needs relative to GDP are significant across regions, specifically in the Asia-Pacific region and in Latin America and the Caribbean.

3. Annual Infrastructure Investment Needs Relative to GDP
(Percent of GDP; billions of 2015 US dollars)



However, carbon pricing initiatives remain nascent in those economies, with insufficiencies in coverage and rates.

4. National and Subnational Carbon Pricing Initiatives as a Share of National Greenhouse Gas Emissions with Average Price Rate
(Percent of national greenhouse gas emissions; US dollars a tCO_2e)



Sources: Climate Policy Initiative (2021); Emissions Database for Global Atmospheric Research; Emissions Database for Paris Reality Check; EORA Global Supply Chain Database; Notre Dame Global Adaptation Index; World Bank (2019); and IMF staff calculations.
Note: In panels 1 and 2, the infrastructure needs for mitigation include the energy and transport sectors, and infrastructure needs for adaptation include the water and sanitation, irrigation, and flood protection sectors. The climate finance flow includes both emerging market and developing economies and advanced economies in selected regions; the infrastructure investment needs are calculated for all low- and middle-income countries. Therefore, the infrastructure needs gap is underestimated. In panel 2, the GDP-weighted average vulnerability score measures a country's exposure, sensitivity, and capacity to adapt to negative effects of climate change. In panel 3, the size of the bubble represents the GDP. In panel 4, "price rate" is the cost per metric ton of carbon dioxide equivalent emissions from both the carbon tax and emission trading system. The coverage of each carbon pricing initiative is presented as a share of annual national greenhouse gas emissions for 2021. Detailed variable definitions can be found in Online Annex 2.1. tCO_2e = metric ton of carbon dioxide equivalent.

18. Investment in emerging market and developing economies is still tilted toward the fossil fuel sector, which has experienced a substantial rebound in debt issuance since the Paris Agreement. In the coal sector, the growth of outstanding debt (bonds and loans) was more than 400 percent between the first quarter of 2016 and the second quarter of 2022, with a nearly 500

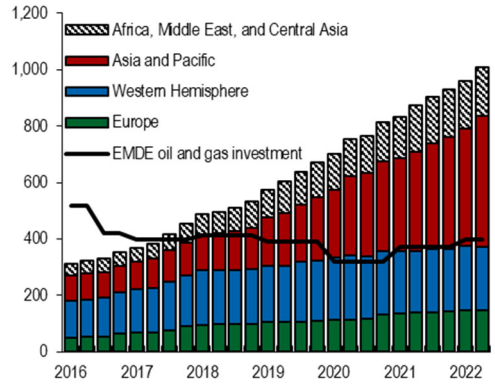
percent increase in the Asia-Pacific region (Figure 2.4, panels 1 and 2). The ability to raise debt financing has also been high in the oil and gas sector, where outstanding debt grew 225 percent, with a more than 400 percent increase in the Asia-Pacific region over the same period (primarily via bank loans). Moreover, debt of companies in emerging market and developing economies with coal power expansion plans increased about 350 percent between 2016 and 2022; annual growth in the second quarter of 2022 was nearly 30 percent. This increase occurred despite warnings that achievement of net-zero targets requires halting new oil and gas field development, new coal mines and extensions beyond projects already committed to as of 2021 (IEA 2021a). Against this backdrop, Russia's war in Ukraine and the move away from Russian energy in Europe could result in a significant setback, incentivizing further fossil fuel exploration in emerging market and developing economies.

Figure 2.4. Debt Levels of Emerging Market and Developing Economy Companies Operating in Fossil Fuel Industries Continue to Increase

Debt levels of companies headquartered in Asia and the Middle East have increased at the highest rate…

1. Total Debt of Companies Operating in the Oil and Gas Industry Domiciled in EMDEs

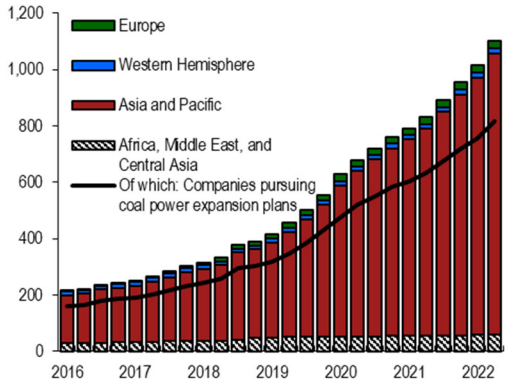
(Billions of US dollars)



…while debt levels of companies pursuing expansion plans have also increased, notably in Asia.

2. Total Debt of Companies with a Significant Role in the Thermal Coal Value Chain Domiciled in EMDEs

(Billions of US dollars)



Sources: Bloomberg Finance L.P.; Urgewald; and IMF staff calculations.

Note: Companies in panel 1 include those with expansion activities in the upstream and midstream sectors. Total debt includes bonds and loans. Data are based on a sample of roughly 80 companies for which debt statistics are available from 2016 onward, out of 250 identified companies headquartered in EMDEs. Companies in panel 2 include those meeting criteria set out by Urgewald. Total debt includes bonds and loans. Data are based on a sample of 106 parent companies and subsidiaries for which debt statistics are available from 2016 onward, out of roughly 2,200 identified that are headquartered in EMDEs. The sample represents roughly 25 percent of the installed coal power capacity of companies headquartered in EMDEs. Companies with expansion plans are those planning to develop new coal-fired power capacity of at least 100 megawatts. EMDE = emerging market and developing economy.

19. Further, the climate information architecture in emerging market and developing economies remains underdeveloped despite recent advances. There is a lack of granular, quality climate data in these economies, and there are challenges in terms of both availability and accessibility. Data sets on climate variables (for example, temperature and precipitation) and carbon intensity are sparse, especially for Africa, small island developing states, and regions in high-mountain Asia (NGFS 2022b). While climate-related corporate disclosures have recently improved—mostly across Asia, Chile, Peru, South Africa, and Türkiye—disclosures remain voluntary in most countries and lack standardization, consistency, and reliability because of an absence of auditing requirements. Current disclosures cannot give a consistent picture of financial sector exposure to climate-related risks and opportunities because of the lack of high-quality, consistent, and comparable climate data.

20. The Chinese and European taxonomies have propelled several emerging market and developing economies—primarily in Asia and Latin America—to develop their own regional or national taxonomies. The taxonomies of the Association of Southeast Asian Nations (ASEAN),

as well as Indonesia, Malaysia, and Singapore (via a "traffic light" approach),[6] are notable examples of transition taxonomies. They aim to identify improvements in emissions over time and across sectors, including within the most carbon-intensive sectors, to support the transition to a low-carbon economy. Nonetheless, most existing taxonomy projects have still not been tested for robustness to meet long-term temperature goals and for their impact on financial markets, including by potentially diverting investment from carbon-intensive activities or companies facing complex transitions (IEA 2021a). As for global initiatives such as the International Platform on Sustainable Finance Common Ground Taxonomy and regulations and policies in advanced economies (primarily Europe and the United States), the impact on emerging market and developing economies is unclear at this point; these initiatives could, however, serve as benchmarks for capital market development in these countries, notably given regulatory spillovers and data needs.

Environmental, Social, and Governance Scores and Investment Funds Put Emerging Market and Developing Economy Firms at a Disadvantage

21. ESG investing is a major and growing investment trend, but its impact on climate finance in emerging market and developing economies may be limited. The Global Sustainable Investment Alliance estimates that the assets under management of funds with an ESG-related investment mandate have reached $35.3 trillion, or about 36 percent of global assets under management (GSIA 2020). About half of ESG funds' assets are allocated to equities (52 percent at the end of the second quarter of 2022). A small increase in the share of ESG fund allocations to emerging market and developing economies could in principle result in significant investment flows.

22. A general challenge for ESG scores and investing, however, is the lack of focus on ESG impact, including climate change. ESG scores are based on a large number (usually more than 100) of ESG-related data points, such as whether a firm has a carbon transition plan (an E component). Typically, a higher ESG score indicates better ESG "performance" of a firm.[7] Recent IMF research, however, finds that there is limited scope for investment strategies based on ESG indicators to meaningfully help mitigate climate change (Elmalt, Kirti, and Igan 2021). Historically, ESG ratings evolved as a means to manage nonfinancial risks, rather than to assess the ESG benefits of firms.[8] Recent scrutiny around the labeling of ESG funds further suggests that not all ESG funds sufficiently incorporate ESG factors into their investment strategies.

23. ESG scores appear to be systematically lower for emerging market and developing economy firms than for advanced economy firms. While the distribution of ESG scores from different providers can differ significantly (Berg, Kölbel, and Rigobon 2022), listed emerging market and developing economy firms tend to have, on average, lower scores than their advanced economy counterparts (Figure 2.5, panel 1). This is true also for the individual E, S, and G scores (see Online Annex 2.6 for a more detailed analysis of ESG scores). One determinant of ESG scores appears to be firm size (Drempetic, Klein and Zwergel 2019). In the data sample of listed firms, however, emerging market and developing economy firms, on average, are not significantly smaller than advanced economy firms (Figure 2.5, panel 2). Online Annex 2.6 contains a more formal regression analysis, showing that in addition to size, industry composition, firms' financial performance, and other

[6] A traffic light approach means that an economic activity may be characterized as green, amber, or red, depending on its contribution to climate change mitigation, according to a series of technology- and emission-related criteria.

[7] For some providers the opposite is the case. One prominent example is Sustainalytics (owned by Morningstar), for which a higher score represents a higher ESG risk and therefore lower ESG "performance." See www.sustainalytics.com/esg-data.

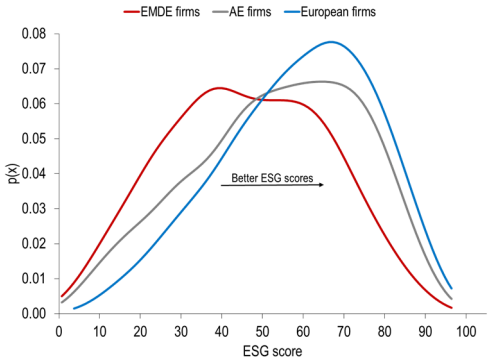
[8] Indeed, the most prominent ESG rating providers clearly state that their scores are risk ratings. For MSCI, the largest ESG rating provider by market share, see www.msci.com/our-solutions/esg-investing/esg-ratings/what-esg-ratings-are-and-are-not. For Sustainalytics, the second largest, see www.sustainalytics.com/esg-data.

unobserved firm characteristics cannot fully account for the lower ESG scores of these economies' firms.[9] These results also hold true for E scores only. Which ESG characteristics can account for the systematically lower scores of emerging market and developing economy firms is difficult to pinpoint. A large number of data points are used to construct ESG scores, and these data points differ depending on the industry. Further, the individual ESG characteristics that feed into the scores, and the weight they receive, are at the discretion of ESG scoring providers and vary substantially across providers.

Figure 2.5. ESG Scores and Fund Allocations Are Systematically Lower for Firms in EMDEs

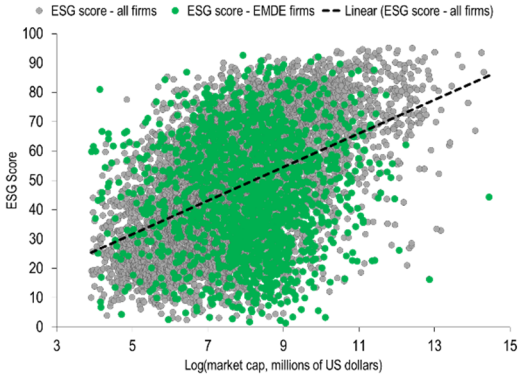
The distribution of ESG scores of firms is dominated by scores for firms listed in advanced economies.

1. Smoothed Distribution Function of ESG Scores
(Probability)



This skewing cannot be explained by the size of EMDE firms, which on average does not differ from advanced economy firms in the sample.

2. ESG Scores and Firm Size

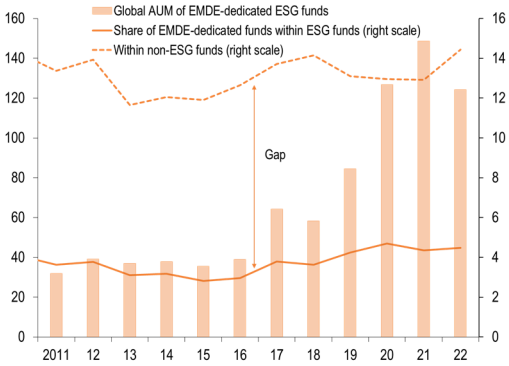


Allocations of ESG funds to EMDEs are lower than those of other funds…

3. Share of EMDE Allocations of ESG vs. Other Funds
(Percent)

…which is driven partly by the relatively small size of ESG funds dedicated to EMDEs.

4. EMDE-Dedicated ESG Funds vs. EMDE Non-ESG Funds
(Billions of US dollars; percent)



Sources: Morningstar; Refinitiv; and IMF staff calculations.
Note: Panels 1 and 2 are based on listed firms only—more than 6,200 in total, of which more than 1,300 are from EMDEs. Panel 1 excludes US firms for the Refinitiv ESG scores because the data have a bias toward covering small US firms and penalize these firms for not reporting E data. This is not the case for most other ESG rating providers. Panel 1 shows a smoothed distribution function of the ESG scores. A higher score implies better ESG performance. Panels 3 and 4 include data up to the end ofsecond quarter of 2022. AE = advanced economy; AUM = assets under management; EM = emerging market; EMDE = emerging market and developing economy; ESG = environmental, social, and governance.

24. Allocations to emerging market and developing economies (equities and bonds) by ESG investment funds are also lower than those by non-ESG funds (Figure 2.5, panel 3).[10] One reason for the significant and persistent difference is the lack of ESG funds dedicated to these

[9] Another potential explanation is the lack of reporting of ESG data, which induces a penalty in the analyzed ESG data. This is, however, not the case for all ESG scoring providers.

[10] The difference in allocations to emerging market and developing economies between ESG and non-ESG funds holds true separately for equities and bonds. See Online Annex. 2.4.

economies (Figure 2.5, panel 4). But emerging market and developing economy allocations between ESG funds and other funds also differ for global funds that invest in both advanced and emerging market and developing economies and (see Online Annex 2.7).[11]

Harnessing the Opportunities to Scale Up Private Climate Finance in Emerging Market and Developing Economies

25. Given the scale and variety of climate investment needs, a single instrument or approach is unlikely to be sufficient or advisable. The opportunities discussed in this chapter present a set of feasible and complementary tools for different use cases and country circumstances.

New Financing Instruments and the Role of Multilateral Development Banks

26. Innovation in climate finance has proceeded rapidly, including four distinct types of instruments and approaches that address different fundamental challenges and therefore have different use cases (Table 2.1 and Online Annex 2.4). *Structured finance vehicles* purchase green bonds from emerging market banks and target large institutional investors. MDBs purchase equity or provide a credit risk guarantee to these structures to reduce the risks such that pension funds or insurance companies can invest. *Blended finance* more broadly combines public and donor capital to de-risk infrastructure investments for private capital, thereby helping to mobilize and scale up climate private finance. *Outcome-based sustainable debt instruments,* such as sustainability-linked bonds, include an incentive mechanism to address information asymmetries between issuers and investors (called "greenwashing," when sustainability benefits of investments are not as high as issuers claim). In *"pay-for-success" private financing* for public sector projects, third-party investors, including private investors, provide the initial investment and develop a project. The public sector then purchases the project for an amount linked to the project's sustainability performance—investors receive higher compensation with higher performance (measured by indicators agreed on in advance).

27. The public sector, including MDBs and DFIs, have an important role to play in employing some of these instruments.[12] To attract private capital, the various risks associated with emerging market and developing economy financial assets (ranging from credit, foreign exchange, and macroeconomic risks to governance and political risks) must be reduced. National development banks, MDBs, and DFIs can efficiently employ their resources and expertise to crowd in private finance. By absorbing a portion of these risks, providing technical assistance and capacity development, and lending their reputation and expertise, these institutions and banks can play an important role in attracting private investors that would not otherwise have provided funding for climate-beneficial investments in emerging market and developing economies. Naturally, this entails risks for the public sector, which need to be managed appropriately (Prasad and others 2022).

28. The emerging market green bond fund established by the International Finance Corporation (IFC) and asset manager Amundi exemplifies efficient use of MDB resources to attract private finance. The fund (AP EGO) set up by Amundi pooled green bonds issued by banks in various emerging markets and developing economies. It thereby leveraged on the expertise of local banks and their critical role as a source of financing in these economies. The IFC, part of the World

[11] A link between systematically lower scores of emerging market firms and low ESG fund allocations to these economies' assets is suggestive, but it is difficult to establish it formally. To what extent ESG funds use ESG scores (and from which providers) in determining their investment allocations is typically not publicized. Further, ESG funds often combine the use of ESG scores with other criteria to determine their asset allocations.

[12] Unlike MDBs, which provide financial assistance to promote economic and social development, DFIs are specialized development banks or subsidiaries set up specifically to support *private* sector development. These are usually majority-owned institutions of national governments and source their capital from national or international development funds or benefit from government guarantees.

Bank Group, purchased a first-loss/equity tranche of the green bond fund. This reduced the credit risk for other investors to what is called "investment-grade level," allowing pension funds to invest (see Online Annex 2.5). IFC's equity investment of $125 million enabled a fund totaling $2 billion, a multiple of 16 (Bolton, Musca, and Samama 2020).

Table 2.1. Selected Innovative Financial Instruments for Climate Finance

Type of Instrument	Structured Finance and EMDE (Closed-End) Fixed-Income Funds	Blended Finance for Infrastructure and Other Complex Projects	Outcome-Based Sustainable Debt Instruments	Private Finance for Public Sector Projects ("Pay for Success")
Examples	Green bond funds: IFC-Amundi; Axa's Blue Like an Orange (in progress)	Equity, mezzanine/first-loss finance for infrastructure projects	Sustainability-linked instruments (bonds, loans, commercial paper, etc.)	Environmental impact "bonds"
Description	Green bonds issued by EMDE banks (against green loans) are securitized into green bonds with the public sector providing credit risk reduction	MDBs or the public sector make an equity or mezzanine investment, or provide a guarantee to de-risk and crowd in private investors	Issuer receives a bonus (pays a penalty) if sustainability target agreed on in advance (based on clearly defined indicators) is met (missed)	Contract with a public sector authority that pays if predefined environmental outcomes are achieved
Use case	Emerging markets with existing bank loans to green projects	New infrastructure projects (for example, in the energy sector); use of new types of technologies with potentially higher risks; agriculture	Support firm-level or government-level alignment with sustainability targets (such as greenhouse-gas-emission reductions)	Adaptation finance, nonbankable transition finance
Fundamental challenges addressed	Reduction in credit risk (through elevation to investment-grade finance), scaling, diversification, potential currency risk reduction through pooling	Mitigation of credit and political risks; mitigation of information asymmetry problems	Information asymmetry ("greenwashing")	Capacity limits in developing complex green projects (such as in infrastructure); potential inefficiencies in public sector investment
Targeted private investors	Institutional investors, including pension funds and insurance companies	Specialist investors and investment funds; local investors	All	Specialized funds, donor funds, MDBs
Mechanism to ensure climate benefits	Selection of eligible bank loans; usual green bond certification	Project selection and technical assistance	Bonus (or penalty) provides incentive to fulfill sustainability target	Project selection; due diligence
Public sector/MDB involvement	De-risking (purchase equity tranche/provide first-loss guarantee); technical assistance	Own resources for equity/mezzanine investment and guarantees; provide specialized expertise for project design	None. Sovereigns could issue to support market development and set standards	Direct investment; technical assistance
Design/ incentive issues	Requires existing bank loans and technical assistance for banks to issue green bonds	Complex contractual agreements; extensive equity/mezzanine investment and guarantees can create moral hazard; limits returns for other equity investors	Sustainability targets may not be sufficiently ambitious; penalties need to be high enough to motivate issuer to achieve target	High financial and political risks for private investors
Potential to scale up finance	High	Limited by public sector MDB resources	Limited by issuer characteristics	Limited by fiscal resources

Source: IMF staff illustration.
Note: EMDE = emerging market and developing economy; MDB = multilateral development bank.

29. MDB resources could be targeted more to attracting private sector climate finance. On average, MDBs attracted only 1.2 times the amount of private finance (equity and debt) relative to commitments of their own resources in 2020 (Figure 2.6, panel 1). There is an ongoing and long-standing discussion about how to leverage the resources of MDBs most efficiently for climate finance (Basu and others 2011). The use of equity has the greatest potential to maximize co-financing because

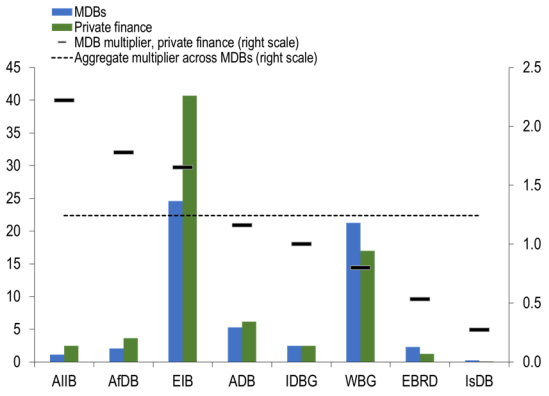
it enables a potentially high multiple of additional debt finance. The use of equity, however, remains very limited, at about 1.8 percent of total MDB commitments to private climate finance in emerging market and developing economies (Figure 2.6, panel 2).

Figure 2.6. Multilateral Development Banks Have Scope to Draw in More Private Climate Finance for Emerging Market and Developing Economies

MDBs crowd in private finance on average of only about 1.2 times the resources they commit themselves…

1. MDB Climate Finance from Their Own Resources and Private Investors (private finance), 2020

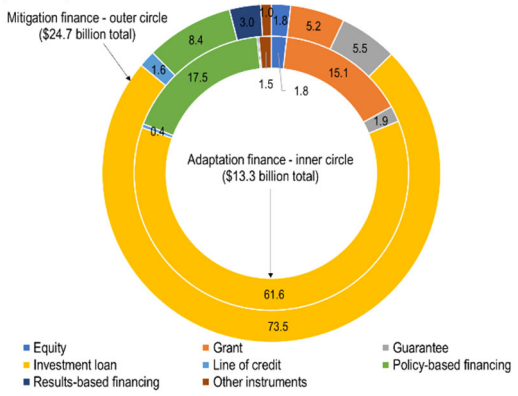
(Billions of US dollars; ratio)



…in part because they invest a small share in equity instruments or guarantees.

2. Use of Instruments: Total Commitments of MDBs' Own Resources, 2020

(Percent)



Sources: World Bank, *2020 Joint Report on Multilateral Development Banks' Climate Finance;* and IMF staff calculations.
Note: Commitments include the nominal value of guarantees, which may or may not lead to use of a multilateral development bank's own resources. ADB = Asian Development Bank; AfDB = African Development Bank; AIIB = Asian Infrastructure Development Bank; EBRD = European Bank for Reconstruction and Development; EIB = European Investment Bank; IDBG = Inter-American Development Bank Group; IsDB = Islamic Development Bank; MDB = multilateral development bank; WBG = World Bank Group.

30. Scaling up MDB commitments significantly would ultimately require an expansion of their own resources for climate finance. Developing climate-resilient and beneficial infrastructure projects is a key component of climate finance for economies at all levels of development. Infrastructure finance faces various well-known challenges, including a lack of investable projects (Ehlers 2014; Fouad and others 2021). Supporting the complex development of infrastructure projects, including through technical assistance, and providing financing constitute the core contributions of MDBs.

31. Sustainability-linked bonds, the main outcome-based debt instrument to date, have been very popular among emerging market issuers and have the potential to be used even more. These bonds feature a contractually agreed sustainability performance target based on a key performance indicator.[13] Unlike green bonds and other use-of-proceeds instruments, issuers may use the proceeds freely. Emissions and other environmental goals (mainly energy efficiency and water consumption) are the dominant performance indicators among emerging-market-based issuers of sustainability-linked bonds (Figure 2.7, panel 1). These bonds may also be used as a transition finance instrument if a target for reduction of greenhouse gas emissions is in line, say, with a net-zero-emission pathway. These features can be appealing to emerging market and developing economy issuers. Unlike green bonds, which require firms to engage in projects using highly developed green technologies, sustainability-linked bonds signal an improvement over time—independent of the current level of development.

32. Apart from operational advantages for emerging market issuers, outcome-based instruments can signal to investors that the issuing firm is committed, for example, to

[13] For instance, a sustainability performance target could be a firm's direct (scope 1) and indirect greenhouse gas emissions (scope 2), and the associated key performance indicator could be a specific level that the company pledges to achieve by, say, 2030.

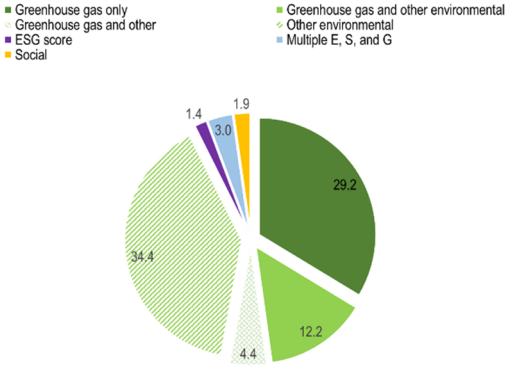
improving its emissions over time. The financial incentive to reach the target, if set sufficiently high, can be a strong incentive for the issuer and alleviate investors' concerns about greenwashing. Sustainability-linked bonds, and other outcome-based instruments, are also very suitable for investors looking to ensure the sustainability impact of their investments.

33. Current practical challenges for sustainability-linked bonds remain. While sustainability targets are sometimes seen to lack ambition (ING 2021), the penalty for not reaching them is often low—in the case of sustainability-linked bonds, less than 25 basis points for most emerging market issuance (Figure 2.7, panel 2). Typically, the penalty comes in the form of a step-up the issuers must pay on the bonds' coupon payments if the sustainability performance target is missed.[14] The penalty event date typically occurs several years after issuance to give the issuer time to reach the performance target. This reduces the dollar value of the penalty and the incentive for the firm to reach the target.

Figure 2.7. Sustainability-Linked Bonds–Conceptually Solid Instruments with Practical Issues

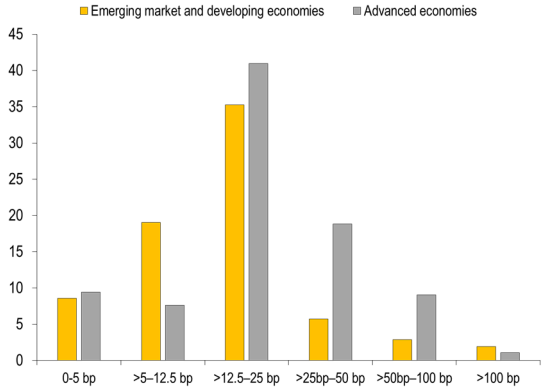
Most sustainability-linked bonds have either a greenhouse gas or another environmental target…

1. Sustainability Target, by Share of EMDE Issuance Amount
(Percent)



…but the small penalties are unlikely to be high enough to create strong-enough incentives for issuers to fulfill the pre-agreed target.

2. Coupon Penalties, by Share of Issuance Amount
(Percent)



Sources: Bloomberg Finance L.P.; and IMF staff calculations.
Note: bp = basis point; ESG = environmental (E), social (S), and governance (G); GHG = greenhouse gas.

34. A new instrument is known as "pay-for-success" finance for climate purposes, also dubbed "environmental impact bonds." While pay-for-success instruments were developed for social projects (social impact bonds), they could also be applied to environmental projects.[15] An important potential use is for adaptation finance. Private sector participation could be particularly effective for adopting less proven but innovative green technologies, where the public sector lacks the necessary expertise. In less developed economies, where capacity to develop such projects is often limited, this financing mechanism could expand the types of potential green and adaptation projects, with the public sector ultimately retaining ownership of the project. It could also incentivize efficient implementation of complex projects if payments to private investors are designed to increase sufficiently with performance. The contractual arrangements are bespoke and complex, however, and require technical assistance as well as assurance against political risks—a potential role for MDBs.

[14] The large majority of sustainability-linked bonds features a coupon step-up (or penalty) in the case the sustainability target is missed. In relatively rare cases, the coupon is reduced if the target is reached. The incentive mechanism, however, is symmetric to the case of a coupon penalty (Berrada and others 2022). Other relatively uncommon types of penalties include a redemption premium or a penalty payment to a third party such as a not-for-profit organization dedicated to combating climate change.

[15] To date, environmental impact bonds have been structured only for US municipal projects. The first was issued by DC Water in September 2016 to finance the construction of green infrastructure to manage stormwater runoff in Washington, DC.

The Role of the IMF and the New Resilience and Sustainability Trust

35. The IMF can play a catalytic role in climate finance through its policy advice, surveillance, and capacity development by drawing on its track record as a catalyst for official and private finance. The IMF can mitigate macroeconomic risk by providing advice through bilateral and multilateral surveillance, assessing countries' economic and financial developments during Article IV consultations, performing risk assessments in Financial Sector Assessment Programs, providing climate macro-financial country assessments, and enhancing countries' capacity development. The IMF is already playing a leading part in advocating for carbon pricing. It's Climate-Public Investment Management Assessment is a framework that helps governments identify potential improvements in public investment institutions and processes to build low-carbon and climate-resilient infrastructure (IMF 2021a). This can help give higher priority to climate change mitigation and adaptation in infrastructure development.

36. Together with other large global policy institutions, the IMF can help strengthen the climate information architecture in emerging market and developing economies. The IMF is playing a key role identifying data gaps, promoting climate-related disclosure, and developing operationalization guidelines for taxonomies to ensure interoperability.[16] Global policy institutions such as the IMF can partner with global data providers to supply them with regularly updated macroeconomic and climate-related data and make such data accessible to the public in a well-structured and accessible way. The IMF has started publishing a Climate Change Indicators Dashboard, which includes indicators on climate financing.[17]

37. Countries, particularly eligible and qualifying emerging market and developing economies, with limited fiscal space can benefit from IMF Resilience and Sustainability Trust (RST) financing. This new financing facility focuses on longer-term structural changes, including climate change and pandemic preparedness, that entail macroeconomic risk and on policy solutions that have a strong global public good nature (IMF 2022). The RST could play a catalytic role by helping develop a conducive investment climate through reforms that improve the regulatory environment and enhance the quality of data and disclosures, as well as support policies to make infrastructure more resilient.

Transition Taxonomies

38. Transition taxonomies, such as those developed in Southeast Asia and discussed earlier in this chapter, can yield significant benefits for emerging market and developing economies. These taxonomies can focus on innovative technologies for sectors in which it is difficult to abate emissions because of technological and cost challenges (such as for cement, steel, chemicals, and heavy-duty transport). They also help promote corporate disclosure of transition plans to meet the Paris Agreement goals and can inform temperature ratings at the company and portfolio levels. By not relegating carbon-intensive industries—the industries with the greatest potential to reduce greenhouse gas emissions—to the sidelines, transition taxonomies can be an important tool for emerging market and developing economies and can incentivize private investment informed by climate change targets (see Online Annex 2.3).

[16] IMF, BIS, OECD, and WB (forthcoming).

[17] The IMF Climate Change Indicators Dashboard includes a range of distinctive indicators that demonstrate the impact of economic activity on climate change, grouped into five categories: economic activity, cross-border, financial and risks, government policy, and climate change data. See https://climatedata.imf.org/.

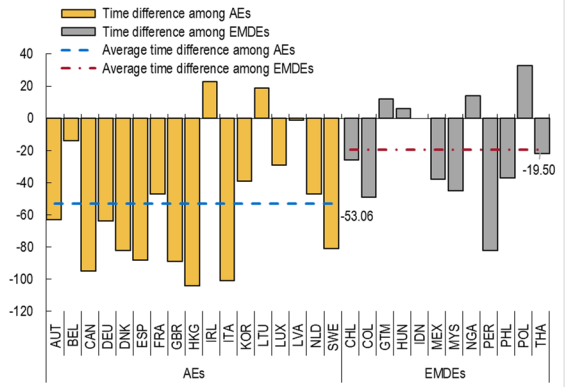
The Role of Sovereign Bond Issuance

39. Sovereign issuers have been latecomers to the issuance of sustainable debt, but they can still have a positive effect on private markets. In most cases, sovereigns issued their first sustainable debt instrument after the private sector did so (Figure 2.8, panel 1). Emerging market and developing economy sovereigns, however, have generally been faster to follow the private sector. The time lag of sovereign sustainable bond issuance has been less than 2 years on average for emerging market and developing economies versus close to 4.5 years for advanced economies. Typically, sovereign issuance has had a positive impact on private issuance, emphasizing the impetus to market development that a sovereign can provide (see Online Annex 2.8 for a formal regression analysis controlling for the momentum in the growth of private debt).[18] In addition, sovereigns can help set sustainability reporting standards. All 39 sovereign issuers to date have detailed issuance frameworks setting high standards. For green bonds, for instance, all sovereign green bond issuance frameworks require at least one second-party opinion (which certifies the use of proceeds for green projects) and impact reports (which document the environmental impact).

Figure 2.8. Sovereign Sustainable Debt Issuance

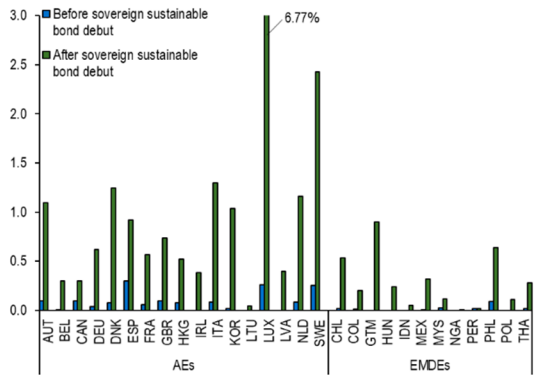
Sovereigns have been latecomers in sustainable debt markets…

1. Lag between First Corporate Sustainable Bond Issuance and Sovereign Sustainable Bond Issuance
(Months)



…but usually have had a positive impact on private issuance.

2. Annualized Average Corporate Sustainable Bond Issuance before and after First Sovereign Sustainable Bond Issuance
(Percent of GDP)



Sources: Bloomberg Finance L.P.; IMF, *World Economic Outlook*; and IMF staff calculations.
Note: The data sample includes sustainable bond issuance between 2007 (the issuance of the first sustainable bond) and the end of June 2022. Panel 2 displays annualized average corporate sustainable bond issuance as a percent of GDP. Panels 1 and 2 include only countries where both the government and at least one private firm issued a sustainable bond. Nine countries have issued a sovereign sustainable bond but have not seen private sector issuance. The negative numbers in panel 1 imply that the first corporate sustainable bonds were issued earlier than the first sovereign sustainable bonds. Panels use International Organization for Standardization (ISO) country codes. AE = advanced economy; EMDE = emerging market and developing economy.

The Potential Benefits of the New International Carbon Markets for Emerging Market and Developing Economies

40. Carbon markets offer substantial opportunities for emerging market and developing economies. The 2021 United Nations Climate Change Conference, known as COP26, has led to completion of the rulebook for implementation of Article 6 of the Paris Agreement, providing a framework to issue carbon credits in a new international carbon market, as well as to trade

[18] Nine sovereigns (not shown in Figure 2.8) have issued a sustainable bond that has not been followed by any private issuance from firms in the same jurisdiction. The countries and months of issuance are Andorra (May 2021), Benin (July 2021), Ecuador (January 2020), Fiji (November 2017), Isle of Man (September 2021), Serbia (September 2021), Slovenia (July 2021), and Uzbekistan (July 2021).

internationally transferred mitigation outcomes (ITMOs).[19] Advanced economies should be able to buy ITMOs from emerging market and developing economies, opening up a wider market for trade and potentially increasing competition for emission reductions by these economies. Estimates show the potential to generate from $330 billion to $475 billion in net financial flows to emerging market and developing economies by 2030 and to prevent up to 6 percent of these economies' total energy-related emissions over the same period (IEA 2021a). Since the COP26, countries have initiated engagement strategies and processes to become potential IMTO sellers and buyers. Despite the opportunities ITMOs present, there are challenges. They offer limited potential for adaptation purposes and make it difficult to avoid double counting of emission reductions by the buyer and seller of ITMOs. In addition, they can be complicated when it comes to cost-efficient implementation of measurement, reporting, and verification processes.

Conclusion and Policy Implications

41. Scaling up private climate finance in emerging market and developing economies calls for a multipronged approach with improvements across various dimensions, including support from multilateral development banks, the IMF, and the public sector. This reflects both the scale of financing needs and the variety of investments needed to achieve material climate change mitigation and adaptation.

42. Innovative financing instruments can help overcome some of the challenges faced by the private sector in emerging market and developing economies, such as credit and political risks and lack of scale. In larger emerging markets with functioning bond markets, investment funds (such as the Amundi green bond fund set up with the help of the World Bank Group's IFC) provide a good example of how to draw in institutional investors. Such funds should be replicated and scaled up to incentivize issuers in emerging markets to generate a sufficient supply of green assets to finance green projects. By relying on public markets, these funds can draw in large amounts of private finance with relatively little use of MDB or public sector resources.

43. New types of outcome-based debt instruments—in particular, sustainability-linked bonds—can help alleviate greenwashing if contractual details of these bonds are set properly. For these bonds to achieve a material climate impact, sustainability targets should be linked to emission-reduction targets in line with the Paris Agreement. This type of instrument would be very suitable for emerging market firms with ample scope to improve their emission intensity. The penalties associated with missing the target, however, need to be set such that private issuers have a sufficient incentive to fulfill the targets.

44. A set of initiatives focused on bolstering the issuance of sustainable bonds by the private sector, local governments, and government agencies should be considered. If small and medium-sized firms do not have access to the bond market, they may not be able to benefit from the initiatives that involve structures with risk-mitigating features at their core. However, MDBs and international financial institutions will remain at the center of initiatives that channel climate funds to emerging market and developing economies by (1) undertaking long-term initiatives to build local currency bond markets to create and promote the development of efficient, scalable, and sound markets; (2) providing guarantees, subsidizing issuance costs, and taking first-loss positions in funding

[19] Under Article 6.2 of the Paris Agreement, a country that is achieving its climate objectives faster than it has pledged to in its nationally determined contribution can transfer ITMOs to countries with slower progress. This allows countries with a broad spectrum of mitigation options available to focus on implementing the lowest-cost abatement measures to meet their climate pledges while selling the more expensive emission reductions to international buyers, thereby financing part or all of their climate action.

vehicles and securitizations; and (3) assisting in the issuance of climate bonds via technical assistance that improves governments' institutional capacity.

45. For less developed economies, green infrastructure projects will remain a key instrument, and MDBs will naturally play a key and long-standing role in developing such projects. More climate financing resources could be channeled through MDBs to support such projects by increasing their capital base and reconsidering their approaches to risk appetite via partnerships with the private sector supported by governance and management oversight. MDBs could then make greater use of equity finance (currently only about 1.8 percent of their commitments to climate finance in emerging market and developing economies). MDBs' equity can draw in much larger amounts of private finance, which currently is equal to only about 1.2 times MDBs' own resources.[20] This would likely require governments to increase MDB resources. The costs of increasing funding for MDBs would be more than offset by domestic economic benefits as a result of avoided costs of eventually worthless fossil fuel assets and by the benefits from reduced emissions.

46. The IMF can play a key role in strengthening the climate information architecture and helping emerging market and developing economies set up climate and other policies to promote private climate finance. Capacity building (along the lines of Article 6.8 of the Paris Agreement) will be paramount to foster the climate information architecture. Ensuring internationally interoperable sustainable finance taxonomies and climate disclosures is essential to avoid fragmentation. Together with other international bodies, the IMF can play an important coordination and facilitation role. Continued advocacy and assistance with the design and implementation of carbon pricing will remain central: well-calibrated carbon prices can redirect private finance from polluting to greener investments.

47. The IMF's new Resilience and Sustainability Trust (RST) is a catalytic tool to attract climate-related private investment. The RST can provide affordable long-term financing to support countries undertaking macro-critical reforms to reduce risks, including those related to climate change. It provides predictability by improving countries' policy frameworks, with a clear timeline. The additional fiscal space made available by the RST could also be used to co-fund official and private-sector-financed climate-related projects. In doing so, the RST could catalyze (official and) private sector investments for climate-related finance.

48. Shifting the focus of ESG scores toward sustainability impact and ensuring proper ESG fund labeling practices will likely require external intervention by regulators and supervisors—not only at the national level but coordinated across jurisdictions. ESG scores are not designed to ensure sustainability impact because they are constructed primarily to reflect ESG-related financial risks. In addition, the labeling practices of ESG funds have come under scrutiny because in some cases the ESG focus of the funds' investment strategies may be less than advertised to investors. Regulators and supervisors could consider introducing clearer and more focused classifications and requirements for ESG funds. The classification systems of the European Union and United Kingdom are prime examples because they set clear and ambitious requirements, in particular for climate impact.

49. ESG scores are systematically lower for firms in emerging market and developing economies. This feature and others, such as the high positive correlation between firm size and ESG

[20] A detailed proposal for MDBs to provide equity financing to replace coal with renewables is presented in a recent IMF working paper (Adrian, Bolton, and Kleinnijenhuis 2022).

score, deserve further investigation. Increased transparency and clarification by ESG rating providers would be welcome.

50. Substantially strengthening the climate information architecture in emerging market and developing economies is a prerequisite for scaling up private climate finance. Data availability, quality, and comparability in climate-policy-relevant sectors (for example, energy, agriculture, and land use) in these economies should be improved, in conjunction with climate-related corporate disclosure regulations. In addition, methodologies to assess funding gaps should be developed promptly, particularly for the infrastructure gap in climate change mitigation and adaptation. Transition taxonomies are prime tools to enhance data collection regarding decarbonization options and characteristics in hard-to-abate and carbon-intensive sectors across value chains (see Online Annex 2.3). While such asset-level approaches can inform transition plans at a corporate level, they may also be useful to develop portfolio-level alignment methodologies. They can provide a clear signal by emerging market and developing economy issuers about the climate benefits of their assets, including in sectors with ample scope for emission reductions. Shared common principles to operationalize such taxonomies and other alignment approaches would avoid fragmentation and misalignment and foster comparability and consistency across jurisdictions while taking into consideration these economies' specific industrial structure, decarbonization and adaptation priorities.

51. The international carbon market envisioned under Article 6 of the Paris Agreement could foster climate finance in emerging market and developing economies—particularly adaptation finance. The momentum generated by COP26 should be leveraged to fully implement the international carbon market mechanisms, since there is agreement on the key rules and modalities for their implementation. Both implementation of the bilateral trade of carbon emission reduction among nations (Article 6.2) and global trading of carbon emission reductions (Article 6.4, similar to the Clean Development Mechanism) could significantly reduce the costs of achieving the temperature goals of the Paris Agreement. The global market under Article 6.4 will directly support adaptation finance in emerging market and developing economies by transferring a fixed share of traded carbon to a fund to finance adaptation projects and programs in developing economies (the "Adaptation Fund"). This has the potential to provide a very significant increase in much-needed adaptation finance. Parties to the UNFCCC as well as MDBs should therefore provide as much support as possible toward timely and full implementation of the UNFCCC international carbon markets.

52. In parallel, specialized public climate funds, such as the Green Climate Fund (also under the auspices of the UNFCCC), should receive sufficient resources to fill the adaptation financing gap. Advanced economies should allocate to such funds a significant share of their annual financing pledges to developing economies under the Paris Agreement. Adaptation finance often cannot generate returns for private investors, but it can yield very large social benefits for the countries most affected by climate change.

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Scaling Up Private Climate Finance in Emerging Markets: Challenges and Opportunities—Online Annex

Online Annex 2.1. Data Sources and Description

Online Table 2.1.1. Data Description and Sources

Variable	Description	Source
Sustainability-linked loan	Loan instruments where borrowers set a contractual target for the achievement of a sustainability goal (e.g., greenhouse gas emission [GHG] reduction).	Bloomberg Finance L.P.
Sustainability-linked bond	Bond instruments where issuing entities set a contractual target for the achievement of a sustainability goal (e.g., greenhouse gas emission reduction).	Bloomberg Finance L.P.
Sustainability bond	Bond instruments where proceeds are to be used for a combination of green and social projects.	Bloomberg Finance L.P.
Social bond	Bond instruments where proceeds are to be used for social projects (e.g., building of affordable housing).	Bloomberg Finance L.P.
Green loan	Loan instruments where proceeds are to be used for projects intended to deliver a positive environmental impact (e.g., renewable energy, green buildings).	Bloomberg Finance L.P.
Green bond	Bond instruments where proceeds are to be used for projects intended to deliver a positive environmental impact (e.g., renewable energy, green buildings).	Bloomberg Finance L.P.
Sustainable Instrument	Financial instruments including sustainability-linked loan, sustainability-linked bond, sustainability bond, social bond, green loan, and green bond.	Bloomberg Finance L.P.
Territorial GHG Emission	Total territorial emissions of Kyoto greenhouse gas excluding land use, land use change, and forestry in gigaton (Gt) CO2 equivalent. Territory-based emissions, or production emissions, are those that take place within a country's territorial boundaries and include exports but omit imports.	EORA Global Supply Chain Database; PRIMAP-hist
GDP	Gross domestic product in US dollars.	WEO Live
Maturity	The initial length of time that will be taken by the borrower/issuer to repay the loan/bond.	Bloomberg Finance L.P.; IMF staff calculations
Private sustainable bond	Sustainable bonds issued by financial institutions and nonfinancial companies in the industrial, renewable energy, and utilities sectors.	Bloomberg Finance L.P.; IMF staff calculations
Sovereign sustainable bond	Sustainable bonds issued by central government.	Bloomberg Finance L.P.; IMF staff calculations
Other government-related sustainable bond	Sustainable bonds issued by agencies and local authorities, as well as covered bonds.	Bloomberg Finance L.P.; IMF staff calculations
Environmental sector fund equity	A fund is labeled an “environmental sector fund” when its strategies invest in environmentally oriented industries, such as renewable energy or water.	Morningstar

Environmental impact fund equity	A fund is labeled an environmental impact fund when its strategies intend to invest in companies with a positive environmental record or are specifically involved in industries that positively impact the environment. This also includes strategies that invest in securities whose use of proceeds contributes to positive environmental impact.	Morningstar
Low-carbon/fossil-fuel-free fund equity	A fund is labeled a low-carbon/fossil-fuel-free fund when its strategies seek to make a measurable impact through their investments in or tilt toward companies with small or decreasing carbon footprints or low carbon risk, and/or through avoidance of or reduced exposure to fossil fuels.	Morningstar
Total EMDEs fund equity	Total equity assets under management allocated to emerging market and developing economies (EMDEs) for funds in the sample.	Morningstar
Total AEs fund equity	Total equity assets under management allocated to advanced economies (AEs) for funds in the sample.	Morningstar
Mitigation climate finance flow	An activity classifies as "mitigation climate flow" if it contributes to reducing or avoiding GHG emissions or enhances GHG sequestration through the enhancement of sinks and reservoirs.	Climate Policy Initiative (2021)
Adaptation climate finance flow	An activity classifies as “adaptation climate flow” if it aims to reduce the vulnerability of human or natural systems to the impacts of climate change and climate-related risks, by maintaining or increasing adaptive capacity and resilience.	Climate Policy Initiative (2021)
Private mitigation/adaptation climate finance flows	Mitigation/adaptation climate finance flows to private recipients, which refer to privately owned companies (including finance institutions, privately owned special purpose vehicles, non-governmental organizations), etc.	Climate Policy Initiative (2021)
Public: multilateral DFIs mitigation/adaptation climate finance flows	Mitigation/adaptation climate finance flows to public multilateral development finance institutions’ (DFIs’) recipients.	Climate Policy Initiative (2021)
Public: others mitigation/adaptation climate finance flows	Mitigation/adaptation climate finance flows to public recipients other than multilateral DFIs (including commercial financial institutions, corporations, funds), etc.	Climate Policy Initiative (2021)
Vulnerability score	GDP-weighted average vulnerability score, which measures a country's exposure, sensitivity and capacity to adapt to the negative effects of climate change. Lower scores are better.	Notre Dame Global Adaptation Initiative; WEO Live; IMF staff calculations
Annual infrastructure investment needs (preferred scenario)	Annual infrastructure investment need is calculated under the preferred scenario, which is compatible with full decarbonization by the end of the century (and need not cost more than more-polluting alternatives), thereby achieving climate change stabilization at 2°C.	World Bank, *Beyond the Gap* report
Price rate of carbon price initiatives	Price rate is the cost per metric ton of carbon dioxide equivalent emissions, including both carbon tax and the emissions trading system (ETS).	World Bank Database; IMF staff calculations

National GHG emissions coverage of carbon price initiatives	The coverage of each carbon pricing initiative and is presented as a share of annual national GHG emissions for 2021 based on data from the Emission Database for Paris Reality Check (PRIMAP-hist).	Paris Reality Check (PRIMAP-hist); EORA Database; Emission Database for Global Atmospheric Research; World Bank Database; IMF staff calculations
Government	These include bilateral climate-related development finance reported to the OECD-DAC Creditor Reporting System (OECD 2021) to track official development assistance (ODA) and other official flows (OOF) in 2021 and domestic financing through public budgets carried out by central, state, or local governments and their agencies.	Climate Policy Initiative (2021)
National DFIs	Development Finance Institutions (DFIs) owned by a single country and whose finance is directed domestically. These are distinct from state-owned FIs in that they have a specific development mandate in their operations.	Climate Policy Initiative (2021)
Bilateral DFIs	Development Finance Institutions (DFIs) chartered by a single country that direct finance flows internationally.	Climate Policy Initiative (2021)
Multilateral DFIs	Development Finance Institutions (DFIs) chartered by multiple countries.	Climate Policy Initiative (2021)
Multilateral funds	Multilateral climate funds including commitments only from DFIs' own resources.	Climate Policy Initiative (2021)
State-owned FI	Institutions if they are at least majority owned by a government or government agency.	Climate Policy Initiative (2021)
Commercial FIs	Providers of private debt capital (and occasionally other instruments), including commercial and investment banks.	Climate Policy Initiative (2021)
Funds	Private equity, venture capital, and infrastructure funds.	Climate Policy Initiative (2021)
Households and individuals	Family-level economic entities, which include high-net-worth individuals and their intermediaries (e.g., family offices investing on their behalf).	Climate Policy Initiative (2021)
Corporations	Corporations, which can have activities in the energy sector, in other sectors, or in both (e.g., a large water utility company installing both hydropower generation and water treatment facilities).	Climate Policy Initiative (2021)
Grants	Transfers made in cash, goods, or services for which no repayment is required.	Climate Policy Initiative (2021)
Low-cost project debt	A debt evidenced by a note that specifies, in particular, the principal amount, interest rate, and date of repayment and is extended at terms preferable to those prevailing on the market.	Climate Policy Initiative (2021)
Project-level market rate debt	A debt evidenced by a note that specifies, in particular, the principal amount, interest rate, and date of repayment and is extended at regular market conditions.	Climate Policy Initiative (2021)
Project-level equity	A stock or any other security representing an ownership interest.	Climate Policy Initiative (2021)
Debt	Direct debt investment by a company or financial institution.	Climate Policy Initiative (2021)
Equity	Direct equity investment by a company or financial institution.	Climate Policy Initiative (2021)

Assessment of Infrastructure Needs and Gaps

The methodology used in the chapter to calculate infrastructure investment needs is based on the World Bank's *Beyond the Gap* report (2019). The so-called preferred scenario ("ambitious goals, high efficiency") used in the chapter involves climate-related spending for mitigation and adaptation purposes, compatible with full decarbonization by the end of the century (which need not cost more than more-polluting alternatives), thereby achieving climate change stabilization at 2°C. In addition to strictly climate-related infrastructure investment, the methodology involves spending efficiency (and still depends on the quality of the policies accompanying the investment); increased, equitable, and sustainable utilization of infrastructure; adaptation measures for infrastructure (e.g., coastal flood protection); and steady flow of resources for operations and maintenance. The methodology assumes that the development of appropriate institutions and governance mechanisms to deliver maintenance is as necessary as the funding stream for an effective protection-based adaptation strategy, as well as for a mitigation strategy. The methodology designates the electricity and transport sectors for mitigation finance and the water supply and sanitation, flood protection, and irrigation sectors for adaptation finance. The infrastructure investment needs are given either in US dollars or as a percentage of GDP, and they include all low- and middle-income countries. The infrastructure investment needs are in 2015 dollars, are discounted with a 6 percent discount rate, and are annualized between 2015 and 2030. The infrastructure investment needs as a percentage of GDP are an average between 2015 and 2030 of annual costs divided by annual GDP. The GDP varies across sectoral analyses depending on calibration year, but the GDP growth rates are all based on the Organisation for Economic Co-operation and Development quantifications of the various shared socioeconomic pathways.

Notre Dame Global Adaptation Index—Vulnerability Score

The vulnerability score used in this chapter stems from the Notre Dame Global Adaptation Index (ND-GAIN). The vulnerability score measures propensity or predisposition of human societies to be negatively impacted by climate hazards. It assesses the vulnerability of a country by considering six life-supporting sectors: food, water, health, ecosystem services, human habitat, and infrastructure. Each sector is in turn represented by six indicators that represent three cross-cutting components: the exposure of the sector to climate-related or climate-exacerbated hazards, the sensitivity of that sector to the impacts of the hazard, and the adaptive capacity of the sector to cope or adapt to these impacts. We calculate the GDP-weighted average vulnerability score in each region.

World Bank Carbon Pricing Data

The carbon pricing data set sample provides up-to-date information on existing carbon pricing initiatives around the world sourced from the World Bank. Our sample includes both national and subnational implemented carbon pricing initiatives showing the greenhouse-gas-emission coverage and price rate per metric ton of CO2 equivalent emission. For the greenhouse-gas-emission coverage, the data are originally presented as a percentage of 2015 global greenhouse gas emissions, and we adjust those as a percentage of 2021 national greenhouse gas emissions. For the subnational initiatives, we aggregated the coverage into the national level. Uruguay is not

included in the calculation because of missing emission coverage data. For the average price rate, if one country has implemented multiple national and subnational carbon price initiatives, we calculated the average price rate. There are also circumstances where one initiative has several price rates corresponding to different covered sectors; then we include only one price rate per initiative in the calculation. Specifically, the price rate for Argentina includes only "most liquid fuels"; the price rate for Mexico is the "upper rate." For the average price rate across advanced economies, we use the "fossil fuels" price rate for Denmark, "transport fuels" price rate for Finland, "transport fuels" price rate for Iceland, "gasoline" price rate for Luxembourg, and "general tax rate" for Norway. Price rates are not necessarily comparable between carbon pricing initiatives because of differences in the number of sectors covered and allocation methods applied, specific exemptions, and different compensation methods. Prices are not necessarily comparable between carbon pricing initiatives because of differences in the number of sectors covered and allocation methods applied, specific exemptions, and different compensation methods. Uruguay is not included because of missing emission coverage data.

ESG Score Data Description

The total number of firms worldwide in the database was 10,142 as of 2020—the latest available data at the time of analysis. About 6,200 also have a Refinitiv ESG score in the respective year. In general, the separate E, S, and G scores (pillars) have coverage that is essentially the same as the aggregate ESG score.

In 2020, the regional coverage in terms of market capitalization was 73 percent of firms from advanced economies (20 percent from Europe) and 23 percent from emerging market and developing economies.

The methodology adopted by Refinitiv for scoring firms is relatively complex, as it combines a vast amount of different types of data and different aggregation systems (see Refinitiv 2022). First, the database is based on 450 data points (or metrics), which can be Boolean indicators and numeric indicators, such as ratios and analytics. Of these 450 metrics, 186 comparable measures are actually used for the ESG scoring. Depending on the firm's industry, a subset of these indicators is then aggregated, using different weightings, into 10 categories. The 10 categories, in turn, are aggregated further to compute the three (E, S, and G) pillars.

ESG Investment Fund Sample Description

The investment fund data set comprises about 117,000 existing open-end and exchange-traded funds sourced from Morningstar. In our sample, funds are included only if assets under management exceed $100 million, which reduces the sample to about 36,000 funds. The sample period extends from 2010:Q1 to 2022:Q2. Their aggregate assets under management amounted to about $46 trillion (versus $52 trillion in the entire Morningstar data set) as of end-June 2022. The analysis uses the Morningstar definition of ESG funds, and the data sample comprises 3,600 ESG funds and 7,900 EMDE-dedicated funds. Funds with a global investment strategy ("global funds") comprise a large share of the funds in the data sample, at about 8,900.

The Morningstar definition of ESG funds comprises the following types of funds (see Morningstar 2020):

- *ESG Incorporation Funds*, which use ESG criteria as a central part or binding factors of their security-selection and portfolio-construction process.
- *Impact Funds*, which seek to make a measurable impact that is often focused on specific themes or uses the 17 UN Sustainable Development Goals as a framework for evaluating the overall impact of the portfolio.
- *Environmental Sector Funds*, which invest in environmentally oriented industries, such as renewable energy or water.

Region and Country Classification

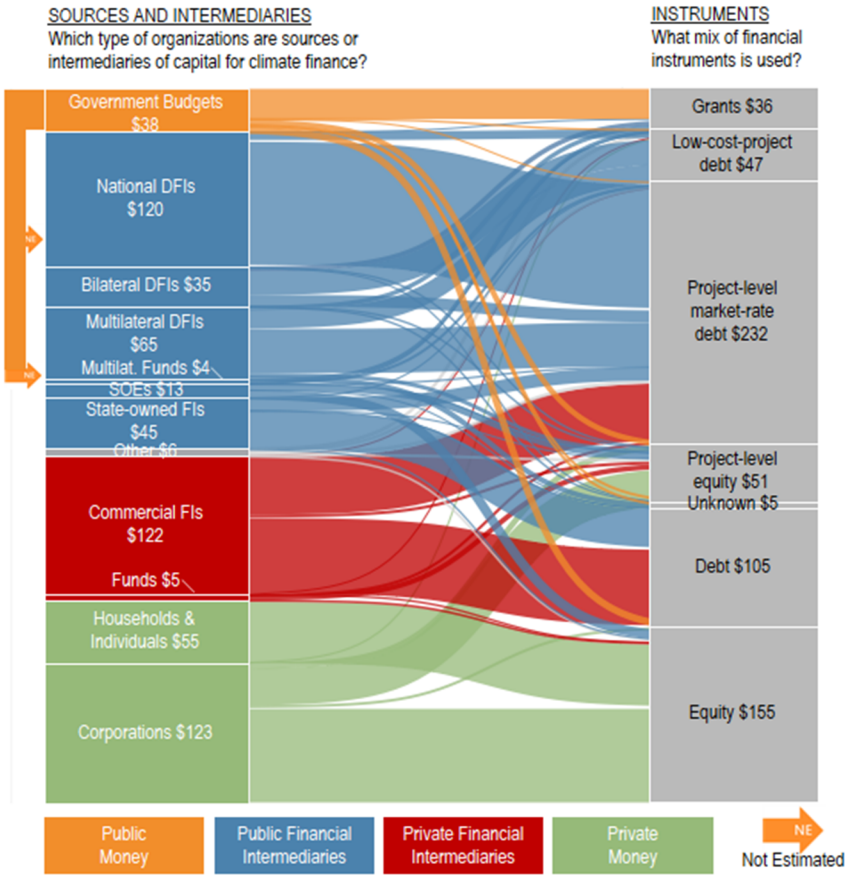
The definitions of emerging market and developing economies (EMDEs) and advanced economies (AEs) vary slightly across different data sets. In most cases, they strictly follow the *World Economic Outlook* (WEO) definitions of EMDEs and AEs.[1] Morningstar has a different classification system: some countries in Europe are classified as EMDEs, but the WEO identifies them as AEs, such as Estonia, Latvia, and Lithuania. Also, Morningstar includes small island states, which are not covered by the WEO definition.

[1] The *World Economic Outlook* definition of emerging market and developing economies and advanced economies can be found here: World Economic Outlook Database April 2022 -- WEO Groups and Aggregates Information (imf.org).

Online Annex 2.2. Global Climate Finance Flows

Figure 2.2.1. Climate Finance Flows in Mitigation and Adaptation
(Billions of US dollars)

The climate finance market is characterized by a complex ecosystem of participants and instruments beyond those that are sustainable finance instruments (as in Chapter 2, Figure 2.1, panel 1). The private sector's role in climate finance is debt-dominated.



Sources: Climate Policy Initiative (2021); and IMF staff calculations.
Note: Data are the average of 2019 and 2020. Detailed definitions of variables can be found in Online Table 2.1.1 DFIs = development finance institutions; FIs = financial institutions; SOEs = state-owned enterprises.

Online Annex 2.3. Transition Taxonomies

Taxonomies have been developing primarily in Asia (ASEAN, Malaysia, Bangladesh, Mongolia, Indonesia, Vietnam, Singapore, Philippines, Thailand, India) but also in South Africa, Colombia, Mexico, Chile, Brazil, and Sri Lanka. Those include so-called green taxonomies (e.g., South Africa) but also "transition finance" taxonomies.

Transition finance taxonomies determine whether and how assets are aligned with emission reduction goals while taking into consideration different transition paths across sectors and economic activities, as well as across countries. In contrast to purely green taxonomies, transition taxonomies do not set climate and/or environmental criteria only for activities that respect the Paris Agreement objectives (e.g., a threshold of carbon intensity in the cement sector that complies with the 1.5 degrees Celsius goal) but set intermediate steps and/or greenhouse-gas-emissions pathways to illustrate the different steps of the transition process. The adopted criteria essential for the economic activities to decarbonize in line with global goals are aimed at achieving those objectives in the most transparent manner, thanks to a so-called traffic light system (or color scheme). This system distinguishes different levels of climate performance in a sector-agnostic way; it therefore also embeds economic activities that, as of now, cause substantial environmental harm—meaning they must decommission and/or transition.

In existing taxonomies in EMDEs (mainly the ASEAN taxonomy and national taxonomies in Singapore, Malaysia, and Indonesia), which often follow the broader philosophy of the proposals of the European Platform on Sustainable Finance for transition taxonomies ("The Extended Environmental Taxonomy," published in March 2022—following a report published in March 2021 on transition finance), categories include all or part of the following:

- Red (significant harm): Activities that significantly harm climate and that should either (1) be abandoned (e.g., energy generation from solid fossil fuels), with the decommissioning of all activities in turn qualifying as environmentally sustainable (in order to facilitate finance for the decommissioning) or (2) may transition to achieve substantial decarbonization (e.g., cement), therefore having to improve in order to halt significant harm.
- Amber (intermediate performance): Activities that significantly impact climate but that do not significantly harm (nor substantially contribute to) climate and/or environmental sustainability objectives. Such activities include (1) those that are not currently zero (or near zero) emissions but that are following a decarbonization pathway aligned with the trajectory required by the Paris Agreement; (2) those facing significant barriers to decarbonization—because low-emission alternatives are not yet available or economically viable and therefore do not currently have a viable well-established technological pathway toward decarbonization but are making all available/possible short-term emission reductions while zero-emission alternatives are being developed (e.g., zero-emission marine transport); and (3) interim solutions, embedding activities that generate less greenhouse gas compared with an alternative and need to be carried out for a limited period of time while alternative low-carbon technologies are developed into viable and scalable solutions (e.g., electricity generation from existing natural gas plants with carbon capture and storage technologies).

- Green (sustainable activities): Activities that fulfill all environmental sustainability requirements under the taxonomy. This category may include activities with low environmental impact—which do not have the potential to contribute substantially to, nor significantly harm, environmental sustainability.

Among the most important criteria are "do no significant harm" (or a similar concept) and the existence of remedial efforts to transition, with a focus on innovation for hard-to-abate sectors (e.g., carbon capture and storage technologies, restoration of gas pipelines to reduce methane leakage, fuel shifting in shipping).

Given that most mandatory disclosure requirements (currently limited to nonfinancial large companies) have been taken up since the mid-2000s mostly in Asia (China, Indonesia, Malaysia, India, Pakistan, Philippines, Singapore—though projects and/or existing regulations are also taking place in Türkiye, South Africa, Chile, and Peru), these transition taxonomies may allow for (1) the concept of "improvement" for carbon-intensive sectors and activities (or even hard-to-abate sectors), especially those not currently with zero or near zero emissions, facing significant barriers to decarbonization and/or providing interim solutions for a limited period; and (2) the publication of transition plans and the use of science-based pathways. The latter may allow companies to set midterm targets, identify pathways to meet climate objectives, and establish implementation plans to meet the targets over a defined period of time.

Figure 2.3.1. Main Categories of Transition Taxonomies in EMDEs

Transition taxonomies follow a so-called pathway approach, from a red category (significant harm) over an amber category (intermediate performance), to a green category (sustainability).

Source: IMF staff illustration.

Online Annex 2.4. Innovative Financing Instruments

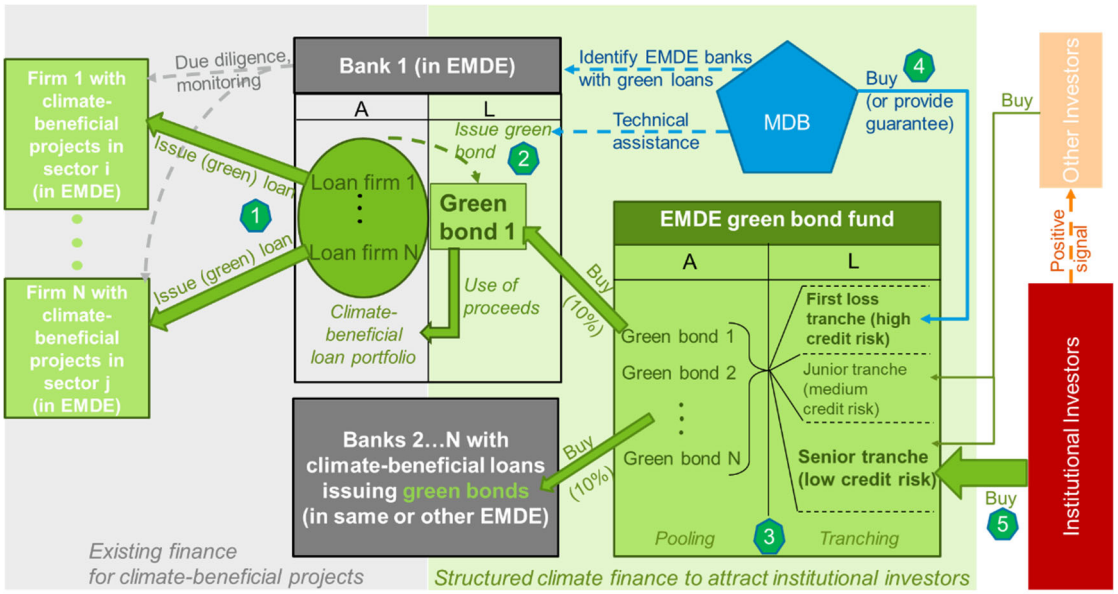
1. *Structured finance vehicles* can purchase EMDE green bonds and target large institutional investors. These investors require scale and diversification, which necessitates EMDE assets to be pooled. EMDE banks supply the underlying assets in the form of green bonds issued to finance loans to firms for climate-related projects.[2] Properly certified green bonds ensure that the loans fund environmentally beneficial projects. The required scale and the use of green bonds mean that this instrument can be used in larger EMDEs with a well-functioning bond market. To fulfill institutional investors' strict rating and credit risk requirements, "de-risking" is required—typically in the form of equity investments or credit risk guarantees by the public sector.
2. *Blended finance* combines public and donor capital with private capital to mobilize and scale up climate private finance. The objective is to support the development of projects in EMDEs and de-risk investments for private capital. Blended finance can take various forms, including grants, equity, or mezzanine finance (a hybrid of equity and debt) provided by multilateral development banks, and guarantees. In the case of green infrastructure projects, for example, blended finance can help alleviate the high risks in the initial phase of a project when it is still being set up but is not yet operational—particularly if new types of green technologies are employed. Given that infrastructure often supplies a public service, in some cases involving natural monopolies (such as water supply), political risks also loom large. Blended finance can alleviate both political and financial risks.
3. *Outcome-based sustainable debt instruments,* such as sustainability-linked bonds and loans, include an incentive mechanism to address information asymmetries between issuers and investors (such as "greenwashing," when sustainability benefits of investments are not as high as issuers claim). Issuers pay a penalty (receive a bonus) if predefined sustainability performance targets are missed (have been achieved).
4. In *"pay-for-success" private financing* for public sector projects, third-party investors, including private investors, provide the initial investment and develop a project. The public sector then purchases the project for an amount agreed on in advance and linked to the project's sustainability performance (measured according to performance indicators also agreed on in advance). This shifts the burden and risks of inefficient project development, for which capacity in poorer countries is often lacking, to private third parties. The purchase price is set such that private investors generate substantial returns if the performance targets are (over-)fulfilled. This instrument could have an important use in adaptation finance, where private finance is otherwise difficult to attract.[3]

[2] Given that the issuance of green bonds can take time, initially these funds also accept conventional bonds and then substitute them with green bonds over the life cycle of the fund.
[3] Penalties and bonuses have an exactly symmetric effect on the incentives of the issuer. See Berrada and others (2022).

Online Annex 2.5. The IFC-Amundi Green Bond Fund

The deal between the International Finance Corporation (IFC), a multilateral development bank (MDB) that is part of the World Bank Group, and Amundi, an asset manager, is an important (and still rare) example of a structured climate finance instrument designed to tap the vast resources of institutional investors (Figure 2.5.1, red box on the right).

Figure 2.5.1. The IFC-Amundi Deal and the Role of MDBs



Source: IMF staff illustration.

There are various steps involved, however, to transform climate-beneficial (green) EMDE financing into an investable asset for pension funds or insurance companies. Starting from the left of Figure 2.5.1, a first step (see numbers in green heptagons) and the starting point is loans by EMDE banks that finance firms with climate-beneficial projects. Relying on EMDE banks serves two purposes—it utilizes the expertise of local banks and allows achievement of scale in a shorter period of time, by building on their already existing customer base and loan portfolios. The EMDE banks then issue a traditional green bond, earmarking the proceeds for the financing of their green loan portfolio (step 2).

As a third step, a share of the bank-issued bonds is bought by a closed-end investment fund—in this case, the Amundi Planet Emerging Green One (AP EGO) fund—and pooled together across banks in different countries. This reduces idiosyncratic credit risks of individual bank issuers and serves to diversify country risk. The fund then structures its shares into different tranches—including a higher-risk junior (equity) tranche and a lower-risk senior tranche.

To reduce the credit risks of the fund (i.e., the pool of EMDE bank bonds) to a level acceptable to institutional investors, the MDB (i.e., the IFC) buys an equity stake (junior tranche) in the green bond funds (step 4). This effectively serves as a loss-absorption buffer and thereby lowers the credit risk for the other more senior tranches. Alternatively, an MDB or donor could purchase a credit risk guarantee, which is envisioned by a fund that is being set up in

cooperation with Blue like an Orange, a specialized investment fund, and AXA, an insurance company. In the case of the AP EGO fund, the multiplication factor between the use of the IFC's own resource and private financing by institutional investors is very high (about 16x; see Bolton, Musca and Samama 2020). This is partly due to the fact that the average credit rating and bank bonds are already fairly close to investment grade. Hence, a relatively small credit cushion is required to lift the rating of the more senior fund tranches to a level required by institutional investors. The fund is "closed-end," meaning that it has a fixed size: capital does not go into or out of the fund once it is established. In the case of the AP EGO fund, the fund has a fixed lifetime, which ends by the time all purchased EMDE green bonds mature.

As a last step (step 5), institutional investors, in the case of the AP EGO fund mostly pension funds, can then buy the more senior tranches of the fund. Having pension funds as investors in the fund, and thereby EMDE bank-issued bonds, has the additional and crucial benefit of sending a positive signal to other investors. To avoid concentration risks, the green bond fund buys only a minor share of the bonds issued by any given bank (in the case of the AP EGO fund, at most 10 percent). Other investors' interest in the newly issued green bonds is likely to increase with the seal of approval from institutional investors with typically very high investment standards—including for sustainability.

The role of the MDB (i.e., the IFC) is crucial and much broader than credit risk reduction alone. Further important roles are the identification of EMDE banks with a green loan portfolio and the provision of technical assistance for these banks to issue a green bond. MDBs have vast experience in operating in a range of EMDEs and can utilize their expertise to identify potential banks across a number of countries. Initially the AP EGO fund held conventional bonds, but those are successively replaced with green bonds as the involved banks built expertise—with the help of the IFC—in how to issue a green bond adhering to international best practices. The "green" label of the bonds, certified by internationally recognized so-called second-party opinion providers, reassures the investors of the climate benefits of the assets held by the fund.

This type of structured and blended finance approach is particularly suitable for larger emerging markets, given the scale requirements of institutional investors. It also requires the ability of banks to issue bonds—either in local or foreign markets. Relying on tradable assets is another factor that supports scalability, as those assets are standardized and can be purchased and sold more easily by a broader range of investors.

Although the starting point for this type of structured and blended finance is already existing bank loans, there is nevertheless a high potential to channel more capital toward climate finance in EMDEs (termed "additionality" in development finance). For one, it can attract a new type of very large and long-term investors (in the case of the AP EGO fund, this includes large foreign investors) that would otherwise not be able to consider climate investment in EMDEs. By generating such new investor interest, banks in EMDEs receive a strong signal that there is a stable source of finance for green loans, and EMDE firms, in turn, see that there is a higher supply of loans for green projects. A replication of this type of green bond fund structure both appears feasible and could potentially create a substantial and persistent push for climate finance in EMDEs.

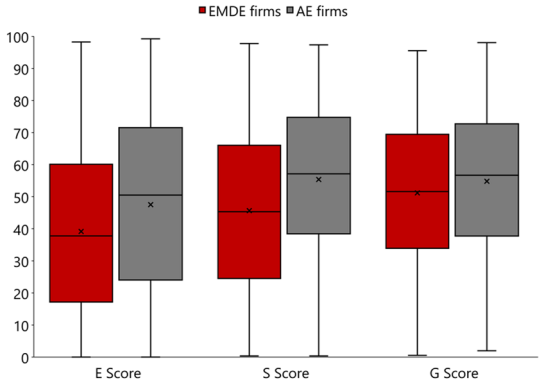
Online Annex 2.6. ESG Scores—Additional Stylized Facts and Analysis

The systematically lower ESG scores of EMDE firms are a salient feature in the ESG ratings data used for the analysis in this GFSR (Refinitiv ESG). The lower scores are clearly present for headline ESG scores (Table 2.6.1, models 1 and 2), as well as for the individual E, S, and G pillar scores (Figure 2.6.1, panel 1).

Figure 2.6.1. ESG Scores Are Lower for EMDE Firms

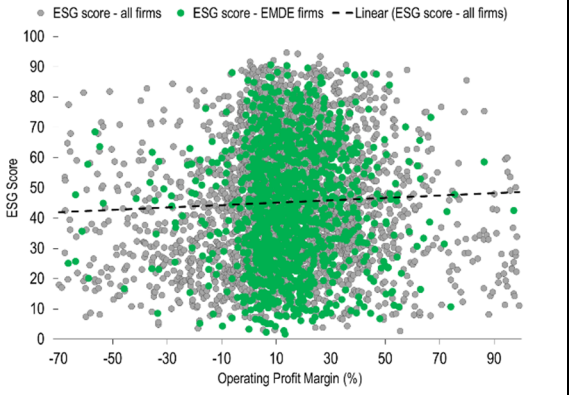
ESG scores are lower for EMDE firms for each of the main E,S, and G pillar scores.

1. Box Plots of Pillar Scores—EMDE versus Other Firms (ESG score)



ESG scores are significantly positively correlated with firm profitability, but this cannot explain the lower scores of EMDE firms.

2. ESG Scores versus Firm Profitability (Percent, end of year; for 2022 end of June)



Sources: Refinitiv; and IMF staff calculations.

Note: Panel 1 shows the box plot of ESG scores for EMDE versus AE firms. The upper and lower bounds of the boxes represent the quartile interval, the middle horizontal line is the median, and the x is the arithmetic mean. The vertical lines depict the range of scores, which genearlly is between 0 (the worst score) and 100 (the best possible score). AE firms exclude US firms for Refinitiv data, as it imposes a penality for not reporting ESG-relevant data in company publications. The Refinitiv data suggest that a lack of ESG public disclosure is much more prevalent among US firms than among firms in other countries—including EMDEs. AE = advanced economy; EMDE = emerging market and developing economy; ESG = environmental, social, governance.

To understand whether firm characteristics can explain the lower score of EMDE firms, characteristics that are known to influence ESG scores are jointly included in a panel regression:

$$ESG\ Score_{i,t} = \mu + \beta \times EMDE\ firm_i + \gamma \times X_{i,t} + d_{s,t} + \varepsilon_{i,t},$$

where i denotes the individual firms (about 6,200 listed firms), and t is the year (2010–21). $EMDE\ firm_i$ is a dummy equal to 1 if firm i is located in an emerging market or developing economy. X represents firm-level and time-varying control variables (size, profitability), and d represents sector and time dummies.

In addition to the strong positive relationship with firm size documented in Chapter 2, the data also show a significant positive relationship with firm profitability (Figure 2.6.1, panel 2)—but this does not explain the significantly lower ESG scores for EMDE firms (Table 2.6.1, model 2). Further, the positive relationship between firm profitability and ESG scores disappears if various other controls are included.

On average, the overall ESG scores for EMDE firms are about 2.4 points lower than those of other firms (Table 2.6.1, model 1). This negative difference becomes larger and statistically more significant after controlling for relevant firm characteristics. Controlling for firm subindustry (and a time fixed effect), EMDE firm scores are an average 3.6 points lower. This difference

grows to almost 5 points in model (5), which controls for firm size (market cap and total assets) and operating profit margin as well as for year × industry fixed effects. The results suggest that EMDE firms within the same sector in the same year, adjusted for size and profitability, have a lower ESG score.

Table 2.6.1. Regression Results—ESG Scores and EMDE Firms

Model	(1)	(2)	(3)	(4)	(5)
D(EMDE Firm)	-2.432*	-3.605**	-4.467**	-4.685***	-4.852***
	(0.0950)	(0.0274)	(0.0123)	(0.000690)	(0.000772)
Log(Market Cap)				2.495***	2.899***
				(0.000266)	(0.000361)
Log(Total Assets)				4.837***	4.637***
				(3.31e-07)	(1.22e-06)
Operating Profit Margin			0.0712*		-0.0252
			(0.0577)		(0.303)
Observations	61,131	61,131	57,517	60,243	56,963
R-squared (adjusted)	0.002	0.029	0.024	0.316	0.304
Year Fixed Effects	No	Yes	Yes	Yes	No
Industry Fixed Effects	No	Yes	Yes	Yes	No
Year X Industry Fixed Effects	No	No	No	No	Yes

Sources: Refinitiv ESG; and IMF staff calculations.
Note: Robust *p*-values are in parentheses, clustered by firm subindustry and year. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The analogous results hold true for E scores only (Table 2.6.2). On average, the E scores for EMDE firms are about 6-7 points lower than those other firms, which is a substantially larger difference than for the overall ESG score. For climate-conscious investors, focusing on the E score alone will hence not alleviate the issue of lower scores for EMDE issuers.

The robust results are strongly suggestive of a disadvantage in ESG scores for EMDE firms. This, however, leaves open the question of why scores for EMDE firms are systematically lower. One possible explanation is a lack of reporting of relevant ESG data, which in the case of the Refinitiv ESG scores results in a penalty—firms that do not disclose data points that are relevant for the ESG score for a given industry in effect get a lower score. ESG scores for EMDE firms may also be lower because of systematic difference in actual ESG performance in specific areas. In the data however, it is not possible to distinguish between a lower score because of non-reporting and a lower score because of worse ESG characteristics.

Table 2.6.2. Regression Results—E Scores and EMDE Firms

Model	(1)	(2)	(3)	(4)	(5)
D(EMDE Firm)	-5.639***	-6.754***	-7.362***	-6.152***	-6.177***
	(0.00834)	(0.00464)	(0.00186)	(0.000367)	(0.000380)
Log(Market Cap)				1.582***	1.952***
				(0.00414)	(0.00281)
Log(Total Assets)				7.976***	7.869***
				(5.86e-09)	(4.21e-09)
Operating Profit Margin			0.0499		-0.0502
			(0.344)		(0.261)
Observations	49,473	49,473	47,972	48,856	47,562
R-squared (adjusted)	0.008	0.032	0.034	0.311	0.312
Year Fixed Effects	No	Yes	Yes	Yes	No
Industry Fixed Effects	No	Yes	Yes	Yes	No
Year X Industry Fixed Effects	No	No	No	No	Yes

Sources: Refinitiv ESG; and IMF staff calculations.
Note: Robust *p*-values are in parentheses, clustered by firm subindustry and year. Regressions include all firms with non-zero E scores. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Online Annex 2.7. ESG Funds—Additional Stylized Facts

The systematically lower ESG scores of EMDE firms are mirrored in the allocation of ESG funds. This is true for both EMDE *bond* holdings and *equity* holdings[4] (Figure 2.7.1, panel 1). In the first half of 2022 the difference in EMDE equity allocations narrowed substantially, however. This largely reflected strong outflows from EMDE-dedicated funds, of which there are few among ESG funds (see Chapter 2, Figure 2.6, panel 4).

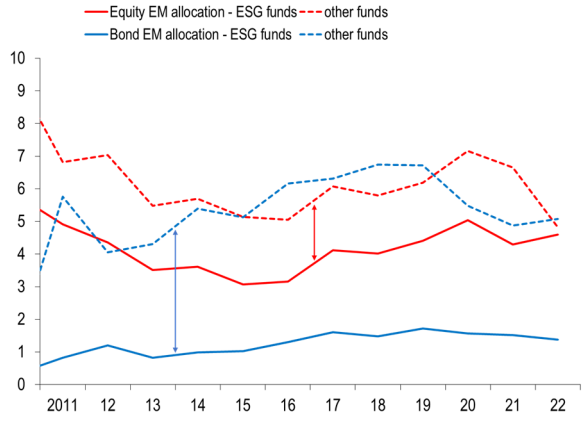
EMDE-dedicated funds, which by definition have a very high allocation to EMDE assets, are driving a large part of the difference between the EMDE allocations of ESG and other (non-ESG) funds. At end-June 2022, this difference in EMDE total EMDE asset allocations (EMDE equities and bonds) stood at 5.8 percentage points. More than half of this difference (3.2 percentage points) was driven by funds dedicated to investing in EMDEs.

But also when looking at global funds that invest in both AE and EMDE assets (and hence have no geographic dedication), there is still a substantive difference in EMDE holdings between ESG and other funds (Figure 2.7.1, panel 2). Naturally, it is less pronounced (the difference at end-June 2022 was 1.7 percentage points) than for the whole sample of funds, but the difference remains persistent and sizable.

Figure 2.7.1. Average EMDE Allocations by ESG and Other Funds

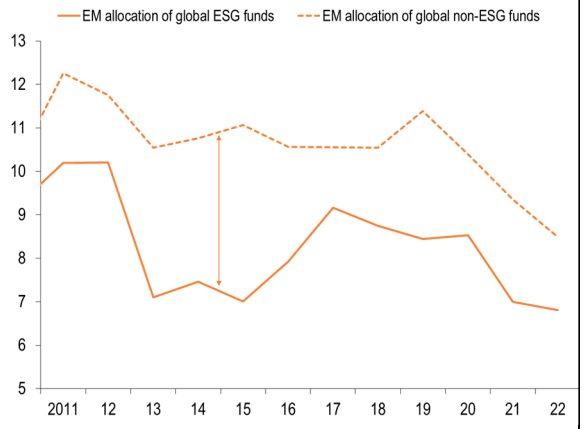
EMDE allocations are lower for ESG funds, both for equities and bonds, though the difference in equity allocations has shrunk in 2022.

1. EMDE equity and Bond Allocations for ESG versus Other Funds (Percent, end of year; for 2022 end of June)



EMDE allocations are also lower for global funds that invest in both EMDEs and advanced economies.

2. EMDE allocations (equities and bonds) of global funds (Percent, end of year; for 2022 end of June)



Sources: Morningstar; and IMF staff calculations.
Note: Panels 1 and 2 show the fund size-weighted shares of EMDE allocations. Panel 2 restricts the sample to funds with a global investment focus and that have nonzero allocations to both advanced and emerging market and developing economies.

[4] In addition, funds have potentially large cash holdings, which by assumption are neither included in advanced nor emerging market and developing economy allocations.

Online Annex 2.8. Sovereign Sustainable Bond Issuance—Additional Analysis

To further analyze whether sovereign issuance of sustainable bonds has a positive effect on corporate sustainable bond issuance, various controls are introduced:

$$\frac{Corp\ Sus\ issuance_{c,t}}{GDP_{c,t}} = \mu + \beta \times D(Sov\ sust\ debut_{c,t+1\to T}) + d_c + d_t + \frac{\Delta Priv\ Debt_{c,t-1}}{GDP_{c,t-1}} + \varepsilon_{i,t},$$

where c stands for country and t for time (year). $\frac{Corp\ Sus\ issuance_{c,t}}{GDP_{c,t}}$ is the aggregate issuance of corporate sustainable debt in a given year divided by annual GDP (in percent). $D\left(Sov\ sust\ debut_{c,t+1\to T}\right)$ is a dummy that is equal to 1 after the sovereign in country c has issued a sustainable bond (until the end of the sample in 2021).

The controls are country dummies (d_c) and time dummies (d_t), which can control for a common (global) trend in sustainable bond issuance. Introducing these controls in models (2) and (3) in Table 2.8.1 reduces the absolute effect of sovereign bond issuance by about half, but sovereign sustainable bond issuance retains a highly statistically significant and positive effect on corporate bond issuance. The effect of sovereign issuance remains strongly positive, even when accounting for possible momentum in the growth of private debt more generally in model (4), proxied by the lagged change in private debt to GDP $\left(\frac{\Delta Priv\ Debt_{c,t-1}}{GDP_{c,t-1}}\right)$.

Table 2.8.1. Regression Results—The Effect of Sovereign Sustainable Debt Issuance on Corporate Issuance

Model	(1)	(2)	(3)	(4)
Sovereign Sustainable Debut	0.569***	0.265***	0.305***	0.278***
	(0.000)	(0.000)	(0.000)	(0.000)
Private Debt to GDP (t–1)				0.000382
				(0.801)
Observations	858	858	858	806
Country Dummy	No	No	Yes	Yes
Time Dummy	No	Yes	Yes	Yes
R-squared adjusted	0.0858	0.198	0.251	0.255

Sources: Bloomberg Finance L.P.; IMF, *World Economic Outlook;* and IMF staff calculations.
Note: *p*-values are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Chapter 3

ASSET PRICE FRAGILITY IN TIMES OF STRESS: THE ROLE OF OPEN-END INVESTMENT FUNDS

Chapter 3 at a Glance

- Since the global financial crisis, there has been remarkable growth in open-end investment funds. The total value of their net assets has quadrupled since 2008, reaching $41 trillion in the first quarter of 2022 and accounting for approximately one-fifth of the assets of the nonbank financial sector.
- Open-end funds play an important role in financial markets, but those that offer daily redemptions while holding illiquid assets can amplify the effects of adverse shocks by raising the likelihood of investor runs and asset fire sales. This contributes to volatility in asset markets and potentially threatens financial stability.
- These concerns are particularly pertinent now as central banks normalize policy amid heightened uncertainty about the outlook. A disorderly tightening of financial conditions could trigger significant redemptions from these funds and contribute to stress in asset markets.
- Assets (particularly bonds) held by relatively illiquid funds are more "fragile," with higher return volatility, especially in periods of market stress. A significant decline in fund liquidity such as that observed during the March 2020 market turmoil can increase bond return volatility by more than 20 percent.
- Investments by advanced economy open-end funds in emerging markets have grown significantly over the past decade, with important implications. A significant decline in the liquidity of advanced economy bond funds comparable to that observed in March 2020 can increase the return volatility of emerging market corporate bonds by more than 20 percent.
- Importantly, the adverse effects of less liquid open-end investment funds on asset prices could lead to a tightening of domestic financial conditions, reinforcing the vicious cycle between investor runs and asset market volatility.

Policy recommendations

- Policymakers should ensure that adequate liquidity management tools are used by these funds. A wide range of tools is available to potentially mitigate the vulnerabilities and systemic impact of open-end funds, but effective implementation of these tools is lacking.
- Tools that aim to limit vulnerabilities by reducing the risk of investor runs such as swing pricing or anti-dilution levies can be potentially effective to mitigate asset price fragilities associated with less liquid open-end funds. Swing pricing is routinely used by open-end funds in some jurisdictions, but to further strengthen its effectiveness, policymakers should provide guidance on its implementation, ensure that swing factors fully reflect the price impact of trades, and encourage disclosure of swing pricing practices and calibration methodologies.
- Additional liquidity management tools could include limiting the frequency of redemptions by linking it to the liquidity of funds' portfolios to directly address the underlying vulnerability related to the liquidity mismatch.
- Tighter monitoring of funds' liquidity risk management practices by supervisors and regulators should be considered.
- Given the adverse cross-border spillover effects, recipient economies need to take appropriate policy responses to mitigate potential systemic risks from volatile capital flows sourced from open-end funds. These should include continued deepening of domestic markets; the use of macroeconomic, prudential, and capital flow management measures; and foreign exchange intervention in line with the recommendations of the International Monetary Fund's Institutional View.

Introduction*

1. The rapid growth of open-end investment funds (OEFs) has raised concerns about financial stability. OEFs, which are mutual funds that can issue or redeem shares daily at a price set at the end of the trading day, are an important component of the nonbank financial sector and have grown significantly in the past two decades.[1] Their total net assets have quadrupled since the global financial crisis, reaching $41 trillion in the first quarter of 2022 and accounting for approximately one-fifth of the nonbank financial sector's assets (Figure 3.1, panel 1). The growth of the OEF sector reflects the increasing shift in financial intermediation from banks to nonbank financial institutions, which can be attributed at least in part to the tighter regulations on banks as well as bank balance sheet deleveraging following the global financial crisis (see the April 2015 *Global Financial Stability*

* The authors of this chapter are Felix Suntheim (lead), Andrea Deghi, Pierre Guérin, Zhi Ken Gan, Anna-Theresa Helmke, Tara Iyer, Junghwan Mok, and Xinyi Su, under the guidance of Fabio Natalucci, Mahvash Qureshi, and Mario Catalan. Itay Goldstein served as an expert advisor.

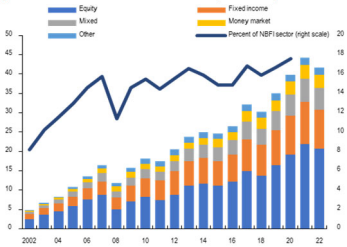
[1] The end-of-day net asset value reflects the difference between the total value of the fund's assets and liabilities divided by the number of shares outstanding. OEFs are different from other types of investment funds such as closed-end funds, which issue a fixed number of shares initially to raise capital for investments that can later be traded on secondary markets between investors but not redeemed. They also differ from exchange-traded funds, which can be traded on exchanges throughout the day, similarly to stocks, but whose shares can be created and redeemed only by authorized participants.

Report [GFSR]).[2] Most OEFs are domiciled in advanced economies and invest in equities issued in advanced economies (Figure 3.1, panel 2); however, the share of funds investing in relatively less liquid assets, such as corporate bonds or emerging market bonds and equities, has been rising rapidly (Figure 3.1, panel 3).[3] The growing importance of OEFs for the functioning and liquidity of asset markets has prompted increased scrutiny of their potential role in amplifying excessive volatility—or "fragility"—in these markets, especially when market liquidity deteriorates.[4]

Figure 3.1. Developments in Open-End Investments Funds

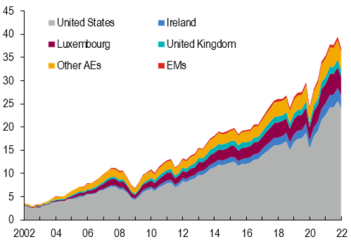
Open-end investment funds have grown substantially and now represent approximately one-fifth of the nonbank financial sector.

1. Total Net Assets and Share of the Nonbank Financial Intermediation Sector, 2002:Q1–2022:Q1
(Trillions of US dollars; and percent)



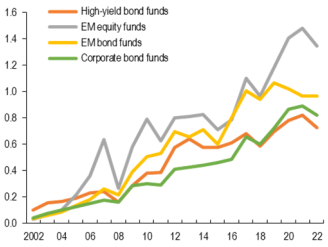
Most of these funds are domiciled in advanced economies…

2. Total Net Assets by Domicile, 2002:Q1–2022:Q1
(Trillions of US dollars)



…and have been increasingly investing in less liquid assets.

3. Total Net Assets, 2002:Q1–2022:Q1
(Trillions of US dollars)



Sources: FSB (2021); Morningstar; and IMF staff calculations.
Note: In panel 1, nonbank financial inte
rmediation includes all financial institutions that are not central banks, banks, or public financial institutions (FSB 2022). Panel 3 shows groupings based on Morningstar classifications; groupings may overlap and are not mutually exclusive. EM bond funds include both corporate bond funds and sovereign bond funds. Total net asset value is the difference between the total value of a fund's assets and liabilities. AE = advanced economy; EM = emerging market; NBFI = nonbank financial intermediation.

2. OEFs holding illiquid assets can worsen fragility in asset markets through the liquidity mismatch between their asset holdings and liabilities. In the face of adverse shocks, OEFs that offer daily redemptions to investors but hold relatively less liquid assets are vulnerable to the risk of investor runs (or large outflows) that could force these funds to sell assets to meet redemptions. The sale of assets could in turn generate downward pressure on asset prices that may amplify the initial effects of the shocks by inducing additional redemptions. These price pressures would be further intensified if funds were to engage in herding—that is, mimic other investors' trading behavior, possibly ignoring their own information and beliefs.[5]

3. Financial stability concerns about OEFs resurfaced during the financial market turmoil of March 2020. Amid heightened uncertainty about the economic outlook, OEFs that were invested in relatively less liquid assets experienced historic outflows and a "dash for cash" at the onset of the COVID-19 pandemic (Figure 3.2, panels 1 and 2). This contributed to market dislocations and liquidity problems that were resolved only after the Federal Reserve's unprecedented policy response—in particular, the purchase of corporate bonds and exchange-traded funds (ETFs) in primary and secondary markets (Liang 2020; Falato, Goldstein, and Hortaçsu 2021; Hespeler and Suntheim 2020; IMF 2021).

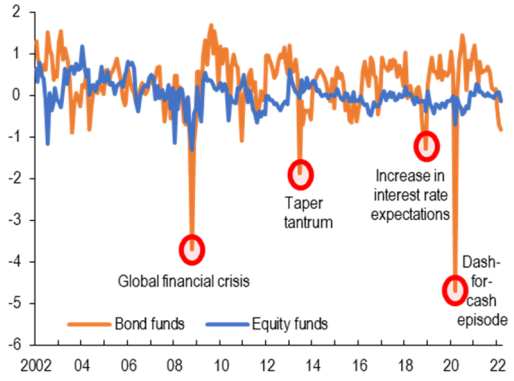
[2] These factors may possibly be working in conjunction with an increased demand for financial products offering daily liquidity.
[3] OEFs invest in different types of assets, ranging from very liquid (such as cash or short-term, highly rated sovereign bonds) to less liquid (such as certain types of corporate bonds) to highly illiquid (such as real estate or infrastructure investments). Assets that are liquid can be bought or sold in a short period of time at a low cost, that is without affecting their price. However, liquidity can vary across assets and over time. The focus of this chapter is primarily on funds investing in bonds and equities, and implications of their relative illiquidity are examined.
[4] Excessive volatility or fragility is induced in asset prices if they are susceptible to trading shocks that sway these prices away from their fundamental values (Greenwood and Thesmar 2011). See the April 2015 GFSR for a detailed discussion of the possible role of investment funds in generating macro-financial stability risks.
[5] Studies show evidence of herding by OEFs, especially when market stress is elevated (for example, Brown, Wei, and Wermers 2014; Cai and others 2019). Leverage is another potential factor that could exacerbate existing vulnerabilities and contribute to asset price fragility. An analysis of fund leverage is outside the scope of this chapter due to data limitations.

4. The resilience of the open-end investment fund sector may be tested again if financial conditions tighten abruptly as central banks normalize the stance of monetary policy. Amid persistent inflationary pressures, major central banks are significantly normalizing their policy stance, and financial conditions have tightened since the beginning of 2022 (see Chapter 1). This has led to large outflows from OEFs in recent months, especially from high-yield corporate bond funds and emerging market equity and bond funds (Figure 3.3, panels 1 and 2). More aggressive monetary policy tightening by central banks against a backdrop of continued inflationary pressure, as well as increased uncertainty about the macroeconomic outlook stemming from persistent supply chain disruptions and Russia's invasion of Ukraine (see Chapter 1 of the October 2022 *World Economic Outlook* [WEO]) could cause a sudden repricing of risk and a disorderly tightening of global financial conditions. Such an adverse shock, combined with the inherent vulnerability of OEFs holding illiquid assets but offering daily redemptions, could trigger further outflows from these funds and amplify stress in asset markets.

Figure 3.2. How the March 2020 Market Turmoil Highlighted the Vulnerabilities of Open-End Investment Funds

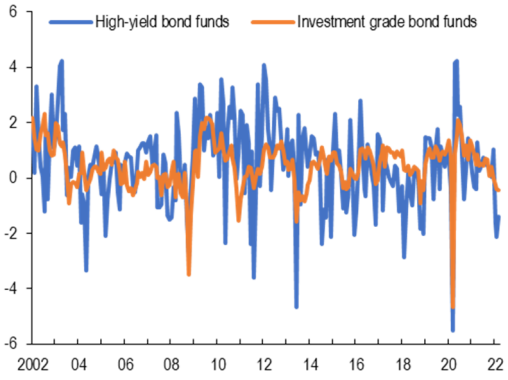
In March 2020, open-end investment funds experienced larger outflows than in previous market stress episodes…

1. Monthly Net Flows, 2002:Q1–2022:Q1
(Percent of lagged total net assets)



… especially from relatively less liquid funds such as high-yield bond funds.

2. Monthly Net Flows of High-Yield and Investment-Grade Bond Funds, 2002:Q1–2022:Q1
(Percent of lagged total net assets)

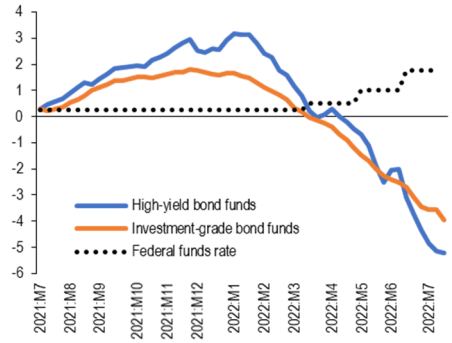


Sources: Morningstar; and IMF staff calculations.
Note: Panel 2 shows fund groupings based on Morningstar classifications.

Figure 3.3. Large Outflows from Open-End Investment Funds amid Monetary Policy Tightening by Major Central Banks

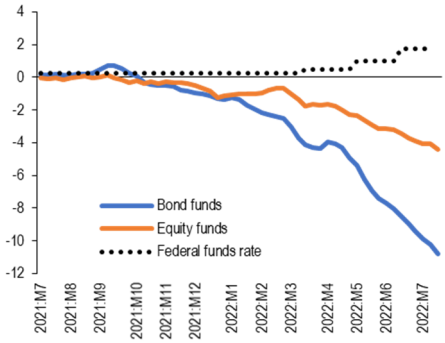
In recent months, outflows from open-end bond funds have increased sharply in sync with the tightening of monetary policy by the Federal Reserve.

1. Cumulative Fund Flows into Open-End Bond Funds and Federal Funds Rate, July 2021–July 2022
(Percent)



Outflows have also been pronounced from emerging market bond and equity funds.

2. Cumulative Fund Flows into Emerging Market Open-End Investment Funds and Federal Funds Rate, July 2021–July 2022
(Percent)



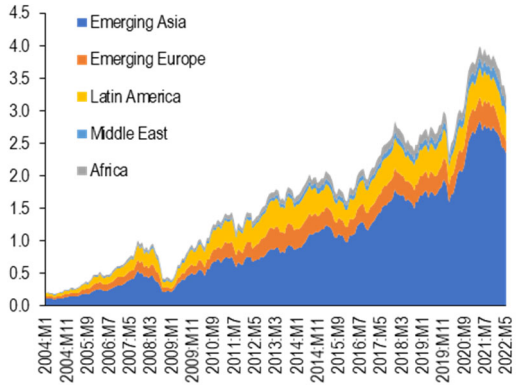
Sources: Emerging Portfolio Fund Research; and IMF staff calculations.
Note: Cumulative flows are calculated based on US$ flows as a percent of beginning of period's total net asset values.

5. An adverse shock to the open-end investment fund sector could have significant ramifications for emerging market economies. Since the global financial crisis, these economies have received large capital inflows from OEFs, especially into bond markets (Figure 3.4, panels 1 and 2). At the onset of the pandemic in March 2020, emerging market economies saw large and abrupt outflows of about $78 billion, followed by sustained and large inflows. More recently, in the face of tighter global financial conditions, investors have retrenched from emerging market economies, with outflows from equity and bond markets totaling $69 billion since the beginning of 2022. A disorderly tightening in global financial conditions could trigger further fund outflows and a worsening of financial conditions in these economies.[6]

Figure 3.4. Cross-Border Investment by Open-End Investment Funds in Emerging Market Economies

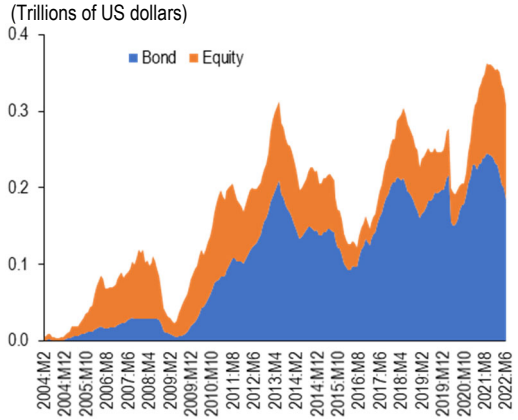
Open-end investment funds have been playing an increasingly important role in emerging markets…

1. Funds' Portfolio Allocations into EM Bond and Equity Markets
(Trillions of US dollars)



…and especially in bond markets.

2. Cumulative Cross-Border Equity and Bond Fund Flows into EMs
(Trillions of US dollars)



Sources: Emerging Portfolio Fund Research; and IMF staff calculations.
Note: EM = emerging market.

6. Despite the financial stability risks, effective implementation of policy measures by governments or regulatory authorities to mitigate the vulnerabilities associated with OEFs holding illiquid assets has been lacking. Several policy options are available to address these vulnerabilities and risks through better liquidity management by funds. Liquidity management tools could be applied to the asset side of funds' balance sheets (for example, limits on investing in illiquid assets or limits on asset concentration and requirements to hold a minimum amount of liquid assets). They could also be applied to the liability side (such as in-kind redemptions, redemption suspensions or gates, and side pockets, as well as price-based measures such as redemption fees, anti-dilution levies, and "swing pricing").[7]

7. Studies point to the potential effectiveness of price-based measures such as swing pricing, redemption fees, and anti-dilution levies in reducing investors' incentive to run on funds.[8] These measures ensure that trading costs are borne only by the exiting investors, for example, by adjusting the net asset value when facing outflows (swing pricing) or by imposing a fee

[6] In the case of emerging markets, the importance of benchmark-driven portfolio flows has increased significantly over the years, which poses additional risk as these flows tend to be highly sensitive to global factors, potentially increasing the risk of excessive outflows with a spike in investor risk aversion (Arslanalp and others 2020; April 2019 Global Financial Stability Report [GFSR]).

[7] In-kind redemptions are a tool by which a fund's portfolio assets are distributed to redeeming investors on a pro rata basis. Suspensions temporarily prevent investors from withdrawing their capital from a fund. Redemption gates restrict investors' ability to redeem when total redemptions exceed a certain level. Side pockets are sub-funds (segregated accounts) that typically hold less liquid assets and have longer redemption periods. Redemption fees are charges imposed on investors redeeming their shares, typically to discourage short-term trading. Anti-dilution levies are fees imposed on redeeming investors to compensate the remaining investors for the transaction costs caused by the redemptions. Swing pricing allows funds to adjust their net asset value based on the transactions of the redeeming investors such that trading costs are borne by the exiting investors.

[8] See, for example, Jin and others (2022) and Emter, Fecht, and Peia (2022).

on redeeming investors (anti-dilution levies). This is desirable from an investor protection perspective—both in normal times and in times of market stress—because it prevents dilution of the shares of the fund's remaining investors. But it also has a systemic impact by dampening investors' incentive to redeem ahead of others, thereby reducing the risk of investor runs. Moreover, unlike other tools, such as less frequent redemptions (or "gates"), price-based measures do not restrict funds' ability to provide daily liquidity—which is a key feature of OEFs. However, to date, these measures have been adopted only by funds in certain jurisdictions, and there are questions about their calibration and effectiveness, especially in periods of severe market stress (Lewrick and others 2022).

8. In the absence of adequate liquidity management by funds, central banks have stepped in during episodes of severe market stress to provide liquidity backstops to the financial sector, including to OEFs, but such interventions may lead to underpricing of risk by investors. Unlike banks, investment funds do not generally have access to central bank liquidity facilities or deposit insurance. They are also not subject to the same intensity of prudential oversight, or to the capital and liquidity requirements, imposed on banks. However, in episodes of severe market stress, such as during the March 2020 market turmoil, central banks have had to purchase a range of risky assets, including corporate bonds, to ease strains on liquidity to help prevent asset fire sales by funds, which could have led to a further deterioration in market liquidity. Such interventions, while at times warranted to prevent systemic crises, may result in moral hazard and systematic underpricing of risk by funds.[9] It is therefore essential to work toward a policy and regulatory framework that addresses the vulnerabilities associated with OEFs, and mitigates potential risks to financial stability, while minimizing the need for central banks to intervene in financial markets.

9. Against this backdrop, this chapter analyzes the contribution of OEFs to asset price fragility and discusses different policy options to mitigate the risks. The chapter begins by laying out a simple conceptual framework to discuss the nature of potential financial stability risks arising from OEFs. Next, it uses a sample of 17,000 OEFs domiciled in 43 countries and holding more than 450,000 bond and equity securities and examines a period from the fourth quarter of 2013 to the second quarter of 2022 to construct quantitative measures of vulnerabilities of OEFs, defined mainly in terms of the illiquidity of their asset holdings.[10] The chapter then empirically analyzes the extent to which these vulnerabilities drive fragility in asset markets—measured as volatility of asset returns—especially during episodes of market stress. It also examines potential cross-border spillovers from funds domiciled in advanced economies to asset prices in emerging market economies. In addition, it investigates the channels through which fund illiquidity is transmitted to asset price fragility and assesses its impact on broader financial conditions. Finally, the chapter analyzes the role of liquidity risk management tools in mitigating the vulnerabilities and risks associated with OEFs.[11]

A Conceptual Framework to Understand the Financial Stability Risks of Open-End Investment Funds

10. OEFs that hold illiquid assets but offer daily redemptions to investors may experience severe outflows in periods of market stress. OEFs that offer such daily redemptions

[9] Moral hazard could arise because repeated liquidity support by central banks may incentivize funds as well as end investors to take on more risk without fully internalizing the costs of such risk-taking.

[10] The sample period is chosen based on the availability of consistent portfolio holdings data required for the empirical analysis. See Online Annex 3.1 for a detailed description of the sample and variable definitions. All online annexes are available at www.imf.org/en/Publications/GFSR.

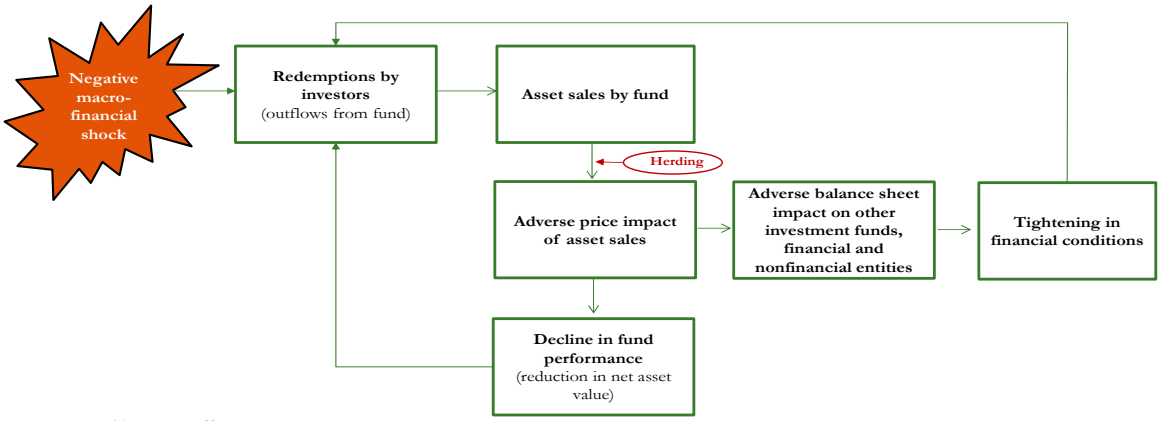
[11] Several studies have assessed the role of funds in generating fragility in corporate bond and equity markets. The main contribution of this chapter is to use a global sample of funds, composed of both equity and bond funds, investing in a large group of advanced and emerging market economies. In addition, the chapter looks at the transmission of shocks from OEFs to broader financial conditions, examines the cross-border spillover effects of fund vulnerabilities on asset prices and financial conditions, compares OEFs with ETFs, and analyzes several policy options.

but hold assets that cannot be liquidated quickly without material loss of value are subject to an asset-liability "liquidity" mismatch. This mismatch reflects an inherent vulnerability of the fund that gives rise to the risk of sudden and large redemptions by investors (runs on funds). The risk arises because investors can redeem shares from the fund on a daily basis at its current net asset value without bearing the full transaction costs of their redemptions. These costs are then effectively borne by the investors who remain in the fund.[12] This externality creates an incentive for investors to redeem ahead of others—known as the "first-mover advantage"—particularly from funds that hold less liquid assets that may be more difficult and costly to sell (Chen, Goldstein, and Jiang 2010; Goldstein, Jiang, and Ng 2017).

11. Funds facing outflows may be forced to sell assets, putting downward pressure on asset prices. In the face of redemptions, OEFs may need to sell assets to pay out investors if the funds do not have enough cash or cash-like assets. This could depress asset prices, particularly of less liquid assets, amid tight financial conditions (Figure 3.5).[13] Moreover, in the presence of herding by funds, trading activity in the same direction could exacerbate selling pressure and cause asset prices to diverge from fundamental values.

Figure 3.5. Liquidity Mismatch of Open-End Investment Funds and Systemic Risk

Redemptions from open-end funds can trigger fire sales of assets that can result in tighter overall financial conditions.



Source: Prepared by IMF staff.
Note: In addition to the adverse price impact, asset sales by the fund can incur other transaction costs such as commissions and fees, which will adversely affect its net asset value. High leverage and low levels of liquidity provision in the market could further amplify the impact of redemptions on asset sales.

12. Depressed asset values can, in turn, lower the performance of funds and induce further redemptions and asset fire sales, amplifying the impact of shocks. Lower asset prices could also adversely affect the balance sheets of other financial and nonfinancial entities, including funds not originally affected by the shock, and potentially lead to a broad-based tightening of financial conditions that could reinforce the vicious cycle of redemptions and asset fire sales, thus threatening macro-financial stability.[14]

[12] Transaction costs include direct costs such as commissions and fees, as well as indirect costs such as the impact on asset prices resulting from their sale by the fund to meet redemption requests. The price impact tends to be larger when the underlying market liquidity is poor.

[13] Jiang and others (2022) find that redemptions from corporate bond funds generate price pressures and that during the COVID-19 crisis bonds held largely by more illiquid funds experienced more negative returns. By contrast, Choi and others (2020) find little evidence for such price pressures after controlling for issuer-time fixed effects, which they attribute to funds' liquidity management strategies. Ma, Xiao, and Zeng (2022) reconcile the findings by showing that the price impact generated by the unprecedented outflows during the COVID-19 pandemic depended on the pecking order of liquidation adopted by funds. In periods of stress, price pressures can emerge even in otherwise liquid assets. In equity markets, Coval and Stafford (2007) show, outflows from mutual funds put price pressure on securities that are sold by distressed funds.

[14] Depressed asset prices can also adversely affect the ability of firms to raise capital (Zhu 2021).

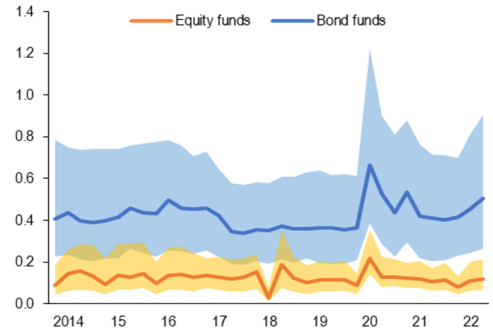
Vulnerabilities of Open-End Investment Funds and Asset Markets: Some Stylized Facts

13. OEFs that invest in corporate bonds, especially high-yield bonds, tend to be much more illiquid than equity funds. Because the first-mover advantage for investors will generally be greater in less liquid funds, the level of illiquidity of a fund's portfolio is a useful gauge of its vulnerability. Illiquidity is measured here as the value-weighted average of the bid-ask spreads of the securities held by the fund.[15] By that measure, illiquidity tends to be much higher for bond funds than for equity funds (Figure 3.6, panel 1). Among bond funds, those holding corporate high-yield bonds and emerging market bonds tend to be the most illiquid, while those investing in advanced economy sovereign bonds are the most liquid (Figure 3.6, panel 2).

Figure 3.6. Liquidity of the Portfolio Holdings of Open-End Investment Funds

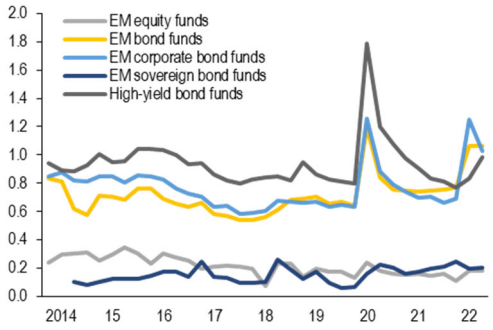
The liquidity of funds' portfolios has generally been stable but deteriorated dramatically in March 2020…

1. Fund-Level Bid-Ask Spread
(Interquartile range, percent)



… particularly for high-yield and EM bond funds.

2. Fund-Level Bid-Ask Spread by Fund Type
(Percent)



Sources: FactSet; Morningstar; Refinitiv; and IMF staff calculations.
Note: Fund-level illiquidity is the weighted average of the bid-ask spreads of the fund's portfolio of securities. In panel 1, the solid lines indicate the median, and the shaded area indicates the interquartile range of fund-level illiquidity. In panel 2, the median fund-level bid-ask spreads are shown for groupings of assets based on Morningstar classifications; these groupings are not mutually exclusive. EM = emerging market.

14. The liquidity of funds' portfolios deteriorated dramatically during the March 2020 market turmoil and has been worsening again in recent months. The liquidity of OEF portfolios had been relatively stable for several years before the COVID-19 pandemic but deteriorated rapidly in March 2020 amid heightened uncertainty about the outlook. The deterioration in fund-level liquidity, indicated by the increase in bid-ask spreads of funds' portfolios, was particularly severe for funds invested in relatively less liquid assets, such as high-yield and emerging market bonds. Consistent with the view that liquidity mismatches heighten the risk of runs on funds, redemptions from these funds reached record levels, as shown in Figure 3.2. The liquidity of funds' portfolios worsened again in the first half of 2022, especially for high-yield and emerging market bond funds. In fact, for the latter, liquidity reached levels similar to that observed in March 2020 (Figure 3.6, panels 1 and 2).

15. Assets held by more illiquid funds may be more susceptible to selling pressure caused by large redemptions from funds. To gauge the extent to which assets are vulnerable to selling pressure stemming from fund redemptions, the analysis constructs an asset-level "vulnerability measure" that captures the illiquidity of the portfolios of funds holding that asset.[16]

[15] Bid-ask spreads are a widely used measure of liquidity that reflect the difference between "sell" and "buy" prices quoted by market participants, such as broker dealers. Alternative measures rely on higher-frequency price data or transaction data, which are not available for the global sample and various asset classes considered in this chapter.

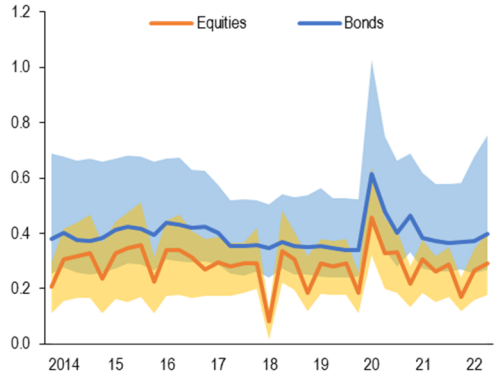
[16] The measure is constructed following Jiang and others (2022) and captures the weighted-average liquidity of the funds holding the assets, with liquidity defined as the value-weighted quoted bid-ask spread of funds' portfolios and the weights reflecting the share of a fund's ownership of the asset. See Online Annex 3.2 for further details.

Not surprisingly, the data show that less liquid assets such as bonds are generally held by more illiquid funds and are therefore more vulnerable to selling pressure than equities (Figure 3.7, panel 1). Across different types of bonds, corporate high-yield and emerging market bonds are more likely to be held by more illiquid funds and are hence highly vulnerable to fund redemptions (Figure 3.7, panel 2). The vulnerability of these assets increased dramatically during the COVID-19 crisis, when liquidity mismatches in OEFs increased (as shown in Figure 3.6), and it has risen again in 2022, in some cases close to levels seen during the early days of the pandemic.

Figure 3.7. Asset-Level Vulnerability Measure

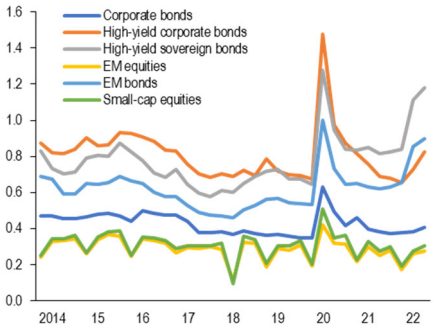
Fixed-income securities are held by more illiquid funds and are thus on average more vulnerable than equity securities.

1. Asset-level Vulnerability due to Funds' Illiquidity: Bonds vs. Equity
(Interquartile range, index)



Less liquid securities such as high-yield and EM bonds are generally held by more illiquid funds, and recently their vulnerabilities have reached levels almost as high as in March 2020.

2. Asset-level Vulnerability due to Funds' Illiquidity for Different Asset Types
(Median, index)

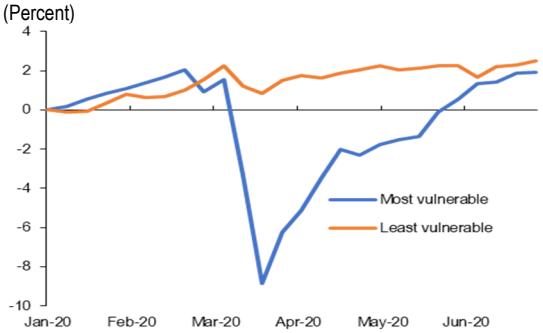


Sources: FactSet; Morningstar; Refinitiv; and IMF staff calculations.
Note: Panel 1 displays the evolution of asset-level vulnerabilities for bonds and equities. The vulnerability measure is constructed following Jiang and others (2022) and captures the weighted average liquidity of its owners, with liquidity defined as the portfolio-level bid-ask spread. See Online Appendix 3.2 for further details. In panel 1, the solid line indicates the median, and the shaded area is the interquartile range for the asset-level vulnerability measure. In panel 2, the lines indicate the median asset-level vulnerability for specific asset classes. EM = emerging market.

Figure 3.8. Bonds Held by Vulnerable Funds Have Underperformed in 2020 and 2022

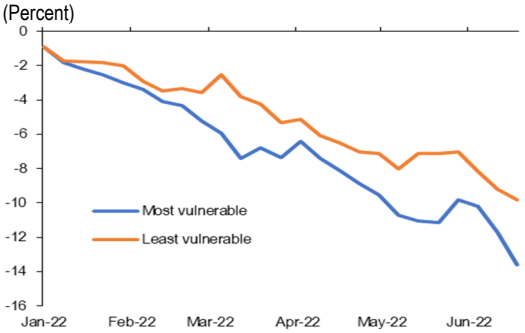
During the dash-for-cash episode in March 2020, bonds held by more illiquid funds had lower returns.

1. Cumulative Bond Returns by Asset Vulnerability, 2020:Q1–Q2
(Percent)



Vulnerable securities have also underperformed so far in the 2022 bear market.

2. Cumulative Bond Returns by Asset Vulnerability, 2022:Q1–Q2
(Percent)



Sources: Morningstar; and IMF staff calculations.
Note: Most (least) vulnerable bonds are those in the top (bottom) tercile of the distribution of the asset-level vulnerability measure in 2019:Q4 (panel 1) and 2021:Q4 (panel 2). Average cumulative returns are weighted by market value. See Online Annex 3.2 for a more comprehensive econometric analysis confirming results in this descriptive analysis.

16. More vulnerable assets experience sharper price declines than other assets in periods of market stress. The higher vulnerability of assets held by less liquid funds is visible during two recent episodes of market stress. In March 2020, at the height of the financial market turmoil driven by the COVID-19 pandemic, fixed-income securities held by more illiquid funds experienced a sharper drop in prices (that is, lower returns) than those held by liquid funds (Figure 3.8, panel 1).

This pattern was repeated in the first half of 2022, when global asset markets declined in response to monetary policy tightening by major central banks and the war in Ukraine (Figure 3.8, panel 2).[17]

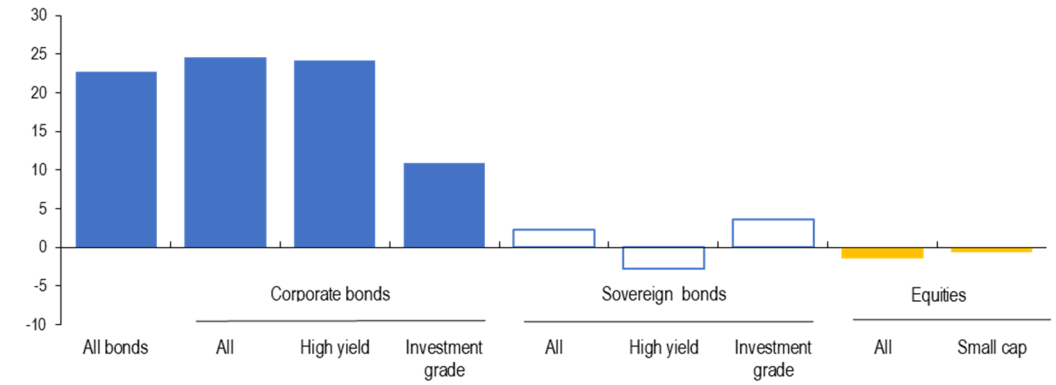
17. Taken together, these initial observations suggest that the vulnerabilities of OEFs could indeed adversely affect asset markets. In the discussion that follows, the chapter investigates the strength of the relationship between fund-level vulnerabilities and the fragility in asset markets (measured by the volatility of equity and bond returns).

How Open-End Investment Fund Vulnerabilities Can Contribute to the Fragility of Asset Prices

18. Individual fixed-income securities that are held by less liquid funds tend to have more volatile returns than those held by liquid funds, after taking into account a wide range of other security characteristics that could affect the volatility of returns. The empirical analysis shows that the illiquidity of OEFs contributes to the fragility of bond returns in addition to what can be expected based on other bond characteristics, including their liquidity, rating, and maturity (Figure 3.9, panel 1).[18] A one standard deviation increase in the vulnerability measure of an average bond increases its return volatility by 23 percent relative to the median return volatility of the bond (first bar on the left).[19] By contrast, the volatility of returns of relatively more liquid assets, such as sovereign bonds and equities, does not appear to be strongly affected by the liquidity of the funds that hold them.

Figure 3.9. Open-End Investment Fund Vulnerabilities Contribute to Fragility in Corporate Bond Markets

Corporate bonds held by less liquid funds tend to experience significant return volatility, but more liquid asset classes, such as sovereign bonds or equities, do not.



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

Note: The figure shows the coefficient on the asset-level vulnerability measure in a regression of quarterly asset return volatility on the lagged vulnerability measure over the period 2013:Q4–2021:Q4. Asset-level vulnerability is calculated based on the illiquidity of the funds holding that asset (following Jiang and others 2022). Coefficients are shown by asset class. Asset return volatility is calculated based on weekly returns over one quarter and is expressed relative to the sample median of the respective asset class. Asset-level vulnerability is defined as a z-score (de-meaned and divided by the standard deviation of the respective subsample). For details of the estimated regression models, see Online Annex 3.2. Solid bars indicate statistical significance at 10 percent or lower.

[17] For equities, no meaningful difference is found between the returns of those held by more vulnerable funds relative to less vulnerable funds, consistent with the notion that liquidity mismatches play a less important role in more liquid markets such as the equity market.

[18] The analysis is robust to the use of security and issuer fixed effects combined with time fixed effects, which controls for time-varying issuer characteristics such as credit risk. See Online Annex 3.2 for a detailed description of the empirical approach and robustness tests.

[19] This finding is comparable to that reported by Jiang and others (2022), who find that a one standard deviation increase in the vulnerability of US corporate bonds is associated with a 16 percent higher return volatility.

19. The sensitivity of asset price fragility to fund vulnerabilities increases in periods of market stress. The analysis considers two measures of stress: (1) uncertainty (or fear) in financial markets, proxied by the Chicago Board Options Exchange Volatility (VIX) Index; and (2) US monetary policy uncertainty.[20] The analysis shows that the previously documented adverse impact of asset-level vulnerability on bond return volatility is more pronounced when financial or monetary policy uncertainty is elevated (Figure 3.10, panel 1). A one standard deviation increase in the vulnerability measure is associated with about a 20 percent increase in bond return volatility (relative to median volatility) when the VIX Index or monetary policy uncertainty is high (at the 75th percentile of their distribution) relative to when they are low (at the 25th percentile of their distribution).

20. Notably, in periods of high macro-financial uncertainty, the return volatility of more liquid assets such as sovereign bonds also appears to increase. This could be consistent with funds following a "pecking order" when liquidating assets in times of stress (Ma, Xiao, and Zeng 2022). Funds with sufficient liquid assets may sell those first to raise cash before selling their illiquid assets. In such cases, even otherwise liquid assets can become fragile.[21]

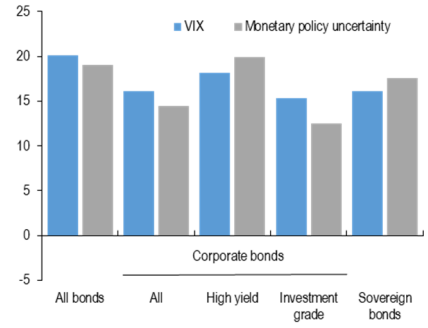
21. Herding can further amplify the effect of fund vulnerabilities on asset prices. As discussed above, the simultaneous selling of assets by investment funds that hold similar portfolios or have similar strategies and behaviors could drive asset prices away from fundamentals and induce more volatility, especially under strained market liquidity conditions. The results of the analysis show that this is indeed the case: the impact of fund-level illiquidity on volatility is higher for securities that experience higher levels of herding (where herding is measured as the tendency of funds to trade in the same direction, following Cai and others 2019). A one standard deviation increase in the vulnerability measure has a 3 percent to 5 percent larger effect on return volatility (relative to the median) for securities exposed to sell-herding compared with those that are not exposed (Figure 3.10, panel 2).

Figure 3.10. Asset-Level Vulnerabilities Amplified by Market Stress and Herding

The return volatility of fixed-income assets held by more illiquid funds increases as macro-financial uncertainty rises.

1. Differential Effect of Vulnerability on Bond Return Volatility in High- vs. Low-Stress Situations

(Percent of median volatility)



Herding by funds can also amplify the adverse effect of vulnerabilities on return volatility.

2. Differential Effect of Vulnerability on Bond Return Volatility for Securities with High vs. Low Herding

(Percent of median volatility)

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

Note: Panel 1 shows the difference in the impact of the asset-level vulnerability measure on asset return volatility at high and low levels of the Chicago Board Options Exchange Volatility (VIX) Index and the monetary policy uncertainty measure (where high and low refer to the 75th and 25th percentiles of the sample distribution of the corresponding stress variables, respectively). Panel 2 shows the difference in the impact of the asset-level vulnerability measure on asset return volatility at high and low levels of sell-herding (where high and low are defined as the 75th and 25th percentiles of the sample distribution of the herding measure, respectively). The herding measure is based on Cai and others (2019); sell-herding considers only securities with more sellers than buyers. See Online Annex 3.2 for further details on the estimated regressions. Solid bars indicate statistical significance at 10 percent or lower.

[20] US monetary policy uncertainty is measured based on textual analysis of newspaper articles (Husted, Rogers, and Sun 2020). Based on this measure, monetary policy uncertainty was elevated in 2019 and has been rising since the end of 2021. The VIX Index spiked during the market turbulence in March 2020, when uncertainty about the effect of the COVID-19 pandemic was high (see Online Annex 3.2).

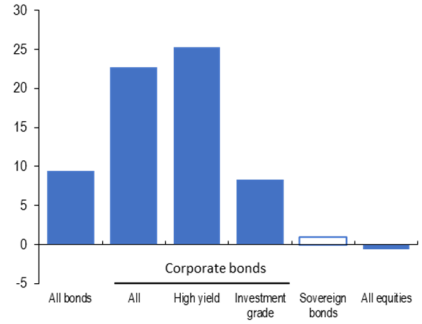
[21] Empirical analysis conducted later in the chapter supports the view that funds follow a pecking order of liquidation in times of stress.

22. Emerging markets are particularly vulnerable to sharp outflows from OEFs. Fund-level vulnerabilities in advanced economies tend to spill over to asset prices in emerging market economies, particularly to corporate bond prices (Figure 3.11, panel 1). A one standard deviation increase in the vulnerability measure of emerging market corporate bonds held by funds domiciled in advanced economies is associated with a 23 percent increase in their return volatility relative to their median volatility. The impact is magnified during market stress: a one standard deviation increase in vulnerability is associated with a 14 percent higher impact on bond return volatility in periods when the VIX Index is high compared with periods when it is low (Figure 3.11, panel 2).

Figure 3.11. Spillovers from Advanced Economy Open-End Investment Funds to Asset Prices in Emerging Market Economies

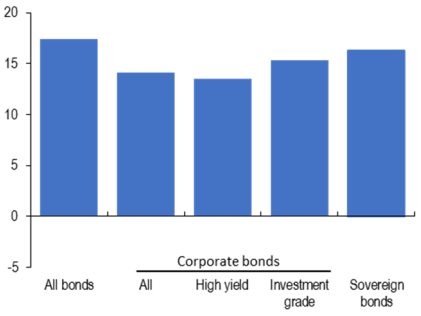
Vulnerabilities from funds domiciled in advanced economies can spill over to bond markets in emerging markets...

1. Effect of Advanced Economy Fund Vulnerability on EM Asset Return Volatility
(Percent of median volatility)



...and the effect is particularly pronounced in periods of high financial uncertainty.

2. Differential Effect of Advanced Economy Fund Vulnerability on EM Asset Return Volatility in High- vs. Low-Stress Situations
(Percent of median volatility)



Sources: Morningstar; and IMF staff calculations.
Note: Panel 1 shows the spillover effect of vulnerabilities from funds domiciled in advanced economies on EM securities markets by regressing EM bond and equity return volatility on asset-level vulnerability measures that are calculated considering advanced economy funds only and relevant controls. Panel 2 shows the difference in the impact of the asset-level vulnerability measure at high and low levels of the Chicago Board Options Exchange Volatility Index (for which high and low refer to the 75th and 25th percentile of the sample distribution, respectively). See Online Annex 3.2 for a detailed description of the regression models. Solid bars indicate statistical significance at 10 percent or lower. EM = emerging market.

23. These findings suggest that vulnerabilities associated with funds' liquidity mismatches generate fragility in asset markets, especially in fixed-income markets. The results also show that this fragility is amplified when macro-financial uncertainty is high and funds engage in herding. The next section will shed light on some of the underlying mechanisms through which fund vulnerabilities tend to influence asset return volatility.

Transmission of Risks from Open-End Investment Funds to Asset Price Fragility

24. An adverse shock can create a vicious circle, especially for less liquid funds, whereby investor redemptions force funds to liquidate portfolios, generating selling pressures that reduce the market value of securities and lead to further redemptions. This vicious circle is illustrated in Figure 3.5, and the analysis confirms the empirical relevance of this mechanism through three main findings:

- Less liquid funds tend to face larger outflows, particularly during periods of high uncertainty and volatility, as measured by an increase in the VIX Index (Figure 3.12, panel 1).[22]
- Outflows from funds lead to selling pressure. Bonds with higher vulnerability—that is, those held by less liquid funds—are more likely to be liquidated when funds experience large outflows, with the effects being particularly pronounced for high-yield bonds (Figure 3.12, panel 2).[23] Further

[22] The higher sensitivity of fund outflows to fund illiquidity during periods of stress complements previous findings by Chen, Goldstein, and Jiang (2010) and Goldstein, Jiang, and Ng (2017), who show a stronger sensitivity of outflows to the poor performance of illiquid funds.

[23] The selling pressure measure captures the difference between sales and purchases of bonds by OEFs that experience extreme outflows and inflows, respectively, with a large positive (negative) value indicating strong selling (buying) pressure.

analysis shows that in periods of market stress, such as during the COVID-19 market turmoil, funds appear to follow a pecking order of liquidation, selling relatively more liquid assets within their portfolio first (Figure 3.12, panel 3).[24] This result implies that selling pressure on funds can also have a sizable price impact on asset markets that are usually considered liquid (such as sovereign bonds) when uncertainty is high, as illustrated in panel 1 of Figure 3.10.

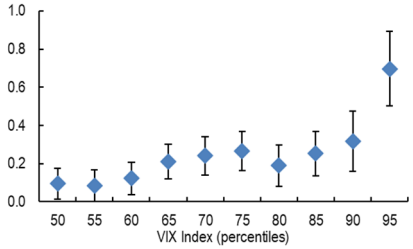
- Selling pressures induced by fund outflows lead to significant price movements in the underlying assets. Estimating the impact of selling pressure on the abnormal returns of different assets during the COVID-19 market turmoil suggests that selling pressures can cause substantial price movements and negative abnormal returns for bonds (Figure 3.12, panel 4).[25]

Figure 3.12. Transmission Channels of Open-End Investment Fund Vulnerabilities

Illiquid funds tend to face larger outflows, especially at high levels of stress.

1. Effect of Fund Illiquidity on Fund Outflows by Level of Financial Stress

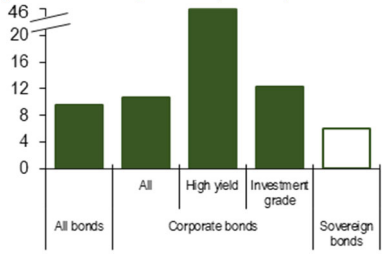
(Percent of fund size)



Assets held by less liquid funds face stronger selling pressures.

2. Effect of Fund Vulnerabilities on Selling Pressures

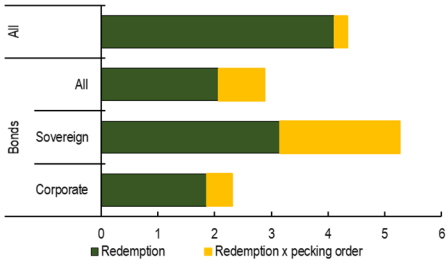
(Percent of average sell-off pressure)



During periods of market stress, more liquid securities are more likely to be sold first following large investor redemptions...

3. Pecking Order and Sensitivity of Liquidations to Fund Outflows During the COVID-19 Market Turmoil

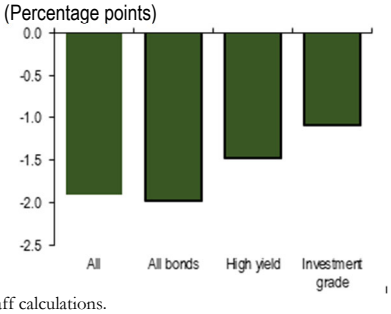
(Percentage points)



...and subsequent selling pressure can lead to significant price movements in the underlying assets.

4. Effect of Fund Outflows on Asset Returns during the COVID-19 Market Turmoil

(Percentage points)



Sources: Bloomberg Finance L.P.; FactSet; Haver Analytics; Morningstar; and IMF staff calculations.

Note: Panel 1 shows the results of fund-level panel regressions in which outflows from funds are regressed on fund-level illiquidity measures while controlling for fund-level characteristics and country-time fixed effects. The results are presented at different levels of market stress identified as periods when the Chicago Board Options Exchange Volatility (VIX) Index is above a given percentile of its sample distribution. Error bars correspond to 90 percent confidence intervals. In panels 2–4, "All" refers to all securities in the sample, including equities. Panel 2 shows the effect of the asset-level vulnerability measure on selling pressures of assets over the sample period. The indicator of selling pressure is constructed following Jiang and others (2022) and is based on realized fund trades conditional on large fund flows to capture selling pressures for a given asset. A large positive (negative) value of the measure indicates strong selling (buying) pressure. The value of the estimated coefficient for high-yield corporate bonds is equal to 46 percent (the *y*-axis is truncated for visual clarity). Panels 3 and 4 show the results of an event study analysis focusing on the COVID-19–induced market turmoil in the first quarter of 2020. Panel 3 shows the effect of 10 percent fund outflows ("redemptions") on securities liquidations when the outflow is interacted with a fund-security-level pecking order indicator for each security. The pecking order of a security in a given fund's portfolio corresponds to its liquidation rank as defined in Ma, Xiao, and Zeng (2022). It is computed for each asset held by a given fund as the total portfolio share of other securities held by the same fund that are relatively less liquid (that is, have a higher bid-ask spread). Panel 4 shows the effect of liquidation-adjusted outflows from funds on abnormal returns of different assets. Abnormal returns are calculated as the difference between a security's return and the average return of assets with a similar maturity and rating. Solid bars indicate statistical significance at 10 percent or lower. See Online Annex 3.2 for a detailed description of the variables and empirical methodology.

[24] Such a pecking order—known as horizontal slicing—implies that the likelihood of a fund's sale of a given security depends not only on the absolute level of liquidity of the security but also on its liquidity relative to other assets in the fund's portfolio; that is, its liquidation rank (Ma, Xiao, and Zeng 2022). The liquidation rank of a security in a fund's portfolio corresponds to the portfolio share of other bonds held by the same fund that are less liquid. This implies, for example, that an investment-grade bond held by a high-yield fund might be among the first assets to be sold, while the same bond held by an investment-grade fund might be liquidated much later in the pecking order (as more liquid assets might be available in the investment-grade fund). See Online Annex 3.3 for further details.

[25] The measure of selling pressure used here accounts for funds' liquidation policies. Intuitively, the "liquidation-adjusted" outflow of two securities held by the same fund will depend on the pecking order followed by the fund, since securities higher up in the pecking order are more likely to be sold by the fund to raise the cash needed when facing outflows.

Spillovers to Financial Markets from Vulnerabilities in Open-End Investment Funds

25. Through their effect on asset prices, fund vulnerabilities may generate broader macro-financial stability risks. As shown in the previous section, investor redemptions from funds lead to selling pressure that increases market volatility and depresses asset prices. The reduction in asset prices could in turn adversely affect the balance sheets of other financial and nonfinancial entities and lead to a broader tightening of financial conditions, generating macro-financial stability risks. A preliminary look at the data suggests that average financial conditions across countries are indeed correlated with average asset-level vulnerability (the extent to which assets are held by illiquid funds). That is, financial conditions appear to tighten with an increase in asset holdings by less liquid OEFs, and vice versa (Figure 3.13, panel 1).

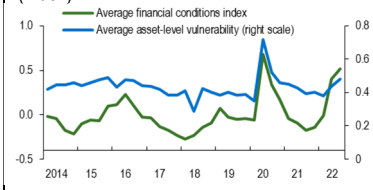
26. Formal empirical analysis confirms that fund vulnerabilities can lead to market-wide effects, and that the strength of the relationship varies with the level of market stress.[26] On average, an increase in the vulnerability measure for less liquid assets such as bonds is associated with a significant tightening of financial conditions in the next period (Figure 3.13, panel 2). No similar effect is visible for more liquid equity securities. Furthermore, this effect is amplified as financial conditions tighten.

Figure 3.13. Open-End Investment Fund Vulnerabilities and Financial Conditions

An increase in asset holdings by more illiquid open-end investment funds is associated with tighter financial conditions…

1. Average Financial Conditions and Asset-Level Vulnerabilities

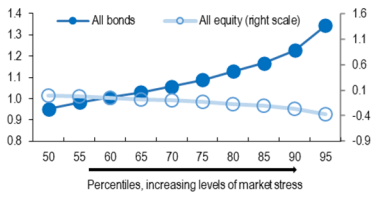
(Index)



…and the relationship is stronger when financial conditions are tight.

2. Impact of Asset-level Vulnerabilities on Domestic Financial Conditions

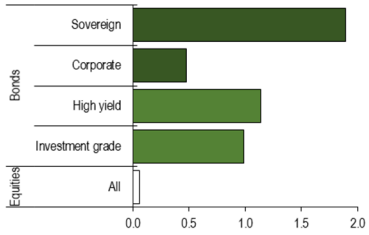
(Index)



Fund vulnerabilities imply negative cross-border spillovers for EMs…

3. Spillover Effects from Fund Vulnerabilities in AEs to Financial Conditions in EMs

(Index)



Sources: Bloomberg Finance L.P.; FactSet; Haver Analytics; Morningstar; and IMF staff calculations.

Note: Panel 1 shows the average asset-level vulnerability and domestic financial conditions index across countries. Higher values of the financial conditions index indicate a tightening of financial conditions. The index is set to zero at its historical average. See Online Appendix 3.2. for a description of the domestic financial conditions index. Panels 2–4 show the results from country-level panel regressions with fixed effects in which the domestic financial conditions index in period $t+1$ is regressed on asset-level vulnerabilities averaged at the issuer-country level in period t. Panel 2 is estimated using panel quantile regressions to assess the relationship between financial conditions and fund vulnerabilities at different levels of market stress. The model controls for domestic macro-financial factors and external shocks such as domestic and US monetary policy shocks, average GDP growth of foreign economies, changes in global liquidity conditions, and commodity price shocks. In panel 3, spillover analysis is performed by substituting domestic fund vulnerabilities with a measure capturing foreign fund vulnerabilities, which is computed as the average asset-level vulnerability from holdings of funds domiciled in advanced economies. Panel 3 shows the effect when restricting the country-level panel regressions to EMs. Solid dots and solid bars indicate statistical significance at 10 percent or lower. AE = advanced economy; EM = emerging market.

27. The impact of fund vulnerabilities in source countries can also spill over to financial conditions in recipient economies. On average, increased holdings of domestic assets by nonresident advanced economy illiquid funds are associated with significant tightening in domestic financial conditions of recipient countries in the period that follows (Figure 3.13, panel 3). While such spillover effects from advanced economy funds are present for the full sample of countries, they are much stronger for emerging market economies (Online Annex Figure 3.2.2).

[26] Country-level panel regressions are estimated looking at the impact of average asset-level vulnerabilities (that is, the extent to which domestic securities are held by more illiquid funds) on future domestic financial conditions while controlling for other relevant domestic and external factors such as domestic and US monetary policy shocks, average GDP growth of foreign economies, changes in global liquidity conditions, and commodity price shocks.

28. Overall, these results show that OEFs can transmit shocks to financial conditions, both domestically and across borders. Reducing the vulnerabilities associated with these funds could thus help mitigate asset price fragility and risks to macro-financial stability. In this context, the next section looks at the role that liquidity risk management tools can play to enhance the resilience of the sector.

Liquidity Management Tools to Address the Risks from Open-End Investment Funds

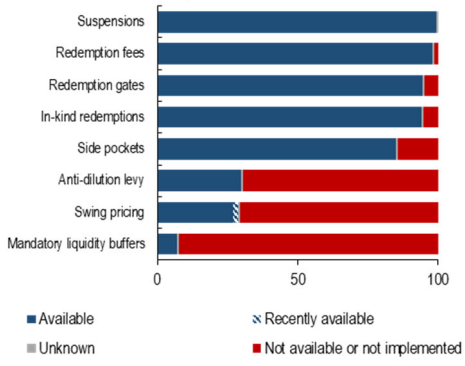
29. Liquidity management tools can potentially reduce the vulnerabilities associated with OEFs and mitigate their potential to amplify asset price fragility. The availability of liquidity management tools varies by jurisdiction, but in general a wide range of tools is available to OEFs across all major jurisdictions (Figure 3.14). Tools that limit investors' ability to redeem when funds experience severe outflows—such as redemption suspensions, redemption fees, redemption gates, or in-kind redemptions—are the most widely available. However, these are generally deployed only in periods of extreme market stress, and funds tend to be concerned about the stigma associated with their use.[27] Anti-dilution levies and swing pricing are tools that can potentially reduce OEF vulnerabilities ex ante by passing on transaction costs (including asset liquidation costs) to investors exiting the fund, thus reducing their incentives to run. However, anti-dilution levies and swing pricing are available only in a limited number of jurisdictions, and their utilization remains limited.[28] Mandatory requirements on holding minimum liquidity buffers appear to be the least-used tools across jurisdictions.

Figure 3.14. Availability and Implementation of Liquidity Management Tools

The availability and implementation of liquidity management tools vary across jurisdictions.

Share of Funds with Available Liquidity Management Tools, 2021:Q4

(Percent of total fund size)



Sources: ESMA (2020); IOSCO (2015); Morningstar; and IMF staff calculations.
Note: Bars represent the total net assets of funds across jurisdictions that can and do implement liquidity management tools.

30. There is no clear consensus yet on the effectiveness of liquidity buffers in mitigating fund vulnerabilities.[29] Liquidity buffers could provide funds with additional flexibility to time their asset sales when facing outflows. However, they do not eliminate the first-mover advantage and can also adversely impact long-term fund performance by constraining the capacity of funds to provide investors with exposure to particular investment themes or asset classes.

31. In general, funds holding relatively less liquid securities tend to have higher cash buffers, even if not mandated. Liquidity buffers of OEFs vary widely across and within fund types, ranging from 0.5 percent to 4 percent for equity funds and from 1 percent to 9 percent for bond funds (Figure 3.15, panel 1). Funds holding relatively illiquid securities—as measured by their

[27] For example, Grill, Vivar, and Wedow (2021) document that during the COVID-19 market turmoil, at least 215 funds suspended redemptions and that those funds subsequently experienced larger outflows than comparable funds, suggesting reputational costs associated with fund suspensions.

[28] Swing pricing is commonly used by funds in Europe (BoE and FCA 2021; ESMA 2021) but has not been implemented by funds in the United States, despite approval to do so by the Securities and Exchange Commission in 2018. A key reason for this lack of adoption in the United States is that funds there may not necessarily know the size of net flows into the fund before the price of a fund is determined. This precludes them from applying a swing factor that is based on net flows.

[29] For example, Giuzio and others (2021) argue that cash buffers can reduce run risks and costly sales of illiquid assets. However, dynamic cash rebuilding by funds after outflows could also exacerbate rather than reduce run risks (Zeng 2017). Jiang, Li, and Wang (2021) further show that corporate bond funds may not necessarily use their more liquid asset holdings relative to illiquid assets during periods of market stress to maintain portfolio liquidity.

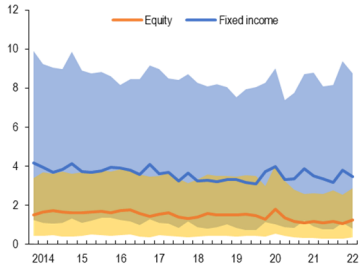
bid-ask spread—on average hold larger cash buffers, which could provide them with the ability to pay redeeming investors without forcing asset sales in stressed market conditions (Figure 3.15, panel 2). There is, however, no meaningful difference between the cash holdings of funds that use swing pricing as a liquidity management tool and those that do not. Analyzing the impact of redemptions on funds' cash buffers suggests that in normal times funds facing outflows deplete their cash buffers to pay out investors, though this does not necessarily hold in times of severe market stress, when funds appear to preserve the liquidity of their portfolios (Figure 3.15, panel 3).[30]

32. Swing pricing appears to be an effective tool to reduce fund-induced asset price fragility, but calibration is key. In contrast to ex post liquidity management tools such as gates or suspensions, which address runs on funds once they occur, swing pricing is an ex ante tool that eliminates first-mover advantages in OEFs by directly imposing the transaction costs associated with redemptions on the redeeming investors (such as in ETFs; Box 3.1). However, this requires "swing factors" (that is, the adjustment factor applied to the fund price at which investors can redeem or subscribe to mutual fund shares) to be calibrated to reflect the full cost of outflows, including the price impact of asset liquidations.[31] This calibration could be challenging for highly illiquid assets or in periods of extreme market stress when assessing the price impact of trades may be difficult due to price dislocation.[32]

Figure 3.15. Liquid Asset Holdings of Open-End Investment Funds

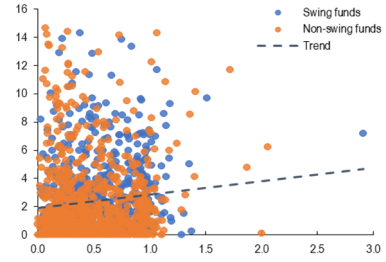
Cash buffers vary widely within and across funds…

1. Cash and Cash Equivalent, 2013:Q4–2022:Q1
(Percent of fund's net assets)



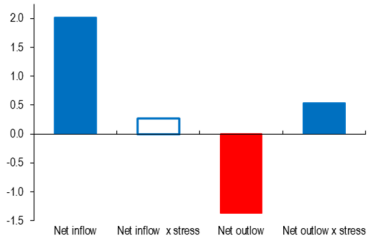
… but tend to increase with the illiquidity of a fund's portfolio, with no notable difference between funds that use swing pricing and those that do not.

2. Cash and Cash Equivalent Holdings and Portfolio Illiquidity
(Percent)



Funds appear to rely less on cash buffers to manage investor redemptions in periods of stress.

3. Effect of Investor Flows on Fund Cash Buffers
(Percent)



Sources: Morningstar; and IMF staff calculations.
Note: Cash and cash equivalents include cash held in bank accounts as well as certificates of deposit, currency, money market holdings, and other high-quality fixed-income securities with a maturity of less than 92 days. Panel 1 shows the median level of cash and cash equivalents relative to a fund's total net assets, and the blue and yellow areas indicate the interquartile range. Panel 2 shows the average portfolio illiquidity of funds (over the sample) relative to their cash holdings in percent of total net assets. Panel 3 shows the coefficients from a regression of the percentage change in fund-level cash holdings on net inflows as a percent of fund assets, net outflows as a percent of fund assets, and interaction terms with a stress dummy equal to 1 when the Chicago Board Options Exchange Volatility Index is above its 90th sample percentile. Net inflows are equal to positive net fund flows and zero otherwise. Net outflows are calculated as the negative of net fund flows when fund flows are negative and are zero otherwise. See Online Annex 3.4 for further details on the regression models and variables. Solid bars indicate statistical significance at 10 percent or lower.

33. Swing pricing mitigates vulnerabilities from OEFs but investor run risks remain if swing factors are set too low. The chapter's analysis shows that the adverse impact of fund vulnerabilities on the volatility of bond returns is reduced by about one-third if more funds implement swing pricing (Figure 3.16, panel 1).[33] However, this mitigating effect is not sufficient to

[30] This finding is consistent with Jiang, Li, and Wang (2021), who show that during tranquil market conditions, corporate bond funds tend to reduce liquid asset holdings to meet investor redemptions, but in periods with heightened uncertainty, they tend to preserve portfolio liquidity.

[31] Anti-dilution levies can have a similar effect by imposing a fee on redeeming investors.

[32] The expected price impact will depend not only on the trading needs of a single fund but also on those of other funds, making it particularly difficult for funds to accurately estimate price impact in times of stress. Optimally, swing factors would incorporate the trading behaviors of the overall fund sector.

[33] This result is in line with Jin and others (2022), who show that swing pricing can eliminate the first-mover advantage arising from the traditional pricing rule and significantly reduce outflows during market stress. However, the result of swing pricing needs to be interpreted with caution because limited data about the use of swing pricing by funds make it difficult to accurately identify its effect. The empirical analysis

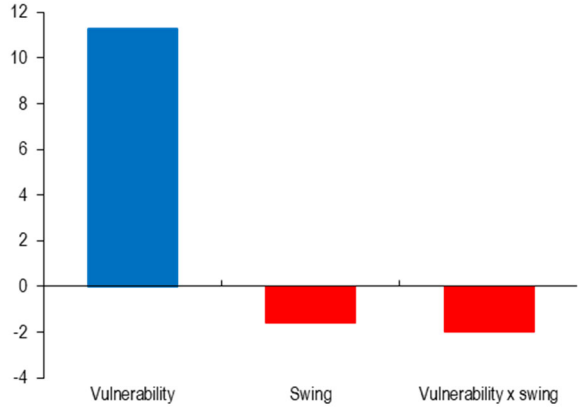
fully offset the increase in return volatility induced by illiquid funds' holdings of the bonds.[34] The limited effectiveness of swing pricing could be the result of insufficient calibration of the swing factor. Studies estimating the optimal swing factor for OEFs that would fully eliminate run risks and the associated vulnerabilities find it to be in the range of 0 to 9 percent, with the higher end of the range applying to periods of stress when price impact is high and for funds whose investors react strongly to poor performance (Capponi, Glasserman, and Weber 2020; Anadu and others 2022).[35] Currently, many funds are constrained by maximum swing factors, which they typically set substantially below 9 percent (Figure 3.16, panel 2) and define in their prospectuses.[36] These caps tend to be set based on direct trading costs, such as commissions and bid-ask spreads, without fully accounting for indirect costs such as the price impact of asset sales. Funds may also set the swing factors low out of competitive pressure because some investors may value liquidity provision and prefer funds with low caps on the size of the swing factors. Such caps may limit the ability of funds to adjust swing factors sufficiently to cover the impact of redemptions in times of stress on asset prices, thereby reducing the effectiveness of swing pricing in eliminating run risk.

Figure 3.16. Effectiveness of Swing Pricing in Reducing Asset Price Fragility

Swing pricing can partially mitigate asset price fragility due to fund vulnerabilities.

1. Effect of Swing Pricing on Bond Return Volatility

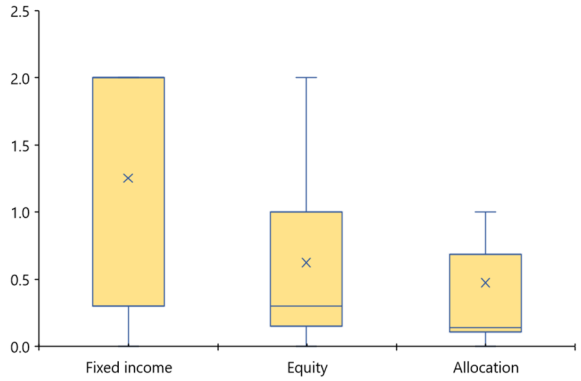
(Percent of median volatility)



However, swing factors are often capped at low levels, potentially reducing their effectiveness in periods of market stress.

2. Maximum Downward Swing Factor among 200 Sample Funds

(Boxes cover the 25th–75th percentiles; means are denoted by x's; percent)



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

Note: Panel 1 shows the coefficients from a regression of return volatility on asset-level vulnerabilities and an asset-level swing pricing exposure variable, in which swing pricing funds are defined as funds domiciled in Luxembourg or the United Kingdom. Effects are based on weekly asset price volatilities. See Online Annex 3.2 for further details on the empirical framework. Solid bars indicate statistical significance at 10 percent or lower.

Conclusion and Policy Recommendations

34. Open-end investment funds play an increasingly important role in financial markets but raise financial stability concerns. The share of global financial assets held by OEFs has grown dramatically over the past two decades. However, vulnerabilities associated with the liquidity mismatch between their asset holdings and liabilities can subject some funds to investor run risk that

proxies for swing pricing by classifying funds domiciled in countries where swing pricing is ubiquitous as "swinging funds" and the rest as "nonswinging funds." See Online Annex 3.2 for a description of the empirical methodology.

[34] These results capture only the direct effect from funds' adoption of swing pricing on the price volatility of bonds in their portfolio. The introduction of swing pricing at the fund level likely offers additional benefits by reducing run risks for other funds holding similar assets, thereby stabilizing the fund market segment as a whole.

[35] Capponi, Glasserman, and Weber (2020) calibrate the optimal swing factor as a function of the direct price impact on assets that would result from funds' transactions following investor redemptions. Anadu and others (2022) consider ETF premiums and discounts to derive the optimal swing factors for funds investing in short-term corporate bonds. The latter approach may have several limitations because ETF premiums and discounts may also be driven by factors such as the ability of authorized participants to provide liquidity. In addition, ETF investors may differ (have different liquidity preferences) from OEF investors.

[36] In most jurisdictions where swing pricing is permitted, funds are required to publish the maximum swing factors they may apply in their prospectus and cannot apply a larger swing factor without changing the prospectus.

can lead to severe dislocations in financial markets and amplify the adverse macro-financial impact of exogenous shocks.

35. The analysis in this chapter shows that OEFs holding illiquid assets that offer daily redemptions to investors are a key driver of asset price fragility. The most affected assets are those in less liquid markets, such as corporate bonds. The volatility of their returns increases significantly—especially in times of market stress—if these assets are held by more illiquid funds. The impact of fund vulnerabilities can have significant cross-border spillover effects and lead to greater asset price volatility in emerging market economies. They may also have system-wide implications by contributing to a tightening of domestic financial conditions, thereby reinforcing the vicious cycle between redemptions, fund asset sales, and the price impact of these sales.

36. Policy action is needed to mitigate the risks associated with OEFs. A wide range of liquidity management tools is available that could potentially mitigate the vulnerabilities associated with OEFs and reduce their systemic impact, but effective implementation of these tools is lacking.

37. Policy tools that limit vulnerabilities ex ante by reducing the risk of investor runs may be preferable to those that attempt to mitigate the impact of such runs once they are underway. Liquidity management tools that limit investors' ability to redeem—such as redemption suspensions or gates—do not address the intrinsic first-mover advantage problem associated with some OEFs and are typically adopted by funds already facing significant outflow pressures, which may limit their effectiveness in mitigating systemic risks.[37] Holding cash and other liquidity buffers may give funds the flexibility to respond to shocks but do not necessarily reduce the risk of investor runs and hence may also be insufficient to address the systemic risks associated with less liquid OEFs.[38] By contrast, price-based tools, such as swing pricing or anti-dilution levies, can reduce investors' incentives to front-run others by passing on transaction costs to redeeming investors, thereby protecting investors and mitigating systemic risks. However, more widespread adoption by funds and appropriate calibration of these tools is key to their effectiveness.

38. Policy interventions may be necessary to ensure that price-based measures are set at adequate levels, especially in periods of stress and poor market liquidity. Swing pricing, for example, has been a market-led innovation in many jurisdictions, introduced to protect investors from the dilution of their fund shares. However, fund-imposed caps on swing factors could constrain funds' ability to fully pass on the transaction costs to redeeming investors and, thus far, may have limited the effectiveness of swing pricing as a macroprudential tool in times of stress. Funds could therefore be required to eliminate caps and to calibrate swing factors such that they fully reflect the price impact of a fund's asset sales.[39] Policymakers should further investigate how to enhance the effectiveness of swing pricing and other price-based liquidity management tools—for example, by encouraging the disclosure of swing pricing practices and calibration methodologies and by improving the availability of aggregate fund flow data in real time to help funds determine the appropriate swing factors, especially during times of stress. Tighter monitoring of liquidity risk management practices by supervisors and regulators should also be considered to ensure the appropriate implementation of liquidity management tools.

39. Other liquidity management tools could include linking the frequency of redemptions to the liquidity of funds' portfolios in order to directly address the underlying vulnerability related to liquidity mismatch. This option may be suitable for funds holding very

[37] Such tools could even exacerbate run risks because investors may try to redeem before the measures are applied by the fund.

[38] Tools such as redemption suspensions and liquidity buffers may also be less desirable from an end-investor perspective because they restrict access to liquidity and constrain funds' investment mandates, respectively.

[39] In periods of extreme stress when market liquidity is very poor, swing factors or anti-dilution levies may be very large or difficult to calibrate. In such cases, redemption suspensions or gates may be an alternative, easier-to-implement tool. In a similar vein, IMF (2021) proposes a "waterfall" approach of progressively more aggressive liquidity management tools, such as redemption deferrals in case of moderate shocks, followed by in-kind redemption for moderate to large shocks, and market-wide fees or gates for large shocks.

illiquid assets (for example, real estate) for which the appropriate calibration of price-based tools is difficult even in normal times. It may also be suitable for funds based in jurisdictions where price-based tools cannot be effectively implemented for operational reasons. In such cases, investors could be offered the opportunity to redeem early in exchange for a redemption fee that is calibrated to reflect stress conditions and prevent dilution of the shares of remaining investors.

40. Given the adverse cross-border spillover effects of fund vulnerabilities, recipient countries will also need to take appropriate policy steps to mitigate potential systemic risks arising from the volatility of capital flows sourced from international funds. Recipient countries need to be mindful of the volatility of capital flows originating from funds in advanced economies and emphasize continued deepening of domestic markets; appropriate use of debt management tools; and use of macroeconomic, prudential, capital flow management, and foreign exchange intervention tools in line with the IMF's Institutional View to address risks arising from surges and sharp reversals in portfolio investments by OEFs (IMF 2012, 2022).

41. Policymakers should investigate the viability of exchange-traded funds (ETFs) as an alternative to OEFs. ETFs do not appear to be subject to the same liquidity vulnerabilities as OEFs (Box 3.1). Empirical analysis shows that bonds held by ETFs experience a smaller increase in volatility during periods of stress than comparable bonds held by OEFs. However, other evidence also shows that ETFs can increase nonfundamental volatility in asset markets and amplify the sensitivity of cross-border capital flows to global financial conditions.

42. Policymakers should put in place adequate disclosure requirements to allow for a proper assessment of the role of leverage in amplifying vulnerabilities from OEFs (IMF 2021). At present, the reporting of leverage, especially via the use of derivatives (synthetic leverage), is limited, which prevents a comprehensive assessment of its role in contributing to OEF vulnerabilities.

43. Policymakers should consider measures to bolster the provision of liquidity and market resilience. Regardless of the vulnerabilities associated with some OEFs, large scale redemptions and asset sales by OEFs or other market participants could result in fire sales and dislocation of asset prices if markets are not sufficiently liquid. Measures to improve liquidity provision, such as encouraging central clearing and supporting greater transparency in bond trading, should be considered to reduce risks from liquidity mismatch in OEFs and to support the functioning of securities markets in periods of stress (see the April 2015 GFSR and IMF 2021).

44. Competitive pressure and concerns about stigma may prevent funds from voluntarily implementing optimal policy solutions; policymakers should therefore consider mandating the adoption of liquidity management tools and enhanced disclosure. Over the past 15 years, central banks have had to intervene several times in financial markets during stress episodes to provide emergency liquidity support. To the extent that entities not included in the traditional regulatory perimeter continue to benefit from such support, policymakers may have to consider more extensive regulation of investment funds in the absence of adequate liquidity management practices to limit financial stability risks. Given the global operations of funds and their cross-border spillover effects, liquidity management practices should be deployed consistently at the global level to ensure their effectiveness, which calls for greater international regulatory coordination.

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Box 3.1. Exchange-Traded Funds Generate Less Asset Price Fragility but May Also Be Vulnerable[1]

Exchange-traded funds (ETFs) allow investors to buy and sell shares within a trading day, but unlike open-end investment funds (OEFs) they are not vulnerable to investor runs. ETFs have grown rapidly and constitute a substantial part of the investment fund universe (Figure 3.1.1, panel 1). They differ from OEFs in that they do not guarantee investors the ability to redeem shares at the funds' net asset value (that is, the price at the end of the trading day). Instead, ETFs are traded continuously in secondary markets at varying prices. These market prices are determined primarily by supply and demand for the ETF, and investors bear their own transaction costs when buying or selling. As a result, ETFs are not subject to the same first-mover advantage that gives rise to run risk in OEFs. Empirical analysis shows that bonds held by ETFs experience less of an increase in volatility during periods of stress than comparable bonds held by OEFs (Figure 3.1.1, panel 2).

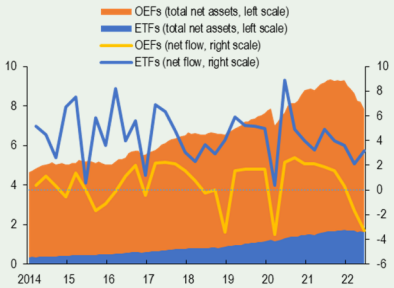
ETF discounts reflect market liquidity costs. ETF prices are tied to the ETFs' net asset value through an arbitrage mechanism. Authorized participants, which tend to be large broker dealers, have the exclusive right to create and redeem ETF shares in exchange for a basket of portfolio securities. This process ensures that the secondary market price of ETFs remains close to the fund's net asset value. However, when market liquidity deteriorates and the balance sheets of broker dealers are constrained such that they may be limited in their ability to match buyers and sellers (that is, make markets), the gap between the net asset value and the ETF's share price could increase (Pan and Zeng 2020). Similar to the way in which mutual funds pass on transaction costs to redeeming investors when using swing pricing, this difference between the net asset value and the ETF price (referred to as the *ETF discount*) reflects transaction costs borne by investors who want to buy or sell the ETF. For example, during the March 2020 stress episode, when liquidity conditions were poor, the discounts on ETFs increased dramatically, reaching more than 5 percent across all bond ETFs (up to 27 percent for high-yield bond ETFs and up to 13 percent for investment-grade bond ETFs; see Figure 3.1.1, panel 3). These discounts are indicative of the swing factor that would be required by an OEF with a similar portfolio structure and investor base.

ETFs are also subject to vulnerabilities. The provision of intraday liquidity by ETFs makes them attractive for liquidity traders with short-term horizons. Together with the arbitrage activities of authorized participants who create and redeem ETF shares, this facilitates the transmission of nonfundamental shocks from short-term-liquidity traders to securities markets. Consistent with this transmission, ETFs can increase nonfundamental volatility in asset markets (Ben-David, Franzoni, and Moussawi 2018) and amplify the sensitivity of cross-border capital flows to global financial conditions (Converse, Levy-Yeyati, and Williams 2020). Moreover, leveraged and inverse ETFs that rely on derivatives and short sales to amplify returns can introduce additional volatility in securities markets because of the need to rebalance the leveraged positions at the end of the trading day.

Figure 3.1.1. Asset Price Fragility and Exchange-Traded Funds

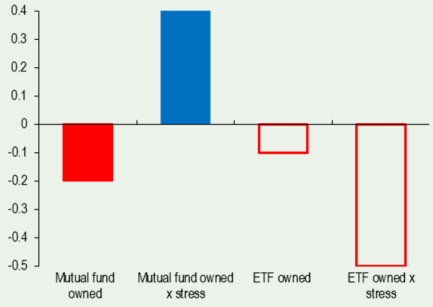
Inflows of ETFs have been large over the past decade.

1. Total Net Assets and Flows of Bond ETFs and OEFs
(Trillions of US dollars; percent of total lagged net assets)



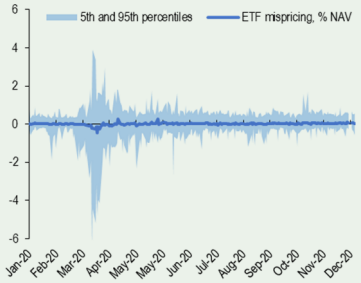
In periods of stress, ownership by OEFs is associated with higher asset price fragility than ownership of ETFs…

2. Effect of OEF Ownership and ETF Ownership on Bond Return Volatility
(Percent of median volatility)



…and at the same time, ETF discounts tend to increase when aggregate liquidity deteriorates.

3. Difference between ETF Price and Fund Net Asset Value in Percent of the Fund Net Asset Value for Bond ETFs
(Percent)



Sources: FactSet; Morningstar; Refinitiv; and IMF staff calculations.
Note: Panel 2 shows the coefficients from a regression of return volatility on asset ownership and an interaction term between asset ownership and a stress dummy equal to 1 when the Chicago Board Options Exchange Volatility (VIX) Index is above its 90th sample percentile and zero otherwise. "Mutual fund owned" refers to the total amount of an asset held by OEFs, but not by ETFs, as a percentage of its market capitalization. Effects are based on weekly asset price volatilities. The regression includes asset and issuer fixed effects. Standard errors are clustered at the asset and quarter levels. Solid bars indicate statistical significance at 10 percent or lower. Panel 3 shows the distribution of ETF mispricing for the sample of bond ETFs domiciled in the United States or Luxembourg. ETF mispricing is calculated at daily frequency as the difference between the ETF closing price and the fund NAV divided by the fund NAV. ETF = exchange-traded fund; OEF = open-end investment fund; NAV = net asset value.

[1] The author of this box is Anna-Theresa Helmke.

Asset Price Fragility in Times of Stress: The Role of Open-End Investment Funds—Online Annex

Online Annex 3.1 Data Sources and Sample Description

Online Annex Table 3.1.1. Data Description and Sources

Variable	Description	Source
Fund variables		
Fund net flow	Fund flow as percentage of fund total net assets of the previous quarter.	Morningstar
Fund return	Fund assets' performance as percentage of fund total net assets of the previous quarter.	Morningstar
Fund cash holdings	Deposit in portfolio base currency that can be withdrawn at any time. Consistent with the literature (Jiang and others, 2022), negative fund cash holdings are set equal to zero and fund cash holdings larger than 20 percent of the fund's total net assets are set equal to 20 percent of the fund's net assets.	Morningstar
Fund cash equivalent holdings	Fund cash and equivalents include cash held in bank accounts as well as certificates of deposit, currency, money market holdings and other high quality fixed income securities with a maturity of less than 92 days. Consistent with the literature (Jiang and others, 2022), negative fund cash and equivalents holdings are set equal to zero and fund cash and equivalents holdings larger than 20 percent of the fund's total net assets are set equal to 20 percent of the fund's net assets.	Morningstar
Swing pricing (dummy variable)	Dummy variable which is equal to one when the fund is domiciled in a country in which the use of swing pricing is permitted by regulators and common across funds, and equal to zero otherwise. In the baseline analysis, Luxembourg and the UK are classified as swing pricing domiciles.	Morningstar
Expense ratio	The 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. The fund's total expense ratio (in percent) is winsorized at the 1st and 99th percentiles.	Morningstar
Portfolio illiquidity	Holding-weighted average bid-ask spread excluding cash.	IMF staff calculation
ETF premium/ discount	Difference between ETF NAV and closing ETF price measured as a percentage of the ETF NAV. Observations are winsorized at the 1st and 99th percentiles.	Morningstar
Total net assets	The fund's total assets under management in USD measured at the end of each quarter.	Morningstar
Security-level variables		
Bid-ask spread	For equities, the spread is based on daily closing prices; for other asset classes, the spread is based on multiple inputs using daily closing bid-ask prices from an exchange, composite bid-ask prices, and Refinitiv's evaluated bid-ask prices.	Refinitiv
Market capitalization	Current market price multiplied by the amount currently in issue	Refinitiv
Return	Total return index. For equities, this shows a theoretical growth in value of a share holding over a specified period, assuming that dividends are re-invested to purchase additional units of an equity or unit trust at the closing price applicable on the ex-dividend date. For fixed income, this is the return on investment, including interest payments, as well as appreciation or depreciation in the price of the bond. Variable is winsorized at 1.5 percent level.	Refinitiv
Fraction MF (ETF) ownership	Fund's holding value of a security divided by the market capitalization of the security	Factset; Refinitiv; IMF staff calculation
Security ratings	S&P long-term local currency ratings for issuer and issue (in the case of fixed income)	Refinitiv
Turnover	The value of all trades for a stock or bond on a particular day	Refinitiv
Age	Age of the equity or fixed income as denoted by date of incorporation or issuance	Refinitiv
Skewness of returns	The skewness of daily or weekly returns over a quarter for a given security	Refinitiv; IMF staff calculation

Price-to-Book ratio	For equities, this is the share price divided by the book value per share	Refinitiv
Volatility	Standard deviation of daily or weekly returns over a quarter	Refinitiv; IMF staff calculation
Security-level swing exposure	The ownership of a given asset by open-end mutual funds that use swing pricing as a percentage of its total mutual fund ownership	Factset; Morningstar; IMF staff calculation
Issuer	Issuing entity of the security	Refinitiv
Coupon rate	This is the annual percentage rate payable on a bond	Refinitiv
Bond maturity	Time to maturity for a bond	Refinitiv; IMF staff calculation
Macro-financial variables		
Change in global liquidity	The BIS global liquidity indicator (GLIs) tracks credit to non-bank borrowers, covering both loans extended by banks and funding from global bond markets through the issuance of international debt securities (IDS). Quarter-over-quarter change of the variable is used in the analysis.	BIS
Commodity price shock	Pure oil price expectation shock as defined in Bauermeister (2021). To filter out the "pure" expectation component market-based surprises are regressed on fundamental oil supply and demand shocks.	Bauermeister (2021)
Domestic monetary policy shocks	Domestic monetary policy shocks are estimated by regressing the policy rate on a set of controls and use the residuals as the identified shocks. The set of controls includes contemporaneous and lagged values of inflation, log U.S. GDP, log foreign GDP, as well as lagged values of the policy rate and a quadratic time trend.	Haver Analytics; IMF staff calculations
Financial condition index (FCI)	The financial condition index is based on a principal component analysis of 11 key price-based variables to capture the price of risk. For methodology and a description of all the variables included in the financial condition index, refer to Online Annex 3.2 of the October 2017 *Global Financial Stability Report*. Alternative indicators are also constructed following the approach in Koop and Korobilis (2014). Positive values of the index indicate tighter-than average financial conditions.	IMF staff estimates
Foreign GDP growth	Average real GDP growth of foreign economies relative to a given domestic economy	Haver; IMF staff calculations
GDP growth	Quarterly real GDP growth	IMF, World Economic Outlook; IMF staff calculations
MPU	Monetary Policy Uncertainty index for the United States obtained from text analysis of newspapers articles.	Husted and others (2020)
VIX	CBOE Volatility Index	Haver Analytics
Source: IMF staff		

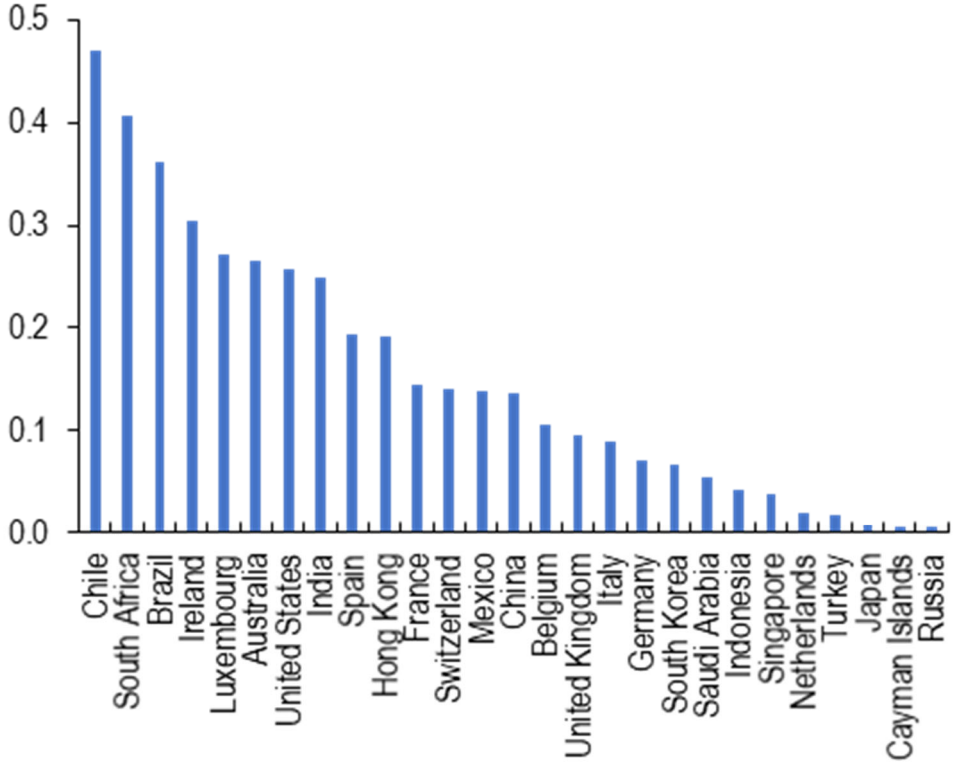
Investment fund sample description

The chapter's analysis relies on data of 17,000 open-end funds sourced from Morningstar with portfolio holdings data from Factset.[1] Of those, about 14,000 were in existence at the beginning of 2021. The sample period extends from 2013:Q4 to 2022:Q2. The OEFs in the sample are domiciled in 43 countries and can be grouped into the following global broad category groups: allocation, alternative, equity, and fixed income. Online Annex Figure 3.1.1 shows the size of open-end funds relative to the non-bank financial intermediation sector by country.

[1] Comprehensive portfolio holdings data is only available starting 2013:Q4.

Online Annex Figure 3.1.1. Total Net Asset Values of Open-End Funds Relative to Non-Bank Financial Intermediation Sector

(Percent)



Sources: FSB (2021); Morningstar; and IMF staff calculations.
Note: nonbank financial intermediation includes all financial institutions that are not central banks, banks, or public financial institutions (FSB 2022). NBFI = nonbank financial intermediation.

Online Annex 3.2 Analysis of Asset-Level Vulnerabilities

Construction of Asset-Level Vulnerability Measure

Following Jiang and others (2022), a measure of asset price vulnerability is calculated in two steps. First, a fund-level illiquidity measure is constructed as a weighted average of bid-ask spreads (illiquidity) of assets held by the fund:

$$Fund\ illiquidity_{j,t} = \frac{\sum_{i=1}^{I} Holding\ amount_{j,i,t} \times Bid-Ask_{i,t}}{\sum_{i=1}^{I} Holding\ amount_{j,i,t}}, \quad (1)$$

where $Holding\ amount_{j,i,t}$ is the market value of asset *i* held by fund *j* in quarter *t*, and $Bid - Ask_{i,t}$ is the bid-ask spread of asset *i* at the end of quarter *t*.[1]

Second, the asset price vulnerability measure is calculated based on the weighted average of investing funds' illiquidity, where the weights represent funds' relative holdings of the asset, as follows:

$$Asset\ level\ Vulnerability_{i,t} = \frac{\sum_{j=1}^{J} Holding\ amount_{j,i,t} \times Fund\ illiquidity_{j,t}}{\sum_{j=1}^{J} Holding\ amount_{j,i,t}}, \quad (2)$$

where $Holding\ amount_{j,i,t}$ is the market value of asset *i* held by fund *j* at the end of quarter *t*, and $Fund\ illiquidity_{j,t}$ is the illiquidity of fund *j* in quarter *t* (defined above).[2]

Effect of Asset-Level Vulnerability on Asset Price Fragility

Next, the chapter analyzes how the asset-level vulnerability measure affects asset-price fragility, measured as future return volatility. The following equation is estimated for each asset class (δ) separately:

$$\sigma^{\delta}{}_{c,i,t+1} = \beta_0^{\delta} + \beta_1^{\delta} Asset\ Level\ Vulnerability^{\delta}{}_{c,i,t} + \beta_2^{\delta} Controls^{\delta}{}_{c,i,t} + \gamma_i^{\delta} + \gamma^{\delta}{}_{c,t} + \varepsilon^{\delta}{}_{c,i,t+1}, \quad (3)$$

where $\sigma_{c,i,t+1}$ is the standard deviation of annualized weekly returns over the next quarter for asset *i* in country *c*, as a percent of the sample median, and $Asset\ Level\ Vulnerability_{c,i,t}$ is the standardized version of the vulnerability measure defined in equation (2). The model includes country-time fixed effects ($\gamma_{c,t}$), which absorb any time-varying country characteristics, and asset fixed effects (γ_i), which absorb any time-invariant asset characteristics. Standard errors are clustered at the quarter and asset levels. Regressions are run for various asset classes that include bonds and equities.[3]

Controls are specific to the asset class. The model for bonds includes the following controls: bid-ask spread, log of market capitalization, weekly returns, mutual fund ownership, time to maturity, and security ratings. The model for equities includes the following controls: bid-ask

[1] The chapter uses Refinitiv bid-ask spreads as the primary measures of asset liquidity. Bid-ask spreads capture transaction costs, inventory costs, and asymmetric information.

[2] There could be concerns about the liquidity of asset *i* and the asset-level vulnerability measure being too closely related—for example, in cases where funds only hold a few assets. The typical fund, however, holds a large number of assets (about 150 on average), which implies that excluding a specific asset from the fund-level vulnerability measure to construct the corresponding asset-level vulnerability measure is unlikely to impact these measures significantly.

[3] The regressions are estimated separately for all bonds, corporate bonds, high-yield corporate bonds, investment-grade corporate bonds, sovereign bonds, high yield sovereign bonds, and investment grade sovereign bonds, as well as for all equities and small cap equities.

spread, log market capitalization, weekly returns, mutual fund ownership, turnover, log age, skewness, mid-price, one-year return, and the price to book ratio.

A range of robustness checks have been performed on the baseline specification by using:

- Alternative definitions of the asset vulnerability measure: asset vulnerabilities from global equity funds only, from fixed-income funds only, from mixed funds only;
- Alternative specifications of fixed effects: country, borrower, time, borrower-time fixed effects, borrower-time and asset fixed effects;
- Alternative specifications of the dependent variable as annualized daily return volatility instead of annualized weekly return volatility;
- Alternative definitions of the asset vulnerability measure based on the definition of the portfolio-level bid-ask spread: using the average spread in the quarter before the portfolio holdings are observed;
- Alternative definitions of the vulnerability measures: including cash holdings when calculating fund-level illiquidity;
- Alternative definition of the vulnerability measures: including only funds that hold a large and diversified portfolio (at least 100 securities per quarter);
- Alternative specifications of controls in the equity and bond regressions, including using lagged volatility in the equity regression models;
- A restricted sample of securities with high mutual fund ownership.

The original conclusions are robust to these changes.

Effect of Asset-Level Vulnerability on Asset Price Fragility in Times of Stress

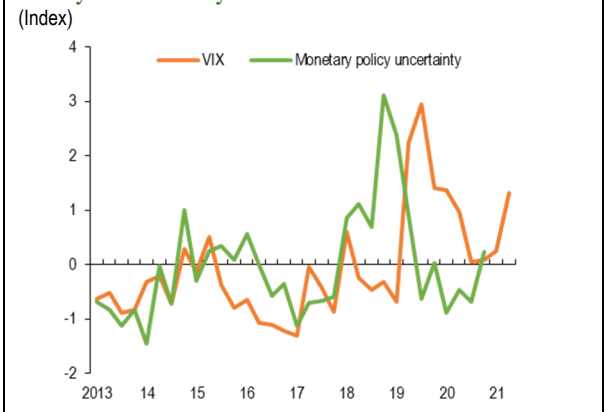
To test whether measures of asset price vulnerability amplify the impact of market stress events on asset price volatility, the following equation is estimated separately for each asset class:

$$\sigma_{i,t+1} = \beta_0 + \beta_1 Stress_t + \beta_2 Asset\ level\ Vulnerability_{i,t} + \beta_3 Stress_t \times Asset\ level\ Vulnerability_{i,t} + \beta_4 Controls_t + \gamma_i + \varepsilon_{i,t+1}, \quad (4)$$

where *i* is an asset and *t* is time (quarter). γ_i indicates asset fixed effects. $Stress_t$ is defined as financial uncertainty (VIX) or uncertainty about monetary policy in the United States. The latter is obtained from textual analysis of newspaper articles in the daily publications of the Washington Post, Wall Street Journal, and New York Times containing the following triple of keywords: (i) "uncertainty" or "uncertain," (ii) "monetary policy(ies)" or "interest rate(s)" or "Federal fund(s) rate" or "Fed fund(s) rate," and (iii) "Federal Reserve" or "the Fed" or "Federal Open Market Committee" or "FOMC" (see Husted and others, 2020).

The VIX spiked driven by market turbulence in March 2020, when uncertainty about the effects of the COVID-19 pandemic was high. Monetary policy uncertainty was elevated in 2019 and has been rising since the end of 2021 (Online Annex Figure 3.2.1). Equation (4) is estimated by asset class using as dependent variable the next-quarter volatility of bond or equity returns relative to the median volatility of returns. The control variables are the same as those used in equation (3). The estimation is based on quarterly data and the sample period extends from 2013:Q4 to 2021:Q4. Standard errors are clustered by both asset and time.

Online Annex Figure 3.2.1. VIX and US Monetary Policy Uncertainty



Sources: Haver Analytics; Husted and others (2020); and IMF staff calculations.
Note: Both stress variables—VIX and monetary policy uncertainty in the United States—are standardized so that the vertical axis indicates the number of standard deviations relative to the mean of the series. The monetary policy uncertainty variable is available until the third quarter of 2021.

A range of robustness checks have been performed by using:

- Alternative specifications of fixed effects: country, industry, country-time, industry-time fixed effects;
- Alternative definitions of the stress variable: defining financial stress as a dummy variable that takes a value of one when the VIX is in the upper decile of its sample distribution;
- Alternative definitions of the asset vulnerability measure: defining an asset as vulnerable if its vulnerability measure is in the upper half or top quartile of the asset vulnerability distribution by asset class and zero otherwise;
- A balanced panel of assets in the regression analysis, starting from 2013:Q4.

The original conclusions are robust to these changes.

Bond Returns During the March 2020 Dash-for-Cash Episode

Figure 3.8 shows the performance of bonds during the March 2020 Dash-for-Cash episode. To better understand if more vulnerable assets performed poorly in this episode relative to less vulnerable assets, the following regression model is estimated using weekly data:

$$Return_{i,t} = \alpha_c + \beta_1 \; Asset\ level\ vulnerability_i + \beta_2\, I_{\_Stress} + \beta_3\, I_{\_Stress}\; x\; Asset\ level\ vulnerability_i \theta \;\; Controls_i + \mu_c + \epsilon_{i.t}, \quad (5)$$

where $Return_{i,t}$ indicates the weekly return of security *i* in time t, $Asset\ level\ Vulnerability$ is the asset-level vulnerability measure defined above and control variables are the same as in equation 3 with the addition of lagged weekly returns. All other control variables are also lagged as of 2019:Q4. The model also includes industry-level (or alternatively country-level) fixed effects. Standard errors are clustered at the asset and week levels. $I_{\_Stress}$ is a dummy variable equal to 1 in the last three weeks of February and first week of March (following Jiang and others, 2022), and zero otherwise. The regression model is estimated using data for the first and second quarters of 2020.

The results show that β_3 is negative and statistically significant across all bond asset classes in, supporting the hypothesis that asset-level vulnerabilities induced by fund illiquidity lead to a decline in asset returns, that is, an increase in asset price fragility, in periods of market stress.

Spillovers of Global Investment Fund Vulnerabilities to Emerging Market Securities Markets

To assess the possible cross-border implications of open-end fund vulnerabilities, a restricted version of equation (3) is estimated for assets issued by firms of EMs and using an asset-vulnerability measure calculated only from funds domiciled in advanced economies.[4] A range of robustness checks similar to those outlined above is performed and the results are robust to these changes.

Herding as an Amplifier of Asset-Level Vulnerabilities

When investors trade simultaneously and in the same direction, their trading behaviors could amplify asset price volatility. Following Cai and others (2019) the herding behavior by open-ended mutual funds in equity and bond markets is examined. Herding is defined by how much the trading pattern of a security varies from the market-wide trading pattern in the same period. In other words, herding is the tendency of funds to trade a given asset together in the same direction (either buy or sell) more often than would be expected if they traded independently. Following Cai et al. (2019), a herding measure of asset *i* in quarter *t* is calculated as follows:

$$HM_{i,t} = |p_{i,t} - E[p_{i,t}]| - E|p_{i,t} - E[p_{i,t}]|, \tag{6}$$

where $p_{i,t}$ is the proportion of buyers among all active traders of asset *i* in quarter *t*,

$$p_{i,t} = \frac{\#\ of\ Buy_{i,t}}{\#\ of\ Buy_{i,t} + \#\ of\ Sell_{i,t}}, \tag{7}$$

and the term $E[p_{i,t}]$ is the expected level of buying intensity of asset *i*, which is estimated from the market-wide intensity of buying denoted as $\bar{p}_t$:

$$\bar{p}_t = \frac{\sum_{i=1}^{I} \#\ of\ Buy_{i,t}}{\sum_{i=1}^{I} \#\ of\ Buy_{i,t} + \sum_{i=1}^{I} \#\ of\ Sell_{i,t}}. \tag{8}$$

Since the first term of equation (5) is always greater than zero, the second term is added as an adjustment factor so that the expected value of the herding measure, $HM_{i,t}$, is zero under the null hypothesis of no herding. Under this hypothesis, funds' decisions to buy or sell assets in each quarter are made independently.[5]

The chapter also distinguishes between a buy herding measure (*BHM*) for assets with higher proportion of buyers than the market average, and a sell herding (*SHM*) for assets with a lower proportion of buyers than the market average, which are defined as follows:

$$BHM_{i,t} = HM_{i,t} | p_{i,t} > E[p_{i,t}], \tag{9}$$

[4] EMs are 53 economies included in the IMF's Vulnerability Exercise for Emerging Market Economies.

[5] In other words, under the null hypothesis, all assets are sold or bought with the same probability in a given quarter, meaning $\#\ of\ Buy_{i,t}$ follows a binomial distribution with parameter $n = \#\ of\ Buy_{i,t} + \#\ of\ Sell_{i,t}$ and $p = E[p_{i,t}]$.

$$SHM_{i,t} = HM_{i,t} | p_{i,t} < E[p_{i,t}] . \quad (10)$$

To test whether herding behavior amplifies the impact of asset-level vulnerability on asset price volatility, the following panel regression is estimated:

$$\sigma_{i,t+1} = \beta_0 + \beta_1 Herding_{i,t+1} + \beta_2 Asset\ level\ Vulnerability_{i,t} + \beta_3 Herding_{i,t+1} \times Asset\ level\ Vulnerability_{i,t} + \beta_4 Controls_{i,t} + \gamma_i + \gamma_{c,t} + \varepsilon_{i,t+1}, \quad (11)$$

where $\sigma_{i,t+1}$ is the asset return volatility (standardized relative to its median), and $Herding_{i,t+1}$ is one of the herding measures described above. Controls include the average bid-ask spread, log of bond issue size, bond rating, the share of mutual fund ownership, and maturity when analyzing bonds. The model includes security-level and country-time fixed effects. Standard errors are clustered by both security and time.

The Aggregate Effect of Vulnerability on Financial Conditions

Aggregate (country-level) vulnerability measures are calculated from the asset-level vulnerability measures specified in equations (2). To study whether aggregate vulnerabilities affect country-specific financial conditions, the following panel quantile regression is estimated:

$$Financial\ Conditions_{c,t+1}^{[\tau]} = \alpha_c^{[\tau]} + \beta^{[\tau]}\ Aggregate\ Vulnerability_{c,t} + \theta^{[\tau]} Controls_{c,t} + \epsilon_{c.t+1}^{[\tau]}, \quad (12)$$

where $Financial\ Conditions_{c,t+1}^{[\tau]}$ denotes the τ quantile of the financial conditions index in country *c* at time *t+1*.[6] $Controls_{c,t}$ includes the following macro-financial and external factors: domestic and US monetary policy shocks, domestic GDP growth, foreign GDP growth (averaged across foreign countries), change in global liquidity conditions, and commodity price shocks.[7] A country's aggregate vulnerability is calculated as the weighted average of asset-level vulnerabilities across all assets issued domestically, with weights representing the relative market values of the assets. Results are also reported for aggregate vulnerability measures based on asset classes. The model includes country fixed effects and coefficients that are common across countries but estimated for different quantiles (τ) of the financial conditions index.

Robustness checks have been performed to evaluate the effects of:

- Including autoregressive terms of both the dependent and independent variables;
- Including time fixed effects instead of time-varying global common factors (such as US monetary policy rate and changes in global liquidity conditions);
- Constructing alternative financial conditions indices based on a factor model with time-varying parameters that includes a broader set of macro-financial variables (as in Koop and Korobilis 2014);

[6] The financial conditions index is based on a principal component analysis of 11 price-based variables. It captures the price of risk (see Online Annex 1.1 of the October 2018 GFSR) and a larger value of the index indicates tighter financial conditions.

[7] Domestic monetary policy shocks are estimated by regressing the policy rate on a set of controls, and use the residuals as the identified shocks. The set of controls includes contemporaneous and lagged values of inflation, log U.S. GDP, log foreign GDP, as well as lagged values of the policy rate and a quadratic time trend. Commodity price shocks correspond to pure oil price expectation shocks, as defined in Bauermeister (2021). To filter out the "pure" expectation component, market-based surprises are regressed on fundamental oil supply and demand shocks.

- Using alternative asset-level vulnerability measures based on: (i) alternative aggregation of the portfolio-level bid-ask spread; (ii) more granular breakdown of asset classes; (iii) simple instead of weighted averaging across securities.

The results are broadly robust to these alternative specifications.

To examine whether fund vulnerabilities in advanced economies influence financial conditions in EMs, a modified version of equation (11) is estimated as follows:

$$Financial\ Conditions_{c,t+1}^{EM} = \alpha_c + \beta \quad Foreign\ Aggregate\ Vulnerability_{c,t}^{AE} + \theta \quad Controls_{c,t} + \epsilon_{c.t+1}, \tag{13}$$

where $Financial\ Conditions_{c,t+1}^{EM}$ denotes the financial conditions index of an emerging market economy *c*. $Foreign\ Aggregate\ Vulnerability_{c,t}^{AE}$ is the average asset-level vulnerability from funds located in advanced economies that hold assets in the emerging market economy *c*.

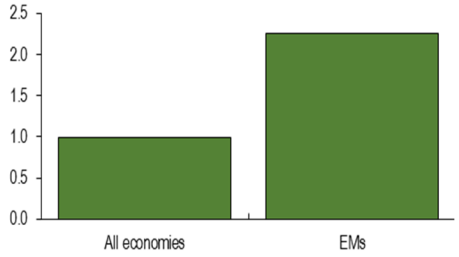
Online Annex Figure 3.2.2 shows the magnitude of the spillover effects in emerging markets compared to that estimated for all the economies.

Online Annex Figure 3.2.2 Spillovers from asset level vulnerabilities to financial conditions

Fund vulnerabilities imply larger negative cross-border spillovers for EMs than for other economies

Cross-border Spillover Effects from Fund Vulnerabilities in Advanced Economies to Financial Conditions in EMs vs. All Economies

(Index)



Sources: Bloomberg L.P., FactSet, Haver; Morningstar, and IMF staff calculations.
Note: The results from country-level panel regressions with fixed effects in which domestic financial conditions index in period t+1 is regressed on asset-level vulnerabilities averaged at the issuer country-level in period t are shown. The spillover analysis is performed by substituting domestic fund vulnerabilities with a measure capturing foreign fund vulnerabilities, which is computed as the average asset-level vulnerability from holdings of funds domiciled in advanced economies. Panel 4 compares the magnitude of the spillover effects in EMs with that estimated for all the economies. Solid dots and full bars indicate statistical significance at 10 percent or lower.

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Online Annex 3.3 Mechanisms Through Which Investment Fund Vulnerabilities Affect Asset Price Fragility

Due to strategic complementariness among investors, funds exposed to liquidity mismatches may experience more severe outflows in periods of stress (Chen and others, 2010; Goldstein and others, 2017). Funds that face outflows create selling pressures in securities markets. More illiquid funds are more likely to experience large outflows and contribute to selling pressures that can temporarily depress asset prices.

To understand these mechanisms, the chapter performs the following analyses:

Examine whether vulnerable funds—those holding relatively illiquid assets—tend to experience more extreme outflows in periods of stress. This mechanism is examined by estimating the following panel (fund-level) regression:

$$Y_{j,t} = \beta_1 Fund\ illiquidity_{j,t} + \beta_2 Stress_t \times Fund\ illiquidity_{j,t} + \beta_3 Controls_{j,t} + \mu_{c,t} + \gamma_j + \varepsilon_{i,t+1}, \quad (1)$$

where $Y_{i,t}$ denotes the outflows from fund *j* in period *t*—the negative fund flows (with sign inverted) expressed as a percentage of the fund's size. $Fund\ illiquidity_{j,t}$ is the fund-level illiquidity measure defined in equation (1) of Online Annex 3.2. $Controls_{j,t}$ includes fund size, fund age, and past fund's returns.[1] γ_j are fund fixed effects and $\mu_{c,t}$ are country-time-fixed effects. $Stress_t$ is an indicator variable that takes the value 1 when the VIX Index is above a given percentile of its sample distribution; results are presented for the percentiles 50, 55, …, 95 to examine the presence of amplification effects of fund illiquidity on fund outflows in periods of stress. The coefficients of interest are β_1 and β_2. If illiquid funds face larger outflows in time of stress, the sum of β_1 and β_2 is expected to be positive and increasing in the level of stress (i.e. higher when the stress dummies are defined using higher percentiles of the VIX sample distribution).

Examine the relation between asset-level vulnerabilities and selling pressures. Following Jiang and others (2022), selling pressure is computed as follows:

$$Selling\ Pressure_{i,t} = \frac{\sum_{j=1}^{J}(Sell\ Amt_{j,i,t}|Flow_{j,t}<25^{th}Pctl - Buy\ Amt_{j,i,t}|Flow_{j,t}>75^{th}Pctl)}{Amount\ Outstanding_{i,t}}. \quad (2)$$

$Sell\ Amt_{j,i,t}$ is the par amount of security *i* sold by fund *j* in quarter *t* (equal to zero if there is no selling). $Buy\ Amt_{j,i,t}$ is the par amount of security *i* purchased by fund *j* in quarter *t* (equal to zero if there's no buying). $Flow_{j,t}$ is the quarterly percentage flow of fund *j* in quarter *t*, adjusted for fund returns. $Amount\ Outstanding_{i,t}$ is the outstanding amount of security *i*. Intuitively, selling pressure captures the difference between sales and purchases of bonds by investment funds that experience extreme outflows or inflows. A large value indicates strong selling pressure.

The following quarterly regression on asset-vulnerability measures is performed:

[1] Results are robust to including fund's past returns as a control.

$$Selling\ Pressure_{i,j,t} = \beta_0 + \beta_1 Asset\_Level\ Vulnerability_{i,t} + \beta_2 Controls_{i,j,t} + \mu_{c,t} + \gamma_i + \varepsilon_{i,j,t}, \quad (3)$$

where $Controls_t$ include fund size (log), investment fund ownership percentage, issuer rating, average bid-ask spread and past volatility. The model controls also for country-time fixed effects ($\mu_{c,t}$) and asset fixed effects (γ_i). The coefficient of interest is β_1. If assets exposed to vulnerable funds face stronger selling pressures the coefficients of β_1 should be positive.

Examine the sensitivity of asset liquidations to pecking order and fund outflows. A pecking order of liquidation followed by funds would imply a higher sensitivity of asset liquidations to fund outflows of assets that are more liquid relative to the other assets in a fund's portfolio. To test this, the following model is estimated:

$$Y_{i,j,t} = \lambda_0 Ouflows_j + \lambda_1 Outflows_j\ x\ Pecking\ Order_{i,j} + \mu_t + \gamma_j + \alpha_i + \epsilon_{i,j,t}, \quad (4)$$

where $Y_{i,j,t}$ corresponds to the percentage change of shares of security *i* sold by fund *j* at time *t*. Pecking order corresponds to the liquidation rank of security *i* in fund *j* computed as the share of other assets held by the same fund that are less liquid:[2]

$$Liquidation\ rank_{i,j} = \sum_{g(i')} Share_{g(i'),j}\, x\, 1\left[Liquidity\ group_{g(i)} > Liquidity\ group_{g(i')}\right] + \frac{1}{2} Share_{g(i),j}, \quad (5)$$

where $Share_{g(i'),j}$ is the share of asset *j* in the liquidity group $g(i')$ of fund *j*.

Beyond potential confounding factors due to comoving macroeconomic variables, there is a risk that the security-level comparison of prices and liquidations washes out the price impact that is common across securities. To address such concerns, the analysis in equation (4) focuses on the COVID-19 crisis event when large sell-offs by investment funds were more likely to have impacted asset prices beyond what can be explained by fundamentals (Falato and others, 2021b; Jiang and others, 2022; Ma and others, 2022). Results from this analysis are reported in Figure 12 (panel 3). If a pecking order of liquidation is followed, the coefficients λ_0 and λ_1 should be positive.

Examine whether selling pressure has an impact on asset prices. First, as large outflows could be triggered by a deterioration in fundamentals, a measure of selling pressure is constructed taking into account the differential selling pressure of outflows on assets that are higher up in the liquidation rank of a given fund. Following Ma and others (2022), this liquidity-adjusted selling pressure measure is computed as follows:

$$Liquidation\_Adjusted\ \ Selling\ Pressure_{i,t} = \sum_j Fund\ outflow_{j,t}\ x\ \left(\hat{\lambda}_0 + \hat{\lambda}_1 Liquidation\ rank_{i,j}\right) x\ \frac{Holding_{i,j,t-1}}{\sum_k Holding_{i,k,t-1}} \quad (6)$$

where $\hat{\lambda}_0$ and $\hat{\lambda}_1$ are coefficients estimated from equation (4). This approach provides a more accurate measurement of the price impact of funds' asset flows since asset liquidations are

[2] To calculate the liquidation rank, funds' securities are separated into "liquidity groups" based on their level of liquidity in the sample distribution for each quarter. Asset liquidity is measured using the bid-ask spreads of the securities.

empirically estimated based not only on outflows but also take into account funds' liquidation policies, therefor reducing reverse causality concerns.

The analysis then evaluates whether the sell-off pressure measures lead to asset price pressure using the following model:

$$Abreturn_{i,t+1} = \beta_0 + \beta_1 Liquidation\_Adjusted\ Selling\ Pressure_{i,t} + \beta_2 Controls_{i,t} + \mu_i + \theta_c + \varepsilon_{i,t+1} \quad (7)$$

where $Abreturn_{i,t+1}$ is the difference between the quarterly return and the size-weighted average return of a pool of comparable securities. Controls include turnover, credit rating, amount outstanding, maturity, issuer volatility, maturity, and country fixed effects (μ_i and θ_c, respectively).[3] The model is estimated separately for each asset class. As above, the analysis focuses on the COVID-19 episode to empirically identify how fund liquidity transformation can amplify the effect of fund outflows triggered by a deterioration in fundamentals.

For robustness, the analysis in iii. and iv. is performed using ratings as an alternative measure of asset liquidity to define liquidity groups. In addition, the analysis is performed also on the full data sample (2010:Q1-2021:Q4) while controlling for differences in the sensitivity of asset liquidations to pecking order and fund outflows across time depending on the level of VIX. The results from these alternative specifications are broadly in line with the results from the baseline specifications.

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[3] For bonds, maturity fixed effects are constructed using the maturity at issuance of the securities. Maturity is discretized in seven groups with 5 years interval. The last group corresponds to securities with a maturity greater than 30 years.

Online Annex 3.4 Analysis of Liquidity Management Tools

Swing Pricing

To analyze the effect of swing pricing on fund induced asset price fragility, the following regression specification is estimated:

$$\sigma_{i,t+1} = \beta_0 + \beta_1\, Asset\_level\, Vulnerability_{i,t} + \beta_2\, Swing\_exposure_{i,t} + \beta_3\, Swing\_exposure_{i,t} \times Asset\_level\, Vulnerability_{i,t} + \beta_4\, bid - ask_{i,t} + \beta_5 Controls_{i,t} + \gamma_i + \mu_{i,t} + \varepsilon_{i,t+1}, \quad (1)$$

where, $Swing\_exposure_{i,t}$ is the ownership of a given asset *i* by open-end mutual funds that use swing pricing as a percentage of its total mutual fund ownership. γ_i is an asset fixed effect. $\mu_{i,t}$ denotes country-time fixed effects. For fixed income securities controls include log size, the lagged return, log time to maturity of the bond, issue ratings, lagged price volatility, and fund ownership. In the baseline specification, $Swing\_exposure_{i,t}$ is defined at the security level, as follows:

$$Swing\_exposure_{i,t} = \frac{\sum_{j=1}^{J} Holding\ amount_{j,i,t} \times I_j^{Swing\ country}}{\sum_{j=1}^{J} Holding\ amount_{j,i,t}}, \quad (2)$$

where $I_j^{Swing\ country}$ is a dummy variable that takes the value one if fund *j* is domiciled in a country in which the use of swing pricing by open-ended mutual funds is common, and zero otherwise. In the baseline specification, $Swing\ country = \{Luxembourg, UK\}$.

The following robustness checks have been performed:

- Using alternative definitions of the set of swing countries;
- Including time-varying global stress indicators (such as the VIX index) instead of time fixed effects;
- Using different sets of control variables.

The results are broadly robust to these alternative specifications.

The Role of Cash Buffers

To understand how funds use cash buffers to manage investor redemptions, the chapter estimates the following fund-level regression specification based on Jiang and others (2020):

$$\Delta Cash\ equiv_{j,t} = \beta_0 + \beta_1\, Net\ inflow_{j,t} + \beta_2\, Net\ inflow_{j,t} \times Stress_t + \beta_3\, Net\ outflow_{j,t} + \beta_4\, Net\ outflow_{j,t} \times Stress_t + \beta_5 Controls_{j,t} + \gamma_j + \varepsilon_{i,t+1}, \quad (4)$$

where $\Delta Cash\ equiv_{j,t} = (Cash\ equiv_{j,t} - Cash\ equiv_{j,t-1})/Cash\ equiv_{j,t-1}$ is the percentage change in fund *j*'s holdings of cash and equivalents in quarter *t*.[1] Controls include log fund size, quarterly returns, expense ratio and portfolio illiquidity, all in lags. Portfolio illiquidity is measured as the average bid-ask spreads of securities excluding cash equivalents held by the fund. The results are robust to changes in specification that focus only on specific fund types (e.g., bond or equity funds).

[1] All variables are measured at the fund portfolio level, except the expense ratio which is based on the oldest share class.

Exchange-Traded Funds

In periods of stress, assets with higher ETF ownership may be less fragile than those that are mostly owned by open-end mutual funds.[2] To test this hypothesis, the chapter examines how fragility is affected by open-end fund and ETF ownership in both tranquil and stress times. The regression analysis is carried out using the following specification:

$$\sigma_{i,t+1} = \beta_0 + \beta_1 MF\_own_{i,t} + \beta_2 ETF\_own_{i,t} + \beta_3 MF\_own_{i,t} \times Stress_t + \beta_4 ETF\_own_{i,t} \times Stress_t + \beta_5 bid-ask_{i,t} + \beta_6 Controls_{i,t} + \gamma_i + \varepsilon_{i,t+1}, \quad (5)$$

where $MF\_own_{i,t}$ and $ETF\_own_{i,t}$ denote the percentage ownerships of asset *i* at time *t* corresponding to open-end mutual funds and ETFs, respectively. These are calculated at the security level as follows:

$$ETF\_own_{i,t} = \frac{\sum_{j=1}^{J} Holding\ amount_{j,i,t} \times I_j^{ETF}}{Market\ Cap_{i,t}} \quad (6)$$

$$MF\_own_{i,t} = \frac{\sum_{j=1}^{J} Holding\ amount_{j,i,t} \times I_j^{OEF}}{Market\ Cap_{i,t}} \quad (7)$$

A key concern with this specification is that ETFs and open-end mutual funds could endogenously self-select into assets with different and unobservable levels of fragility. The chapter addresses such endogeneity issues by exploiting variation in ownership bases across nearly identical bonds (i.e., by matching different corporate bonds held by ETFs and open-ended mutual funds, while holding constant fund issuer, maturity, and coupon rate). In addition, all regressions control for various security-specific illiquidity proxies, including bid-ask spreads.

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[2] While open-ended mutual funds are redeemable directly from the fund company at the fund net asset value (NAV), ETFs are traded on the secondary market at the prevailing market price. As a result, ETFs are not subject to the same first-mover advantage that gives rise to run risks in, and fire sales by, open-ended mutual funds. In contrast, to ensure that the secondary market price of ETFs remains close to the fund NAV, ETFs have a built-in arbitrage mechanism that functions through so-called authorized participants (APs). APs are often large broker-dealers that have exclusive rights to create and redeem ETF shares directly with the fund sponsor in exchange for a basket of portfolio securities in primary markets. Thus, even though ETFs are not subject to first-mover advantages and run risks, there exists evidence that APs' arbitrage activities also lead to increased volatility of security prices (see Ben-David and others, 2018). The differential impact of open-ended mutual funds and ETFs on security price volatility is an empirical question addressed by this chapter.