MSCI

RESEARCH INSIGHT

Report for the Norwegian Ministry of Finance

On the global market portfolio, private-equity markets and Chinese public-equity markets

April 2024

Keith Crouch
Executive Director, MSCI Research

Yang Liu
Executive Director, MSCI Research

Luis O'Shea
Executive Director, MSCI Research

Monika Szikszai
Vice President, MSCI Research

Thomas Verbraken
Executive Director, MSCI Research

Zhen Wei
Managing Director, MSCI Research

Wei Xu
Executive Director, MSCI Research

The authors thank Jacob Escobar, Aayush Maheshwari, Dora Pribeli, Will Robson, Oleg Ruban, Lev Soynov, Andy Sparks and Raman Aylur Subramanian for their contributions to this report.

Note: *This research study was commissioned by the Norwegian Ministry of Finance. The analysis in this study is based on historical data and simulations and should not be taken as an indication or guarantee of any future performance or actual portfolio or fund performance. Past performance does not guarantee future results. Additionally, none of the analysis or observations or conclusions in this study constitutes, or is intended to constitute, investment advice or a recommendation to invest in any particular financial product or fund or to adopt any particular investment strategy or asset allocation. You cannot invest in an index. MSCI does not issue, sponsor, endorse, market, offer, review or otherwise express any opinion regarding any investment or financial product, including with respect to any investment or financial product that may be based on or linked to the performance of any MSCI index.*

Contents

Executive summary

In Section I of this paper, we describe the evolution of the global market portfolio, a theoretical portfolio that includes investment assets worldwide, weighted according to their market values. We estimated the size and breakdown of the full global market portfolio. In addition, we sized the investable global market portfolio, accessible to international investors. We covered asset classes such as public equity, public fixed income, private capital, real estate and infrastructure. In Sections II and III we zoom in on two sub-categories of the global market portfolio: private-equity markets and Chinese public-equity markets, respectively. We discuss the main characteristics of those markets through our equity and private-capital solutions.

Global market portfolio

The full global market portfolio had a market capitalization of USD 247 trillion, while the investable global market portfolio, which excludes investments that are not easily accessible to institutional investors, had a market capitalization of USD 192 trillion as of December 2022 (see Exhibit 1). The investable global market portfolio expanded by USD 61 trillion or 6.6% annually since 2015.

	Full global market portfolio		*Free-float-adjusted*	
	Market cap (in USD trillions)	Relative size (in %)	Market cap (in USD trillions)	Relative size (in %)
Total	*246.7*	*100.0%*	*191.9*	*100%*
Fixed income	*130.9*	*53.1%*	*105.4*	*55%*
Public equity	*93.8*	*38.0%*	*64.5*	*34%*
Private real estate	*8.5*	*3.4%*	*8.5*	*4%*
Listed real estate	*4.8*	*2.0%*	*4.8*	*3%*
Private equity	*3.7*	*1.5%*	*3.7*	*2%*
Listed infrastructure	*3.3*	*1.3%*	*3.3*	*2%*
Private debt	*1.0*	*0.4%*	*1.0*	*1%*
Unlisted infrastructure	*0.6*	*0.2%*	*0.6*	*0%*

Exhibit 1: Market size of the full and investable global market portfolios (in USD trillions and relative weights of the asset classes). As of Dec. 31, 2022. Source: Bank for International Settlements, MSCI

The largest asset class in both the full and investable global market portfolios was fixed income, accounting for more than half of the total market capitalization. Public equity was the second largest asset class, with a share of 34% in the investable global market portfolio. Real estate, infrastructure, and private equity each formed less than 10% of the global market portfolio, but they exhibited faster growth compared to other asset classes over the past seven years, leading up to 2022.

As of 2022, the dominant region in both the public-equity and fixed-income markets was the U.S., with a free-float-adjusted market capitalization of USD 36 trillion and USD 45 trillion, respectively. The U.S. also had the largest private-equity market, with a gross valuation of USD 2.3 trillion. China emerged as the fastest-growing public-equity market over the span of the seven years leading up to 2022, becoming the second-largest market with a market capitalization of USD 4.9 trillion. Its fixed-income market was the third-largest.

The regional breakdown of the global market portfolio did not necessarily reflect the relative importance of economies. For instance, while contributing significantly to global GDP and global public-equity-market revenues, China's stock market was comparatively small, particularly in terms of free-float-adjusted market capitalization (7% of the global equity markets as of 2022). In contrast,

the U.S. exhibited the highest stock-market-capitalization-to-GDP ratio and the debt-to-GDP ratio compared to other regions.

Asset allocations deviated from the global market portfolio's weights and varied across different groups of investors depending on their investment horizon, risk tolerance, liabilities and preferences. Among asset owners, sovereign wealth funds had the largest allocation to public equities and alternatives while pension funds had a relatively larger allocation to fixed income and relatively lower allocations to public equities and alternatives (The Thinking Ahead Institute 2023).

Private-equity markets

As shown in Exhibit 2, private-equity markets' gross valuation has increased by about 150% over the past five years leading up to December 2022, reaching approximately USD 4 trillion, whereas in comparison, public equities' market capitalization during this period grew by about 20%. Compared to public-equity markets, the sector allocation in private-equity markets tilted toward information technology, health care, industrials and consumer discretionary, while underweighting other sectors. An analysis of holding periods, which increased for buyout and venture-capital funds, showed that more of the private companies' life — and potential value creation — is happening within private-equity funds. This may be a consideration for investors who want to be exposed to the broadest opportunity set possible. Furthermore, our analysis of the historical performance of private- relative to public-equity markets showed that buyout and to a lesser extent venture-capital funds showed outperformance across many vintages.

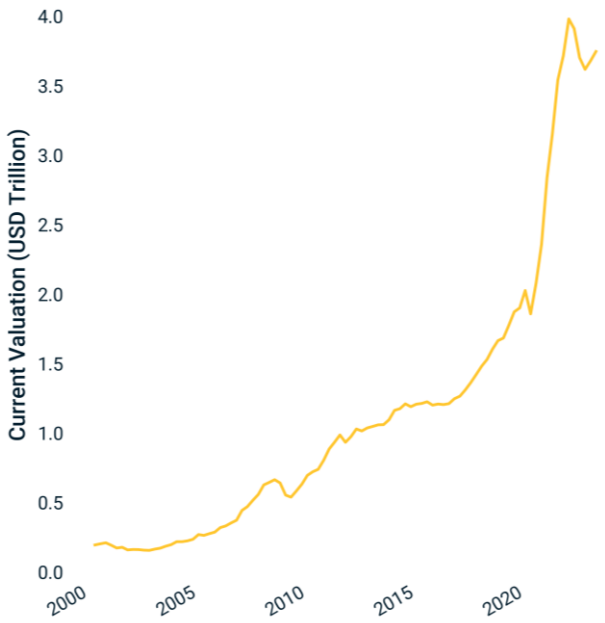


Exhibit 2: Current gross valuation as of each quarter end date back to March 31, 2000, for all private-equity funds (including venture-capital, buyout and other strategies).

The nature of private-equity investments, however, also gives rise to a perhaps more complex set of risks than public markets. Market risk is more difficult to estimate because of the lower transparency and the lagged nature of private-equity valuations. We used our risk model to

disentangle a private-equity portfolio's exposure to and correlation with public-equity markets, as well as its pure private-return component, a potential source of diversification. A stylized example illustrated how the risk of an allocation to public equities and bonds changed when adding private equity into the allocation mix. While the tracking error tended to increase with growing allocation to private equity, the total risk went up at a slower pace (and even remained relatively stable for a private-equity allocation up to 5%). This underscores the importance of assessing private equity and total portfolio risk with a variety of metrics beyond the tracking error.

In addition to market risk, private-equity investments are exposed to funding risk and related liquidity risk. The former implies that the general partner (GP) of the funds in the portfolio may call more capital than expected in some periods of time. Empirical data shows that capital calls and distributions show some cyclicality, and net cash flows (distributions minus contributions) have historically turned negative during times of market stress. This in turn may create liquidity risk, as assets may need to be sold to fund the capital calls at times when market liquidity is depressed. Finally, the unpredictability of capital calls and distributions may lead to a pacing (or allocation) risk as the investor may not be able to maintain the particular target allocation for their portfolio.

Besides the complexities related to managing risk in private equity, performance measurement also has its challenges. We discuss the advantages and disadvantages of different performance metrics, such as internal rate of return, multiple of invested capital, public-market equivalent and direct alpha. In addition, for a well-diversified investor we discuss the importance of pooled performance measures for portfolio-level questions. Especially when measuring performance relative to public-equity markets, we recommend using a framework that adjusts for leverage, beta and fees. Given the uncertainty around betas and valuations, it is a good practice to assess the sensitivity of performance to these parameters. Additionally, performance attribution can be a useful tool for understanding how each decision in the investment process impacts the performance of a private-equity portfolio.

Chinese public-equity markets

China's equity ecosystem has become more sophisticated in recent years, marked by increased participation from institutional and foreign investors. The China ETF market has grown significantly, with assets under management reaching USD 285 billion by the end of 2023, up from USD 57 billion in 2017. There has also been an expansion in equity derivatives like index futures and options, along with fintech developments enhancing online trading and digital wealth management.

Meanwhile, Chinese equities still have a modest global-market presence relative to the country's economic size and potential due to some remaining market-accessibility issues and reporting requirements for capital repatriation.[1] Retail investors have historically dominated the market for China A shares, though institutional and international investors are gaining influence. For instance, individual investors' trading volume has decreased from over 85% in 2016 to about 60% by mid-2022, with institutional and foreign investors now holding nearly 23% of A shares' market value.

The inclusion of China A shares in major global equity indexes and the expansion of Stock Connect programs have integrated this market more into the global scene. China A shares still show low

[1] "MSCI Global Market Accessibility Review," June 2023.

correlation with other global markets, however, partly due to unique policy and economic factors in China. Government regulations and state interventions also significantly influence stock prices.

China A shares' different size segments showed distinctive characteristics. Small caps have outperformed large and mid-caps in the long term and absorbed more trading activities, as they are more exposed to high-growth, high-tech industries that are essential to China's economic reform agenda. The large- and mega-cap segment of China A shares demonstrated a relatively low historical return dispersion compared to small caps and was considered as core China onshore exposures for long-term institutional investors.

Comparing onshore and offshore markets, the onshore China A equity market offers a more diverse sector composition, performing slightly better than the offshore market in the long term, from November 2008 to September 2023. A combined China-equity opportunity set represented by the MSCI China Index, including both onshore and offshore equities, provided diversified exposure to the Chinese economy and has outperformed the individual markets (see Exhibit 3).

Key metrics[2]	China onshore	China offshore	MSCI China Index	MSCI EM Index	MSCI ACWI Index
Total return* (%)	5.6	5.4	5.7	7.0	10.4
Total risk (%)	25.1	24.4	23.4	19.2	15.7
Return/risk	0.22	0.22	0.24	0.36	0.66
Sharpe ratio	0.19	0.19	0.21	0.32	0.61
Price to book* **	2.0	1.8	1.7	1.7	2.1
Price to earnings* **	15.3	13.5	12.8	13.6	17.5
Dividend yield* (%)**	1.9	2.1	2.4	2.7	2.5

*Exhibit 3: Period: Nov. 28, 2008, to Sept. 29, 2023. * Gross returns annualized in USD *** Monthly averages*

In allocating to Chinese equities, institutional investors may often choose between what can be termed "integrated" and "dedicated" approaches based on their outlook, experience and resources. The integrated approach is aligned with broad benchmarks, maintaining existing investment processes, while the dedicated approach proposes flexibility, often with a focus on China or China A shares. There are different approaches for determining the appropriate size of a dedicated China program, ranging from simple market-cap weights to other indicators such as economic growth, trade levels, currency internationalization and quantitative models.

Investment implementation varies, with options like direct stock purchases, indirect investments through funds and passive or active strategies. Such execution choices are often dictated by an institution's investment objectives, risk appetite and resources, with recent trends favoring index-based strategies. Institutions have increasingly adopted a diversified approach, blending different investment styles and internal or external management to align with their goals and the evolving dynamics of the Chinese equity market.

[2] China's onshore and offshore equity markets are measured by the MSCI China A index and the MSCI China ex A index. Integrated China is represented by the MSCI China Index. Prior to China A inclusion in June 2018, the MSCI China ex A Index and the MSCI China Index were exactly the same.

Section I: Global market portfolio

Introduction

This section analyzes the composition and historical evolution of the global market portfolio since 2006. The global market portfolio represents a theoretical portfolio that includes assets worldwide, weighted according to their market values. Our estimate of the global market portfolio encompasses investment opportunities such as stocks, bonds and private assets. We also provide an estimate of the *investable* global market portfolio, which excludes investments that are not easily accessible to institutional investors.

The global market portfolio is shaped by both the demand for and supply of capital. On one hand, investors' preferences and constraints influence the composition of the global market portfolio. The asset-class weights reflect the collective investment decisions made by investors based on their risk appetite, return expectations and market outlook. On the supply side, governments, corporations and other entities play a crucial role by issuing securities to raise funds. The global market portfolio is constantly evolving as investors reassess their investment strategies and new securities enter the market. Market events, economic conditions and changes in regulations can significantly impact the global market portfolio's composition.

The global market portfolio is the aggregate portfolio of all investors globally and represents their views in terms of asset-class pricing. Sharpe (2010) argued that the global market portfolio reveals important information for asset allocation; and, more generally, the global market portfolio represents the opportunity set available to institutional investors. However, a previous study (Doeswijk, Lam and Swinkels 2014) showed that asset allocations vary across different groups of investors. Based on a recent study by the Thinking Ahead Institute, the average allocation to public equities and alternatives tends to be higher for sovereign wealth funds (46.6% and 30.6%) than for pension funds (39.6% and 24%) (The Thinking Ahead Institute 2023). While the market portfolio might be the right portfolio for the average, or representative investor, it is not necessarily the right portfolio for all investors. The weights in the global market portfolio may not represent the optimal diversified exposure for an investor because of the presence (or lack) of liabilities, the properties of an investor’s income stream or because there are factor risks that command a return premium (in addition to the market premium), which the investor has a comparative advantage in harvesting.

In what follows, we will first discuss the composition of the global market portfolio, including a discussion of the assumptions made in the estimation. Next, we will look at how the composition changed through time. In a third section, we will assess how representative equity and fixed-income markets are in terms of regional breakdown, when compared to regional differences in economic importance. Finally, we briefly discuss trends in the asset allocation of major investor types.

Composition of the global market portfolio

We focused our analysis on capital assets — i.e., assets that are an “ongoing source of something of value” (such as stocks) and provide an infinite stream of income (Greer 1997). Consumable and store-of-value assets are excluded from our estimate of the global market portfolio. In terms of asset classes, we covered public equity, public fixed income, listed and unlisted real estate and infrastructure and private equity and debt. The analysis is limited to investments within the focus of institutional investors; for example, small businesses and private housing are excluded from our

estimation. We also excluded commodities from our estimate of the global market portfolio, as they are generally not considered a capital asset. However, gold plays a significant role, with the physical financial gold market being sized around USD 5 trillion[3] and an additional USD 1 trillion of open interest in gold derivatives, according to the World Gold Council's estimate (World Gold Council 2023). They estimate the gold held by investors, excluding central banks' reserve holdings, accounts for 1% of their estimate of the global market portfolio.

Achieving a portfolio that perfectly replicates the global market portfolio might be practically challenging due to various factors such as limited investability, liquidity constraints or regulatory restrictions. The investable global market portfolio refers to a subset of the global market portfolio that is realistically accessible and investable for institutional investors. We refer to the *full* and *investable* global market portfolio to distinguish between these two concepts for public equities and public fixed income.

Exhibit 4 shows the size and composition of the full global market portfolio (USD 247 trillion), as well as its breakdown by asset classes, as of December 2022. Fixed income accounted for 53.1% of the total market capitalization, while public equity had a share of 38.0%. Real estate, infrastructure and private equity respectively formed 5.4%, 1.6% and 1.5% of the full global market portfolio. When incorporating the free-float adjustment for public equities and excluding central-bank holdings from fixed income, the size of the global market portfolio decreased to USD 191.9 trillion, as shown in Exhibit 4. Compared to our previous analysis in 2016 (Gupta, et al. 2016), fixed income was still the largest segment of the investable global market portfolio (54.9%), followed by public equity (33.6%). Real estate, infrastructure and private equity respectively accounted for 7.0%, 2.0% and 1.9%. The evolution of the market capitalization of the full and investable global market portfolio is shown in Exhibit 76 and Exhibit 77 and the evolution of its weights in Exhibit 78 and Exhibit 79

In what follows, we examine each of the individual asset classes in more detail and, where possible, break down the asset class by regions, sectors or asset types.

	Full global market portfolio		*Free-float-adjusted*	
	Market cap (in USD trillions)	Relative size (in %)	Market cap (in USD trillions)	Relative size (in %)
Total	*246.7*	*100.0%*	*191.9*	*100%*
Fixed income	*130.9*	*53.1%*	*105.4*	*55%*
Public equity	*93.8*	*38.0%*	*64.5*	*34%*
Private real estate	*8.5*	*3.4%*	*8.5*	*4%*
Listed real estate	*4.8*	*2.0%*	*4.8*	*3%*
Private equity	*3.7*	*1.5%*	*3.7*	*2%*
Listed infrastructure	*3.3*	*1.3%*	*3.3*	*2%*
Private debt	*1.0*	*0.4%*	*1.0*	*1%*
Unlisted infrastructure	*0.6*	*0.2%*	*0.6*	*0%*

Exhibit 4: Market size of the full and investable global market portfolio (in USD trillion and relative weights of the asset classes). As of Dec. 31, 2022. Source: Bank for International Settlements, MSCI

[3] This figure includes gold bars and coins, gold-backed ETFs and central banks' reserves.

Public equity

We sized the full public-equity market by aggregating the market capitalization of all stocks that were part of and considered for inclusion in the MSCI ACWI and MSCI Frontier Markets (FM) Investable Market Indexes (IMI), as well as stand-alone equity indexes not part of the aforementioned indexes.[4] Note that this universe is larger than the indexes themselves. We excluded the MSCI ACWI Core Infrastructure and MSCI ACWI IMI Core Real Estate Index constituents from the public-equity segment and included them in infrastructure and real-estate asset classes, respectively. For estimating the investable equity market, we used the free-float-adjusted market capitalization of companies in the index.[5]

As of December 2022, public equities accounted for 33.6% (USD 64.5 trillion) of the investable global market portfolio and 38.0% (USD 93.8 trillion) of the full global market portfolio. Exhibit 80 in the appendix shows the historical evolution of the full and investable global equity markets over the past 17 years. In 2022, 69% of the full equity market was considered investable by our free-float adjustment, which equals the average over the full period. Exhibit 81 shows the size of core infrastructure and real estate compared to our estimate of the free-float-adjusted equity market. In 2022, their weight was 4.0% and 2.4%, respectively.

Exhibit 82 and Exhibit 83 illustrate the regional and sectoral breakdown of MSCI ACWI + FM IMI. These exhibits highlight the relative expansion and contraction of regions and sectors through time. The U.S. was by far the largest free-float-adjusted public-equity market (USD 35.9 trillion in 2022, compared to USD 37.5 trillion for the U.S. and Canada combined). The region that grew most in terms of its free-float-adjusted public-equity market capitalization was China (from USD 0.4 trillion in 2006 to USD 4.9 trillion in 2022). The information-technology sector had the largest global market capitalization in 2022 (USD 12.9 trillion), but this was not always the case: In 2006 it was only fourth, with financials leading up until 2019.

In 2022, the number of global listed companies was comparable to the number in 2006 (Exhibit 5) but there was significant regional variation (Exhibit 84). Global market capitalization and especially revenues relative to GDP, however, increased over that period. In developed markets, the number of listed companies generally decreased in line with the de-equitization trend, while it increased in emerging markets, especially in China. Notably in the U.S., the number of public companies (excluding those trading on over-the-counter (OTC) markets) decreased from around 5,000 in 2006 to about 4,000 in 2022. Despite this decrease in the number of listed companies, the full market capitalization relative to GDP increased from 121% to 153%, while sales relative to GDP went up from 77% to 92%. In contrast, in China the number of listed companies increased from about 1,400 to 5,000, while market capitalization relative to GDP grew from 73% to 85% and sales relative to GDP grew from 32% to 96%. Exhibit 84 in the appendix shows these statistics for more regions.

The stagnating number of global listed companies and declining number of U.S. listed companies contrast with the increasing number of investee companies held by private-equity funds, as we will describe in the Part II (see Exhibit 9). While one could conclude that this suggests a decreased importance of public-equity markets, Roe and Wang (2023) challenge this thinking by pointing out that market capitalization, revenues profits and investment are growing faster than the economy.

[4] Examples of stand-alone markets are Argentina, Ukraine and Zimbabwe. Based on MSCI's market-classification methodology.
[5] The methodology for free-float adjustment can be found in the "MSCI Free Float Data Methodology" (MSCI 2023).

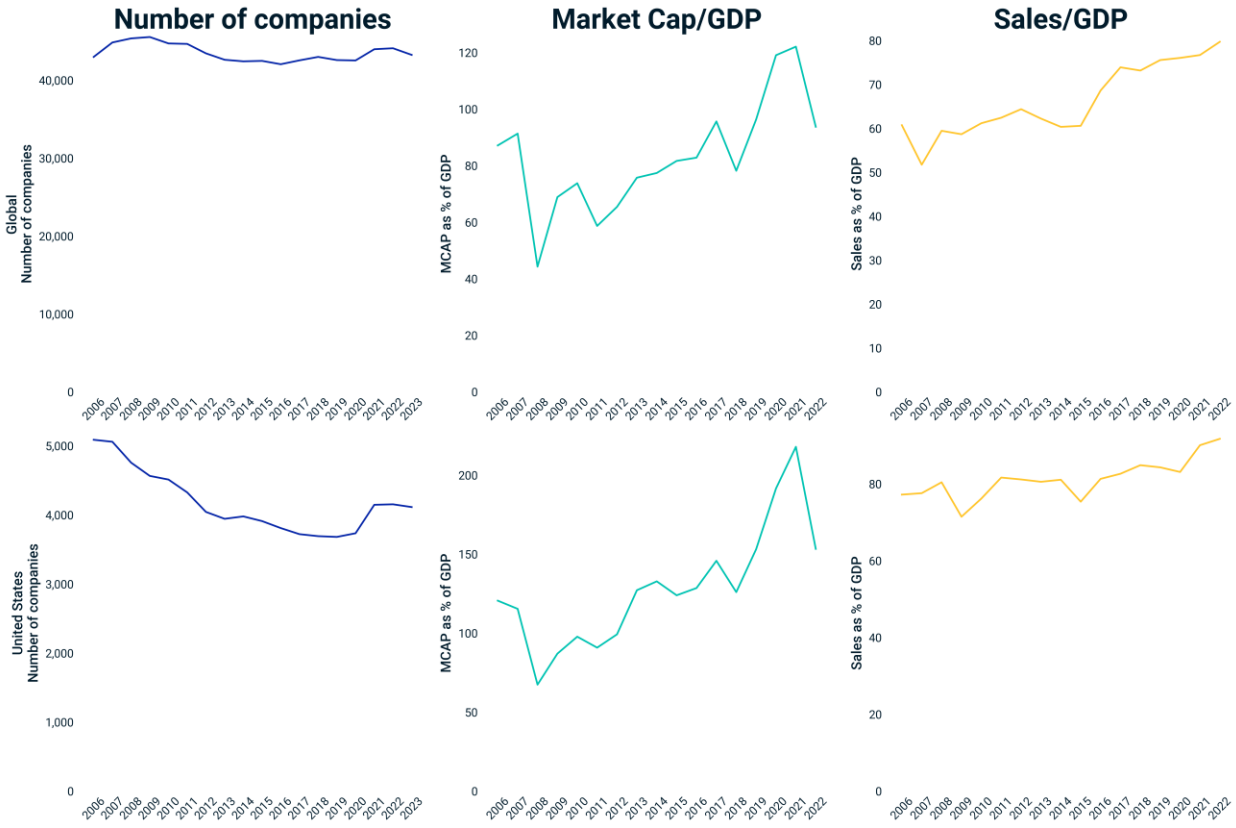


Exhibit 5: Evolution of the number of public companies, their full market capitalization to GDP and sales to GDP for the global equity market and for the U.S. (excluding OTC market).

Fixed income

The full global fixed-income market is represented by outstanding debt securities[6] as determined by Bank for International Settlements (BIS).[7] For estimating the investable subset of fixed-income securities, we excluded the estimated size of central-bank and foreign-official holdings of government debt for each year.[8, 9] Private debt is included as a separate category.

The fixed-income asset class accounted for 54.9% (USD 105.4 trillion) of the investable- global market portfolio in 2022 and slightly less (53.1%, USD 131.0 trillion) in the full global market portfolio. Over the analysis horizon, U.S. assets comprised the largest share in total and government debt, as Exhibit 85 and Exhibit 86 show. China had the most significant change in debt levels: Its total debt outstanding grew to USD 21.7 trillion from USD 1.2 trillion. In the section

[6] Based on the BIS's definition, debt securities include the following instruments: bills, bonds, notes, negotiable certificates of deposit, commercial paper, debentures, asset-backed securities, money market instruments and similar instruments normally traded in financial markets.
[7] Data retrieved as of October 2023.

[8] The dataset behind the article (Arslanalp and Tsuda 2014) was used in the estimation.
[9] We excluded central banks' holdings of government bonds from the investable universe. A more detailed approach would involve excluding their corporate-bond and mortgage-security holdings as well. The size of these holdings is noteworthy. As of December 2022, the European Central Bank held corporate bonds totaling EUR 344 billion (excluding asset-backed securities or covered bonds). Additionally, the U.S. Federal Reserve held USD 2.6 trillion of mortgage-backed securities. By way of comparison, the ECB's holdings of government debt was EUR 2.6 trillion and the Federal Reserve's holdings of U.S. Treasurys was USD 5.5 trillion.

"Representativeness of the investable global market portfolio" we will further explore how different regions' outstanding debt compared to the size of their respective economies.

A segment of fixed-income markets that plays an important role is short-maturity or "cash-like" debt, which primarily consists of debt instruments that have maturities of less than one year, such as Treasury bills and commercial papers. Its main roles for investors are:

- **Liquidity management.** It provides investors with a mechanism to manage their cash needs effectively. Institutional investors, for instance, might invest their idle cash in these instruments to earn a return while maintaining the flexibility to meet any unforeseen financial obligations.
- **Risk Mitigation.** The short duration of these instruments inherently reduces the market and interest-rate risk, making them an attractive option for risk-averse investors.
- **Facilitating Market Mechanisms.** The market for short-maturity fixed income also provides high-quality collateral in financial transactions, including repurchase agreements (repos) (Committee on the Global Financial System 2017).

Exhibit 6 shows the ratio of short-maturity U.S. debt to all U.S. debt between 2000 and 2022, illustrating an increase in the share of short-term debt during crisis periods, such as the 2008 global financial crisis and the 2020 COVID-19 pandemic.[10] The share of outstanding commercial papers was highest in 2007 and declined after the financial crisis due to the reduction in issuance of asset-backed commercial paper (Baklanova, Kuznits and Tatum 2020). As for Treasury bills, the U.S. Treasury may issue these instruments during crises to meet escalating fiscal demands without being locked into long-term obligations. Investors, on the other hand, gravitate toward the relative safety and liquidity of U.S. government-backed short-term securities amid market uncertainty. In crisis times, the market for U.S. short-term debt becomes a key space where the government's need for funds and investors' desire for safe and easy-to-access investments meet (U.S. Government Publishing Office 2021).

[10] The general statement that debt maturity drops during crises holds true across all markets (Chen, et al. 2019).

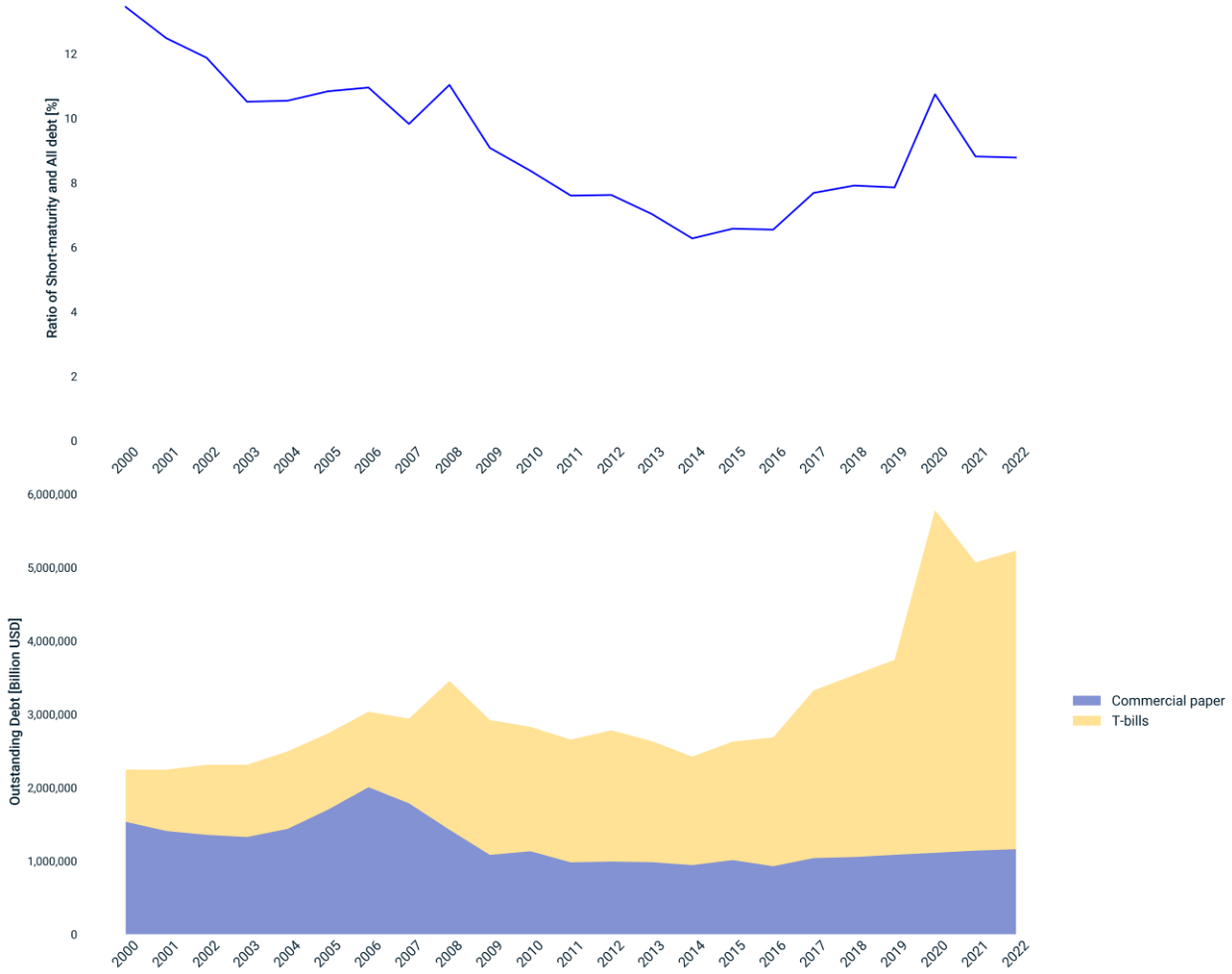


Exhibit 6: Ratio of short-maturity debt (represented by commercial papers and Treasury bills outstanding) to all debt in the U.S. (top); and the share of commercial papers and T-bills in short-maturity debt (bottom). Source: Board of Governors of the Federal Reserve System

Private equity

We estimated the gross valuation of private-equity and private-debt markets using the Burgiss Manager Universe (BMU). The BMU represents a dataset of private-capital funds, funds of funds and their underlying investment holdings dating back to 1978. Sourced exclusively from limited partners (LPs), the BMU contains the complete transactional history for all funds and includes only closed-end private-equity-style funds with manager discretion over cash flows. This means that any evergreen funds, open-end funds and other related vehicles such as directs and co-investments are excluded. No data is sourced via voluntary manager data submissions, web scraping or U.S. Freedom of Information Act requests. Since fund cash flows are actual cash flows from LPs, the BMU represents the actual investment experience from the perspective of LPs. Note that for private equity, we do not apply a free-float adjustment.

Private equity's gross valuation accounted for 1.9% or USD 3.7 trillion of the investable global market portfolio in 2022, which amounted to 1.5% of the full global market portfolio. The size of the private-equity market as compared to the free-float-adjusted public-equity market grew from 1.3% in 2006 to

5.7% in 2022, as shown in Exhibit 7. In Section II, we will discuss private-equity markets in more detail.

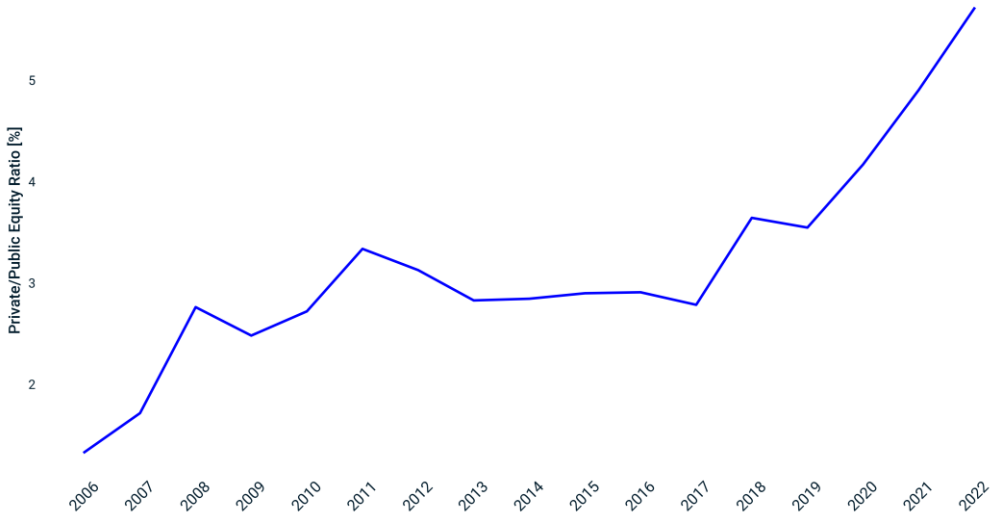


Exhibit 7: Gross valuation of private equity in comparison to market capitalization of free-float-adjusted public equities.

While private capital is not listed, private-equity *management* companies are often listed on a stock exchange. Based on two exchange-traded funds focusing on such listed private-equity companies, their weight in MSCI ACWI Investable Market Index was around 0.45% as of Jan. 2, 2024.[11]

Real estate

The size of the real-estate market was estimated by MSCI, which began tracking the size of the professionally managed global real-estate investment market in 2006. The methodology distinguishes investment-oriented real estate from owner-occupied or noninvestment properties. Market-size data was enriched by leveraging the MSCI Real Capital Analytics (RCA) transactions database, adjusting historical estimates based on market-growth rates for more accurate comparisons.

Private and listed real estate made up 7.0%, or USD 13.3 trillion, of the investable global market portfolio in 2022 (5.4% of the full global market portfolio). Exhibit 87 and Exhibit 88 in the appendix show the evolution of professionally managed real estate by sector and region. The office sector was largest over the horizon, despite its 8.8% decrease in market size compared to the 4.1% decrease of the full real-estate universe. The share of the U.S. in the global real-estate market grew to 40% from 36% over the analysis horizon and remained dominant (USD 5.4 trillion in 2022). The second-largest country was China with a market size of almost USD 1 trillion. The U.K. had a 13% decrease in its market value in 2022 and was overtaken by Japan as the third-largest country.[12]

[11] We looked at "PSP - Invesco Global Listed Private Equity ETF" and "iShares Listed Private Equity UCITS ETF." Within these respective exchange-traded funds, 24 and 27 companies are constituents of the MSCI ACWI Investable Market Index, accounting for 0.41% and 0.47% free-float adjusted market cap weight, respectively.
[12] More details can be found in Patkar and Neshat (2023).

Infrastructure

Listed infrastructure is estimated by the free-float-adjusted market capitalization of the companies considered for inclusion in the MSCI ACWI Core Infrastructure Index. The net asset value (NAV) of unlisted-infrastructure markets was estimated using the BMU dataset. Listed and unlisted infrastructure constituted 1.3% and 0.2% of the investable global market portfolio, respectively.

Evolution of the investable global market portfolio

Since our previous report of 2016, the size of the investable global market portfolio grew by almost USD 61 trillion.[13] This translates to a 6.6% annual growth rate over seven years, although growth was not steady. In 2020, the global market portfolio grew by 16.1%; during the worst year, 2022, the market capitalization decreased by 6.8%. When looking at the evolution of the composition of the global market portfolio over time, it is important to note that these changes can be attributed to two sources: changes in issuance patterns and relative changes in prices. For example, the -19.9% price return of the MSCI ACWI + FM Investable Markets Index in 2022 contributed significantly to the decrease in public-equity market capitalization of -20.6%.

While all asset classes gained in market capitalization during these seven years, as shown in Exhibit 8, most USD-value growth happened in the fixed-income and public-equity asset classes (USD 31.4 trillion and USD 20.9 trillion, respectively). Growth in outstanding debt could be partly attributed to the challenges raised by the COVID-19 pandemic, when increased borrowing needs met with low capital costs. Even before the pandemic, starting in 2010, outstanding emerging-market debt increased, which accelerated during the pandemic. Generally, government debt led the way with the fastest annual debt accumulation since 1970 (Kose, et al. 2021). Based on our analysis, global investable debt outstanding (including government and corporate debt) grew by 15.1% in 2020, at a rate unprecedented since the global financial crisis. The market capitalization of public equities grew significantly during several years, with close to 20% annual growth rates in 2017 and from 2019 through 2021. A 20.6% drop in market capitalization occurred in 2022, after the stock market sold off amid inflation concerns and the Russia-Ukraine war (Jordan-Wood and Neely 2022). Private equity's market capitalization grew steadily until 2021, which was followed by a 7.6% drop in 2022.

Exhibit 90 in the appendix shows the relative growth of market capitalization since 2016: Private equity and unlisted infrastructure grew most significantly, with 191% and 164% increases, respectively. Exhibit 8, on the other hand, shows the absolute change in the asset-class weights since 2016. Despite the growth of debt outstanding, the weight of fixed income in the investable global market portfolio shrunk by 1.6 percentage points. The asset class with the largest weight increase was private equity, with its weight changing to 1.9% from 1.0%.

[13] MSCI's previous estimation for June 2015 was USD 125 trillion. Using the current methodology, we obtained USD 127 trillion as of end of December 2015. This difference is attributed to multiple sources such as the six-month difference in the analysis date and the change in methodologies for several asset classes. Most notably the larger dataset used for estimating the public-equity universe (inclusion of frontier markets and stand-alone indexes; inclusion of all stocks *considered* during the index construction) accounts for almost USD 2 trillion difference.

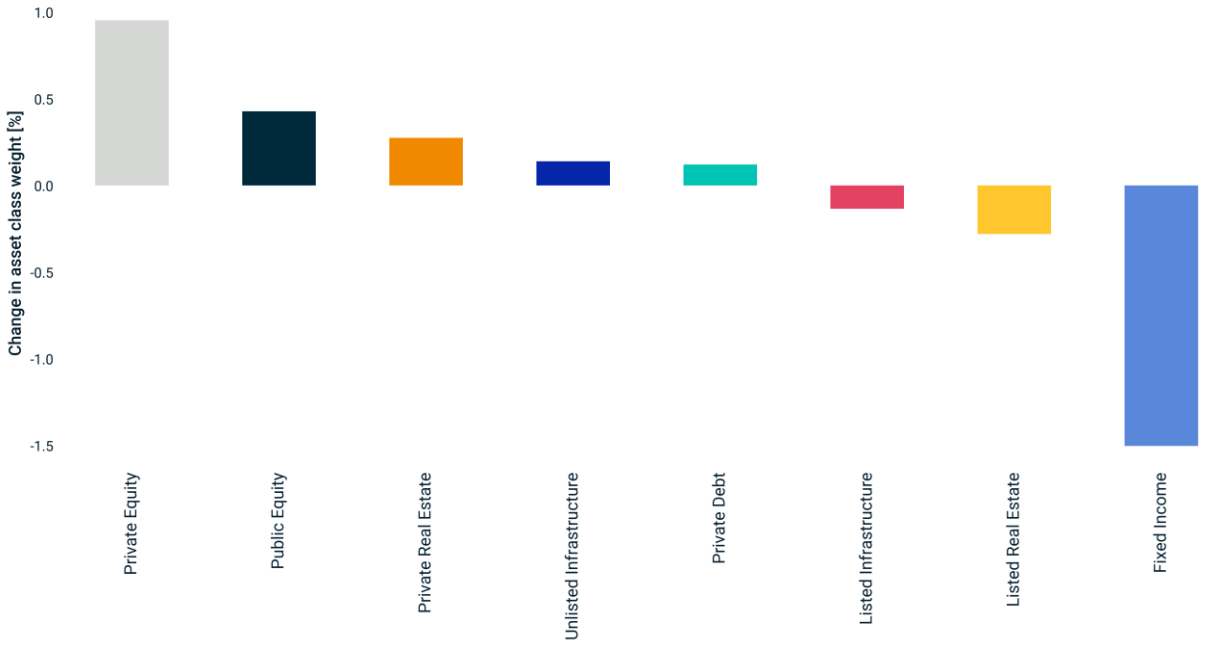


Exhibit 8: Change in asset-class weights in the investable global market portfolio from 2016 to 2022.

Representativeness of the investable global market portfolio

In this section, we assess how representative the full and investable global market portfolio were for the real economy, by comparing regional weights with the relative size of their economies, assessed by GDP. While this represents the total value of goods and services produced and the global market portfolio measures market capitalization, the relative comparison can provide insights and highlight potential differences between regions' financial markets and their economic sizes. As the global market portfolio may be used as a strategic benchmark, it is useful to keep in mind that this portfolio does not necessarily reflect the relative importance of economies.

Looking at public equities first, we observe in Exhibit 92 that developed markets accounted for 83.4% of the investable public-equity market, while they contributed 54.1% to global GDP and 61.2% to public-equity-market revenues. Stocks' market-capitalization-to-GDP ratio was highest for the U.S., with its full public-equity market of USD 39 trillion versus a GDP of USD 25.5 trillion (Exhibit 91). The U.S. also stood out in terms of free-float market capitalization, with 92% of its total market capitalization being investable. Despite its significant share in global GDP (18.1%) and global public-equity-market revenues (21.7%), China's stock market was relatively smaller, especially the free-float-adjusted market capitalization, which accounted for 7.7% of global equity markets.[14] Emerging-market countries excluding China had a weight comparable to China in the investable global equity markets (7.8%), although their combined contribution to world GDP was slightly lower (14.9%), a share similar to their share in revenues (15.4%).

For fixed-income markets we saw a stark difference between developed and emerging markets: Investable debt relative to GDP was 1.4 for developed markets, while it was 0.7 for emerging-market

[14] For proxying the Chinese equity market, this section included all stocks considered for inclusion in the MSCI ACWI + FM Investable Market Index. In comparison, in the section dedicated to China equity markets, we used Chinese constituents of the MSCI ACWI Index and a hypothetical full A-share inclusion, proxied by the MSCI China All Shares Investable Market Index (which is a smaller universe, as only constituents are considered).

countries (Exhibit 93). Although it was on the rise in the last two decades, emerging-market countries' debt indeed remained relatively low compared to developed-market economies (Gaspar, Poplawski-Ribeiro and Yoo 2023). In terms of relative weights, we saw similar trends as in public-equity markets: U.S. investable debt markets accounted for 41% of global investable debt, significantly higher than its share in global GDP (25.7%).

Finally, we turn to private-equity markets (Exhibit 95 and Exhibit 96). The U.S. accounted for an even larger weight (61.3%) in global private-equity markets compared to investable public-equity markets (55.6%).[15] The weight of developed-market countries ex U.S. was closer to those markets' contribution to global GDP (28.3% and 25% respectively). Over recent years, there has been a gradual increase in private-equity investments within Asia, especially in China (USD 0.3 trillion). Some of the most important factors driving the development of private-equity markets are opportunities for a quick and profitable exit, the cost of capital and legal traditions (Kumar and Orleck 2002).

Asset-owner allocations

While the global market portfolio represents the aggregate risk and return preferences of all global investors, asset allocations vary across different groups of investors. There are various factors that may impact allocations, such as the investment horizon, risk tolerance, liabilities and cash-flow needs, regulatory and tax considerations, the investor's size and access to markets, as well as their investment beliefs and expertise.

Asset owners generally have a longer horizon than other institutional investors, although different types of asset owners face varying degrees of constraints. Pension funds usually have lower risk appetite. Life insurers and defined-benefit schemes especially are bound by their liability structure and may have a preference for holding more fixed-income instruments, whereas funds providing unit-linked contracts and defined-contribution plans are influenced more by members' preferences and might hold more equities to enhance returns (Committee on the Global Financial System 2007). Compared to pension funds, sovereign wealth funds tend to have a greater risk appetite as they generally do not face short-term liability constraints, and income from commodities and trade surpluses can be invested in projects or assets that may take longer to yield returns (World Economic Forum 2011), (Fernandes 2011).

Based on the Thinking Ahead Institute's most recent "The Asset Owner 100" report (The Thinking Ahead Institute 2023), the top 100 asset owners account for a total of USD 23.4 trillion of investments at the end of 2022, with the top 20 asset owners accounting for about 55% of these assets under management. The weighted average allocation of the top 100 asset owners is predominantly in public equities (42.6%), followed by fixed income (30.3%) and alternatives (27.1%). The allocation to alternatives is largest in North America (35.4%) and smallest in the Asia-Pacific region (17.1%).

When distinguishing between investor types, sovereign wealth funds had the largest allocation to public equities (46.6%) and alternatives (30.6%). For the eight sovereign wealth funds in the top 20 of asset owners, the allocation to public equities, fixed income and alternatives is 49%, 21% and 29%, respectively, and has been relatively stable over the past seven years. The most important regional difference between sovereign wealth funds in the top 100 is that allocation to public equities tends

[15] This comparison is impacted by some of the assumptions in determining the investable universe of private capital. For instance, in China, numerous sizable funds are deemed "closely held." Consequently, they are excluded from the BMU, impacting regional comparisons. The BMU represents the aggregate investment portfolio of our global client base.

to be highest in the Asia-Pacific region, while that region has the lowest allocation to alternatives. An analysis carried out for the Norwegian Pension Fund Global by CEM Benchmarking (2023) shows a trend of increasing allocation to alternatives among a group of 191 funds globally, and among the peers of the Norwegian Pension Fund Global.

Compared to sovereign wealth funds, pension funds in the top 100 asset owners have a larger allocation to fixed income (36.3%) and lower allocations to public equities and alternatives (39.6% and 24%, respectively). The regional differences are more pronounced among pension funds. Allocation to fixed income ranges from 46.3% in APAC to 26.5% in North America, while the allocation to alternatives is 7.1% in APAC and 36.7% in North America. According to another study of the Thinking Ahead Institute (The Thinking Ahead Institute 2023), over the past 20 years, the seven largest pension markets[16] have decreased their public-equity allocation from 50% to 42% and their fixed-income allocation from 38% to 32%, while allocation to alternatives has increased from 9% to 23%. This report also highlighted a global decline in home bias in equity allocations over the past 20 years, from 67.1% to 37.7%, and to a lesser extent in fixed-income allocations, from 85.3% and 70.1%.

These allocation trends put the global market portfolio in perspective and show how different investor types and regions deviate from the average weights in this portfolio. Generally, large asset owners allocate more to public equities and alternatives; their long investment horizon and risk tolerance may give them more opportunities to harvest risk premia in the long run.

[16] Australia, Canada, Japan, Netherlands, Switzerland, UK, US, representing USD 43,838 bn in total.

Section II: Private-equity markets

Introduction

In Section I, we touched on the growth of private-equity markets over the past years. In this section, we will first discuss the private-equity markets in more detail and discuss key trends.[17] Next, we discuss private-equity market risk and the challenges for estimating it. We summarize the MSCI Private Equity Model and apply it to a stylized example to understand how the inclusion of private equity impacts the tracking error of an investment allocation relative to a reference portfolio of public equities and bonds. We also suggest alternative and complementary measures for risk management. Finally, we discuss the complexity of measuring the performance of private-equity investments, discuss best practices in the industry and illustrate how performance attribution can help investors better understand how each decision in the investment process impacts the performance of a private-equity portfolio.

Description of private-equity markets

As of the first quarter of 2023, private-equity funds had 75,000 investments in more than 40,000 active companies, totaling approximately USD 4 trillion in gross valuation. Over the past five years, the number of actively held companies and their combined gross valuation have increased by around 70% and 150%, respectively, as the private-equity industry has experienced substantial capital inflows and valuation increases (see Exhibit 9). As discussed in Section I, this has led to an increase in the weight of private assets in the global market portfolio.

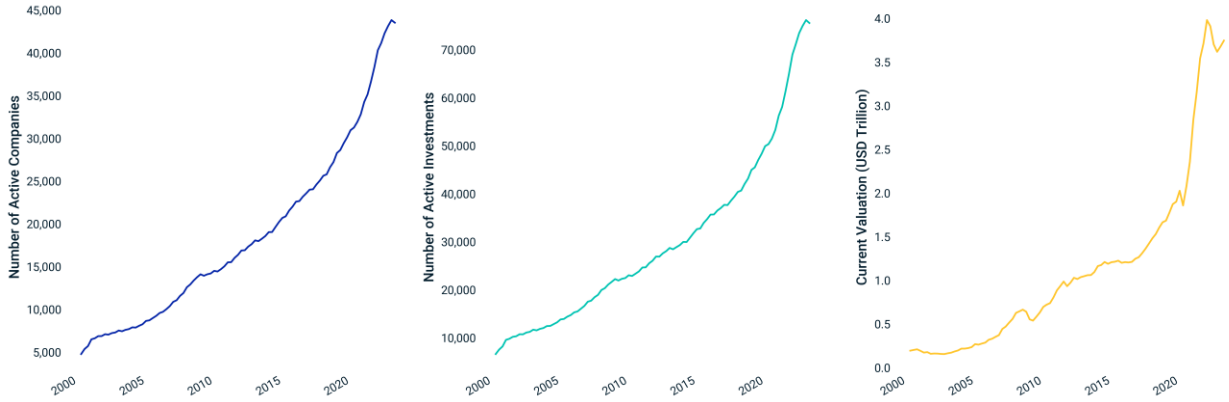


Exhibit 9: Current valuation and number of investments as of each quarter-end date back to March 31, 2000, for all private-equity funds based on the BMU (including venture capital, buyout and other strategies).

[17] In some charts, we also show data on other segments of the private capital markets, such as Private Debt. Wherever not mentioned explicitly, the analysis focuses on Private Equity.

Sector composition

Comparing sector composition in private equity and public equity, we observe meaningful differences between the companies held by private-equity funds and those available in the listed markets, as shown in Exhibit 10. As of March 2023, private-equity investments were more concentrated in information technology (31.0% versus 19.4%), health care (16.5% versus 12.0%) and industrials (14.7% versus 11.4%). On the other hand, private-equity investments are less concentrated in utilities (0.3% versus 2.9%), energy (0.7% versus 4.9%) and materials (3.1% versus 5.3%).

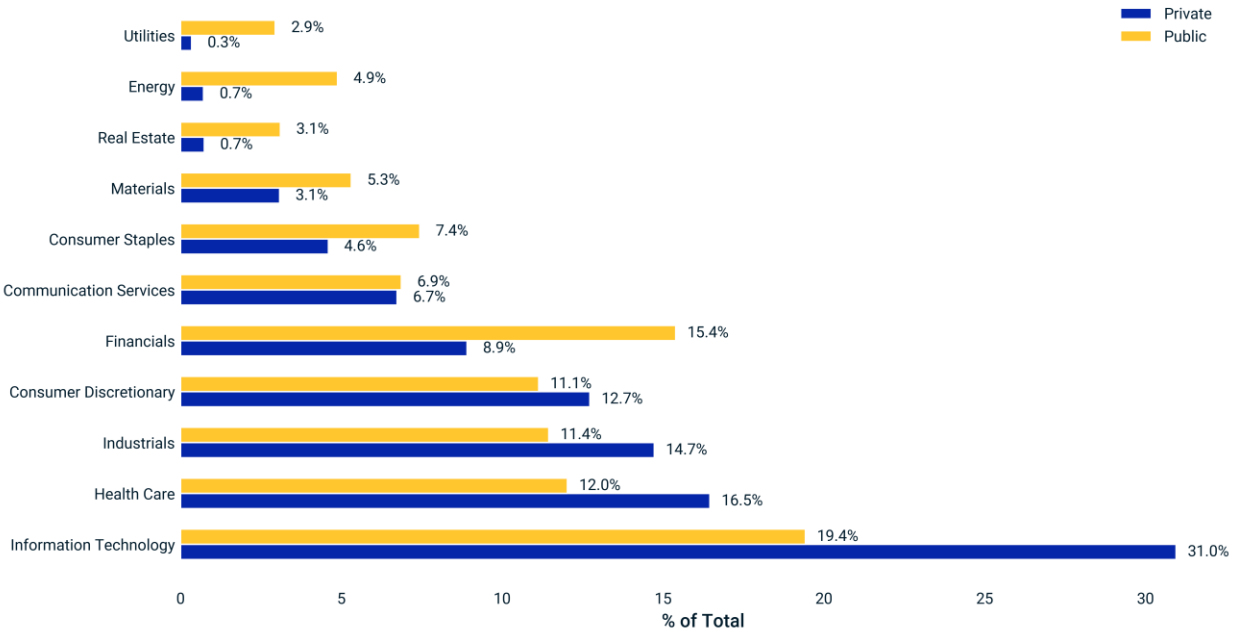


Exhibit 10: Current composition of private-equity funds relative to public markets. Private-equity data based on the gross valuation of the underlying portfolio companies. Public-equity sector composition based on the MSCI ACWI + FM Investable Market Index. As of March 31, 2023.

As shown in Exhibit 11, the composition of private-equity funds' aggregate holdings has shifted over time, mirroring many of the changes seen in listed markets. Information technology is currently the largest sector at 31.0% of current gross valuation, and no other sector has dominated the industry in the same manner. For a brief period from 2010 through 2014, consumer discretionary was the largest sector, and there are a handful of individual quarters where other sectors were largest, but these never persisted.

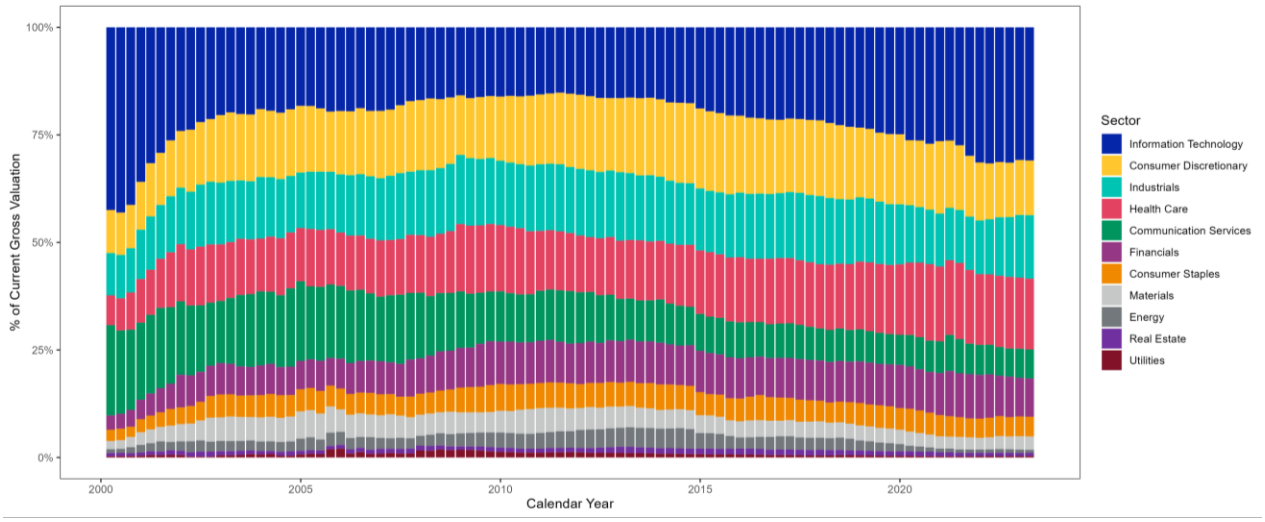


Exhibit 11: Sector decomposition based on gross valuation of all active investments held by private-equity funds since March 31, 2000.

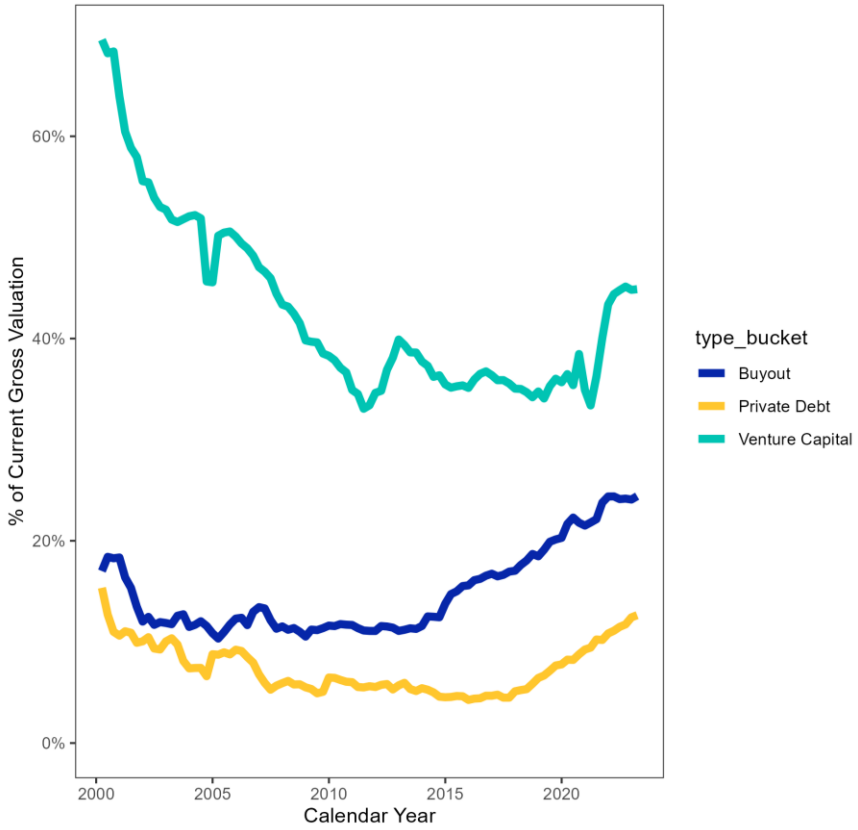


Exhibit 12: Percentage of gross valuation, by asset class, of information-technology investments by quarter.

While investments in information technology were often associated with venture capital, accounting for nearly 70% of the valuation at the start of 2000, that relationship has weakened over time, as information-technology companies have matured and joined other segments of the private-equity and private-debt investment holdings. Currently, information-technology companies represent a large and growing portion of buyout and private-debt funds' holdings (see Exhibit 12).

Private-company characteristics

As of December 2022, the median revenue for companies held by private-equity funds was USD 65 million, while for those held by private-debt funds it was USD 175 million. Within private-equity funds, buyout funds reported annual revenues of USD 136 million and a median total enterprise value (TEV) of USD 345 million (see Exhibit 13). Meanwhile, companies held by venture-capital funds, with generally lower disclosure rates, showed median revenues of USD 17 million and a median total TEV of USD 205 million.

Asset class	Metric	Number of companies with data	Coverage (% of valuation)	75th	50th	25th
Private equity	Revenue	17,122	78%	227.1	64.7	16.2
Venture capital	Revenue	6,590	57%	83.2	16.6	2.5
Buyout	Revenue	8,088	86%	394.6	135.9	53.5
Private debt	Revenue	4,839	41%	496.0	175.0	62.7
Private equity	EBITDA	14,112	71%	39.2	9.4	(2.1)
Venture capital	EBITDA	3,890	36%	0.1	(7.5)	(33.8)
Buyout	EBITDA	8,093	87%	62.1	21.0	6.7
Private debt	EBITDA	4,663	41%	92.2	32.0	9.8
Private equity	TEV	10,005	58%	891.0	265.7	81.8
Venture capital	TEV	2,983	32%	918.7	205.4	50.0
Buyout	TEV	5,719	70%	1,075.4	344.5	113.9
Private debt	TEV	3,298	30%	1,814.0	600.8	191.0

Exhibit 13: All metrics in USD millions. Fundamental summary statistics for companies held by private-equity, venture-capital, buyout and private-debt funds, as of Dec. 31, 2022. Private equity represents a superset of venture capital, buyout and other categories. All figures are subject to disclosure limitations in financial statements.

Key trends by fund type

While the aggregate private-capital industry is large and growing fast, there are significant size differences among the various underlying segments, such as venture-capital and buyout funds, private-debt funds and funds of funds. Consequently, there are meaningful differences in the relative investability of these segments for large institutional investors as they need to balance between minimizing the number of individual fund investments (each of which has its own diligence, accounting and operational burden), investing toward their target allocation and building an appropriately diversified portfolio.

Private-capital investing is done through the container of the fund, and so the relative size and mix of those fund containers is critically important. The following section explores these issues for the various segments of the private-capital universe.

Fundraising by size bucket

Exhibit 14 shows the universe of funds raised since 2000 and groups them according to the capital raised. We see divergence between the different asset classes as well as some of the cyclicality of the fundraising cycle. Realistically, the two or three smallest buckets in Exhibit 14 may not be part of the investable universe for a large institutional investor.

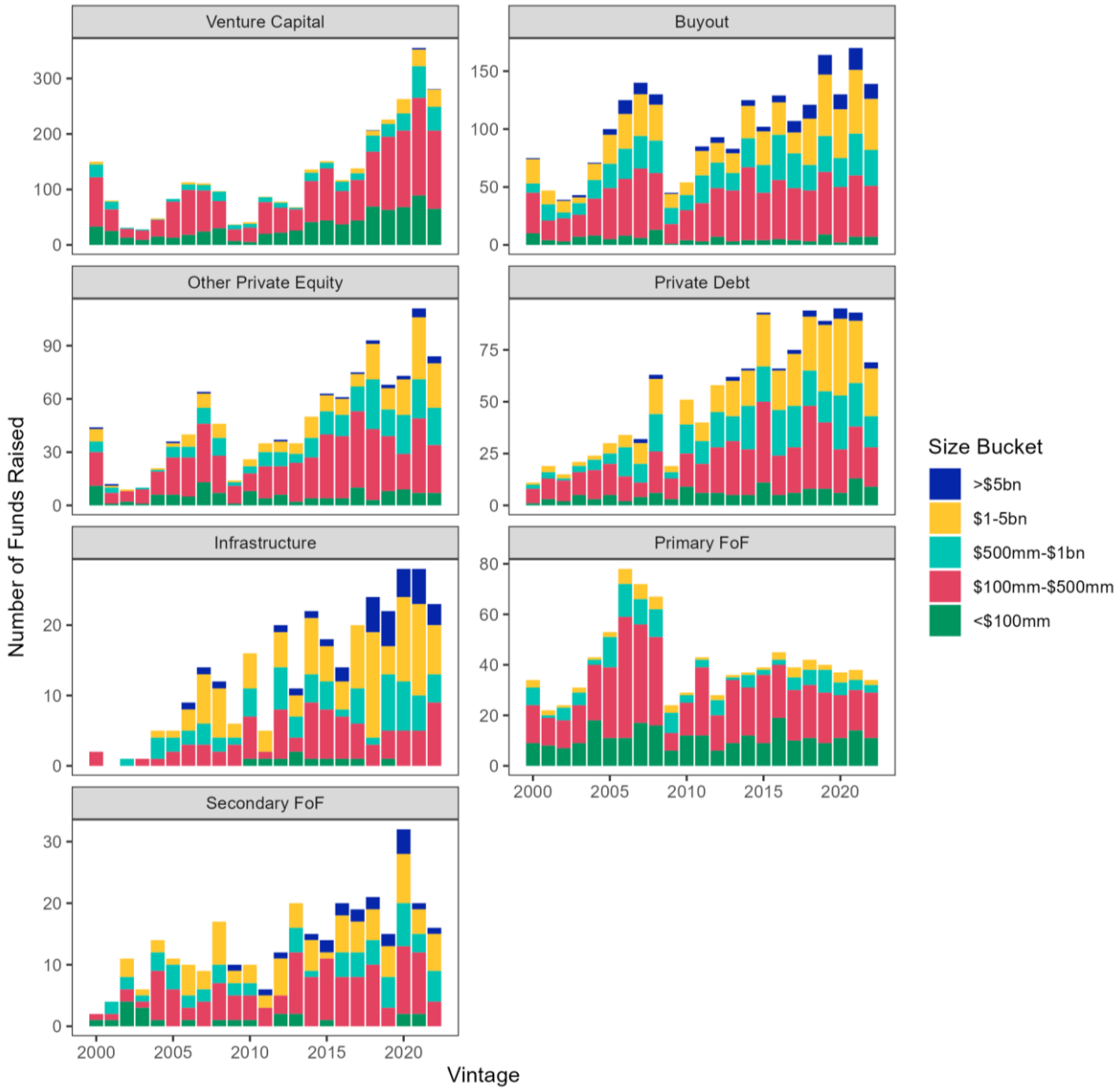


Exhibit 14: Number of funds raised by size bucket over time. Data between 2000 and 2022.

When grouping by capital raised, however, we see that, for most segments shown, the bulk of capital was raised by the largest funds, as shown in Exhibit 15. Hence, an investment program selecting the largest funds only would still target a substantial portion of the universe. For buyout and infrastructure funds specifically, more than 50% of capital raised in recent vintage years fell into the largest size bucket (i.e., larger than USD 5 billion), while private debt was mostly concentrated in vehicles with a size between USD 1 and 5 billion. For venture capital, only 50% of aggregate capitalization was raised by funds larger than USD 1 billion. In the following sections, we discuss some of the private-equity market segments in more detail.

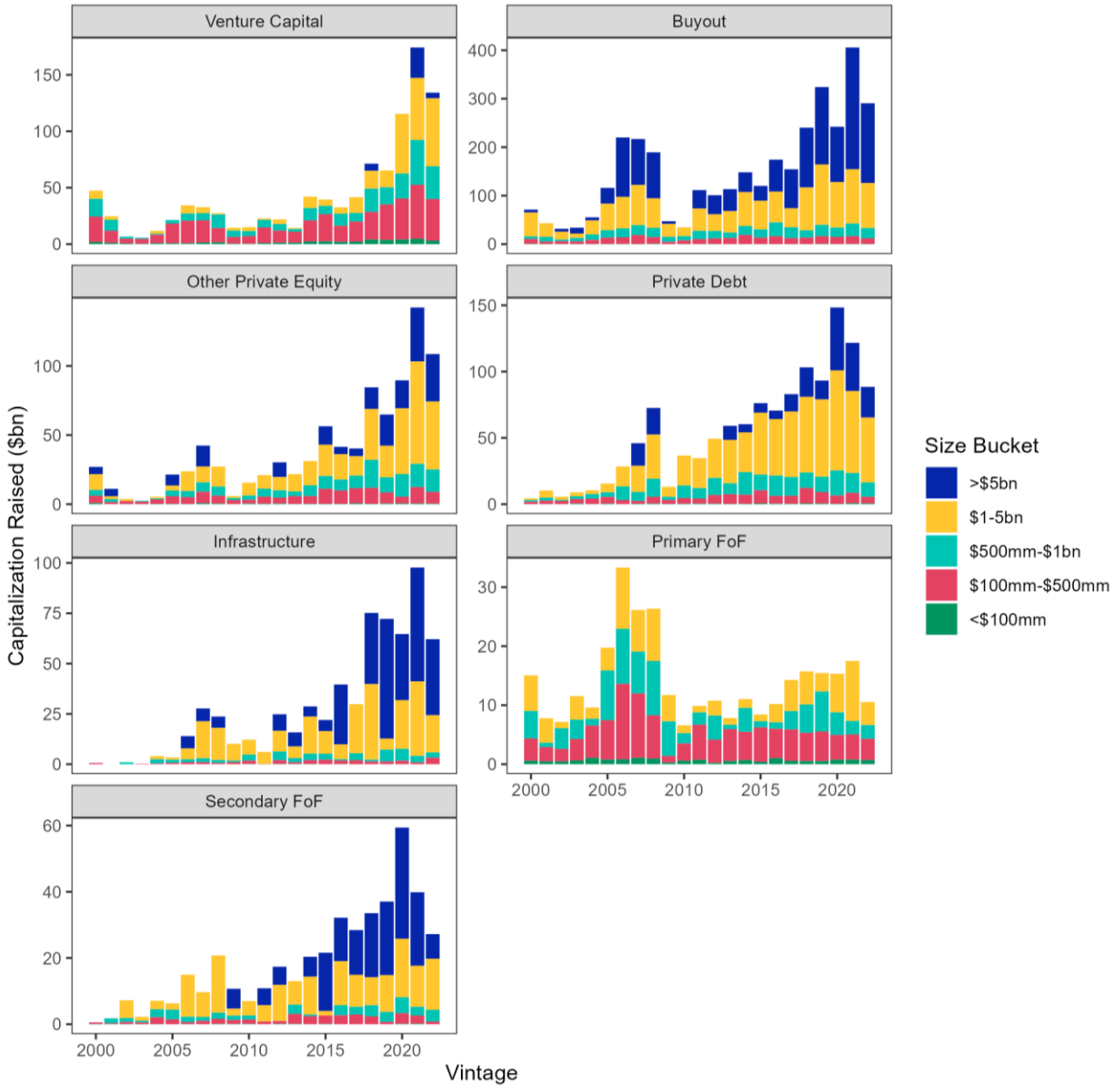


Exhibit 15: Capitalization raised by size bucket. Data between 2000 and 2022.

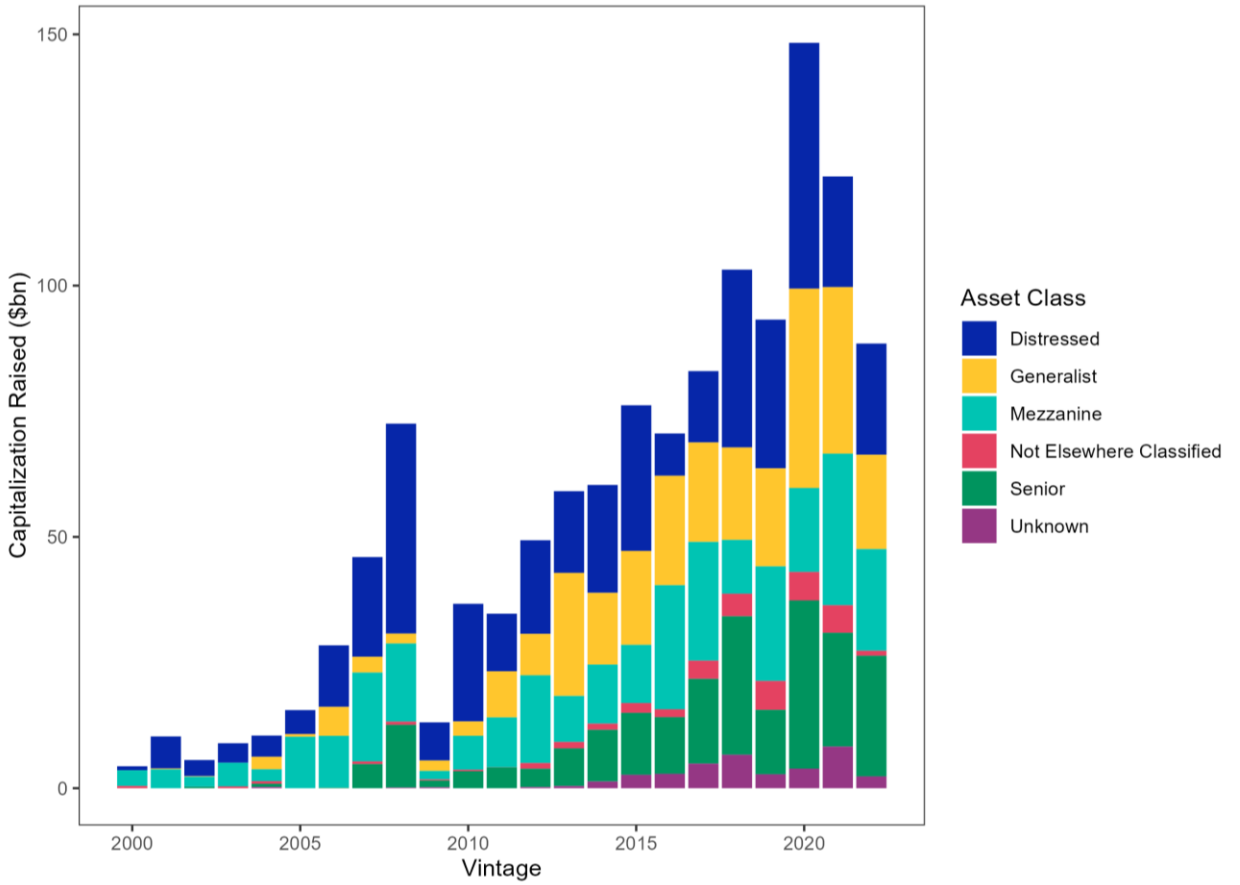


Exhibit 16: Private-debt sub-strategy fundraising by vintage. Data between 2000 and 2022.

Private debt

Private debt is a growing part of the private-capital universe. While some of the underlying strategies have longer histories, Exhibit 16 shows there has been a meaningful increase in the amount of capital raised by senior-debt-focused funds since 2010 as traditional bank lenders have pulled back from lending to small-to-mid-sized companies. Additionally, the asset-class taxonomy employed in the Burgiss Manager Universe recognizes funds with a flexible investment mandate: Those are presented in the generalist category below and include many direct-lending funds that lend across the capital structure.

Fund of funds

Another category to consider is fund of funds, which have additional considerations beyond just their relative size and investability. They allow for better diversification across fewer commitments, lowering the operational, accounting and diligence work in building a diversified portfolio, as each fund of funds vehicle invests in multiple underlying Funds. Furthermore, investing through funds of funds could allow access to funds that otherwise may be too small to be considered by a large institutional investor, such as significant parts of the venture-capital universe, emerging markets and first-time managers. While funds of funds could increase access to a larger part of the private-capital space, they charge a second layer of fees.

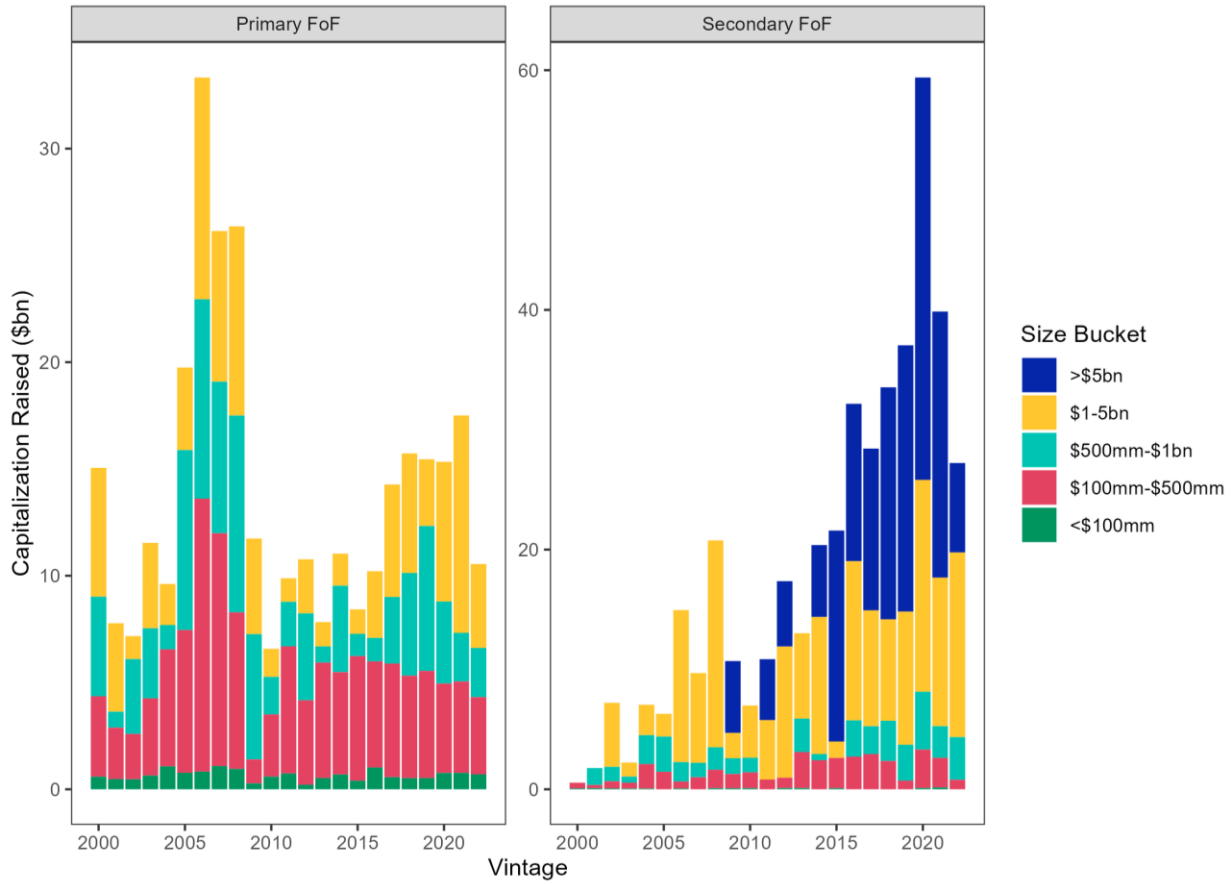


Exhibit 17: Funds of funds' fundraising by type over time. Data between 2000 and 2022.

Furthermore, there is an important strategy distinction as to whether funds of funds focus on primary opportunities (newly raised funds) or secondary opportunities (the purchasing of existing limited-partnership interests and, more recently, continuation vehicles). Exhibit 17 shows that secondary funds of funds raise more capital. However, they only allow access to those fund commitments sold in the secondary market.

Infrastructure

Another fast-growing segment of the private-capital universe consists of infrastructure funds which are classified under real assets in the Burgiss Manager Universe but contain large investments in companies operating in the infrastructure space. As shown in Exhibit 15, infrastructure fundraising is dominated by the largest fund-size buckets as infrastructure projects represent some of the largest investment targets within private capital.

Exhibit 18 highlights that the risk segmentation of infrastructure funds is different from those investment opportunities generally available in the listed markets. That is, private-capital infrastructure funds tend to raise many value-added funds with a lower focus on core opportunities.

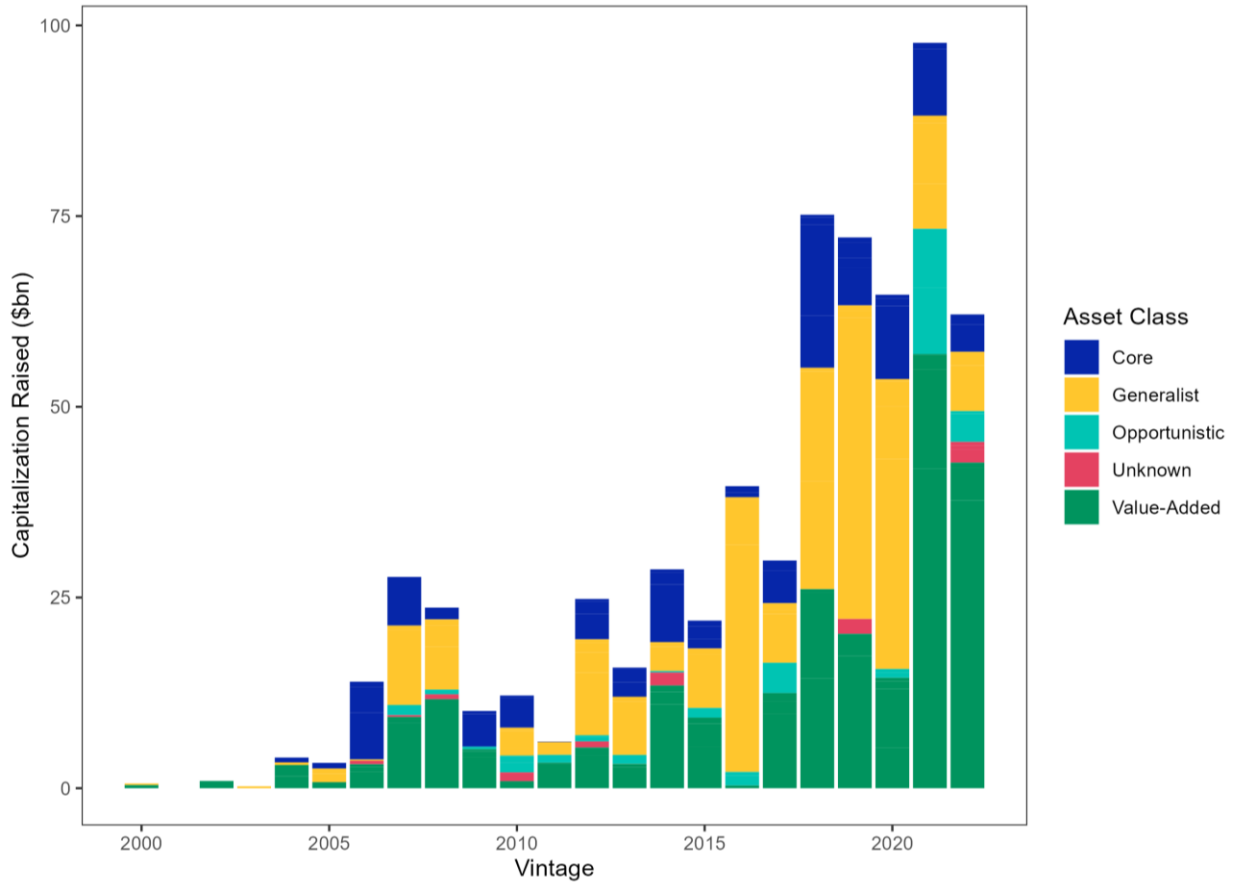


Exhibit 18: Private-infrastructure fundraising by strategy over time. Data between 2000 and 2022.

Co-investments and directs

Finally, we discuss both co-investment opportunities and direct investing, which, while functioning very differently, are often considered as a single area of private capital. Co-investments are investments made alongside a private-capital fund manager in just a single or small set of investment opportunities and with lower (or no) fees charged. Investors considering co-investment opportunities as part of their mandate will sometimes begin making investments directly into private companies (equity, debt or a mixture of the two), which requires that the institutional investor builds out the appropriate deal sourcing, underwriting and monitoring expertise.

Both strategies can facilitate investing large amounts of capital with more timing certainty than standard funds, but they require an additional level of expertise and diligence and can produce a more concentrated portfolio than investment in funds (and certainly funds of funds) would create.

Key trends in time to IPO/exit

Exhibit 19 explores the underlying investments held by venture-capital and buyout funds with a focus on holding periods and exit strategies. Holding periods have been lengthening in both buyout and venture-capital funds. From an average of just four to five years before 2010, holding periods have risen to seven years for the buyout segment and six years for venture capital in the most recent exit years.

If we isolate those investments exited since 2019 and break out initial public offerings (IPOs) from other exits, we can see that investments that exited via an IPO have a holding period approximately two years longer than non-IPO exits (see Exhibit 20). The takeaway from the two exhibits below is that more of these private companies' lives — and the potential value creation — is happening within the private-equity funds.

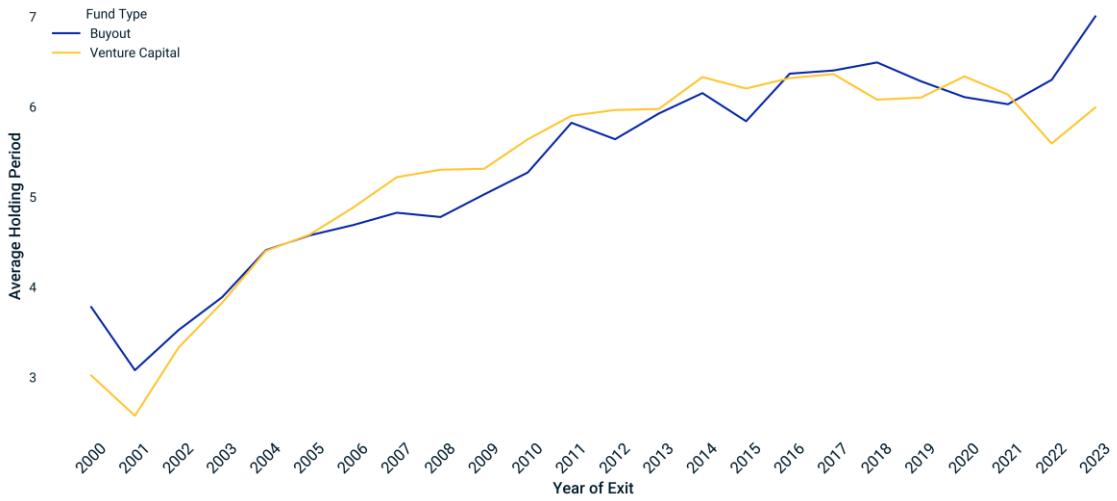


Exhibit 19: Average holding periods for investments exited in a given year.

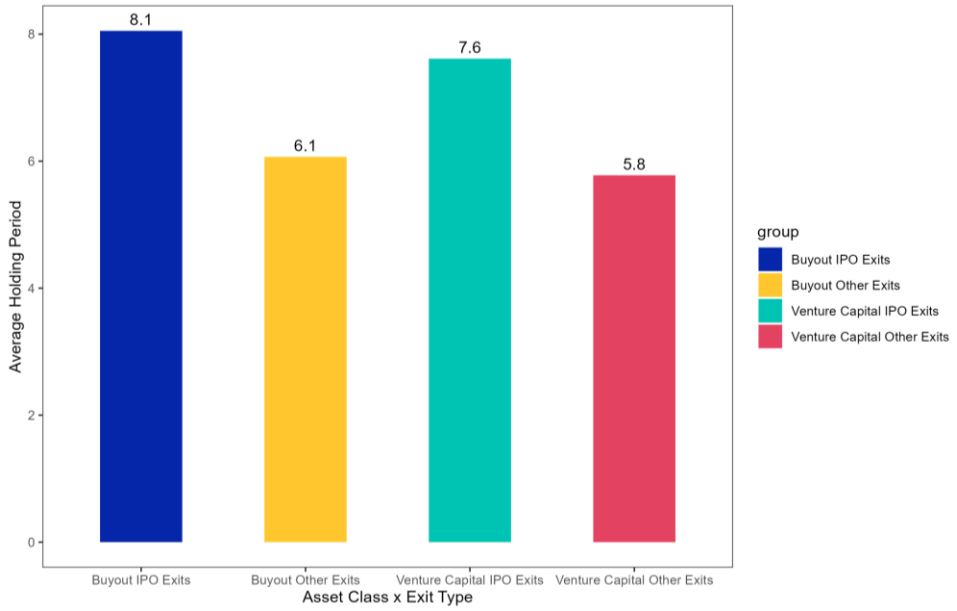


Exhibit 20: Average holding periods by exit type for investments exited since 2019.

Private-equity market risk

Assessing the market risk of private equity, i.e., the uncertainty of the intrinsic value of private assets, is important for making consistent asset-class comparisons and gauging the risk of the total portfolio. Typical approaches to modeling private-equity risk often fall into one of two extremes: One extreme focuses on the "private," using the smooth valuations, while the other focuses on the "equity" in "private equity," using a public proxy. Both sources of information have benefits and drawbacks, as summarized in Exhibit 21.

Information source used to assess private-equity risk	Benefits	Drawbacks
Private-equity valuations and fundamentals	• Valuation-based returns are more accurate in the long run • "Faithful" to the investment	• Subjective in the short run • Lagged • Scarce • Smoothed
Public equity and debt	• Timely • Market-based	• Misses liquidity premia • Misses private-market effects • Mismatched assets

Exhibit 21: Different sources of information have benefits and drawbacks.

Both the public-equity and private nature of private equity are evident in Exhibit 22. In the short run, the valuations gradually rise and fall over many quarters, resulting in low short-term volatility. The lag in the response to the public market also leads to low contemporaneous correlations with public assets. But in the long run, these artifacts of the valuations disappear. The low short-term *volatility* does not prevent large *risk* at a longer horizon. Note that Exhibit 22 is not meant to make any statement about the performance of private versus public equity. That requires a more nuanced discussion, which will follow in a later section.

In what follows, we will discuss various characteristics of private-equity markets, such as the smooth valuations, the pure private-equity component, which distinguishes private from public equity, and its beta to public-equity markets.

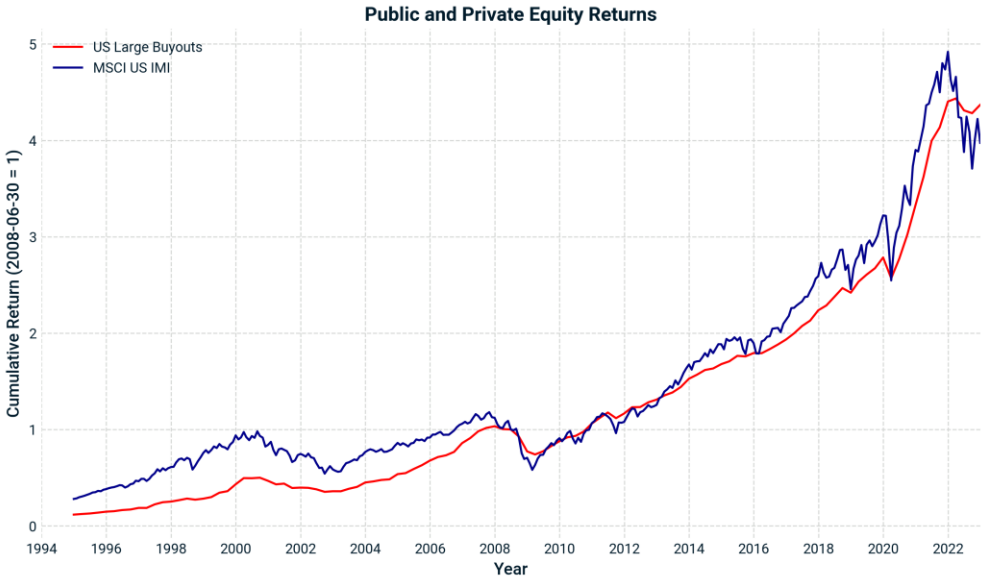


Exhibit 22: The cumulative returns of public and private equity (net of fees) show that in the short run, the smooth valuations of private equity might suggest low risk. Similarly, the lag in returns leads to low contemporaneous correlations with public equity, at the quarterly horizon. However, these artifacts disappear at a longer horizon, where large risk and high correlations are apparent. Data between Dec. 30, 1994, and Dec. 30, 2022.

Smooth private-equity valuations

The smoothness of private-equity returns poses a challenge for risk forecasting. While the scarcity of private-asset data typically blurs the picture, the smoothness can systematically distort the apparent risk by introducing autocorrelation[18] in the returns, leading to an understatement of both the stand-alone risk and the systematic correlations of private equity.

Exhibit 23 provides a demonstration of these distortions by comparing the volatility of private-equity valuations to public-equity volatility over a range of return horizons.[19] The apparent low short-term private-equity volatility rises as the horizon increases. In other words, private-equity volatility is understated in the short term but *eventually converges* to higher levels. The disconnect between the short-term and long-term behavior of the valuations is the source of the problem, but it also points toward a solution. The long-run convergence of valuation and true value implies that accurate information is embedded in the valuations, but we must work harder to extract it, as discussed in the model-description section.

[18] See also Exhibit 37 for an illustration of autocorrelation in private-equity valuations.
[19] Volatility at each return horizon is annualized using the square root of time, based on return data between 1994 and 2023. Due to autocorrelation in private-equity returns, the short-term volatility estimate is understating true volatility.

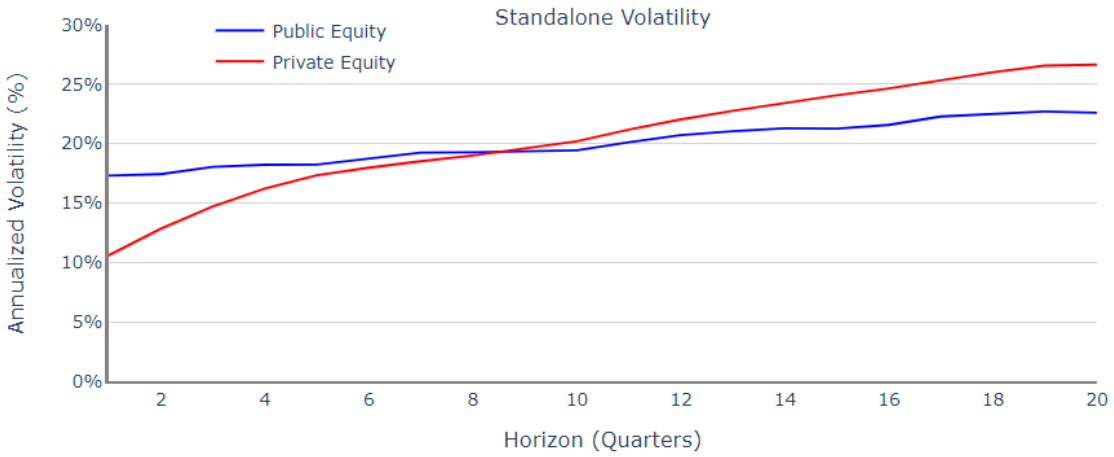


Exhibit 23: The annualized volatility of private assets rises significantly with the return horizon, in contrast with public equity volatility. Volatility at each return horizon is annualized using the square root of time. Based on return data between 1994 and 2023.

Pure private-equity component

Exhibit 24 shows the broad behavior of buyout funds in the U.S. compared with a public proxy constructed to match the fundamentals of these assets. Although significant commonality is apparent, it is also clear that the public proxy is insufficient to capture the entirety of buyout funds' behavior. In other words, part of the return is unexplained by the public proxy, which is a source of risk and return. This "pure private" component provides an intermediate level of diversification between market risk and idiosyncratic risk.

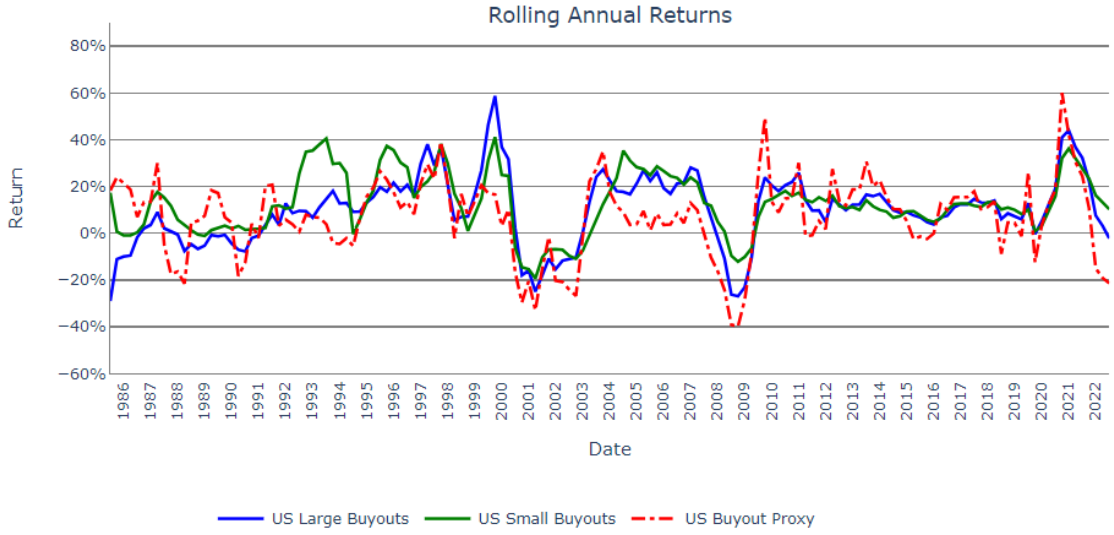


Exhibit 24: The rolling annual returns of U.S. buyouts have significant commonality with a public-proxy portfolio, but also significant differences, which cannot be attributed to differences in leverage or beta. The difference in return is the "pure private" return.

Private-equity beta

As Exhibit 22 suggests, there is some commonality between public- and private-equity markets. This source of systematic risk and its magnitude can be captured by the private-equity beta to public markets. While there is a large literature, private-equity beta estimates vary significantly across studies, as discussed by Korteweg (2023): The median beta estimate based on net-of-fee fund-level data is 1.1 for buyout funds and 1.4 for venture-capital funds, aligned with the general view that venture-capital funds are riskier than buyout funds. However, the net-of-fee beta estimates range between 0.7 and 1.5 for buyout funds and between 1 and 2.7 for venture-capital funds.[20] As the author points out, while these studies cover varying methodologies, data sources and estimation universes, the wide ranges underscore that estimation of private-equity beta is a non-trivial exercise.

Private-equity beta is influenced by many factors, which include but are not limited to leverage, company size and sector tilt. For example, the greater leverage of, e.g., U.S. buyout funds typically leads to high levels of market beta. Exhibit 25 shows the median leverage of buyout and venture-capital funds as well as public equities, as of September 2023. Portfolio companies invested in by private-equity and venture-capital funds are mostly micro- to small-cap companies, which could result in even higher betas. In addition, the cyclical nature of sectors heavily invested in by buyout and venture-capital funds could give beta another boost. A final consideration is that private-equity beta may be asymmetric, as the upside of net returns is dampened by fees, but not the downside. However, further research is needed to quantify the magnitude of this effect.

	Median leverage (September 2023)
Buyout	1.51
Venture capital	1.00
MSCI ACWI Investable Market Index	1.26

Exhibit 25: Median leverage of private and public equity by strategy. Leverage is based on the investee/public companies' balance sheets and is measured as (net debt + equity)/equity. Data as of September 2023. Source: MSCI Private Capital Solutions

Other types of financial risk in private-equity markets

While this section focused on market risk in private-equity markets, we briefly highlight some other types of financial risk that could directly affect the value of the portfolio (including other, nonprivate portions, if liquidation is required). **Funding risk** is the risk that GPs (of the funds in the portfolio) may call more capital than expected in some period of time. Exhibit 26 shows aggregate quarterly contributions and distributions for the BMU funds in the buyout and venture-capital segments.[21] For buyout funds, cash flows contracted during crisis periods like the 2008 global financial crisis and the 2020 onset of the COVID-19 pandemic. Exhibit 26 also shows that net cash flows, i.e., distributions minus contributions, turned negative in the previously mentioned crisis periods, creating a need for funding at times when market liquidity decreased.

[20] The range for buyout funds excludes two beta estimates that fall outside the min-max range in the box plot in Korteweg (2023).
[21] While Exhibit 26 shows the aggregate dollar value of the cash flows, a natural way of normalizing distributions and contributions is dividing them by net asset value and unfunded capital, respectively. We show those in Exhibit 97 in the appendix.

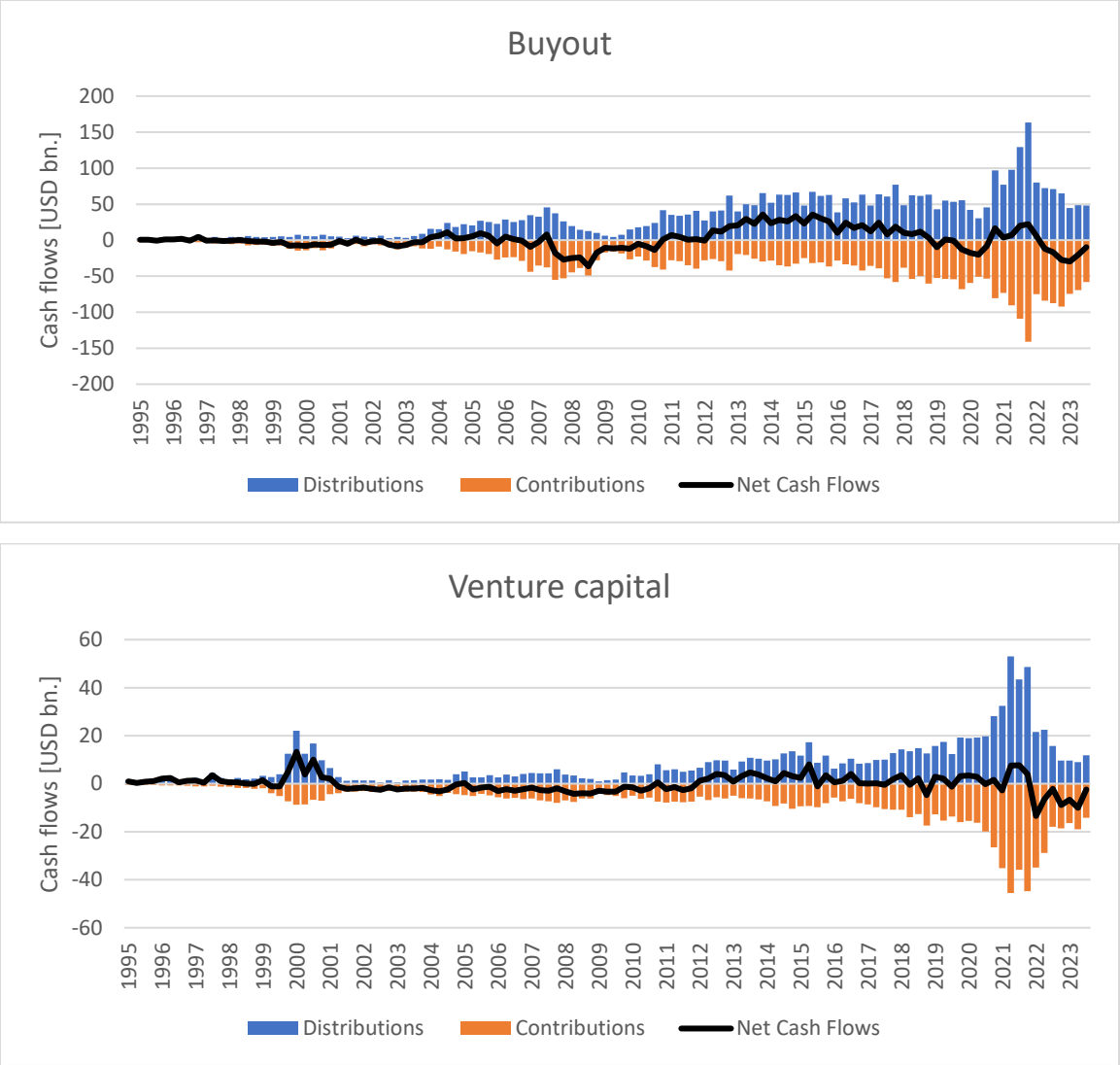


Exhibit 26: Quarterly cash flows from BMU funds through Q3 2023. Distributions are in blue; contributions in orange. The black line indicates net cash flows (distributions minus contributions). Source: MSCI Private Capital Solutions

Following Takahashi and Alexandar's model (2001), investors typically consider fund age as the sole driver for fund cash flows. However, in MSCI's Private Asset Cash Flow Scenario Analysis research, we found that buyout contributions, distributions, and hence net cash flows are tied to market variables, such as lagged public-equity returns, beyond the age effect (Liu and Demond 2022). Understanding the connection between private-asset funding risk and the market could be important.[22] Establishing the connection is also essential to the integration of private assets into total plan liquidity management.

A further comment is that, while Exhibit 26 shows the aggregate behavior of the market, private-market vintage capitalization tends to grow over time due to an increase in both the number of funds and the fund size. This creates a life-cycle problem whereby the market gets younger over time. Younger portfolios will generally produce more capital calls relative to distributions because more

[22] Market variables relevant to each private-asset strategy could vary.

funds will be early in the J-curve. While this is the appropriate way to view the market, an alternative and useful perspective is to disentangle changes in fund behavior — cash flows — from this demographic effect. In Exhibit 27, the cash flows are based on a perhaps more realistic "steady-state" allocation whereby USD 100 is annually committed to the most recent vintage in the respective segment.[23] From the exhibit it is clear that the net cash flows still exhibit cyclicality, but the steady-state allocation shows a more reassuring picture for asset owners with mature allocations (and following a similar steady-state allocation process), as net cash flows tended to be higher than for the unadjusted market.

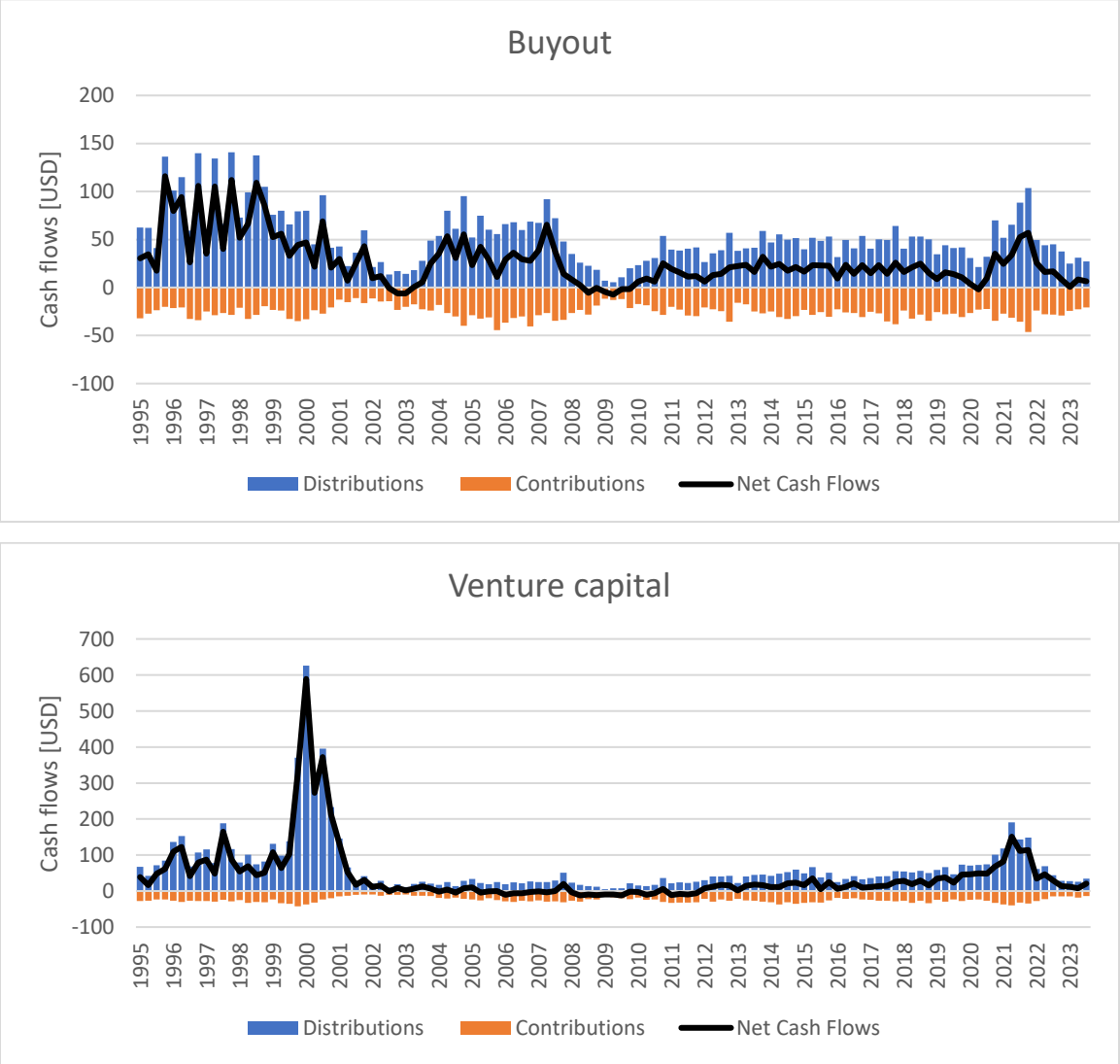


Exhibit 27: Quarterly cash flows from BMU funds through Q3 2023. Distributions are in blue; contributions in orange. Funds are reweighted such that each vintage within an asset class receives a USD 100 commitment, emulating a steady-state portfolio. The black line indicates net cash flows (distributions minus contributions). Source: MSCI Private Capital Solutions

[23] Within the vintage of a private-equity segment, we assume market-cap weights. That is, within the vintage-2000-buyout segment, USD 100 is invested proportionally to the size of the relevant funds.

Furthermore, given the private nature, significant **liquidity risk** comes with private-equity investments. While LP stakes in private-capital funds cannot be sold at a time scale of weeks, at a time scale of months a secondary market does exist. The process usually requires the involvement of the GP (since the limited-partnership agreement usually contains a right-of-first-refusal clause). Stakes are often sold in blocks without a price being assigned to each individual stake. They price usually at a significant discount to NAV, with discounts of over 10% being common (and occasionally exceeding 20%). In addition, it is not unusual for the sale to be structured in the form of a partial payment at the time of sale with the balance being provided several quarters later.

Finally, **pacing (or allocation) risk** refers to the investor not being able to maintain the particular target allocation for the portfolio; this allocation may be along various dimensions such as industry, geography or other asset characteristics (such as entity leverage — especially relevant for buyout funds). However, since an LP must rely on the GP to make these decisions, it is impossible to achieve this allocation precisely. In fact, even the coarsest allocation, namely the private NAV (in effect, the allocation to private assets) is difficult to target precisely. Broadly speaking, this could also be classified as "agency risk" — a term that would also cover funding risk.

MSCI Private Equity Risk Model

As discussed in the section "Private-equity market risk," private equity has commonalities with public equity while it also has its unique private-equity return component. To model private-equity risk, the MSCI Private Equity Model (PEQ2) balances the "equity" and "private" aspects of "private equity," and brings together information both from public markets and private valuations, as shown in Exhibit 21.

The PEQ2 model decomposes private equity's "true" return as:

$$True\ Return = Beta_{public} \cdot Public\ Factor\ + Beta_{private} \cdot\ Pure\ Private\ Factor + Asset\ Specific$$

Private equity's "true return" aims to capture the "intrinsic value," which differs from valuations, and can be considered as the hypothetical value for which it could be traded on a daily basis as a liquid asset. Valuations, on the other hand, are based on the GP's assessment and are smooth in nature.

According to the above equation, private-equity returns are driven by an asset's exposures to systematic factors in the public market, its exposure to pure private factors and an asset-specific component. Such a return decomposition enables the estimation of a private asset's stand-alone risk, private-asset correlations with other asset classes and the diversification benefits of the inclusion of private assets in a multi-asset-class portfolio.

The MSCI Private Equity Model covers 17 private-asset strategies by region, as shown in Exhibit 28, based on MSCI Private Capital Indexes. One benefit is that this data is sourced from LPs, making it less prone to selection and survivorship biases.[24]

[24] See Harris (2023) for a discussion of different sources of private-equity data.

Pure private factor	Public proxy
US PE large buyouts	MSCI USA IMI
US PE small buyouts	MSCI USA IMI
US PE early-stage ventures	MSCI USA Small Cap/HEALTH CARE MSCI USA Small Cap/INFORMATION TECH MSCI USA Small Cap/TELECOM SVC
US PE late-stage ventures	MSCI USA Small Cap/HEALTH CARE MSCI USA Small Cap/INFORMATION TECH MSCI USA Small Cap/TELECOM SVC
US PE distressed	Merrill Lynch US High Yield Index
US PE mezzanine	Merrill Lynch US High Yield Index
Europe PE large buyouts	MSCI AC Europe IMI
Europe PE small buyouts	MSCI AC Europe IMI
Europe PE early-stage ventures	MSCI AC Europe Small Cap/HEALTH CARE MSCI AC Europe Small Cap/INFORMATION TECH MSCI AC Europe Small Cap/TELECOM SVC
Europe PE late-stage ventures	MSCI AC Europe Small Cap/HEALTH CARE MSCI AC Europe Small Cap/INFORMATION TECH MSCI AC Europe Small Cap/TELECOM SVC
Europe PE distressed	Merrill Lynch Euro High Yield Index
Europe PE mezzanine	Merrill Lynch Euro High Yield Index
Asia PE large buyouts	MSCI AC Asia IMI
Asia PE small buyouts	MSCI AC Asia IMI
Asia PE early-stage ventures	MSCI AC Asia Small Cap/HEALTH CARE MSCI AC Asia Small Cap/INFORMATION TECH MSCI AC Asia Small Cap/TELECOM SVC
Asia PE late-stage ventures	MSCI AC Asia Small Cap/HEALTH CARE MSCI AC Asia Small Cap/INFORMATION TECH MSCI AC Asia Small Cap/TELECOM SVC
Asia PE distressed	Merrill Lynch Global Emerging Market Credit Asia

Exhibit 28: PEQ2 covers six private-equity strategies in Europe and the U.S. and five strategies in Asia. When three proxies are listed (strategies for early and late-stage ventures), the estimation uses a portfolio of the three indexes (index cap-weighted average).

The PEQ2 model employs a Bayesian de-smoothing framework[25] for exposure and factor estimation, designed to prevent misleading conclusions from smooth valuations and to minimize the impact of small-dataset noise. At its core, this approach revolves around the fundamental question: *What is our best risk estimate based on our current knowledge?* This methodology effectively synthesizes diverse information sources and diminishes noise without imposing rigid assumptions on the data. To estimate private-equity exposures to the public market, each private-equity strategy is mapped to a public proxy, as shown in Exhibit 28. Because private-equity data is too scarce and smooth for standard backtesting, the estimation methodology has been tested with simulation studies. This

[25] The concept of de-smoothing, as introduced by Geltner in 1993, plays a crucial role in the model estimation.

analysis suggested that the use of Bayesian priors can significantly reduce noise, perhaps cutting the estimation error by a factor of two or more.[26]

Drivers of private-equity risk in the PEQ2 model

As shown in Exhibit 29, the **public-to-private betas** are a significant source of systematic risk inherent in private equity, despite potentially lower correlations with public markets. The model's ability to link private equity to public proxies allows it to respond to shocks in public markets, maintaining a consistent view of risk between public and private assets. This responsiveness is important because it helps in accurately reflecting the risk profile of private equity in varying market conditions, especially during times of crisis.

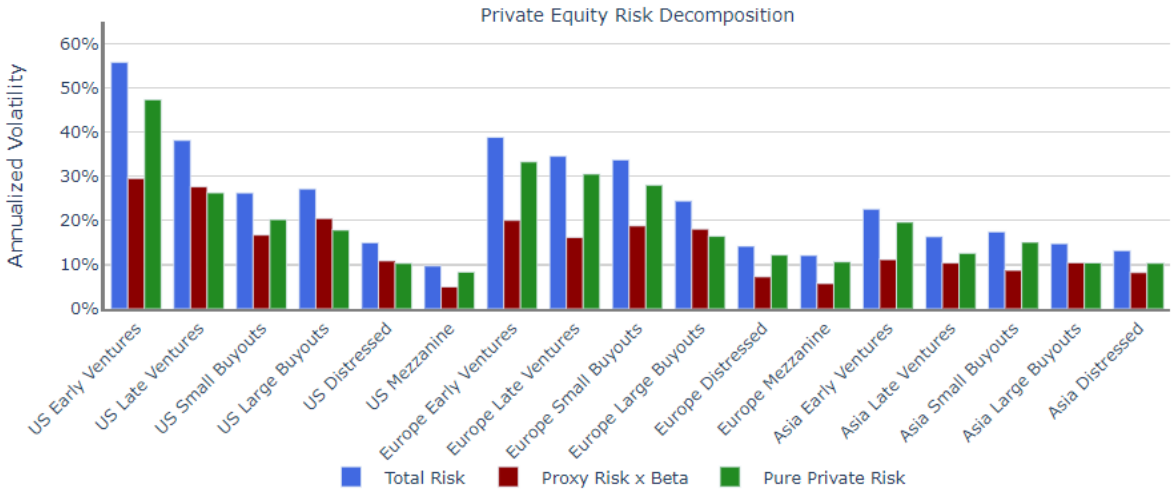


Exhibit 29: Forecasts of the total risk, beta-adjusted public proxy's risk and pure private risk for various segments of the private-equity markets. Based on MSCI PEQ2 Model, as of September 2023.

Exhibit 30 shows the model beta for the 17 strategies. Betas of buyout funds vary between slightly below 0.8 and 1.2, depending on the region. These betas fall within the range of private-equity betas found in the literature and are higher than betas calibrated from valuation-based returns. While

[26] For a more detailed discussion of the PEQ2 model estimation and testing, we refer to the MSCI Model Insight paper (Shepard and Liu 2014).

private equity's leverage relative to public-equity markets affects the beta, other factors such as company size and sector concentration may have an impact as well.

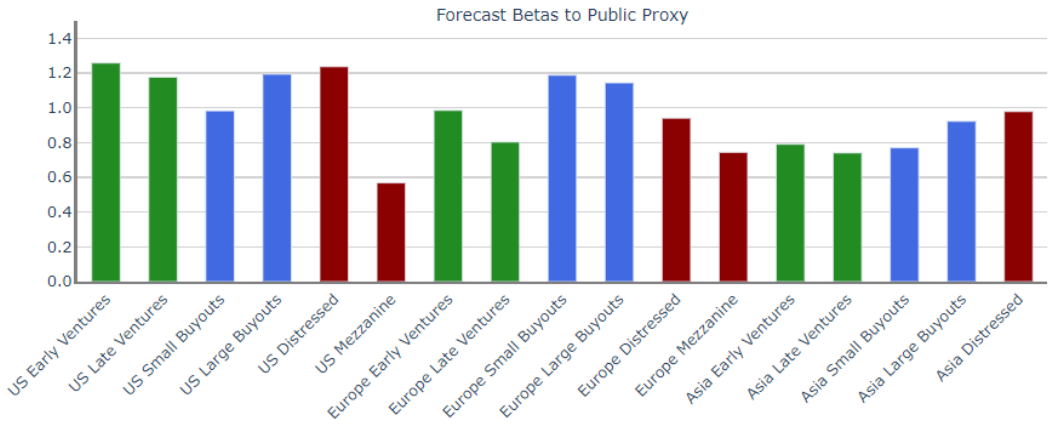


Exhibit 30: Model estimates of the beta of private equity to the public proxy of each segment. The high betas show private equity to be a source of significant systematic risk. As of March 2023.

PEQ2 **public proxies** are exposed to factors in public-factor models. Through the proxy exposures, private assets get exposed to public factors, which results in a holistic view on the exposures of the total portfolio to the public-market drivers.

The **pure private return** is a result of the model estimation, described in the previous section. This return component is orthogonal to the public-market component and captures characteristics of private-equity investments that cannot be replicated by public proxies, such as liquidity premia and differences in company characteristics. For various segments of private equity, the total risk includes a large contribution from the pure private component, as shown in Exhibit 29.

Finally, **asset-specific risk** is a nontrivial component to a specific asset's total risk. In the PEQ2 model, asset-specific risk is modeled based on the public proxies. However, it is less relevant at the portfolio level due to diversification.

Jointly, these drivers capture the public and private nature of private equity investments, combining various information sources. While it tackles the problem of autocorrelation, it also provides a robust estimation of the private-to-public beta through a Bayesian approach. An advantage of this methodology is that it allows to compare private equity to other asset classes on a like-to-like basis,[27] allowing for a comprehensive assessment of total portfolio risk through common risk drivers, such as public equity and bond risk factors, as well as pure private return drivers.

Managing private-equity risk

Investors in private assets need to understand market risk as it helps estimate the risk of not receiving the expected return on investment. It also serves as a basis for risk monitoring, providing early warnings on the components of the portfolio that are likely to breach risk budgets and

[27] This not only includes the comparison to public equity and bond markets, but also other alternative asset classes such as private real estate and private infrastructure, which can also be modeled through a combination of private and public information sources.

potentially cause significant losses over time. As mentioned in the previous section, it is important that such a risk assessment can be consistently applied across various asset classes, facilitating benchmarking and allocation decisions.

Investors often follow a framework in which a portfolio is considered as a collection of exposures to a set of return sources, e.g., asset classes, also known as the X-Sigma-Rho framework (Menchero 2011). In this decomposition, the contribution of a return source to the portfolio's risk is a function of 1) the portfolio's exposure to the source; 2) the stand-alone risk of the return source; and 3) the correlation of the return source with the total portfolio. As we will discuss later, each of these components in the risk decomposition can provide useful information about the risk profile of the total portfolio.

In what follows, we will first focus our attention on the tracking error and how it changes when private equity is included in the allocation, using a stylized example. Second, we will briefly discuss the opportunity-cost model, which is an alternative approach to risk management, used by some investors who include private assets in their allocation. Finally, we will present a set of additional risk measures that could provide more context for risk management, going beyond the tracking error relative to a reference portfolio. Measures such as a return source's correlation with the total portfolio can illustrate diversification benefits from the inclusion of private equities, even though the tracking error might increase.

Tracking error in the presence of private equity

Tracking error is often used to regulate risk relative to a benchmark or reference portfolio. For this use case, it is important to be able to assess risk across asset classes in a consistent manner. The smooth private-equity returns could make private equity appear to have a lower correlation with public equity than it actually does. In what follows, we have used the MSCI Private Equity Model to assess the tracking error and risk of an allocation including private equity.

We have set up a stylized example of a reference portfolio, consisting of 70% U.S. equities and 30% U.S. government and investment-grade corporate bonds.[28] We then created various portfolios, starting from the reference portfolio and gradually adding private equity, funded by selling public equity. For the private-equity allocation, we used a well-diversified model portfolio of large U.S. buyout funds. Note that adding private equity to the portfolio introduces a new return source: While private equity is partially driven by public-equity returns, part of its return is impacted by pure private-equity factors.

Exhibit 31 shows how the inclusion of U.S. private equity increased the tracking error, which reached around 90 basis points (bps) for a 5% allocation to private equity, according to our risk model.[29] This does not come as a surprise given the pure private-equity exposure that is orthogonal to the public-equity portfolio. However, the total risk of the allocation increased by only 15 bps due to the diversification effect of the pure private-equity factor.

[28] The reference portfolio is represented by a 70% weight in the MSCI USA Index, 18% weight in the MSCI U.S. Government Bond Index and 12% weight in the MSCI USD Investment Grade Corporate Bond Index. Private equity in the alternative allocation is represented by a model portfolio of large U.S. buyout private-equity funds.

[29] Note that this risk number assumes the private-equity investment is in a relatively large number of funds, diversifying away the specific risk. For more concentrated private-equity portfolios, the active and total risk would generally be larger due to the contribution of specific risk.

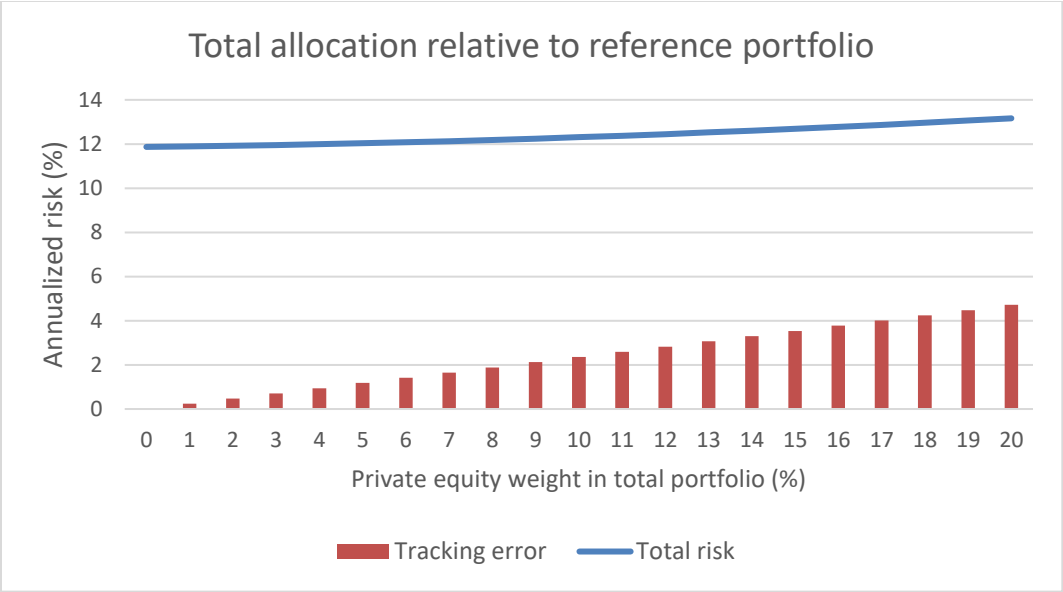


Exhibit 31: The active risk relative to a reference portfolio of public equity and bonds, as well as the total risk, goes up when adding private equity. Based on the MSCI Private Equity Model. As of November 2023.

Exhibit 32 shows the evolution of tracking error and total risk over time for a 5% allocation to the model private-equity portfolio. We observed that while the total risk of the portfolio fluctuated more through time, the tracking error was relatively stable between 80 and 100 basis points.

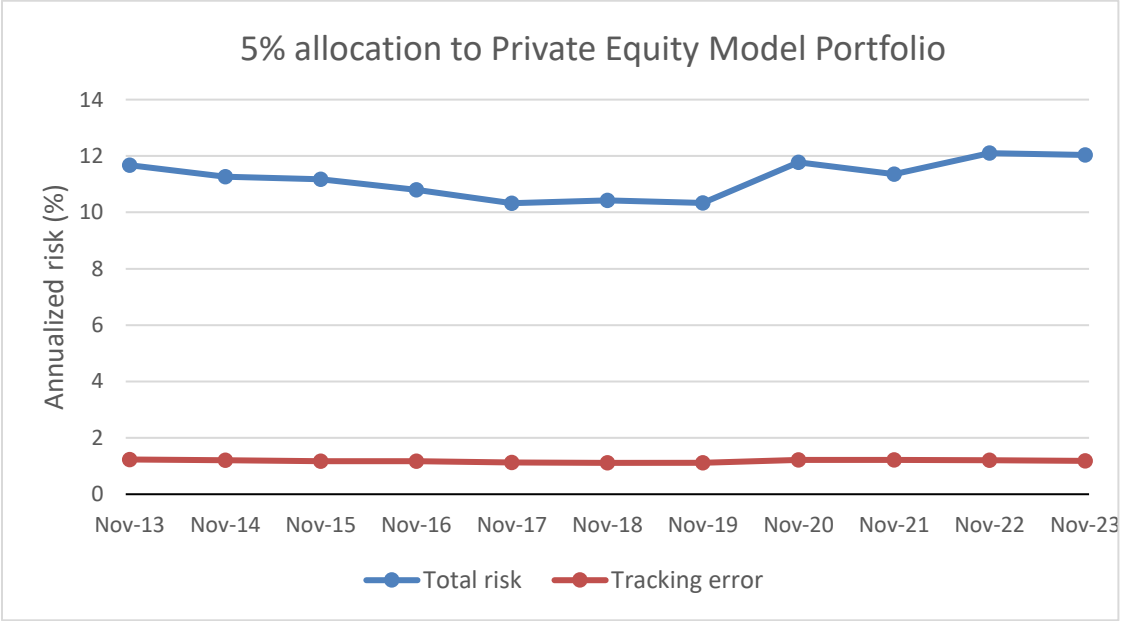


Exhibit 32: Evolution of tracking error and total risk relative to the reference portfolio. Based on MSCI Private Equity Model

The stylized example above illustrated that replacing part of the public-equity allocation with private equities increased the tracking error relative to the reference portfolio of public equities and bonds. If the tracking-error budget remains unchanged, the allocation to private equity will have to be traded off with opportunities for active management in public investments. Alternatively, the private-equity allocation could be regulated on a stand-alone basis, relative to a private-equity benchmark or a public index plus a spread. A third option is to use the opportunity-cost model, briefly discussed in the next section.

The opportunity-cost model

The opportunity-cost model is generally used within the total-portfolio approach for asset allocation.[30] This approach aims to provide a consistent and coherent framework for analyzing investment decisions across both private and public markets. The model looks beyond asset-class labels, focusing instead on a factor-like approach to portfolio construction. The factors at this layer are the low-cost investment strategies selected for the reference portfolio.

Before making any portfolio allocation, the asset owner first decides on the mix of reference portfolio components that best replicates its risk and return. The investment decision is effectively funded by this mix. The funding portfolio becomes the top-level performance benchmark, or hurdle rate, for the investment and represents the opportunity cost of the investment decision. For example, instead of investing in a large U.S. buyout fund, an asset owner could have invested passively in a liquid and low-cost alternative in the public equities space to provide a similar risk profile (potentially applying leverage). However, the pure private exposure illustrated in the previous section is not replicable by low-cost public market alternatives and may represent a premium that can be harvested by sophisticated investors.

The proponents of the opportunity cost model argue that the analysis of assets according to their equity and bond return exposures allows for better comparability of investment opportunities. The portfolio manager must articulate the marginal benefits of any investment decision in excess of the funding portfolio. At the aggregate level, the difference between the fund and reference portfolio returns represents the overall value added by active management.

However, there are several caveats to its use. First, the model may only be suitable for true long horizon investors. It is inevitable that there will be significant risk and performance differences over any short period in time between private investments and the public components of the funding portfolio. As noted by (Ang, Brandt and Denison 2014), for alternative asset class investments it could be almost a decade for the total portfolio investment thesis to be realized. Second, the two legs of each investment decision potentially require a more time and data intensive process relative to the traditional approach.

A final consideration is that the factor risk decomposition provided by this approach focuses only on the relationships between the investment and selected public asset class indexes. It is also important to get insight into the nature of the orthogonal risks of each investment, including exposures not available in public markets and idiosyncratic risks, which represent opportunities for security selection. The funding portfolio will give an indication of how this investment performs against other asset classes in the public reference portfolio, but it will not assess the relative

[30] For example, CPPIB, GIC and the New Zealand Superannuation Fund have identified themselves with the Total Portfolio Approach (The Thinking Ahead Institute 2019). Norway's Government Pension Fund Global employs the opportunity cost model for its real estate investments (Bauer, Christiansen and Døskel 2022)

performance of the specific investment to other opportunities in the asset class. An asset-class specific benchmark, e.g., for large U.S. buyout funds, could help to ensure alignment between allocation and implementation.

Additional risk measures

As mentioned in the previous sections, the tracking-error approach as well as the opportunity-cost model may provide an incomplete view of portfolio risk. In Exhibit 33, we provide additional risk measures that can help complete the picture.

We revisit the hypothetical example used for Exhibit 31, with a 5% allocation to private equities. The inclusion of private equities introduced a tracking error of 89 bps relative to the reference portfolio, but the total risk of the allocation went up only from 12.09% to 12.23%. While the stand-alone risk of private equity is larger than that of public equity, its correlation with the total portfolio is lower than that of public equity (0.79 versus 0.99), which is why the portfolio's total risk did not increase significantly.

	U.S. equity	U.S. fixed income	U.S. private equity	Total
Weight	65%	30%	5%	100%
Total risk (TR)	17.12	4.70	26.59	12.23
Correlation	0.99	0.11	0.79	
Total risk contribution	11.02	0.15	1.06	12.23
Marginal contribution to TR	0.17	0.01	0.21	0.12
Relative to reference portfolio				
Active weight	-5%	0%	5%	0%
Tracking error (TE)	5.33	12.45	19.30	0.89
Active correlation	0.17	0.00	0.77	
Tracking-error contribution	-0.14	0.00	1.03	0.89
Marginal contribution to TE	0.028	-0.0001	0.205	0.0089

Exhibit 33: This table provides an overview of potential risk measures for a more comprehensive risk assessment of the allocation. Based on MSCI Private Equity Model. As of November 2023.

In fact, based on the X-Sigma-Rho framework, we can calculate the contribution to total risk (1.06%) of U.S. private equity as the product of its weight in the portfolio (5%), its stand-alone risk (26.59%) and its correlation with the portfolio (0.79). This highlights the important role of correlations in determining total portfolio risk. The largest stand-alone risk sources do not always contribute most to aggregate total portfolio risk. When it comes to tracking error, the contribution of, e.g., private equity is the product of its active weight (5%), stand-alone risk (26.59%) and active correlation (0.77). Note that the active correlation is much larger for private equity than for the fixed-income and public-equity allocations, leading to a significantly larger contribution from private equity to the portfolio's tracking error.

The marginal contribution to total risk is a statistic that helps investors understand how the total risk would change if they increased the allocation to that segment of the allocation by 1% (by borrowing the equivalent amount of cash). It is the product of an asset class's stand-alone risk with its

correlation with the portfolio. Exhibit 33 shows that adding private equity would increase total risk most, while adding fixed income would have the smallest impact on total risk.

When there is information about the expected returns of asset classes, the total risk and tracking error can be used to calculate the ex-ante Sharpe ratio and information ratio of segments of the asset allocation and the total portfolio. One can then assess whether the inclusion of private equity would lead to superior risk-adjusted total and active returns. Under the assumption that total risk does not change significantly for a 3% to 5% allocation to private equity (as suggested by the analysis in Exhibit 31), the allocation's Sharpe ratio would increase if private equity were to deliver excess returns compared to public-equity markets.

Another useful perspective is the risk decomposition in the risk-factor space, which looks through asset-class labels and focuses on the fundamental factors driving portfolio risk. This view of risk could help in assessing whether swapping public for private equity increases the contribution of public equities to total and active risk. Exhibit 34 shows that the contribution of public-equity factors (such as market, industry and style) is not larger for the new allocation. Most of the contribution to active risk is driven by pure private-equity factors. This decomposition between public and pure private exposure can help investors understand how private-equity investments overlap with, but also differ from, those in public-equity markets.

	Reference portfolio	*New allocation*	
Factors	**Total risk contribution**	**Total risk contribution**	**Active risk contribution.**
Local-market risk	**12.05**	**12.23**	**0.89**
Common factor risk	11.83	12.04	0.87
Market	*11.78*	*11.93*	*0.03*
Industry	*0.18*	*0.18*	*0.00*
Style	*-0.29*	*-0.29*	*0.00*
Term structure	*-0.03*	*-0.03*	*0.00*
Spread	*0.18*	*0.18*	*0.00*
Private equity	*0.00*	*0.06*	*0.84*
Selection risk	0.23	0.19	0.02
Total risk	**12.05**	**12.23**	**0.89**

Exhibit 34: Risk-factor decomposition of the total and active risk for the reference portfolio and investment portfolio with 5% allocation to the model private-equity portfolio. Based on MSCI Private Equity Model. As of November 2023.

In addition to traditional risk measures, scenario analysis is another approach that could add value to the risk-management practice. While traditional risk approaches are calibrated to historical data, scenario analysis allows a more forward-looking assessment of the potential impact of specific market events or longer-term structural changes. As an illustration, Exhibit 35 shows the one-year impact to the asset allocation under four hypothetical macroeconomic scenarios (Verbraken and Baker 2023). While fixed income often tended to provide a cushion against losses in risky assets, the mild-stagflation scenario in Exhibit 35 envisions an outcome where both equities and fixed-income assets lose considerable value, similar to what happened in 2022. Although scenario analysis partly relies on subjective inputs, it can help explore ranges of portfolio impacts that are not necessarily captured by traditional risk models.

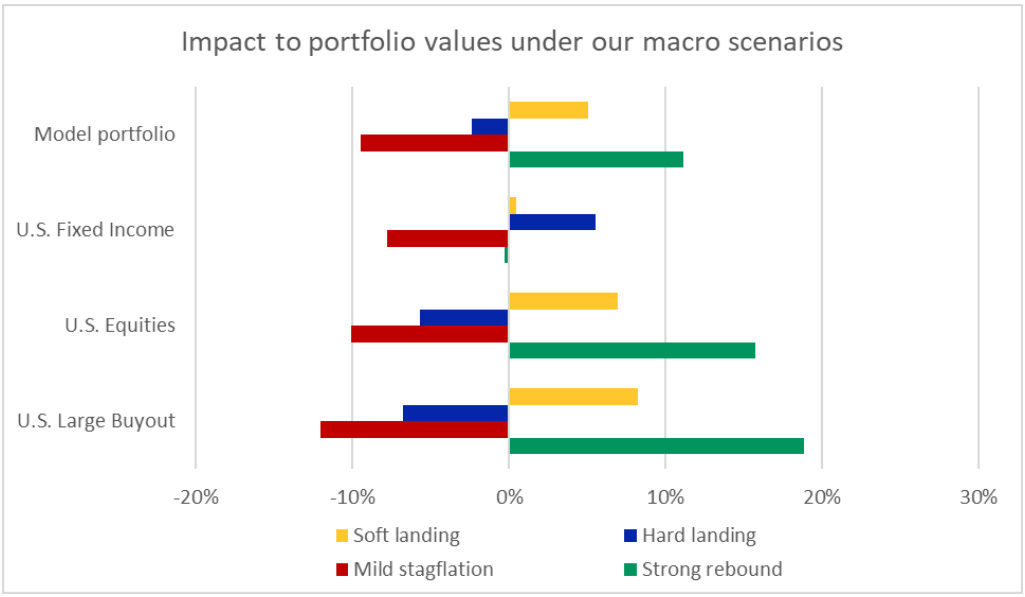


Exhibit 35: Impact to asset allocation under four hypothetical scenarios. Source: MSCI Multi-Asset-Class Model

Scenario analysis could also be incorporated in asset allocation, by putting less emphasis on backward-looking, short-term risk, but instead prioritizing resilience to potential macroeconomic uncertainties while preserving similar levels of long-run expected returns (Shepard, Tiantian and Li 2022). With an increasing focus on potential systemic risks among asset owners (The Thinking Ahead Institute 2023), scenario analysis could help prepare for uncertain and unprecedented future scenarios.

Performance measurement in private capital

In this section we discuss performance measurement and reporting and the various issues and limitations associated with measuring performance in private-capital markets. Next, we discuss benchmarking and performance attribution.

Performance reporting in private capital

Measuring performance in private capital is limited by the frequency of the underlying data, which in this case relies on valuations reported by the fund — typically on a quarterly basis, albeit with a delay of 55 to 90 days depending on the quarter. However, as will be discussed in the next section, due to the varying amount of capital deployed during the life of the fund as well as the subjective nature of fund valuations, quarterly returns paint a limited picture of fund performance. This has led to a proliferation of additional measures.

The most common is the **internal rate of return** (**IRR**). It is the rate of return that, when used to discount all fund cash flows (treating the current fund valuation as a distribution), results in a value of zero. Since it potentially covers cash flows during the entire life of the fund, it is generally considered a long-term measure (in contrast to a more short-term measure such as a quarterly return). In addition, it is a money-weighted measure, since it is sensitive to the relative magnitude of cash flows; for example, this means that small cash flows (perhaps at the start and end of a fund's life) will affect the IRR much less than large cash flows in the middle of a fund's life. This contrasts with the compounding of quarterly returns (often called time-weighted rate of return, or TWRR),

which treats quarters with small starting and ending NAVs on equal footing with quarters in the middle of a fund's life when the NAVs will be large. Since IRR is a *rate* of return, it does not reflect the magnitude of distributions in excess of contributions. For example, a fund could achieve a 20% IRR by investing USD 1 and returning USD 1.20 a year later; or it could achieve the same return by investing the same amount and returning USD 2.48 five years later.

These two cases are distinguished by **total value to paid-in** (**TVPI**), which is a simple ratio of the proceeds and unrealized value of the fund to the contributed capital. It directly expresses how much capital was generated by the investment but, unlike IRR, is not sensitive to how long the fund took to do so. Thus, both measures are usually quoted. A measure of a fund's duration can also be computed, but that is rarely reported.

Usually, IRR is computed "since inception" (or "inception to date"), resulting in a money-weighted return since the beginning of the life of the portfolio. For a long-lived portfolio, this will be a slow-moving measure of return and may suffer from other problems, as discussed in the next section. Investors may want a more short-term notion of IRR. For these purposes, one can compute a point-to-point IRR over any set of quarters, treating the initial fund valuations as cash inflows and unrealized valuations as cash outflows. In fact, the quarterly modified Dietz return[31] can be considered an approximation (usually a very good approximation) to a one-quarter IRR. In reports, common point-to-point IRRs include 1- and 3-year IRRs.

All the measures mentioned above are absolute measures of return. An additional class of measures assesses performance relative to an — often liquid — index. Over the last couple of decades various measures have been proposed, such as, early on, the Long-Nickels index-comparison method. Nowadays, most reporting of relative returns focuses on two measures: **direct alpha** (**DA**) and **Kaplan-Shoar public-market equivalent** (**KS-PME**), which can be considered as generalizations of IRR and TVPI.[32] They measure the excess return relative to that index (Gredil, Griffiths and Stucke 2022) (Kaplan and Schoar 2005). Additional measures are sometimes used, such as distributions to paid-in (DPI), which is similar to TVPI but ignores the unrealized fund value.

An example performance report is shown in Exhibit 36, whereby each investment has been paired with a peer group from the same private asset class (e.g., buyout) and vintage year. As one moves up the portfolio (e.g., to all buyout or the entire portfolio), results are aggregated via pooling as one might do with assets that are not private. We will discuss pooling further in a later section.

[31] The modified Dietz return over some period is the change in the fund's value divided by (what can be thought of as) the average value of the fund over that period. For short periods it produces a very similar return to the one-quarter IRR but avoids the use of a root-finder. In fact, the modified Dietz return can be considered a first-order approximation to the IRR.

[32] In fact, to compute IRR and TVPI, one must choose a currency in which to denominate all cash flows and valuations. If one generalizes this to denominating in terms of a numeraire, then one can use an index to denominate such cash flows. From this perspective, DA and KS-PME are precisely IRR and TVPI but using an index as a numeraire instead of a currency.

Asset class	Vintage	Mod. Dietz (1q)	IRR (3y)	IRR	TVPI	Dir. alpha	KS-PME
All	**All**	**1.2%**	**23.3%**	**14.7%**	**1.90**	**4.1%**	**1.20**
Venture capital	**All**	**-0.1%**	**24.0%**	**14.2%**	**2.07**	**3.5%**	**1.21**
Venture capital	2022	-0.1%	-18.1%	-18.1%	0.85	-18.6%	0.85
Venture capital	2021	-2.6%	-15.6%	-15.6%	0.79	-15.2%	0.79
Venture capital	2020	-1.2%	8.6%	8.2%	1.17	-1.5%	0.97
…	…	…	…	…	…	…	…
Venture capital	2000	-14.4%	18.9%	1.3%	1.09	-3.6%	0.81
Buyout	**All**	**3.8%**	**21.9%**	**16.1%**	**1.65**	**5.8%**	**1.19**
Buyout	2022	3.1%	-1.1%	-1.1%	0.99	-10.9%	0.94
Buyout	2021	4.0%	10.0%	10.0%	1.11	11.3%	1.13
Buyout	2020	5.5%	11.5%	11.3%	1.20	5.4%	1.10
…	…	…	…	…	…	…	…
Buyout	2000	1.6%	34.1%	17.2%	1.96	11.9%	1.56

Exhibit 36: This table displays a variety of performance measures across several different hierarchy levels of a portfolio. Mod. Dietz (1Q) is the quarterly return (not annualized) computed using the modified Dietz formula.

Next, we will focus on the limitations of various performance measures used for private assets. We start with the subjectivity of reported valuations and the statistical consequences thereof. Then we highlight properties of IRR, such as reinvestability (or lack thereof) and its so-called stickiness, as well as the change in the reported performance of funds during their life (the J-curve). We also touch on how long an investor must wait for a fund's performance measure to become a reliable measure of final performance. Finally, we discuss the beta assumptions required for relative measures.

The impact of valuation errors and smoothing

Private-capital data suffers from at least two forms of lags. The first, a reporting lag, is the delay between the as-of date of data and when it becomes available to the investor. This lag is usually longest in the fourth quarter, when the quarterly report is typically audited. As a result, a fund's NAV for the end of December may become available only in April.

The second lag could be termed a valuation lag (or smoothing) and is an econometric artifact: While fund cash flows are objective, their valuations are subjective and depend on backward-looking data such as comparable transactions and company accounting data. This leads to autocorrelation of valuations, as can be seen in Exhibit 37.

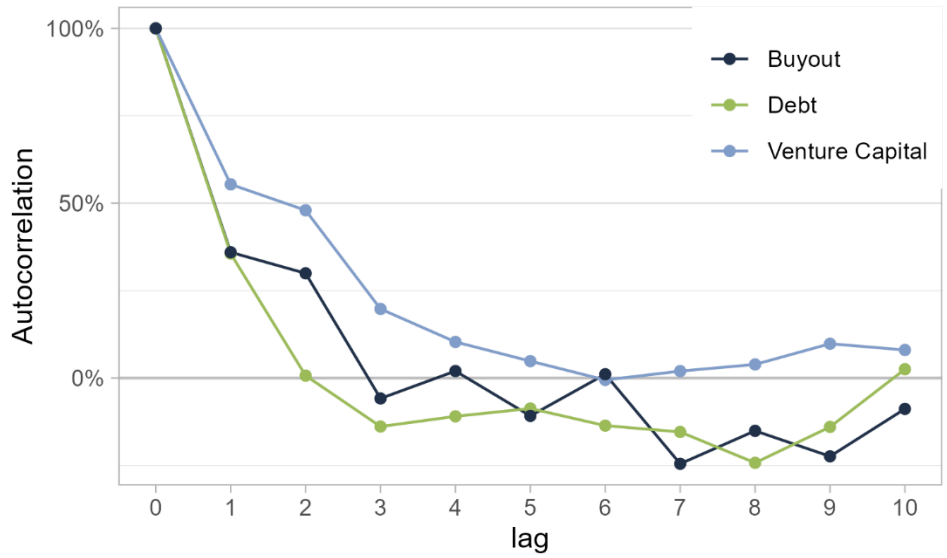


Exhibit 37: Autocorrelation of quarterly returns as a function of lag in quarters.

Next, we turn to valuation errors — i.e., the difference between the valuation of a fund's holdings and the price they would fetch if they were sold. The presence of significant valuation errors in private-capital data can be most clearly detected when a fund exits from an investment. If a fund exits from a small (relative to the fund's NAV) investment, then such an error will have little effect on the fund's return. In contrast, exiting from a large investment with a significant valuation error will have a large effect on the fund's return. Thus, valuation errors are a source of unexpected returns, and the dispersion of these unexpected returns will be larger, the larger the exit as a fraction of a fund's NAV. This effect can be seen clearly in Exhibit 38, where one sees the dispersion in returns generally growing as the size of the exit grows. These errors are sizable, and in principle could be random; due to smoothing, however, some portion of them results in a systematic bias.

Finally, notice that these effects vary across asset classes. Private debt seems to suffer significantly less from these effects. It is possible, however, that this could be a result of their being marked to market as if the underlying loans were very similar to more liquid counterparts. How true this is may require a full credit cycle to become evident. In contrast, venture capital, probably because of the difficulty of arriving at accurate valuations, is impacted most by autocorrelation. Exhibit 38 also suggests a decline in the size of errors after 2005-2010, which is most noticeable for buyout funds. This may be due to a 2007 change in the Financial Accounting Standards Board (FASB) guidance (FAS 157 2007) requiring the use of fair values for illiquid assets (as opposed to holding them at cost, for example). This change may have resulted in a decrease in valuation errors.

Because of these valuation errors and their smoothed nature, short-term (namely, quarterly) returns paint an incomplete picture of private-capital performance. Longer-term measures can reduce the above problems, although they raise some issues of their own. Possibly the simplest measure is TVPI. Also often used is IRR, which is a "money-weighted" measure of return and discussed in the next section.

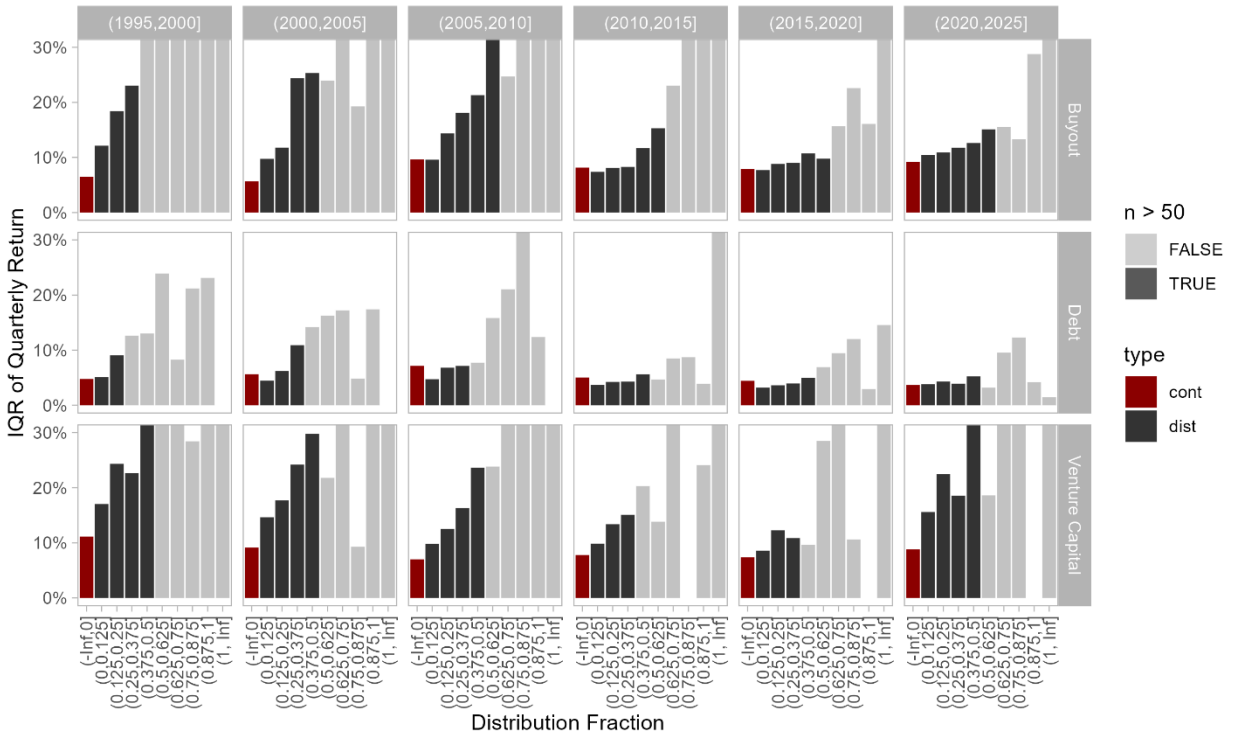


Exhibit 38: This chart shows how the dispersion in quarterly returns generally grows as the fund distributes more capital, which can be explained by the presence of valuation errors. The interquartile range (IQR) of quarterly returns as a function of distribution size (as a fraction of fund NAV). Some portion of the IQR is the natural variation in returns across funds. This is captured by the leftmost bar (in red). However, in quarters with a significant exit, the valuation error also contributes to the IQR, and the larger the exit, the larger this effect. Bars in gray have less than 50 observations and are less significant.

Internal rate of return: Reinvestability and stickiness

It is sometimes argued that an IRR implies the return can be reinvested (Phalippou 2008), when in fact the IRR of a cash-flow stream is merely the rate of return of that stream that makes its present value zero, with no further assumptions about reinvestment. In a sense, it is the return for a certain finite duration of time. Indeed, by combining the TVPI and IRR, one can even estimate a fund's effective duration.[33]

A more subtle problem with IRR is what is sometimes termed its "stickiness": The IRR of a long-lived portfolio tends to have its IRR stuck if it is large in the early stages of the fund. An extreme example of this pathology is illustrated in Exhibit 39. It includes all funds in the BMU as a hypothetical portfolio using market-capitalization weights and combining vintages from 2009 to 2022. In addition, it includes vintage year 1985, which — critically — has a small market cap compared to any of the more recent vintages. Despite the old vintage's seeming insignificance, the IRR of the portfolio is essentially equal to that of the 1985 vintage, which is completely out of line with the IRRs of the more recent vintages. In other words, the portfolio's IRR has become stuck at the IRR of the old vintage. The reason for this behavior is that because the old vintage has a high IRR, the discounted

[33] One can define the "effective duration" of a fund as log(TVPI)/log(1 + IRR), where IRR is the annually compounded IRR. The rationale for this formula is that, for a hypothetical fund with a single contribution and a single distribution, it recovers the amount of time between those two cash flows. Thus, one can think of the formula as generalizing the notion of duration to any sequence of cash flows for which an IRR can be computed.

value of the recent cash flows is very low and has little ability to change the IRR from that of vintage 1985. In fact, for recent vintages to compete with the old vintage, their capitalization would need to grow exponentially at a rate similar to the old vintage's IRR; this is far from how capitalizations have actually grown since 1985. This is the well-understood phenomenon of compound growth. However, it does mean that IRRs of long-lived portfolios can be counterintuitive, or at least hard to interpret. A simple solution is to assess temporally focused subsets of the portfolio, typically per-vintage IRRs.

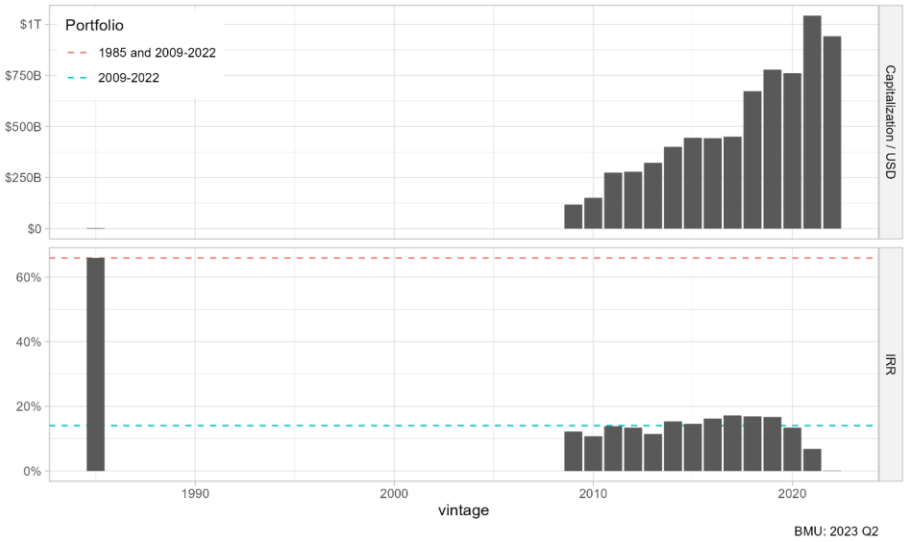


Exhibit 39: Capitalization and since-inception IRRs of vintages 1985 and 2009 to 2022 for all global funds in the BMU. The two dotted lines are the since-inception IRRs of the portfolios consisting of these vintages, including and excluding vintage year 1985. Note that the capitalization of vintage year 1985 is very small (and can be missed in the above chart).

Behavior of fund performance early in life

The performance of a fund early in its life is not indicative of its final performance for at least two reasons. First, when managers make investments, their portfolio companies may take time to perform as expected. This is perhaps especially true in the case of buyout funds due to changes made with the help of the GP. Furthermore, even if there is an increase in value, GPs may choose to value them conservatively early on. Finally, because of how funds call fees, these fees exert an outsize effect on performance when the NAV of the fund is low. This combination results in funds' having lower returns early in their lives. This effect is termed the J-curve.[34] This can be seen clearly in Exhibit 40, which shows that, especially for private-equity funds, performance as measured by IRR takes two to three years to stabilize.

[34] The term "J-curve" is also used to denote the fact that a fund's net cash flows are negative early in its life and tend to become positive later in its life; we will not use it in this sense in this document.

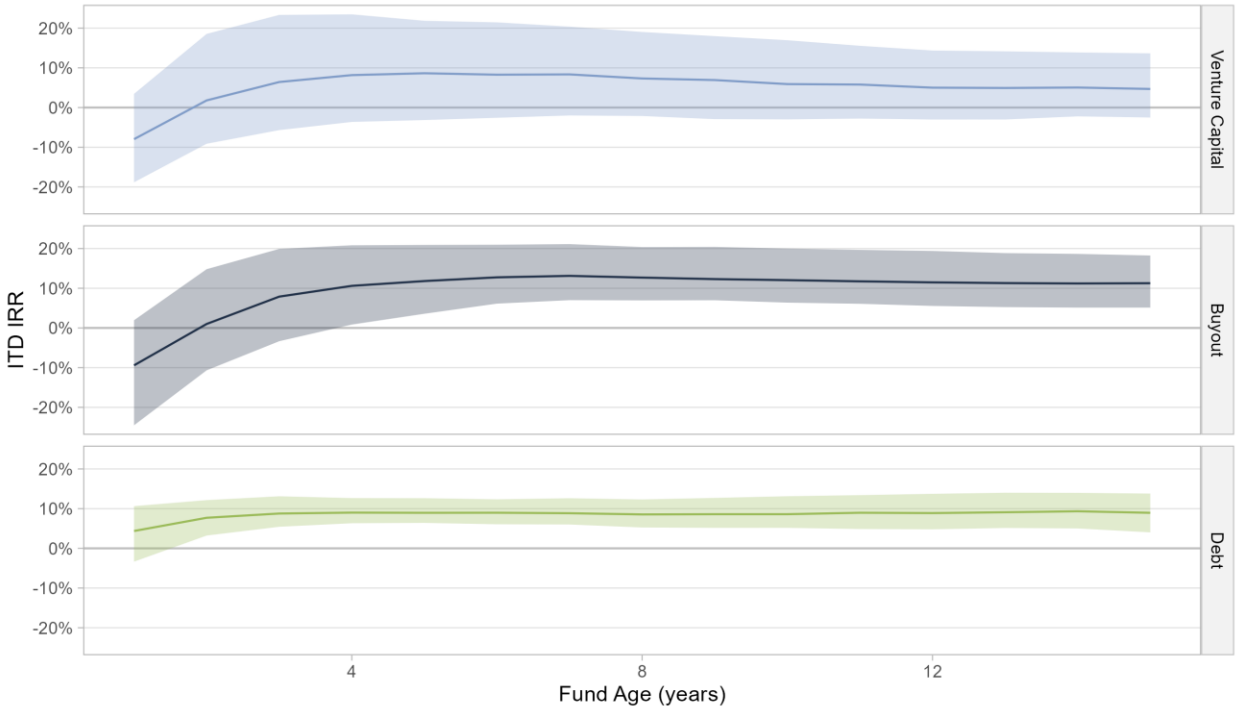


Exhibit 40: This chart displays the inception-to-date (ITD) IRR of funds as a function of their age. The solid line is the median, and the shaded area is the interquartile range. Data as of Q2 2023. Source: BMU

The fact that, on average, early fund performance is biased downward raises the question of how long investors should wait until they can expect an individual fund's performance to be close to its final performance — i.e., its performance when it liquidates. An approximate answer can be obtained by looking at the typical NAVs of funds as a function of age, as displayed in Exhibit 41. As long as a fund has a significant NAV (as a fraction of the fund's size) one can expect its performance to still be exposed to market factors. This chart suggests that fund performance should settle down sometime after the peak NAV — i.e., after about five years for equity funds and after about four years for debt funds.

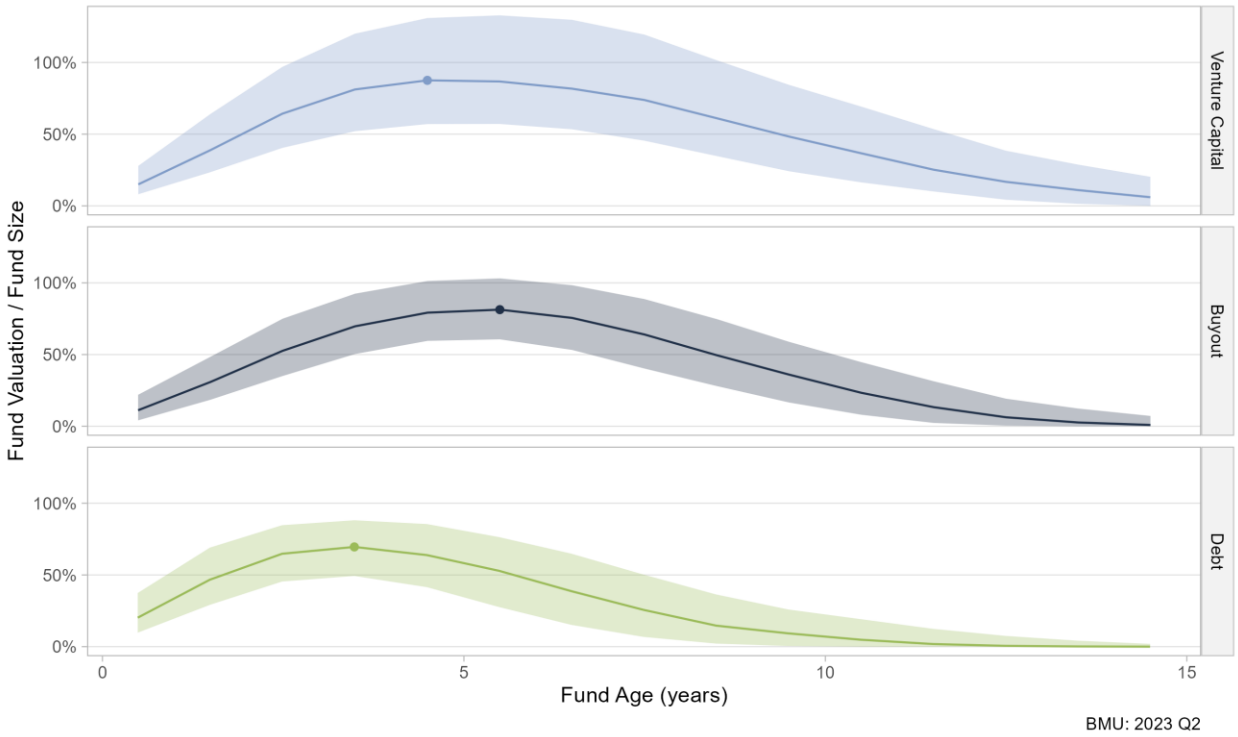


Exhibit 41: This chart displays the evolution of fund valuations as a fraction of fund size as a function of fund age. The solid line is the median, and the ribbon is the IQR.

This is born out in Exhibit 42, which tracks how long it takes for most (75%) funds to have an IRR close to their final IRR. Since "close" is a relative term,[35] we use one-fifth of the asset class's IRR as the bound. Note that these are somewhat arbitrary choices, but serve to illustrate that by this measure a stable IRR takes many years to establish itself, up to well over six years.

[35] Presumably, it would be appropriate to use a tighter bound for debt funds, which have lower returns, than for equity funds, which tend to have higher returns.

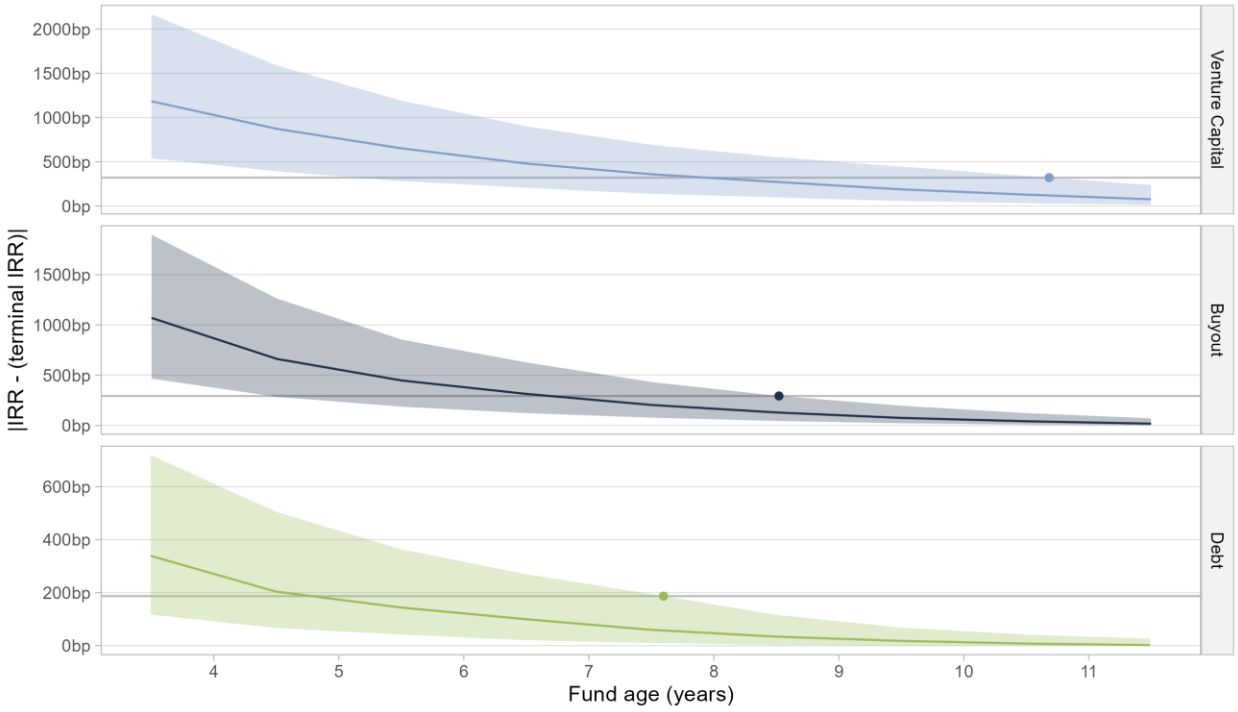


Exhibit 42: This chart displays the absolute value of the difference between funds' IRR and their final IRR. The solid line is the median, and the ribbon is the IQR. The gray horizontal line is one-fifth of the pooled IRR of each asset class.

Finally, one could argue that the previous analysis is overconservative because it focuses on *absolute* performance. As an illustration, consider a fund that has distributed most of its investments but still has some unrealized value. Suppose that, in a fund's last few years, the broad market exhibits large returns (positive or negative), then most likely its remaining investments will track the market and this will move the fund's return significantly. This might result in its current IRR not being close to its final IRR. Relative to other funds from the same vintage, however, it will probably be affected in similar ways, since they too will be exposed to the same market moves. An investor might be interested in how long the *relative* performance takes to stabilize. In this case one may wish to look at a relative version of the previous exhibit. In Exhibit 43, we document the fraction of funds that are in the same quartile (as determined by IRR) as the final quartile of the fund. At inception, this fraction is around 25%, because there is almost no track record and hence the early quartile is essentially random. As the fund ages, its quartile comes closer to its final quartile. If one wants most funds (say 75%) to belong to the same quartile as their final quartile, then one must wait more than six years. In summary, fund performance takes a significant amount of time to stabilize. As an approximate rule, six years must pass before the performance is indicative of final performance.[36]

[36] These comments apply to isolated funds. Portfolios of funds will converge somewhat more rapidly due to diversification of idiosyncratic fund effects. This could be studied by using Monte Carlo sampling.

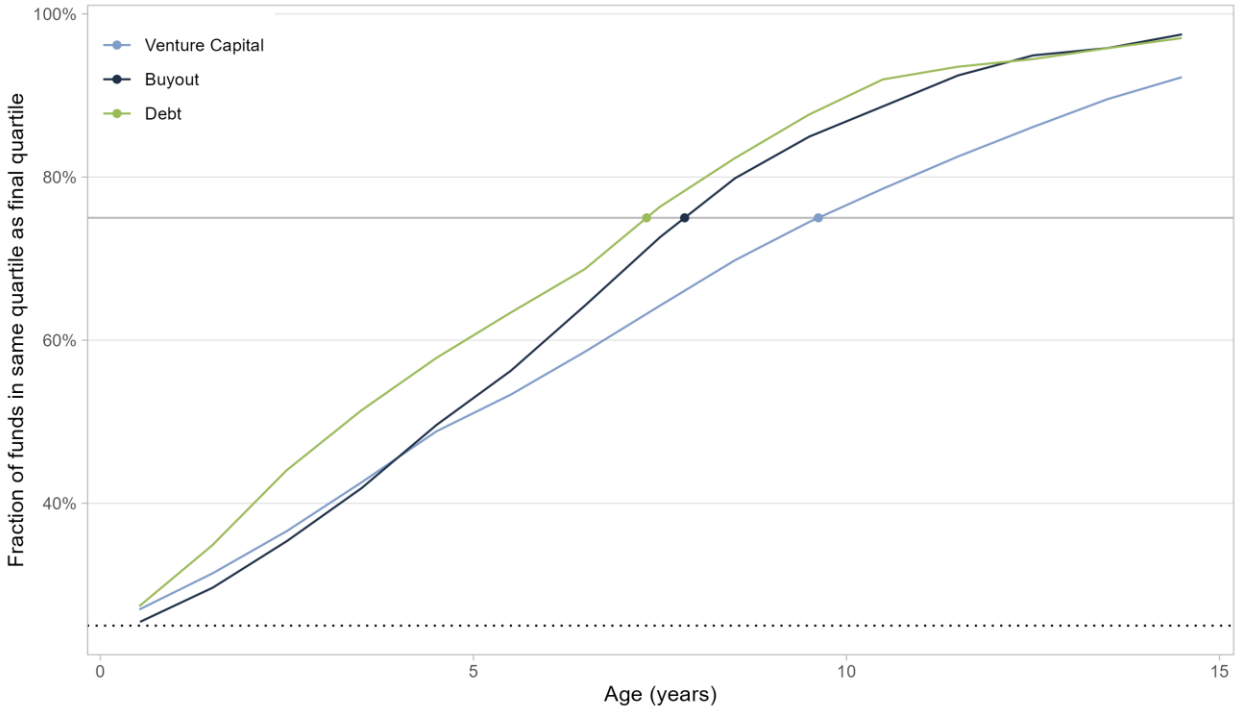


Exhibit 43 This chart displays the fraction of funds that are in the same IRR quartile as their final quartile. The dotted line is at 25% and represents the quartile being chosen at random.

Assumptions for relative performance

A further issue with any performance measure is the significant amount of unrealized value in a fund until late in its life. Given our earlier comments on valuation errors, this has the potential to skew the apparent performance of recent vintages. We discuss this issue further in the next subsection devoted to relative performance.

Since private capital does not have a simple cash-flow pattern, computing its return relative to an index is not a trivial matter. In response, various relative performance measures have been devised. While some of the original approaches (such as the Long-Nickels index-comparison method) are now considered problematic, two of the approaches discussed above are widely considered to be reliable — DA and KS-PME — which conceptually share a simple idea, that one can treat an index as a unit of account (or numeraire) and then denominate a fund's cash flows and unrealized valuation in terms of that unit. Indeed, this is already what is done when computing performance relative to some base currency;[37] thus these measures can be considered a generalization of this. From this perspective, DA is simply the IRR of a cash-flow stream denominated in an appropriately chosen index, and KS-PME is the multiple (or TVPI) of a cash-flow stream also denominated in that index.

For both of these relative measures, one needs to choose an index. In principle, one could use a public index that is considered the opportunity cost for investing in private capital. If so, however, one may wish to risk-adjust the index. For example, if one considers the assets of buyout funds to be most similar to slightly levered public equity, then a levered index may be the natural alternative to

[37] Technically, a currency would not be considered a numeraire since it is not usually considered investable. Instead, something like the money-market account in that currency would be a suitable numeraire. Similarly, when using an index as a numeraire, one should use a total-return index.

investing in buyout funds. Thus, a required assumption is choosing the most suitable index and its leverage. For example, in the case of buyout funds, estimates of beta to a broad index of public equities range from around 0.7 to up to 1.5 (see the section "Private-equity market risk"). Additionally, one can discount the valuation to account for the fact that these may not always be reliable. Given the uncertainty around private-equity betas and valuations, assessing performance measures using ranges of these input parameters helps investors understand the sensitivity of the performance measure to the assumptions.

Conclusion and relevance to long-term investors

Quarterly returns are often used when integrating private capital into broader reporting. To properly understand the performance of private capital, however, it is important to complement this with longer-term measures. TVPI is a simple ratio of distributions to contributions, but ignores how long it takes to generate the return. IRR is a *rate* of return, but, conversely, does not indicate the magnitude of distributions per unit of contributions. Furthermore, IRR must be used with caution for a temporally disperse portfolio.

For investors interested in their return relative to an opportunity cost, relative measures (KS-PME and DA) are useful. For investors seeking to understand the long-term utility of adding private assets to their portfolio, these relative measures are particularly useful, especially given the earlier comments regarding IRR.

Exhibit 44 summarizes the advantages and limitations of the mostly used performance measures. As there is no perfect solution, investors often report various measures which help understand performance from various perspectives.

MEASURE	ABS/REL	PERIOD	ADVANTAGES	LIMITATIONS
QTD RETURN	Absolute	Short (1 quarter)	Useful for integration with other, more liquid asset classes.	Subjectivity of fund valuations imply short-term returns are smoothed.
TVPI (OR MOIC)	Absolute	Long (unbounded or since inception)	Simplicity and transparency.	Does not take into account timing of cash flows.
IRR	Absolute	Long (unbounded or since inception)	Rate of return. Ubiquitous. Often used in carry computations.	- IRRs should not be interpreted to mean returns can be reinvested. - For temporally disperse portfolios can yield counterintuitive results.
KS-PME	Relative	Long (unbounded since inception)	Relatively simple (measure is a relative multiple).	Does not take into account timing of cash flows.
DIRECT ALPHA	Relative	Long (unbounded or since inception)	Rate of return.	Similar problems to IRR although tend to be less problematic.

Exhibit 44: Summary of advantages and limitations of various private-equity return measures used by investors.

Empirical analysis: Private-equity performance

We studied the historical performance of global buyout and venture-capital funds[38] relative to public-equity markets. We used direct alpha as the relative performance metric and assessed pooled investments grouped by vintage year. The starting point for our analysis was to compare private-equity performance against the total returns of the MSCI ACWI Investable Market Index (IMI). As the light-gray bars in Exhibit 45 show, both buyout and venture-capital funds outperformed this index for most vintages since 2000. An alternative benchmark is provided by the dark-gray bars: These compare performance against a modified version of the MSCI ACWI IMI, in which sector weights are adjusted to account for the sector allocation in the respective private-equity universe.[39] As shown in the exhibit below, the sector adjustment led to slightly lower direct alpha for most vintages, in particular for venture capital.

In Exhibit 45, we make another adjustment reflected by the colored dots, which reflects a levered public-equity index (leverage of 1.2x as opposed to leverage of 1x in the base case).[40] Generally, increasing leverage reduces direct alpha, as it makes listed equities harder to beat. Note that we show but do not attach much meaning to the performance of vintages between 2020 and 2023, as they are still in the early stage of their life cycle. Performance at this point may not be a good indicator of the performance over the full lifetime of the fund.

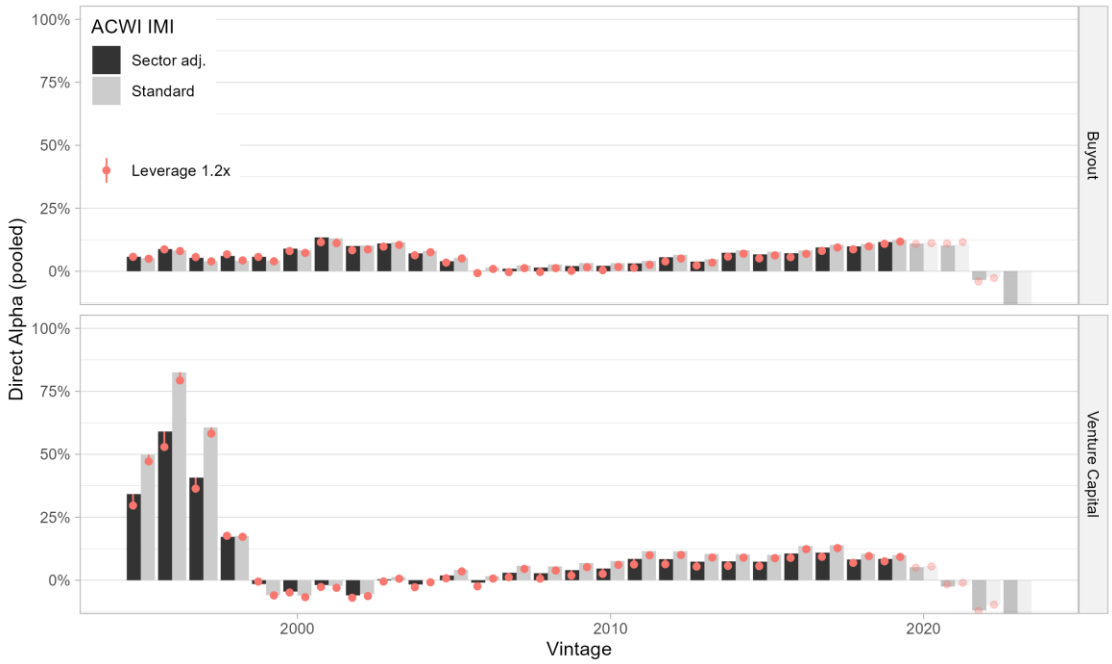


Exhibit 45: Direct alpha of buyout and venture-capital funds relative to MSCI ACWI Investable Market Index, across vintages (light gray). The dark gray uses a sector-adjusted version of the MSCI ACWI IMI as a benchmark, whereby GICS

[38] Based on BMU; funds as of Q3 2023 and holdings as of Q2 2023.

[39] In practice, we used the Global Industry Classification Standard (GICS®) sector indexes for the MSCI ACWI IMI (such as the MSCI ACWI IMI Information Technology) and created the top-level performance by applying the sector weights in the private-equity universe (as in Exhibit 11, but for the buyout and venture-capital segments separately) to daily index returns. Sector weights are linearly interpolated between quarters. GICS is the industry-classification standard jointly developed by S&P Global Market Intelligence and MSCI.

[40] To create levered portfolios, we used the one-day USD secured overnight financing rate (SOFR) as the cost of borrowing for dates after March 2006. Between May 1997 and March 2006, we used the one-day LIBOR. Prior to May 1997 we proxy borrowing costs with the effective U.S. benchmark federal-funds rate.

sector weights reflect the sector allocation of the respective private-equity funds. The red dot shows performance relative to a levered version (1.2x) of the respective public-equity benchmarks.

Exhibit 46 has the exact same setup as described above, with the only difference that we replaced the MSCI ACWI IMI with the MSCI ACWI Small Cap Index (and sector-adjusted and levered versions of the latter). Compared to using the MSCI ACWI IMI as a benchmark, direct alpha was generally smaller in the first decade of the century while the situation reversed in the second decade. As with the MSCI ACWI IMI, the sector adjustment and leverage tended to reduce direct alpha across vintages.[41] While no indication of future performance, historical performance relative to public equities was relatively good for the vintages in our analysis.

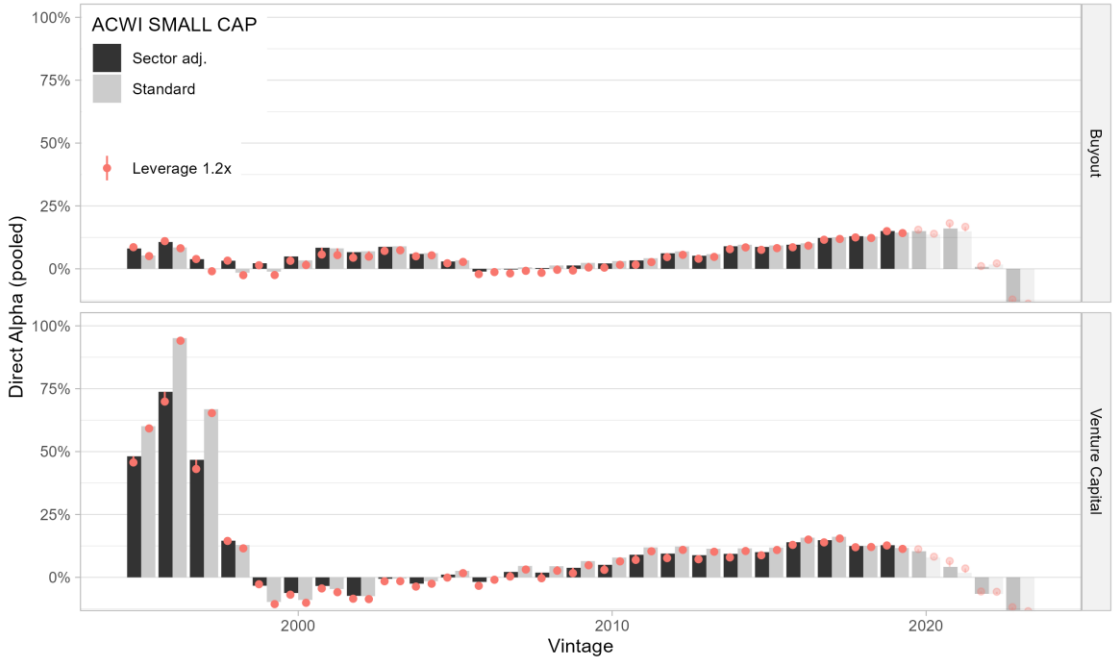


Exhibit 46: Direct alpha of buyout and venture-capital funds relative to the MSCI ACWI Small Cap Index, across vintages (light gray). The dark gray uses a sector-adjusted version of the MSCI ACWI Small Cap Index as a benchmark, whereby GICS sector weights reflect the sector allocation of the respective private-equity funds. The red dots show performance relative to a levered version (1.2x) of the respective public-equity benchmarks.

We would also like to comment on why the two exhibits above display the pooled direct alpha, as opposed to the median direct alpha. First, note that, in general, in private capital the difference between pooled and median performance is material, with the former usually exceeding the latter. This difference tends to be largest in vintages or asset classes that perform well. Pooled returns (or direct alphas) tend to be larger than the corresponding median for a variety of reasons that are discussed elsewhere in this document (although "convexity" rather than asymmetric returns tends to be the dominant reason). However, what we would like to stress here is that the pooled measure is the natural measure to focus on if one is interested in the behavior of a *portfolio*. The reason for this is that pooling is precisely the formation of a (typically large) portfolio formed by the constituent funds in the analysis; the performance measure (such as direct alpha) is then computed for the

[41] For buyout funds, measuring direct alpha relative to a levered small-cap index is probably a quite conservative method of measuring relative performance. For example, according to the PEQ2 model, large U.S. buyout funds have a beta of around 1.2 relative to the MSCI ACWI IMI. Replacing this all-cap index with a small-cap index as a public proxy could lead to a smaller beta. For venture capital, the simultaneous application of the small-cap benchmark and leverage might be more appropriate, as venture capital's public proxy in the PEQ2 model is a small-cap index.

entire portfolio. Thus, pooled measures capture the portfolio performance of a well-diversified investor with access to similar investments as those in the analysis universe.

Performance attribution

Although there is a need among investors for performance attribution for private capital, to date, no approach has become standard practice. In this section, we first discuss how to form an appropriate benchmark in the context of private capital. We then describe reporting relative to a benchmark and expand this into a simple approach for performance attribution.

Benchmark returns: Median versus pooled

In this section, we briefly discuss how to form a suitable benchmark for private assets.[42] The central idea is that, as in benchmarking in other asset classes, one should create a potentially investable-benchmark *portfolio* and use its performance as the benchmark. This is often termed "pooling" in private capital and can be contrasted with assessing median returns. For small investors — i.e., investors making a small *number* of investments — the median return, in addition to the pooled return, may be relevant. For an investor with a large number of diversified investments in private capital, however, the pooled return is of greatest relevance.

Exhibit 47 illustrates the often-wide differences between the two returns, with median returns usually being smaller. In the case of venture capital, the differences are significant, with the median returns almost always smaller. This is often incorrectly attributed to skewness in the returns; venture capital — so the argument goes — relies on a small number of very large winners, and hence their returns enjoy a long right-hand tail, in turn making the median smaller than the pooled return. While there may be some truth to the large dispersion of returns among venture-capital funds (and even more so among their underlying holdings), this is not the correct explanation for the discrepancy. Exhibit 48 attributes the discrepancy to various effects and shows that when the difference is large (such as for venture capital) the dominant effect is *convexity*. This effect, also known as Jensen's Inequality, captures the intuition that limited- liability investments have unbounded upside but are bounded (by zero) downside.

[42] This is discussed at greater length in O'Shea and Jeet (2019).

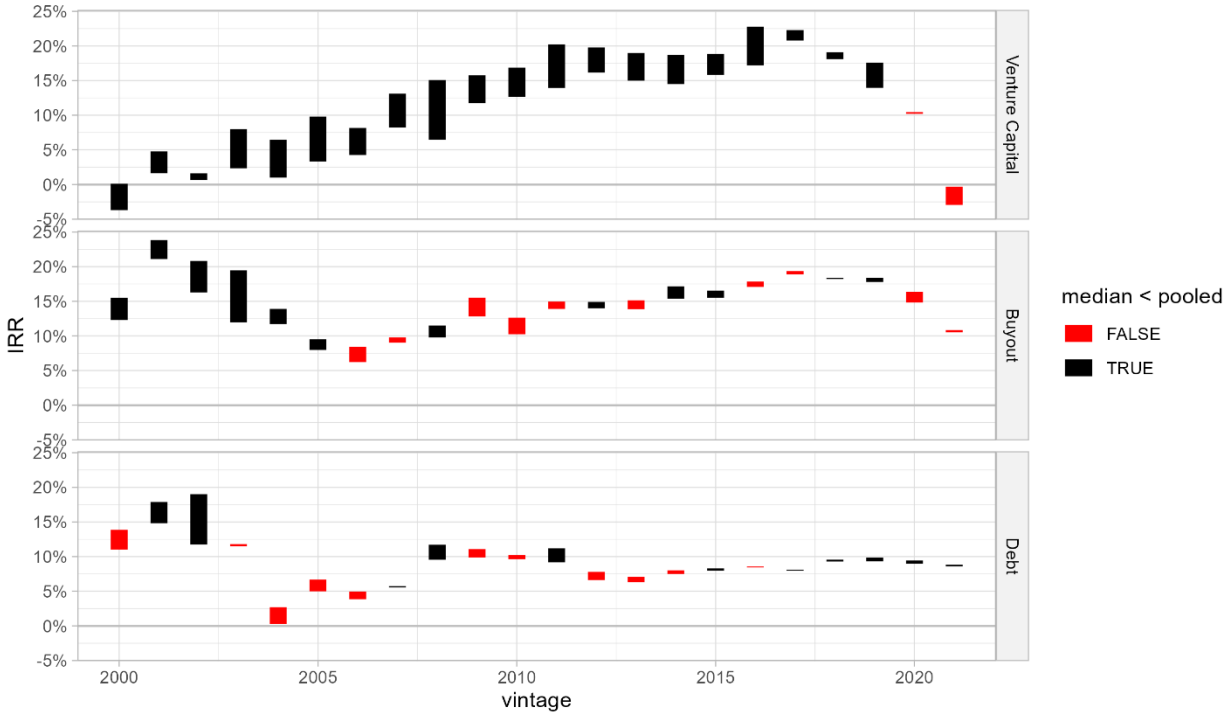


Exhibit 47: Chart of since-inception pooled and median IRRs for each vintage. Each bar is bounded by the median and pooled IRRs and colored black if the pooled return is greater than the median and red otherwise.

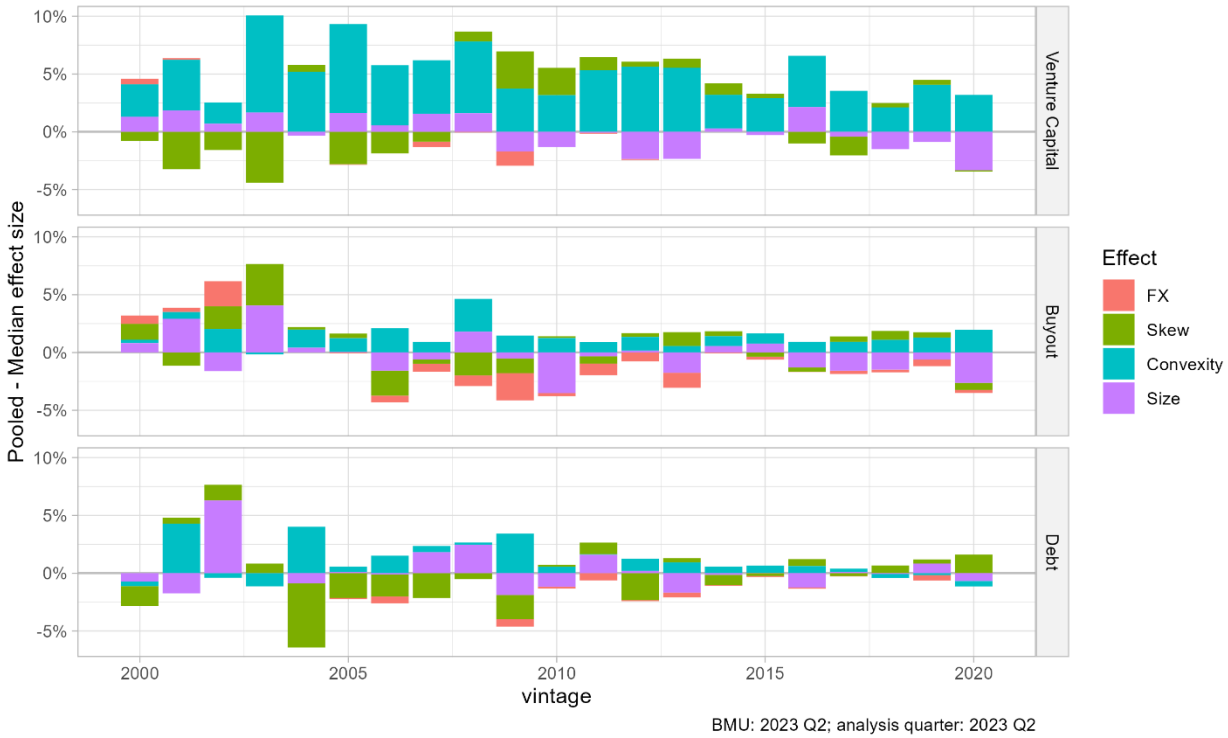


Exhibit 48: Attribution of pooled IRR minus median IRR to various effects.

In summary, there a variety of effects that tend to make the median returns lower than the pooled returns in a universe of funds (such as the BMU). It is the pooled performance that is usually of most relevance for benchmarking purposes.

Performance relative to benchmark

Given the comments in the previous section, it is natural to compare a portfolio of investments to corresponding peer groups. For example, an investment in a 2019 buyout fund could be compared to the performance of a peer group of all 2019 buyout funds from the BMU. That peer group should be pooled – in effect forming a portfolio – and thus allowing any measure that can be computed for a portfolio to be computed for the peer group. Furthermore, as one ascends the portfolio hierarchy (e.g., to all buyout funds), then the corresponding peer groups should be aggregated by pooling with weights determined by the LP commitments (or possibly target commitments).[43] Exhibit 49 shows an example of a potential report. It represents a portfolio with investments in buyout and venture capital in vintages from 2000 to 2023.[44] The table shows only three-year IRR and TVPI, but since both portfolio and benchmark are genuine portfolios, any measure can be computed.

		Portfolio		Benchmark	
Asset class	**Vintage**	**IRR (3y)**	**TVPI**	**IRR (3y)**	**TVPI**
All	**All**	**23.3%**	**1.90**	**26.1%**	**1.99**
Venture capital	**All**	24.0%	2.07	26.8%	2.21
Venture capital	2022	-18.1%	0.85	-12.9%	0.91
Venture capital	2021	-15.6%	0.79	-2.9%	0.96
Venture capital	2020	8.6%	1.17	12.9%	1.24
…	…	…	…	…	…
Venture capital	2000	18.9%	1.09	10.8%	1.01
Buyout	**All**	**21.9%**	**1.65**	**24.3%**	**1.67**
Buyout	2022	-1.1%	0.99	-0.3%	1.00
Buyout	2021	10.0%	1.11	11.1%	1.12
Buyout	2020	11.5%	1.20	17.6%	1.28
…	…	…	…	…	…
Buyout	2000	34.1%	1.96	31.6%	1.90

Exhibit 49: Illustration of paired portfolio and benchmark performance. All aggregation is via pooling. Note that for illustrative purposes the table only displays two performance measures (namely three-year IRR and TVPI)

While Exhibit 49 compares the investment portfolio relative to the benchmark at various levels of aggregation and across multiple performance measures, investors often want to drill down further into the drivers of performance. In the next section, we discuss a simple approach to performance attribution in private-capital markets.

[43] This approach is described in more detail in O'Shea and Jeet (2019).
[44] We omitted vintages from 2001 to 2019 for reasons of space, and 2023 is omitted since the results are not yet meaningful.

Simple approach to performance attribution

Comparing the performance of each investment to a similar peer group (matched by characteristics such as asset class and vintage) can be thought of as a simplified approach to performance attribution that focuses only on a selection effect. In other words, if an investment was made in a 2019 buyout fund, then in principle the investor could have invested in any of those funds or several of them. Instead, the investor selected a single such fund, creating a difference in performance between that pooled group and the single fund — a selection effect.

More generally, an investor may seek to attribute performance differences to other decisions, earlier in the decision-making process. For example, perhaps the earliest decision is to allocate a certain portion of capital from public investments (as represented by some index) to private investments (at market weights). The investor may later decide to adopt a strategic asset allocation. This decision may be followed by a series of other decisions, culminating in fund selection. Each decision produces an impact on performance, as measured by any performance measure.

In Exhibit 50, we describe a simple approach for such attribution, whereby we assume that the measure of primary interest to the investor is three-year IRR. This approach is agnostic to the choice of performance measure, however. We can contemplate an investment process that takes an investment in a broad equity index as the baseline. The first decision is to switch (in this case all) capital to private equity (in this case buyout and venture capital) with a mix determined by the market weights of those two asset classes. In Exhibit 50, the first portfolio is labeled “Public” and the second “Private.” The top of the black bar over the “Private” label is simply the three-year IRR of that portfolio. We would like to determine how much of that return comes from the public markets. This can be determined by computing a point-to-point three-year DA relative to the public index represented by the public portfolio. This is shown in Exhibit 50 as the total length of the black bar over the private label. The gray bar is then simply drawn from zero to the bottom of the black bar. In effect, we are interpreting DA as the excess performance over the index (and hence the remainder is the public performance). To highlight the value of this procedure we also computed (in the usual way) the return of the public index over that three-year period and show it as a vertical black line inside the gray bar. Note that it is different from the gray rectangle. The reason for this difference is that the IRR of the private portfolio is money-weighted and the usual return of the index (as represented by the vertical line) does not incorporate the money-weighting used in the IRR calculation. However, the three-year IRR and DA are incorporating of the correct money-weighting and hence lead to different returns. In other words, the gray rectangle represents the correct money-weighted public return.

After shifting to invest in a private portfolio, one can make a strategic asset allocation (in this case 50:50 in buyout and venture capital); this is represented by the portfolio labeled strategic. Again its three-year IRR is the top of the bar over the corresponding label. We can proceed in this way, making finer decisions, eventually culminating in fund selection.[45] As can be seen, all effects are positive except for the selection effect, which is quite negative.

[45] For the purpose of this example, selection is done algorithmically by picking the five largest funds in each vintage/asset class pair.

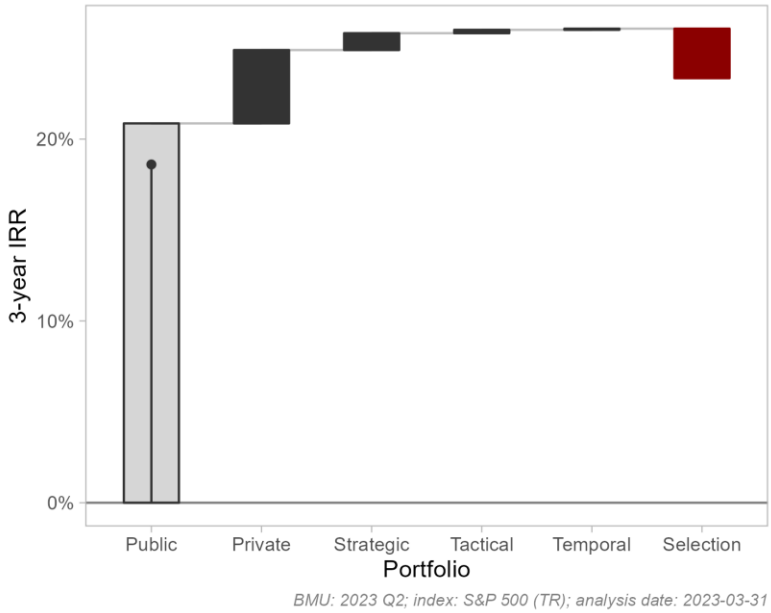


Exhibit 50: Performance attribution for three-year IRR.

A virtue of this simple approach to performance attribution is that it relies entirely on forming different portfolios (notional portfolios) and hence any performance measure can be attributed. For example, Exhibit 51 attributes various types of returns, while Exhibit 52 shows how even TVPI can be attributed in this way. Also of note is that effects can change sign under different measures. For example, the temporal decision (overinvesting in certain vintages and underinvesting in others) seems to have resulted in a negative effect in the long term (i.e., for IRR and TVPI — both long-term measures), while it had a positive effect more recently (i.e., for three-year IRR and one-quarter modified Dietz return).

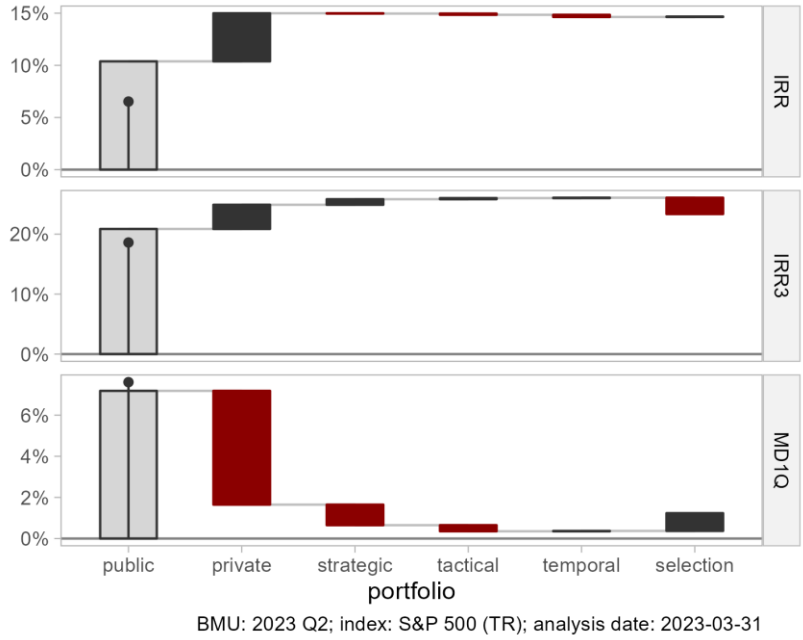


Exhibit 51: Performance attribution for various difference measures of return; MD1Q is modified Dietz return over one quarter.

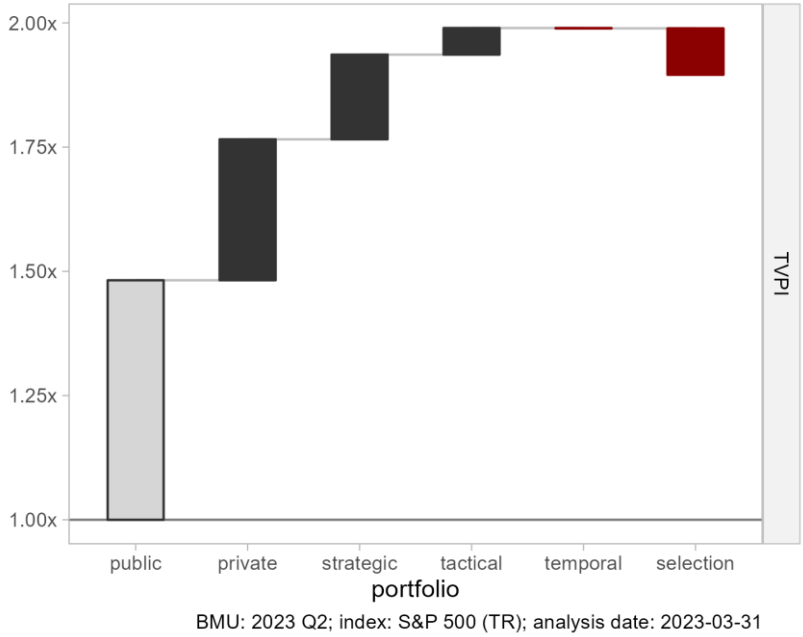


Exhibit 52: Performance attribution for TVPI.

Section III: Investment in Chinese public equities

Introduction

China's rise in global economic influence, increased market size, improved market accessibility and recent global geopolitical tensions have led to more investors to reconsider their China equity allocation. Due to the complexity of China's market landscape and investment opportunity set, however, it is no simple task to redesign a China allocation program.

In this section, we will first look at the development of the Chinese equity market over the years and its status in global equity markets. Then we examine and summarize the characteristics of Chinese equity markets from the perspective of size segments and share types (onshore versus offshore). Finally, we focus on the macro aspects of configuring and implementing China equity allocations. We discuss quantitative and qualitative criteria in sizing and implementing the China equity allocation based on the market opportunity set, economic growth and fundamentals, trade and investment considerations, level of currency internationalization and other areas of targeted outcomes optimized from quantitative models.

Description of the Chinese equity market

Development of the Chinese equity market

China's equity market has two components from the perspective of listing location: the stocks listed in the domestic mainland market, primarily known as CNY-denominated A shares, and HKD-/USD-denominated B shares[46] and offshore-listed stocks in Hong Kong, the U.S. and a few other markets.[47] The full market capitalization of China's equity market, as measured by the constituent universe of the MSCI ACWI IMI (MSCI 2023-2), reached USD 9.1 trillion as of the end of June 2023, second only to that of the U.S. (see Exhibit 53).

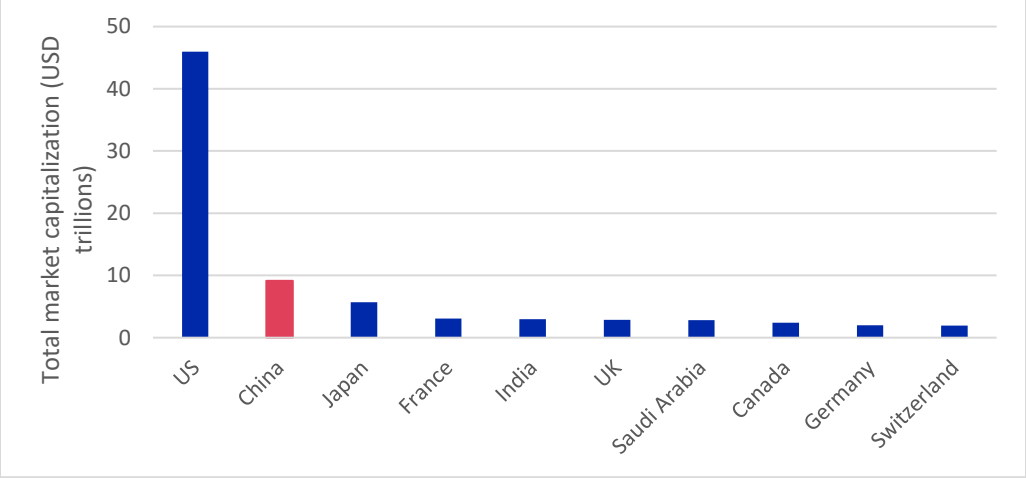


Exhibit 53: Full market cap in the MSCI ACWI IMI as of June 30, 2023.

[46] More details can be found in Xu, Xu and Wei (2021).
[47] For example, Singapore and Germany.

As of October 2023, foreign investors accessed Chinese local equities mainly through two programs, the mainland-Hong Kong Stock Connect programs (Stock Connect) and the QFII/RQFII[48] programs. Over the past decade, China's regulators have implemented a handful of upgrades on these programs to facilitate capital inflows, including quadrupling the quota of Stock Connect, simplifying the QFII application process and removing the limits of QFII. Currently, around 70% of foreign-owned A shares are invested through the Stock Connect.

The Stock Connect provides a connection between mainland stock exchanges (Shanghai and Shenzhen) and Hong Kong's stock exchange, allowing foreign investors to trade eligible A shares in the mainland (Northbound) and mainland investors to trade eligible stocks listed in Hong Kong (Southbound).

The eligible universe of the Northbound Stock Connect was expanded in March 2023 to more than 2,500 companies, which covered most of the investable A shares. The program also optimized the trading-calendar days and omnibus trading arrangements.

Exhibit 54: China's market-liberalization efforts.

During the past few years, China's equity ecosystem has become increasingly sophisticated and comprehensive, with more participation from institutional and foreign investors and a variety of new equity-financial-product launches. Although China's Northbound Stock Connect — a major channel for international investors to trade in China A shares — had a total net outflow of USD 26 billion from August to December 2023, the compound annual growth rate over five years for China A shares owned by foreign investors still reached 19% at the end of 2023. In terms of equity financial products, the total assets under management (AUM) linked to ETFs reached CNY 1.6 trillion by the end of 2022, compared with CNY 0.37 trillion by end of the 2017 (Shanghai Stock Exchange 2023).

The listing of derivatives also accelerated in recent years, including the launch of MSCI China A 50 Connect Index futures on the Hong Kong Stock Exchange, as well as mid- and small-cap-focused index futures and options on the China Financial Futures Exchange, Shanghai Stock Exchange and

[48] Qualified Foreign Institutional Investors. Renminbi Qualified Foreign Institutional Investors. More details can be found in (Wei, China A Shares: What Have We Learned? 2020).

Shenzhen Stock Exchange. With the expansion of the listed equity universe and proliferation of product creation, fintech innovations have also flourished, including the growth of online-trading platforms, mobile applications and robo-advisers, enabling easier market access for retail investors and facilitating the development of digital wealth-management services.

However, Chinese equities' weight in global allocations (as proxied by the MSCI ACWI IMI) remains relatively low, compared to the size of China's economy. Both the current 20% partial inclusion of China A shares and relatively low free float have contributed to the current status. In a hypothetical scenario of China A shares' full inclusion, the free-float market cap of Chinese equities increased from USD 2.06 trillion to USD 4.18 trillion, as shown in Exhibit 55.

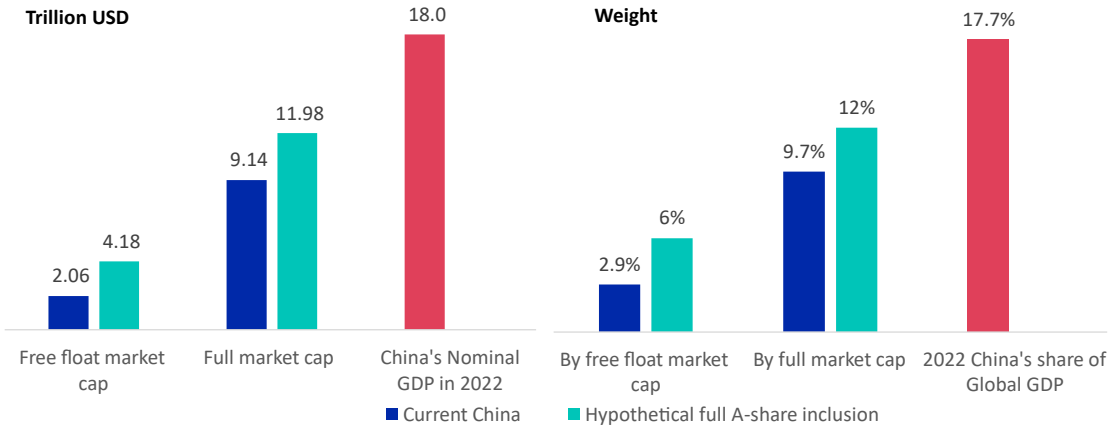


Exhibit 55: Size of Chinese equities in the MSCI ACWI IMI. Hypothetical full A-share inclusion is proxied by the MSCI China All Shares IMI, which includes China A shares and onshore small caps. Data as of June 30, 2023.

In terms of single-stock trading, retail investors still exert a predominant impact in the market for China A shares. However, domestic and international institutional investors are increasing their footprint in the equity market, both through single-stock trading and the ETF and futures markets.

According to the Shanghai Stock Exchange, retail investors contributed more than 85% of total trading volume and held 23.7% of market value in 2016 (Shanghai Stock Exchange 2017). By mid-2022, these investors' contribution to total trading volume dropped to around 60% (CSRC Chairman Yi Huiman's speech in 2022 Financial Street Forum (Chinese) 2022). Additionally, domestic institutional investors and foreign investors combined to hold 22.8% of the total free-float market value of A shares by the end of May 2022 (CSRC Vice Chairman Li Chao's speech in "China's ten years" press conference. (Chinese) 2022).

Compared to other major markets, China's equity market still has a considerably high level of retail participation, as measured by retail trading volume as a percentage of total trading volume. According to a survey conducted with 34 exchanges by World Federation of Exchanges (2022), the average retail participation in Europe, the Americas and the Asia-Pacific region was 31%, 13% and 61%, respectively, as shown in Exhibit 56. The survey also mentioned that in 2020, the Shenzhen Stock Exchange, Saudi Stock Exchange (Tadawul) and Taipei Exchange reported the highest retail-participation rates (all around 80%). The Shenzhen Stock Exchange and Taipei Exchange are two of the main listing exchanges for small- and medium-size enterprises among emerging technology firms in China and Taiwan.

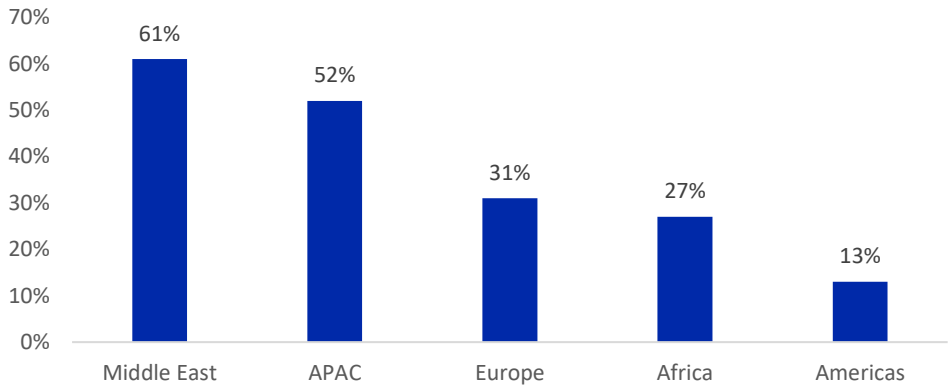


Exhibit 56: Average retail participation by region in 2020. Source: World Federation of Exchanges

China in emerging markets

The market for China A market saw increased integration in the global equity market in recent years. Inclusion of China A shares in major global equity indexes, such as the MSCI Emerging Markets Index, has led to greater foreign-investor participation and increased general liquidity of the market since 2018. The expansion of the Stock Connect programs, allowing cross-border trading between mainland China and Hong Kong, has further promoted market integration and enhanced accessibility of the China A shares for international investors.

Despite evidence of market integration, the performance of Chinese equities, particularly China A shares, continued to exhibit relatively low correlation to the rest of world compared with other emerging markets (see Exhibit 58).

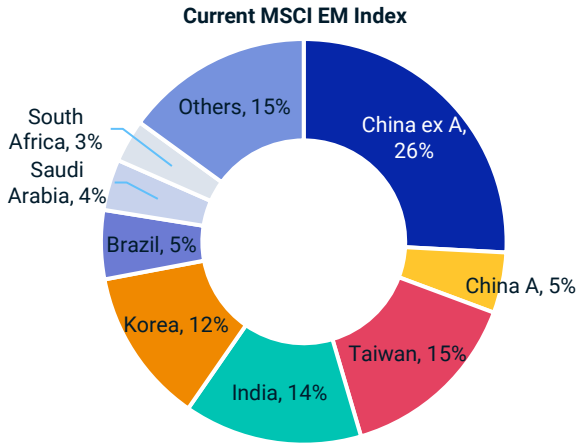


Exhibit 57: Country weights in the MSCI Emerging Markets Index. Data as of July 31, 2023.

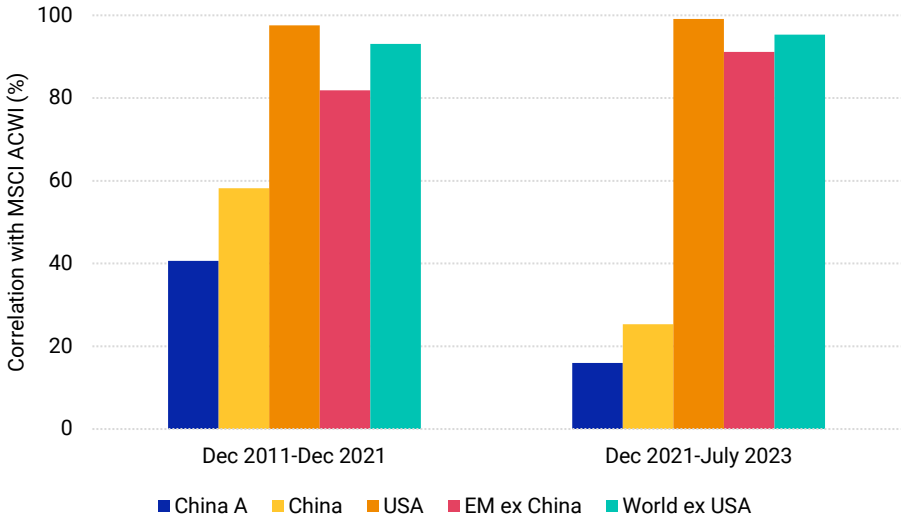


Exhibit 58: Index correlations with the MSCI ACWI Index. Return correlation is calculated based on monthly gross returns in local currency.

International and domestic investors' participation

Foreign investors' holdings of China A shares relative to the free-float market value rose very quickly after 2015 and has been flat since 2019, at around 4.5% to 5% (see Exhibit 59). This suggests that international investors might have had concerns amid the COVID-19 pandemic and China-U.S. trade tension. The AUM represented by foreign holdings dropped by 19% in USD terms after 2021, which was mainly driven by the weak performance of the broad equity market and depreciation of the CNY relative to the USD.[49] Despite weak market performance during the past three years, foreign investors have become increasing impactful in the market for China A shares.

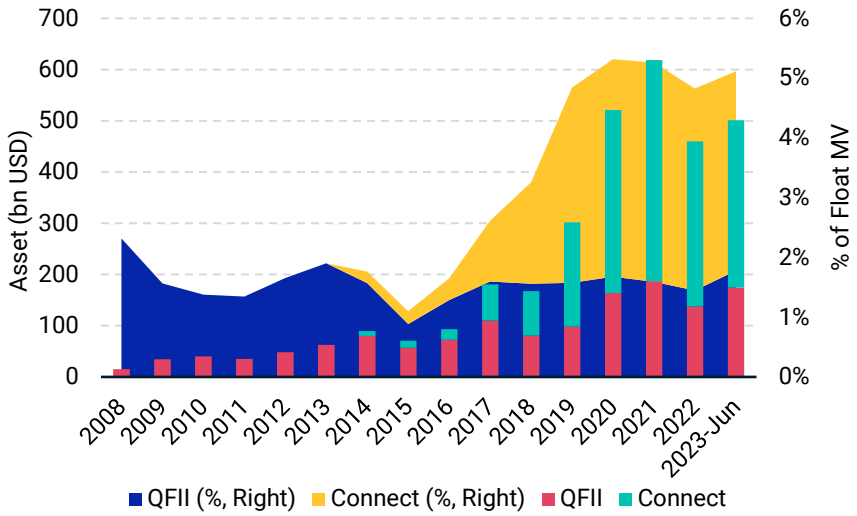


Exhibit 59: Share of holdings held by foreigners in the China A Index. Data as of June 30, 2023. Source: People's Bank of China, Wind

[49] The MSCI China A Index was down by 20.5% from Dec. 31, 2021, to June 30, 2023. And CNY fell by 13% relative to USD over the same period.

Not all international investors took a simple replication of the northbound Stock Connect opportunity set, which is currently the predominant channel for access to China A shares. As shown in Exhibit 60, as of Sept. 20, 2023, international investors tended to implement an overweight to high-tech and growth-oriented sectors and themes compared to the broad China A market, as measured by the MSCI China A Index,[50] which covers the eligible large- and mid-cap stocks through the Stock Connect.

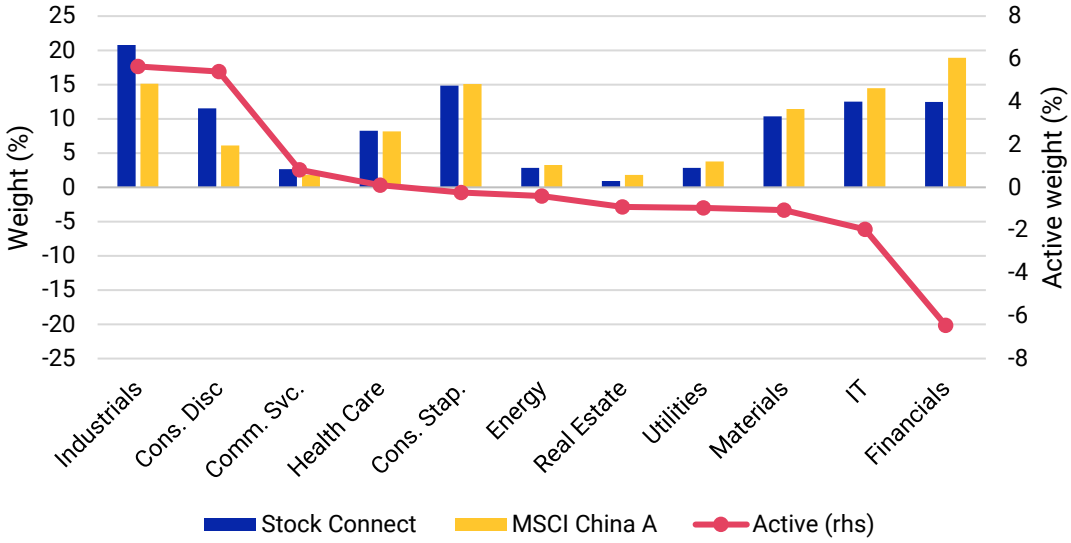


Exhibit 60: Holdings under Stock Connect versus MSCI China A Index, by sectors. Data as of Sept. 20, 2023. Source: Wind

As a result of these dynamics, prices of China A shares are influenced by a combination of international and local investors' return requirements and risk preferences.

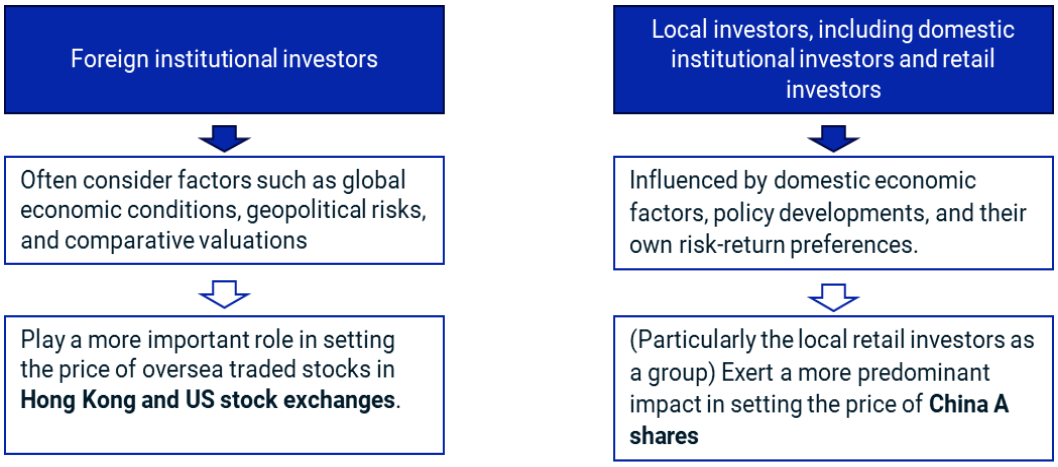


Exhibit 61: Market influence of international investors and domestic investors.

Governmental regulations play a significant role in the Chinese equity market and can impact stock prices. The Chinese government exercises influence over the market through policies, regulatory

[50] The MSCI China A Index is composed with Stock Connect-eligible stocks, which are accessible to international investors.

decisions and interventions, aiming to maintain stability, manage systemic risks and promote economic objectives. Stock prices and investor sentiment can be impacted by regulatory measures, including changes in trading rules, market-access restrictions and interventions during periods of market stress.

State intervention in the Chinese equity market, particularly during times of volatility or major economic events, can impact price discovery and market efficiency. Interventions, such as circuit breakers, suspensions of trading, shorting-selling restrictions or interventions by state-owned entities may introduce distortions and hinder the accuracy of price formation. Some of these interventions may also be common in other markets, including developed markets. The extent of state intervention and its impact on stock prices can vary, and efforts to strike a balance between intervention and market-driven price discovery are ongoing.

Chinese regulators have announced several changes to further support the stock-market recovery in 2023:

1. Cut the security-trading stamp tax in half.
2. Reduce the margin of leverage trading from 100% to 80%.
3. Slow the pace of mainland IPOs.
4. Put restrictions on the trading activities of major shareholders (ones with a stake of 5% or more).
5. Relax the requirement on the refinancing of real-estate companies.

China vs. other emerging markets: Assessing market accessibility

According to the 2023 MSCI Global Market Accessibility Review,[51] China's offshore-listed stocks had no or limited accessibility issues across most measures. The locally listed A shares are still having issues in areas including foreign-ownership limits, foreign room[52] and capital-flow restriction. The delivery-versus-payment practice in mainland China is currently different from that in other global markets, and the current T+0/T+1 settlement cycle continues to pose operational challenges such as pre-funding and pre-delivering of shares to some institutional investors. Further, restrictions over transferability, stock lending and short selling posed further difficulties for trading.

On the other hand, some improvements have been observed in recent years. For example, Chinese regulators have been actively promoting the use of offshore Renminbi (RMB). The RMB remained one of the 10 most widely used currencies as an international payment and is recognized by the International Monetary Fund (IMF) as a reserve currency. The RMB is not fully convertible onshore, but investors are able to tap into the offshore RMB market in Hong Kong (CNH) for securities settlement through Stock Connect. The IMF also recognized that investor registration and account setup became simplified by using Stock Connect and under the QFI scheme. Also, the launch of futures and options products in recent years has provided international institutional investors with a wider range of available investment instruments.

[51] The MSCI Global Market Accessibility Review aims to serve as a tool to track the evolution of accessibility in individual markets and to inform market authorities of the areas perceived as not meeting international standards for which improvement would be welcomed by international institutional investors.
[52] MSCI defines foreign room as the proportion of shares still available to foreign investors relative to the foreign-ownership limit.

	China	China A	Brazil	Saudi Arabia	India	Korea	Taiwan	Thailand
Openness to foreign ownership								
Investor-qualification requirement	++	+	++	+	+	++	+	++
Foreign-ownership limit (FOL) level	-	-	+	-	-	++	+	-
Foreign-room level	++	-	++	++	-	+	++	-
Equal rights to foreign investors	+	+	-	-	+	+	+	-
Ease of capital inflows / outflows								
Capital-flow restriction level	++	+	++	++	++	++	++	++
Foreign-exchange market-liberalization level	++	+	-	++	-	-	-	+
Efficiency of the operational framework								
Market entry								
Investor registration and account setup	++	+	-	+	-	-	-	++
Market organization								
Market regulations	+	+	+	++	+	++	++	++
Information flow	++	+	+	+	++	-	+	++
Market infrastructure								
Clearing and settlement	++	-	-	+	-	-	-	+
Custody	++	++	++	+	++	++	++	++
Registry/depository	++	++	++	++	++	++	++	++
Trading	++	++	++	++	++	++	++	++
Transferability	++	-	+	-	-	-	+	++
Stock lending	++	-	++	-	++	++	+	+
Short selling	++	-	++	-	+	+	+	+
Availability of Investment Instruments	++	+	-	++	-	-	++	++
Stability of institutional framework	+	+	+	+	+	+	+	+
++: no issues; +: no major issues, improvements possible; -: improvements needed								

Exhibit 62: Measures of market accessibility between China and selected major EM countries.

Large caps and small caps, onshore and offshore

Small caps in China A Shares have been expanding quickly during the past few years. For example, the MSCI China A Onshore Small Cap Index reached 2,700 constituents after MSCI's May 2023 index review, compared with 1,260 constituents as of May 2018. As shown in Exhibit 63, the small caps outperformed both the large and mid-caps from 2004 to the end of September 2023, as it was exposed more to the new economies and high-tech industries that were increasingly important in China's economic-reform agenda.

	MSCI China A Onshore Large CAP Index[53]	MSCI China A Onshore Mid CAP Index	MSCI China A Onshore Small CAP Index
Total return* (%)	8.8	7.5	12.1
Total risk (%)	27.9	30.4	33.0
Return/risk	0.32	0.25	0.37
Sharpe ratio	0.20	0.14	0.27
Number of constituents* **	200	349	1282
Price to book* **	1.9	2.5	2.5
Price to earnings* **	14.2	28.5	50.3
Dividendyield* ** (%)	2.0	1.0	0.7

*Exhibit 63: Key metrics for the MSCI China A Onshore Large, Mid and Small Cap Indexes. Data from Dec. 31, 2004, to Sept. 29, 2023. *Gross returns annualized in CNY. ***Monthly averages.*

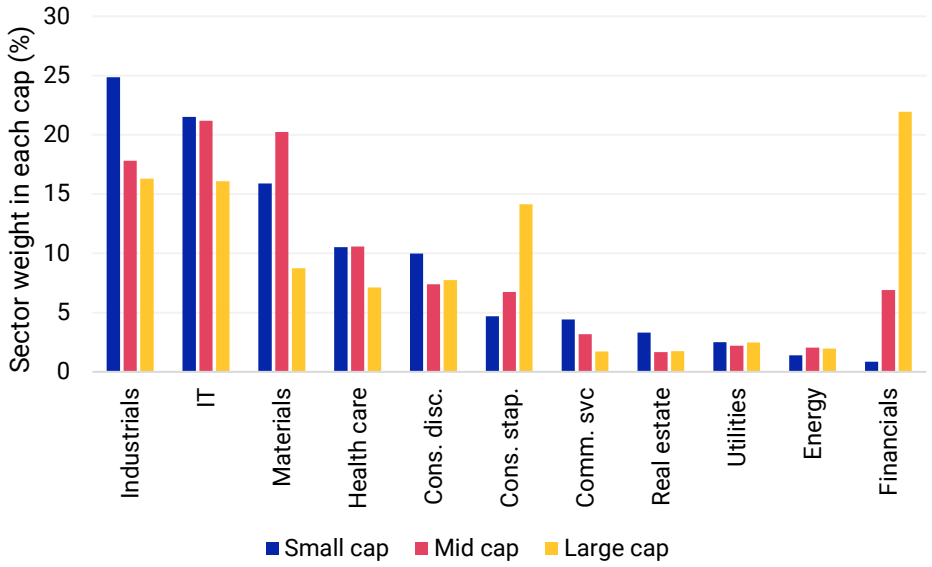


Exhibit 64: China A shares: Cap breakdown by GICS sector. Based on MSCI China A Onshore IMI as of July 31, 2023

[53] MSCI China A Onshore Index is composed with domestic China A shares which are accessible to local investors. MSCI China A Onshore IMI includes large cap, mid cap and small cap stocks which are categorized according to MSCI GIMI methodology.

In aggregate, China A shares small cap also absorbed more trading than their large and mid-cap peers. The domestic A shares market, as proxied by MSCI China A Onshore IMI, had 30% weight from small cap stocks, which contributed 60% average daily trading volume in past 90 days as of Sep 29, 2023 (see Exhibit 65).

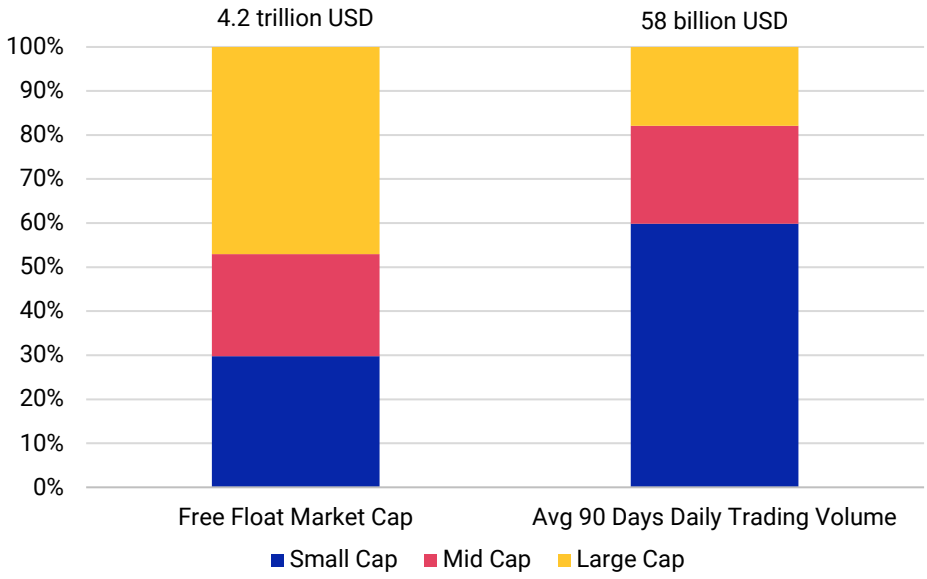


Exhibit 65: China A shares' free-float market cap and daily trading volume by size segment. Based on the MSCI China A Onshore IMI as of Sept. 29, 2023.

Generally speaking, the participation ratio in northbound Stock Connect was higher in large caps that became eligible for northbound trading since 2014 (see Exhibit 66). A large universe of small-cap stocks became eligible for northbound trading only since March 13, 2023, and is still relatively new to global investors. On a stand-alone basis, the size of certain China A small caps is still not large enough for institutional investors, especially for long-term asset-allocation purposes.

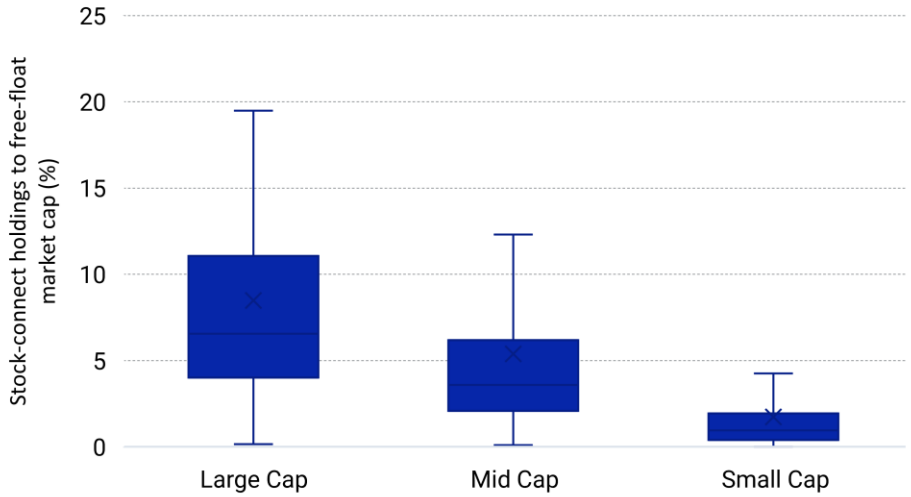


Exhibit 66: China A shares: stock-connect holdings to free float market cap by size segment. Data as of Sept. 20, 2023. Source: Wind, MSCI

Exhibit 67 shows that, compared with offshore listed China equities and other emerging and developed equity markets, China A shares have higher cross-sectional volatility.[54] This means that the difference between top performers and bottom performers is comparably larger, and it could provide potentially more alpha potentials through stock selection or rules-based stock-picking strategies. Among the A shares, small-cap stocks showed more trading opportunities (see Exhibit 68).

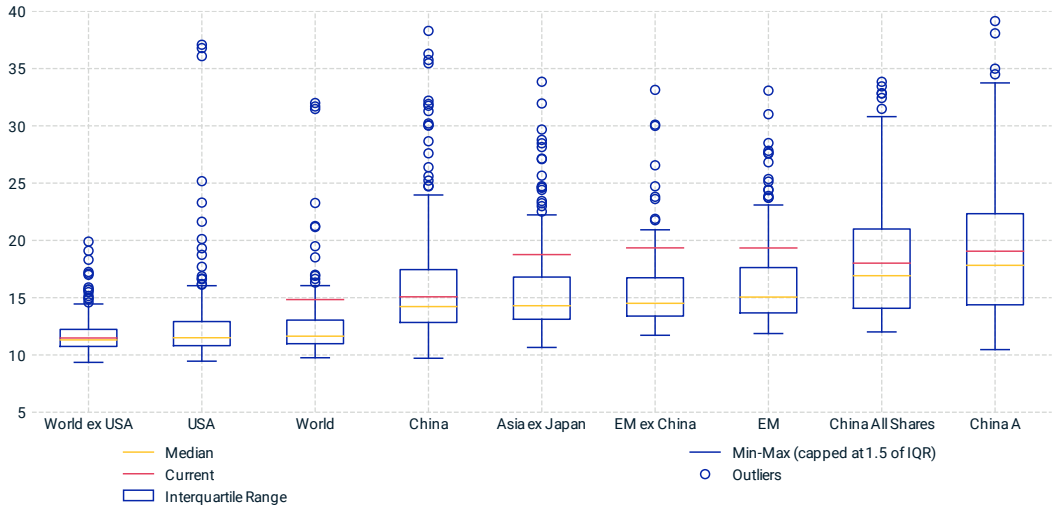


Exhibit 67: Global equity markets' cross-sectional volatility. Based on weighted cross-sectional standard deviation of trailing three-month returns of the MSCI country and regional Investable Market Indexes, from January 2010 to July 2023.

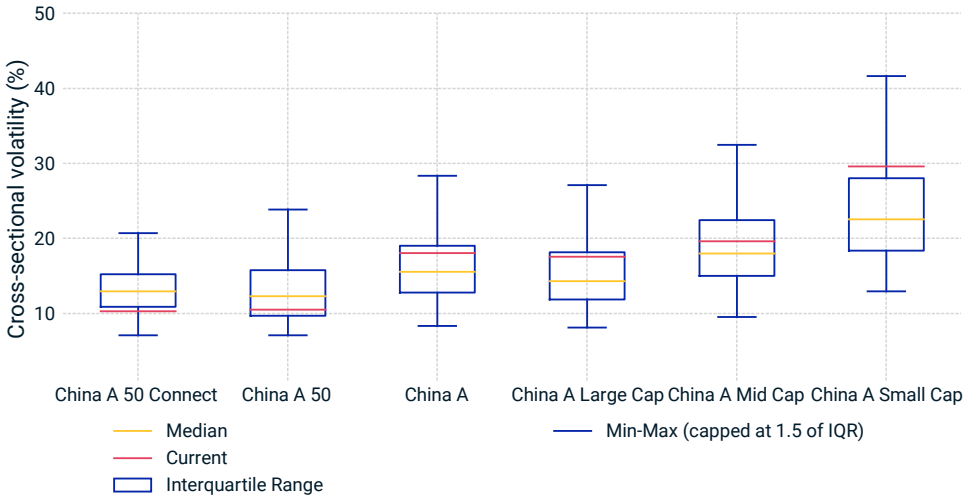


Exhibit 68: China A equity market's cross-sectional volatility by size segments. Based on weighted cross-sectional standard deviation of trailing-three-month returns from Nov. 30, 2012 to Apr. 30, 2023. The MSCI China A Onshore Small Cap Index is used to represent China A small caps.

[54] It's a measure of dispersion extent. Here we calculated it based on the weight of the cross-sectional standard deviation of trailing three-month returns of the respective indexes. Larger cross-sectional volatility means that index constituents' returns moved more differently from each other.

On the other hand, the large- and mega-cap segment of the China A shares demonstrated relatively low historical return dispersion, indicating more maturity of the market segment. As a result, some investors are making use of the market-capitalization-weighted indexes such as the China A 50 Connect Index (Xu and Wei 2021) in their investment process. In addition to the distinctive features of onshore large- and small-cap companies, China offshore companies and onshore companies also exhibit different characteristics.

China's equity market is segregated into different listing locations resulting in many share types.[55] The market for onshore China A shares is larger, less concentrated and more diverse than the offshore market. The market capitalization of China's offshore equity market represented by the MSCI China ex A Index[56] is around 40% of China onshore equity, as represented the MSCI China A Index. The latter also had significantly more constituents and a lower concentration,[57] as shown in Exhibit 69.

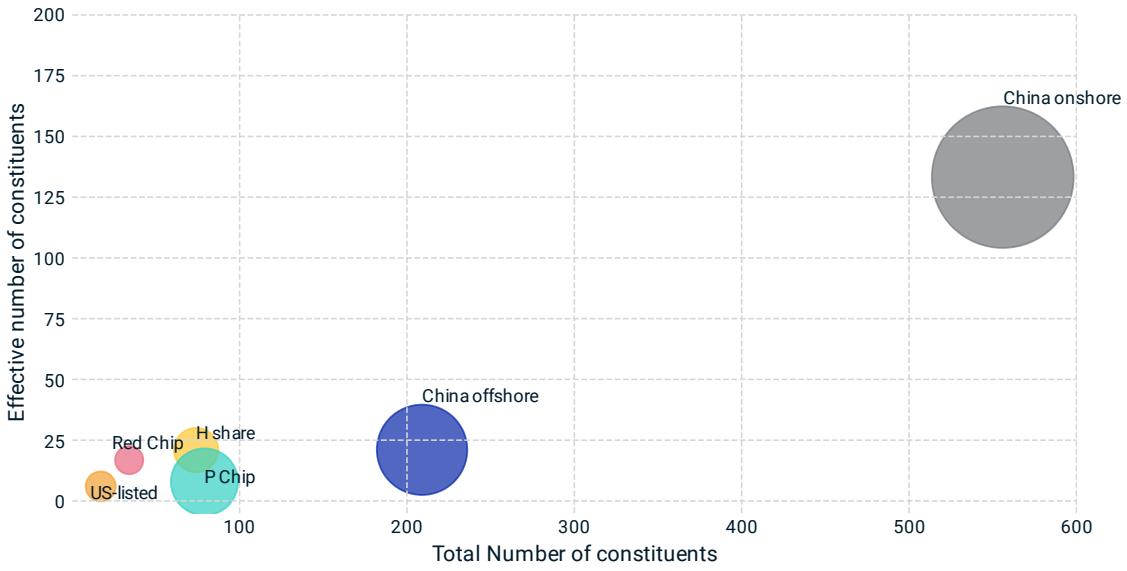


Exhibit 69: China onshore and offshore equity markets' size and concentration. Bubble size indicates the full market capitalization in USD. Concentration measured by effective number of constituents, which is calculated as the inverse of the Herfindahl-Hirschman Index (HHI). As of Sept. 29, 2023.

Moreover, Exhibit 70 shows that each offshore-listed share type was dominated by the top two or three sectors, but with varied sector-allocation profiles. Consequently, the China onshore equity market showed the potential to be balanced and resilient in market downturns, while offshore equities possessed greater sensitivity to market sentiment and sector rotation. An integrated

[55] A shares and B shares are listed in mainland China, denominated in CNY (A shares) or USD/HKD (B shares). H shares, red chips and P chips are listed on the Hong Kong Stock Exchange, and refer to securities incorporated in mainland China, securities of state-owned companies incorporated outside of mainland China and securities of privately owned companies incorporated outside of mainland China, respectively. Overseas-listed refers to securities (including ADRs) listed outside of mainland China and Hong Kong.
[56] The MSCI China ex A Index includes Hong Kong and overseas listed Chinese companies and Shanghai and Shenzhen listed B shares. B shares are freely accessible to foreign investors and have a small weight of 0.23% in the MSCI China Index as of Oct 31, 2023.
[57] Concentration measured by effective number of constituents, which is calculated as the inverse of the Herfindahl-Hirschman Index (HHI)

Chinese-equity opportunity set that includes both onshore and offshore equities may offer more diversified exposure to the Chinese economy.

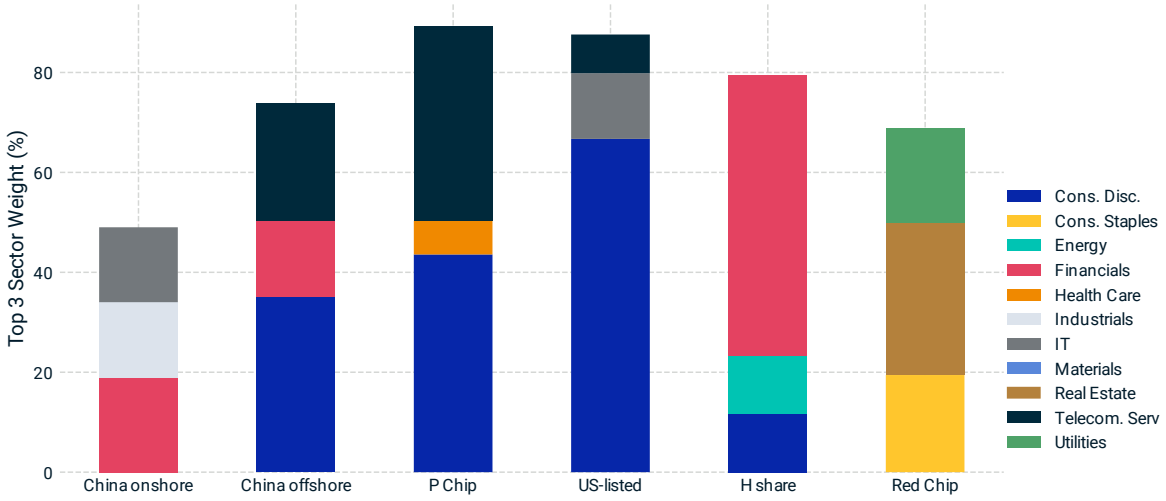


Exhibit 70: Top sectors of China's onshore and offshore equity markets. As of Sept 29, 2023.

Exhibit 71 and Exhibit 72 show that, from November 2008 to September 2023, China's onshore equity market slightly outperformed China's offshore equity market by 20 bps per year, with higher total annualized risk. At the same time, although the integrated MSCI China Index underperformed both emerging markets and global markets, it outperformed the China onshore and China offshore markets separately. Prior to 2021, China offshore and integrated China outperformed emerging markets and global markets but experienced a sharp decline afterward amid the COVID-19 lockdown, geopolitical tension and other internal and external headwinds (Xu and Xu 2022).

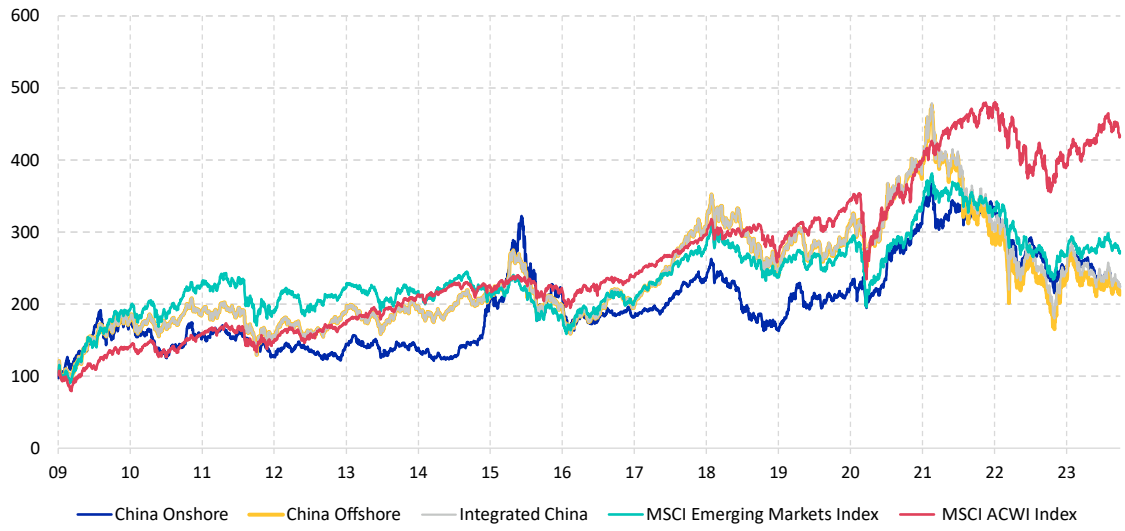


Exhibit 71: Cumulative performance of China's onshore and offshore equity markets.

Key metrics[58]	China onshore	China offshore	MSCI China	MSCI EM Index	MSCI ACWI Index
Total return* (%)	5.6	5.4	5.7	7.0	10.4
Total risk (%)	25.1	24.4	23.4	19.2	15.7
Return/risk	0.22	0.22	0.24	0.36	0.66
Sharpe ratio	0.19	0.19	0.21	0.32	0.61
Price to book* **	2.0	1.8	1.7	1.7	2.1
Price to earnings* **	15.3	13.5	12.8	13.6	17.5
Dividend yield* (%)**	1.9	2.1	2.4	2.7	2.5

*Exhibit 72: Period: Nov. 28, 2008, to Sept. 29, 2023. * Gross returns annualized in USD *** Monthly averages*

Considerations on implementing China equity allocations

Typical framework on China allocation

When considering how to allocate to China, the choice of approach has partly reflected investors' differing levels of experience with and varying outlooks for Chinese equities, as well as their current resource dedication and constraints. Investors with positive convictions about the long-term prospects for China's economic growth or an alternative view about the underweighting of China in externally managed active EM portfolios may choose to "top up" their China allocation. Investors taking this option have generally selected between an integrated or dedicated approach, depending on their views about deviating from their policy benchmark.

- Integrated approach: Investors that more closely follow broad-based benchmarks or who do not want to disrupt their current process by introducing a dedicated China program may consider a broad allocation reflecting a higher weight for China versus the market-cap-weighted benchmark index.
- Dedicated approach: Less-constrained investors, or those who value the flexibility of a separate China focus, might raise their China exposure via a discrete China program or, more narrowly, one focused on China A shares only.

[58] China onshore and China offshore equity markets are measured by the MSCI China A Index and the MSCI China ex A Index. The MSCI China Index represents the integrated China equity opportunity. Prior to China A shares' inclusion in June 2018, the MSCI China ex A Index and the MSCI China Index were exactly the same.

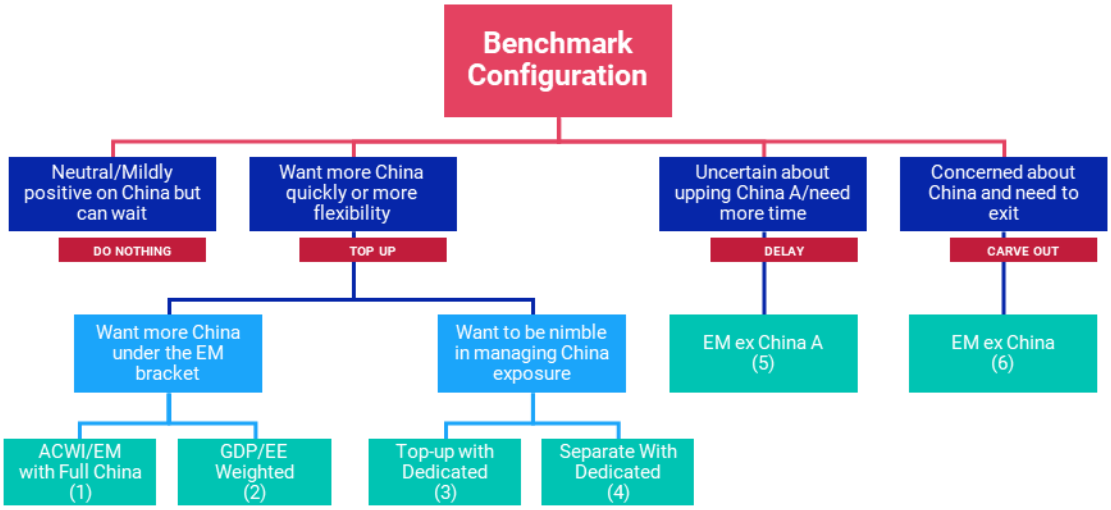


Exhibit 73: Framework for benchmark configuration.

Given different investment objectives and constraints, there also are different approaches to determine the appropriate size of a dedicated China program (see Exhibit 74 and Exhibit 73). While referencing China's market-cap weight in global and regional benchmark indexes is a simple approach to start with, investors might also consider indicators such as economic growth and fundamentals, exposure of trade and investment, level of currency internationalization and optimized outcomes from quantitative models.

Approach	**Intuitions**	**Reference example**
Market-capitalization-weighted benchmark index.	To follow general market accessibility and composition.	• MSCI standard indexes • MSCI indexes with 100% inclusion of China A
Economic growth and fundamentals.	To reflect the economic role of China.	• MSCI GDP indexes • MSCI Economic Exposures database
Trade and investment.	To match the trading and investment activities related to China.	• Trade size • Size of foreign direct investment
Level of currency internationalization.	To prepare for potential currency/reserve exposures.	• IMF SDR Basket
Optimized outcomes of quantitative models.	Using techniques including setting up return targets on future growth expectations, risk budgets based on country risks or maximizing the outcome of utility.	• MSCI indexes' fundamental data • MSCI Barra models • Optimizations

Exhibit 74: Approach to determine the size of a dedicated China program.

According to MSCI Research (Wei 2021), we found that the minimal ex-ante total risk of the EM portfolio was achieved when around 60% was allocated to the MSCI China Index or around 30% to the MSCI China A Index in the dedicated China and dedicated China A programs, respectively. By comparison, China and China A shares' weights in the MSCI EM Index were 39.1% and 4.8%,

respectively, as of Dec. 31, 2020 (see Exhibit 75).

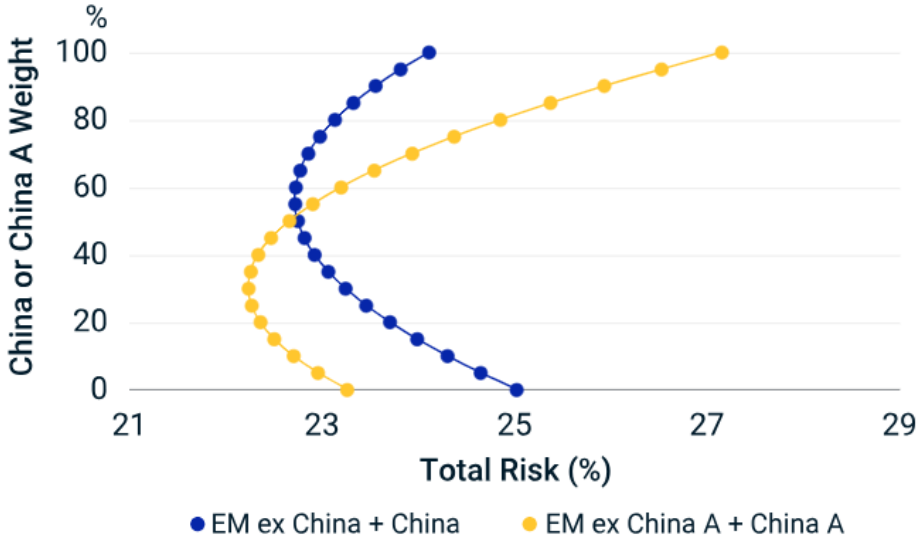


Exhibit 75: Total Risk with Different Allocations to MSCI China and China A Indexes. The ex-ante total risk is calculated using the MSCI Barra Global Equity Model (GEMLT), as of Dec. 31, 2020.

Implementation style

Large institutional investors employ different implementation styles when investing in Chinese equities, depending on:

- Investment objectives
- Risk appetite
- Resources

Direct-investment approach	Indirect-investment approach
Directly purchase individual stocks or bonds in the Chinese equity market, conducting their own research and analysis.	Investing in Chinese equities through mutual funds, ETFs or other investment vehicles.

Passive versus active investing

Institutional investors have the option to pursue passive or active investing strategies when allocating funds to Chinese equities.

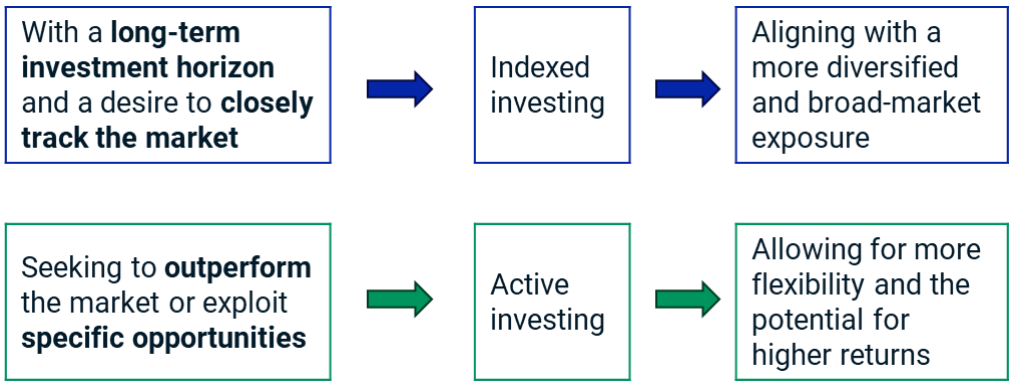
Passive investing	Active investing
Replicating the performance of a specific index, such as the MSCI China A 50 Connect Index or the MSCI China Index, by investing in ETFs or index funds.	Actively managing portfolios, making investment decisions based on research, analysis, and forecasts.
This approach aims to track the broad market rather than outperform it.	Active managers may employ strategies such as stock selection, sector rotation, and timing to generate returns that outperform the market.

Internally managed versus externally mandated

Institutional investors may choose to manage their investments in Chinese equities internally or delegate the responsibility to external asset managers. More resourceful institutions rely on their own investment team to conduct research, execute trades, and manage the portfolio in-house. This approach gives the institution direct control over investment decisions and execution. Many large institutions including those with internal management capabilities on Chinese equities outsource investment management to third-party asset managers. Institutional investors select external managers based on their expertise, track record, and alignment with investment objectives.

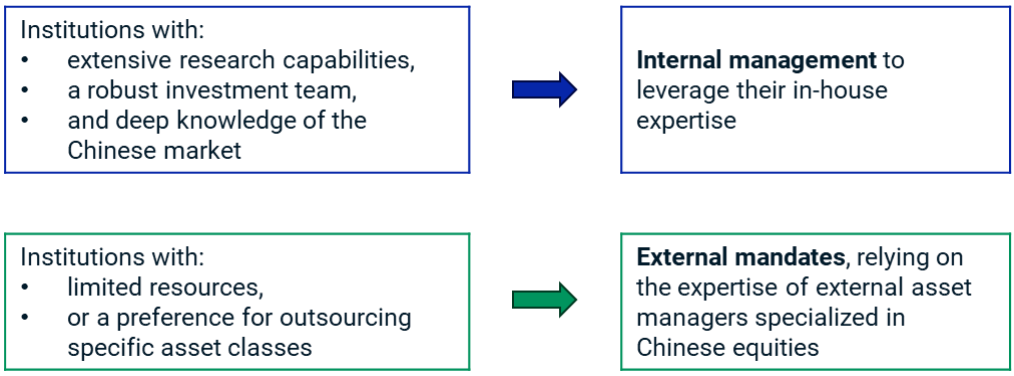
Investment objectives and risk appetite

Institutional investors' investment objectives and risk appetite play a significant role in determining their approach to investing in Chinese equities.



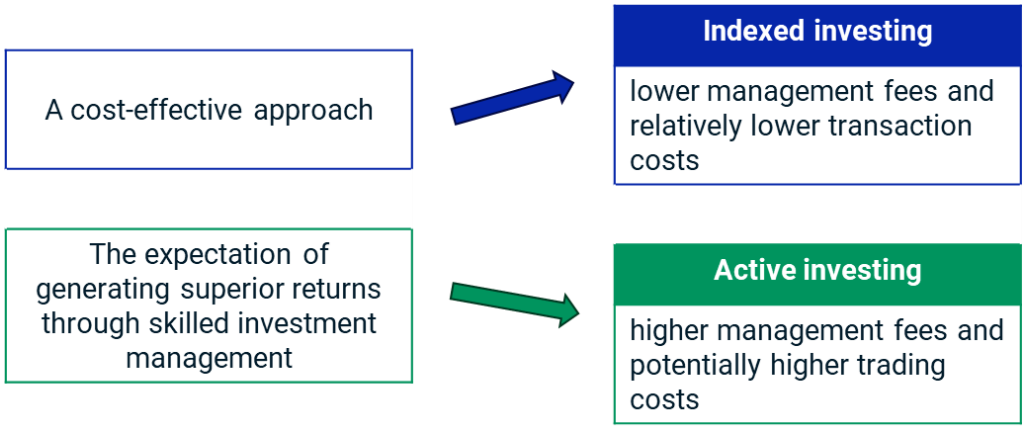
Resources and expertise

The availability of resources and expertise within institutional investor organizations can influence their approach to investing in Chinese equities.



Cost considerations

The cost-efficiency of investment strategies can be a determining factor for institutional investors.



Conclusion

It's worth noting that the investment landscape and preferences of large institutional investors in Chinese equities continue to evolve. Market conditions, regulatory developments, and shifting investor preferences can influence the adoption of different investment styles, such as a shift from active management to index-based strategies witnessed in 2023.

Additionally, institutions may adopt a diversified approach, combining multiple implementation styles, indexed, quantitative and active investing, as well as internal and external management, to create a well-rounded investment strategy that best aligns with their investment objectives, risk preference, and governance process.

An institutional investor's choice of implementation style for a strategy dedicated to China A shares could be influenced by factors such as investment objectives, risk appetite, resources, local expertise, cost considerations amongst other considerations. A customized approach that suits the specific requirements and preferences of each institutional investor is sometimes preferred to strike a better balance across various consideration factors in the Chinese equity market.[59]

[59] Such consideration may include a balance between core market exposure and growth-oriented small-cap allocation, a balance between long-term financial value creation and consideration of ESG and climate-related risks, a balance between the need for market liquidity and a private-equity-like long-term growth-investing mindset.

Appendix: Additional exhibits

Section I: Global Market Portfolio

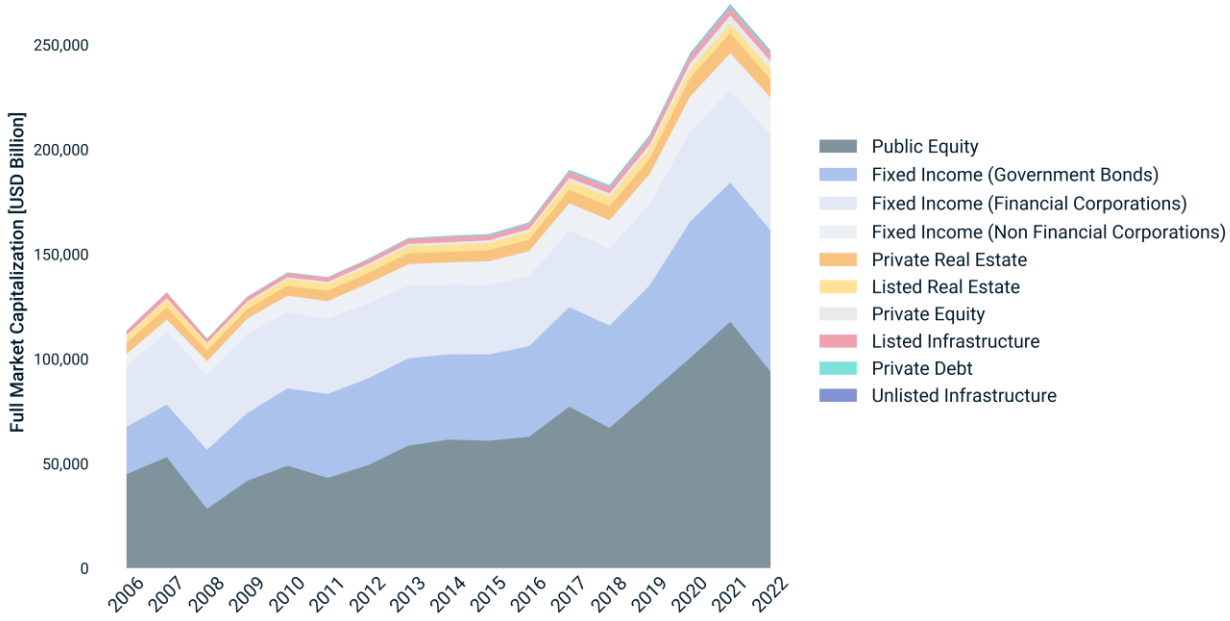


Exhibit 76: Evolution of the full global market portfolio (from December 2006 to December 2022).

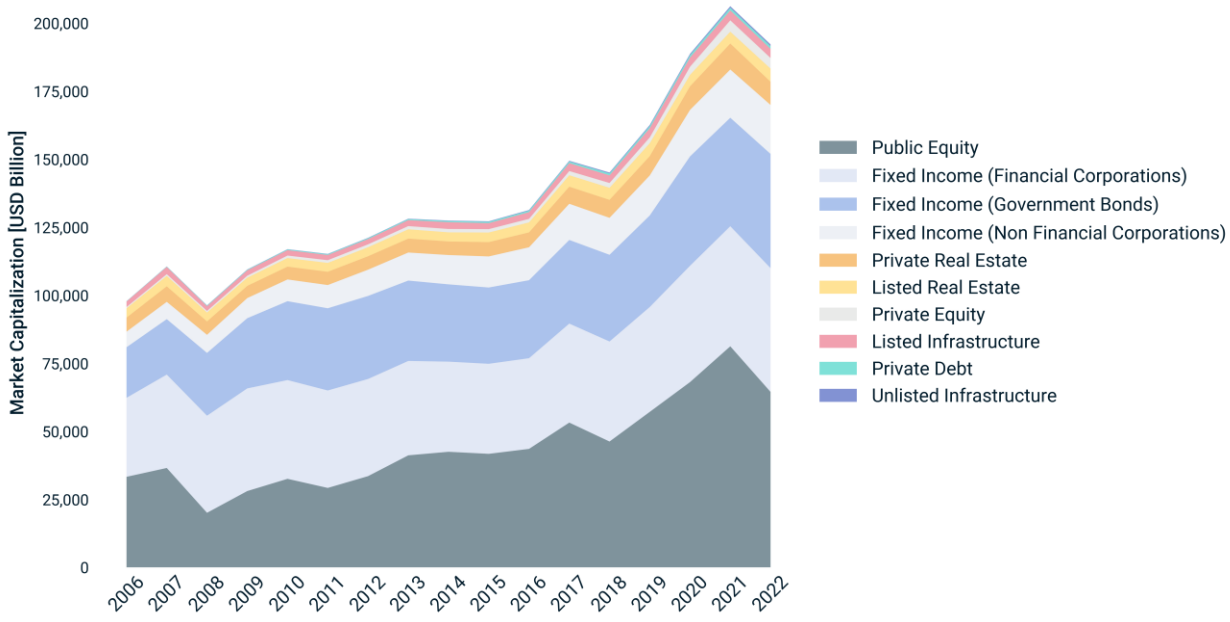


Exhibit 77: Evolution of the investable global market portfolio (from December 2006 to December 2022).

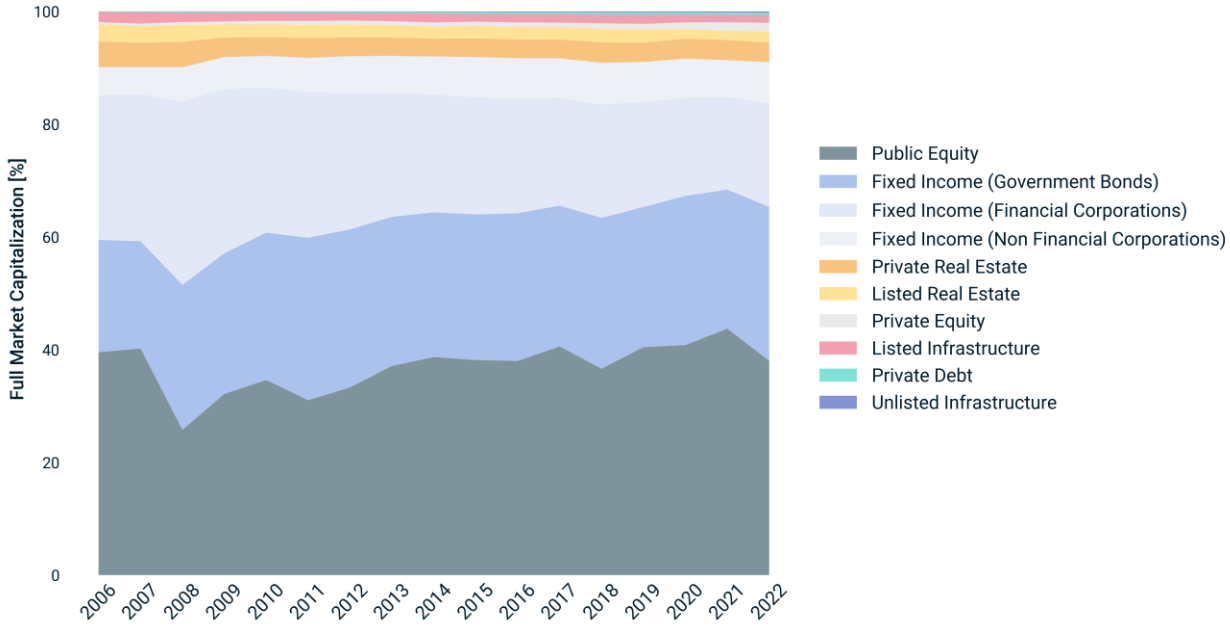


Exhibit 78: Evolution of the asset-class market size in the full global market portfolio (from December 2006 to December 2022).

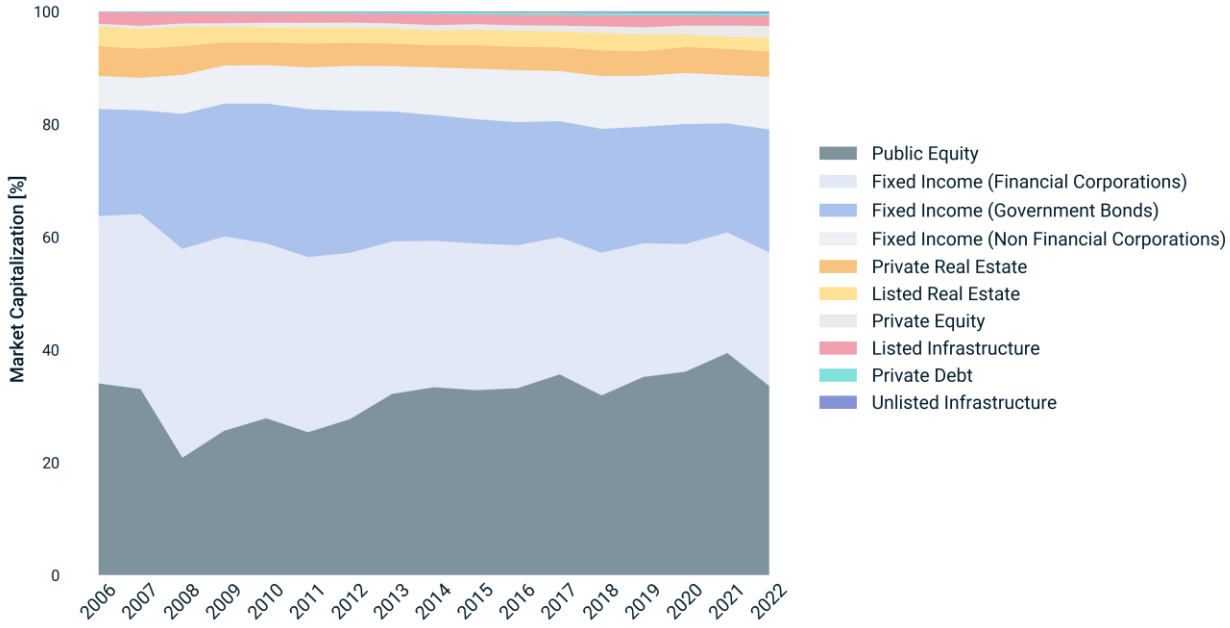


Exhibit 79: Evolution of the asset-class market size in the investable global market portfolio (from December 2006 to December 2022).

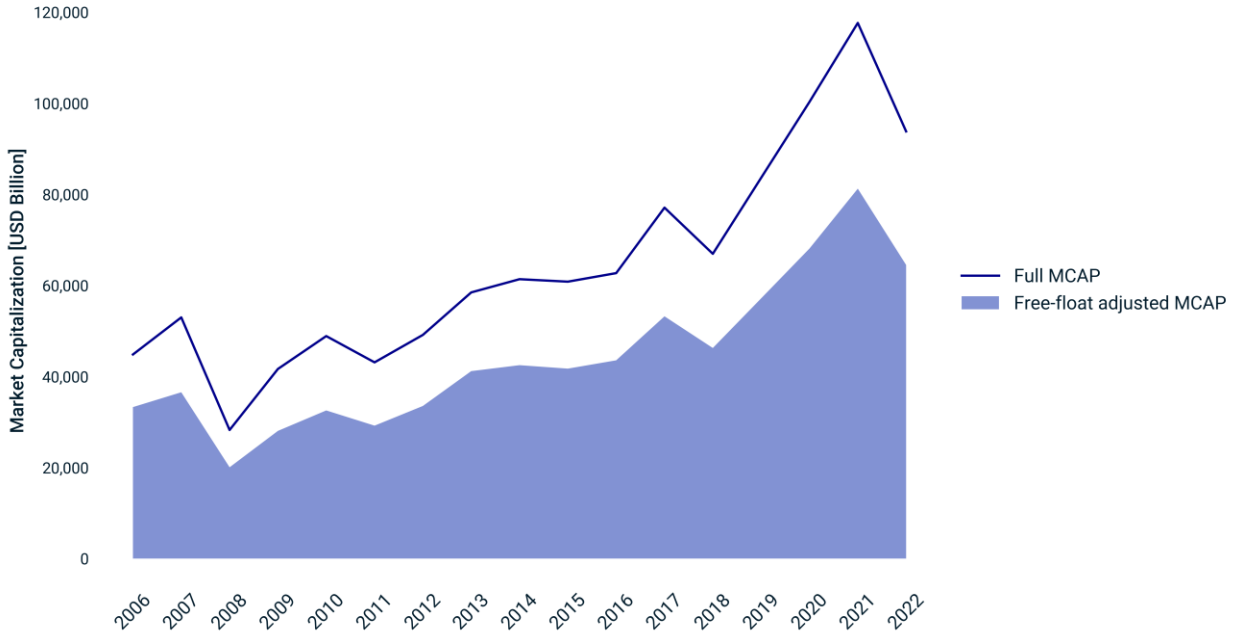


Exhibit 80: Evolution of the full and free-float-adjusted market capitalization of public equities.

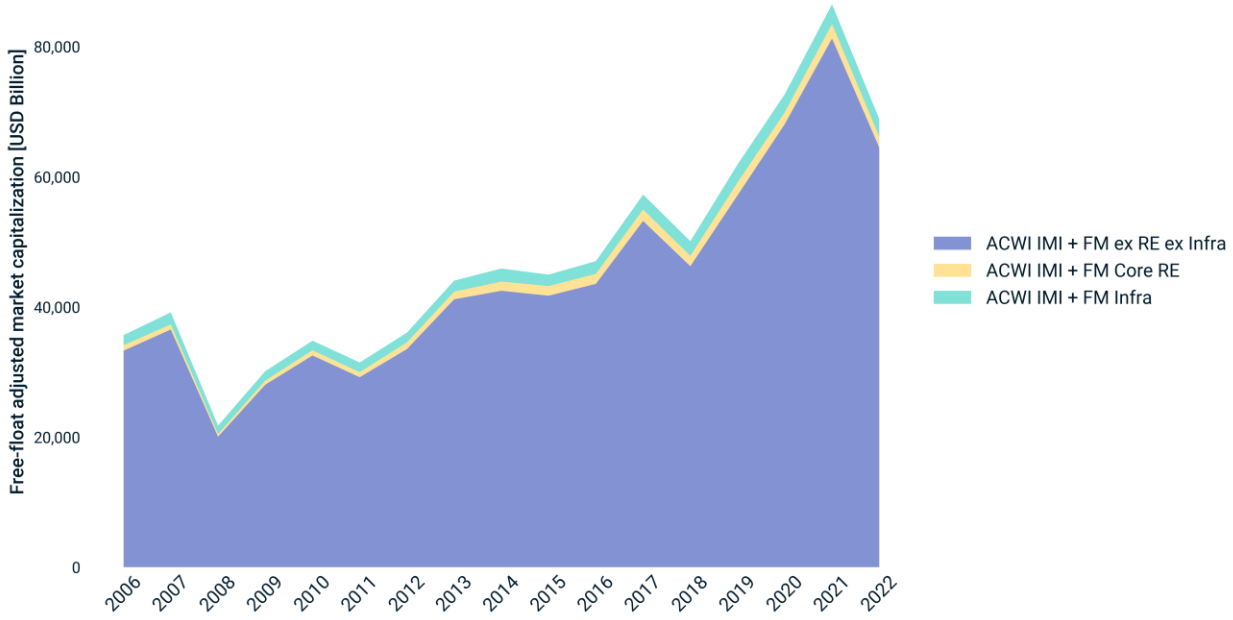


Exhibit 81: Evolution of the free-float-adjusted market capitalization of the MSCI ACWI + FM IMI over time by asset type.

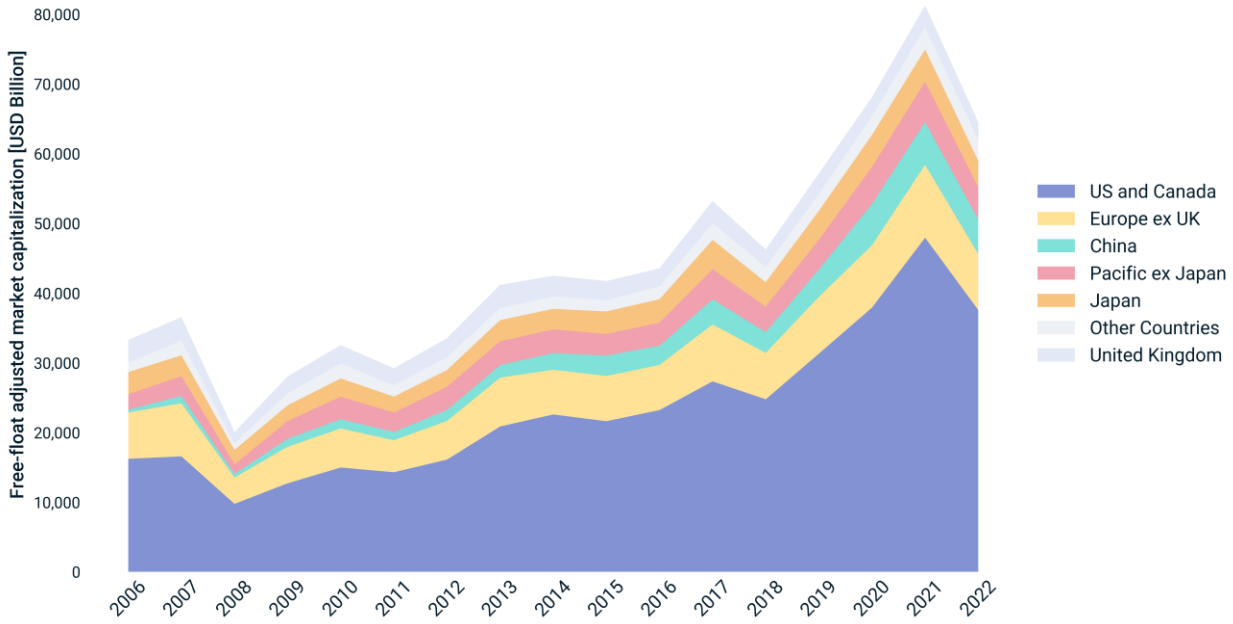


Exhibit 82: Evolution of the free-float-adjusted market capitalization of public equities by region.

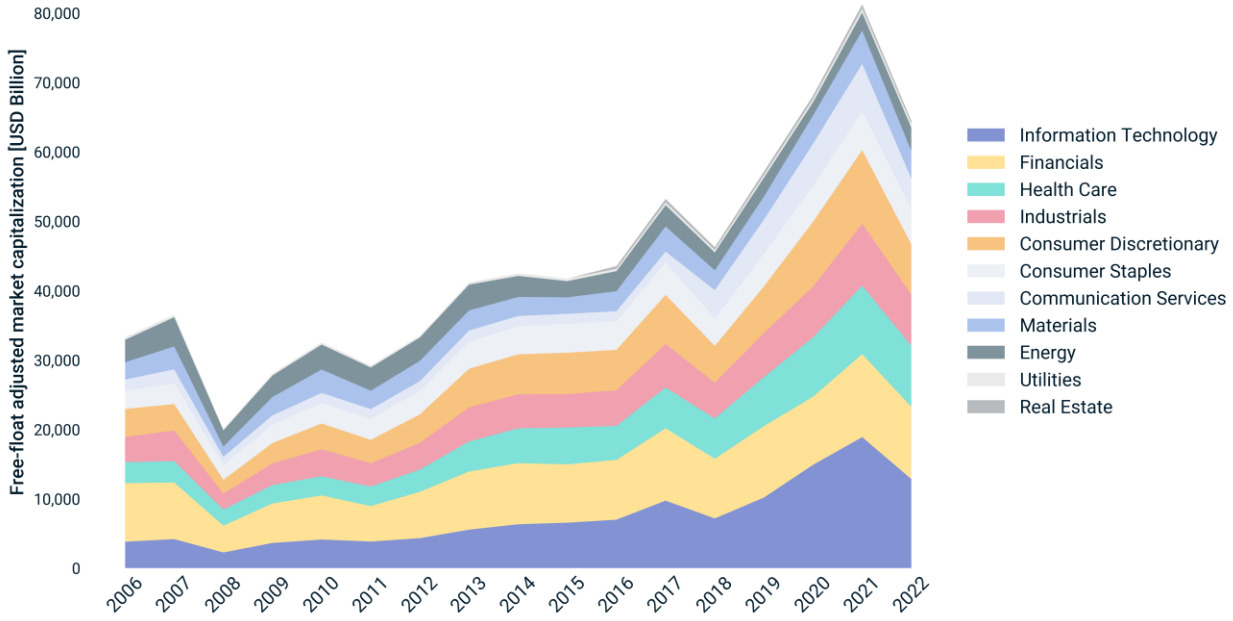


Exhibit 83: Evolution of the free-float-adjusted market capitalization of public equities by GICS sector.[60]

[60] Real estate was introduced as a GICS sector in 2016.

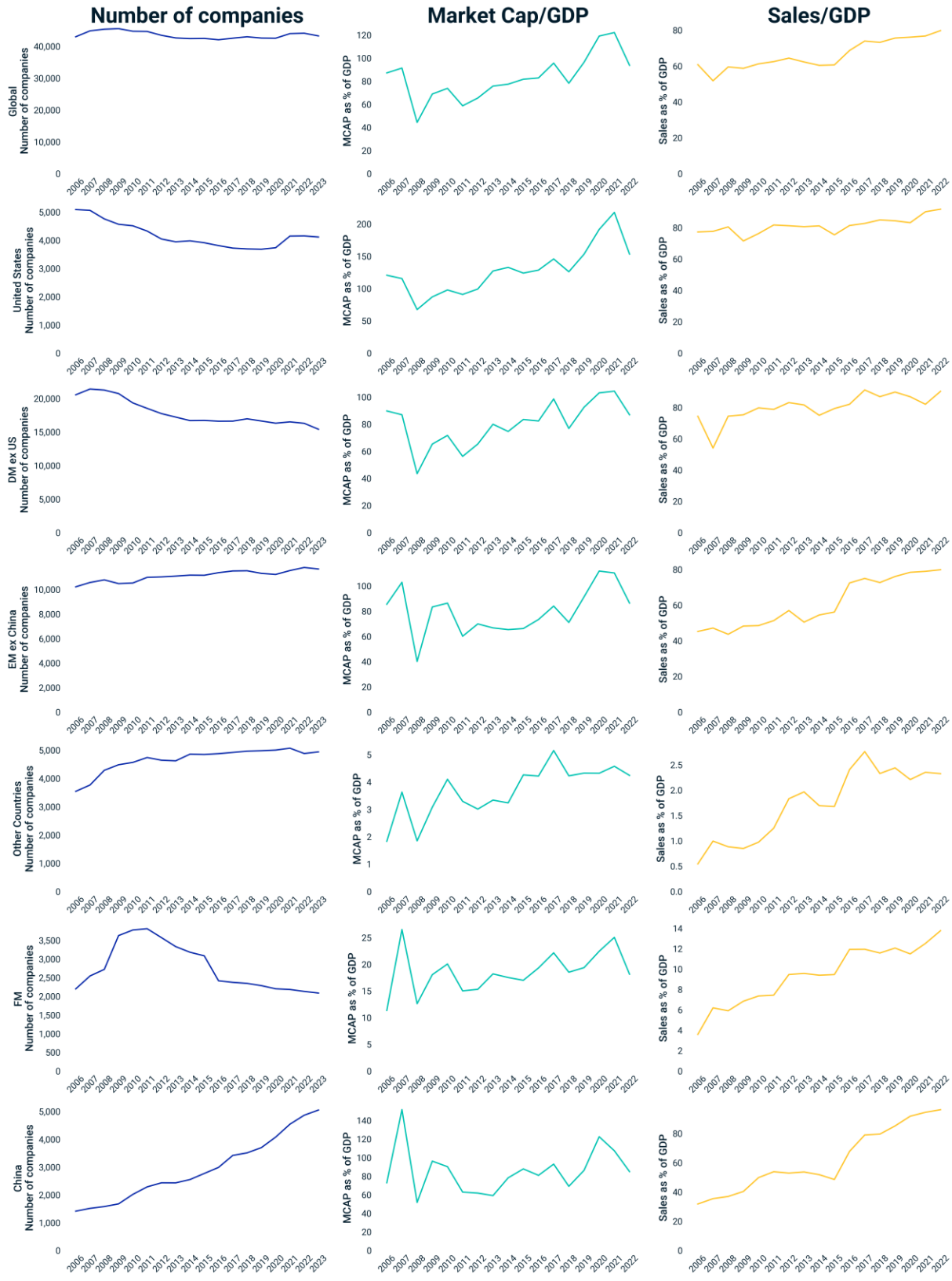


Exhibit 84: Evolution of the number of public companies and their full market capitalization to GDP and sales to GDP, for the global equity market by region, excluding OTC markets.

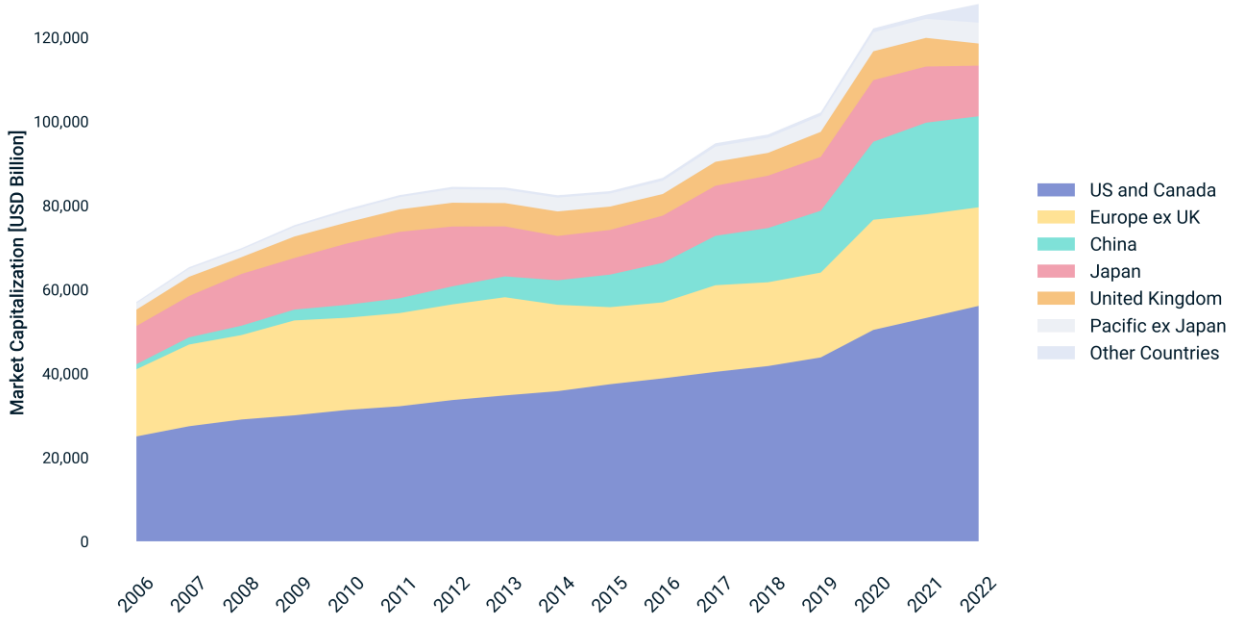


Exhibit 85: Evolution of total debt outstanding (Including debt issued by financial corporations, nonfinancial corporations and governments) by region.

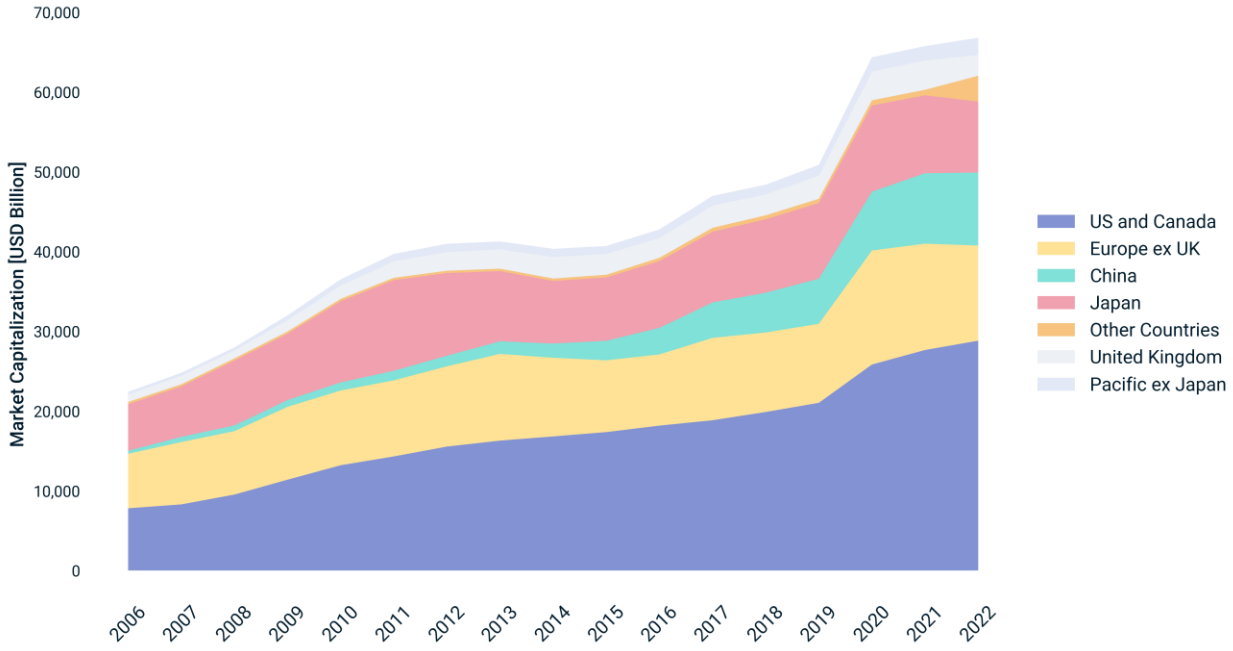


Exhibit 86: Evolution of outstanding government debt by region.

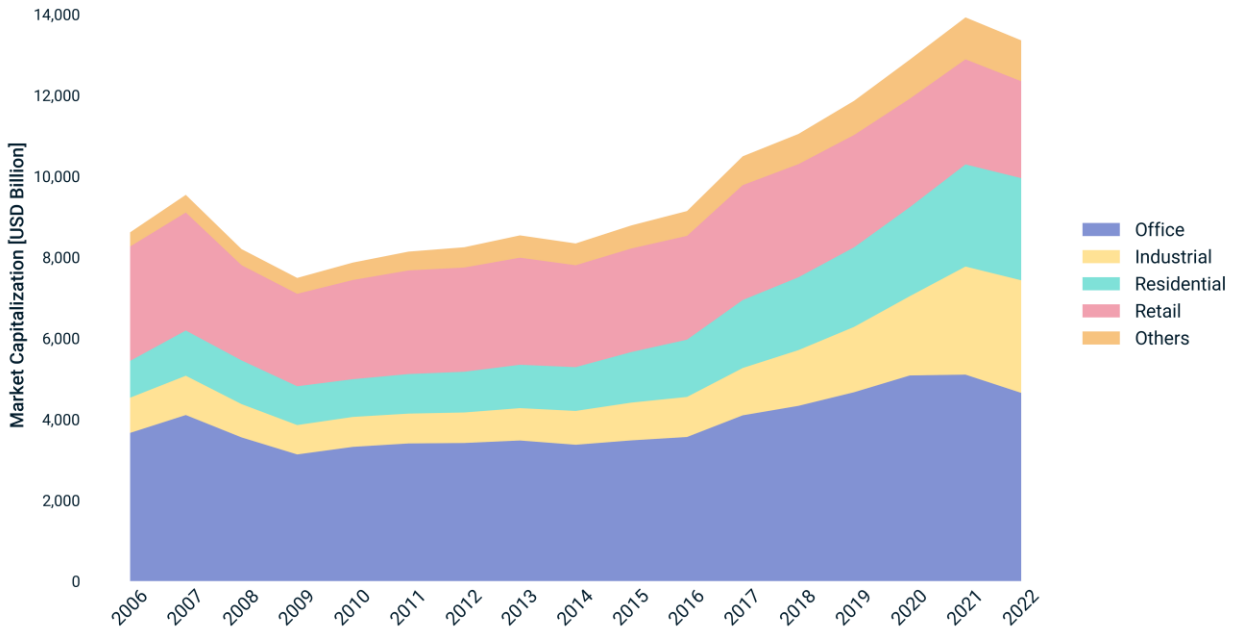


Exhibit 87: Evolution of professionally managed real estate by sector.

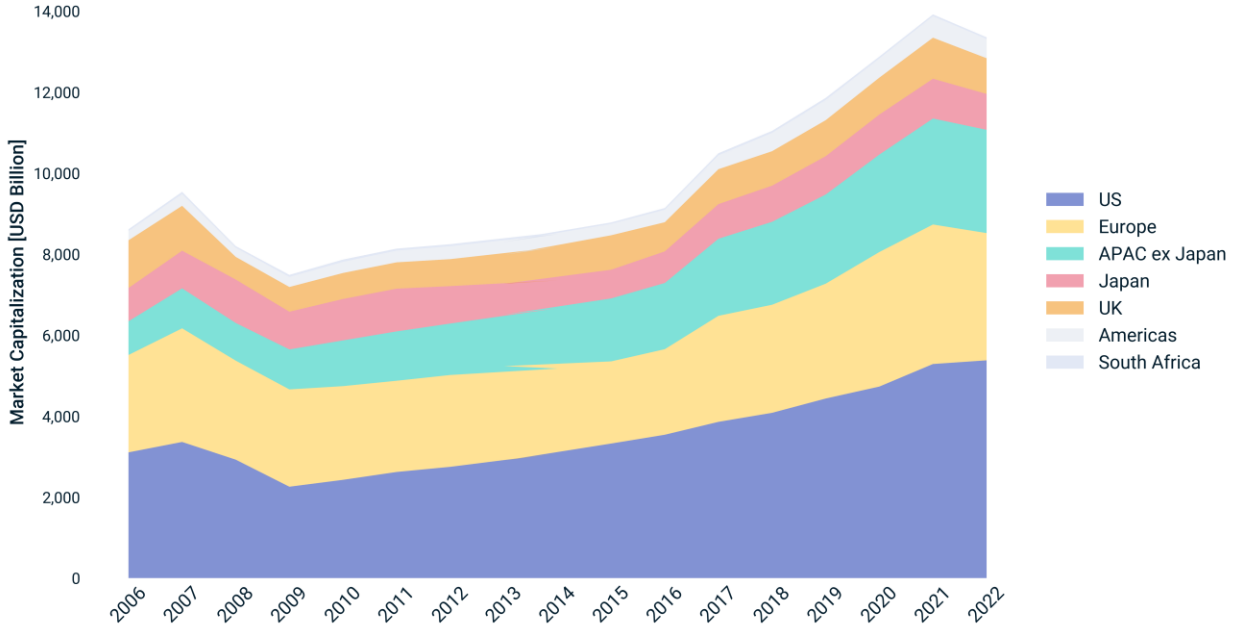


Exhibit 88: Evolution of professionally managed real estate by region.

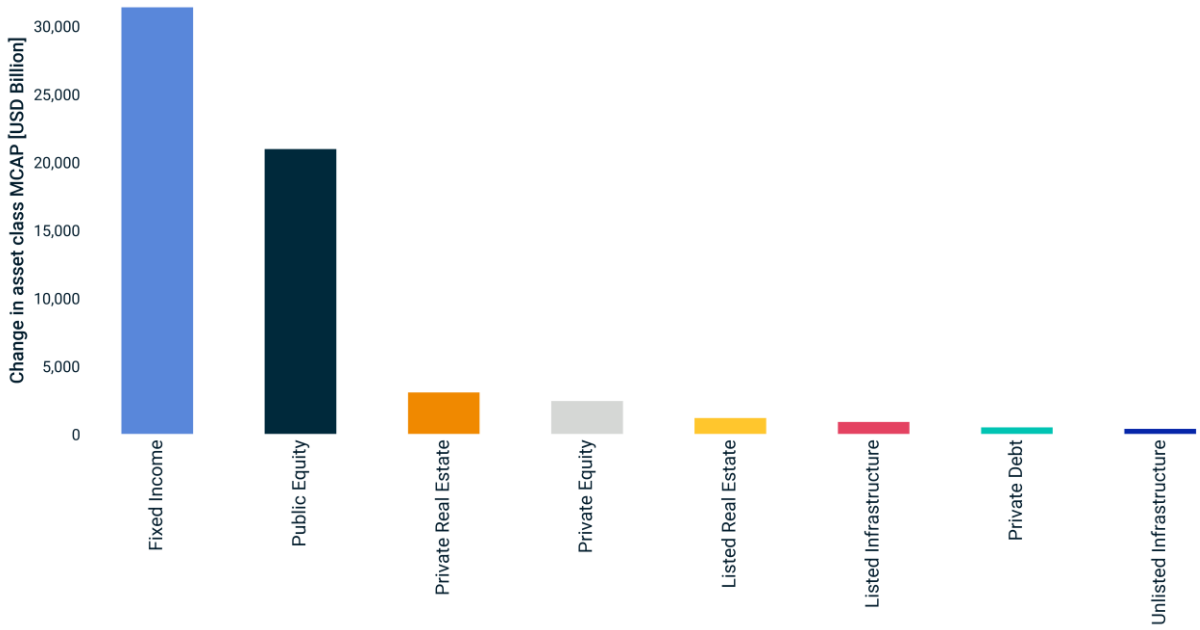


Exhibit 89: Change in the investable market capitalization of the global market portfolio from 2016 to 2022.

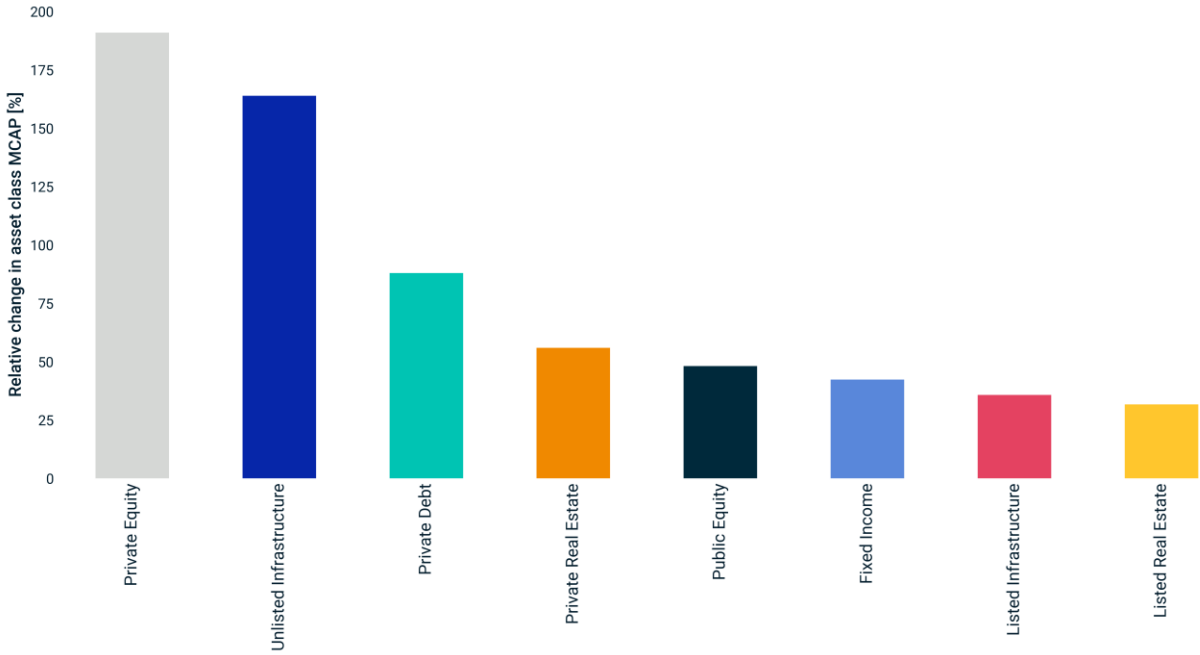


Exhibit 90: Relative change in investable market capitalization of asset classes from 2016 to 2022.

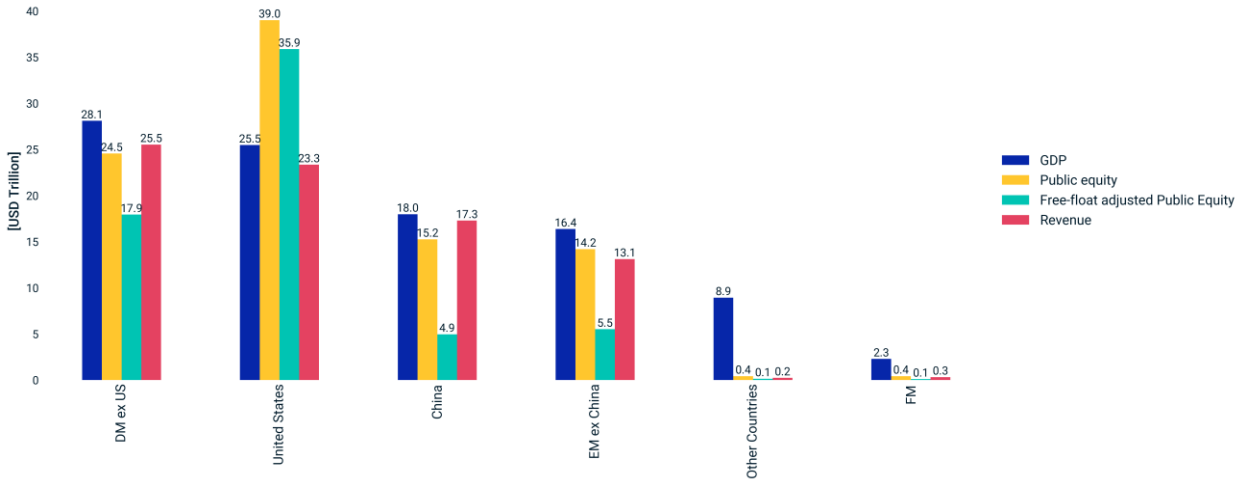


Exhibit 91: Absolute comparison of GDP,[61] full and free-float-adjusted market capitalization and revenue of public-equity markets in 2022 for regions.[62]

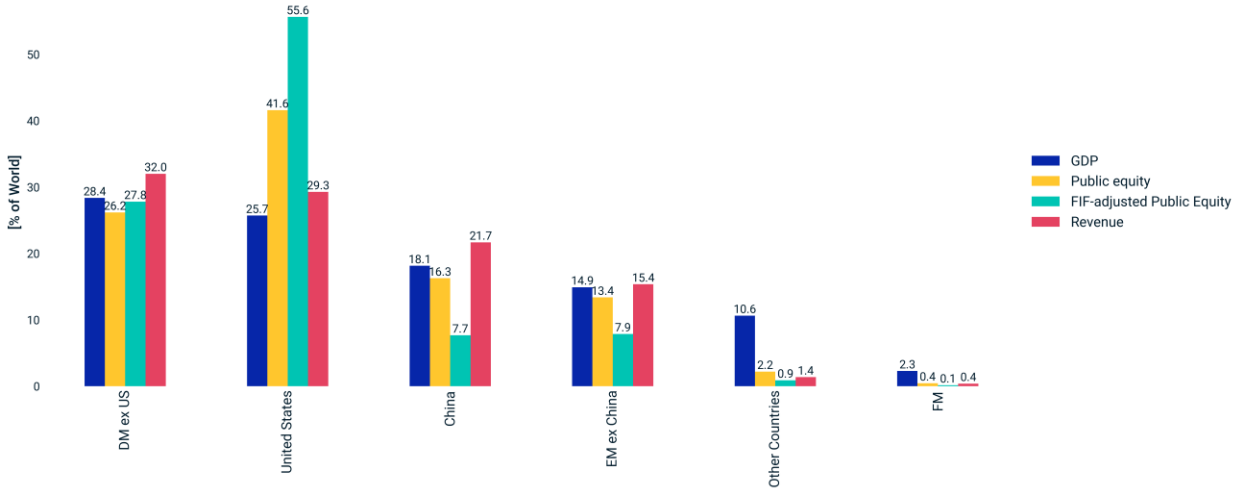


Exhibit 92: Comparison of GDP and public-equity market capitalization and revenues in 2022.

[61] GDP as determined by the World Bank.
[62] Developed markets, emerging markets and frontier markets are categorized based on the MSCI Market Classification. Uncategorized and stand-alone markets are included in "Other Countries" buckets.

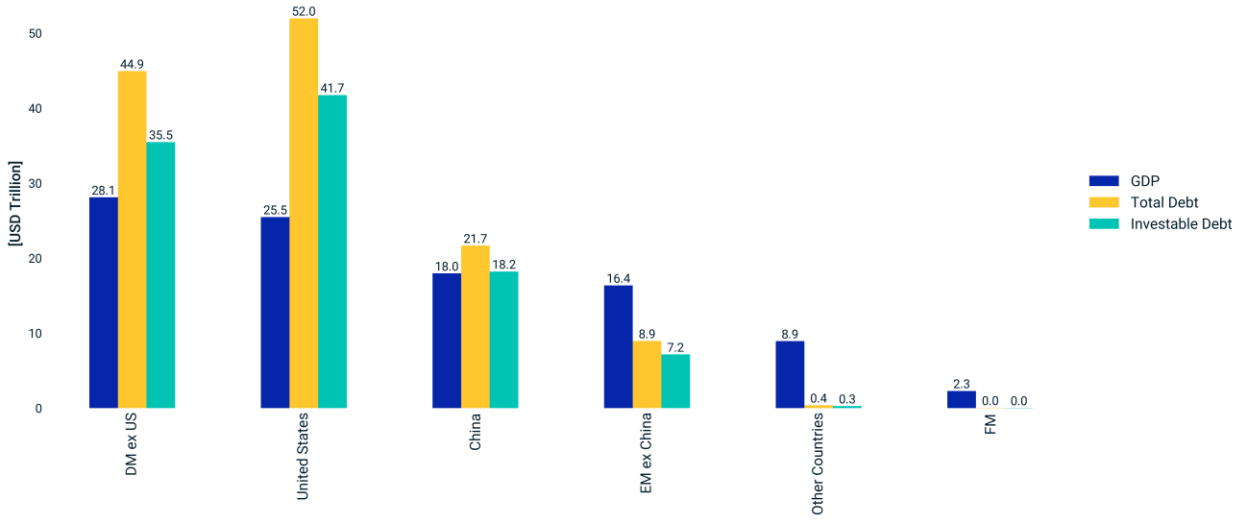


Exhibit 93: Absolute comparison of GDP and fixed-income markets in 2022.

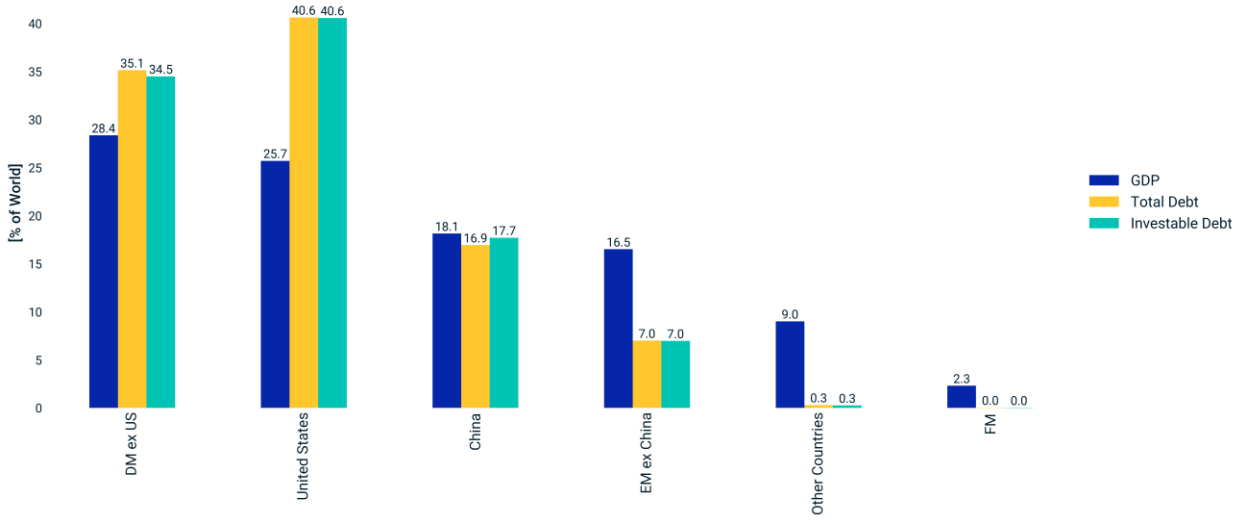


Exhibit 94: Relative comparison of GDP and fixed-income markets in 2022.

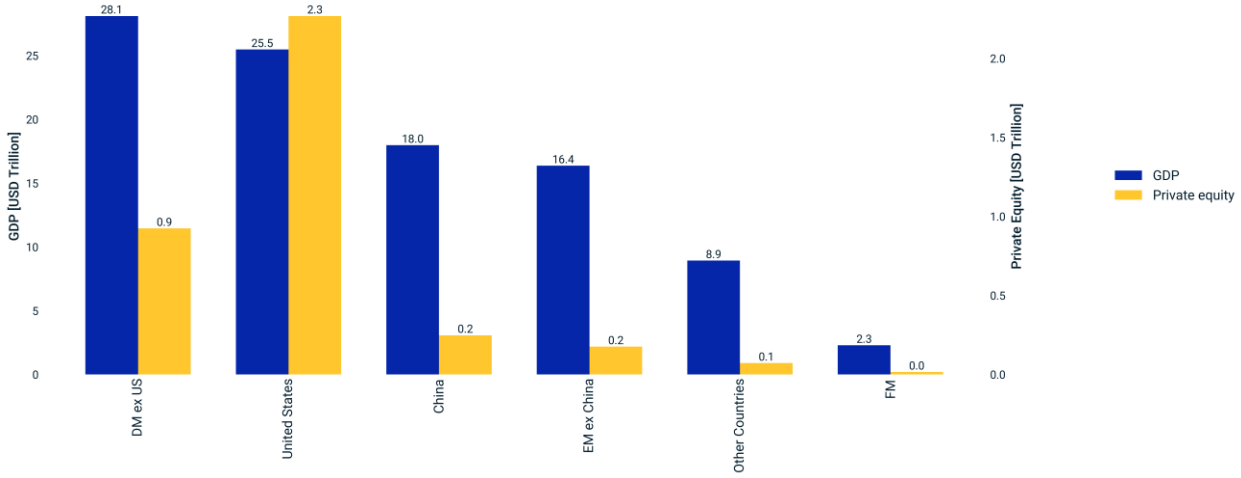


Exhibit 95: Absolute comparison of GDP and private-equity markets in 2022.

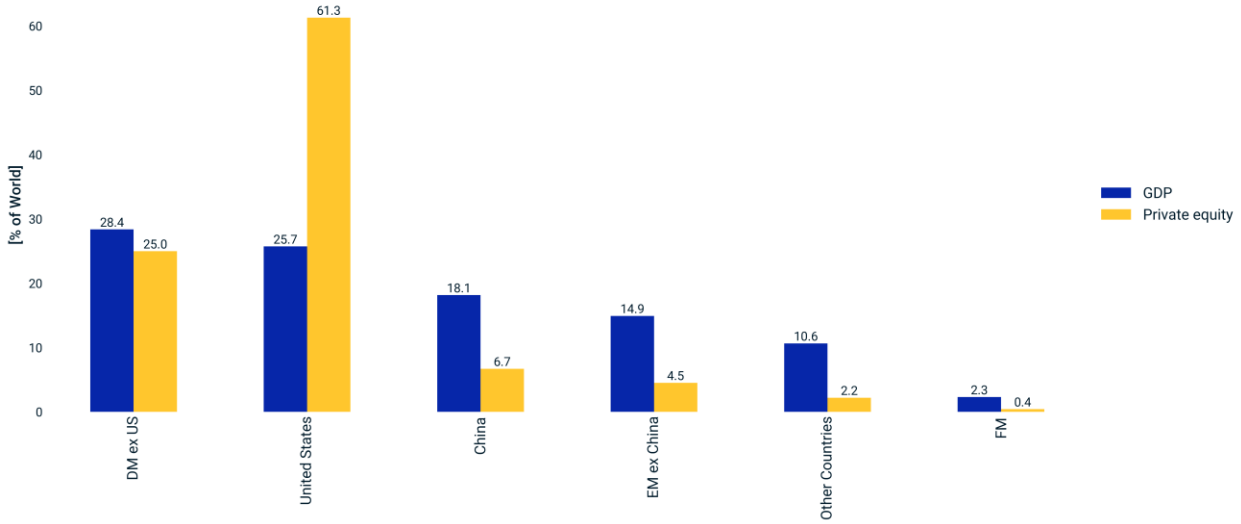


Exhibit 96: Relative comparison of GDP and private-equity markets in 2022.

Section II: Private-equity markets

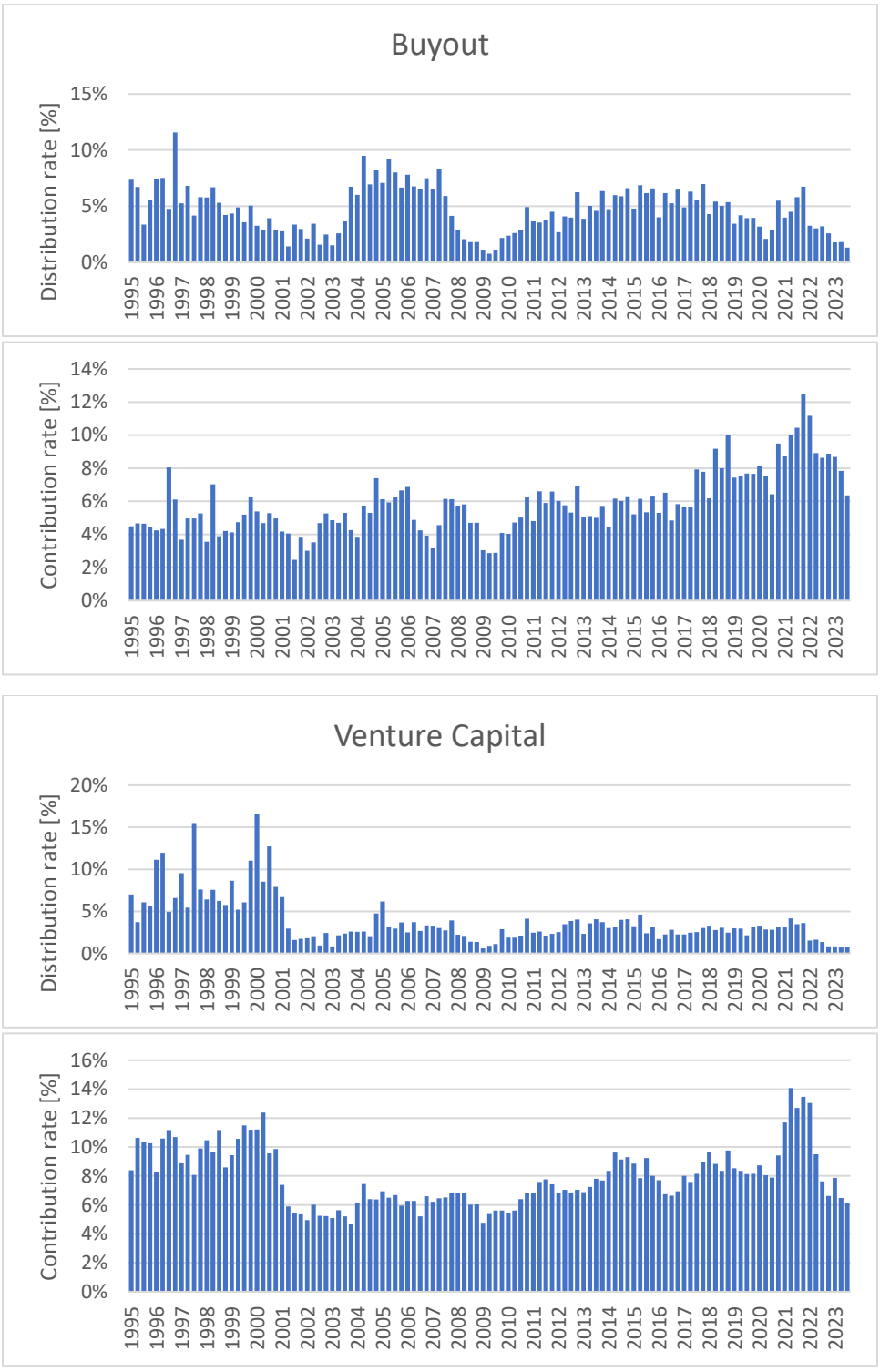


Exhibit 97: Quarterly distribution and contribution rates from BMU funds through Q3 2023. Distributions rates are distributions divided by net asset value. Contribution rates are contributions divided by unfunded capital. Source: MSCI Private Capital Solutions

References

Ang, Andrew, Michael W. Brandt, and David F. Denison. 2014. "Review of the Active Management of the Norwegian Governmnet Pension Fund Global."

Arslanalp, Serkan, and Takahiro Tsuda. 2014. "Tracking Global Demand for Advanced Economy Sovereign Debt." *IMF Economic Review, Volume 62, Number 3,.*

Baklanova, Viktoria, Isaac Kuznits, and Trevor Tatum. 2020. "Primer: Money Market Funds and the Commercial Paper Market." *U.S. Securities and Exchange Commission.*

Bauer, Rob , Charlotte Christiansen, and Trond Døskel. 2022. "A Review of the Active Management of Norway's Government Pension Fund Global."

CEM Benchmarking Inc. 2023. "Investment Benchmarking Analysis (for the 10-year period ending December 31, 2021) for the Norwegian Government Pension Fund Global."

Chen, Sophia, Paola Ganum, Lucy Qian Liu, Leonardo Martinez, and Maria Soledad Martinez Peria. 2019. "Debt Maturity and the Use of Short-Term Debt: Evidence form Sovereigns and Firms." *IMF Departmental Paper No. 2019/001.*

Committee on the Global Financial System . 2007. "Institutional investors, global savings and asset allocation." *CGFS Papers No. 27.*

Committee on the Global Financial System. 2017. "Repo Market Functioning." *CGFS Papers No. 59.*

2022. "CSRC Chairman Yi Huiman's speech in 2022 Financial Street Forum (Chinese)."

2022. "CSRC Vice Chairman Li Chao's speech in "China's ten years" press conference. (Chinese)."

Doeswijk, Ronald Q., Trevin Lam, and Laurens Swinkels. 2014. "The Global Multi-Asset Market Portfolio, 1959-2012." *Financial Analysts Journal 70, no. 2* 26-41.

FAS 157. 2007. "Statement of Financial Accounting Standards No. 157: Fair Value Measurements."

Fernandes, Nuno. 2011. "Sovereign Wealth Funds: Investment Choices and Implications Around the World."

Gaspar, Vitor, Marcos Poplawski-Ribeiro, and Jiae Yoo. 2023. "Global Debt Is Returning to its Rising Trend." *IMF Blog.*

Gredil, Oleg, Barry E Griffiths, and Rü Stucke. 2022. "Benchmarking Private Equity: The Direct Alpha Method." *Journal of Corporate Finance.*

Greer, Robert. 1997. "What is an Asset Class, Anyway?" *Journal of Portfolio Management, 23* 86-91.

Gupta, Abhishek, Dimitris Melas, Raghu Suryanarayanan, and Andras Urban. 2016. "GLOBAL MARKETS & RETURN DRIVERS: Analysis for the Ministry of Finance, Norway."

Harris, Robert S., Tim Jenkinson, Steven N. Kaplan, and Rüdiger Stucke. 2023. "Has Persistence Persisted in Private Equity? Evidence from Buyout and Venture Capital Funds." *Journal of Corporate Finance, Volume 81.*

Jordan-Wood, Samuel, and Christopher J. Neely. 2022. "Russia's Invasion of Ukraine and Its Impact on Stock Prices." *Federal Reserve Bank of St. Louis.*

Kaplan, Steven N., and Antoinette Schoar. 2005. "Private Equity Performance: Returns, Persistence, and Capital Flows." *The Journal of Finance, 60: 1791-1823.*

Kortweg, Arthur. 2023. "Risk and return in private equity." *Handbook of the Economics of Corporate Finance, Vol 1: Private Equity and Entrepreneurial Finance, Forthcoming. Last revised: May 2023.*

Kose, M. Ayhan, Peter Nagle, Franziska Ohnsorge, and Naotaka Sugawara. 2021. "What Has Been the Impact of COVID-19 on Debt? Turning a Wave into a Tsunami." *World Bank Group, Policy Research Working Paper 9871.*

Kumar, Vinay, and Scott Orleck. 2002. "Why Does Private Equity Vary Across Countries and Time?" *Duke University, Durham, North Carolina.*

Liu, Yang, and Andrew Demond. 2022. "Has Liquidity Dried Up in Private Equity?" *MSCI Research.*

Menchero, Jose. 2011. "Risk Contribution Is Exposure Times Volatility Times Correlation: Decomposing Risk Using the X-Sigma-Rho Formula." *Journal of Portfolio Management, 37(2), 97-106.*

MSCI. 2023. " MSCI GLOBAL MARKET ACCESSIBILITY REVIEW."

MSCI. 2023. *ACWI IMI's Complete Geographic Breakdown.* June 30. https://www.msci.com/research-and-insights/visualizing-investment-data/acwi-imi-complete-geographic-breakdown.

MSCI. 2023. "MSCI Free Float Data Methodology."

O'Shea, Luis, and Vishv Jeet. 2019. "How to Benchmark Private Capital … and How Not To." *Burgiss.*

Patkar, Rishikesh, and Razia Neshat. 2023. "MSCI Real Estate Market Size: The size of the professionally managed global real estate investment market in 2022."

Phalippou, Ludovic. 2008. "The Hazards of Using IRR to Measure Performance: The Case of Private Equity for a discussion of this and related topics."

Roe, Mark J., and Charles C. Y. Wang. 2023. "Are Public Firms Disappearing? Corporate Law and Market Power Analyses."

Shanghai Stock Exchange. 2023. "ETF Industry Development Report."

Shanghai Stock Exchange. 2017. "Shanghai Stock Exchange Statistics Annual (Chinese)."

Sharpe, William. 2010. "Adaptive Asset Allocation Policies." *Financial Analysts Journal 66, no. 3* 45-59.

Shepard, Peter, and Yang Liu. 2014. "Model Insight - The Barra Private Equity Model (PEQ2)." *MSCI Research.*

Shepard, Peter, Grace Qiu Tiantian, and Ding Li. 2022. "Building balanced portfolios for the long run." *GIC and MSCI.*

The Thinking Ahead Institute. 2023. "Global Pension Assets Study."

The Thinking Ahead Institute. 2023. "The Asset Owner 100."

The Thinking Ahead Institute. 2019. "Total Portfolio Approach (TPA). A global asset owner study into current and future asset allocation practices."

U.S. Government Publishing Office. 2021. "FEDERAL DEBT MANAGEMENT." *GAO-21-606.*

Verbraken, Thomas, and Will Baker. 2023. "Macro Scenarios in Focus: Higher Rates for Longer." *MSCI Research.*

Wei, Zhen. 2020. "China A Shares: What Have We Learned?" *MSCI Research.*

Wei, Zhen. 2021. "Drivers of China Equities' Sell-Off." *MSCI Research.*

World Economic Forum. 2011. "Future of Long-term Investing."

World Federation of Exchanges:. 2022. "Retail trading: an analysis of global trends and drivers."

World Gold Council. 2023. "Gold Market Primer: Market size and structure."

Xu, Shuo, and Zhen Wei. 2021. "A Sector-Balanced Approach to China A Mega-Cap Exposure." *MSCI Research*.

Xu, Shuo, Wei Xu, and Zhen Wei. 2021. "Foundations of Dedicated China Allocations: Part 2." *MSCI Research* 16.

Xu, Wei, and Shuo Xu. 2022. "Drivers of China Equities' Sell-Off." *MSCI Research*.

Contact us

msci.com/contact-us

AMERICAS

United States	+ 1 888 588 4567 *
Canada	+ 1 416 687 6270
Brazil	+ 55 11 4040 7830
Mexico	+ 52 81 1253 4020

EUROPE, MIDDLE EAST & AFRICA

South Africa	+ 27 21 673 0103
Germany	+ 49 69 133 859 00
Switzerland	+ 41 22 817 9777
United Kingdom	+ 44 20 7618 2222
Italy	+ 39 02 5849 0415
France	+ 33 17 6769 810

ASIA PACIFIC

China	+ 86 21 61326611
Hong Kong	+ 852 2844 9333
India	+ 91 22 6784 9160
Malaysia	1800818185 *
South Korea	+ 82 70 4769 4231
Singapore	+ 65 67011177
Australia	+ 612 9033 9333
Taiwan	008 0112 7513 *
Thailand	0018 0015 6207 7181 *
Japan	+ 81 3 4579 0333

* toll-free

About MSCI

MSCI is a leading provider of critical decision support tools and services for the global investment community. With over 50 years of expertise in research, data and technology, we power better investment decisions by enabling clients to understand and analyze key drivers of risk and return and confidently build more effective portfolios. We create industry-leading research-enhanced solutions that clients use to gain insight into and improve transparency across the investment process.

To learn more, please visit www.msci.com.

Notice and disclaimer

This document is research for informational purposes only and is intended for institutional professionals with the analytical resources and tools necessary to interpret any performance information. Nothing herein is intended to promote or recommend any product, tool or service.

This document and all of the information contained in it, including without limitation all text, data, graphs, charts (collectively, the "Information") is the property of MSCI Inc. or its subsidiaries (collectively, "MSCI"), or MSCI's licensors, direct or indirect suppliers or any third party involved in making or compiling any Information (collectively, with MSCI, the "Information Providers") and is provided for informational purposes only. The Information may not be modified, reverse-engineered, reproduced or redisseminated in whole or in part without prior written permission from MSCI. All rights in the Information are reserved by MSCI and/or its Information Providers.

The Information may not be used to create derivative works or to verify or correct other data or information. For example (but without limitation), the Information may not be used to create indexes, databases, risk models, analytics, software, or in connection with the issuing, offering, sponsoring, managing or marketing of any securities, portfolios, financial products or other investment vehicles utilizing or based on, linked to, tracking or otherwise derived from the Information or any other MSCI data, information, products or services.

The user of the Information assumes the entire risk of any use it may make or permit to be made of the Information. NONE OF THE INFORMATION PROVIDERS MAKES ANY EXPRESS OR IMPLIED WARRANTIES OR REPRESENTATIONS WITH RESPECT TO THE INFORMATION (OR THE RESULTS TO BE OBTAINED BY THE USE THEREOF), AND TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, EACH INFORMATION PROVIDER EXPRESSLY DISCLAIMS ALL IMPLIED WARRANTIES (INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF ORIGINALITY, ACCURACY, TIMELINESS, NON-INFRINGEMENT, COMPLETENESS, MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE) WITH RESPECT TO ANY OF THE INFORMATION.

Without limiting any of the foregoing and to the maximum extent permitted by applicable law, in no event shall any Information Provider have any liability regarding any of the Information for any direct, indirect, special, punitive, consequential (including lost profits) or any other damages even if notified of the possibility of such damages. The foregoing shall not exclude or limit any liability that may not by applicable law be excluded or limited, including without limitation (as applicable), any liability for death or personal injury to the extent that such injury results from the negligence or willful default of itself, its servants, agents or sub-contractors.

Information containing any historical information, data or analysis should not be taken as an indication or guarantee of any future performance, analysis, forecast or prediction. Past performance does not guarantee future results.

The Information may include "Signals," defined as quantitative attributes or the product of methods or formulas that describe or are derived from calculations using historical data. Neither these Signals nor any description of historical data are intended to provide investment advice or a recommendation to make (or refrain from making) any investment decision or asset allocation and should not be relied upon as such. Signals are inherently backward-looking because of their use of historical data, and they are not intended to predict the future. The relevance, correlations and accuracy of Signals frequently will change materially.

The Information should not be relied on and is not a substitute for the skill, judgment and experience of the user, its management, employees, advisors and/or clients when making investment and other business decisions. All Information is impersonal and not tailored to the needs of any person, entity or group of persons.

None of the Information constitutes an offer to sell (or a solicitation of an offer to buy), any security, financial product or other investment vehicle or any trading strategy.

It is not possible to invest directly in an index. Exposure to an asset class or trading strategy or other category represented by an index is only available through third party investable instruments (if any) based on that index. MSCI does not issue, sponsor, endorse, market, offer, review or otherwise express any opinion regarding any fund, ETF, derivative or other security, investment, financial product or trading strategy that is based on, linked to or seeks to provide an investment return related to the performance of any MSCI index (collectively, "Index Linked Investments"). MSCI makes no assurance that any Index Linked Investments will accurately track index performance or provide positive investment returns. MSCI Inc. is not an investment adviser or fiduciary and MSCI makes no representation regarding the advisability of investing in any Index Linked Investments.

Index returns do not represent the results of actual trading of investible assets/securities. MSCI maintains and calculates indexes, but does not manage actual assets. The calculation of indexes and index returns may deviate from the stated methodology. Index returns do not reflect payment of any sales charges or fees an investor may pay to purchase the securities underlying the index or Index Linked Investments. The imposition of these fees and charges would cause the performance of an Index Linked Investment to be different than the MSCI index performance.

The Information may contain back tested data. Back-tested performance is not actual performance, but is hypothetical. There are frequently material differences between back tested performance results and actual results subsequently achieved by any investment strategy.

Constituents of MSCI equity indexes are listed companies, which are included in or excluded from the indexes according to the application of the relevant index methodologies. Accordingly, constituents in MSCI equity indexes may include MSCI Inc., clients of MSCI or suppliers to MSCI. Inclusion of a security within an MSCI index is not a recommendation by MSCI to buy, sell, or hold such security, nor is it considered to be investment advice.

Data and information produced by various affiliates of MSCI Inc., including MSCI ESG Research LLC and Barra LLC, may be used in calculating certain MSCI indexes. More information can be found in the relevant index methodologies on www.msci.com.

MSCI receives compensation in connection with licensing its indexes to third parties. MSCI Inc.'s revenue includes fees based on assets in Index Linked Investments. Information can be found in MSCI Inc.'s company filings on the Investor Relations section of msci.com.

MSCI ESG Research LLC is a Registered Investment Adviser under the Investment Advisers Act of 1940 and a subsidiary of MSCI Inc. Neither MSCI nor any of its products or services recommends, endorses, approves or otherwise expresses any opinion regarding any issuer, securities, financial products or instruments or trading strategies and MSCI's products or services are not a recommendation to make (or refrain from making) any kind of investment decision and may not be relied on as such, provided that applicable products or services from MSCI ESG Research may constitute investment advice. MSCI ESG Research materials, including materials utilized in any MSCI ESG Indexes or other products, have not been submitted to, nor received approval from, the United States Securities and Exchange Commission or any other regulatory body. MSCI ESG and climate ratings, research and data are produced by MSCI ESG Research LLC, a subsidiary of MSCI Inc. MSCI ESG Indexes, Analytics and Real Estate are products of MSCI Inc. that utilize information from MSCI ESG Research LLC. MSCI Indexes are administered by MSCI Limited (UK).

Please note that the issuers mentioned in MSCI ESG Research materials sometimes have commercial relationships with MSCI ESG Research and/or MSCI Inc. (collectively, "MSCI") and that these relationships create potential conflicts of interest. In some cases, the issuers or their affiliates purchase research or other products or services from one or more MSCI affiliates. In other cases, MSCI ESG Research rates financial products such as mutual funds or ETFs that are managed by MSCI's clients or their affiliates, or are based on MSCI Inc. Indexes. In addition, constituents in MSCI Inc. equity indexes include companies that subscribe to MSCI products or services. In some cases, MSCI clients pay fees based in whole or part on the assets they manage. MSCI ESG Research has taken a number of steps to mitigate potential conflicts of interest and safeguard the integrity and independence of its research and ratings. More information about these conflict mitigation measures is available in our Form ADV, available at https://adviserinfo.sec.gov/firm/summary/169222.