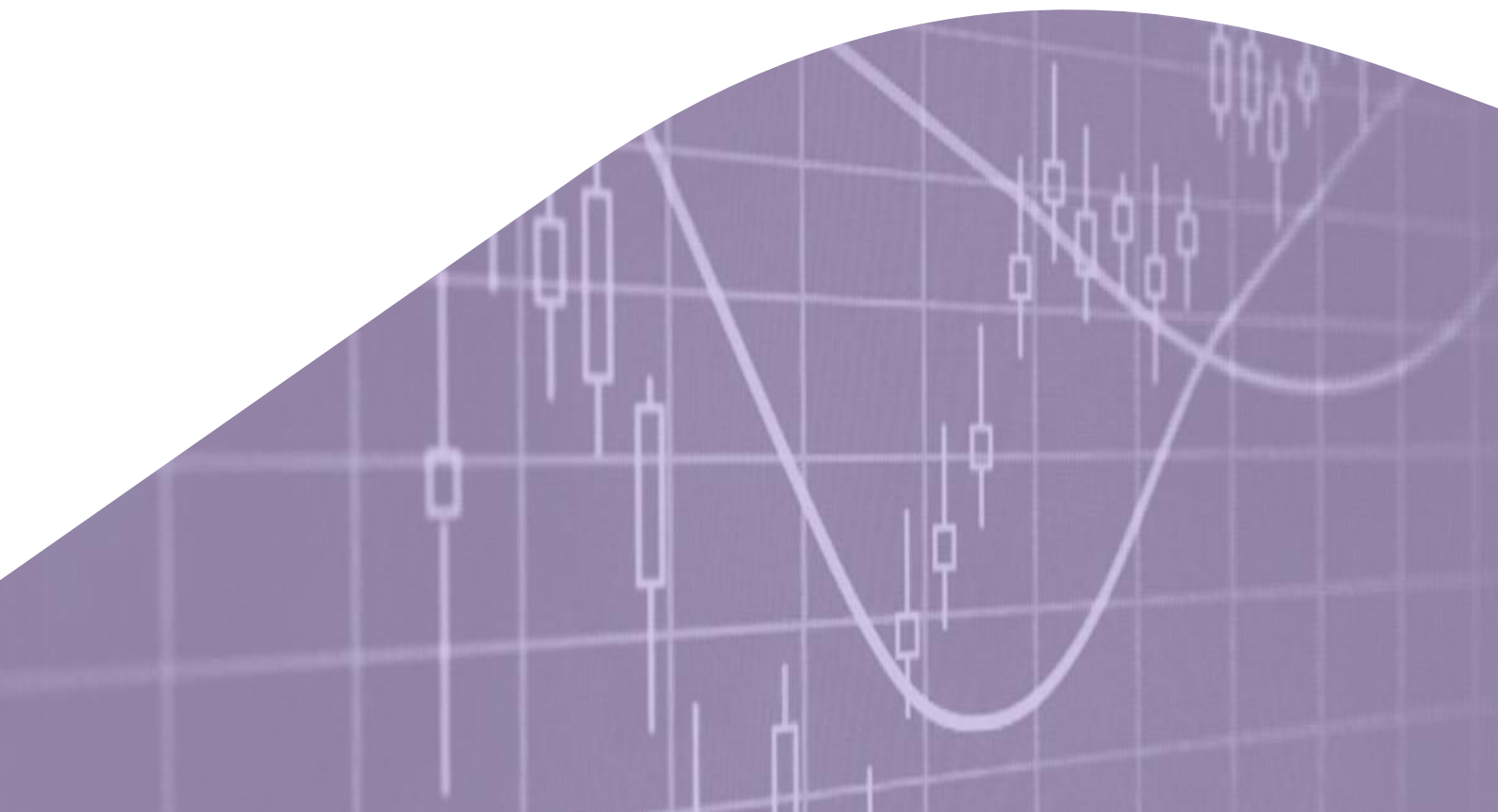


ESMA TRV Risk Analysis

Financial Innovation

# Artificial intelligence in EU investment funds: adoption, strategies and portfolio exposures



## ESMA Report on Trends, Risks and Vulnerabilities Risk Analysis

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## Financial Innovation

# Artificial intelligence in EU investment funds: adoption, strategies and portfolio exposures

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## Summary

This article evaluates the impact of artificial intelligence (AI) and its recent advancements in the EU investment management industry.

First, it studies the **operational use of AI by fund managers**, i.e. the extent to which the adoption of AI tools by asset managers plays a role in the investment process. Investment funds that promote their use of AI still represent a minor share of the industry, with their number having peaked in 2023. These funds typically aim to integrate AI into systematic investment strategies, but have not delivered significantly higher or lower performance and have had mixed success among investors, experiencing outflows in recent periods. Instead, asset managers use generative AI and tools based on large language models primarily to support human-driven investment decisions.

Second, the article assesses **investment in AI**, i.e. the portfolio allocation to AI-related companies by EU investment funds. Since 2023, actively managed equity funds increased the share of their portfolio invested in a set of AI-driven companies by over 50% – from 9 to 14 percentage points – with the market value of these positions doubling. While this is in line with the outsized growth of these companies' market capitalisation throughout the AI-focused market rally, this increased exposure might shift the risk profile of some funds and amplify market risks. Correlated adverse conditions due to the uncertain outcomes associated with a fast-evolving technology – be it shifts in expectations, operational setbacks, or regulatory challenges – could significantly affect fund portfolio valuations.

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## Introduction

This article evaluates the impact of artificial intelligence (AI) and its recent advancements in the EU investment management industry. Several recent AI-related developments, such as the rise of large language models (LLMs) and generative AI (GenAI), have caught the attention of financial market participants eager not to miss out on the gains unlocked by AI's presumed transformative potential across industries. In turn, regulators and policymakers worldwide have turned to monitoring the implications and risks associated with AI, as poorly managed AI systems can exacerbate vulnerabilities through algorithmic biases, self-reinforcing feedback loops and data quality issues, potentially impairing effective risk management.<sup>2</sup> AI-related third-party dependencies and the concentration of service providers could also increase systemic fragilities in the financial sector. Meanwhile, the recent AI frenzy has raised questions around the sustainability of the sector's valuations and its uncertain earnings, as large technology companies with growing stakes in AI-enabling hardware and AI-driven products and services drive stock market gains and AI-branded start-ups increasingly attract funding.<sup>3</sup>

To assess the impact on the investment fund sector, we delineate two main ways in which AI impacts fund managers.

1. **Operational use of AI:** First, we study the extent to which the adoption of AI tools by asset managers is reshaping the investment process. In an industry with decreasing margins and increasing competition from cost-efficient and innovative investment products, the adoption of innovative tools such as AI may afford fund managers a decisive competitive advantage through

more efficient allocation, productivity enhancement and operational cost savings.

2. **Portfolio investment in AI:** Second, we assess the investment channelled towards AI by EU investment funds via their portfolio exposure to companies tied to AI. While financing the blooming sector of AI-enabled innovation allows investors to participate in potentially large economic gains, rising valuations of technology companies may induce outsized exposure to the sector and lead to correlated risk-taking.

The European Securities and Markets Authority (ESMA) found that an increasing number of asset managers used AI and natural language processing (NLP) in investment strategies, risk management and compliance, but the adoption of fully AI-based investment processes remained marginal (ESMA, 2023). Since then, the recent breakthroughs in language model technology have increased interest in the adoption of AI in financial markets, spurring a proliferation of both general-purpose and finance-tailored NLP and GenAI-based tools.<sup>4</sup> However, comprehensive figures on the uptake of AI in the asset management sector and data on how it enhances and reshapes key decision-making processes, such as portfolio allocation, are scarce.

This article sheds light on these aspects by leveraging a comprehensive dataset of regulatory and marketing documents made available to investors from 44,000 EU investment funds. Turning the unstructured dataset into quantitative insights by means of NLP and human analysis shows that investment funds formally promoting their use of AI in the investment process still represent a minor share of the industry, with their number having peaked in 2023. These findings are consistent with recent survey-based evidence according to which asset managers use GenAI and LLM-based tools primarily to support human-driven investment decisions and to enhance productivity in activities such as risk

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<sup>2</sup> In the EU, the AI Act – the first comprehensive regulation on AI by a major regulator globally – entered into force in August 2024.

<sup>3</sup> See '[AI frenzy tests Big Tech's newfound cost discipline](#)', Financial Times, 4 August 2023, and '[AI startups ride on investor frenzy to raise billions in 2024](#)', Reuters, 4 October 2024.

<sup>4</sup> Based on a recent survey, more than half of asset managers reported that they planned to use GenAI in the

future (Mercer Investments, 2024). Looking at patent filings related to asset allocation or portfolio management, the International Monetary Fund found that filings related to AI or machine learning (ML) have surged to 70% of the total in 2023 (IMF, 2024). They include the use of ML techniques to enhance the efficiency of cash flow and liquidity management, automate asset class rebalancing, improve valuation and forecasting methods, and interpret unstructured and alternative data.

management, compliance and administrative tasks.<sup>5</sup>

Finally, the article turns to assessing the extent to which AI-related growth opportunities are shaping the allocation of European investment. Since 2023, active investment funds have increased the share of their portfolio invested in a set of AI-driven companies by over 50% – from 9 to 14 percentage points – with the market value of these positions almost doubling, in line with the substantial growth of these companies' market capitalisation.

## 1. Operational use of AI by fund managers

### Operational relevance of AI

Portfolio managers have long used a variety of tools that can be classified under the umbrella of AI, to enhance fundamental analysis, extract signals from data and improve optimisation and forecasting techniques (ESMA, 2023). Since the first GenAI tools based on LLMs – such as ChatGPT – became commercially available in late 2022, renewed interest has been devoted to gauging how AI is being deployed across investment management and its transformative potential for this industry.

Some sources suggest that asset managers are increasingly using AI to guide investment decisions.<sup>6</sup> According to recent surveys, asset and wealth managers broadly see disruptive technologies such as AI and GenAI as transformational, with most practitioners believing that such technologies are improving operational efficiency (84%), fuelling revenue growth (80%) and boosting employee productivity (72%) (PwC, 2024). The vast majority of asset managers globally indeed use AI in their investment strategies or research (54%) or plan to do so in the future (37%). However, still few managers (14%) view AI as a key part of the

investment process. As a matter of fact, funds' use of AI for investment management appears to be largely focused on augmenting existing capabilities and aimed at informing rather than determining the final investment decisions (Mercer Investments, 2024).

While there is increasing evidence that large firms are moving fast in the experimentation with and the deployment of GenAI both in Europe and in the United States so as not to fall behind competitors<sup>7</sup>, AI's uptake in the industry might be uneven due to scale-related challenges. Smaller asset management companies may struggle to keep up with larger firms in the adoption of AI due to limited budgets, knowledge barriers or technological challenges.<sup>8</sup> In the meantime, larger players are accessing talent and technology from start-ups through acquisitions or joint ventures to speed up development and market roll-out (PwC, 2024).

Competition among vendors to offer accessible and customisable AI tools and services provides smaller asset management firms a way to integrate advanced technologies without needing in-house development. These solutions reduce upfront costs and technical barriers, helping smaller firms stay competitive. However, relying on third-party AI providers introduces risks, including increased dependency on external expertise and potential service interruptions. Concentration risks may also arise if many firms depend on the same providers, creating systemic and operational vulnerabilities. The Financial Stability Board considers service provider concentration in the market for LLMs and GenAI as a significant and growing concern from an operational vulnerability perspective (FSB, 2024).

### EU investment funds' use of AI

ESMA found that investment funds that promote the use of AI in their name obtained mixed success among investors in recent years, characterised by alternating inflows and outflows and only EUR 1bn in assets under management

<sup>5</sup> See Mercer Investments (2024) and PwC (2024).

<sup>6</sup> See '[AI is promoted from back-office duties to investment decisions](#)', Financial Times, 2 June 2024.

<sup>7</sup> See '[Axa IM joins growing list of firms to test generative AI](#)', Ignites Europe, 9 April 2024, and '[Over 100 working](#)

[on generative AI at Fidelity](#)', Ignites Europe, 20 October 2023.

<sup>8</sup> See '[SMEs struggle to implement AI – Here's why](#)', Medium, 22 October 2024.

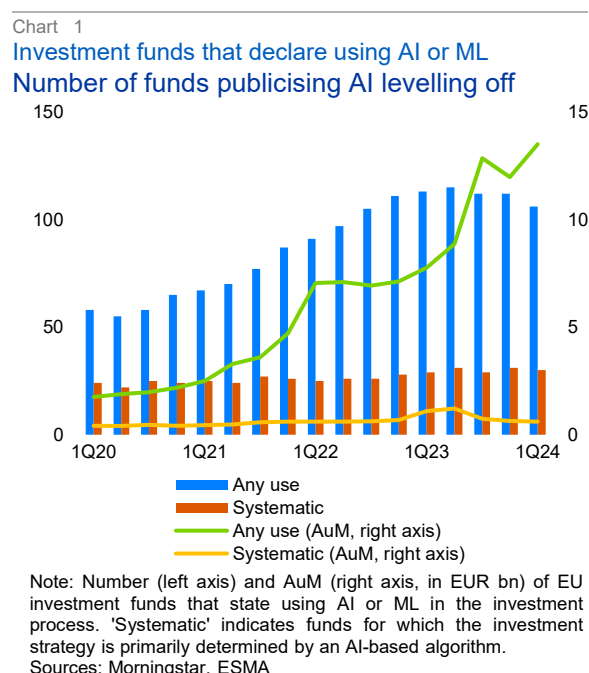
(AuM) in the second quarter of 2024 – less than 0.1% of the total (ESMA, 2024). However, only a minority of the funds that use AI are likely to make this theme central to their selling proposition by branding themselves in this way.

To shed further light on the extent to which funds are likely to have integrated AI into their investment process, we identified the funds that disclose their use of AI or ML in their communications to investors. To do so, we used text-mining methods to screen 825,000 regulatory and marketing documents issued by 44,000 EU investment funds.<sup>9</sup> Then, we inspected all documents in which the phrases ‘artificial intelligence’ or ‘machine learning’ occurred, and identified those funds that mentioned using AI or ML operationally as part of their investment process, as opposed to investing their portfolios in AI-related companies.<sup>10</sup> We also inspected funds whose names contain these terms or their abbreviations, and – for funds not already in our sample – similarly identified those that stated that AI or ML underpin their investment.<sup>11</sup>

The results of this exercise indicated that most investment funds do not explicitly advertise the use of AI: in total, we found 145 funds – including four exchange-traded funds (ETFs) – that indicated leveraging AI (or, more specifically, ML) in their investment strategies. Over half of these (74) were equity funds, followed by mixed-asset funds (31), funds investing in alternative assets (29) and fixed-income funds (10). All funds that stated the use of AI – with the exception of two index-tracking ETFs – were actively managed funds. The competitive landscape was diverse, with 86 fund management companies offering funds domiciled in 12 different EU countries. Most

of the funds (133) also catered to retail investors.<sup>12</sup>

Chart 1 shows how many of these funds have been on the market and their AuM over the past few years. The number of funds advertising their use of AI doubled from 57 at the beginning of 2020 to 115 in mid-2023. However, since then, this number has slightly decreased to 106 such funds in the first quarter of 2024. With just over EUR 13bn in AuM, their footprint in the market remains relatively small, representing approximately 0.1% of the AuM of all undertakings for collective investment in transferable securities (UCITS).<sup>13</sup>



Given that AI can play very different roles in fund investment strategies and portfolio management processes, next we closely inspected each of these funds’ claims to determine whether AI is

<sup>9</sup> The sample of analysed documents was collected through Morningstar and includes 79,000 prospectuses, 488,000 key investor information documents (KIIDs) and packaged retail investment and insurance product key information documents (PRIIPs KIDs), and 258,000 factsheets and marketing documents. The sample refers to both currently existing and past funds, mostly UCITS, while the coverage for AIFs is scarce. The sample was collected starting in 2020 and was updated yearly.

<sup>10</sup> To accomplish this, we manually reviewed mentions of AI and ML in several thousand documents. We identified mentions of AI and ML in 22 EU languages. Hence, our search is not limited to English-language documents. We

identified funds that use AI or ML as the sole investment strategy as well as funds that state that AI or ML support one of a range of available investment strategies.

<sup>11</sup> The sample of fund names includes over 70,000 funds.

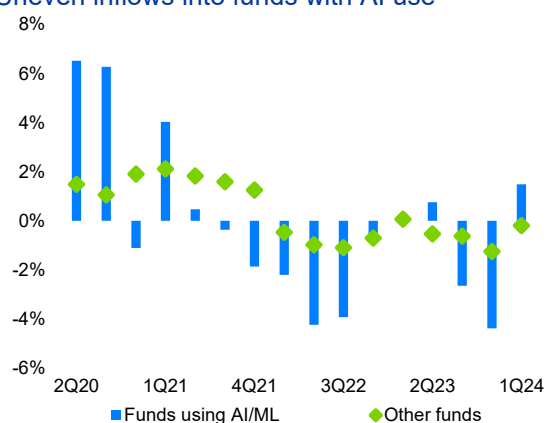
<sup>12</sup> Praxmarer and Simon (2024) conducted a similar screening on 155,630 filings from 44,582 US mutual funds. They found 103 funds that declared using AI, ML or NLP at some stage of their investment process.

<sup>13</sup> This share is based on a subsample of 101 funds classified as UCITS at the end of 2023 with AuM of EUR 11.2bn. This compares to a total of EUR 10.8tn in AuM held by EU UCITS funds (EFAMA, 2024).

considered the main driver of investment decisions.<sup>14</sup> In only about 30% of the funds does AI appear to play such a key role. These funds also tend to be smaller, as they account for just 5% of the original sample's AuM. When looking at whether funds publicise their use of newer AI tools such as GenAI and LLMs, only one fund mentioned using GenAI to enhance stock screening and analysis in a marketing document, and none mentioned doing so in regulatory documents.

Chart 2 further shows that funds using AI have obtained mixed success among investors, having experienced mainly net outflows over the last three years, faring almost always worse than other EU investment funds when normalised by the funds' AuM.

Chart 2  
Flows of investment funds that declare using AI or ML  
Uneven inflows into funds with AI use



Note: Bars represent investor flows (in % of AuM) for 133 EU open-end investment funds that state using AI or ML in the investment process. Squares represent investor flows (in % of AuM) for 34,000 EU open-end investment funds investing in equity, fixed income, mixed assets and alternative assets.  
Sources: Morningstar, ESMA

In further analysis, we similarly identified all funds that mention NLP and found only nine additional entities that reported using related methods within the investment process.<sup>15</sup>

Our findings complement rather than contradict existing evidence pointing to a growing interest in AI among investment managers. First, they confirm that most funds that use AI have yet to adopt a systematic investment approach rigorously entrusted to AI-based models. This is consistent with existing evidence suggesting that AI advancements are unlikely to be immediately translated into automated portfolio allocation and rebalancing processes.<sup>16</sup> Second, we do not claim that our figures capture all funds where AI supports the investment process. As reported in the previous subsection, many funds take advantage of AI tools to carry out intermediate steps of the information-gathering and decision-making processes with no automated or direct effect on the investment strategy or policy, which are usually the focus of investor disclosure documents. Our findings suggest that, in such cases, fund management companies largely omit explicit references to these tools.

For the same reasons, the figures above likely do not include entities that use AI in corporate activities that lie outside the investment process, such as marketing, client interaction, compliance and other administrative and control tasks. These activities are expected to represent a significant part of the overall value creation opportunities

<sup>14</sup> The extent to which an AI model determines the investment decision and the degree of human judgment involved in the process vary widely and are not always clear from the funds' disclosure documents. Thus, this exercise inevitably entails a degree of subjectivity. As an example, we classified a fund as one using AI in a systematic way as it states in the prospectus that it 'seeks to achieve long-term capital growth *primarily* through a proprietary quantitative stock scoring model that utilises artificial intelligence (AI)' and 'uses advanced techniques such as deep learning, thereby *differing from conventional models or algorithms*' [emphasis added]. In contrast, AI was not considered the main determinant of the investment strategy of a fund stating that 'the investment manager uses proprietary data analysis and machine learning techniques to *help* identify stocks that are expected to outperform the global equity market'

[emphasis added]. AI was also not considered the main driver if it is used in combination with other strategies or decision layers. An example is a fund that uses 'quantitative and qualitative techniques' and 'systematic, proprietary quantitative and qualitative models, based on artificial intelligence and machine-learning capabilities'.

<sup>15</sup> We constructed a separate sample for funds mentioning the use of NLP, as we observed that this term can have a broad meaning among AI practitioners, involving anything from simple text mining to advanced ML models.

<sup>16</sup> ESMA (2023) already highlighted some limiting factors to funds' adoption of full AI-driven systematic strategies, chiefly data and modelling challenges such as time series breaks, regime shifts, and a low signal-to-noise ratio.

afforded to asset managers by newer AI technologies such as GenAI.<sup>17</sup>

Among the funds that do mention the use of AI or ML in their investor disclosure documents, one third include one of these terms directly in their name, thus leveraging their innovative approach in their marketing strategy and making AI central to their selling proposition.<sup>18</sup> However, only in about half of them the investment strategy is primarily determined by AI, whereas the rest use AI only in the preliminary steps of the investment process or as part of a range of strategies. These vehicles may have been conceived by asset management companies with the objective of catering to a specific group of clients who have a favourable view of innovative and sophisticated investment approaches. Overall, given their limited footprint in the industry and upon further inspection of funds' regulatory and marketing documents, occurrences of 'AI-washing' (i.e., the practice of exaggerating the amount of AI technology a company uses in its products, which could pose significant investor protection concerns) in the EU investment management industry currently appear contained.<sup>19</sup>

## Performance and costs of funds using AI

Using AI at an operational level can, at least conceptually, influence a fund's business performance in significant ways.

- **Portfolio performance.** The deployment of AI in portfolio selection processes may yield superior portfolio allocation outcomes and with that a stronger relative performance of the fund, at least in the short run.
- **Fund costs.** The onboarding of AI tools is generally associated with raising the

operational efficiency of a company, which should lead to lower production costs that, ideally, would be passed on to investors as relatively lower fees and charges. This effect may, however, be dampened by higher operational costs associated with the investment needed to obtain and operationalise the new technology.

Existing evidence on whether AI gives funds an edge that allows them to outperform their peers is scarce and inconclusive. In the EU, ESMA (2023) did not find evidence of either the outperformance or underperformance of 65 funds that were using AI until 2022. Studying US mutual funds, Praxmarer and Simon (2024) found that AI-managed funds perform similarly to their human-managed counterparts, while Chen and Ren (2022) found that AI-powered funds significantly outperform human-managed ones but do not outperform the market. Table 1 shows that the average returns and the risk-adjusted returns ('alphas') of funds that stated using AI over the three years leading up to the third quarter of 2024 were not significantly different from those of funds that did not make any reference to the use of AI in their investment strategy.

In unreported statistical tests, we also controlled for other characteristics – such as a fund's size, age, and geographical investment focus – in order to compare the performances of funds that use AI and funds that are otherwise similar. No statistically significant difference emerged between the two groups.<sup>20</sup>

We then checked whether funds that use AI have higher or lower costs than funds that do not use AI. Equity funds that use AI appear to charge slightly lower fees than other equity funds (– 15

<sup>17</sup> See ['Invesco wants to use generative AI to cut costs but not yet pick stocks'](#), Financial Times, 19 March 2024, and ['Amundi CEO: generative AI will improve client service'](#), Ignites Europe, 10 April 2024.

<sup>18</sup> Fund names that do not include AI or ML often use other keywords associated with quantitative investment, such as 'quant', 'numeric' or 'smart alpha'.

<sup>19</sup> However, instances of alleged AI washing in financial services have emerged in other contexts. For instance, in the United States, the Securities and Exchange Commission charged two investment advisers with malpractice amounting to AI washing. See ['SEC Charges](#)

[Two Investment Advisers with Making False and Misleading Statements About Their Use of Artificial Intelligence'](#), Securities and Exchange Commission, 18 March 2024.

<sup>20</sup> Specifically, we estimated linear regression models of fund returns, alphas and total expense ratios on a number of fund characteristics over the sample period, including whether the fund uses AI, or, in alternative specifications, whether it has AI in its name and whether AI is the main decision-maker. Control variables included fund size, age, total expense ratio and benchmark. Significance

basis points or 10% lower on average, statistically significant at the 5% level).<sup>21</sup> However, the result is the opposite for fixed-income, mixed-asset and alternative-asset funds, although for none of these fund types is the difference statistically significant.<sup>22</sup>

Overall, these results suggest that, while they fail to offer investors higher-than-average performance, funds' adoption of AI currently does not come with higher fees for their clients. This is in line with the seeming lack of robust demand inherently tied to AI and of strong publicity around its use in the investment process.<sup>23</sup> At the same time, evidence of a cost advantage is weak. Thus, one open question remains whether investment managers can further deploy AI while containing operating expenses and offering clients lower fees than their competitors.

Table 1  
Characteristics of funds that declare using AI or ML  
Performance and costs not consistently different

	AI funds	Other funds	Difference
<i>Equity</i>			
Return (%)	1.11	0.70	[− 0.21, 1.03]
Alpha (%)	− 0.37	− 0.35	[− 0.23, 0.19]
TER (%)	1.37	1.52	[− 0.002, − 0.31] (*)
<i>Fixed income</i>			
Return (%)	0.43	− 0.14	[− 0.13, 1.26]
Alpha (%)	− 0.07	− 0.14	[− 0.15, 0.29]
TER (%)	1.02	0.87	[− 0.18, 0.46]
<i>Mixed assets</i>			
Return (%)	0.38	0.31	[− 0.30, 0.43]
Alpha (%)	− 0.17	− 0.12	[− 0.21, 0.11]
TER (%)	1.55	1.52	[− 0.19, 0.26]
<i>Alternative assets</i>			
Return (%)	0.80	0.56	[− 0.62, 1.10]
Alpha (%)	− 0.16	− 0.09	[− 0.38, 0.23]
TER (%)	1.63	1.49	[− 0.20, 0.48]

(\*) Indicates that the estimated difference in means is different from zero with a 95% confidence level.

Note: The table shows the average performance and costs of EU investment funds that declare using AI or ML as part of the investment process (column 'AI funds') and of other EU investment funds (column 'Other funds') split by fund type. The sample does not include ETFs, index-tracking funds and share classes reserved to institutional investors. The column 'Difference' displays the 95% confidence interval for the difference between the values in the columns 'AI funds' and 'Other funds', based on a *t*-test for the equality of means. 'TER' is the average total expense ratio (or per-annum ongoing costs) between 2020 and 2023. 'Return' and 'Alpha' are average raw returns and alphas, net of costs, calculated quarterly over 12 quarters from Q3 2021 to Q2 2024 if the fund has at least eight observations. 'Alpha' is calculated with reference to a fund's technical indicator benchmark. The variables are first averaged across a fund's retail share classes to obtain variables at the fund level. Sample sizes for the TER (AI funds/other funds): equity 55/7762, fixed income 8/5307, mixed assets 29/7363, alternative assets 17/694. Sample sizes for alpha (AI funds/other funds): equity 35/7739, fixed income 7/5110, mixed assets 23/7482, alternative assets 10/741.

Sources: Morningstar Direct, Refinitiv Lipper, ESMA

levels were obtained clustering standard errors at the fund level to account for autocorrelation in the dependent variable.

<sup>21</sup> Interestingly, this cost advantage widens to 43 basis points for the subsample of 13 equity funds that brand themselves as 'AI fund' or similar, but shrinks to 8 basis points (not statistically significant) for the subsample of 13 equity funds where AI determines the investment strategy.

<sup>22</sup> ESMA (2023) did not find evidence in either direction for the smaller sample of 65 funds using AI identified as of October 2022.

<sup>23</sup> In the United States, a number of active ETFs that claim to implement AI-driven strategies have been launched in recent years. Bartram et al. (2021) identified 13 active ETFs holding less than 1% of the total assets managed by active ETFs in equities. They charge slightly higher fees than other active ETFs, but do not significantly outperform them. IMF (2024) confirmed that genuinely AI-driven strategies are still in their early stage as indicated by the very small share of the market represented by AI-powered ETFs.

## 2. Portfolio investment in AI by EU funds

### AI-related companies and indices

Enthusiasm in financial markets around AI's potential to revolutionise sectors like healthcare, finance, and manufacturing has fuelled investor interest towards companies that stand to benefit from AI-driven innovation, spanning robotics, big data and automation.

This optimism has propelled the market performance of companies on the frontier of AI development or deployment, prompting the creation of numerous indices that aim to track AI's high-growth opportunities. These indices provide a structured way for investors to capitalise on AI's anticipated long-term economic and technological impact. Fund managers aiming to provide exposure to AI may also rely on these indices to benchmark their performance, as is common in the case of traditional industries and sectors.

Among the numerous indices available on the market that capture a wider range of technology companies, we identified seven indices that focus on and strongly emphasise the AI theme.<sup>24</sup> These indices tend to offer a more diversified exposure to the sector than the one that would result if the selected companies were weighted by their market capitalisation, with the largest index constituent not weighing beyond 4–5%.<sup>25</sup> The weight of the top 10 constituents averages 37%, far below the 78% of the market-capitalisation-weighted Standard and Poor's 500 Information Technology Index (S&P 500 IT Index) (Table 2).

The high concentration of the S&P 500 IT Index is common to other market-capitalisation-weighted indices and is due to the increasingly

outsized role of a few large technology companies, chiefly the so-called Magnificent Seven stocks (Apple, Microsoft, Amazon, Alphabet, Meta, Nvidia and Tesla). This group of high-performing and influential companies has dominated the US stock market in recent periods, accounting for 50% of the index's year-to-date gain as of October 2024.<sup>26</sup>

Table 2

#### Indices focused on AI sector

#### AI indices: limited overlaps and concentration

Index name	Constituents [Number]	Overlap [Constituents appearing in other indices]	Concentration [Weight of top 10 constituents]
Indxx AI	84	45	34%
MS Global Next Gen AI	49	39	60%
Nasdaq CTA AI	50	43	34%
ROBO Global AI	55	37	23%
S&P AI Enablers	34	25	36%
Solactive GenAI	39	28	43%
WisdomTree AI & Innovation	75	54	25%
Memorandum item: value-weighted technology index			
S&P 500 IT	69	–	78%

Note: Characteristics of seven selected AI-related indices and the S&P 500 IT Index. For the S&P Kensho Global AI Enablers, due to data limitations the constituents of the ESG-screened version of the index (34 instead of 37) are considered.

Sources: Nasdaq, WisdomTree, VettaFi, Solactive, Morningstar, Indxx, S&P Global, ESMA

While the Magnificent Seven stocks and a few other – mostly large – companies appear in most of the AI indices, taking a closer look at their composition reveals a marked diversity in the sets of companies that the different index providers picked to represent the AI sector. Chart 3 shows that, out of the 198 constituents of the seven selected indices, only 16 are included in at least five indices. Conversely, 115 firms (58%) appear in only one index. Out of the 83

<sup>24</sup> These are Nasdaq's CTA AI Index, WisdomTree's AI & Innovation Index, ROBO Global's AI Index, Solactive's Generative AI Index, Morningstar's Global Next Generation AI Index, Indxx's AI Index and S&P Kensho Global's AI Enablers Index.

<sup>25</sup> To compare, as of November 2024, the largest company included in the indices (Apple) accounted for above 7% of the market capitalisation of the entire S&P 500 Index and 23% of the market capitalisation of the S&P 500 IT Index.

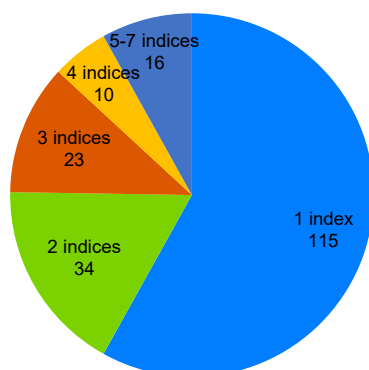
<sup>26</sup> As a result, their total weight in the S&P 500 has more than doubled over the past 10 years, making up nearly one third of the index's entire market capitalisation and nearly 23% of the MSCI World Index as of mid-2024. See '[S&P 500 counts on final 'Mag 7' push for best year this century](#)', Reuters, 29 October 2024.

companies included in two or more indices, three quarters are US companies, while 10 are domiciled in East Asian countries, four in Israel and only six in the EU.<sup>27</sup>

Chart 3

### Indices focused on AI sector

#### Only few BigTechs appear in all indices



Note: The chart shows the number of companies that appear in one, two, three, four or more AI indices, in the sample of the 198 index constituents from seven index providers.

Sources: Nasdaq, WisdomTree, Indxx, VettaFi, Solactive, Morningstar, S&P Global, ESMA

The varied compositions of AI-focused indices may, to some extent, arise from their differing methodologies and criteria for selecting companies, emphasising different industry trends and applications. However, in principle, none of the indices declare focusing on a narrow interpretation of the technology limited to specific industries. Most aim to include companies engaged in the various stages of the AI value chain, variably defined by the index providers as AI ‘enablers’, ‘developers’, ‘engagers’ or ‘enhancers’.<sup>28</sup> Thus, the diversity in AI-focused indices may, to some extent, reflect fundamental

uncertainty and subjectivity regarding the definition of AI and its beneficiaries. AI encompasses a broad spectrum of technologies and applications, leading to differing interpretations of which companies genuinely drive or leverage AI innovations. Additionally, opinions may vary on which sectors – hardware, software or AI-adjacent industries – will benefit most from AI advancements.

Chart 4 displays the performance of the seven AI indices and of the broader S&P 500 IT Index. The rebased values of the indices remain tightly clustered between 2020 and the beginning of 2023, after which their trajectories spread out as all indices increase in value but at very different paces.

A significant driver behind the recent divergence appears to be the different weight attributed by the indices to the Magnificent Seven and other large-capitalisation stocks, which were at the forefront of the AI-driven bull run in 2023 and 2024, with the most and least successful indices being respectively the most and second-least concentrated in terms of weight of the top 10 constituents. Consistent with this interpretation, all AI indices underperformed the value-weighted S&P 500 IT Index, notwithstanding its lack of a specific focus on AI. This pattern demonstrates how megacap stocks (i.e. stocks with a capitalisation or market value over USD 200bn) have been a significant determinant of an investment portfolio’s performance in recent years, potentially obscuring the differences stemming from the heterogeneous stock

<sup>27</sup> This global distribution closely resembles other related AI industry figures. For instance, 61% of the total global funding for AI start-ups goes to US companies, 17% to those in China and just 6% to those in the EU. Around 70% of foundational AI models have been developed in the United States since 2017 (European Commission, 2024).

<sup>28</sup> Roughly, AI ‘enablers’ provide the foundational technologies, infrastructure, tools and platforms that make AI development and deployment possible, such as hardware, cloud computing platforms and essential datasets. AI ‘developers’ and ‘engagers’ design, build and train AI models and algorithms. AI ‘enhancers’ and ‘adopters’ integrate AI technologies into their workflows, products or services. However, these terms do not always have universally agreed definitions and scopes. For instance, despite the name, the S&P Kensho Global AI Enablers Index does not only include companies that

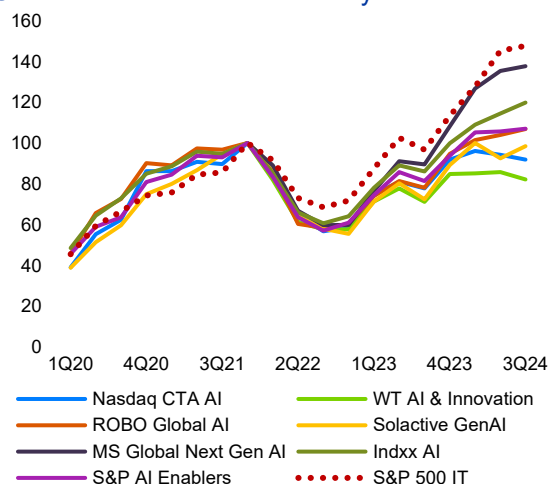
produce foundational technologies such as semiconductors and chips, but also companies that develop AI-based services and functionalities, such as Adobe, Alibaba, Alphabet, Dell, Microsoft and Oracle, which could be considered to fit the definition of developers, engagers or enhancers. The EU’s AI Act (Regulation (EU) [2024/1689](#) laying down harmonised rules on artificial intelligence) adopts yet another terminology, distinguishing between ‘deployers’, who operate an AI system under their own authority in a professional capacity, and ‘providers’, who develop AI systems with a view to placing it on the market or putting it into service under their own name or trademark (Article 3). However, deployers can become providers if certain circumstances are met, for example if they put their name or trademark on, or make a substantial modification to, a high-risk AI system already placed on the market (Article 25).

selection approaches that underpin different sectoral indices.

Chart 4

## Indices focused on AI sector

## Uneven reflection of market rally



Note: Performance of selected indices with base value equal to 100 in 4Q21. Nasdaq CTA AI: Nasdaq CTA Artificial Intelligence TR; WT AI & Innovation: WisdomTree Artificial Intelligence & Innovation; ROBO Global AI: ROBO Global Artificial Intelligence NTR; Solactive GenAI: Solactive Generative Artificial Intelligence TR; MS Global Next Gen AI: Morningstar Global Next Generation Artificial Intelligence TR; Indxx AI: Indxx Artificial Intelligence NTR; S&P AI Enablers: S&P Kensho Global AI Enablers TR; S&P 500 IT: S&P 500 Information Technology Sector TR.

Sources: Nasdaq, WisdomTree, VettaFi, Solactive, Morningstar, Indxx, S&P Global, ESMA

## Fund investments in AI companies

As large technology companies that have positioned themselves as AI enablers, engagers and adopters have driven sectoral indices and the wider stock market upwards, questions have arisen around the sustainability of these increasing valuations amid uncertain earnings. Against this background, important insights may be gained by monitoring the extent to which European investment is channelled towards AI-related growth opportunities.

We do so by assessing the share of EU investment fund portfolios allocated to stocks of companies significantly exposed to AI. In order to define that exposure, we rely on the expertise of major index providers – which design benchmark indices that aim to systematically track market

segments – and draw from the 198 constituents of the seven AI indices presented in the previous section to identify a set of AI-related companies. Given the significant divergences in the indices' compositions, we discard the 115 companies that appear in only one index. Thus, we define as AI stocks the equity instruments issued by the remaining 83 constituents that are included in at least two of the seven indices. In this way, while relying on more than one source for the definition of an AI-related company, we aim to take a considerably broad view of the AI sector, including not only megacap stocks, but also large- and mid-capitalisation firms that, from different angles, stand to benefit from the development and integration of AI technologies.

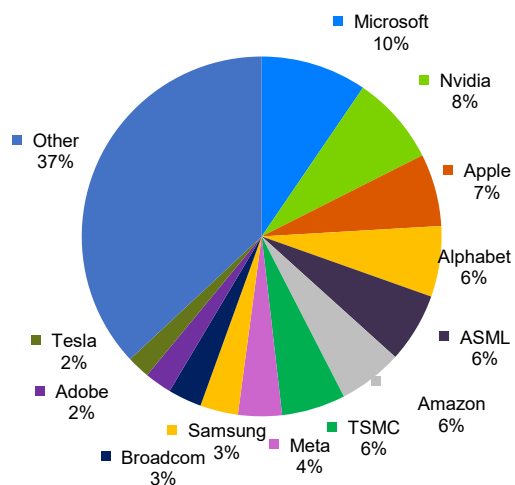
Next, we assess fund exposures to AI stocks on the basis of portfolio holdings data from Morningstar covering 10,370 equity investment funds domiciled in the EU from January 2021 to June 2024.<sup>29</sup> Over the sample period, the funds held 780,000 distinct securities, among which we identify the equity instruments issued by the AI companies as defined above via a comprehensive name-based matching process.

Chart 5 illustrates a breakdown of EU funds' investment in AI stocks as of June 2024. On the one hand, more than 50% of the market value held by funds is concentrated in the largest companies, including six of the Magnificent Seven, which are also those that appear more often in AI-focused indices. Positioning themselves at the forefront of technological innovation, these companies have, in recent years, allocated considerable resources and effort towards AI development. While individually representing a smaller share of funds' investment, the remaining companies' stocks collectively make up for a significant portion of the market value, indicating that EU investment is directed towards a diversity of stakeholders in the AI industry.

<sup>29</sup> Most funds report their holdings at least monthly. For funds with less frequent reporting (e.g. quarterly or semi-annually), holdings are interpolated to estimate monthly

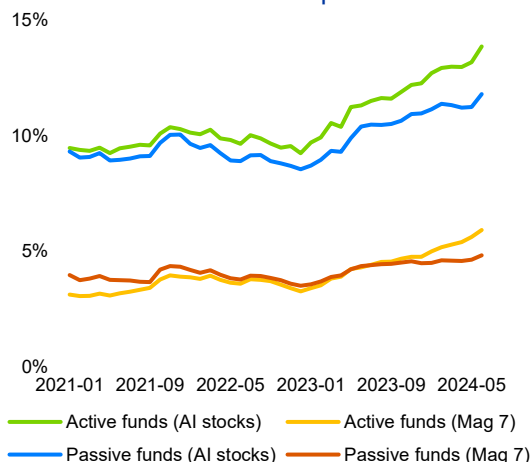
values. As 96% of the funds in the sample are UCITS, our data offer scarce visibility on alternative investment funds.

Chart 5  
 EU funds' investment in AI companies  
 Large tech companies dominate exposure



Note: Outstanding value of AI companies' shares held by EU equity investment funds as of June 2024. 'AI companies' refers to 83 companies that appear in at least two out of seven AI-sector indices.  
 Sources: Morningstar, ESMA

Chart 6  
 EU funds' investment in AI companies  
 Positive trend for active and passive funds



Note: Share of AI companies and of Magnificent Seven (Mag 7) stocks (as a % of the net asset value) in the portfolio of EU equity investment funds. 'AI companies' refers to 83 companies that appear in at least two out of seven AI-sector indices. 'Magnificent Seven' refers to Apple, Microsoft, Amazon, Alphabet, Meta, Nvidia and Tesla.  
 Sources: Morningstar, ESMA

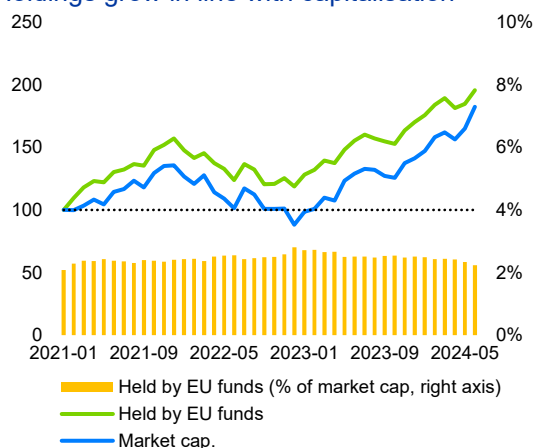
Chart 6 shows that, after remaining stagnant at around 9% for two years until the beginning of 2023, the AI portfolio share increased to 12% for passive funds and 14% for active funds as of June 2024, with their collective market value doubling from EUR 242bn to EUR 474bn. This increase was driven in part by the Magnificent Seven stocks, whose share in active funds saw a significant uptick from 3% to 6% but was also supported by broader exposure to other AI companies.<sup>30</sup> Although in line with the outsized growth of these companies' market capitalisation throughout the AI-focused market rally, the increase in the share of AI stocks is significant in relative terms, as EU fund portfolios started from lower levels of concentration than global and US value-weighted indices. For comparison, over the same period the weight of the AI companies as a share of the MSCI World Index grew from 28% to 33%, while the Magnificent Seven saw their weight within the index increase from 17% to 23%.

Expanding on this broader market-level perspective, Chart 7 compares the growth of the value of AI funds' investment with the overall increase in the market capitalisation of AI stocks. The market capitalisation of AI companies has grown substantially, but EU funds' investment levels in these firms have risen at a comparable rate. As a result, EU funds maintained a stake of just above 2% of the market capitalisation of AI stocks, scaling their exposure in line with market growth.

<sup>30</sup> In detail, passive funds' holdings of AI stocks increased from EUR 70bn to EUR 153bn, with the investment in the Magnificent Seven growing from EUR 30bn to EUR 63bn. Active funds' holdings of AI stocks increased from EUR

187bn to EUR 232bn, with the investment in the Magnificent Seven growing from EUR 57bn to EUR 138bn.

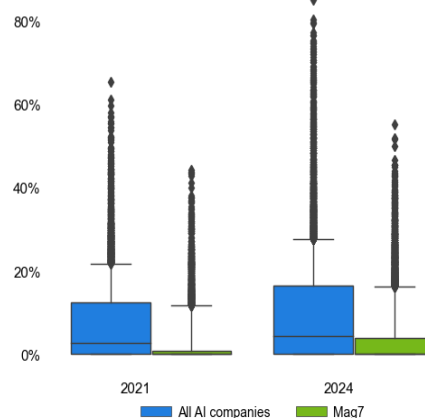
Chart 7  
**EU funds' investment in AI companies**  
**Holdings grow in line with capitalisation**



Note: The chart shows the market value of EU equity funds' holdings of AI companies and the market capitalisation of AI companies (left axis, as indices rebased in January 2021), as well as EU funds' holdings as a percentage of the AI companies' market capitalisation (right axis). 'AI companies' refers to 83 companies that appear in at least two out of seven AI-sector indices.

Sources: Morningstar, Refinitiv Eikon, ESMA

Chart 8  
**EU funds' investment in AI companies**  
**Increasing number of concentrated funds**



Note: Distribution of the portfolio share invested in AI companies and in Magnificent Seven (Mag 7) stocks (as a % of the net asset value) for EU equity investment funds in January 2021 (6,916 funds) and June 2024 (9,116 funds). 'AI companies' refers to 83 companies that appear in at least two out of seven AI-sector indices. 'Magnificent Seven' refers to Apple, Microsoft, Amazon, Alphabet, Meta, Nvidia and Tesla. The horizontal line within each box shows the median exposure, the box edges represent the 25th and 75th percentiles, and the whiskers are the 10th and 90th percentiles.

Sources: Morningstar, ESMA

Finally, Chart 8 provides a more granular view of fund exposure by showing the distribution of fund portfolio shares invested in AI stocks for January 2021 and June 2024. The box plots show that over this period a number of funds increased their exposure both to AI stocks in general and to the Magnificent Seven in particular, shifting the distributions upwards. While more than a quarter of the funds still had no exposure to AI companies as of mid-2024, another quarter had an exposure above 15%, and 10% had an exposure above 27.5%. There were also more funds with extremely concentrated portfolios (e.g. with above 50% invested in either the AI stocks or the Magnificent Seven) than in 2021. This suggests that not all funds with a high exposure to fast-growing AI stocks dumped shares to avoid breaching regulatory or self-imposed diversification rules, as has been the case, for example, in the United States.<sup>31</sup>

As funds increasingly allocate larger portions of their portfolios to AI-related companies, higher concentration and lower diversification might affect their overall risk profile. If these companies face correlated adverse conditions due to the highly uncertain outcomes of investment in AI-driven innovations – be it shifts in expectations, operational setbacks or regulatory challenges – the impact on fund portfolio valuations could be sizeable and possibly relevant at a systemic level.<sup>32</sup> Therefore, while the growing investment in AI-related firms signals confidence in the sector, it also necessitates vigilant risk management and diversification strategies to mitigate potential downsides.

<sup>31</sup> See ['Tech boom forces US funds to dump shares to avoid breach of tax rules'](#), Financial Times, 25 October 2024.

<sup>32</sup> The European Central Bank noted that the concentration of equity market capitalisation and earnings among a few large firms raises concerns over the possibility of an AI-

related asset price bubble and, in a context of deeply integrated global equity markets, it points to the risk of adverse global spillovers should earnings expectations for these firms be disappointed (ECB, 2024).

## Conclusion

The ability of investment managers to leverage AI is becoming a key consideration for firms due to the widely held view that this technology has significant potential in underpinning future growth. While asset managers are turning to newly developed AI technologies in the hope that they will bring improvements across a range of business processes, this article suggests that few EU funds have deeply overhauled their investment strategies as a result – at least based on entities' own assessment and disclosure documents. Our findings are consistent with existing evidence suggesting that asset managers use new AI tools primarily to support human-driven investment decisions. For instance, GenAI can upgrade portfolio management by improving structured and unstructured data analysis, supporting analysts with coding and enhancing the capacity to detect and utilise market signals. Meanwhile, elements of predictive ML have long been deployed as part of quantitative investment strategies but are not necessarily always advertised as AI.

Notwithstanding this somewhat subdued promotion of AI by funds, depending on the trajectory of its penetration in investment management, new forms of risk to investor protection and financial stability may arise in the future, tied to third-party dependencies and service provider concentration, cyber threats, model and data governance, and increased market correlations (FSB, 2024; ESMA, 2023).

When looking at how financial markets are strategizing investment in the sector, the marked diversity in the composition of AI-focused indices is suggestive of the debated nature of AI's economic impact and the differing opinions on which companies stand to benefit most from AI advancements.

Against a backdrop of a strong market rally, the portfolios of EU funds have tilted towards AI-focused equities, increasing their exposure to a small group of leading technology companies but also to a broader range of firms that contribute to AI development and adoption.

While this trend indicates a growing recognition of the transformative potential of AI and its role in driving innovation and technological growth, this increased concentration of investment in a specific sector, particularly in a limited number of firms with potentially correlated outcomes, may amplify systemic vulnerabilities. Given the increasing weight allocated to AI-related companies, a sector-specific downturn could have broader implications and knock-on effects. Against this background, exposure in less liquid segments – such as the debt and private equity markets – warrants particular attention. The growing interconnectedness of AI-related firms with broader economic activities further elevates these risks, underscoring the need for the ongoing monitoring of investment trends in AI-related companies, as the sector's rapid growth continues to reshape the composition and risk profile of equity fund portfolios.

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