Finance, Sustainability, and Technology: Co-evolution in "Super" Asset Owners' Context

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Super Asset Owners

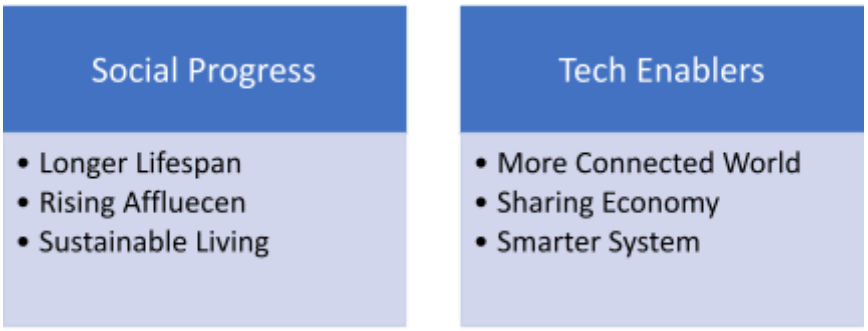
Who holds power in financial markets? For many, the answer will probably be the large investment banks, big asset managers, and hedge funds that are often in the media's spotlight. But increasingly a new group of long-term investors, which includes some of the world's largest sovereign wealth funds (SWFs), public pension funds, central bank reserve funds, have emerged to become the very influential capital markets players and investment firms, with more than $30 trillion in assets under management ("*super asset owners*"), according to the data compiled by Global SWF in 2021.

Decades ago, these super asset owners were few in number, lightly staffed, and seemingly one step behind their more adventurous institutional fund peers. Today, they have transformed themselves from remote passive allocators to local, direct, active investors fostering the tech unicorns and displacing public markets as the most important sources of capital. The shift in the risk profile of their investments, from safe, real assets to the frontiers of tech innovation, suggest that across the board these long-term investors are "grown-up" investors that will play a leading role in the forthcoming digital economy. This chapter will illustrate their two important and directly linked roles in the global digital economy: the new venture capitalists and ESG guardians.

The New Venture Capitalists – "Unicorn Makers"

Given their typically global mandate and long-term investment horizon, the asset owners increasingly build their portfolios based on major future trends, rather than on short-term market movements. Furthermore, they are not just passive actors affected by global megatrends, instead they actively influence the megatrends by their investments. For example, Temasek of Singapore has identified six structural trends, which collectively define the direction of its investment strategy: "Investing for a Better, Smarter, More Sustainable World" (see Figure 1 below):

Figure 1: Temasek Identified Six Structural Trends



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The digital transformation of the world economy is arguably the most important global trend today, and that is the new investment frontier for these super asset owners. Their ample resources and long time horizon, as well as their need to diversify globally and by sector, have helped to transform the private markets for digital companies. They have helped create and sustain an environment that has fostered the rise of the likes of Uber, Alibaba, Spotify, and other transformative players in the digital economy, as well as the well-known unicorn-maker, the Softbank Vision Fund.

Because of their large portfolio size, these super asset owners tend to write bigger checks into tech startups than typical venture capital (VC) funds in the Silicon Valley. For example, in 2018 Ant Financial, the fintech arm of Chinese e-commerce giant Alibaba, raised around $14 billion in what market watchers called the biggest-ever single fundraising globally by a private company (according to market data firm Crunchbase, $14 billion amounted to the largest confirmed single fundraising round in history). Thanks to the billions of investments from Singapore SWF GIC and Temasek as well as Canadian pensions like CPPIB, the fundraising valued the company at over $150 billion, making Ant Financial the highest valued unicorn in China (and the world).

But what has fundamentally changed the venture investment landscape is the $100 billion Vision Fund that Saudi SWF fund PIF jointly established with Mubadala (SWF fund of UAE) and Japanese telecommunications giant SoftBank Group in 2017. To put things in perspective, in 2018 the entire venture capital fund industry was reported to have raised a total of $53.9 billion, slightly over half of Vision Fund's war chest. The scale and speed of Vision Fund investments across the globe is the best example how the super asset owners have altered the VC ecosystem as the powerful "unicorn makers".

ESG Guardians

For decades, many of these long-term funds preferred to remain in the shadows. Little was known about them and their nature on the long-term helped keep it this way. In recent years, however, the nature of these investors has begun to evolve. Alongside accumulating a large and growing pool of capital, these asset owners have transformed operations in three critical ways: attracting better talent, adding more asset classes, and expanding into active investment strategies.

No longer simply channeling their trillions through Wall Street handlers, these asset owners have instead become active, direct investors. As they get involved in their portfolio companies directly and deeply, the long-term investors are also becoming key arbiters of ESG and SDG principles. As major holders of equities, they have weighed in on sustainability, governance, climate change and more. In doing so, they have united across continents, giving one voice to their trillions as they speak to the companies with whose management they engage.

For example, on climate change, the most significant movement is the One Planet SWF Working Group formed by six hydrocarbon wealth powers (Norway and five Middle East funds including ADIA, KIA, PIF, QIA, and the more recently joined Mubadala) and the New Zealand Superannuation Fund (NZ Super). Representing several trillions of assets under management, the funds held the One Planet Summit on December 12, 2017, which was followed by the Climate Finance Day (building upon the success of the 2015 Paris Agreement to collectively mitigate the effects of climate change), and the working group was established at the event.

For the asset owners, climate change is both a financial risk for long-term portfolios, and an opportunity, as the development of technology and changes in government policy create new avenues for investments. During the transition to a lower-carbon economy, long term investors have embraced opportunities ranging from solar and wind energy infrastructure in both developed and emerging markets, to early stage venture investments in the battery and mobility sectors.

For example, combining big spending on direct investments with promotion of ESG goals, a pair of deep pocketed asset owners, GIC (Singapore) and ADIA (UAE), have teamed up to back green, sustainable energy in the developing world. Both participated in 2019 in a nearly $500 million equity round to back a pair of green energy projects totaling $2 billion in India. This brings their aggregate investment to $2.2 billion in the issuer, Greenko Holding. With the latest round, Greenko Holding will be developing the two (2.4 gigawatt total) projects, each with wind and solar generation and hydro energy storage. GIC is majority shareholder of Greenko, which holds the record for Asia's largest green bond issuance at $1 billion.

Besides being the only non-oil SWF fund in the One Planet working group, NZ Super also signed onto a broader grouping launched at the same time which is more favored by pension funds. Characterized by Bloomberg Business Week as "the biggest, richest, and possibly the most benevolent bully the corporate world has ever seen," *Climate Action 100+* has been signed by more than 450 investors from across dozens of countries, who collectively control more than $40 trillion in assets, including prominent pension funds such as ABP, BCI, CDPQ, CalPERS, GPIF, ISIF, and OTPP. They have pledged to work with their investee companies to ensure that they are minimizing (and disclosing) the risks and maximizing the opportunities presented by climate change.

Now the tech revolution is presenting the same mix of opportunities and risks for the asset owners. On the one hand, investing into the high-growth tech sector can diversify their portfolios and generate superior financial returns. Given both their capital power and long-term investment horizons, they are best positioned for financing digital infrastructure (such as smart cities) that is critical for a sustainable global economy (Kamiya & Ma, 2019). On the other hand, major technological and disruptive innovations are disrupting traditional industries, putting asset owners' existing portfolio companies at risk. They must act to "future-proof" their portfolios, as well as their own operating models. As will be seen in the next section, these long-term investors are all rushing into the digital economy revolution.

According to the IFSWF 2024 annual review, in 2024 digital infrastructure emerged as a cornerstone sector for these investors, with $9.4 billion invested across 53 deals, including $5.4 billion in data centres and telecommunications. This strategic realignment reflects sovereign wealth funds' resolve to fortify portfolios against volatility, champion sustainability, and drive transformative growth in a complex global landscape.

Naturally, the asset owners' dual roles of new venture capitalists and ESG guardians met in the emerging digital economy. This paper will analyze long term investors' growing impact on the "new economy" ESG topics in three key directions.

First, Setting ESG Standards in the Cyberspace

The long-term asset owners' size alone means that their actions, collectively and even individually, can have material impacts even when the intent is simply prudent management.

They expect ESG to be an integral part of corporate strategy. That includes making expenditures to address ESG issues, while clearly communicating the rationale and benefits to the business strategy.

For example, Norway's fund NBIM holds, on average, 1.5% of every listed company on earth, making it an investor that boards around the globe must heed (see Box: **Talk vs. Walk**). Leveraging its ESG experience from the carbon energy sectors, similar responsible investing actions are being taken by the Norwegian NBIM, and it was not shy about voting against management of Google, Amazon, and Facebook.

[Talk vs. Walk
There are two main approaches that these institutional investors deploy when they seek to influence the strategies of their portfolio companies. To achieve environmental, social, and governance (ESG) aims, for example, they may remain as shareholders or (co-)owner and engage with the top management and boards of such companies in order to reduce emissions (the "talk" channel). Or, they can "vote with their feet," by divesting polluting companies from their portfolio (the "walk" channel).

NBIM is well positioned for active engagement with public companies' management. By most accounts, its $1 trillion plus portfolio holds, on average, 1.5% of every listed company on Earth. NBIM's report on responsible investing released in March 2020, covering its 2019 voting, engagement with management, and follow up, runs to over 100 pages. Of the more than 9000 companies in which it holds voting shares, NBIM cast votes in more than 97%, and it was not shy about voting against management even in its top holdings, such as Google, Amazon, and Facebook.

For climate change, NBIM has exercised both options: on the one hand engaging with companies developing strong decarbonization strategies; and on the other hand, divesting from heavy polluters like coal and fossil fuel companies. An ongoing and intriguing debate among SIF investors is whether it is better to divest, or better to engage. In practice, many SIFs use both channels and typically start with "talk."**]**

Another digital economy ESG play was led by NZ Super. A March 15, 2019 shooting massacre at two mosques in Christchurch, New Zealand, left 51 dead, and horrifyingly, it was livestreamed on Facebook and disseminated on Twitter and YouTube. In a swift and focused response, NZ Super took the lead in organizing a campaign, *Christchurch Call*, which set out voluntary commitments for governments, companies and wider society to work together to eliminate terrorist and violent extremist content online–the world of Facebook, Google (YouTube), and Twitter. The $40 billion NZ Super has taken the lead in promoting this powerful trend, and Christchurch Call is the first global coalition to campaign about social media issues. After launching Christchurch Call, NZ Super quickly rallied the major New Zealand institutional investors; within a week most had signed up to support the cause. By the end of 2019, 102 asset managers from around the globe, controlling more than $13 trillion in assets, have signed up.

Their actions reveal a major shift: ESG-conscious asset owners (especially SWF and public pension funds) are starting to campaign for a sustainable cyberspace, using tactics developed from "green investments" in sectors relating to fossil fuels and climate change. Until recently, the New Zealand and Norway funds are best known for their decarbonization efforts. Both have integrated climate-risks into their investment processes thoroughly and systematically.

NZ Super has developed low-carbon portfolio strategy for its whole portfolio, and NBIM divested thermal coal positions from its holdings.

Now they are focusing on the major tech companies, which reflects the increasing sophistication of the SIF investors, because tech companies are often deemed to be greater ESG pioneers than many other sectors. That's most obvious for the E (environmental) aspect. For example, Google and Apple have built green headquarters. The tech industry in general has earned (relatively) high ESG scores because innovations tend to do social and environmental good. For example, a December 2019 report commissioned by the telecom industry estimated that the use of mobile technology enabled people to reduce greenhouse gas emissions by 2,135 million tons in the previous year, the size of Russia's annual emissions.

The asset owners are looking now at the social (S), and more fundamentally, the governance (G) issues of the digital economy. The rapid pace of technological advancement, especially artificial intelligence (AI) and machine learning (ML), is creating disruption and anxiety in the society. At the same time, the institutions that have traditionally had the responsibility of shaping the societal impacts of new technology are struggling to keep up with its rapid change and exponential impact. Through their influence on tech companies, the asset owners can join efforts with government and society stakeholders to usher in a sustainable digital transformation.

As tech giants such as GAFA (Google Amazon, Facebook, and Apple), as well as numerous AI-driven startups (some of which may quickly emerge as dominant global players), gather ever more data about their users, they are increasingly shaping people's lives and politics. For new investments, these long-term investors' ESG policies have led to greater scrutiny of the tech companies, especially their dealings with data privacy, information security, and their role in enabling government and corporate surveillance, at a time data is viewed by many as the "new oil" of the "new economy". For existing portfolio companies, they take on more active governance roles to mitigate and even pre-empt advanced tech's negative externalities on society.

Second, Using Tech to Become Better ESG/SDG Investors

Amid disruptions from new technologies, the sustainability of the world economy is critical for the asset owners that seek long-term, sustainable returns from their investments. Consequently, most SIFs make global tech investments, either through external funds or directly; at the same time, they are integrating ESG factors into their investment process, leveraging tech capabilities for data analysis.

For example, in July 2018, One Planet published an Investment Framework designed to accelerate efforts to integrate financial risks and opportunities related to climate change in the management of large, long-term asset pools like those of sovereign funds and pension funds including the following aims:

- foster a shared understanding of the key principles, methodologies, and indicators related to climate change;
- identify climate-related risks and opportunities in their investments; and
- enhance their investment decision-making frameworks to better inform their priorities as investors and participants in financial markets.

One Planet hopes that more asset owners and then the general institutional investors industry will adopt the Investment Framework. Its success, interestingly, is dependent on data and technology. That's because across the industry, high-quality company-level environmental data – for example, those relating to carbon emissions and environmental impact – is still not readily available.

To make informed investment decisions, investors demand timely, relevant, accurate, and complete climate-related data. As such, the Investment Framework encourages long-term investors to adopt agreed standards that promote the disclosure of material climate-related data. With the help of big data technology, the investors collectively would improve the volume, quality, and consistency of financial data to promote ESG investments effectively.

APG, the pension manager for ABP and a few other Dutch pension schemes, is another great example. APG expresses its commitment to responsible investing by codifying such investing within one of its nine headline investment beliefs, and it has used digital tech for implementation.

For instance, relating to the ESG and SDG discussions in the previous section, whereas some asset owners say they are waiting for standardized data or more academic proof to implement ESG strategies, APG has used AI to select companies that contribute sufficiently to the UN SDGs. They use this by ingesting vast amounts of structured and unstructured data. Responsible investing experts have trained the machines to identify potential Sustainable Development Investments (SDI's), including to which SDG they contribute.

Recognizing that this challenge is common across other asset owners, APG decided to spin out this intellectual property (IP) to the SDI Asset Owner Platform. With PGGM (NL), Australian Super, and BCI (Canada) joining the SDI Asset Owner Platform, the ambition is to utilize technology to its fullest and to refine and extend the algorithms in a transparent way, thus fulfilling their fiduciary duty in an efficient way. With the end product of SDI classifications and the underlying data being available via regular market data distributors, the SDI Asset Owner Platform aims to set a broad standard used by a broad group of investors. This further creates a lever in the engagement of the long-term asset owners and their asset managers with their holdings, and to monitor and steer their portfolio on investing into the SDGs.

And identifying SDI is only a fraction of how technology can and is applied. Alternative Data in combination with AI and ML is now starting to get fully embedded in managing the portfolio and portfolio risks. Applications adding climate risk overlays on the Global Positioning System (GPS) locations of physical assets in the investment portfolios are getting more common. This has now unleashed also in the ESG domain an all-out race on access to alternative data and the talent required to create value out of it (Monk, Prins & Rook, 2019; Monk, Prins, & Rook, 2021). Next to the war on tech talent, APG hired a meteorologist to their responsible investing team for interpretation of the climate data. This emphasizes the commitment these long-term asset owners have to become better ESG/SDG investors.

Another example is CIC, China's sovereign wealth fund. In 2020, following a review of peer experience and its own practices, CIC formulated an ESG investment policy framework to take sustainability into account throughout the lifecycle of its investments.

Take Logicor, a large portfolio of logistics assets in Europe, as an example. After completing its investment in Logicor, which manages an extensive network of over 600 properties across 17 countries in Europe, CIC encouraged Logicor to develop stronger ESG policies, formulate an ESG development strategy, and publish regular ESG reports. These include leveraging new technologies to boost resource utilization efficiency and curb energy use and greenhouse gas emissions.

Third, Using Technology to Improve the ESG of the Long-Term Asset Owners Themselves

The use of technology is not only increasingly prevalent on the ESG investment side, but also on the operation of the asset owners themselves. For example, the participant side of pension funds. In 2020 four major Dutch pension providers, APG, Blue Sky Group, Nationale-Nederlanden and PGGM, launched *Mijnwaardeoverdracht.nl* (MyValueTransfer). The joint initiative optimizes value transfers using decentralized technology, which is also known as blockchain. Already about fifty percent of the participants can use the platform. In the near future, more pension providers will join the platform, which will further increase its reach.

A value transfer is the transfer of an accrued pension pot from a previous job to the pension pot of a new job. Until now, arranging a value transfer has been complicated and time consuming. The site connects the administrations of parties in the pension sector with decentralized technology. In this way, all the information is available at once to compare the various options and to transfer the pension.

The platform is one of the first blockchain-based applications available to the general public. The participating parties jointly designed the platform. Because all parties exchange the necessary information in real time, they reduce the turnaround time of a value transfer from nine months to approximately thirty minutes. In a clear step-by-step plan, the pension saver compares the current and old pension scheme and can thus make a well-considered choice. The decentralized set-up also safeguards the privacy of users of the platform, which has been determined by independent auditors. In short, new blockchain technology can speed up and simplify a process for the pension saver, while achieving efficiency at the back end.

These asset owners are now investigating where this philosophy can be put to further use. For example, one pension policy requires pensioners abroad to make an expensive and sometimes dangerous annual trip to an embassy. A digital app then makes it possible to provide this proof once before being shared with the required parties, instead of the participant going through the currently lengthy process with each party separately.

In the New AI Era

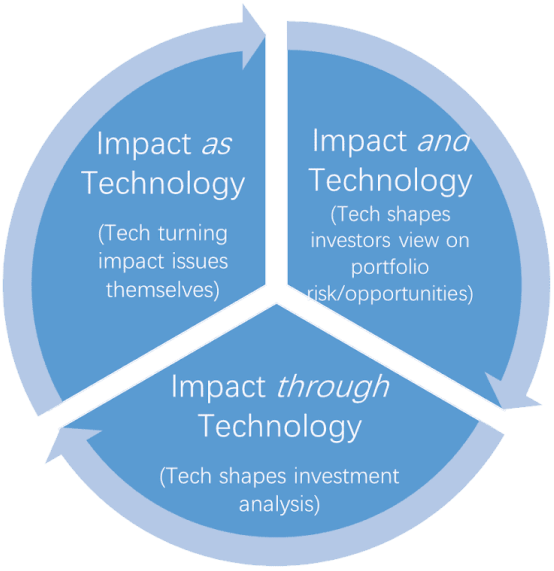
In an era defined by rapid technological disruption and global sustainability imperatives, super asset owners are undergoing a profound transformation. No longer passive stewards of capital, they emerge as proactive architects of change — shaping markets, driving innovation, and redefining what it means to be a responsible investor.

They now stand at the intersection of investment, technology, and impact. With tens of trillions of dollars under management and long-term mandates, they are uniquely positioned to lead impact investing in the new era of AI digital economy.

The convergence of artificial intelligence (AI), big data, blockchain, cloud computing, and many more digital technologies is fundamentally reshaping how the sovereign funds and pension funds invest and operate. There are three perspectives for super asset owners regarding the relationship between technology and impact (see **Figure 2** below):

1. **Impact as Technology**: New technologies, such as AI, constitute impact issues themselves
2. **Impact and Technology**: Tech revolution changes investors' evaluation of risks and opportunities in their portfolios
3. **Impact through Technology**: Advanced technologies enable investors to be more sophisticated and effective in impact investing

Figure 2: Technology and Impact - Three Perspectives for Super Asset Owners



First, Impact as Technology.

SWFs are positioning themselves as impact investors by actively investing in AI technology and data infrastructure, recognizing the transformative potential of these assets to drive long-term economic growth and societal development. A prime example is Saudi Arabia's Public Investment Fund (PIF). In late 2024, PIF partnered with Google Cloud to establish an advanced AI hub in Saudi Arabia, signaling a strategic move to build domestic technological capacity while attracting global tech talent and investment.

By backing such ventures, PIF is fostering a new ecosystem where AI research, cloud computing, and data governance converge to support smart cities, healthcare, education, and sustainable infrastructure — sectors critical to its future economy. The partnership's societal impact is equally significant, as it plans to feature joint research on Arabic language models as well as Saudi-specific AI applications.

Second, Impact and Technology.

One of the most compelling examples of how sovereign wealth funds are adapting to the AI era for their portfolio management is the world's largest SWF, NBIM of Norway. With nearly $2 trillion in assets under management and holding 1.5% of all listed companies in the world,

NBIM has long been using its shareholder voting power to push for stronger climate disclosures, board diversity, and corporate accountability.
In recent years, NBIM has voted against management at major tech firms like Alphabet (Google), Amazon, and Meta (Facebook) when they failed to meet its expectations. Furthermore, driven by the latest AI revolution, NBIM in 2023 and 2024 took a significant step forward by developing new AI-related voting guidelines.

The new guideline emphasizes transparency, explainability, and accountability in AI systems, expecting companies to clearly disclose how AI is designed, trained, and tested, and to ensure that all stakeholders can understand and assess the impacts of these technologies. Meanwhile, NBIM has actively engaged with peer institutions and global organizations to shape emerging standards for AI governance.

Third, Impact through Technology.

Recent AI innovations have opened new possibilities for investors to integrate sustainability criteria into their investment process and portfolio construction. Increasingly, the market recognized that "traditional" ESG data does not give investors a comprehensive perspective on companies' ESG performance. (For example, most ESG data is self-reported and hence likely to be biased.)

Now, new technologies allow investors to supplement their analysis with unstructured data (for example, sentiment analysis based on companies' disclosure) and extra-financial data (such as news items and social media). In their recent annual reports, many sovereign funds repeatedly point to an overarching goal of using data to make better, more informed investment decisions.

For example, the investment teams of GIC, a major SWF of Singapore, use AI tools—such as their bespoke ChatGPT-like bot, ChatGIC—for summarization and "opinion mining" of annual reports, management call transcripts, and alternative data, enabling them to quickly distill key insights and focus on material issues amid information overloads. They leverage AI and quantitative techniques to assess complex risks of new investment opportunities, including those related to climate and sustainability.

In summary, leading sovereign funds and pension funds are increasingly deploying AI-powered tools across the entire investment lifecycle—from idea generation and due diligence to post-investment monitoring and engagement. These tools are not only enhancing efficiency but also enabling deeper, more nuanced insights that support long-term, sustainable value creation. As a result, these super asset owners are transforming themselves into more sophisticated, impact-driven investors.

Standing at the intersection of investment, technology and impact, the super asset owners, as the guardians for our digital future, will increasingly lead investments in the AI economy, uniting to vote on corporate AI agenda, adopting AI to monitor the conduct of portfolio companies, chiding the management of others, and rebalancing their portfolios to de-risk them for climate change and technological disruption.

Conclusion
The world's long-term investors have shaken off their traditional, passive investor roles and stepped into the vanguard of the digital transformation we are all living through. As

increasingly active investors, they can increase engagement with the companies in which they hold meaningful stakes – especially in the emerging tech unicorns. They are becoming new "ESG guardians" by applying their expertise from carbon energy sector into the new digital economy. Using new technologies, the asset owners are becoming better ESG investors across the board.

As long-term investors they can reap higher long-term returns of environmental, social risk adjusted portfolios and ESG engagement. And given the funds are some of the world's biggest investors, their ESG positions can affect how quickly corporations put their businesses on a more sustainable footing. As the long-term investment capital of the world, how they respond to ESG matters will have long-term positive impact in the corporate world.

However, there is an acute paucity of ESG data, calling the asset owners working with the tech sectors beyond investment relationship. There is a lack of long-term empirical evidence that links ESG criteria to financial returns and demonstrates outperformance compared to mainstream investments. The good news is that investors are at a unique moment in time when technology has become applicable to real world and real time scenarios as they now have access to sufficient computing power, connectivity, and effective algorithms to analyze data.

As seen in many examples of this article, the super asset owners are also investing in digital technologies for their own investment capabilities. They reorganize their ESG investment efforts based on the convergence of technological innovation and data, which is altering how investments are not only conceived but also implemented. For example, AI and ML are used to improve and even guide decision making, and during such process, long-term, high quality ESG data may actually emerge from these long-term investors' in-house IT systems.

Moving forward, long term asset owners will increasingly lead ESG and the SDGs in the digital economy, relying on AI to monitor the conduct of portfolio companies, chiding the management of others, and rebalancing their portfolios to de-risk them for climate change and technological disruption. Where appropriate, they will not hesitate to create platforms as lever for the impact they can and want to have. The future of investing is at an inflection point, and these long-term asset owners are becoming guardians for both global climate change and our digital future. Given their long-term perspective in an increasingly short sighted world, we should be happy to have them picking up this role.

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