Tech Disruption

Managing exposure to breakthrough technologies

Alistair Barker, Ashby Monk, Dane Rook

1. Welcome

The ascendance of ChatGPT and other forms of generative AI has many investors asking, "How might these technologies impact my portfolio?" This kind of concern over "tech disruption" (economic and market shakeups caused by breakthrough technology) is nothing new: many investors also worry about the consequences of quantum computing, autonomous transportation, radical new fuel sources, bio-pharmaceuticals and scores of other promising-but-uncertain innovations. These worries are valid, given how the dot-com bubble remains an all-too-recent memory for many investors. However, given the amount of fretting over tech disruption (TD), it's surprising that so few investors have coherent processes for handling TD in terms of analyzing and managing the risks and opportunities TD poses for their overall portfolios. Here, we examine how some of the world's leading investors navigate TD. We uncover best practices for all investors—regardless of whether they choose to play "defense" or "offense" when it comes to TD.[1] To the best of our knowledge, this is the first formal study of how professional investors (and, specifically, institutional investors) manage TD risks and opportunities.

Addepar is uniquely situated to help guide investors through TD management. Our network of close relationships with some of the world's top academics in finance (especially through our connection with Stanford University) and leading investment institutions grants us privileged insight into novel approaches to handling TD at the asset and portfolio levels, including what resources are needed and what does/doesn't work in practice. TD management is very much a nascent, evolving field of research and practice. This research brief encapsulates what we've learned thus far and contains actionable ideas for all investors, no matter their size or resources.

[1] The topic of technological disruption—and its handling by investors—is vast. For a fuller treatment, we direct readers to Barker et al. [2023].

2. NTK

Here are the key insights from this ARB that readers "need to know":

- Bottom–up balance: Many investors emphasize either a "defensive" or "offensive" posture when managing TD in their portfolios, but the top investors balance these two strategies (i.e., they control the downside risks of TD while still creating upside exposure). Achieving a balanced approach to TD requires a whole-portfolio perspective derived from bottom-up analysis.
- Network necessity: Successful TD management requires sourcing timely, differentiated information, and the most successful investors don't rely on consultants to get it. Instead, they use strategically cultivated networks, which often include links to venture capitalists, but also include academics, seasoned entrepreneurs or other technology specialists.
- Transfer potential: In conducting diligence, investors should probe an external manager's ability to transfer (actionable) TD-related information. Indeed, information transfer is a main reason some premier investors participate in VC funds (a function that they see as being at least as valuable as the returns those funds typically deliver).
- Conceptualization matters: How an investor conceptualizes TD dictates how well they can manage it. Innovation axes and DARLing analysis (both of which are discussed below) are two tools that can be combined to form a comprehensive perspective of TD.

3. Significance

Tech disruption (TD) is an inalienable part of modern life. The past two centuries have produced new technologies that have transformed societies and economies (e.g., electrification, automobiles, the internet, smartphones)—at what seems to be an accelerating rate. However, given humanity's present dependence on tech, little guidance exists regarding how investors should factor TD into portfolio management. Whether through radical step changes in industrial processes or the bursting of hype bubbles, TD can quickly spur drastic movement in asset values. Yet, it's not only quick-onset TD that challenges investors; TDs that occur at a slower pace can be equally as problematic (e.g., when investors commit to long-term illiquid investments, such as private equity funds).

In general, it's not obvious how investors should *ideally* manage TD, because (among other things):

- The same disruptive technologies can have impacts that span numerous industries and asset classes (just consider the vast range of companies that could be materially affected by generative AI). Traditional diversification tactics may not be effective tools for handling the most significant TD-related risks.
- Pursuing upside TD opportunities can be challenging. Many institutional investors perceive "picking winners" early as a gambling exercise best left to specialists (namely, venture capitalists).
- It can be tough to find strategies (defensive or offensive) that scale to the point of having significant effects at the portfolio level (to wit, few investors allocate more than a very small minority of their capital to VC funds).

Despite these challenges, investors are finding success in managing TD-related risks and opportunities. And although many of these players are well-resourced institutional investors (like sovereign wealth funds), some of their approaches are adoptable by even the smallest investors—and these approaches should be treated as emerging best practices.

4. Context

Here, we provide finer detail on what tech disruption (TD) is, how it relates to other risk factors and what it means to manage it in an investment portfolio. To begin, some readers may find a more exact definition of *tech disruption* useful. We use Barker et al.'s [2023] notion of TD as "major alterations in established industries as a result of the emergence of a new technology."[2] Thus, even though a given TD might be confined to a single industry, it's also possible for it to encompass many industries. Such mass-scale TDs are usually termed *industrial revolutions*.[3]

Moreover, just as TD can occur at different scales, it can also transpire at different rates. For example, the uptake of the internet and mobile phones was slower than the rise of smartphones. Related to speed is the "continuity" of TDs: the evolution and adoption of some technologies seems part of a smoother, steadier advancement (e.g., the hybridization of the internet and mobile

[2] Those authors continue to observe: "This is an 'investment-centric' definition; it does not consider a technology that causes changes in social/individual behavior to be disruptive unless it has economic consequences at industrial scales. Likewise, a technology that births a new industry without significantly affecting existing industries is not 'disruptive' under our definition (however, we struggle to conjure examples of such a technology)."

[3] People sometimes refer to 'the Industrial Revolution" (singular), a period of increased mechanization and a shift to factory-based production methods lasting from the 1760s to 1840s. However, many historians and technologists argue that there have been (at least) three other "industrial revolutions" since then (if one assumes an industrial revolution is synonymous with mass-scale TD; see Rook et al. [2017]). We adopt this latter view that multiple revolutions have occurred in recent centuries.

phones into smartphones). Other TDs appear to be radical step changes. For example, even though neural networks have been continually improving for decades, the advent of ChatGPT et al. represents a jarring leap forward for AI. Overall, the diversity of TDs—regarding their scale, pace and (dis)continuity—poses serious considerations for investors in how TD can and should be managed. This prompts questions such as will a single strategy for TD management suffice, or is a collection of approaches needed?

Many investors don't consider TD a traditional risk factor in the same way that inflation, unemployment and interest rates are (see the Findings section)—at least, not at the portfolio scale.[4,5] And, unlike traditional risk factors, TD suffers from data deficiencies. Whereas data on traditional risks are often standardized, readily available and reach far back in history, TD data (much like ESG data):

- Often qualify as "alternative data" (see Monk et al. [2019]) and can suffer from issues concerning quality, granularity and completeness.
- Can frequently be hard to obtain. Even when it is obtainable, it often comes in forms that aren't amenable to straightforward quantitative analysis (e.g., subjective testimonials or values that don't fit into standard financial models)[6].
- May be hampered by perceived concerns over relevance. Namely, it may be questionable whether a historic TD episode counts as a "comparable" instance for future TD analysis.

Most investors we've studied—formally (which we report on below) and informally—cite the foregoing data problems as reasons for treating TD risk as unmanageable (or only manageable to a very limited extent).[7] However, *managing* TD can amount to more than just handling its associated risks. Depending on an investor's preferences, constraints and goals, it can also entail pursuing upside TD opportunities. More generally, *TD management* can be seen as a combination of the following:

- Factoring expectations about TD into ex-ante capital allocation across asset classes, industries or other broad categories of investments and

[4] This status quo persists even though the public filings of most companies specifically list "technology" as a risk factor in their quarterly and annual reports (although this is usually done in general, non-specific terms). Some investors who use a bottom-up approach to portfolio construction do assess this technological risk on an asset-by-asset basis. However, our work with investors suggests that comparatively few of these bottom-up investors meaningfully assess or manage technological risk across assets.

[5] See Barker et al. [2023] for more detail on what differentiates traditional and non-traditional risk factors.

[6] Notably, short data histories tend to mean that TD risk is difficult to assess through usual mean-variance analysis.

[7] Said differently: many investors acknowledge that TD poses risks, but take little strategic or concerted action to address those risks. As we discuss later, this perception of unmanageability may be partly caused by the lack of a cohesive framework for conceptualizing and acting on TD in portfolios. (Also see Barker et al. [2023].)

- Regularly modifying TD exposures at the asset level (i.e., by choosing to hold specific assets) as new TD-related information and data become available.[8]

From what we've noticed, when most investors attempt to manage TD (or contemplate doing so), they fixate on the latter element. That is, TD gets managed at the asset level *in reaction* to new information on evolving technologies.[9] And it's the acquisition of that information (and the process of integrating it into well-governed investment decisions) that causes investors the greatest angst. That angst—and how to alleviate it—is the focus of the remainder of this ARB.

5. Approach

To better understand emerging practices in TD management (TDM) among investors (i.e., what practices are common and what should be treated as best practices), we conducted a series of 20 elite case studies. The subjects of these studies were world-class institutional investment organizations (e.g., sovereign wealth funds, large public pension funds and endowments), with assets under management ranging from $10 billion (USD) to nearly $1 trillion. Our subject pool spanned four continents (North America, Europe, Asia and Australia) concerning the location of the domicile.

At each of these organizations, we undertook multiple semi-structured interviews, each with top-level decision makers (primarily chief investment officers, chief risk officers, chief executive officers and senior portfolio managers). We followed the interview techniques established by Strauss and Corbin [1998] and Davies [2001]. Furthermore, we adhered to guidelines set by Clark [1998] and Clark and Urwin [2008] and assured subjects that their anonymity would be preserved (both at the individual and organizational levels) because doing so has been proven to increase the degree of richness and candor in subjects' responses. In that spirit, this ARB covers synoptic findings rather than specific details of any single organization's situation or activities. We present the key takeaways from these case studies in the next section.

[8] These twin ingredients to managing TD (ex-ante expectations and ex-post portfolio modifications) directly translate into a variety of management actions, for example, using expectations to craft scenarios and perform impact testing; identifying "critical points" for the future (i.e., what level relevant variables must achieve before action is taken); and determining rules for rebalancing against TD risks.

[9] Put differently, many investors simply reduce their exposures to disrupted companies only after the disruption conspicuously begins.

6. Findings

Of the 20 institutional investors we studied, most believed that TD is a significant risk factor for their portfolios—one that's worth managing. However, all subjects agreed that managing TD presents sizable challenges. Many subjects found these challenges similar to those posed by ESG (e.g., risks that can take a long time to materialize or are highly uncertain, a need to rely on alternative data and difficulty aligning with existing processes and governance).[10]

Among the investors in our study, there was meaningful divergence in the approaches used for TD management (TDM). These approaches can be split into four camps:[11]

- Dismiss: A small minority of investors in our study choose not to manage TD at all (even though some admit that TD can have meaningful impacts on returns). This group of investors were all similar in that they tend not to make direct investments, hold significant positions in alternative assets or be well resourced relative to the total volume of assets they manage. We believe that such traits meaningfully influence (and bias) these investors' perspectives of TDM.
- Defense: Most investors we studied approach TD from a defensive standpoint.[12] Characteristically, these investors hold portfolios that are heavy in "incumbent" assets (i.e., assets that TD tends to threaten), for example, value stocks, non-new real estate and infrastructure, LBO funds, commercial credit and fixed income. Reactionary divestment (that is, selling out of positions that TD threatens too much) is the chief way that investors in this group manage TD-related risks (many interviewees highlighted the scalability of divesting). A few members of this group shift industry allocations (mostly within public equity portfolios) in response to new TD-related information (those who do not express doubts that they could effectively execute such reallocations). A limited fraction of this group believed defensive TDM could be partly achieved as a side effect of thematic investing strategies, yet none of these investors pursued TD as a specific "theme". Several of these investors have made allocations to venture capital (VC) funds but stated that their VC allocations were not made to gain the upside from TD. Rather, such investments were made based on their high expected returns and general diversification potential.

[10] Indeed, multiple subjects consider TD an outright ESG issue (their position was that TD is inherently tied to innovation, which directly intersects with sustainability and governance issues for investments).

[11] It was not necessarily the case that a given investor adopted only one approach across its organization and portfolio. Some investors took different approaches with different asset classes, but most use just a single approach for their entire portfolio.

[12] Most subjects felt that taking a defensive stance on TD is easier than pursuing the performance upside from TD. However, many subjects also expressed the view that an organization's defensive posture on TD matters more (in terms of the ultimate impact on performance) than how it chooses to play "offense" on TD.

Universally, the reason given by this group for not making serious efforts to pursue upside opportunities in TD was that doing so profitably is very difficult. (Weak information flows were cited as a chief cause of this difficulty; we discuss this problem more extensively below.)

- Offense: A minority of investors in our study claimed that their approach to TDM is chiefly upside oriented (versus being geared around downside protection). Most of this group has holdings in VC funds for this purpose, yet few do any "in-house" venture investing. The most sophisticated of these investors said that the primary motivation for their VC programs is for information flows. They treat external VC funds as sources of information on TD and apply this information to other portfolio segments. (Moreover, they see this information-sourcing function of VC as being about as important as the returns/diversification benefits of VC, if not more.) However, few subjects in this group believed that their approach to TDM was "comprehensive." They felt that simply adding assets with an upside potential doesn't fully handle TD at the portfolio level.
- Hybrid: A very small minority of investors in our study claimed to put equal effort into playing both defense and offense in their approach to TDM. Participation in VC is at the crux of most of these investors' TDM strategies, with strategic tilts and divestment playing lesser roles. These investors all emphasized the importance of "bottom-up" analyses of TD in their portfolios. Nevertheless, many felt that their defensive and offensive TDM efforts aren't well coordinated, largely due to the viscosity of information flows within the organization. (That is, information on TD-related topics tends to flow slowly and is often siloed in different parts of the organization.)

An observation that struck us squarely from these interviews was how heavily funds in our study tended to rely on external VC funds for managing TD, despite the shortcomings of doing so, namely:

1. The upside effects (and downside offsets) of VC don't usually scale in terms of influence on TDM across the whole portfolio. (This is because most investors can make only relatively small allocations to external VC.[13])
2. The TD-related benefits of VC may be blunted by VC funds' efforts to diversify. That is, to control risk in a fund's performance, a VC manager may not invest as heavily in truly disruptive technologies as their (LP) investors desire (and instead place a large proportion of capital in opportunities that rely on safer, non-disruptive technology).

[13] As we note later, however, being able to make only a small relative allocation to venture investments is not as limiting as might at first be suspected. *How* one invests in VC matters significantly. For example, direct venture deals or being an LP in a fund that readily shares information can have more of an informational payoff than participating in a VC fund run by GPs who are stingy with information. (It's this informational payoff that can help "scale" TDM to a broader portfolio.)

3. There is the possibility that VC managers might not freely share (actionable) TD-related information. This is clearly problematic when LP investors want to extract TD "signals" from their VC programs.
4. Simply adding VC funds to a portfolio is an incomplete approach to defense (or offense) in TDM in managing portfolio segments other than VC.

Plainly, involvement in VC funds is a valuable TDM strategy, but in isolation, it doesn't amount to a comprehensive TDM approach.[14]

Across the investors in our study, subjects claimed that two factors would prompt them to increase their TDM efforts: clearer, more actionable frameworks and perspectives for thinking about and handling TD (as both a risk and opportunity), as well as improved TD-relevant information and data.[15] We discuss the former in the next section and turn our present attention to processes for sourcing information on TD.

Among our subjects, a variety of creative TDM initiatives exist, including the following:

- A fund that has a specific "disruptive technology" subunit within its infrastructure investing team. This subunit is small in headcount and budget share but functions as a source of knowledge on TD for the broader organization.
- One fund hired a technologist to serve as a dedicated "disruption analyst," whose role is to analyze disruption risks and opportunities within the portfolio and wider markets, as well as serve as an exclusive consultant for internal investment teams.

[14] Worth mentioning is that *how* investors are involved with VC funds can vary substantially from one fund to the next. One of the largest funds in our sample has VC-related positions in over 1,000 companies, whether through VC funds or its own direct venture program. Part of that investor's TDM strategy is to "seed" disruption readiness in its broader portfolio. As its early-stage investments mature and grow, they move to other segments of the portfolio (e.g., public equity) and represent a higher percentage of overall holdings (thus increasing the share of assets that stand to benefit from TD). Similarly, this investor also frequently introduces companies in its venture portfolio to companies elsewhere in its portfolio (this investor tends to take majority shares in most of its holdings), hoping to improve TD-related practices in the latter group. Admittedly, most investors cannot leverage VC in quite this way, but even small investors (in terms of assets under management) can find proactive ways to participate in VC. For example, one subject in our study is a relatively small public pension fund that has a policy of not investing in large, "name-brand" VC funds. Instead, they only allocate capital to VC managers where they can have considerable influence as LPs—that is, places where their "money makes a real difference to the GPs" (thus increasing the likelihood that those GPs will serve as effective information sharers of TD and other risks/opportunities).

[15] Our research subjects noted organizational hurdles can hamper TDM. Foremost among these was friction to information flows in the organization: siloing and poor communication channels usually inhibit such flows, which means that different parts of the portfolio may be differently informed about TD. This can lead to overall incoherence in TDM (concerning investment decisions). The tendency for investment organizations to be structured around asset classes (e.g., some teams focusing on public equities, others focusing on public debt, others focusing on private equity, etc.) was cited as a primary cause of this fragmented information and discoordinated TDM in general. In such cases, when teams don't share TD-related information effectively, TDM is ultimately applied unequally across the portfolio, so TD is managed worse for some assets than others. Other hurdles noted by our subjects include the possibilities of senior leaders being unwilling to prioritize TDM; the change-resistant, incrementalist mindset that pervades many institutional investment organizations (which is often at odds with the step-change nature of TD); and misaligned incentives (employees are often remunerated for short-term performance, whereas TD-related risks and payoffs sometimes don't materialize for several years).

- Several funds hire interns (e.g., graduate students in science or engineering disciplines) to act as temporary internal experts on TD-related issues of concern/interest.
- Many funds have satellite offices in "high-tech" centers, such as Silicon Valley, or close to university campuses. Teams in these offices are not only tasked with sourcing TD-related information from those geographies but also being "test centers" for some of the new tech they identify (e.g., if they find a new data tool that might benefit the broader organization, they have an obligation to act as a trial user).[16]
- One fund (a university endowment) taps the expertise of professors and other researchers for insights into TD.

With all else being equal, access to TD information seemed to be the primary determinant of each investor's approach to TDM: the better their access, the more proficient they appear to be at TDM and the more their approach better balances defense and offense. Overwhelmingly, the investors in our study turned to their networks for TD-related information (rather than deriving it from primary research or in-house sources).[17] Within their networks, most investors in our study relied primarily on their external asset managers for TD insights and information. None relied on external consultants (the reason given was that few consultants provide TD information that's both differentiated and clearly actionable relative to its cost).

Overall, our assessment is that the quality of an investor's network is—more than any other variable—what drives the quality of its TDM.[18] That said, having a good network doesn't automatically translate into good TDM. There must also be a sound process for extracting information from that network and integrating it into investment decisions. Such a process partially depends on tools for conceptualizing and analyzing TD, which we cover in the next section.

7. The ARB-itrage

[16] Several subjects cautioned against focusing exclusively on the "obvious" locations (namely, Silicon Valley) for such offices. They also advised considering geographies that might offer truly differentiated TD perspectives.

[17] "Networks" in this sense are an investment organization's relationship systems—contractual and otherwise — with external entities. An investor's network includes (for example) external managers, consultants, employees' relationships with experts/professionals outside the organization and any *privileged connections* the organization may have (e.g., a university endowment might have special access to academic pioneers at the cutting edge of specific technologies).

[18] A close second (regarding what determines the quality of TDM) is investor "plasticity"—that is, how readily an investor's governance, delegations etc. can be adapted to tackle TD-related risks and opportunities (or at least those TD risks and opportunities for which the investor has high conviction).

The above findings identify a few best practices for investors in managing technological disruption (TD). These are practices that all investors can undertake—not just well-heeled sovereign wealth funds and endowments.

1. Cultivate a network of external relationships that can provide timely, reliable information on TD. For many investors, this likely consists mostly of external asset managers. But there are straightforward ways to cultivate other valuable nodes, for example, becoming involved in tech forums and conferences or contacting university professors in technical disciplines (some may ask to be paid consulting fees or for donations to their research, but many are willing to share ideas for the price of a cappuccino).
2. Have a well-governed process for harvesting information from your organization's network (regardless of its composition). That process should rigorously guide how such information is converted into investment decisions.
3. When conducting due diligence on external asset managers, fully assess what their TDM abilities are and whether they're willing to share TD-related information.
4. Ensure that TD-related information flows fluidly within your organization and drives people to realize the value that TD analysis can bring to portfolio outcomes. Where possible, investors should aim to have an internally consistent/unified perspective for understanding, analyzing and acting on TD information. This is achieved partly through sound governance and knowledge management and partly by using an appropriate framework that can aggregate asset-level TD analysis into a whole-portfolio perspective.

Respecting the fourth practice in this list, we found that practically all investors in our study lacked a cogent framework for analyzing TD risks and opportunities. To close this gap, Barker et al. [2023] proposed a TDM framework that builds on the tools of innovation axes [Rook et al. 2017] and DARLing analysis [Rook et al. 2021]. We summarize these tools below and encourage readers to investigate the original papers for more extensive details and explanations.

Innovation Axes

Industrial revolutions can be considered extreme TD events, which can be underpinned by more than one disruptive technology. There have been at least three such revolutions in the past three centuries (the first lasted from the 1760s to the mid-1800s, the second went from the 1870s until about World War II, and the third ran from the 1960s until the early 2000s). Many technologists now agree that we are experiencing a fourth revolution.

In exploring commonalities across these events, Rook et al. [2017] found that the innovations that fueled them shared five characteristics: that is, the technologies behind these revolutions brought

about the same five *dimensions* of change, even though the specific changes varied from one revolution to the next. Those authors termed these dimensions "innovation axes" and labeled them as control, integration, reconfigurability, scale and sustainability impact:

> "**Control** concerns how the behavior of an output or process is determined, as well as how specifically it is determined (e.g., how variable are the outputs of an assembly line? Are routes taken by delivery drivers centrally decided, or do the drivers have flexibility in routes they take?) **Integration** reflects the extent to which units in an economic (sub-)system are interlinked or coordinated. **Reconfigurability** is the ease with which (or extent to) which an output or process can be adjusted to meet shifting conditions or needs. **Scale** relates to both 'size' (in terms of physical proportions) and 'flow' of processes (e.g., sequential or parallel?) (for example, innovation along this Axis might involve extending the footprint of a supply chain from dozens to thousands of miles, or creating medical therapies that target specific cells or genes, rather than entire tissues or organs). **Sustainability impact** measures resource intensity or wastefulness (i.e., whether an output or process can be produced/executed over a long horizon without needing major revision)." [Rook et al., 2017, p. 2–3]

The authors determined that these innovation axes map to historical industrial revolutions in the manner depicted in Table 1, below.

Table 1

How Innovation Axes Map to Industrial Revolutions

Axis of Innovation	Industrial Revolution			
	First (1760s to mid-1800s)	***Second*** (1870s to about WWI)	***Third*** (1960s to early 2000s)	***Fourth*** (began ~ early 2010s)
Control	Mechanization	Standardization	Automation	Autonomy
Integration	Networked Transportation	Electrification	Decentralization	Hyperconnectivity
Reconfigurability	Fixed-Purpose Machines	Heavy-Duty Construction	Reprogrammability	Adaptability
Scale	Factory-Based Production	Mass-Production Systems	Digitalization	On-Demand
Sustainability Impact	Intensified Throughput	Resource Exploitation	Resource Depletion	Renewability

Source: Rook et al. [2017]

The authors noted that major disruptive technologies tend to generate significant advancements along several of these axes simultaneously (i.e., even if a particular technology doesn't spur a full-blown revolution, its potential to significantly disrupt one or more industries will depend on its ability to meaningfully improve incumbent technologies along more than one of these axes). From a TDM standpoint, these axes can be useful in analyzing which emerging technologies can be genuinely disruptive and the channels of impact such technologies might have on their respective industries. Such analysis is valuable in identifying entities that stand to materially lose or gain from tech disruptions.

DARLing Analysis

Entities identified by innovation axes can then undergo DARLing analysis. "DARLing" is an acronym for detection, absorption, recovery and learning, the four critical elements (uncovered by Rook et al. [2021]) that determine how well an asset can position itself and react to exogenous shocks.[19] DARLing analysis was originally developed to study company-level responses to ESG-related shocks but directly applies to TD events as well (see Barker et al. [2023] for justification).

A core aim of DARLing analysis is to derive *submergence* profiles for assets—that is, the expected time series of their drawdown and recovery paths in response to shocks—which creates a quantifiable object that is amenable to risk analysis (for more on this procedure, see Monk and Rook [2023]). In the TDM context, this can lead to impact profiles for individual assets, which can then be aggregated to produce a portfolio-level perspective of TD risks and opportunities. Actions can then be appropriately selected within the frame of this whole-portfolio vantage.

8. Coda

This research brief has uncovered and distilled best practices for investors in managing tech disruption (TD), irrespective of whether their preferred approach is more upside- or downside-centric and regardless of their sizes and resources. We've established the importance of a well-curated network for acquiring TD-related information and the necessity of adopting a coherent perspective of how to analyze and take action on TD. The perspective we most support (and which DARLing analysis is part) originates from a new paradigm we are actively developing

[19] Briefly: "Detection" pertains to an entity's ability to monitor and anticipate a shock. "Absorption" relates to its ability to withstand the initial impacts (direct and indirect) of a shock. "Recovery" reflects its ability to return to its pre-shock trajectory/performance levels or an alternate trajectory that is at least as beneficial, and "learning" involves its capacity to improve itself due to experiencing the shock.

for risk and portfolio management, resilient portfolio theory (RPT). We are discovering that RPT improves many deficiencies of modern risk analytics and can better serve the needs of truly long-term investors. We look forward to sharing a complete treatment of RPT with readers in the very near future.

9. Compass questions

1. With respect to your own organization's network: what are the best sources of (actionable) information on tech disruption (TD)? How adequate are these sources, and how easy would it be to cultivate others like them?
2. What types of TD do you feel are most consequential for your portfolio? Do you think that most people in your organization are well informed about these types of TD?
3. How often do you discuss TD-related issues with your external asset managers? Do these topics regularly surface when conducting due diligence on new managers?

References

Barker, A., A. Monk, and D. Rook [2023] "Technological Disruption and Long-Term Investors: Managing Risk and Opportunities," pre-publication.

Clark, G. [1998] "Stylized Facts and Close Dialogue: Methodology in Economic Geography," *Annals of the Association of American Geographers*, 88(1):73-87.

Clark, G., and R. Urwin [2008] "Best-Practice Pension Fund Governance," *Journal of Asset Management*, 9(1):2-21.

Davies, P. [2001] "Spies as Informants: Triangulation and the Interpretation of Elite Interview Data in the Study of Intelligence and Security Services," *Politics*, 21(1):73-80.

Monk, A., M. Prins, and D. Rook [2019] "Rethinking Alternative Data in Institutional Investment," *Journal of Financial Data Science*, 1(1):14-31.

Monk, A., and D. Rook [2023] "Resilient Portfolio Theory," pre-publication.

Rook, D., S-Y. In, and A. Monk [2021] "The Resilience Manifesto: Integrating ESG and Risk Management, in Investment Portfolios and Organizations," *Social Science Research Network*, available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3942909.

Rook, D., A. Salvatori, J. van Moyland, and P. Rosa [2017] "Innovation Patterns: Upgrading Sectoral Classification for the Fourth Industrial Revolution," *Social Science Research Network*, available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2928335.

Strauss, A., and J. Corbin [1998] *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*, Sage.

Authors

Dane Rook, Head of Research (dane.rook@addepar.com)
Ashby Monk, Strategic Advisor (ashby.monk@addepar.com)
Alistair Barker, Head of Asset Allocation, AustralianSuper (abarker@australiansuper.com)

Notice and Disclaimers

All information provided by Addepar, Inc. or its subsidiaries (collectively, "Addepar"), including without limitation, all text, data, graphs and charts (collectively, the "Information") is the property of Addepar and is provided for informational purposes only. The Information may not be modified, reverse-engineered, reproduced or re-disseminated in whole or in part without prior written permission from Addepar. All rights in the Information are reserved by Addepar.

The Information may not be used to create derivative works or to verify or correct other data or information without prior written permission from Addepar. 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 Addepar 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.

Addepar makes no express or implied warranties or representations with respect to the information (or the results to be obtained, but rather the use thereof), and to the maximum extent permitted by applicable law, Addepar 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.

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 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.

Addepar does not recommend, endorse, approve or otherwise express any opinion regarding any issuer, securities, financial products or instruments or trading strategies and Addepar's research products or services are not intended to constitute investment advice or a recommendation to make (or refrain from making) any kind of investment decision and may not be relied on as such.

Addepar, Investment Sentiment Index and other Addepar brands and product names are the trademarks, service marks or registered marks of Addepar or its subsidiaries in the United States and other jurisdictions.