

**RISE OF THE MACHINES**

FUTURE OF ASSET MANAGEMENT

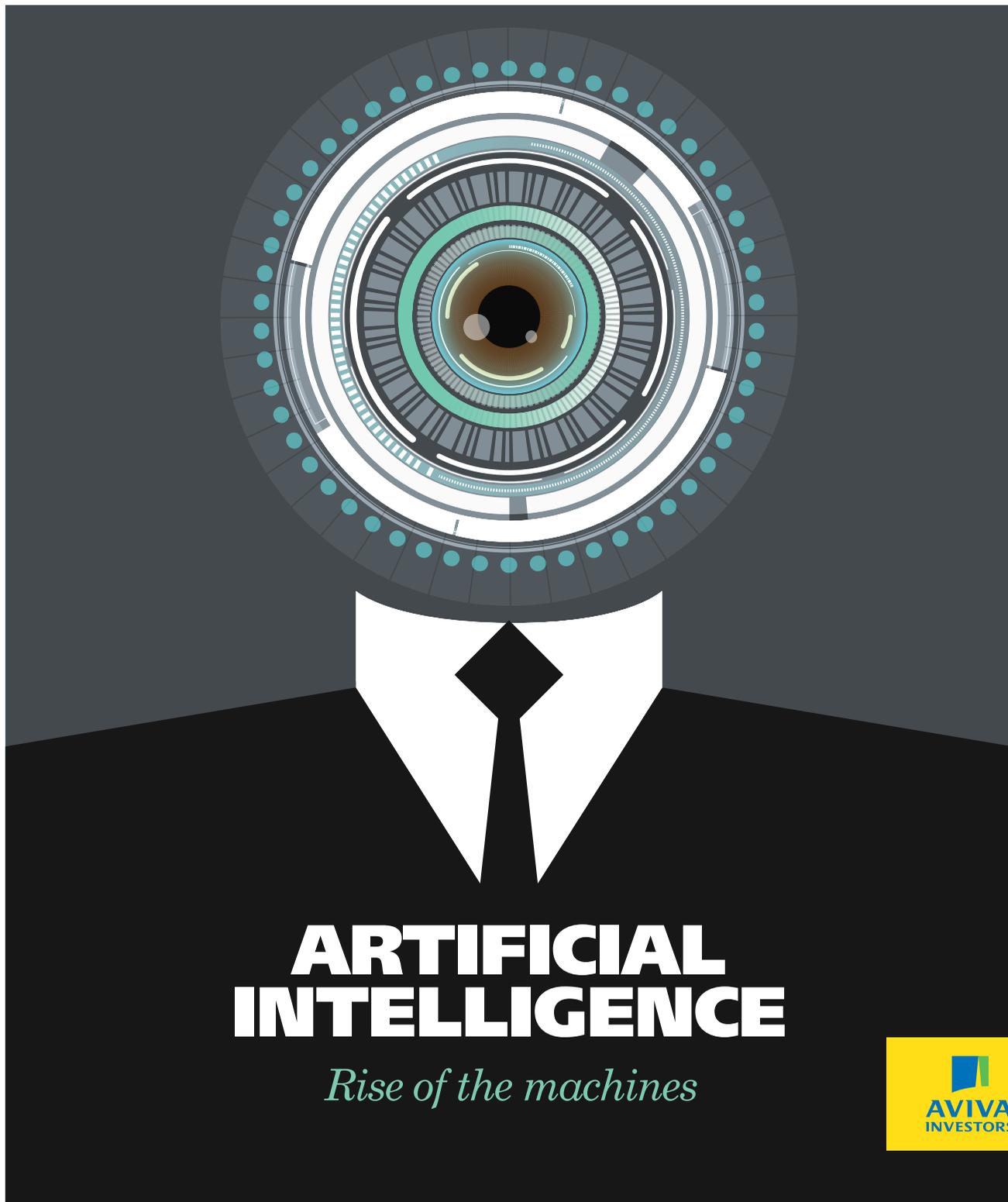
RETURN OF FUNDAMENTALS

BIG DATA

EQUITIES: TAKING THE LONG VIEW

# AIQ

ISSUE 003



# ARTIFICIAL INTELLIGENCE

*Rise of the machines*



# Man versus machine?

The future arrived in the Davies household on Christmas Day, 1982. As my brothers and I fought to tear off the wrapping of a brand new Commodore 64 home computer, I can remember my father's words: "This will change your lives boys".

*He had clearly watched too much 'Tomorrow's World'<sup>1</sup>. While it provided plenty of entertainment over the next few years, the C64 was too limited in what it could do and too slow to be anything other than an expensive toy.*

*Fast forward to today, and it is staggering to consider how far technology has progressed. From smartphones to driverless cars, technology is central to people's everyday lives. Our cover story focuses on one revolutionary area of change – artificial intelligence (AI) – which, depending on your perspective, will transform humankind for the better or lead to a dystopian future where machines control the planet.*

*Some scientists, including Stephen Hawking, argue that the doomsday scenario is not inconceivable. In 2014, Hawking warned: "The development of full artificial intelligence could spell the end of the human race"<sup>2</sup>.*

*If that seems far-fetched, AI is at the very least causing disruption in many industries, which will have investment implications for years to come.*

*Technology features prominently elsewhere in this issue, as we take an in-depth look at other drivers of the so-called fourth industrial revolution, including Big Data and 3D printing. We also consider how easy it will be for financial markets to wean themselves off central bank support, and the future of asset management.*

*We welcome your feedback, so please send any comments to me at the email address below.*

*I hope you enjoy the issue ●*

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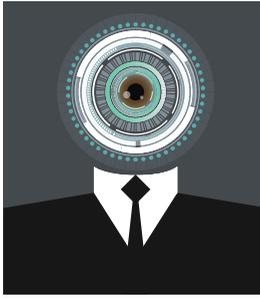
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<sup>1</sup> Tomorrow's World was a BBC television series on developments in science and technology.

<sup>2</sup> <http://www.bbc.co.uk/news/technology-30290540>



COVER STORY

ARTIFICIAL INTELLIGENCE: RISE OF THE MACHINES

20

The growth of machine learning is transforming the economic landscape. Who will be the winners and losers?

OPINION

4 BEATING THE BENCHMARK BLUES  
A real estate strategy based on mimicking indices will not reap rewards, argues Chris Urwin.



VOLATILITY

16 ALL ABOARD THE BIG DIPPER  
Bond volatility has fallen to historic lows, but changes in market structure could reverse this trend.



EQUITIES

5 TAKING THE LONG VIEW  
Accurately assessing companies' long-term prospects is essential, but far from straightforward, says Giles Parkinson.

5



BIG DATA

27 BYTE SIZE  
Will fears over security and privacy limit the Big Data revolution?

27



ECONOMICS

8 THE PRODUCTIVITY PROBLEM  
Developed economies are struggling with low productivity. Is there a solution?



3D PRINTING

31 GO FOURTH AND MULTIPLY  
3D printing is no longer a novelty, but success will not happen overnight.

12

MACRO STRATEGY

THE 14 TRILLION DOLLAR QUESTION

Ahmed Behdenna and James McAlevey consider whether financial markets can be weaned off central bank life support.



35

ASSET MANAGEMENT

FIT FOR THE FUTURE

Asset managers need focus to adapt to a rapidly changing environment.

# REAL ESTATE: BEATING THE BENCHMARK BLUES



**CHRIS URWIN**  
Global Research  
Manager Real Estate

## As we move into a challenging period for real estate, an investment strategy based on mimicking benchmarks will no longer reap reward, argues Chris Urwin.

Historically, many institutional investors have managed commercial real estate (CRE) portfolios with a significant reference to industry benchmarks. In the UK, for example, the Institutional Property Forum (IPF)<sup>1</sup> estimates that about 85 per cent of institutional investors by value deploy strategies that explicitly reference a CRE index as a benchmark.

There are, however, a number of difficulties with the development and application of CRE benchmarks investors should keep in mind. These reflect the characteristics of the asset class and its less-efficient nature relative to stocks and bonds.

CRE indices are typically structured on a sector and geographical basis. These are not, however, the only characteristics that drive performance. Other important contributors include property-specific factors such as age, quality and size; tenure-related factors such as covenant strength, unexpired term and whether it is single or multi-let; and geographical factors such as micro-location.

Academic evidence consistently finds that the sector or regional breakdown is of limited use in explaining relative performance. Devaney & Lizieri,<sup>2</sup> in surveying existing literature and in their own original research, found "sector-region groupings have some validity but do not characterize the variability of returns over time".

These findings reflect the heterogeneous nature of commercial properties, the fact each property's performance will be driven by a wide range of factors and the difficulty of aggregating such assets.

## Benchmark bias

In contrast to equity and bond indices, where performance can be measured from actual transaction prices, most CRE indices are derived from property valuations.

Valuations are subjective, with valuers relying on their judgment of evidence from recent sales of comparable properties. This can introduce error and means a property's value may not accurately reflect the price it would achieve if sold. Inaccuracies may mean a valuation-based index is not a precise estimate of the underlying market-clearing price.

The most prominent bias is valuation smoothing. Valuations are performed infrequently and rely on historic comparables for information. Indices based on these will exhibit serial correlation as the values used in composing a previous value of the index will also be used in determining the current value. This smoothing is particularly an issue when markets move quickly.

A key difference between real estate and more liquid asset classes is frequency of trading. As a result of infrequent trading, the make-up of a CRE index reflects the outcome of investment decisions made over a number of years. The index is slow to reflect how demand for different types of real estate is changing. Instead, it reflects what the market has invested in over, say, the last five to 10 years.

## Implications for portfolio construction

These issues have practical implications for investment strategies and portfolio construction. An investor who pays too much heed to a CRE benchmark in an effort to track or not deviate too far from 'the market' runs three key risks.

### Buying randomly

As the market coverage of any CRE index is incomplete, the sector/geography breakdown of the index is to a degree random. Other index factors, such as asset quality, will also not reflect the overall market. Academic evidence suggests the typical index breakdown by sector and geography falls a long way short of explaining investment performance.

### Buying high

A desire to retain exposure in line with the

benchmark can result in investors buying into markets as they get more expensive. For example, rising shopping centre values may result in the sector representing a bigger share of the benchmark. This may encourage investors to buy more shopping centres to prevent their relative exposure to the sector diminishing. Such an approach can result in investors buying high and selling low.

### Lagging the market

Valuation smoothing and infrequent trading mean valuation-based CRE indices provide a lagging view of market participants' preferences. Whereas in more liquid asset classes, index allocations are the outcome of the market's collective wisdom of which sectors are currently appropriate to invest in, this is less true of real estate. Instead, the benchmark reflects investors' decisions over a number of years. The index is slow to reflect how the underlying demand for different types of real estate is changing.

## The courage of your convictions

Instead of slavishly following a lagging index, investors should aim to construct concentrated portfolios of well-understood assets that allow their expertise to add value. Investors must take a forward-looking view of how the demand for retail, office and industrial space is changing. The evidence suggests fund managers whose portfolios look least like the benchmark index create most value.<sup>3</sup>

As a corollary of this, investors are increasingly willing to view a portfolio's deviation from its benchmark as an opportunity for outperformance rather than just a risk. For these reasons, the importance of benchmark indices is likely to diminish over time ●

1 'UK Institutional Investors: Property Allocations, Influences and Strategies', July 2010.

2 'Individual Assets, Market Structure and the Drivers of Returns', Steven Devaney & Colin Lizieri, June 2005.

3 'How Active is Your Real Estate Fund Manager?', Cremers & Lizieri, December 2013.

# EQUITIES: TAKING THE LONG VIEW

The stock market is frequently, sometimes justifiably, seen as the epitome of short-termism. However, there are plenty of instances where the opposite is true, although accurately assessing companies' long-term prospects is far from straightforward, argues Giles Parkinson.

A frenzy of rapacious mergers and acquisitions, skewed management incentives, cynical share repurchases, and high-frequency trading have given the stock market a bad name in recent times.

Addressing concerns that a culture of short-termism in the stock market can adversely impact corporate behaviour has been high on policymakers' agenda for some time. In 2012, a UK government-backed review of equity markets and long-term corporate decision-making found instances of investment myopia among both fund managers and company boards. The report's author, London School of Economics professor John Kay, warned the culture of short-termism was hurting Britain's economy.<sup>1</sup> His report came just four years after the financial crisis, which is widely believed to have stemmed in part from the excessive focus investment banks and others placed on short-term measures of success.

However, in reality the situation is somewhat different. While there may be plenty of cases of short-termist behaviour, the market also frequently takes an appropriately long-term view. After all, US consumer goods giant Kraft Heinz ultimately failed in its attempt to buy Anglo-Dutch rival Unilever earlier this year, partly because of the latter's ability to convince investors that its sustainable business model would reap even bigger rewards over the long term.

That is not to say companies' long-term outlook is always accurately reflected in their share price. There are plenty of instances where prospects are underappreciated – and for that matter overestimated too. One of the hardest challenges for an equity investor, and yet arguably the most important, is to assess whether or not the long term prospects of a company are being accurately valued.

## The theory

The mantra of most financial textbooks is that the price of any asset should be equal to 'the present value of the sum of the future cash flows it is expected to generate'. What does this mean in practice? If you were offered £100 today or £100 next year, which would you take? Clearly, cash today is better than a promise of the same amount in the future. But what if the offer were £105 in a year's time? Or £110? There becomes a point at which it becomes preferable to defer receipt.

Consciously or not, you are making a calculation about how likely you are to be paid (risk), what else you could do with the money (opportunity cost), and what the money will buy in the future (inflation). These factors go into the 'discount rate', which penalises cash flows more heavily the further into the future they are expected to be received. What is true

TAKING THE LONG VIEW

*continued*

for your wallet is also true for shares, which represent a proportional claim on the future profit stream of a business. The only difference with equities is that the payments are not contractual. You are probably being offered £110 next year. But you might receive more, or less, or even nothing at all.

In order to gauge a 'correct' price for an investment, financial analysts predict the future cash flows likely to accrue from it, discount them at an appropriate rate of interest and sum them up, to arrive at a 'present value'. The key inputs into this discounted-cash-flow analysis are: this year's payment; how fast it is expected to grow and the discount rate. Table 1 shows a simple example of how a company would be valued, using an explicit forecast period of years one through four. Beyond this horizon we assume a terminal value – effectively discounted cash flows of a certain value received in perpetuity.

In the example above, the present value of all these future cash flows amounts to £1,375 at a 10 per cent discount rate.

But what if another company earning the same revenues at the present moment in time opted to reinvest a greater proportion of its profits back into its business to grow those revenues faster? As table 2 shows, it could sacrifice 45 per cent of its current profits – equivalent to earning an 11 per cent margin compared to its short-term focused counterpart's 20 per cent margin – and still be worth the same if that extra investment enabled revenue growth to accelerate to five per cent from two per cent.

Companies essentially face a choice. Either they attempt to maximise margin and cash flow in the near term but suffer lower growth as a consequence, or they take a 'long-term' view, accepting lower

FIGURE 1	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	PERPETUITY
Revenues	£500	£510	£520	£531	£541	
Margin	20%	20%	20%	20%	20%	
Cash flow @ 2% growth	£100	£102	£104	£106	£108	£1,380
Present value @ 10% discount rate	£100	£93	£86	£80	£74	£943
<b>Sum of present values</b>	<b>£1,375</b>					

FIGURE 2	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	PERPETUITY
Revenues	£500	£525	£551	£579	£608	
Margin	11%	11%	11%	11%	11%	
Cash flow @ 5% growth	£54	£56	£59	£62	£65	£1,373
Present value @ 10% discount rate	£54	£51	£49	£47	£45	£1,130
<b>Sum of present values</b>	<b>£1,375</b>					

margins so as to continually reinvest in their business in an effort to achieve higher growth.

The stock market will price the shares of the 'short-term' company on a price/earnings (P/E) ratio of 13.75 – £1,375 divided by current profits of £100. By contrast, the second company's shares will trade on a P/E of 25.5 – £1,375 divided by £54. While at first glance the latter company's shares may look relatively expensive, the higher multiple is justified by the superior growth outlook.

**Sacrificing profits today for growth tomorrow**

Amazon, Costco and Lindt are three examples of companies that sacrifice margins and profits today in return for higher future growth, and where this is appreciated by the market.

Amazon's underlying profitability is obscure, but ever since the internet company's creation, founder Jeff Bezos has exalted the long-term. "When forced to choose between optimizing the appearance of our GAAP accounting and maximizing the present value of future cash flows, we'll take the cash flows," he wrote in 1997 in his inaugural letter to shareholders.

The company's margins are negligible, yet its approach enabled Amazon to take one in every two dollars of the entire growth in US online sales last year. The shares' P/E ratio is 117. In contrast, the S&P 500 index trades on a P/E of 26.

US discount retailer Costco steadfastly earns wafer-thin margins on most of its merchandise, regardless of how much bargaining power over suppliers or scale efficiencies it can extract. The company makes the vast majority of its meagre 3.1 per cent margin from shopper-subscription fees, which have only been raised 10 per cent in the last decade, far below the rate of general inflation. The company's stock trades on a P/E ratio of 30, compared with rival Wal-Mart's 16.

Swiss confectioner Lindt last year reported a 14 per cent margin as it continued to patiently invest in overseas markets outside its European heartland, which may not bear fruit for a decade or more. The company reported organic revenue growth of six per cent in 2016. In contrast, US rival Hershey delivered a 20 per cent margin, yet organic growth was less than one per cent. With Lindt shares trading on a P/E ratio of 35 compared to Hershey on 23, the latter's loss-making international division is coming under increased scrutiny from investors and an incoming chief executive.

The point here is that not only do the likes of Amazon, Costco and Lindt consciously

“

*What matters in the long run is a company's actual underlying business performance and not the investing public's fickle opinion*

”

hold back their margins by choosing to continually reinvest for better growth, but it is their longstanding corporate policy to do so. Investors have come to expect this. In a sense, companies get the shareholders they deserve, and vice versa.

### **Be wary, growth may disappoint**

Of course, there is nothing to prevent a company hitherto earning a low margin from unveiling a new strategy aimed at boosting it. As it starts to make progress towards its goal, its earnings rise, the P/E multiple expands as the market starts to price in faster growth, and the shares may start to attract a new following.

However, the long-term orientated investor needs to be wary. It is important to determine whether or not these higher profits are likely to come at the expense of future growth.

The father of value investing Benjamin Graham once said in the short run the market is like a voting machine – tallying up which firms are popular and unpopular. But in the long run, it is like a weighing machine – assessing the substance of a company. In other words, what matters in the long run is a company's actual underlying business performance and not the investing public's fickle opinion about its prospects in the short run.

Arguably, US-focused food producers General Mills, Kellogg's and Campbell Soup have all gone down this cul-de-sac in recent years and are in the process of being reappraised negatively by the stock market.

For instance, in mid-2016 General Mills unveiled a target to grow its operating margin to 20 per cent by 2018. The share's P/E multiple promptly expanded to 23, having been 19 the year before. Since then, however, cumulative sales have contracted by seven per cent on an organic basis and analysts are now openly questioning the margin goal. Both the share price and P/E multiple are now below where they were ahead of the announcement.

### **The market doesn't always get it right**

While it may be true that in many instances a company's long-term prospects will be accurately recognised by the market, there are cases when that is not the case. That is hardly surprising in a world where such a rapid pace of technological advance can ruin a company's business model almost overnight. Eastman Kodak, Nokia and Blockbuster Entertainment are just three high-profile examples of companies whose long-term growth prospects were pretty much wiped out at a stroke. The implication for investors is that it generally pays to be cautious when evaluating the growth prospects of companies vulnerable to the impact of technological change.

There are other occasions when the market can underappreciate a company's long-term growth prospects if they are obscured by short-term factors. Take the case of British confectionary group Cadbury Schweppes. In the mid-1990s it attempted to open up the Chinese market to Western chocolate, beginning with a pilot study in Hong Kong, Beijing and Shanghai.

Building a presence in a new market from scratch is fearsomely expensive. It entails creating demand person-by-person through advertising and in-store promotion, supported by the high fixed costs of distribution infrastructure. While the company made mistakes and had problems sourcing sufficient fresh milk supplies, the trials showed sufficient promise that they were expanded to the top 200 cities. But at this point, the costs started to escalate, causing material losses. Cadbury was creating cohorts of loyal consumers with high lifetime value at the expense of accounting appearances. Yet the company's management failed to convince investors of the ongoing value-creation in the project and the stock languished on a lowly P/E multiple.

The low margins and stock price attracted the attention of an activist investor, Nelson Peltz. Under increasing pressure from Peltz and other shareholders, the company

curtailed its Chinese ambitions. While that helped boost reported profits it arguably destroyed shareholder wealth. The rest of the story is corporate history: the Schweppes drinks business was spun off as Dr Pepper Snapple and Cadbury was then bought by Kraft.

### **Communication skills**

The fact that companies such as Amazon, Costco and Lindt, with a prominent commitment to investing for growth, are rewarded with high price/earnings multiples by the stock market is testament to the fact that long-termism is alive and kicking. However, management must also play a part in communicating the extent to which their company's reported numbers diverge from true economic value.

Heineken, Unilever and Nestlé are examples of companies with a corporate philosophy that extols the virtues of planning decades ahead, but which have not seen the benefit reflected in their share prices. Each has margins that are generally below those of their peers and report average-to-better revenue growth rates, yet there is no corresponding premium in the P/E multiples of their stock.

In all three cases, the companies' management could and should do a better job of explaining whether margins are being held back by competition or a decision to invest for growth. If it is the latter, they need to explain why it will result in superior growth. The response to activist investors should not necessarily be short-term goals and restructuring. By laying out a clear long-term strategy there is every chance they will be rewarded by the stock market ●

**Giles Parkinson is a Global Equities Fund Manager at Aviva Investors.**

1 <https://www.gov.uk/government/consultations/the-kay-review-of-uk-equity-markets-and-long-term-decision-making>



# THE PRODUCTIVITY PROBLEM

**Developed economies are struggling with low productivity – and the UK is faring worse than most. So what is at the root of the productivity problem? And is there a solution?**

“Streets and courts dart in all directions, until they are lost in the unwholesome vapour which hangs over the house-tops and renders the dirty perspective uncertain and confined; and lounging at every corner...are groups of people whose appearance and dwellings would fill any mind but a Londoner’s with regular astonishment.”<sup>1</sup>

This was the British capital as described by Charles Dickens in the mid-19th century: a city stained by pollution and urban squalor. London still has its fair share of poverty in 2017. But general living standards have improved almost beyond recognition since Dickens’s time.

This progress is in large part down to an economic phenomenon: productivity growth. In his speech at the London School of Economics (LSE) in March, Andrew Haldane, chief economist at the Bank of England, observed that the British standard of living, as measured by GDP per head, has risen 20-fold since 1850. If productivity had remained stagnant over that period, living standards would still be stuck at late-Victorian levels.<sup>2</sup>

“Productivity is not everything, but in the long run it is almost everything,” as Paul Krugman put it. But while economists agree that productivity is vital for economic growth and prosperity, they often struggle to understand its precise determinants. And this is a problem, because productivity growth is slowing across the developed world, with the UK performing particularly badly.

“There was a huge collapse in productivity growth after the financial crisis,” says Stewart Robertson, Senior Economist for

the UK and Europe at Aviva Investors.

“A sharp recovery was anticipated, but while productivity has started to improve, it has not returned to its pre-crisis rate of change. There are lots of questions as to why this is happening – and, as is often the case in economics, lots of competing answers.”

## Productivity slowdown

The financial crisis appears to have exacerbated a productivity slowdown that started 20 years ago. According to the Organisation for Economic Cooperation and Development (OECD), a club of mostly rich countries, a decline in productivity growth is to blame for a fall in output of one percentage point per annum among its members since the late 1990s.

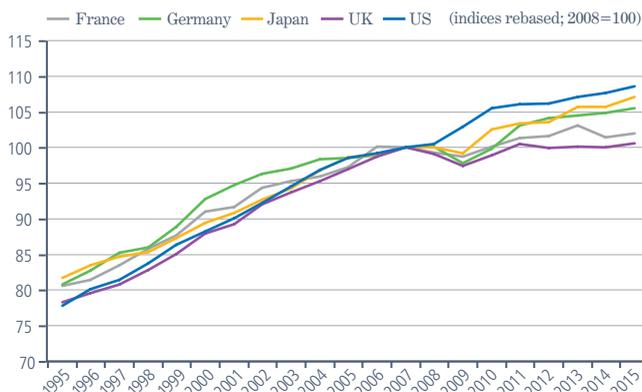
“You can decompose productivity growth into two factors – capital intensity and the efficiency with which capital and labour are combined in the production process, which is usually associated with technological progress – and both have contributed to the productivity slowdown,” says Rafal Kierzenkowski, head of the UK desk at the OECD in Paris. “The problem is widespread.”

To an extent, the slowdown in productivity growth among advanced economies comes as no surprise. As economies mature, they typically shift from manufacturing to services industries: in the UK, for example, the employment share taken by manufacturing fell from 17 per cent to seven per cent between 1990 and 2017.<sup>3</sup>

This transition has implications for productivity. It is relatively straightforward to increase the output of a factory – all you need to do is invest in better equipment to

“*The financial crisis appears to have exacerbated a productivity slowdown that started 20 years ago*”

**Figure 1: Output per hour, international comparison**



Source: Office for National Statistics, 2015

speed up the production line – but more difficult to raise the output of an insurance company without hiring more employees. This is one reason why developing economies tend to grow at a faster clip than their developed counterparts.

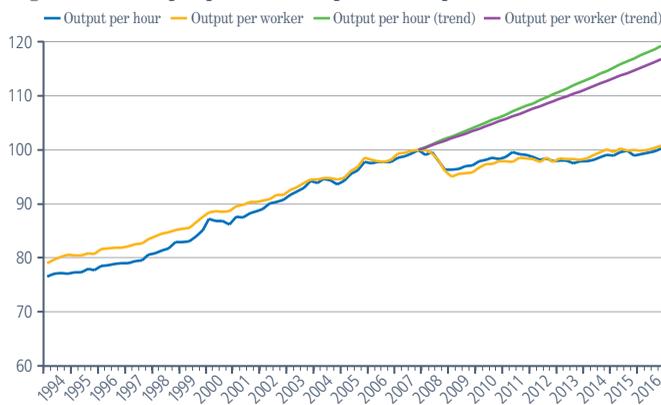
“If you look at the UK and Europe in the 1950 and ‘60s, trend growth ran at five to six per cent partly because you had higher productivity, driven by what Harold Wilson called the ‘white heat’ of technology,” says Robertson. “Productivity growth, coupled with a growing labour force, will tend to push trend GDP growth higher; you see that effect at work in developing economies like India and China today.”

As countries become more prosperous, their citizens tend to live longer and have fewer children; an older work force is inevitably less productive. Ageing demographics and slowing productivity growth can impose a drag on overall GDP growth, especially when these supply-side factors are combined with sluggish demand, a problem many advanced economies are grappling with.

The more optimistic economists hold that improved education and training, coupled with technological breakthroughs such as artificial intelligence, big data and the internet of things, could usher in a new wave of innovation in services industries, boosting productivity growth and lifting developed economies out of their slump. Are they right?

The answer to this question will be of relevance to everyone – not least investors in the financial markets. “If you look at the dividend discount model of equity

**Figure 2: UK output per hour compared with pre-crisis trend**



Source: Office for National Statistics, 2017

valuation, the return you receive is the dividend yield plus the rate of growth over time,” says Robertson. “If the rate of growth is linked to nominal GDP, that’s going to be lower in an environment of sluggish productivity growth.”

Beyond the indirect economic impact on the direction of markets, corporate productivity gains can have a major influence on stock portfolios. Research by PricewaterhouseCoopers shows that a five per cent increase in productivity leads on average to an 11.9 per cent appreciation in a company’s stock price: this effect holds across all sectors and at any point in the business cycle.<sup>3</sup>

Productivity is an important metric for debt investors, too. “We’d much rather lend to

a company that is planning to invest in its business to boost productivity than to a company that wants to raise capital for share buybacks, for example,” says James Vokins, Senior Portfolio Manager, Multi-Strategy Fixed Income at Aviva Investors. “Productivity growth will contribute to improvements in a company’s creditworthiness over the long-term.”

### March of the zombies

The UK provides an interesting case study for the issues surrounding productivity growth, as Britain has severely underperformed despite favourable demographic trends compared with its European neighbours (see figure 1).

## THE PRODUCTIVITY PROBLEM

*continued*

UK output per hour growth stood at 0.4 per cent during the last three months of 2016, higher than in the previous quarter but still far below the pre-crisis average, according to the Office for National Statistics (ONS). Indeed, if productivity growth had continued at its 2007 rate, UK productivity would be 19 per cent higher than it is now and living standards appreciably more comfortable.

Not surprisingly, output in the financial services sector, a key driver of the UK economy, was disproportionately affected by the events of 2008-'09. Data from the ONS published in 2017 shows that banking, which comprises 4.4 per cent of the UK economy, accounts for a fifth of the slowdown in overall productivity growth. Since 2008, productivity in the banking sector has increased by one per cent a year compared with an average of 6.4 per cent each year in the decade before the crisis.<sup>4</sup>

The effects on the banking sector may have contributed to the productivity slowdown in the wider economy by making it harder for companies to gain access to bank funding, with a knock-on impact on corporate investment. Academic research suggests that in the wake of the crisis, low wages meant companies found it cheaper to hire new workers than to invest in new technology.<sup>5</sup>

"Access to credit is the lubricant for growth," says Robertson. "When credit dried up after the crisis, you effectively had idle capital that wasn't being directed towards productive areas of the economy. But this doesn't fully explain the UK's slow recovery from the crisis, because firms have had access to affordable financing for some time now, thanks to quantitative easing, and that doesn't seem to have addressed the problem."

In his speech at the LSE, Haldane conceded that accommodative monetary policy in the wake of the crisis may have enabled the survival of low-performing 'zombie' companies that would have been killed off in a more competitive environment.

Such firms have crowded out their more-productive peers and imposed a drag on aggregate output. But while tighter monetary policy might have raised productivity levels by one to two per cent since 2008, this would have come at the cost of about 1.5 million jobs, which would have amounted to a Pyrrhic victory.

Some sectors of the economy are performing better than others. For example, UK car production hit 1.7 million vehicles in 2016, a 17-year high.<sup>6</sup> Research from the Society of Motor Manufacturers and Traders attributes this strong output growth to increased investment in production and design facilities in recent years. Jaguar Land Rover, for example, made 544,401 cars in 2016, more than 50,000 more than in 2015.

"Car makers are still borrowing to invest and we are seeing strong productivity growth across the car industry as a result," says Chris Higham, Head of Credit Multi-Strategy Fixed Income at Aviva Investors. "But companies in other sectors have been reluctant to follow their lead, despite the low cost of borrowing."

### The long tail

The OECD cites low corporate investment as one of the reasons why British firms are lagging behind their European counterparts. This lack of corporate investment is mirrored in a lack of government investment in transport infrastructure and soft skills, which is also contributing to the UK's low levels of productivity growth.

In his Budget statement in March, UK chancellor Philip Hammond promised new initiatives designed to tackle these issues, including funding for PhDs in science, technology, engineering and mathematics (STEM) subjects and £690 million for local authorities to smooth urban congestion. Such measures may help the UK catch up with its more productive peers on the continent.

But there is another – potentially more insidious – cause of slowing productivity growth: a widening chasm between the 'frontier firms', defined by the OECD as those in the top five per cent by productivity performance, and a 'long tail' of less productive companies.

"Our analysis shows that other advanced economies spend more on research and development, which makes them more efficient and productive [than the UK]," says Peter Gal, economist at the OECD in Paris. "Further, recent studies show important differences in the management practices across businesses within the UK. Over time, the UK has also invested less in infrastructure, such as roads and railways, than its European neighbours, and there is scope to bolster 'soft' infrastructure such as education and skills.

"Overall, this might explain why some firms – the 'frontier' – have very high productivity while other businesses are lagging behind, further contributing to the weaker aggregate productivity performance of the UK," Gal adds.

Productivity among the best-performing firms remains as strong as ever: the top one per cent of British companies have recorded average productivity growth of about six per cent a year since the crisis.<sup>7</sup> The problem is the most innovative firms are increasingly putting clear blue water between themselves and their competitors.

But while the disparity between frontier firms and laggards is particularly acute in the UK, many other countries across the developed world are experiencing the same phenomenon. The issue is known as a lack of 'productivity diffusion', and it is mystifying economists.

Greater movement of people, capital and ideas over recent decades should have led to a greater diffusion of innovative technology and therefore higher productivity, but this does not appear to have been the case. "At the very time we would have expected it to be firing on all cylinders, the technological diffusion engine globally has been misfiring," as Haldane put it.



## Ageing demographics and slowing productivity growth can impose a drag on overall GDP growth



Intriguingly, the nature of emerging digital technologies could be to blame. According to the OECD economists, we may be yet to derive the full benefits of these technologies because we are still in a “transition phase”. Alternatively, they may be so sophisticated and complex that only the biggest and most productive firms are able to take advantage, resulting in a “winner takes all [dynamic]...it is possible that we are entering a new technological wave where know-how is tacitly held by a few, for example, the early adopters – who are learning – while everyone else is still lagging behind.”<sup>8</sup>

If the latter explanation holds, new technologies such as artificial intelligence, which have been hailed as the saviour of productivity in services industries, may not drastically improve overall productivity growth, as the benefits would accrue to a small cadre of market leaders. “New technologies usually benefit the first movers,” says Higham. “You want to be the first company to develop a self-driving car; if you are fourth or fifth it’s more difficult.”

### Productivity and policy

So how can the problem of productivity diffusion be addressed? Measures to boost market competitiveness may help by providing firms with incentives to adopt the latest technologies and facilitating the reallocation of resources away from the ‘zombies’ towards small, go-getting firms. Relaxed planning laws to enable the creation of industrial clusters can also bring advantages; companies can cut costs by sharing infrastructure and proximity is conducive to knowledge sharing.

In a speech in November 2016, Mario Draghi, president of the European Central Bank, argued that the widening gap between productive and unproductive firms should be a spur to structural reforms in the euro zone: he argued for fewer regulatory barriers to entry and a more streamlined bankruptcy regime. A more competitive market environment also encourages more mergers and acquisitions,

which can improve productivity diffusion and enable laggard firms to catch up with more productive peers.<sup>9</sup>

In fact, European M&A is already increasing: M&A activity across the continent totalled \$215.3 billion in the first quarter, higher than at any comparable period since the financial crisis, and cross-border M&A is also on the rise, which may improve technological diffusion on a global scale.<sup>10</sup>

“The M&A boom this year may reflect a lack of aggregate demand,” says Vokins. “But increased M&A is a positive sign for productivity because it shows companies are trying to become more productive by building their knowhow in particular sectors.”

Haldane at the Bank of England has offered more unusual solutions to the diffusion problem, including the development of a “virtual environment” that would enable companies to simulate changes to their business processes and practices before they stump up the capital. Such platforms are already used by many frontier firms to measure the impact of new technologies on their businesses and providing similar

tools to the laggards could be “a potentially cost-effective way of facilitating diffusion”.<sup>11</sup>

Ultimately, the key to stronger productivity growth is likely to involve a mixture of these various approaches: higher investment in skills and infrastructure, market reforms and measures to promote technological diffusion. But as so often in economics, it will be crucial to keep the human element in mind when addressing the productivity problem, says Robertson.

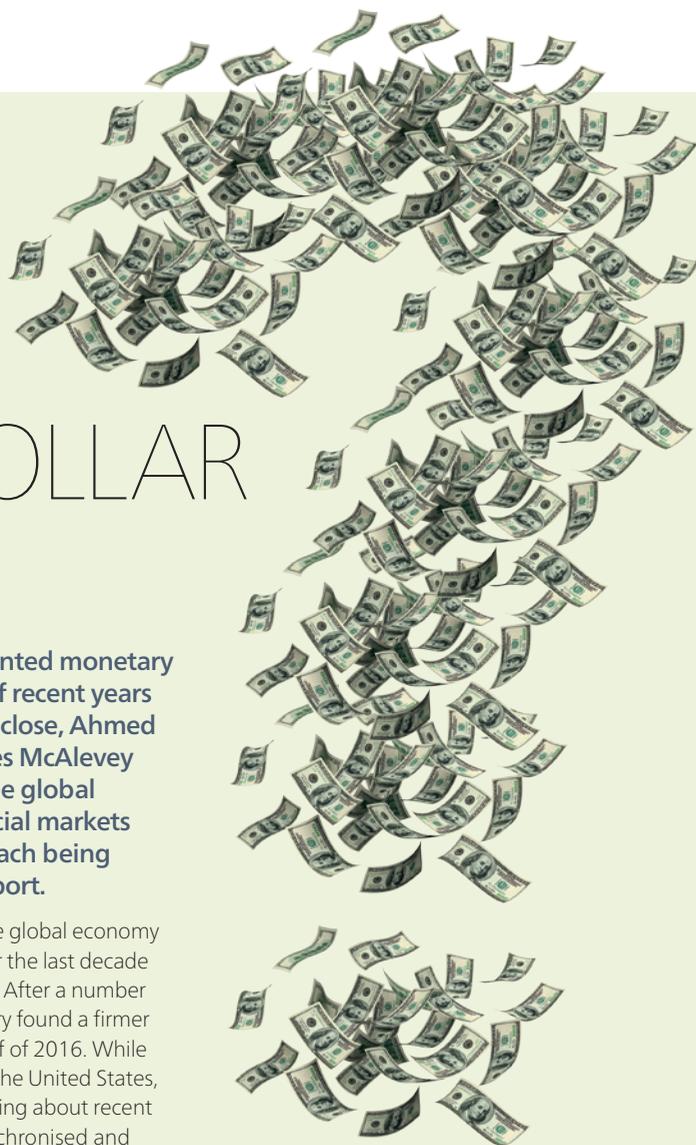
“Improvements in infrastructure and measures to make the business environment more fluid and efficient will bring benefits,” says Robertson. “But productivity in services-led economies is really about people. You need to provide people with the necessary education and training to be able to adapt to new technologies and do their jobs better.

“Then again, you have to remember there will inevitably be limits to human capacity. Back in the early 19th century, it took five people 39 minutes to play Schubert’s Trout Quintet. Today, it still takes five people 39 minutes” ●

1 Sketches by Boz, 1836  
2 ‘Productivity puzzles’, speech given by Andrew G. Haldane, March 2017  
3 ‘Productivity growth: the crucial link between investment and return’, *Financial Times*, June 2013  
4 ‘Bankers join list of five sectors dragging on productivity’, *Financial Times*, March 2017  
5 ‘The great British jobs and productivity mystery’, VoxEU.org, June 2014  
6 ‘17 year high for British car manufacturing as global demand hits record levels’, SMMT, January 2017  
7 ‘Frontier firms, technology diffusion and public policy: micro evidence from OECD countries’, D. Andrews, C. Criscuolo and Peter Gal, OECD, 2015  
8 ‘The best versus the rest: the global productivity slowdown, divergence across firms and the role of public policy: OECD Productivity Working Paper No. 5’, Andrews, Criscuolo and Gal, OECD, 2016  
9 ‘The productivity challenge for Europe’, speech given by Mario Draghi, November 2016  
10 Thomson Reuters  
11 Haldane, ‘Productivity puzzles’



# THE 14 TRILLION DOLLAR QUESTION



**With the unprecedented monetary policy experiment of recent years slowly drawing to a close, Ahmed Behdenna and James McAlevey consider whether the global economy and financial markets will be able to stomach being weaned off life support.**

The deep scars left on the global economy by the financial crisis over the last decade look to be finally healing. After a number of false starts, the recovery found a firmer footing in the second half of 2016. While progress is most clear in the United States, what has been encouraging about recent developments is the synchronised and broad-based nature of the upswing, especially in Europe where activity has been accelerating markedly.

With surveys showing world manufacturing activity expanded at near its strongest rate in over five years in February – gains were seen across developed and emerging countries – the world economy at long last appears able to stand on its own two feet.

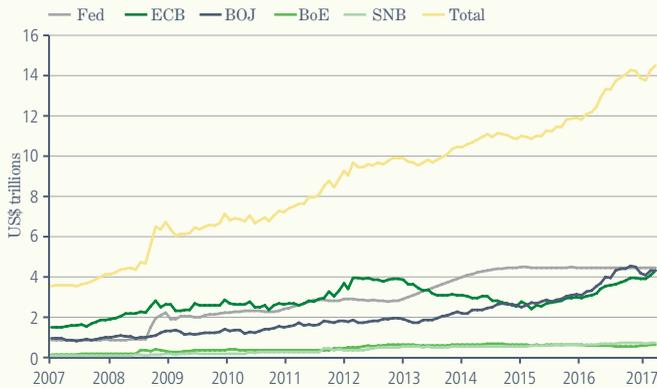
As a result, central banks, which have been omnipresent providers of stability in recent years, are slowly starting to withdraw monetary stimulus, led by the Federal Reserve (Fed). Having virtually met its unemployment and inflation targets, the US central bank has over the past 15 months hiked interest rates by 0.25 percentage points on three occasions. It is widely expected to lift them by another 50 basis points this year. While it is true official interest rates remain firmly anchored at historic lows in most other countries, even here markets have begun to price in hikes further down the line.

Arguably of even more interest than the path interest rates take is what happens to central banks' balance sheets. Since the financial crisis, the size of five of the developed world's leading central banks' balance sheets has ballooned to over \$14 trillion, as can be seen in figure 1.

Although this form of 'money printing' – popularly referred to as quantitative easing (QE) – has not led to the level of inflation forecast by some, many central bankers remain concerned that such bloated balance sheets carry with them long-term risks of inflation and financial market distortions. As a result, in recent months both the Fed and the European Central Bank have begun debating what to do with their balance sheets and it is likely that there will be important new announcements from both these central banks before the end of 2017. Only the Bank of Japan seems likely to continue with policies that will extend its balance sheet markedly further after 2017.

“*Arguably of even more interest than the path interest rates take is what happens to central banks' balance sheets*”

**Figure 1: Central banks' ballooning balance sheets**



Source: Macrobond, Datastream, SNB & Aviva Investors, as at 30/04/2017

Globally, the persistent increase in the scale of QE is likely to come to an end this year, and it is probable that central bank balance sheets will shrink thereafter, assuming the world economy continues to normalise. Against this backdrop, the key questions facing investors are: will the global economy be able to withstand the withdrawal of this liquidity; and what are the implications of this policy shift for different asset classes?

## Unintended consequences

The efforts by central banks in the immediate post-crisis period to prevent debt deflation taking root can be judged a triumph. By slashing interest rates, communicating that they expected to keep rates low for an extended period, and implementing QE, central banks probably helped prevent a repeat of the Great Depression of the 1930s. Keeping real interest rates low played a vital role in enabling heavily-indebted households, corporations and governments to continue servicing their borrowings.

However, buoyed by their apparent success, central banks have in recent years attempted to use QE as a means of sustaining the recovery. In doing so, they arguably went too far since the policy was only really designed as an emergency response to a crisis situation. While recognising that it is impossible to know whether or not the situation might have been even worse without this extra monetary stimulus, it should come as no great surprise this experiment appears to have met with far less success.

While history suggests economies take far

longer to recover from recessions that are preceded by financial crises, the absence of a strong cyclical upswing nearly eight years on from the end of the last US recession is abnormal. It has led a number of economists to hypothesise developed economies are suffering from 'secular stagnation' – a protracted period of extremely weak growth driven by an increased propensity to save and a decreasing propensity to invest. For them, the extraordinary monetary policy measures of the past nine years were always doomed to failure.

We believe this line of reasoning to be wrong. Furthermore, in light of the recent strengthening of activity, we are increasingly confident the global economy will be able to cope with the gradual withdrawal of monetary support, at least in the initial phase of the process. After all, the measures taken in recent years seem to have had many unintended consequences that have limited their impact and in some instances been wholly counterproductive. As such, the removal of this monetary support, far from stifling the recovery, may actually be beneficial should some of these adverse effects begin to reverse.

For example, by fuelling inequality, the monetary policy experiment of recent years has helped to dampen consumption. It has significantly boosted the wealth of the rich by inflating asset prices. At the same time, it has done little for the poorest members of society and in many cases has worked against them by inflating various non-discretionary living costs such as housing – a key item of expenditure. Unfortunately, the rich tend to spend far less of their income on consumption than the poor.

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*The decline in interest rates led to surging demand for all assets capable of generating a reasonable stream of income*

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By slashing the level of income generated by investments, monetary policy has helped to dampen consumption in a second way as people have needed to put more money aside to maintain their anticipated standard of living in retirement. This helps explain why in the US, for example, the savings rate is currently higher than would ordinarily have been expected at this stage of an economic cycle and given the gains in employment and income that have been seen since 2009.

## Financial engineering

Excessively easy policy has arguably created a number of other distortions that have hindered growth. The decline in interest rates led to surging demand for all assets capable of generating a reasonable stream of income. This resulted in one of the largest financial engineering exercises in history, as companies looked to boost shareholder returns by issuing a significant amount of debt and using the proceeds to buy back their own equity or return cash to shareholders in other ways.

Since companies have effectively been incentivised to return cash to shareholders rather than invest for future growth, another unintended consequence has been the low level of capital expenditure seen across most of the developed world in recent years.



## THE 14 TRILLION DOLLAR QUESTION

*continued*

Simultaneously, by artificially suppressing interest rates, monetary policy has worsened the funded status of a large number of pension plans, since it has effectively increased the net present value of schemes' liabilities. That has in turn served to further undermine capital expenditure, with companies forced to divert surplus cash away from investment projects and into their pension schemes.

By lowering interest rates and flattening yield curves, central banks have also had a negative impact on the profitability of banks and other financial institutions such as insurance companies, which tend to benefit from steeper yield curves. By crimping banks' profits, it has arguably restrained bank lending.

So all told, there are plenty of reasons to believe the economic benefits of the monetary policy experiment may have in recent years been outweighed by the costs.

Of course, there are those who argue that with the world economy still relatively fragile and debt-to-GDP ratios so high, it would be unwise in the extreme to reverse monetary easing at anything more than a glacial pace. For some proponents of the

secular stagnation hypothesis and a number of others, the boom in non-financial corporate bond issuance is a primary reason the Fed and others will be unable to tighten policy materially further. They take the view this level of debt will be unsustainable at higher rates of interest.

### Tighter policy need not spell disaster

There are many reasons to believe this line of thought may be flawed. For a start, much of this debt has been issued with long maturities so will not need to be refinanced for a long time. Secondly, to the extent it has been used to buy back stock, companies can simply reverse this process without incurring a loss and potentially even book a significant profit.

Far from hurting economic growth prospects, if the latter stages of monetary easing have indeed been counterproductive, then tighter policy may actually underpin the recovery and reinforce the first genuine economic upswing since the financial crisis. If further support were needed in the event the recovery stalled as policy was tightened,

a more sensible course would be to attempt to stimulate activity via fiscal policy instead.

All of this is not to deny legitimate concerns about the potential impact of tighter monetary policy further ahead. Governments' ability to borrow will be more constrained, especially since funding costs look set to rise. And tighter policy will eventually hinder consumption too if rates begin to rise sharply. But for the next three years or so, so long as central banks do no more than remove some of the excesses that have built up in recent years, we see no reason why economic growth cannot continue to accelerate as all the unintended consequences begin to unwind.

### The 'Great Rotation'

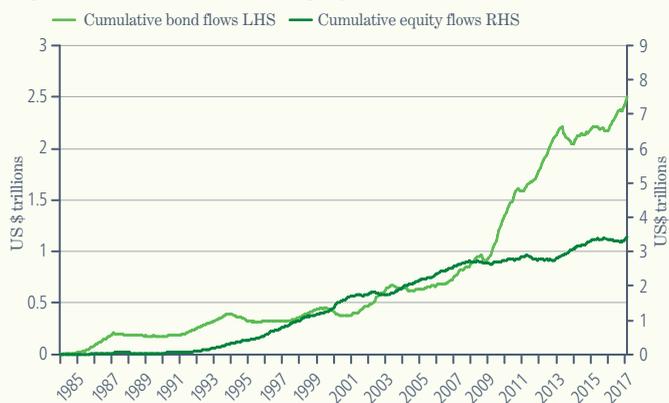
As for what this means for asset prices, it is important to firstly understand what monetary policy has achieved. By slashing interest rates and at the same time buying back government bonds, central banks were ultimately attempting to encourage investors to rebalance their portfolios away from 'risk-free' assets in favour of equities – the so-called Great Rotation.

They never really achieved this goal. Although equities have indeed risen sharply over the past eight years, that has had less to do with investors rebalancing their portfolios towards companies' shares and more to do with the financial engineering employed by the companies themselves.

Investors' reluctance to switch into equities is clearly illustrated by examining retail flows into mutual equity funds. As can be seen from figure 2, they have been weak ever since the financial crisis. No doubt mindful of having suffered two 50 per cent drawdowns over the previous decade, it seems investors have been reluctant to invest in shares for fear of being burned a third time.

Central banks, by purchasing government debt and pushing down interest rates, have

**Figure 2: US retail flows into equity and bond mutual funds**



Source: Deutsche Bank, as at 08/05/2017



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*Investors will have to once again pay much more attention to fundamentals as the impact of central bank stimulus fades*

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encouraged investors to take only so much more risk. For many, it seems the furthest out along the risk spectrum they were prepared to venture was into high-yield bonds. As can be seen in figure 2, flows into mutual bond funds have risen sharply. It appears that whereas investors have been scared of investing in equities, they have been comfortable investing in fixed income; firstly because yields couldn't really move much because of all the central bank buying, and secondly because of the comparatively attractive levels of income on offer.

### **Focusing on fundamentals once again**

Looking forward, investors will have to once again pay much more attention to fundamentals as the impact of central bank stimulus fades. While it remains to be seen how individual central banks handle the process, it seems likely the majority – at least initially – will wish to remove monetary stimulus in a gradual fashion. For instance, rather than selling their stockpiles of debt back into the market, we are likely to see the issues simply being 'run off' their balance sheets – in other words, held until maturity and not replaced.

Nevertheless, we expect government bonds will decline in value since that is the asset class central banks have predominantly bought. Higher term premia and steeper yield curves are to be expected, as economic fundamentals such as rising inflation begin to reassert themselves. Since this is what markets looked like without lots of support, it is reasonable to assume this is how they will begin to look once again in a world without aggressive intervention.

With all investments effectively being priced against a 'risk-free' asset, one would ordinarily expect a rise in government bond yields to trigger a widespread decline in

asset prices. This would be a central argument of the proponents of secular stagnation. However, while rising government bond yields will continue to exert an influence on other asset prices, it is far from clear they will pull them all down in sympathy.

It is true that corporate bonds may find it difficult to avoid the fallout from higher government bond yields, especially if volatility were to pick up in fixed-income markets as QE is withdrawn. That is because higher volatility tends to be accompanied by wider credit spreads. But on the other hand, there are reasons to believe spreads are unlikely to widen significantly and could actually narrow somewhat due to supportive fundamental and technical factors. Supply looks set to shrink as the financial engineering of recent years begins to unwind. Meanwhile, faster economic growth should boost profits, in turn leading to a general strengthening of balance sheets and reduced default rates.

But while it seems certain bonds are going to struggle, equities could do much better than many expect as QE is unwound. It looks as if the 'Great Rotation' may at long last be about to get under way. In a more challenging environment for fixed income generally, equities should suddenly begin to appear relatively attractive to investors. Even though history suggests equities tend to suffer once interest rates rise above four per cent, rates are currently so low that tighter monetary policy appears to present little threat. For the time being at least, the likely improvement in economic fundamentals should outweigh the impact of higher interest rates and leads us to expect a growing number of investors will begin switching out of bonds in favour of equities.

It should also be remembered that savings will continue to provide a continual pool of fresh investment funds. Even though some

of those funds will stay in cash, it seems logical to expect much will begin to find a home in equities. Within equities, we would expect growth and cyclical stocks to outperform income, reversing the trend of recent years.

The global monetary experiment of the last decade is on the verge of unwinding for various reasons. This will have major consequences for investors and financial markets. Whereas in recent years it has been sufficient to focus on liquidity and technical factors, going forward it seems fundamentals will reassert themselves.

The 'risk-on, risk-off' approach that was dominant in the highly-correlated world of recent years is unlikely to prove profitable as the correlation between and within asset classes breaks down, meaning investing is about to get a lot more challenging. Nevertheless, there should still be plenty of profitable opportunities for investors who are able to do their homework, correctly assess fundamental factors, and do not merely rely on the actions of central banks to float all boats simultaneously.

The unconventional approach to monetary policy adopted by major central banks has suppressed volatility across asset classes, resulting in the mispricing of risk and raising the dangers of financial instability. To the extent that a long-overdue normalisation of monetary policy is likely to enable markets to once again price risk accurately, that is to be welcomed, even if it doesn't spell good news for every asset class ●

**Ahmed Behdenna is a Multi-Asset Strategist at Aviva Investors.**

**James McAlevey is a Senior Fixed Income Portfolio Manager at Aviva Investors.**



# BOND VOLATILITY: ALL ABOARD THE BIG DIPPER?

**Since the financial crisis, bond volatility has fallen to historic lows. But changes to the structure of the fixed-income markets suggest volatility could be set for a comeback, creating risks and opportunities for investors.**

The financial crisis of 2008-'09 sent volatility in bond and equity markets soaring to unprecedented levels. But as central banks responded by slashing interest rates and implementing large-scale bond-buying programmes, these market gyrations were quickly brought back under control.

As the markets calmed in the wake of the crisis, bond investors spotted an opportunity to gain extra returns by betting low volatility would persist. 'Selling vol' – essentially the practice of selling insurance against extreme market outcomes – became common.

Other investors loaded up on long-duration bonds, typically more volatile than bonds with shorter maturities, in the expectation markets would remain quiet.

But there is evidence that structural changes in global fixed-income markets, along with potential macroeconomic catalysts, could be about to send volatility higher, creating risks and opportunities for investors in both government and corporate bonds, and derivatives linked to those markets.

"The underlying structure of the fixed-income markets is changing and some of the factors that have kept a lid on volatility in recent years have been removed," says James McAlevey, Senior Portfolio Manager, Fixed Income, at Aviva Investors in London. "We have a deep belief bond volatility is going to return."

Figure 1: Net foreign purchases of US Treasuries, 2005-2017



Source: Macrobond, March 2017

“While some of the variables that have constrained volatility since the financial crisis remain in play, the structure of the fixed-income market is beginning to change”

## Keeping a lid on it

Simply put, bond volatility refers to the degree to which bond prices fluctuate in the secondary market. The most common cause is a rise or fall in interest rates. The duration of a bond is another important factor, because the longer the period before a bond is due, the more sensitive it is to a rise or fall in interest rates.

Volatility plays an important role in pricing, as most bondholders require compensation not just for potential defaults but also mark-to-market risk. However, the relationship between volatility and pricing often goes unacknowledged by non-specialists, according to Jouben Hurren, Credit Portfolio Manager at Aviva Investors.

“Because default rates in investment-grade credit have historically been low, a lot of the premium you get for investing in the asset class derives from mark-to-market risk,” says Hurren. “Take the iTraxx Europe, the main index of credit default swaps. It’s currently trading at a significantly higher level than you would need to compensate investors for the risk of default, based on historical default rates on investment-grade bonds. That premium offers compensation for volatility.”

There are several ways to track bond volatility. The Merrill Lynch Option Volatility Estimate index (MOVE) offers a gauge of expected price swings in US debt by measuring ‘implied volatility’ – a forward looking measure – on one-month Treasury options. The 10-year US Treasury VIX

index (TYVIX), which tracks the volatility of the eponymous securities over a 30-day period, offers a more direct measure of past price swings.

By both of these metrics, volatility has been extremely low since the financial crisis. The MOVE index hit a high of 264 in October 2008 and has since sunk to 57.5, as of May 31. The TYVIX reached 14 per cent at the height of the financial crisis; almost nine years on it is trading at four per cent.<sup>1</sup>

Various factors have contributed to low market volatility. Most importantly, central banks have held interest rates low, removing a common trigger for market movements. Quantitative easing programmes have also ensured strong support for government and investment-grade corporate bonds, exerting downward pressure on yields.

The presence of large numbers of foreign institutional investors in certain sectors of the market was another factor. Taiwanese insurance companies, for example, have in recent years been big buyers of US callable bonds as a means of enhancing returns, dramatically depressing anticipated levels of volatility.

Regulatory changes have also fostered demand for fixed income in the post-crisis period. The Dodd-Frank Wall Street Reform and Consumer Protection Act in the US and Basel III in Europe, along with mandatory central clearing of over-the-counter derivatives, force banks to hold a greater proportion of high-quality liquid securities

on their balance sheets and to post the bonds as collateral on derivatives trades.

## Market shifts

While some of the variables that have constrained volatility since the financial crisis remain in play, the structure of the fixed-income market is beginning to change. McAlevey points to a confluence of factors that could combine to push volatility higher.

Most important is the fact that the Federal Reserve is active again. The US central bank raised the overnight interest rate by 25 basis points on March 15. The US economy is strengthening, with unemployment falling to 4.4 per cent in April 2017, the lowest level since the financial crisis.<sup>2</sup> This provides Janet Yellen with a rationale to raise rates further and two further rate hikes are expected this year.

The fixed-income landscape is changing in other ways. For example, the large, price-insensitive buyers that dominated the market in the post-crisis era have begun to scale back their activity or depart from the market.

“Over a three to four year period, while the Federal Reserve was doing quantitative easing, there were monumental amounts of price-insensitive buyers in the market place,” says McAlevey. “They came in and bought bonds every day and month, they



ALL ABOARD  
THE BIG DIPPER

*continued*

didn't care what the data was; they had cash and they needed to put it to work. That limited the ability of the market to move: when growth picked up or decelerated, the market had nowhere to go."

But the Federal Reserve is no longer engaged in large-scale quantitative easing. In addition, foreign buyers have pulled back (see figure 1). The Chinese government sold almost \$200 billion of US government bonds between January 2016 and January 2017, partly to support the weakening yuan. Japan's holdings, which are mostly owned by private institutions such as banks and pension funds, fell by \$50 billion over the last six months of 2016.<sup>3</sup>

While China and Japan remain major owners of Treasuries – they still hold more than \$1 trillion apiece – domestic players such as US pension funds now own a larger proportion of the market. Because they are more sensitive to price fluctuations than foreign governments, these institutions are more likely to buy and sell their holdings, which may contribute to an uptick in volatility.

Retail investors now also own more of the market than used to be the case, and tend to behave in a more pro-cyclical fashion than larger institutional investors. When sentiment turns, they often sell en masse, amplifying and exaggerating price movements.

**MBS stress**

Liquidity may also be an issue. While regulation has boosted demand for triple-A rated government and corporate bonds, it has also led to a decline in liquidity. Banks have reined in their market-making activities and are now less able to act as shock absorbers during periods of stress. At the same time, changes in market dynamics, such as the rise of electronic trading, have increased the risk of sudden 'spikes' in illiquidity in US Treasury markets, making them potentially more volatile,

according to research from the Federal Reserve Bank of New York.<sup>4</sup>

And the Federal Reserve may further contribute to volatility as it begins to wind down its purchases of mortgage-backed securities (MBS). The central bank started buying these bonds at the height of the crisis in 2008 and has since amassed an MBS portfolio worth \$1.76 trillion as of May 2017.<sup>5</sup> Many of these bonds are likely to re-enter the private markets this year.

MBS as an asset class has what is known in investment jargon as 'negative convexity', which means these bonds are particularly sensitive to changes in interest rates (as the life of mortgage debt tends to get longer as interest rates rise). Investors in these bonds often hedge the attendant risk by buying options against such movements, helping to lift the 'market price' of volatility.

In 2003, so-called 'convexity hedging' was the key driver behind a rise of 1.45 percentage points in benchmark Treasury yields over a two-month period, according to Bloomberg data.<sup>6</sup> "I am not expecting movements of that magnitude, but the roll-off of MBS from the Fed's balance sheet could have significant implications for volatility," says McAlevey.

**Catalysts: lessons from history?**

The factors McAlevey cites will not in themselves be enough to lift fixed-income volatility. But they may remove some of the pressures that have kept volatility low since the financial crisis. This means an economic or political catalyst is more likely to send prices higher or lower, whereas previously the market remained unruffled regardless of the external circumstances.

Politics could be one such catalyst. There is, for example, a risk that President Trump will disappoint investors who are expecting massive fiscal stimulus and tax cuts to deliver economic growth, says Hurren. "You've had a pretty strong rally in terms of

equities and credit since Trump won the election, which means there is a possibility he may surprise the market to the downside. If Trump's plans for the border adjustment tax – the vehicle he's using to make his tax plans revenue-neutral – are blocked, that could spark volatility across fixed-income markets."

The Federal Reserve may also surprise markets by hiking rates more quickly than expected. This is what happened in 1994, when then-Chairman Alan Greenspan presided over a swift tightening in monetary policy. Yields spiked and implied volatility on 10-year US Treasuries rose five percentage points. Volatility also spilled over into overseas bond markets, with implied volatility on French and German government bonds rising 14 and nine percentage points respectively.<sup>7</sup>

Cross-border volatility could also be an issue in 2017 and 2018, as and when the European Central Bank tapers its bond-buying programme. A disorderly tapering process could spook global fixed-income markets in the same way as the so-called 'taper tantrum' of 2013, when the Federal Reserve blindsided the market by announcing it would reduce quantitative easing. The US TVIX hit 8.4 per cent on September 30, 2013, the highest level since the crisis, but quickly levelled out as demand stabilised. Time will tell whether Europe's policymakers have heeded the lesson.

Hurren also points to the Chinese economy as a potential concern. "In 2016, Chinese policymakers focused on moderating the decline in GDP growth, compromising their reform agenda to ensure the country met its target of 6.5-7 per cent. If this approach continues, China may see increased debt and capital outflows, increasing the risk of a sharp deceleration in growth," says Hurren. Global credit spreads widened in January 2016 when Beijing struggled to arrest a slide in its equity markets, demonstrating the influence China can have on markets worldwide.

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*The roll-off of MBS from the Fed's balance sheet could have significant implications for volatility*  
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## Strategies

So how might higher fixed-income volatility manifest itself? And what degree of volatility should investors expect? Figure 2 shows volatility on three-month options on US Treasuries since the 1990s, illustrating how volatility declined in the lead-up to the financial crisis, spiked sharply, and then fell once again to abnormal lows.

“As a base case, we expect volatility to normalise at somewhere close to its 1990s range, perhaps between 80 and 120 on the MOVE index, following the extreme highs of the crisis and the extreme lows seen in the run up to the crash and thereafter,” says McAlevey.

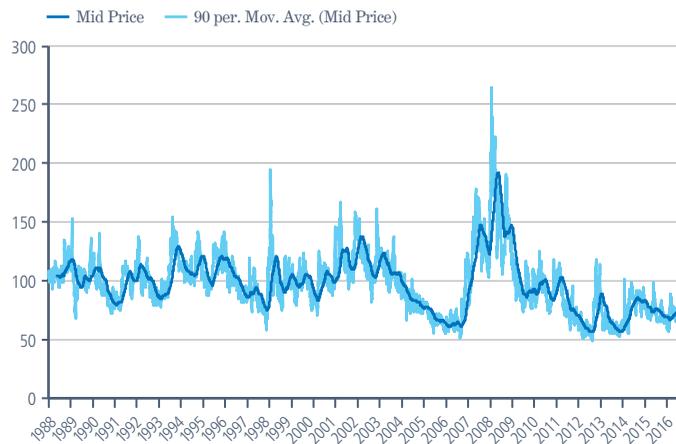
How can investors position themselves in an environment of rising volatility? Firstly, they should be mindful of the duration of the government and corporate bonds they own. Because long bonds are more sensitive to rising interest rates, they are more vulnerable than short-maturity bonds when yields rise and volatility picks up.

The behaviour of German government bonds – assets usually prized for their stability – demonstrates how the interplay between price and yield can wreak havoc on long-dated bonds. Over two weeks in May 2016, the yield on 30-year bunds increased 53 basis points. While that might seem a modest move, the bunds’ price consequently fell 12 per cent, an amount equivalent to 25 years’ worth of accumulated yields on the same securities.<sup>8</sup>

But investors can also look to turn increased volatility to their advantage. The market price of volatility continues to trade at a low level despite the recent changes in market structure, which could present a lucrative opportunity for investors to buy options that pay out when volatility picks up.

“There is no free lunch in bond investing. But since losing money with a traditional long-only bond portfolio in a rising rate environment is a mathematical certainty, investors should start preparing for a return of volatility,” says McAlevey ●

Figure 2: MOVE Index, 1992-2017



Source: Bloomberg, March 2017

- 1 Bloomberg
- 2 US Bureau of Labor Statistics, April 2017
- 3 US Treasury, April 2017
- 4 'Has liquidity in the Treasury and equity markets increased?', Federal Reserve Bank of New York, October 2015
- 5 Federal Reserve Bank of New York, May 2017
- 6 'Bond market calm is threatened by Fed's \$1.75 trillion shift', Bloomberg, March 2017
- 7 'The anatomy of the bond market turbulence of 1994', Bank for International Settlements, 1995
- 8 Bloomberg

# ARTIFICIAL INTELLIGENCE: RISE OF THE MACHINES

The rapid growth of machine learning is set to radically transform the economic landscape. Who will be the winners and losers from the AI revolution?

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*There is universal agreement that AI will have transformative effects on companies, economies and societies*

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In January 2017, a group of scientists and academics from diverse disciplines – robotics, philosophy, economics, and law – descended on Asilomar, a conference centre set amid picturesque pine forest on the Californian coast. These experts had a single purpose in mind: to formulate a set of principles to ensure artificial intelligence (AI) technology benefits society.

Speakers at the conference recognised the enormous potential of AI. As intelligent computers ‘learn’ about human wants and needs, they will make our lives more convenient. AI-powered robots will be able to take over onerous tasks that were once the preserve of human beings, unleashing productivity gains and boosting economic growth.

Others highlighted the potential drawbacks of AI, including what might be called *The Terminator* scenario – the risk malign robots will turn on their human creators. But there is a more pressing danger: that mass automation stokes unemployment and leads to social unrest. As Massachusetts Institute of Technology (MIT) research scientist Andrew McAfee put it in his speech at Asilomar: “If current trends continue, people are going to rise up well before the machines do.”

While experts continue to debate the pros and cons, there is universal agreement that AI will have transformative effects on companies, economies and societies. Investors should take note. Those who are able to identify sectors that will remain buoyant as the wave of AI disruption hits could reap significant rewards. But investors also face various hazards – not least the possibility that they, too, will be replaced by computer algorithms.

### Into the mainstream

Once a niche scientific discipline, AI has begun to dominate mainstream discussions about politics and economics. To take three examples from the opening months of 2017, Microsoft founder Bill Gates has warned of the risks of automating middle-class jobs;<sup>1</sup> French politician Benoît Hamon has called for a tax on AI-driven robots;<sup>2</sup> and UK Chancellor Philip Hammond has announced funding for AI as part of a national productivity drive.<sup>3</sup>

The recent interest in AI gives the impression of an overnight phenomenon. But AI has been in development for decades, explains Jeremy Wyatt, Professor of Robotics and Artificial Intelligence at the University of Birmingham. “The AI algorithms being used now are not completely new: they have their roots in the 1960s when the first neurally-inspired learning methods were invented,” he says. “But recently we’ve made steps forward in this branch of AI, enabling us to solve much harder problems.”

Fifty years ago, Arthur Lee Samuel coined the term ‘machine learning’ to refer to a process that “gives computers the ability to learn without being explicitly programmed”. A subfield of machine learning, known as ‘deep learning’, is what’s generating so much excitement – and trepidation – half a century on. Deep learning involves the construction of artificial neural networks that are modelled on the structures of the human brain. By extracting patterns from data, these networks are able to ‘learn’ and respond to new information without human input.

The simplest example of machine learning is image-recognition software. If a neural

network is fed millions of images labelled ‘aeroplane’, it will begin to recognise salient features – such as wings, fuselage or cockpit – that it can use to identify new pictures of aeroplanes. The more sophisticated machines go even further: AI networks in Google’s secretive ‘X’ research lab have learned to recognise images of cats simply by surfing unlabelled YouTube videos, in a process known as ‘unsupervised learning’.

Powerful GPU systems, originally developed to create hyper-realistic graphics in video games, have dramatically sped up the machine-learning process in recent years. And modern-day researchers have also benefited from masses of web-harvested data, which they can use to train the machines.

Thanks to these advances, machine-learning is approaching what is known in AI circles as the ‘human window’; a phrase coined by British robotics professor Donald Michie to refer to human capacity on any given task. “Humans have a very narrow window of performance,” says Wyatt. “When we reach the bottom of the human window with an AI method, we typically shoot through it very quickly.”

In 2015, during the ImageNet Challenge, a competition that measures machines’ ability to recognise and label images, a team from the Microsoft Research Lab in Beijing achieved a success rate of 96 per cent with their neural network – surpassing the average human rate of 95 per cent for the first time. And once machines have passed through the ‘human window’ on one task, it will not be long before they start outperforming their creators in others.

ARTIFICIAL INTELLIGENCE

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*Most of the eye-catching research in AI is being carried out by big technology companies*  
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“The difference between village idiot and genius level intelligence might be trivial from the point of view of how hard it is to replicate the same functionality in a machine,” as Swedish philosopher and AI expert Nick Bostrom has put it. “The brain of the village idiot and the brain of a scientific genius are almost identical. So we might very well see relatively slow and incremental progress that doesn’t really raise any alarm bells until we are just one step away from something that is radically superintelligent.”<sup>4</sup>

**Tech titans**

Most of the eye-catching research in AI is being carried out by big technology companies. In addition to its ongoing ‘X’ programme, Google now owns DeepMind, a London-based AI research group. DeepMind is the creator of AlphaGo, which grabbed headlines in 2016 when it became the first computer algorithm to beat a human grandmaster at Go, an ancient Chinese board game of dizzying complexity.

Google has also been working on AI-driven facial-recognition technology, known as FaceNet. Tested on its ability to remember 250 million faces in a 2015 study, FaceNet was able to match the face to the right name in 86 per cent of cases. Facebook has developed its own facial-recognition platform, DeepFace, which enables users to automatically ‘tag’ their friends in photographs. China’s Baidu, meanwhile, has become a world leader in voice recognition, which has been shown to outperform human beings in some translation tasks.

It is no coincidence these technology giants are leading the way in AI. As well as abundant capital to finance innovation, firms such as Google, Facebook and Baidu have access to reams of data they can use to train neural networks and commercialise the resulting ‘smart’ machines. Waymo, a unit of Google’s parent company Alphabet, is using its AI technology to develop self-driving cars that can learn from and respond to the

environment around them in real time, hoping to become the market leader in the new industry.

Closer to home, AI powers Amazon’s Alexa, a computerised personal assistant. As they sit in kitchens or living rooms, Alexa devices learn from customers’ requests and adapt to their preferences. And because they are always plugged in to Amazon’s vast digital warehouse of products and services, they are able to predict what customers want next. It’s a neat trick: Alexa both improves the consumer experience and collects useful data on those consumers, cementing Amazon’s advantage over its competitors.

“Amazon wants to know what kind of products you want to buy from them, and Alexa will help them do that,” says Jason Bohnet, Senior Research Analyst at Aviva Investors in Chicago. “They’re devoting massive amounts of resources to the project: there are more than 2,000 engineers in Seattle working on the Alexa team. The goal is to use Alexa to learn about your life – and make it frictionless.”

**The internet of things**

Machines that connect to the Internet, share information and respond autonomously to the world around them will have a widespread application in consumer industries. Much hype has surrounded the potential for the so-called ‘internet of things’ – a network of AI-powered, Wi-Fi-connected gadgets – to transform the home, enabling your refrigerator to automatically order a fresh pint of milk, or your toaster to learn exactly how you like your toast in the morning.

But from an investment perspective, perhaps the most interesting aspect of the internet of things is the way it will enable industrial manufacturers to preserve revenue streams after the point of sale. One example is the elevator industry, where AI-driven systems are enabling companies to retain service contracts on their installations.



*DeepMind CEO and co-founder Demis Hassabis poses with Go grandmaster Lee Sedol*

“Service contracts are quite lucrative, but the original manufacturer doesn’t have a monopoly on them,” says Giles Parkinson, Global Equities Fund Manager at Aviva Investors. “But now manufacturers are teaming up with technology companies to solve this problem.

“For example, KONE uses IBM’s Watson, an AI supercomputer, so that its lifts continue to ‘talk’ to the company after they are installed and inform it when and how they might need repairing. This means KONE is now better positioned to retain service contracts on all of its lifts. KONE’s rivals, Schindler and Otis, have similar artificial intelligence partnerships in place.”

In manufacturing, machine-learning technology is making industrial processes safer, cheaper and more efficient. ABB Group, a Swedish-Swiss technology multinational, has developed an AI algorithm that can detect when electric motors on a production line start vibrating. Learning from the data it has already collected, the programme can decide autonomously whether or not the motor needs to be replaced, and how quickly.

Solutions of this kind will chiefly benefit larger industrial companies that can afford to roll out AI-driven automation at scale, says Max Burns, Senior Research Analyst at Aviva Investors in London. “AI is nascent, but it’s the wave of the future. The beneficiaries will be large companies

with significant installed bases, such as Schneider Electric and Siemens.”

Some industrial companies are developing their own in-house AI software to facilitate greater automation. General Electric, for example, has launched a division called Predix, whose programmes enable GE machines to communicate with each other independently of human input; the company is investing \$5.5 billion every year in Predix’s software platform.

GE is also making this software available to third-party companies, at a price. In doing so, it is gradually becoming a hybrid industrial-software company, just as tech giants such as Google and Intel are using AI to move towards the production of physical devices such as autonomous vehicles. “AI is blurring the lines between the software companies and the industrial companies,” says Burns.

### **White collar disruption**

While the big technology companies will continue to push the boundaries of AI – and make money from their innovations – machine-learning algorithms are becoming more widely available. Microsoft, Amazon and Google have released some of their research as open-source software, enabling other companies to tailor it to their own needs. This means AI’s applications in everyday life could be set to expand exponentially.

It has been suggested AI will hasten the so-called third ‘great wave’ of automation, following similar shifts in the 18th and 19th centuries. And the impact could be even greater in services industries than in manufacturing. While physical robots that replace blue-collar workers can be enormously costly, AI programmes that enable the automation of white-collar work are often extremely cheap to install on personal computers. Although the cost savings will benefit employers, the rapid growth of the technology poses ethical questions.

“The marginal cost of production for physical automation, as opposed to information automation, is still substantial; it costs you £10-20,000 to make a robot,” says Wyatt. “But with IT the cost of reproducing software is essentially zero. Because of this, it will be cheaper for companies to automate white-collar jobs. This means white-collar jobs might be affected by automation more quickly than jobs involving physical labour.”

Sectors such as media, healthcare and financial services are set to be transformed by machine-learning algorithms, which could in theory replace any human role that involves routine computer-based tasks. Indeed, this has already started to happen: just ask any of the 34 people made redundant by Japan’s Fukoku Mutual Life Insurance earlier this year.

# ARTIFICIAL INTELLIGENCE

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Fukoku replaced these workers with an AI system that is able to process policyholders' medical records before calculating pay-outs. The company says by using AI in this way it will boost productivity by 30 per cent and reduce costs by up to £1 million a year. Fukoku paid £1.4 million for the system and will spend about £100,000 each year maintaining it, far less than it would have to pay human workers in salaries.<sup>5</sup>

AI is making an impact in other knowledge-based industries, such as journalism. The Associated Press now uses a programme called Wordsmith, which transforms corporate earnings data into readable stories using an AI-driven method called natural-language processing. And AI algorithms are even breaking news: in 2014, an earthquake in California was first reported by the *Los Angeles Times*, which used AI to write and publish the story within three minutes of the first tremor.<sup>6</sup>

In the legal sector, some firms are already using AI to identify legal precedents; reducing the need to employ squads of frazzled paralegals to sift through voluminous case histories. Others are introducing contract-reviewing robots.

"AI can be used to review rental agreements, for example," says Parkinson. "The right machine can quickly pick up the presence of unusual clauses in contracts, or normal clauses that should be there but aren't. It needs an element of human oversight, but the interesting thing is that it can learn by itself what is contractually normal and what isn't."

Law firm Pinsent Masons has a contract-reviewing platform called TermFrame, which it developed in-house. US financial services giant JP Morgan, meanwhile, has developed a similar system called Contract Intelligence (COIN) that reviews commercial

loan agreements. The bank says COIN has assumed work that took up 360,000 hours of human labour every year and significantly reduced errors.<sup>7</sup>

### Inflection point

For investors, the rapid roll-out of AI across new industries opens up a mind-boggling array of possibilities. Companies with the ability to bring in automation are likely to become more efficient and profitable, but may face taxes or regulatory interference that prevent them from taking full advantage. Others may see whole business lines wiped out – and new ones created – in an instant. One thing is certain: ignoring the impact of AI is not an option.

"It is too early to pick out precise winners and exact losers from AI," says Bohnet. "But as I've read through recent quarterly earnings reports from companies within the technology, media and telecommunications sector, the implementation of AI and machine learning has been the most consistent theme across the board. We're at an inflection point."

Many firms that want to automate processes using AI turn to IBM Watson. IBM has partners in a range of industries, from call centres to escalators to insurance. In March 2017, the company announced it would be teaming up with cloud-computing specialist Salesforce and merging Watson with Einstein, Salesforce's customer-analytics AI platform. This meeting of artificial minds will enable these companies to offer a greater range of AI services to third-party clients.

On a smaller scale, an array of specialist start-up firms has emerged to offer tailored AI solutions in specific market niches. Often these companies become acquisition targets soon after their software is

demonstrated to be commercially viable: AP's Wordsmith programme was developed by a US-based start-up called Automated Insights, which was acquired by a venture capital firm for a reported \$80 million in 2015.<sup>8</sup>

Indeed, AI is driving M&A activity across various industries. Earlier this year, US technology giant Intel acquired Israeli start-up Mobileye for \$15 billion, hoping to use Mobileye's machine-vision technology to enter the self-driving car industry. GE is also making acquisitions to speed up Preditix's growth: in November 2016 it bought Bit Stew, a Canadian data-crunching company, and Silicon Valley machine-learning start-up Wise.io for undisclosed amounts.<sup>9</sup>

Bohnet says investors should monitor developments at the forefront of the AI industry. "You want to invest in the companies that provide the leading-edge AI services, whether that's in equity or debt. These are the companies that are changing the world, and they are only likely to become stronger," he says.

As well as the companies that develop AI technology, Bohnet recommends exploring opportunities to invest in the manufacturers of cutting-edge GPU systems that facilitate the deep-learning process. "NVIDIA and Advanced Micro Devices (AMD) should perform well as AI spreads, because you need super-fast computers to train the machines."

However, investing in sectors that are on the brink of integrating AI can be tricky, because competing firms are likely to copy each other, quickly flattening out any first-mover advantage. Parkinson points to a relatively low-tech precedent: self-service till kiosks in supermarkets.

"The first supermarkets to automate checkouts in this way gained an advantage and were able to cut costs, but others copied them and the gains were soon competed away," he says. "We could see something similar in the service sectors that begin to use AI. Whether incumbents gain an advantage, however, will depend on the specifics of the industry."

The impact of AI is likely to be so all-encompassing that advances in one sector have big implications for others, creating a ripple effect across economies. What will happen to the insurance industry, for example, if self-driving cars become the norm?

"If driverless cars become pervasive it would only be because they were safer," Warren Buffett mused at Berkshire Hathaway's annual meeting in May 2017. "That would mean that the overall cost of auto-related losses had gone down", driving down the premiums for companies such as Berkshire-owned insurer Geico, Buffett said. Such shifting dynamics will make it difficult to monitor the resilience of companies in an investment portfolio.<sup>10</sup>

### **The meteor lands**

Compounding the difficulty in formulating an investment strategy based on AI themes is the risk investors themselves, like personal assistants and paralegals, may become an endangered species. On March 28, asset-management giant BlackRock became the latest firm to announce an automation drive, revealing it would be cutting fund managers and offering retail investors the opportunity to invest in low-cost quantitative stock funds that use computers to select opportunities.

Active fund managers are already facing increasing competition from investment

houses that offer passive, index-tracking strategies such as exchange-traded funds (ETFs), and this trend has been hastened by the rise of 'robo-advisors' that rely on such strategies. AI-driven advisors can learn about customers' investment histories and goals, offering cheap, tailored portfolios. The ramifications are already being felt across the industry, but all is not lost for active managers that can best adapt.

"The way I see it, the fund management industry at the moment is like the dinosaurs: the meteor has landed and food has started to run out," says Parkinson. "The fee pool is under pressure due to passive investing. Active managers will need to offer strategies tailored to specific outcomes, which are harder to replicate with robots."

As the effects of AI-driven automation begin to shake more industries, the wider economic consequences could be enormous. *The Future of Employment*, a study published by Oxford University researchers Carl Frey and Michael Osborne in 2013, concluded that 47 per cent of all jobs in the US are at risk of computerisation, principally due to advances in machine learning and mobile robotics. In developing economies, the figure could be as high as 85 per cent. In a follow-up study in 2017 on the risks of automation faced by middle-class jobs, Frey found insurance underwriters, loan officers, car-insurance assessors and credit analysts were most at risk from robot replacements.

"This is what scares me the most; AI is coming on so quickly it's going to take jobs away," says Burns. "Emerging markets could be hit especially hard. In the same way they skipped landlines and went straight to

“*The impact of AI is likely to be so all-encompassing that advances in one sector have big implications for others*”

## ARTIFICIAL INTELLIGENCE

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mobile phones, these countries might skip straight to automated processes. This is already happening in China, which is investing heavily in automation.”

Fears about the effects of technology on employment are nothing new. In an essay called *Economic Possibilities for Our Grandchildren* (1930), John Maynard Keynes wrote about “technological unemployment”, which results from “our discovery of means of economising the use of labour outrunning the pace at which we can find new uses for labour”. The problem remains: can we create enough new jobs to replace those lost to new technologies?

Recent research reveals a complex picture. Advanced economies are still creating numerous low-paid and high-paid jobs, but those in the middle, especially those based on routine processes, are becoming squeezed, and this may be contributing to economic inequality. Erik Brynjolfsson, a professor at MIT’s Sloan School of Management, says: “Technology is the main driver of the recent increases in inequality. It’s the biggest factor.”<sup>11</sup>

However, AI is also likely to create jobs in new industries, from software development to data security. And there’s another variable: with ageing demographics a pressing problem in many economies, the productivity gains AI promises could offer a remedy for sluggish growth. In Japan, whose population is ageing faster than anywhere else, hand-wringing over technological unemployment is conspicuous mostly by its absence, notwithstanding the recent layoffs at Fukoku.

“In an age when many populations are ageing and declining in size, automation can come to the rescue,” says Wyatt. “The increased productivity it gives is purely and completely a boon – the issue is how you carve up the cake. That’s a problem politicians are going to have to solve.”

## AI, UBI

Recent research from the Organisation for Economic Cooperation and Development (OECD) suggests the productivity gains from new technology may be concentrated in a clutch of ‘frontier’ firms, which means governments should consider ways to encourage the spread of innovative techniques to other companies.<sup>12</sup>

As the rapidity of AI-related change is likely to be unprecedented, it will take time for companies to develop new roles and for the labour force to adapt. With this in mind, politicians in several countries have called for a universal basic income (UBI) to support the ‘precariat’, a social class characterised by discontinuous and insecure work patterns. Simply put, UBI involves payments to citizens to supplement irregular income and provide a safety net while they are unemployed or retraining.

Some high-profile Silicon Valley companies, aware of the social effects their technology threatens to unleash – and negative PR – are converts to UBI. Y Combinator, a tech-focused venture capital firm, has even financed a UBI experiment of its own, joining governments and local authorities in Finland, the Netherlands and Canada in trialling the idea. Washington D.C.-based think tank the Brookings Institution has proposed a less radical concept, ‘wage insurance’ – a government payment that supplements the earnings of laid-off workers who have to take less remunerative jobs – to help ease the effects of middle-class unemployment.

Both UBI and wage insurance would require extra state spending, which raises the question of who pays. Bill Gates is one of many prominent figures who have argued in favour of an AI tax. It is a prospect investors in AI will need to monitor closely, as firms that roll out large-scale automation – along with those that develop the technology that facilitates it – may be first in line if governments decide on this option. In practice, though, policymakers are likely to rely on a mixture of carrot and stick to ensure the gains from AI are not simply hoarded by a handful of Silicon Valley giants.

“Companies that use a great deal of AI could face taxes or regulatory hurdles,”

says Bohnet. “Western governments will probably settle on a more incentive-based approach, promising to treat companies more favourably if they retain workers and create new jobs. But policymakers will definitely need to respond in some way.”

A report commissioned by the outgoing Obama administration in late 2016 shows politicians recognise the opportunities and challenges presented by AI, even if they are yet to put together a comprehensive policy response. The report drew attention to the dystopian possibilities but also acknowledged that AI “can be a major driver of economic growth and social progress” if industries and governments work together.<sup>13</sup>

The Asilomar Principles devised in January showed AI experts are, at least, aware of the need to achieve some sort of consensus. They draw attention to the need for research funding into the social effects of AI, greater communication between policymakers and AI researchers, and laws against the development of lethal autonomous weaponry. It is early days in the AI revolution, but such guidelines may help governments, companies and civil society shape this new technology so it benefits us all ●

- 1 ‘Robots that take people’s jobs should pay taxes, says Bill Gates’, *The Telegraph*, February 2017
- 2 ‘Robot tax, odd as it sounds, has some logic’, *Financial Times*, February 2017
- 3 Hammond said “this government places addressing the UK’s productivity challenge at the very heart of its economic plan” in his Budget speech in March 2017.
- 4 ‘The doomsday invention’, *The New Yorker*, November 2015
- 5 ‘Japanese insurance firm replaces 34 staff with AI’, *BBC News*, January 2017
- 6 ‘The first news report on the L.A. earthquake was written by a robot’, *Slate*, March 2014
- 7 ‘JPMorgan software does in seconds what took lawyers 300,000 hours’, *Bloomberg*, February 2017
- 8 ‘Vista acquires Automated Insights, the startup behind the AP’s “robot” news writing’, *TechCrunch*, February 2015
- 9 ‘General Electric Acquired these 2 artificial intelligence startups’, *Fortune*, November 2016
- 10 ‘Buffett: Driverless vehicles “won’t be a good thing” for business’, *Business Insider*, May 2017
- 11 ‘Technology and Inequality’, *MIT Technology Review*, October 2014
- 12 ‘Frontier firms, technology diffusion and public policy: Micro evidence from OECD countries’, OECD, 2015
- 13 ‘Preparing for the future of artificial intelligence’, Executive Office of the President National Science and Technology Council Committee on Technology, October 2016



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*The companies that control this digital traffic are naturally becoming ever richer and more powerful*  
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**Big Data could be set to deliver great benefits to society – and opportunities for investors. But fears over security and privacy may limit the data revolution.**

On May 7, technology giant Apple became the first US company to achieve a market capitalisation of more than \$800 billion. This milestone attracted reams of media coverage, with analysts feverishly speculating about how long it would take Apple to hit the \$1 trillion mark.<sup>1</sup>

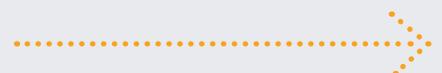
A few days later, a separate Apple-related story appeared in the financial media: the company is set to spend \$1 billion expanding and renovating its data centre in Reno, Nevada.<sup>2</sup> This nugget of information received far less coverage than Apple’s soaring market value, but may help explain it. Apple’s command of data flows is one reason why its shares are skyrocketing.

In a world driven by digital technology, data is arguably the world’s most valuable resource. Little wonder that companies such as Apple, Amazon, Google-parent Alphabet, Facebook and Microsoft amassed a total of \$25 billion in net profit in the first quarter of 2017.<sup>3</sup> These firms are soaring in value, taking much of the credit

for the surge in US stocks to record highs this year. Similarly, in Asia, Chinese technology companies Baidu, Alibaba and Tencent (the so-called ‘BATS’) are in the ascendancy.

According to McKinsey, a consultancy, the world has entered a new era of digital globalisation. International data flows rose 4,500 per cent in the nine years to 2014 and now contribute \$2.8 trillion to global GDP, more than trade in physical goods.<sup>4</sup>

The companies that control this digital traffic are naturally becoming ever richer and more powerful as they discover new ways to make money from the cascades of ones and zeros. The tech giants are profiting from managing and storing data flows, as well as using the data they own to move into new areas such as artificial intelligence and even financial services. But issues over data security and privacy may limit how far the data revolution can reach.



BYTE  
SIZE

*continued*

**Data's big bang**

The massive increase in data production in recent years is a function of the spread of technology into people's everyday lives.

Mobile phones and other personal devices produce a constant stream of information. 'Connected' machines driven by such innovations as artificial intelligence and the internet of things are also contributing to the data explosion.

Jay Brown, chief executive officer at Crown Castle International, a US company that provides infrastructure for broadcasting, mobile phones and wireless broadband, expects mobile data traffic in 2017 "to be roughly twice what was consumed just two years ago". Indeed, he forecasts there will be six times more mobile data traffic by 2020 than in 2015. This growth will be driven by "the adoption of data-intensive applications, such as video streaming, increasing numbers of connected devices and potential new applications, such as fixed wireless broadband".<sup>5</sup>

The expected introduction of 5th generation wireless systems technology (5G) in 2020 could lead to a new "inflection point", says Jason Bohnet, Senior Securities Analyst at Aviva Investors in Chicago. 5G will enable faster processing and production of data and the mass roll-out of data-reliant machines such as autonomous cars.

US technology multinational Intel expects the average person to produce around 1,500 megabytes of data daily by 2020, up from about 650 million currently, while connected machines will spout even bigger plumes of data: a self-driving car may produce around four million megabytes of data a day, and a connected aeroplane five million megabytes. In just three years' time, there will be as many digital bits on the planet as there are stars in the universe, according to research from Dell EMC and IDC, a market research firm.<sup>6</sup>

**Up in the cloud**

Just as trade in physical goods requires ships and warehouses, data traffic needs digital

depots, or data centres, for storage and management. US IT giant Cisco forecasts data centre traffic will hit 15.3 zettabytes in 2020, up from 4.7 zettabytes in 2015 (a zettabyte is a unit equal to one sextillion bytes; by comparison, a megabyte equals a mere one million bytes).

As data centres rely on fast computer processors and servers, as well as vast memory capacity, this will benefit hardware manufacturers such as Dell, Intel and Hewlett Packard, as well as companies such as Crown Castle and Equinix, which focus on operating wireless infrastructure.

But the Silicon Valley giants are also becoming increasingly influential players in data management. Amazon, Salesforce, Google, Apple and Alibaba are now among the leading operators of 'hyperscale' data centres; sprawling, sophisticated facilities needed to run the biggest websites. These centres rely on cloud computing, which facilitates instantaneous access to information and economies of scale by pooling computer-processing resources.

As well as using data centres to power their own businesses, these companies also provide third-party cloud computing services for a fee; effectively 'renting' server space to other firms, opening up lucrative new revenue streams. And increasingly, the big cloud providers are using their technological edge to customise data centres by tailoring the internal networking and data equipment, encroaching on the turf of pure hardware manufacturers.

"Given there are relatively few major global hyperscale cloud providers, and given the capital-intensive nature of the business, these companies will prosper from the growth in data usage and their strong pricing power," says Bohnet. "The leading firms invest billions of dollars, which creates a durable moat and high barrier to entry." Amazon, Google and Facebook reportedly spent \$31.5 billion on capital expenses and leases for their data centres in 2016.<sup>7</sup>

Amazon's cloud arm, Amazon Web Services, produced 9.1 per cent of the company's revenues in 2016 and Bohnet expects this figure to reach around 14 per cent in 2018. Similarly, Alibaba is forecast to generate 7.1 per cent of revenues from its cloud operations next year, up from 2.9 per cent in 2016. And cloud services are also driving strong profit growth: the cloud is expected to deliver an 11.2 per cent increase in profits for

Alibaba in 2018 after imposing a 0.3 per cent drag on its profits last year.

**Big Data, AI and self-driving cars**

As well as profiting from their ability to process, store and manage data, big technology companies are benefiting from the increased value of data they collect from their customers. Their access to data makes these companies extremely attractive to investors, even before they have worked out the best way to commercialise it. Facebook, for example, drew billions in investment long before it started using sophisticated targeted advertising protocols to convert user information into hard cash.

Similarly, car-hailing app Uber's estimated \$70 billion valuation has much to do with the data it owns on transport flows, which it has started to make available to third-party companies – such as hotel giant Starwood – and even governments, which can analyse supply and demand patterns to improve transport infrastructure.<sup>8</sup>

The information owned by big technology companies is set to become even more valuable in an age of artificial intelligence systems, which require vast stores of data to 'teach' smart machines. The big tech firms are taking advantage of this, using their data to create AI-driven programmes and products, opening up new revenue streams and making their existing businesses more efficient.

Take Google, which purchased UK-based AI innovator DeepMind in January 2014 for £400 million.<sup>9</sup> Google is using its data to power DeepMind's cutting-edge AI programmes. At the same time, those programmes are enabling Google to make its data centres more cost-effective. Jim Gao, Google data centre engineer, says DeepMind's machine-learning systems have enabled the company to reduce the energy it uses to cool its servers by up to 40 per cent.<sup>10</sup>

Big Data is also leading technology companies to enter new sectors, such as autonomous cars. The likes of Google (whose car unit Waymo has been spun out into a separate company under the Alphabet umbrella), Apple and Baidu are using their AI algorithms to create hardware and software for self-driving vehicles. These companies' involvement in the autonomous driving industry will provide them with even more data to crunch and commercialise.

# MAKING SENSE OF BIG DATA: THE INVESTMENT PERSPECTIVE

While much continues to be written and said about Big Data, determining which companies are best-positioned to capitalise is no easy task. We asked two equity fund managers for their perspective on the significance of Big Data to the investment decision-making process.

## Henry Sanders, Senior Portfolio Manager, River Road Asset Management\*

“Big Data is fueling a rapid expansion in the way companies perceive and evaluate the world around them. There has been a lot of attention paid to the firms that create the software and hardware housing these datasets. However, investors should also be aware of the impacts predictive modeling and other tools have in how companies manage both their own operations and their relationships with customers.

Firms across all sectors are using these tools to increase their own efficiency and reach out to their customers in new ways. It will be some time before winners and losers emerge, but it is clear new competitive advantages are being established as those firms that embrace Big Data have an opportunity to disrupt the status quo and get an edge on their competition.”

## Giles Parkinson, Global Equity Fund Manager, Aviva Investors

“Ownership of a share represents a claim on the future cashflows of a business. Equity investing is all about the future. Two-thirds of the value of the average stock is underpinned by what happens beyond the next five years – the current attention on investor short-termism notwithstanding. But does that mean successful investing is all about betting on tomorrow’s winners today? Only partially: smartphones didn’t exist ten years ago and Facebook had just 20 million users. As the proverb goes, ‘it is difficult to make predictions, especially about the future’.

Where fundamental change is occurring, it is crucial we are confident it makes the companies we own better businesses. Big Data has the potential to cause major disruption, but it is difficult to invest with any certainty around it yet. Instead, we like to invert the problem. Rather than thinking about disruptive change, and who wins or loses from it, an easier question is to ask, ‘What isn’t going to change, and who is already winning today?’ Humans have drunk beer, decorated our faces, and died for millennia. Leaders in those markets can be expected to benefit from sustained demand for their products as long as there are humans on the planet. We can invest around that.”

\* Henry Sanders is also Co-Manager of the Aviva Investors US Equity Income fund

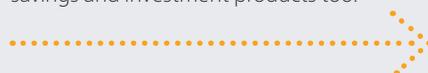
“Self-driving cars will be always be ‘on’, attached to maps with sensors uploading data to the cloud every second,” explains Bohnet. “This means one autonomous car is expected to generate the same amount of data as 5,000 people do today. In other words, if we had one million autonomous cars, they would produce the same amount of data as the entire digital usage of the world at the moment. Add in the internet of things and truly interconnected cities – which will feature parking space sensors and apps – and the cars will be a treasure trove of data.”

Intel is a good example of the synergies technology companies can achieve by entering the self-driving car business. In 2017, the company spent \$15 billion to buy Israeli start-up Mobileye, which specialises in AI driving technology. Data was a big part of the rationale behind the deal.

“The enormous quantities of data coming off a car will frequently use Intel servers and server chips. The car data will be relayed via a modem that Intel can provide. And Intel servers are available to help compute the data in the cloud. The majority of Intel’s profits are still derived from the computer chips business. The move into self-driving technology will diversify its growth story, although it will take many years for this to become a large part of its business,” says Bohnet.

## Big Data and finance

The big technology firms are monetising the data they own in other ways. China’s BATS have led the way in using the information they collect on customers through e-commerce websites, messaging apps and search engines to offer tailored financial services; initially digital payment facilities but now more sophisticated savings and investment products too.



BYTE  
SIZE

*continued*

Financial services firms in the West are also looking to harness the power of Big Data to offer tailored products to their users, says Bohnet. “Technology companies like Amazon and Facebook have a rich data set on people that can be used in various ways, financial services-type products being one of them.

“Assessing a person’s credit rating is one such example. A Facebook profile could have everything needed to prepare a person’s investment profile. If a company knows your occupation, age, where you live and so on, it can infer how you’d like to invest. In turn, this could be used as a lead internally or sold to a third party,” Bohnet adds.

Credit ratings are one area where personal data could prove extremely valuable. US-based credit analytics company FICO conducted a trial that found the number of times people use the word ‘wasted’ on their Facebook profile “has some value in predicting whether they’re going to repay their debt”.<sup>11</sup> In China, peer-to-peer lending company Jubao Internet Technology revealed it is more likely to lend to customers who are Facebook ‘friends’ with celebrities.<sup>12</sup>

Insurance is another area where personal data could be turned into commercially valuable information. In 2016, UK insurer Admiral reportedly opened talks with Facebook over using social media posts to gauge how well or badly someone might drive. And social media data could even have a role in health insurance: researchers at the University of Pennsylvania have discovered a link between the tone of a person’s tweets and their risk of dying of coronary heart disease.<sup>13</sup>

“Many insurers are looking at using social media content as a way to ascertain data on people to assess their risk level,” says Orlando Machado, Customer Analytics & Data Science Director at Aviva. But there are potential issues with using personal data for financial products.

“We are conscious of using customer data in ways they would approve of. This may be a stumbling block to using social media posts for now,” says Machado. “There is a trend among younger people to be less protective of their data and certainly if they see a benefit for them from it. But there is still a need for limits in terms of implied consent for this. We need to test and establish where these data boundaries are.”

**Security, privacy and regulation**

Concerns over data privacy and security may present pitfalls for companies hoping to transform their stores of personal data into commercial assets. Until now, the so-called millennial generation has been happy to share details of their lives on the internet, partly because it is convenient: if an e-commerce company knows your preferences, it can sell you things it knows you will like. But what if you started being turned down for mortgages or credit cards because of misjudged Facebook posts?

For now, Bohnet says, technology firms’ tacit compact with consumers is likely to hold; people tend to trust big tech firms more than banks or governments. A more pressing issue may be data security. As the big technology companies own more and more data on consumers, governments and other companies, the reputational risk associated with data breaches becomes far more significant.

Amazon highlights how seriously security is taken. Its data centres resemble a high-tech fortress in a Hollywood movie: they are patrolled by armed guards, and retinal checks and fingerprint-recognition are required for entry. But hackers are developing more sophisticated methods too, and data security breaches are always a possibility.

The risk that data may be compromised could lead regulators to crack down on technology companies’ incursions into financial services, says Oliver Judd, Senior Research Analyst at Aviva Investors in London. “To the extent that the regulators are behind the curve in dealing with technological change, they may err on the cautious side. In the shadow of 2008 and the regulatory failings associated with that, it will be very difficult for a regulator to approve, say, a new Amazon or Facebook bank without knowing what the data security issues are and what security assurances such an entity can provide.”

Technology companies may be able to circumvent regulation by carving out a niche for themselves as providers of certain financial products without registering as fully-fledged banks, says Bohnet. Perhaps the bigger risk to the Silicon Valley behemoths is that, as they become ever bigger and colonise even more industries, governments will introduce antitrust rules to restrict their reach.

“Is Google a monopoly – do we have to break it up?,” asks Bohnet. “I believe Amazon has the potential to be the highest market-cap stock in the history of the world someday, and it will be a vastly important influence on our lives. Will regulators step in? Unless tech becomes malicious in some way – for instance any civil liberty issues or discrimination among users – I don’t see the US regulators trying to stop them moving into new industries.”

As long as consumers continue to derive benefits, Big Data looks set to be the fuel that will power the largest technology companies to new heights. Apple’s \$800 billion market capitalisation may be just the beginning ●

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# GO FOURTH AND MULTIPLY

**3D printing is seen as a key pillar of what experts are calling the fourth industrial revolution, with the potential to transform manufacturing. But it is not likely to happen overnight.**

The global manufacturing sector is experiencing a new wave of technological change that some believe will lead to the fourth industrial revolution, sometimes referred to as Industry 4.0. Factories will be transformed by a fusion of robotics, artificial intelligence, cloud computing and 3D printing.

Although 3D printing was invented in the early 1980s, the process was too slow and expensive to rival established manufacturing techniques. But recent developments, including faster computer speeds and the introduction of AI technology, have made 3D printing a viable option. It is now being used to create a vast array of objects, including artificial limbs and organs, aero-engine parts, car prototypes, jewellery and hearing aids.

As 3D printing becomes even faster, it is likely to become a vital tool in mass manufacturing, potentially revolutionising the supply chain. For that reason, many analysts believe it will form a key ingredient in the coming fourth industrial revolution. That clearly has implications for investors, according to Max Burns, Senior Industrials Research Analyst at Aviva Investors.

He is not alone in holding that view, with professional services firm KPMG, among others, forecasting that Industry 4.0 will boost productivity, reduce waste and costs, and allow manufacturers to respond more effectively to consumer demand.<sup>1</sup> Investment in 3D printing, also known as additive manufacturing (AM), and other emerging technologies seems set to grow, according to research from KPMG (see figure 1 overleaf).

## Liquid metal

Airbus has been using 3D printers since 1984 and the technology even featured in *Terminator 2* (1991), with the eponymous robotic villain 'T-1000' rising fully-formed from a liquid pool of metal. In reality, AM produces objects by fusing together thin layers of materials such as plastic powder, metal or liquid resin using computer aided design (CAD) software.



GO FOURTH  
AND MULTIPLY  
*continued*

Until recently, the slow speed of 3D printers compared with injection moulding or casting, and the considerable labour costs involved, limited their use to small-scale production and prototypes. But the increasing speed of these machines means they are being used in new industrial areas.

The size of the 3D printing market, which includes all AM products and services, increased from \$1 billion in 2007 to \$6.1 billion in 2016. Terry Wohlers, Principal Consultant and President of independent consulting firm Wohlers Associates, expects it to exceed \$26 billion by 2022, but its potential goes well beyond that. "3D printing could one day become a \$640 billion market if it captures only five per cent of the \$12.8 trillion global manufacturing industry," he says.

3D Systems, a US supplier of AM equipment, and Stratasys, a US-Israeli company, accounted for \$1.3 billion, or 22 per cent of industry sales last year, according to Wohlers. Both companies face increasing competition from General Electric, HP Inc., and others. The number of manufacturers producing and selling 3D printers worldwide reached 97 in 2016, up from 62 in 2015.<sup>2</sup>

In terms of sectors, Wohlers says industrial/ business machines is the largest, accounting for 18.8 per cent of sales in 2016, followed by aerospace (18.2 per cent), motor vehicles (4.8 per cent), consumer products/electronics (12.8 per cent) and medical/dental (11 per cent).

According to Burns, the US and Germany are at the forefront of research into this technology. Wohlers notes the US has the most experience and the largest installed base of AM machines globally. More than two-thirds of manufacturers in the US already use the technology in some way and four in 10 believe it will eventually be used in high-volume production, according to PwC.<sup>3</sup> Meanwhile, Germany has long experience, and is the biggest supplier of machines that build metal parts.

**Figure 1: Expectations of how investment will change in the next three years**



Source: Rethink manufacturing: A UK strategy for Industry 4.0, KPMG, February 2017

"China is lagging, simply because it is focused on lower value-added areas where AM is not yet widespread," says Burns. However, Wohlers believes China could catch up fast. "We are seeing a lot of new start-up companies and also organisations that are producing machines that build metal parts in China. That's important because AM machines that use metal are very hot at this time," he says.

Companies are buying AM machines and increasingly using them to build metal parts for aircraft or medical implants, orthopaedic implants and dental restorations. He adds that Japan, one of the leaders in AM during its infancy in the late 1980s and early 1990s, could also see a 3D comeback.

**Aerospace flies ahead**

AM offers a myriad of advantages over traditional manufacturing methods, according to Burns. Apart from cost and time savings, it facilitates continuous design upgrades, shorter production runs and the production of customised goods. It also reduces the need for large inventories, specialised tooling and skilled labour. Indeed, AM threatens to revolutionise the supply chain by enabling the manufacturing of spare parts on demand and even on site, according to the German engineering giant Siemens.<sup>4</sup>

Furthermore, AM allows for the use of novel designs, with superior performance that would be impossible to produce with traditional manufacturing methods, and the use of materials that are lighter and can deliver significant weight savings. Jerome Rascol, in charge of additive manufacturing at Airbus, says

one of the major advantages of this technology is that "you can replicate structures found in nature, such as the hollow bones found in birds, which have taken four billion years to develop".

As well as using AM to replicate the lightweight structures of bird bones, Airbus is examining the qualities of the Victoria water lily (*Victoria amazonica*), which can support significant loads, including the weight of a small child. The plant's leaf vein structure provides Airbus with a model for reinforcing surfaces, and can now be found on the inner surface of a 3D-printed aircraft spoiler drawn up as part of a concept study.<sup>5</sup>

AM's ability to create strong, lightweight components is of particular interest to the aerospace industry, because the lighter the aircraft, the cheaper it is to operate in terms of fuel costs. There are other advantages. Parts designed for and manufactured by AM "can have a natural and topologically-optimised shape, which would be impossible if produced from a solid block of material", according to Airbus. Such parts are lighter, faster to produce and ultimately much less expensive than conventional ones, the company adds.<sup>6</sup>

As an aircraft architect, Airbus sees great potential in a type of AM known as High Deposition Rate (HDR) or Direct Energy Deposition (DED), which allows for the manufacture of large metal parts. HDR involves the melting of wire, which is deposited at a rate of around 5kg per hour compared to 50-100 grammes per hour using other AM powder bed methods.



## *3D-printed medical devices are fostering a healthcare revolution*



Rascol adds that AM has applications in all areas of an aircraft from “structure, systems, engines and also cabins, where plastic AM can be more competitive than the traditional method of injection moulding, to more complex and customized parts”. AM, he explains, has advantages in terms of cost, weight and reduced lead times, “or simply in providing the ability to manufacture anything that you can simply not produce today in any other way”.

“New companies that supply AM based on new processes are emerging all the time and we need to have a profound understanding of this technology both technically and industrially,” says Rascol. He adds that AM combined with the use of robotics will become increasingly important in the coming decades.

Rascol can imagine a day, decades hence, when AM will be used to construct the entire fuselage structure of an aircraft. No wonder then that Airbus is already making heavy use of AM. Over 1,000 parts in the new A350XWB aircraft are 3D printed, replacing traditionally manufactured parts.

AM cuts waste because it places material only where it is needed, rather than by machining parts from a solid block. Given aerospace manufacturing typically consumes expensive materials, this should lead to significant cost savings. Boeing, for example, has hired the Norwegian 3D printing company Norsk Titanium to print the structural titanium parts for its 787 Dreamliner. According to Norsk, the process is expected to save up to \$3 million for each aircraft, although Boeing has not confirmed this figure. Norsk and Boeing say the titanium parts are the first printed structural components designed to bear the stress of an airframe in flight.<sup>7</sup>

### **AM turbines gathering speed**

Turbine blades are another area where AM is increasingly used. Traditionally, the blades for turbines were either cast or forged, a process that requires the construction of a plug, or full-sized representation of the final blade, which is used to make the mould. This is time-consuming and costly. AM eliminates the need for a plug and allows for the use of “innovative design features such as air-heating through built-in ductwork instead of hand-laid heating wires embedded in the mold”, according to the US Department of Energy.<sup>8</sup> The Department is investing in AM technology to develop cheaper wind turbines.

General Electric (GE), the world’s largest maker of jet engines and gas turbines, is one of the leaders in the race to apply AM and is acquiring companies that specialise in this area. In 2016, GE bought the metal 3D printer makers Concept Laser of Germany and Arcam of Sweden.<sup>9,10</sup> GE has also invested around \$2 billion in developing AM and is deploying the technology in factories around the world to manufacture parts for its aviation, power turbines and oil and gas divisions.<sup>11</sup>

GE has launched a new GE Additive business to accelerate AM processes across GE and for its customers. The company plans to grow its additive business to reach \$1 billion in revenue by 2020 and become a leading supplier of additive machines, materials and software. GE believes the long-term market potential for 3D printing is huge at about \$75 billion and could reduce its product costs by \$3 billion to \$5 billion over the next decade.<sup>11</sup>

GE started testing the largest jet engine ever built, the GE9X, in April 2016. The engine, designed to power the Boeing 777X, contains turbines produced via AM as well as 19 3D-printed fuel nozzles, which spray fuel into the combustion chamber of the engine. The AM parts have helped the GE9X achieve a 10 per cent reduction in specific fuel burn over the engine currently used in the Boeing 777. GE has received more than 700 orders, worth \$29 billion, for the GE9X, which is scheduled to go into production in 2020.<sup>12</sup>

Siemens, also a major producer of turbines, says AM has reduced the period of time from the design of a new gas turbine blade to production from two years to two months. It also claims it can repair parts for industrial turbines using AM up to 60 per cent faster than via conventional methods. The company says the flexibility provided by AM “allows us to more precisely tailor development to our customers’ requirements and deliver individual spare parts on demand”.<sup>13</sup>

### **Transforming healthcare**

The potential for 3D printing is not limited to inanimate objects. AM is ideally suited for supplying body part replacements, such as rebuilding an eye socket or for hip replacements, because of the bespoke, low-volume nature of the sector. Dental implants and most hearing-aid earpieces are already made in this manner.

“A healthcare revolution is taking place throughout the world, founded on the ability to create highly personalized 3D-printed medical devices and patient-specific surgical simulation and direct printing of individualized implants and customized instrumentation,” according to 3D Systems, a US company that engineers, manufactures and sells 3D printers.<sup>14</sup>

Bioprinting is an area of AM with huge potential. It involves the printing of living human tissue that can be replicated, including skin, liver, kidney and cartilage. This allows drugs to be tested on human tissue, which can produce far more accurate results than when tested on animals. It also paves the way for the creation of whole organs such as livers, potentially rendering obsolete the need for transplants, although this is still probably around 10 years away.

### **Raising the speed limit**

For now, the use of AM is mostly confined to low volume, complex, bespoke and expensive parts that were formerly often built by hand. However, as the speed of the 3D printing machines increases, the impact of AM will be more widely felt.

Wohlers acknowledges AM’s “sweet spot” is still customised and limited-edition products, or small quantities of product, such as high-end aircraft parts and orthopaedic implants. “That’s where the payback is the best. It makes less sense to apply AM to low-cost products and those produced in very high volumes, such as plastic trashcans and stadium seats. I don’t know if it ever will,” he says.



## GO FOURTH AND MULTIPLY

*continued*

However, 3D printing is already becoming more prevalent in the jewellery industry and many consumer products companies, including major footwear brands, are now starting to manufacture using AM. The same is true of eyewear, including frames for prescription and sunglasses. "So although AM for production purposes is still in its infancy, the technology is spreading fast and many companies are simply waiting for the cost of the process to fall so that they can ramp up its use significantly," Wohlers says.

Eventually, 3D printing could even have a big impact in the car industry. Car factories run at a "blindingly-fast" pace, says James Balfour, Equity Fund Manager at Aviva Investors, and this has so far limited the uptake of the technology in the automotive sector. "If you are making a few bespoke parts, AM works well, but if you are making every single door knob on a Ford Focus it is simply not practical or economical yet," he explains.

That could change, however. In March 2017, for example, Ford announced it was testing the 3D printing of large-scale parts. "3D printing could bring immense benefits for automotive production, including the ability to produce lighter-weight parts that could lead to greater fuel efficiency. A 3D-printed spoiler, for instance, may weigh less than half its cast metal counterpart," the company said.<sup>15</sup>

### First mover advantage

While 3D printing is already being used in a number of industries, whether it makes the leap from niche to transformational depends on two things: cost and speed. Already, current 3D printers are up to 100 times faster than the early incarnations, and can produce products using a much greater range of raw materials than was once the case.<sup>16</sup> Burns believes AM specialists are currently trying to increase the speed of the printers by two to three times, which would propel the technology into other areas of manufacturing. "That is maybe 10 years away, but it is certainly an area to watch and its influence is growing," adds Burns.

Balfour says AM is not yet affecting the way he invests. "It is an underlying trend and we are monitoring it closely, but we are still waiting for the critical breakthrough on the speed of the printers that would allow them to be applied to mass manufacturing."

Balfour believes the industries most at risk of being disrupted are those where there is a large degree of complicated metal componentry, which requires considerable engineering, and "where a large amount of expensive metal ends up on the floor and sold as scrap". He cites the auto industry and aerospace sector, as well as engineering, which involve the production of complicated piping and valves.

So how can investors position themselves to take advantage of the spread of this new technology? The advent of Industry 4.0 and 3D printing should favour large companies with healthy cash reserves, given the requirement for hefty investment in new technology and training of workers in fresh skills.

First movers should also gain an advantage given the complexities involved in implementing the new methods. Rascol, for example, says Airbus regards 3D printing as a

"game changer and we need to master the technology both as architects of aircraft and as integrators, assembling aircraft from parts supplied by a large number of companies".

The technology could also affect the global supply chain and reverberate through global labour markets, inflicting a broader macroeconomic impact. Although Industry 4.0 may well hurt low-skilled employment in advanced economies, emerging economies that rely on cheap labour costs could be even more vulnerable. In 2016, the International Labour Organisation (ILO) produced a study on the impact of automation (including 3D printing) on the member countries of the Association of Southeast Asian Nations, which found as many as 70 per cent of jobs in Vietnam were at risk of automation.<sup>17</sup>

It appears 3D printing, in combination with other emerging technologies, has significant implications. By revolutionising manufacturing and production lines, Industry 4.0 holds the potential to transform not just corporate fortunes but the global economic landscape, even if we are not creating T-1000 robots out of liquid metal just yet ●

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## FIT FOR THE FUTURE?

**From the rise of passives to regulatory reform; active managers face considerable headwinds. Firms need to be both focused and flexible to be fit for the changing environment, writes Pauline Skypala.**

“

*Asset managers have not exactly stood still and watched the world change around them*

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These are tough times for active asset managers, many of which are seeing market share quickly evaporate as investors pour money into cheap, passive-based strategies. The regulatory environment has also become more challenging, with market watchdogs honing in on whether managers genuinely offer value for money to customers.

As with any industry going through a period of upheaval, there will be winners and losers. Some have already taken fairly radical steps in an effort to be resilient to the headwinds, including merging with rival firms in deals that may be a harbinger of consolidation to come. While the merger between Henderson and Janus Capital in October 2016 raised eyebrows, the alliance between Aberdeen Asset Management and Standard Life, announced in March 2017, is of greater significance. The move has been cast in some quarters as a defensive one, enabling the combined entity to achieve greater scale and cost savings to be better able to compete in a leaner and meaner global environment for asset managers.

Whatever the motivation, these firms are unlikely to be alone in looking for solutions to the outflows and fee pressure as investors turn to low-cost funds. BlackRock and Vanguard, which dominate the passive

investment sector, saw the largest inflows in their history last year. BlackRock reported net inflows of \$202 billion globally in 2016, while Vanguard attracted \$317 billion of net new money.

“The headwinds we are seeing now won’t subside; if anything they will probably accelerate,” says Jeff Margolis, founder and president at Margolis Advisory Group, a US based investment management consultant.

Dan Kemp, chief investment officer at Morningstar Investment Management EMEA, agrees the pressures on asset managers are “greater now than at any time in the previous 20 years”, but believes the developments are mostly positive. There has been a levelling of the playing field in the past five to 10 years due to greater transparency, better access to performance information and regulatory changes. “This makes asset managers more client-focused, which is good for both parties,” says Kemp.

Asset managers have not exactly stood still and watched the world change around them, but the high profit margins commanded by the industry have granted it some immunity from the virus of disruption besetting many others.



## FIT FOR THE FUTURE

*continued*



It is often compared to a super tanker, slow to manoeuvre and face in a different direction. The question of which direction to turn in is now gaining urgency. Undertaking mergers and acquisitions to realise synergies and fill skill or technology gaps is one strategy but the real question, as one observer puts it, is not how much M&A there will be but how much E&E, or euthanasia and extinction.

“Asset management is a challenged industry, where I expect to see more losers than winners,” says Patrick Connolly, head of communications at Chase de Vere.

### Passive problem

A rash of reports by management consultants last year emphasised the challenges, in particular for traditional active managers focused on outperforming a benchmark via security selection. Increasing numbers of investors have deserted them for passive funds, leaving active managers largely reliant on rising financial markets rather than inflows of new money to boost assets under management, according to Boston Consulting Group.<sup>1</sup>

Active managers have found it difficult to differentiate themselves from their passive counterparts in the past decade, as falling rates and massive central bank quantitative easing programmes have helped lift the value of risk assets. As rates normalise

and central banks wind down their unconventional monetary policies, there is a strong feeling among some active managers they will, once again, have more opportunities to show their worth.

“The falling rate environment has undoubtedly played a part in the rise of passives, as investors have enjoyed good returns simply by having exposure to the market,” says Euan Munro, Chief Executive Officer of Aviva Investors. “As rates rise and central banks step back from quantitative easing, returns will become harder to come by. We will see greater differentiation in performance and the stability of returns become increasingly important. The best managers should be able to deliver both: I see that as a real opportunity.”

While markets may return to something resembling normality, this is unlikely to curtail the rise of passives, however. Moody’s Investors Services believes the adoption of passive and low-cost products is an aspect of new technology adoption that will continue irrespective of market environments.

“We estimate that passive investments will overtake active market share [in the US] by sometime between 2021 and 2024,” says Stephen Tu, senior analyst at Moody’s. He expects a similar pattern in Europe and Asia over time. Casey Quirk, a practice of Deloitte Consulting, echoes this view and predicts<sup>2</sup> that nearly half (43 per cent) of the industry’s net new assets will go into passively-managed portfolios over the next five years.

“The tidal wave of passive is not going to subside because all the evidence shows it makes sense,” says Margolis. “It is difficult to generate ‘alpha’ and getting more so. Everyone will need to be more creative around that. You have to accept margins will come down significantly, except in the case of a few boutiques. There will still be room for unusual alpha generators as there will always be parts of investment markets that remain less efficient, but they will have to have lots of data to prove it really is alpha. Moreover, it will take less time to discover and will be arbitraged out faster.”

The US is furthest advanced in the adoption of passive investing, but that trend is also the biggest danger for European active managers, according to Diana Mackay, joint chief executive of Mackay Williams, a mutual fund market analysis and research company.

The data are persuasive. Between January 2010 and December 2016, net inflows to passive funds in Europe amounted to €41.2 billion, while for active funds they were €1.2 billion, says Mackay. Breaking this down further, for equity funds, the inflows were all to passive funds, with active funds seeing outflows. For fixed income, “active is giving way to passive, with the split currently about 50/50”.

The challenge to active management is not just from traditional passive funds tracking market capitalisation-weighted indices. Increasingly it is also coming from “smart beta” and factor based strategies, which Moody’s expects to be “the next hotspot” that will further increase fee pressures.

Noel Amenc, professor of finance at Edhec Business School and chief executive of ERI Scientific Beta, says: “The real challenge to asset managers lies in the realisation that the source of outperformance of a cap-weighted benchmark relies on overweighting factors such as small cap or value. The issue is whether active managers can outperform a factor benchmark. If you calculate with one factor you can find alpha; with a multi-factor model, no one outperforms. The industry should accept the main source of performance is risk; the question is how to manage risk.”

### Structural shifts

The switch to passive is one of five structural shifts identified by McKinsey<sup>3</sup> that are likely to make pursuing “business as usual” a recipe for failure. Primary among these is the end of an anomalous 30-year period of exceptional investment growth. The associated hunt for yield has sent investors into alternative investments, and increasingly into illiquid private markets, a trend set to continue. At the same time, digital disruption will extend beyond disintermediation of retail distribution (via robo advisers) into portfolio management and middle and back office operations. Finally, greater regulatory scrutiny will force a realignment of interests.

These trends are evident globally, if most obviously in the US. McKinsey estimates that up to \$8 trillion of assets, around 25 per cent of the US market, are “at risk”; most notably those invested in the benchmark-hugging strategies common to many asset managers. The coming shake-up will “create opportunities for high quality active managers that add demonstrable value”, as well as passive houses, says the consultant.

Most challenged are mid-sized active managers “trying to be all things to all clients and lacking a distinct source of advantage”.

Casey Quirk says fee pressure and slow growth will force managers to cut costs, in order to keep fee levels at their historic ratio of 25 per cent of returns. It expects median profit margins to fall from 34 per cent to 28 per cent within five years.

“Asset managers face the strongest headwinds yet as an industry,” says Ben Phillips, a principal at Casey Quirk. “Nevertheless, one-third of asset managers are still growing their market share by embracing new, differentiated strategies that reflect changing realities, as well as supporting products and services that appeal to sceptical investors.”

## Multi-asset advantage

The growth of multi-asset and outcome-oriented strategies is one aspect of this. Casey Quirk expects a high proportion of net new flows over the next five years to go into multi-asset, multi-strategy outcome-oriented portfolios that are designed around key investor objectives.

Mackay reports that multi-asset funds have overtaken bond funds in terms of net flows in Europe, and says offering such products is one way to combat the trend to passive. They can be sold as “active allocation” funds, as distinct from traditional balanced funds, and there is less fee pressure in this product category. “The ability to innovate on the product side will be a key determinant of future success,” says Mackay.

Connolly of Chase de Vere also advocates building a presence in the multi-asset fund sector as a vital step for managers as performance of such funds is harder to measure and money invested tends to stick. At the same time, managers need to diversify to avoid being over-reliant on one fund or strategy, he says. Aberdeen’s focus on emerging markets has worked against it recently, he notes, with the manager suffering big outflows as emerging markets fell out of favour with investors. He also advises managers to establish in niche areas, such as socially responsible investment or ethical investment, a direction of travel Mackay similarly endorses. “People don’t trust asset managers and one way round that is to do socially-responsible investment,” she says, noting growing demand for the approach among both investors and advisers.

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*Most challenged are mid-sized active managers “trying to be all things to all clients and lacking a distinct source of advantage”*

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## Socially useful

Offering “investments with purpose” is one of the opportunities that consultant EY<sup>4</sup> also advocates. It names the growing interest in the area, in particular from millennials and affluent women, as one of 10 disruptive drivers of change in the asset management industry.

However, Raj Thamotheram, chief executive of think tank Preventable Surprises, questions whether adopting environmental, social and governance factors alone will help managers; claiming it is not an easy way to pursue outperformance, even if it reduces the trust deficit.

“The main way for active managers to compete against passive is to drop closet indexing, change the culture, and become a high concentration, high conviction manager. If they did that, they would probably become more interested in ESG, even if they didn’t label it like that,” says Thamotheram.

Active management is a zero-sum game, he adds. “The alpha [managers] deliver or not is much less important than the beta [market returns] clients depend on.” Guarding against systemic risks to the beta is the job asset managers should be most focused on, via effective stewardship of the companies they invest in. “If they are not dealing with this, they aren’t being socially useful,” says Thamotheram.

Kemp of Morningstar says investors need to look at managers’ existing fund ranges to see what has changed to improve performance. “If all managers are doing is offering an expensive tracker fund, it won’t last long. It is managers that take a long-term view, keep costs low and act independently that will do well.”

## Recipe for success

McKinsey similarly says managers that meet client objectives, “whether to minimise costs or achieve more predictable

outcomes”, will capture inflows. Success will encompass a range of approaches, including traditional active strategies based on a high conviction approach, alternative investments, outcome-oriented solutions, and smart beta products.

Aviva Investors’ Munro agrees that managers who can consistently deliver desired customer outcomes will thrive, despite the challenging environment. “Historically there has been too much focus on coming up with new products in the hope they sell. Managers would be better served focusing their efforts and resources on offering a smaller number of key strategies designed to meet specific client needs. This isn’t marketing shtick: if you want to be successful, you need to put the client need at the centre of your business strategy.”

McKinsey expects the active management skill set to evolve beyond security selection to sector selection and asset allocation. But it notes that even managers with a demonstrable record of long term outperformance “will need to rethink how they communicate the value proposition of their strategies to clients”.

Amin Rajan, chief executive of Create-Research, an independent research boutique, says there are three basics managers must get right. First is client proximity, meaning understanding clients’ risk tolerance and catering for their needs rather than making them fit into the products on offer.



## FIT FOR THE FUTURE

*continued*

Second is investment capability. "In a world where market valuations are increasingly adrift from fundamentals, bonds have outperformed equities, returns are not predictable or stable over the long term, and diversification has not worked to protect against losses in downturns, do managers understand where the value opportunities and traps are?" Mr Rajan asks. "Can they take advantage of volatility, and do they know what to do when volatility is low?"

The third essential is an alignment of interests, which can be manifested through willingness to road test products before bringing them to market.

Beyond the three basics, a fourth ingredient is becoming increasingly important as investment risk shifts from institutions to individuals with the decline of defined benefit pension schemes. "We are seeing a huge personalisation of risk, but financial literacy is missing. Asset managers have a big role to play in promoting financial literacy," says Rajan.

Regulation and technology challenges are also drivers of change, he acknowledges. Good technology in the front, middle and back office is a requirement to stay in the game, not least because "machine learning is good for producing alpha". But the real differentiators will be the three factors mentioned. "Unless the industry is more receptive to client needs, it will go from boom to bust," Rajan warns.

### Digital disruption

Other commentators put more focus on the likely disruption from technological innovation. Casey Quirk tells managers they need to digitise distribution to reduce costs and engage more directly with customers in order to "own more of the value chain". McKinsey, meanwhile, points to a "once-in-a-generation opportunity" to reboot operating models using data and analytics. Those that take it will gain structural advantages, including a 10-20 per cent cost boost, it says.

Those that don't will be left behind.

Jean-René Giraud, chief executive at Trackinsight, an ETF selection platform (in which Aviva France is an investor), points to an age problem in the industry, with the gap between the technology awareness of industry employees and younger people posing a risk. Fund managers should employ young people, he says, and start with a blank canvas. Many firms have innovation departments, he notes, and are open to shaking up parts of their business, but when real change arrives "it will go so fast they won't be able to respond".

"Distribution will change in ways we don't expect. Big managers are more resilient but the speed at which firms can set up now is phenomenal. Good marketing with good products will reach clients immediately, and venture capitalists are quick to spot opportunities and pour money in."

There is nothing truly revolutionary yet in robo advice, says Giraud, "but when the big idea comes, it will come in distribution".

Some speculate the big idea will come from Silicon Valley rather than Wall Street or London, with one of the big technology companies leveraging its access to personal data and relationship with users to sell financial services. It may yet happen, but that such a threat has not materialised so far shows it is not as easy, or appealing, as it might appear. For a start, Silicon Valley entrepreneurs tend to be allergic to regulation, which is an unavoidable aspect of financial services. Furthermore, as a report by Create-Research<sup>5</sup> concludes, mass customisation is more likely to be led by industry incumbents than a Google-like tech giant because risk management is front and centre of what the industry does.

"In this age of dynamic risk, investors will be unwilling to entrust their money to outsiders without a strong risk culture and an associated brand," says Rajan of Create-Research. This does not rule out incursions by outsiders, via alliances and joint ventures, he adds.



### Future-proof?

Managers cannot say they weren't warned. They have seen the big passive houses more or less monopolising new inflows in recent months and years, the growing popularity of exchange traded funds and smart beta strategies, and the rise of robo advisers. Even as far back as 2006, an industry survey by the IBM Institute for Business Value predicted retail investors would largely switch to passive investing over the next 10 years. Few credited it at the time, but it seems prescient now.

Active managers must find a new formula to answer the threat. Predicting the future is always a hostage to fortune but if current trends persist, the businesses best positioned for success are "specialised alpha shops, beta factories, solution providers, and distribution powerhouses", according to Boston Consulting. Within those categories, managers need to be client-centric, with innovative fee structures aligned with customer interests and an ability to leverage technology to win market share.

The changes needed are as much of mindset and culture as operational. Firms that stick to traditional business models will find success elusive ●

**Pauline Skypala is a market commentator and writer on the asset management industry. Previously, she was deputy markets editor at the Financial Times until December 2015, and edited FTfm from 2004-2012.**

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 2 'Survival of the Fittest: Defining Future Leaders in Asset Management', Casey Quirk  
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