

Unstoppable trends

- THE RISE OF ASIA --
- INCREASING LONGEVITY --
- DIGITAL DISRUPTION --



INVESTMENT PRODUCTS: NOT FDIC INSURED • NOT CDIC INSURED •
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Unstoppable trends

Steven Wieting | Chief Investment Strategist and Chief Economist



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Unstoppable trends are transforming how we live and do business, with profound long-term implications for your portfolio. We explore three of these themes and how to position your wealth to take advantage of them.

We live in an era of information overload. Data and opinions swirl around us at every moment, whether we want them or not. For investors, this can pose great challenges. The latest price move, breaking story, or outrageous tweet can all too easily distract us from what really matters to our wealth.

In spite of the noise, we don't want to miss the signs and signals that will shape the economy and our investments. These appear to be slow-moving and do not generate sensationalized headlines. Yet, these forces are what we describe as 'unstoppable trends': technologies, demographics, and behaviors that will re-shape our future and create economic opportunities.

An unstoppable trend is a major, multi-year phenomenon that has the potential to transform the world around us. By definition, it represents a fundamental challenge or threat to the status quo. Its significance is global and it has implications for almost every industry. And it is likely impacting your portfolio already, for better or for worse.

By contrast, failing to position portfolios appropriately risks both missing out on potential growth opportunities

Three unstoppable trends that we believe to be most relevant for investors over the coming years are the rise of Asia, increasing longevity, and digital disruption.

The rise of Asia concerns a steady shift in global economic power from west to east. We see the region's emerging economies continuing to challenge the dominance of the US and Europe, as its middle class expands dramatically, its population migrates into cities, and its home-grown technologies advance.

Increasing longevity addresses how the aging of the world's population might impact future growth and consumption patterns.

Digital disruption looks at how digital innovation is revolutionizing companies and industries, shaking up long-established ways of doing business.

Why do we believe these trends are unstoppable? All three are shifts that have been building up over many years, and have now acquired an irresistible momentum of their own. The aging of the world's population, for example, is a result of decades of changing fertility patterns. Asia's rise reflects not only long-term demographic developments, but also investment and policy decisions taken many years ago. Digital disruption has unleashed a self-reinforcing cycle that requires businesses to adapt or die. If such trends are not unstoppable, they might nevertheless take as many decades to halt as they have to build up.

Just as we see these trends as unstoppable, we also warn investors not to ignore them. As long-term secular trends, they can persist throughout all stages of the economic cycle. Having portfolio exposure to likely beneficiaries of these trends may therefore provide resilient growth potential. By contrast, failing to position portfolios appropriately risks both missing out on potential growth opportunities and having excessive exposure to businesses likely to fall victim to these trends.

We acknowledge that some investors may have doubts about these trends. There are fears that emerging Asia might be dragged down by a slump in China. Another concern is that the tech industry may face heavy regulation from governments keen to limit its power. We do not dismiss such issues altogether. However, we do not believe they undermine the long-term case. And, indeed, they may help create buying opportunities in the near term. We recall how many investors were also doubtful when we made our case for healthcare – see **Outlook 2018** – after which the sector outperformed.

While unstoppable trends themselves are identifiable, the specific investment opportunities and risks arising from them are often much less obvious. They may be found across a variety of asset classes and markets worldwide, both public and private. They involve straightforward securities and sophisticated strategies. Given their diversity and complexity, we believe that an active approach offers the most efficient way to seek access. In the sections that follow, we explore the dynamics of three unstoppable trends and some of their likely beneficiaries.

The rise of Asia

Steven Wieting | Chief Investment Strategist and Chief Economist
Ken Peng | Head - Asia Investment Strategy



The powerful economic transformation of EM Asian countries has much further to go. But investors generally remain underexposed to the region's attractive growth potential.

A profound shift in global economic power is underway. The emerging market (EM) nations of Asia – see **infographic** – are ascending. The size, demographics, and vibrancy of these nations will challenge the longstanding economic dominance of the US and Europe. EM Asia is the only region to have consistently grown its share of world output over the past four decades. In 1980, it contributed less than a tenth of output, compared to almost one-third today. We believe this trend is set to continue. By 2023, EM Asia could account for almost 40% of world output – **figure 2**. We identify herein several likely drivers of EM Asia's ongoing development.

The demographic dividend

Asia has the largest population of any global region. Four out of ten people on earth today are either Chinese or Indian. The United Nations forecasts that the region's population may swell from 4.5bn to 5.1bn between now and 2040.¹ Of course, population expansion itself tends to raise economic output. But we believe that the forecast changes to the make-up of EM Asia's population will be even more influential.

Specifically, EM Asia's middle class appears to be on the verge of unprecedented growth. Today, around 1.9bn people in the region are defined as middle class: belonging to households with annual incomes of between US\$14,600 and US\$146,000. By 2030, however, the region's middle class population is set to rise to 3.5bn. In terms of the middle class population worldwide, therefore, almost 90% of the growth over this period is forecast to occur in Asia – **figure 3**.

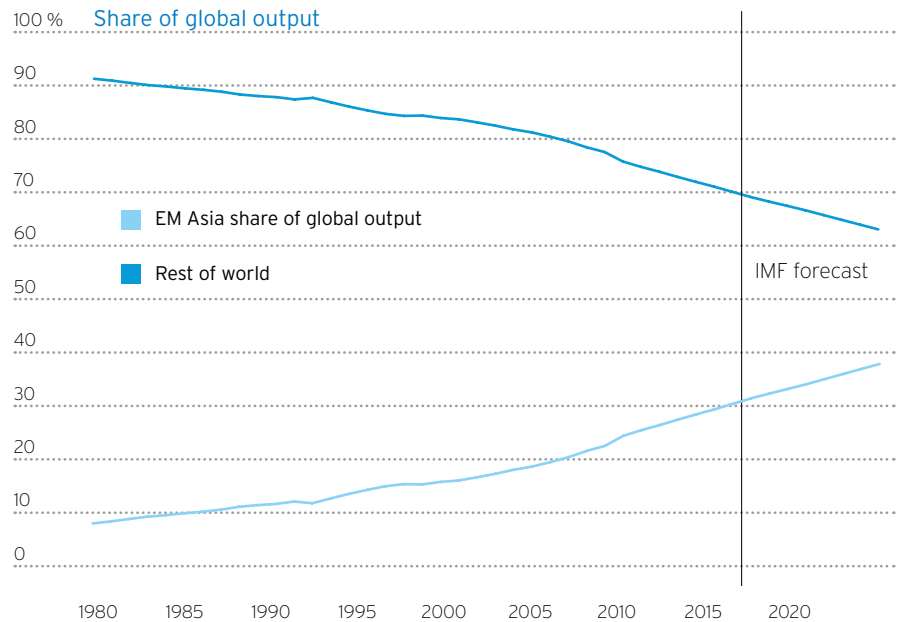
Asia's cities of the future

The new EM Asian middle class will predominantly live in cities. Just under half of the region's inhabitants are currently urban dwellers, compared to more than four-fifths of North Americans. However, this is changing rapidly. By 2030, it is forecast that five of the six world cities with more than 20 million residents will be in EM Asia: Delhi, Shanghai, Mumbai, Beijing, and Dhaka. Delhi's population alone may have grown from 25m to 36m. By 2050, another 1.2bn people may live in cities across the region.² EM Asian urbanization could potentially create numerous benefits. The necessary upgrades to infrastructure – housing, utilities, and warehousing – to

1, 2 United Nations, Department of Economic and Social Affairs, Population Division (2017). World Population Prospects: The 2017 Revision, DVD Edition.



FIGURE 2. EM ASIA'S RISING OUTPUT SHARE

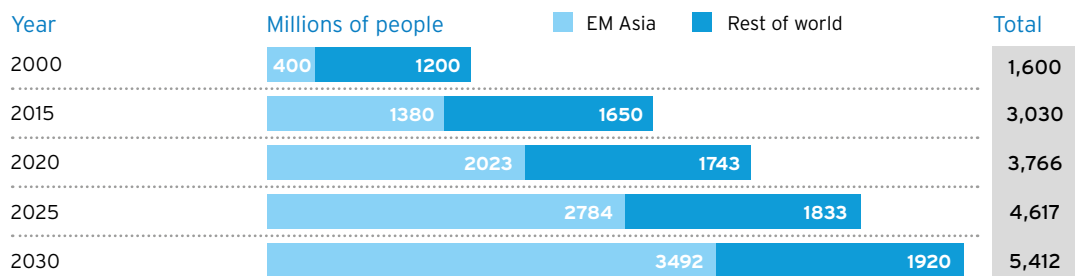


Source: Brookings Institute, as of 10 Oct 2018. All forecasts are expressions of opinion and are subject to change without notice and are not intended to be a guarantee of future events.

accommodate the burgeoning urban population may itself be an important driver of growth, as well as providing investment opportunities. The transition of people from rural areas to cities should also boost productivity. A high proportion are likely to end up working in service industries. Output

per worker in services can be several times higher than in agriculture, where many EM Asians still work today. Higher productivity may then feed into higher real wages, and in turn, into stronger consumer spending. We believe India and Indonesia could be among the main beneficiaries of urbanization.

FIGURE 3. EM ASIA'S RISING MIDDLE CLASS



Source: Brookings Institute, as of 10 Oct 2018. All forecasts are expressions of opinion and are subject to change without notice and are not intended to be a guarantee of future events.

Innovation's new frontier

As well as migrating to cities, we expect the EM Asian population of the future to be even more highly educated. For example, China and India are increasing their spending on public education. The region as a whole is producing large numbers of graduates in science, technology, engineering, and mathematics. The clustering of technologically savvy graduates in large cities typically helps to foster innovative businesses.

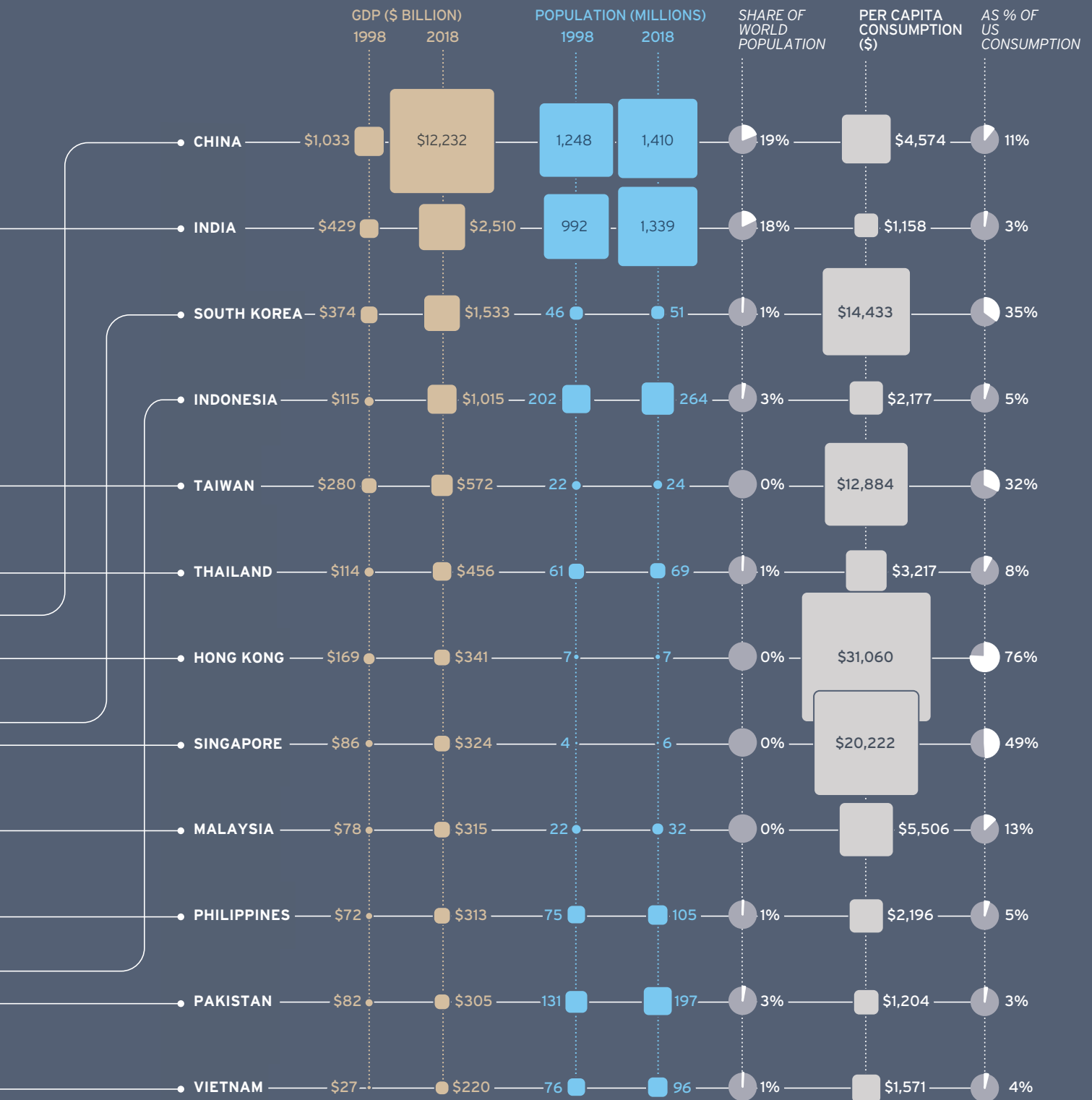
Home-grown innovation is already transforming the EM Asia region. The region's increasingly digitally connected population is generating vast amounts of data. Thanks to looser regulatory environments in key markets - particularly China - it is easier for companies to

exploit this precious resource. As the digital revolution continues - see also **Unstoppable trends: Digital disruption** - we believe that parts of EM Asia's technology industry may have key advantages over rivals in the US and elsewhere, and thus potentially offer attractive opportunities.

By global standards, we see Chinese tech giants in particular as being highly innovative and diverse. Heavy Chinese investment in areas such as artificial intelligence, virtual reality, autonomous driving, and biotech is likely to create future industry leaders. The country was also the world's biggest buyer of industrial robots in 2017, accounting for one in every three installations.



EASTERN PROMISE



Source: Haver Analytics, as of 10 Oct, 2018

Underappreciated Asian development

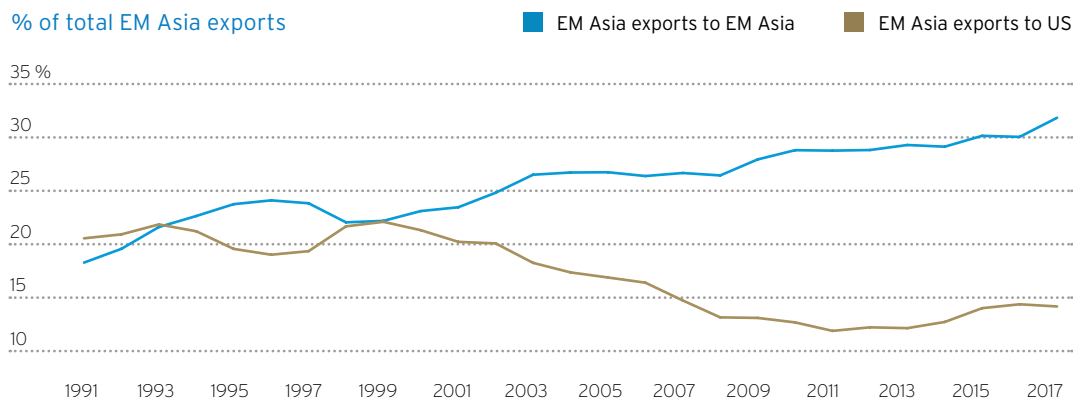
Our advice is to seek out lasting tech disruptors in China and across EM Asia, where longer-term prospects may be stronger than those in other regions.

The combination of demographic change, urbanization, and technological progress could create opportunities for a wide variety of Asian and other consumer businesses. The regional middle class's consumer spending is likely to more than double from US\$12trillion between now and 2030.³ Likely beneficiaries of rising regional incomes include the makers of a wide variety of branded goods, including personal electronics, alcoholic beverages, sportswear, cosmetics, homewares, and cars. Demand for healthcare treatment and for financial products – such as insurance and pensions – is also set to increase.

We believe that the unstoppable trend of Asian development is not sufficiently appreciated by investors as a whole. We frequently encounter portfolios that have little or no exposure to this trend, or indeed to the region more generally. There may be a number of possible reasons for this. In particular, investors may be overestimating the region's challenges, particularly after EM Asia assets' poor performance in 2018.

Recent worries have focused in particular on the effects of rising trade tensions with the US. EM Asia has indeed been one of the main beneficiaries of freer global trade over the last few decades. However, its dependency on export-driven growth has actually been falling.

FIGURE 4. EM ASIAN INTRA-REGIONAL TRADE ON THE UP

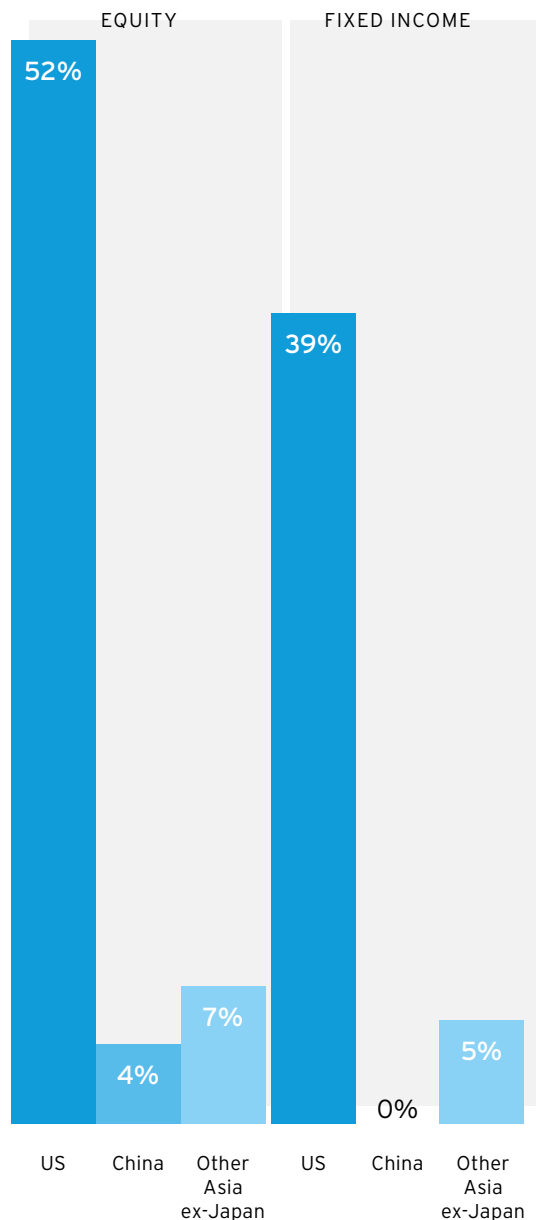


Sources: IMF, Haver Analytics, as of 10 Oct 2018.

³ Source: Brookings Institute, as of 10 Oct 2018. All forecasts are expressions of opinion and are subject to change without notice and are not intended to be a guarantee of future events

FIGURE 5.
EM ASIA UNDERREPRESENTED IN BENCHMARKS

Share of total % of index benchmark



Source: World Federation of Exchanges, Haver Analytics, Bank of International Settlements and Bloomberg Barclays Indices, as of 30 Sep 2018.

In China - the region's largest exporter - exports as a percentage of GDP have halved to 18% over the last decade. Whereas in 1999, EM Asia's exports to the US were 22% of GDP, they stand at 15% today. Trade within the region, by contrast, has expanded to 32% of GDP - **figure 4**. While we believe that new constraints on global trade would be bad for everyone, EM Asia might weather them better than some think.

There is also a belief among some investors that allocating to EM Asia assets and currencies might somehow increase a portfolio's riskiness. But while EM Asian investments themselves have a higher risk profile, adding them to a diversified portfolio may help enhance risk-adjusted returns. We therefore see EM Asia as offering one way to help implement our recommendation to go global - see **Safeguarding assets: Global portfolios are the cornerstone.**

When it comes to global asset benchmarks, EM Asia assets are currently underrepresented. Some 24% of equities and 16% of fixed income in existence globally were issued in the region. However, regional equities and bonds make up just 11% and 5% of global benchmarks - **figure 5**. We therefore expect EM Asian assets to be given greater weightings within such benchmarks over time.

However, we do not advocate merely having passive holdings and waiting for benchmarks to increase their EM Asia weightings. Instead, our favored approach is to seek out individual securities and actively managed strategies that focus upon the most attractive opportunities. Besides the long-term rationale for this, it also makes sense from a shorter-term perspective. The strength of the US dollar and trade war fears caused many EM Asian asset prices to struggle in 2018. This may have created an attractive entry-point for positioning portfolios for ongoing Asian development.

International investing entails greater risk, as well as greater potential rewards compared to US investing. These risks include political and economic uncertainties of foreign countries as well as the risk of currency fluctuations. These risks are magnified in countries with emerging markets, since these countries may have relatively unstable governments and less established markets and economics.

Increasing longevity

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The aging of the world's population presents a major challenge for society and opportunities to boost your portfolio's immunity

None of us are getting any younger and that's a fact. What most people do not know, however, is that the world's population is aging at an unprecedented rate. Around the globe, there are almost one billion people aged 60 and above - more than at any other time in human history. By 2050, more than two billion people will be over 60 years of age. And the 'very senior' population, the number of over-80s, is projected to more than triple, from 137m to 425m over the same period, concentrated in developed nations.¹

Longer lives, fewer children

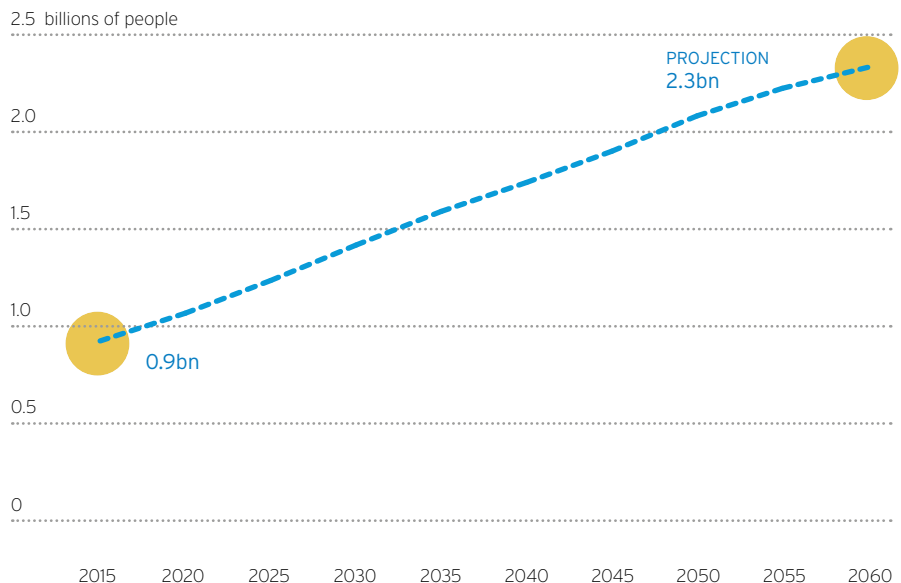
The origins of today's aging populations lie in decades-old patterns of improving life expectancy and deteriorating fertility. Life expectancy has been steadily rising since the late nineteenth century. The United Nations forecasts that this will continue - **figure 1**. Meanwhile, many societies have been producing progressively fewer children per family, reflecting profound social changes including urbanization, increased participation of women in the workforce, higher disposable incomes and a decline in the institution of marriage itself. Even if these long-established trends were to reverse - which we do not expect - they would likely take many decades to do so. For these reasons among others, we consider aging and its associated impacts to be an unstoppable trend.

Unprecedented challenges

The implications of a global demographic transformation of this magnitude are enormous. A shrinking supply of new workers to replace retirees poses challenges for businesses and for overall economic growth. While technology and increased worker productivity may offset some of the shortfall, fewer workers mean less tax revenue and higher social costs, straining government finances due to pensions and healthcare costs. Illness and chronic conditions become increasingly prevalent with advancing years. Spending per capita on healthcare in developed nations for someone aged over 85 can be as much as six times greater than for a 59-year old.²

FIGURE 1. LENGTHENING LONGEVITY

Global over-60s population forecast



Source: United Nations, Department of Economic and Social Affairs, Population Division (2017). World Population Ageing 2017 - Highlights (ST/ESA/SER.A/397). All forecasts are expressions of opinion and are subject to change without notice and are not intended to be a guarantee of future results.



Having already risen sharply in recent years, public spending on healthcare is set to swell inexorably over coming decades. Across the European Union, for example, public spending on healthcare as a proportion of GDP is projected to grow from around 7% to 7.9% by 2050. Additionally, public spending on long-term care – day-to-day support like washing, dressing, and cooking for elderly people – may grow from 1.7% to 2.7% of GDP.³

We expect that the unprecedented challenge posed by longevity will demand unprecedented responses. With a growing amount of economic output likely to be devoted to treating and supporting the elderly, we see growth potential for healthcare, both medical and services, as well as housing and other forms of support. Companies that develop innovative treatments for some of old age's most prevalent illnesses may offer attractive prospects. As well as the potential investment opportunities they may create, we can envisage possible benefits for the economy as a whole. For example, an aging workforce may remain healthier and more productive for longer as more illnesses are treated, in turn helping to sustain economic growth.

Cancer's heavy cost

Cancer is one of the worst blights upon human life. The World Health Organization estimates that the disease will kill around 9.6m people globally in 2018, equivalent to about one death in every six.⁴ Advancing age is the biggest risk factor of all for cancer. The median age for cancer diagnosis according to one study is 66, with more than three-quarters of all new cancers diagnosed in those aged 55 and over.⁵

Aside from human suffering, the economic and social costs of cancer are high and rising. Global spending on cancer medicines may already be somewhat in excess of \$100bn. As the world's population ages further over the coming decades, the cost of treating cancer is at risk of spiraling. Against this backdrop, we believe that

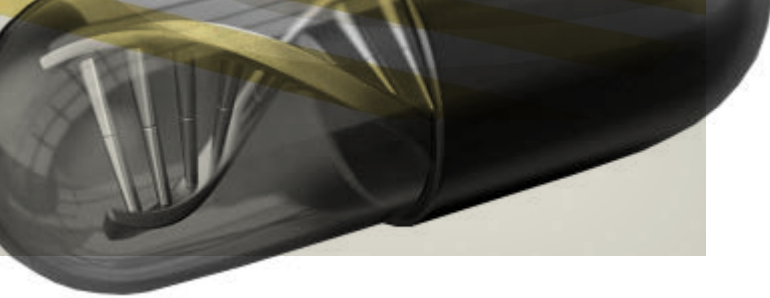
companies working to deliver innovative new cancer treatments may offer an investment opportunity. One such therapy is based on immunology, harnessing a patient's own immune system to fight cancerous cells. It is already playing a role in saving or extending certain cancer patients' lives and could become the main way of addressing advanced cases of cancer, potentially becoming a \$35bn-a-year market.⁶ The next stage of immunotherapy's development may lie in refining today's treatments and combining them with others to seek greater effectiveness still. Furthermore, immunological treatments are likely to be useful in thwarting other age-related illnesses, such as dementia.

Aging's ailments

Of course, cancer is far from the only condition that often accompanies old age. Alzheimer's disease, rheumatoid arthritis, osteoporosis, and diabetic retinopathy are just a few of the other illnesses whose incidence will rise alongside longevity. Some of the leading treatments for these conditions are biologics: big brand-name drugs made from biological rather than chemical sources.

While effective, biologics tend also to be very costly. A year's course of certain treatments can cost tens or even hundreds of thousands of dollars. Biosimilars are synthetic, copycat versions of biologics, which perform the same clinical function but at a fraction of the price. Citi Research believes that biosimilars could take more than \$110bn in revenues from biologics makers in the decade to 2025.⁷ Producers of biosimilars may thus offer an attractive investment profile.

Aside from drugs, medical devices will likely see greater demand as populations continue to age. These include replacement hips, knees, and other orthopedic fittings. We also expect the surgical procedures associated



with these and other treatments to be increasingly carried out with the assistance of robots. Both companies specializing in medical devices and medical robotics may thus have solid growth potential.

Earlier warnings

Of course, while older people as a whole are more susceptible to many diseases, each individual is different. Today, most conditions are identified only after they have developed and produced symptoms. However, tests that can identify a person's genetic predisposition to particular diseases are increasingly becoming available.

Driving such developments is progress in genomics: the study of the structure, evolution, mapping and editing of our entire DNA. Various governments worldwide - notably in the UK, US, and China - are trying to sequence the genomes of large segments of their populations. The aim is to enable fresh understanding of the causes, diagnosis, and treatment of disease. This in turn may lead to powerful new treatments, including genetic or other interventions for previously undiagnosed or untreatable conditions.

As well as government initiatives, individuals are increasingly taking advantage of commercially available personalized tests. These can indicate, for example, the likelihood of later developing older age diseases including Parkinson's, Alzheimer's, breast cancer, and rare blood diseases. Testing enables an individual to determine alongside a health practitioner what steps might be taken to lower the risks, slow a disease's onset, or stall its progression.

Taking preventative steps against potential old age and other diseases could generate important savings for patients and health systems. In parallel, such steps also raise important moral, legal, and financial issues, particularly around allocation of resources and confidentiality.

Patients and insurers, for instance, have diametrically opposing interests when it comes to the disclosure and use of test results. While regulatory issues will require close monitoring, we believe that the companies that provide genetic sequencing instrumentation offer attractive exposure to the long-term secular theme of genomics.

Wearable care

Innovative devices may also play an important role in treating and caring for aging populations. Wearable technologies - such as smart watches - are already helping to give early warnings of health and fitness issues, as well as monitoring existing conditions and events. These include cardiovascular disorders, diabetes, epileptic fits, and falls suffered by the elderly in their homes.

The potential benefits of wearable technologies for elderly users and for society as a whole are numerous. They can monitor for the correct and timely ingestion of medicines and allow for early identification of silent, but potentially fatal changes in patient function, including arrhythmias and pre-stroke brain activity. Through early interventions, treatment costs and hospitalizations may be reduced. They could help older people to stay living independently in their own homes for longer, by guiding their daily activities, monitoring their medication intake, encouraging exercise and calling for help in the event of falls or other difficulties.

We see the wearables market as having significant growth potential. According to ResearchandMarkets, global wearable electronics volumes could expand from 115.8m to 289.5 million units, or compound annual growth of 16.5% between 2017 and 2023.⁸ Aside from further improvements in technology, a key driver may be the insurance industry. Increasingly, health and life coverage may be made contingent upon wearing a device and sharing its data with an insurer. In addition, monitoring and service agency businesses may benefit from sustained use of wearable devices.

Risks to our case

Serving the needs of a relentlessly aging population clearly offers potential opportunities for companies in the healthcare industry and beyond. However, there are also risks. We expect continued advances in medical treatments and technologies to cause disruption, making some existing treatments and technologies redundant. Having significant exposure to victims of such disruption risks underperformance and perhaps losses. An active and diversified approach to investment selection may help mitigate this risk.

Another risk derives from regulation. Faced with rising healthcare costs, governments may intervene more heavily in the marketplace in order to bring down prices. As well as price controls, measures may be taken to increase competition, which could negatively impact certain innovative firms. Political pressure for these and other measures may mount given the rising number of elderly voters and their tendency to turn out and vote.

Boost your portfolio's immune system

Given these unstoppable aging trends and the resulting investment opportunities, we believe that diversified allocations should include exposure to the potential growth companies in the industries we have discussed. Although ours is a multi-year view, we also stress the potential benefits over shorter horizons. The performance of the US healthcare sector, for example, has been positively correlated with increased economic uncertainty, outperforming most other sectors in each of the three last recessions - **figures 2 and 3**. In a late-cycle environment such as today's, therefore, such investments may potentially improve risk-adjusted returns, boosting your portfolio's immune system now and in the future.

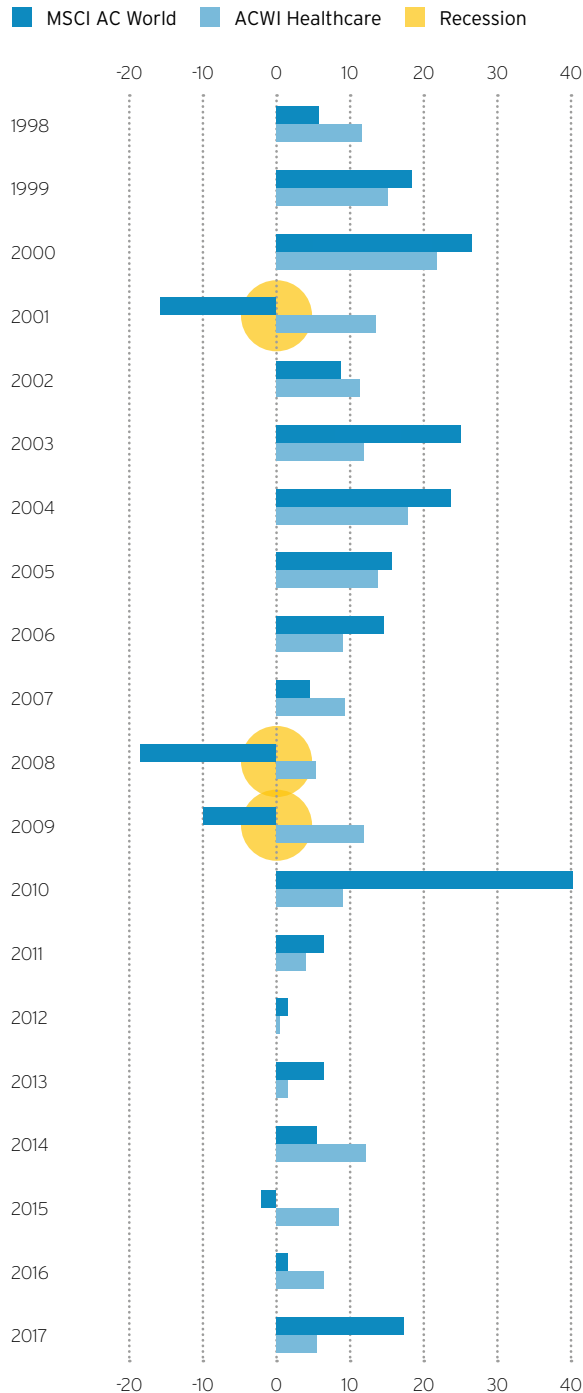
Healthcare industry risks: The healthcare industries are subject to government regulation and reimbursement rates, as well as government approval of products and services, which could have a significant effect on price and availability, and can be significantly affected by rapid obsolescence and patent expirations.

Biotechnology industry risks: The biotechnology industry can be significantly affected by patent considerations, intense competition, rapid technological change and obsolescence, and government regulation.

1. Source: United Nations, Department of Economic and Social Affairs, Population Division (2017). World Population Ageing 2017 - Highlights (ST/ESA/SER.A/397).
2. OECD, Estimating Expenditure by Disease, Age and Gender, 2016
3. OECD, Health at a Glance: Europe 2016 - OECD 2016
4. World Health Organization: Cancer – Key Facts, 12 Sep 2018
5. Age and Cancer Risk was originally published by the National Cancer Institute, April 29, 2015
6. Citi Research, Immunotherapy – The Beginning of the End for Cancer. Important disclosure: https://www.citivelocity.com/cvr/epublic/citi_research_disclosures. For details on the CR ratings system, please refer to the attached link: <https://ir.citi.com/PuXs6xELNHAu7UqkjvWxnihtUeLtAtDxeEh%2B2qaPpPb7uukpx8Qw1vzcuidtMtqgn1BWqJqak8%3D>
7. Citi GPS, Disruptive Innovations
8. Research and Markets, "Wearable Electronics Market: Global Industry Trends, Share, Size, Growth, Opportunity and Forecast 2018-2023"

FIGURE 2. HEALTHCARE'S OUTPERFORMANCE IN RECESSIONS

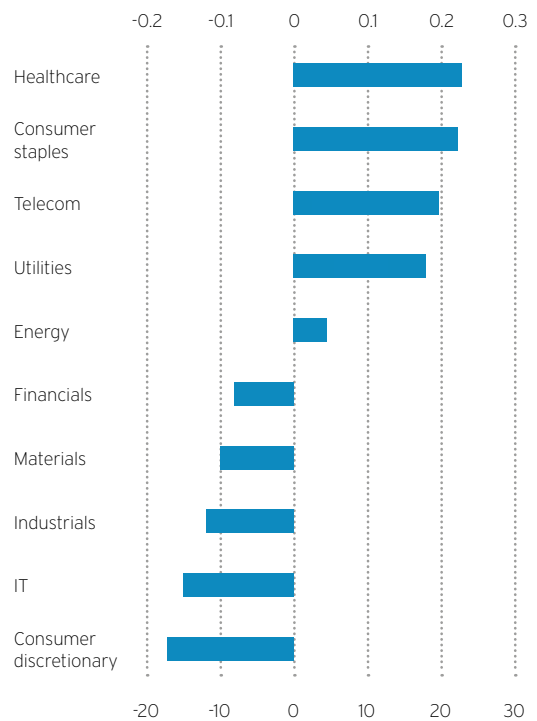
YoY EPS growth (%)



Source: Bloomberg, as of 10 Oct 2018. Past performance is not indicative of future returns. Real results may vary. Indices are unmanaged. An investor cannot invest directly in an index. They are shown for illustrative purposes only.

FIGURE 3. ECONOMIC UNCERTAINTY HAS HELPED HEALTHCARE

Correlation with US economic policy uncertainty



Source: Bloomberg, as of 10 Oct 2018. The chart shows the relationship between sector performance and US economic policy uncertainty. Correlation is a statistical measure of how two assets or asset classes move in relation to one another. Correlation is measured on a scale of 1 to -1. A correlation of 1 implies perfect positive correlation, meaning that two assets or asset classes move in the same direction all of the time. A correlation of -1 implies perfect negative correlation, such that two assets or asset classes move in the opposite direction to each other all the time. A correlation of 0 implies zero correlation, such that there is no relationship between the movements in the two over time. Past performance is not indicative of future returns. Real results may vary.

Digital disruption

Phil Watson | Chief Innovation Officer and Head of the Global Investment Lab



The advance of digital technologies continues to revolutionize business and improve our daily lives, with profound implications for your portfolios.

Digital technologies continue radically to transform the world of business as we know it. Companies just five or ten years old are deploying digital technologies to produce and deliver goods and services in innovative ways that meet customers' needs more effectively than before. In many cases, these companies are disrupting the structure of industries, seizing market leadership from those that have dominated for generations. Incumbent competitors in many sectors will either rise to this digital challenge or suffer decline and perhaps destruction.

The benefits of digital disruption to customers are all around us. The ways we make purchases, send payments and borrow money, communicate with each other, and enjoy entertainment have been revolutionized. In the workplace, a growing number of straightforward and sophisticated tasks - from shifting boxes to life-saving medical procedures - are now undertaken partly or wholly by intelligent machines.

In manufacturing, the way goods are made and even the supply chain for materials is being permanently altered.

Investments in leading digital disruptors have contemporaneously delivered rewards. The equity prices of Facebook, Amazon, Netflix, and Google have outperformed the rising S&P 500 Index by an annualized average of 23% over the last five years – **figure 1**. In the process, such firms are eclipsing longstanding incumbents. In September 2018, Wirecard – a fintech firm founded less than two decades ago – replaced the 148-year old Commerzbank in Germany's DAX 30 Index, of which it had been an original member.

The benefits of digital disruption to customers are all around us

FIGURE 1. MEGA-BITES: FANG OUTPERFORMANCE

January 2014 = 100

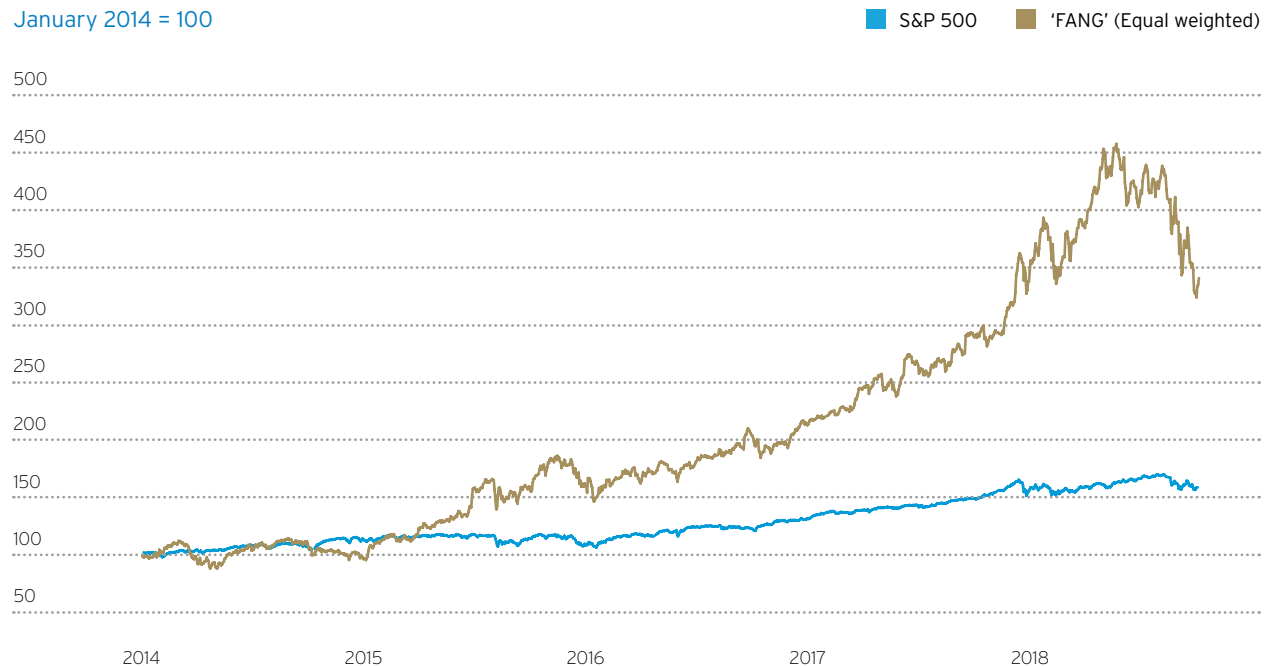
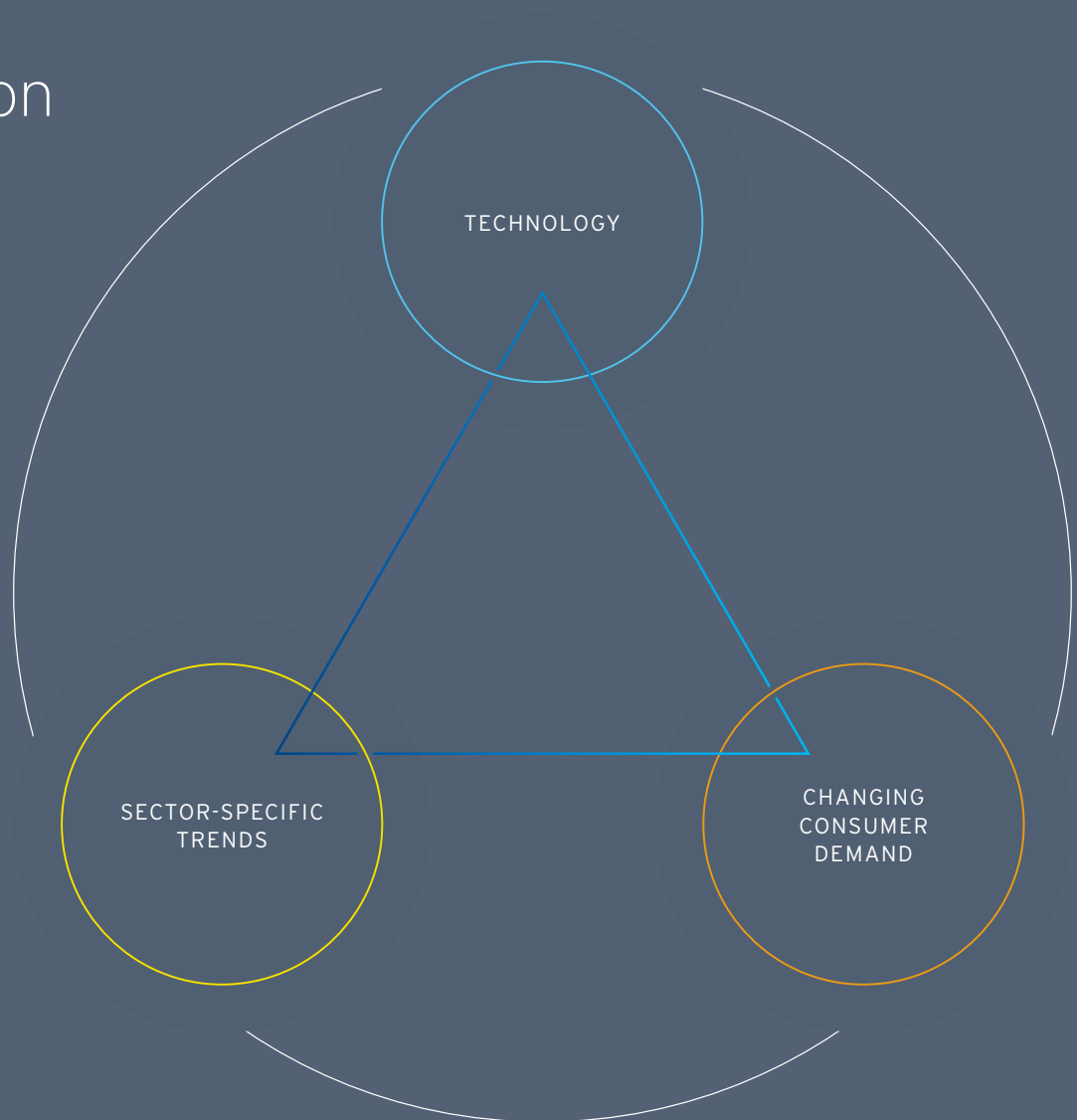


Chart shows average performance of Facebook, Amazon, Netflix, and Google. Source: Haver, as of 28 Nov 2018. Past performance does not guarantee future results. Indices are unmanaged. An investor cannot invest directly in an index. They are shown for illustrative purposes only.

Core innovation catalysts



We believe there is much more digital disruption to come. Venture capitalists, sovereign wealth funds, and family offices are investing hundreds of billions of dollars in early- to late-stage private companies, powering research and development, as well as building new digital infrastructure. Fresh digital technology hubs are opening up, particularly in China, where the government aims to turn the nation into a tech superpower. Crucially, different digitally disruptive forces are converging and reinforcing one another. And yet, there remain many businesses and industries still

only in the early stages of digital disruption. These are just some of the reasons why we believe digital disruption represents an unstoppable trend and a major, long-term investment theme. Here, we consider the importance of three digitally disruptive technologies – artificial intelligence (AI), robotics and automation, and blockchain – as well as the opportunities and risks they may create for your portfolio.

Artificial intelligence

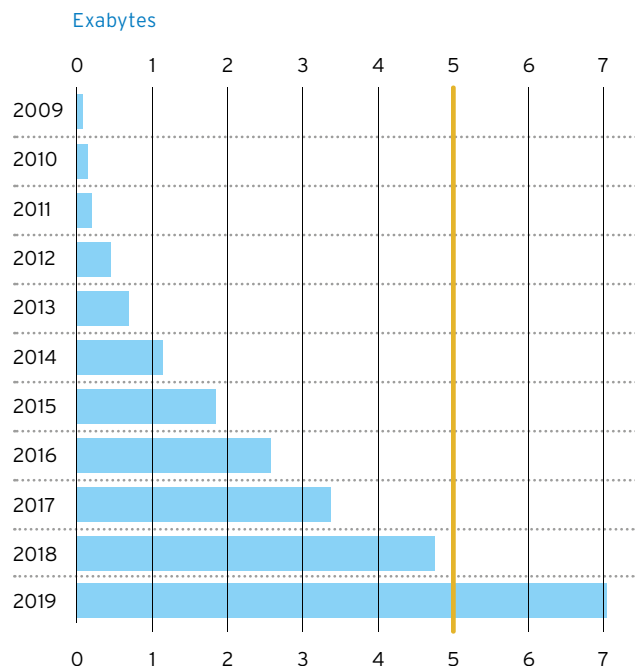
Machines are getting smarter by the day. Artificially intelligent technologies - those that perform work by developing and applying human-like reasoning - are tackling a growing number of ever more complex tasks. From inventory management to counter-terrorism, AI is at the cutting edge of business transformations. Big data is enabling AI's rise. Some 90% of the data in existence today has been created only in the last two years - **figure 2**. AI is already helping to detect illnesses, spot fraud, optimize energy use, compose music, predict and influence purchasing behavior and uncover investment opportunities, to name but just a few. However, AI is in its early stages.

The benefits to the world economy of AI's ongoing advance are likely to be far-reaching. Looking at nineteen broad industry groups, the McKinsey Global Institute believes that AI could create as much as \$5.8 trillion of value annually, with some of the largest potential gains available in retail, transport and logistics and travel. The functions within industries where AI could unlock most value are marketing and sales, followed by supply-chain management and manufacturing.¹

While we expect AI to disrupt many areas within the economy, certain industries look likelier to be affected, to a greater extent, and sooner than others. For example, personal mobility might be on the verge of its biggest disruption since the advent of the motor car. The world's roads today remain dominated by vehicles powered by combustion engines, and controlled by human drivers, who are typically also their owners. However, autonomous vehicles - those that can drive themselves without the intervention of a human controller thanks partly to AI - could be about to change that.

Google estimates that all human data from pre-history to 2003 was roughly 5 exabytes

FIGURE 2. HOURLY MARGINAL DATA STORAGE DEMAND



Source: Haver Analytics, Citi Research, and Bloomberg, as of 22 Aug 2018. All forecasts are expressions of opinion and are subject to change without notice and are not intended to be a guarantee of future events.

¹ McKinsey Global Institute - Notes from the AI frontier, Michael Chui, James Manyika, and Nicolaus Henke, Rita Chung, Pieter Nel, Sankalp Malhotra, April 2018. The value potential estimate includes consumer surplus. <https://www.mckinsey.com/featured-insights/artificial-intelligence/notes-from-the-ai-frontier-applications-and-value-of-deep-learning>.

The road ahead

Tomorrow's transportation systems are likely to look radically different to today's. Combining disruptive technologies including AI, robotics, internet connectivity, advanced computing power and electric batteries, the driverless car of the future might offer many potential benefits. These include reduced emissions, saving many of the lives lost in road traffic accidents globally each year, and easing road congestion, thus enhancing productivity.

The transformation of road transport may also involve a revolution in how vehicles are used and owned. Today, not only are vehicles predominantly owned by their drivers, but they often spend most of the time parked in a driveway. By contrast, the driverless car market of tomorrow may be typified by people hiring RoboTaxis for individual trips, much as they do with Uber-type services today, as well as subscribing to driverless car services. Subscriptions would allow them to summon a vehicle whenever needed, with that vehicle serving other subscribers the rest of the time. In other words, people might not own cars anymore, nor drive them, nor stop at gas stations along the way.

Citi Research estimates that the total addressable RoboTaxi market in the US alone may be worth some \$900bn in revenues. It expects RoboTaxis to begin US commercialization from around 2019, with subscription services potentially accelerating rapidly from the mid-2020s. It also estimates that each fleet of autonomous vehicles with 100,000 subscribers might be able to generate gross lifetime profits of \$2.5bn.² Among potential victims of this disruption are people who currently earn a living from driving - like truck and taxi drivers - as well traditional businesses that are unwilling or unable to embrace AI.

The transformation of road transport may also involve a revolution in how vehicles are used and owned

Smarter healthcare

Another industry that we believe may reap the benefits of AI and other disruptive technologies in the coming years is healthcare. Combining AI with big data creates various possibilities. Detecting disease, analyzing scans, processing insurance claims, and ensuring patients are in the right place at the right time are just a few of the present and potential uses. Quicker, cheaper, and more accurate diagnosis could improve and save lives, as well as limiting rising healthcare costs.

Further ahead, Citi Research believes that applying AI to big data could help perform predictive diagnosis, estimating the probability of a patient having a particular condition. This would involve AI rapidly analyzing a far greater volume of historic data worldwide than a human practitioner could do in several lifetimes, and using this information to predict diagnoses. The healthcare data resources upon which AI could draw have already grown exponentially in recent times. Between 2013 and 2020, healthcare data production is forecast to have grown from 153 Exabytes to 2310 Exabytes.³ Of course, this also creates new challenges, especially around maintaining the security and confidentiality of personal information, itself an industry opportunity.

² Disruptive Innovations VI, Citi GPS: Global Perspectives & Solutions, August 2018

³ Big Data and Healthcare, Stephanie Demko, Citi Research, August 2018. (One Exabyte is 1, 000,000,000,000,000 bytes.)

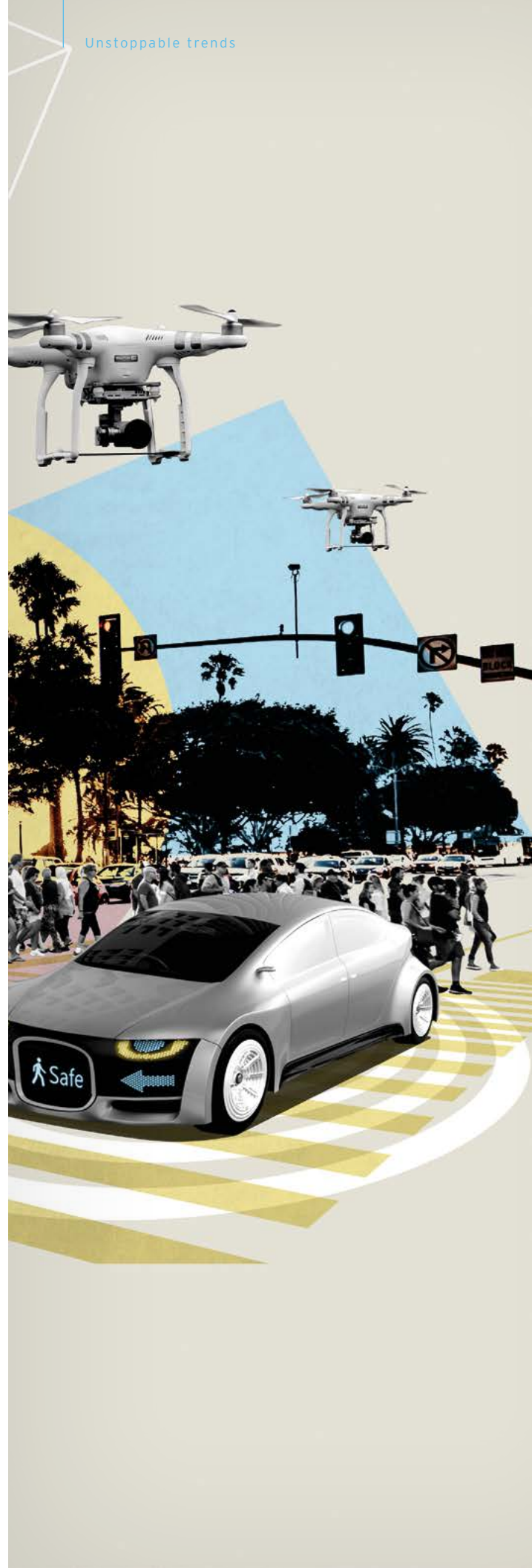
Blockchain

Blockchain is another disruptive technology that we are evaluating. In essence, blockchain is a distributed database, in which information is shared among all users of the network, rather than being held and controlled by a central administrator. All users can store their own copy of the database and all are required to validate new information added to it. Its core characteristics include immutability, validation by consensus, and security.

Chain reaction

We see blockchain's characteristics as adaptable to multiple uses across the economy and society, especially those where trust between users is important. These include automating manual checking processes, eliminating many layers of intermediate steps and middlemen. The recording, storage, and processing of data could thus become simpler, streamlined, cheaper, more accurate, and more trustworthy. As a result, companies across various sectors - as well as governments - are currently looking at how blockchain might help boost their revenues, cut costs, reduce risk, and enhance their processes and output.

We see blockchain's
characteristics as
adaptable to multiple
uses across the economy
and society



The **Blockchain: Users & uses** graphic opposite shows an ongoing Citi Research study into the sort of companies that have announced that they are employing blockchain, as well as how they are applying the technology. The evidence suggests that blockchain is being trialed for processes where verification is critical, but where data does not tend to change significantly. Examples of these include supply chain management, trade finance, and registration of identities and land registration. Smart contracts – blockchain-based contracts whose coding enables them to execute and enforce themselves without human intervention – may have applications in a broad range of contractual transactions, including insurance, securities trades, and the transfer of owned assets, from cars to phones. By maintaining the integrity of data, ownership can be ascertained and assured, from transaction to transaction.

The payments and banking industry is showing interest in blockchain for business-to-business (B2B) payments. Such payments are typically accompanied by a great deal more data, as well as their involving much larger amounts of money. Reconciling data – particularly in cross-border transactions – can be complicated, time-consuming, and subject to error, especially since paper-based payments are often involved. Industry insiders believe the potential scope for savings could be substantial when it comes to reconciliations.

According to the head of global payments at SWIFT – which provides secure financing messaging services – 30% savings may be available on reconciliation

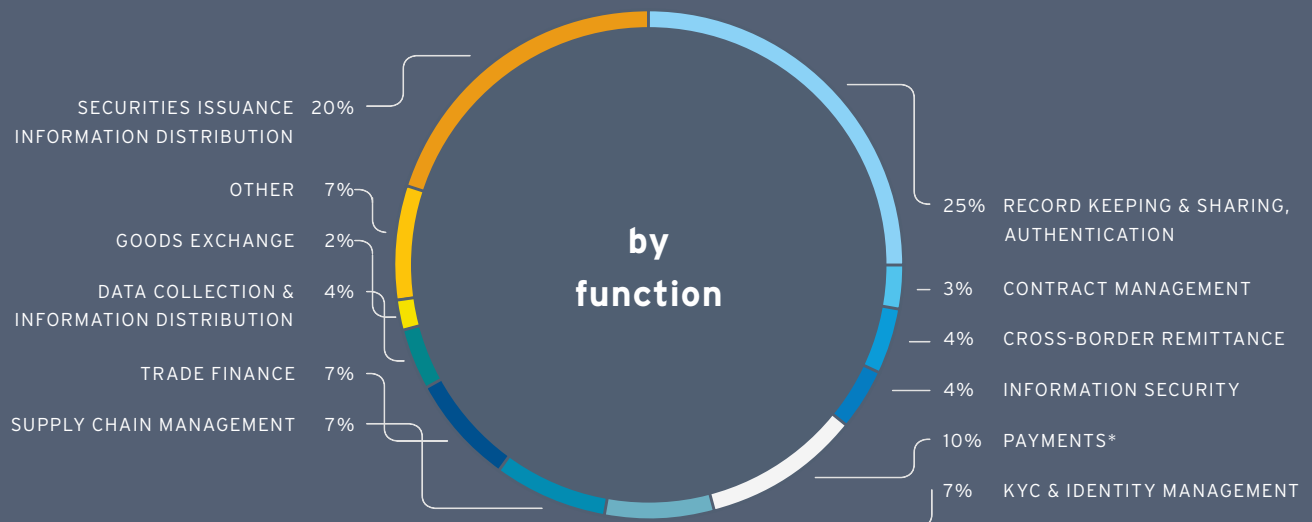
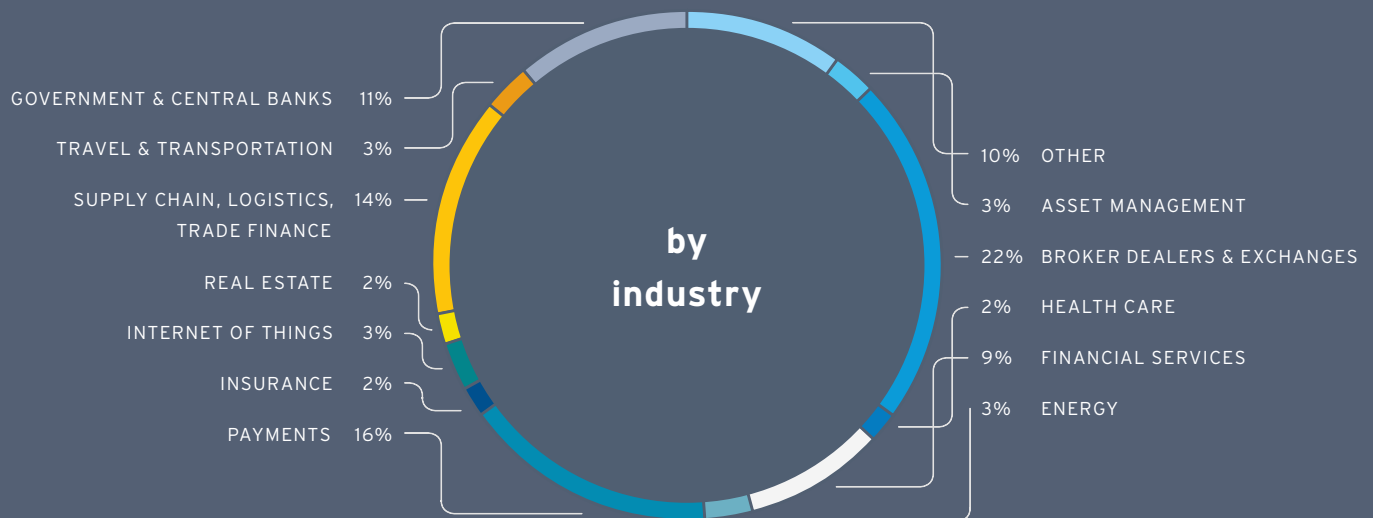
costs of cross-border B2B payments. Among the major challenges faced are keeping data held on blockchain safe from cybercriminals and keeping the blockchain records stored properly.

Likewise, the healthcare industry is assessing blockchain's ability to help manage the burgeoning amounts of patient information. Currently, healthcare records are highly fragmented. Family doctors, healthcare providers, and insurers often use different record-keeping systems, making it hard for them to share critical information. Storing data on blockchain might promote interaction between providers. Records could then be shared and analyzed by AI, drawing upon sources across the world. One risk here is that highly personal data could become compromised. Another is that even if blockchain based systems do emerge, they do not interact effectively, thus replicating today's fragmentation.

While the potential benefits of blockchain are diverse, we would stress that they are likely to take time to be realized. Citi Research sees few signs that this technology is going to have a material impact on public companies' earnings in the near term. They nevertheless maintain a target list of companies exposed to the potential disruption of blockchain that deserve monitoring. These companies are drawn from across the IT, financial, oil & power trading, leisure and restaurants, metals and mining, and telecom communications infrastructure industries. We expect this list to increase over time, with blockchain providing competitive advantages to those companies and industries that adopt it.

While the potential benefits of
blockchain are diverse, they are likely
to take time to be realized

Blockchain: Users & uses



Cumulative announcements from early 2016 to the first half of 2018.

Source: Citi Research, CoinDesk, Finextra, and Company Reports, as of 31 Oct 2018.

Robotics

Programmable machines that can perform work automatically have existed for decades. In this time, their range of uses has multiplied, as has the complexity of the work they can do. Robotic technologies today play a vital part in many industries and increasingly in our everyday lives. Nonetheless, we believe that the growth potential of robotics remains substantial. Much of this may derive from the combination of robotics and other disruptive technologies, such as AI.

Robotics adoption is proceeding rapidly. Global sales of industrial robots reached a new record of 387,000 units in 2017, up 31% over the previous year. Much of the growth is occurring in Asia, specifically in China, Japan, and South Korea – see also **Unstoppable trends: The rise of Asia**. Among industries, the automotive sector – which has long been a heavy user of robotics – continues to account for growth, along with the metal, electrical and electronics, and food industries.⁶

We believe that replacing and complementing human labor with robotic labor is not only desirable, but essential. Productivity gains have been disappointing across many economies over recent years, which has limited overall growth and standards of living. With a rapidly aging global population – see **Unstoppable trends: Increasing longevity** – certain nations and industries now face a large shortage of labor and skills.

The economic and human benefits of increased robotics deployment might be particularly great in medicine. An existing shortage of medical personnel – from specialists to nurses – threatens to worsen over the coming years. Automated help may be at hand, though. Robotic involvement in invasive surgery is still in its infancy,

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perhaps covering only 2% of applicable procedures. However, Citi Research believes that surgery and invasive diagnostics is poised to see an acceleration in adoption. By 2030, it forecasts that robotic deployment may be more than five times greater than today, growing the medical robotics market from \$4bn to \$18bn.⁷

Prepare your portfolio for digital disruption

We believe the unstoppable trend of digital disruption has far to go. While digitally disruptive technologies including the three we have examined here may continue to evolve fairly fast, however, their effects upon businesses may take longer to make themselves felt fully. Disruptors and the disrupted can coexist for many years. The video store's demise did not occur as soon as DVD-by-mail and streaming services emerged. Likewise, we were able to identify the vulnerability of many out-of-town malls and other retail assets several years ago – see **Outlook 2015: Transforming commerce** – well before much of the actual distress began.

6 World Robotics Report 2018 - the International Federation of Robotics (IFR).

7 The Future of Medical Robotics, A Deep Dive into the Procedures, Technologies, and Companies Shaping the Coming Revolution, Citi Research. Citi Research, June 2018.

While digital disruption can take its time, however, you cannot afford to do so in relation to your portfolio. Just as we believe that companies must address the challenge posed by digital disruption, so must their investors. This calls for continual monitoring of your portfolio exposure both to digital disruptors and to their likely victims. At present, we observe that digital winners are under-owned in client portfolios. Citi Private Bank's Global Investment Lab can help you to understand your present exposures to digital risks and opportunities and the possibilities for allocating accordingly. A good first step is to obtain your own personalized Outlook Watchlist report.

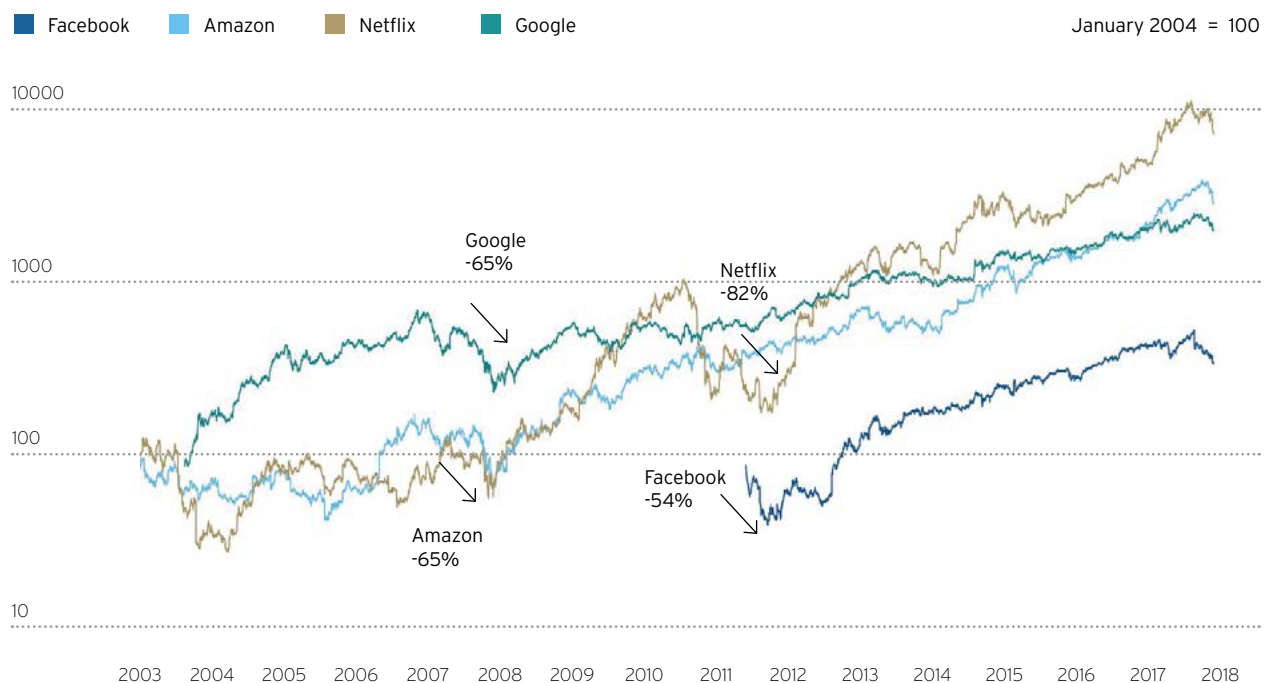
Keeping informed about the overwhelming variety and volume of developments within digitally disruptive technologies poses a further challenge. Also, much of what companies are doing in this regard cannot be understood via conventional sources, such as annual reports. Citi Private Bank's Innovation Office was established specifically to address such issues. Working in partnership with

other teams across Citi's global network, we can be your guide to the forces of innovation that are shaping business and investments, both in the digital space and beyond.

Our approach stresses identifying both the risks and the opportunities. As well as the uncertainties associated with new technologies and how companies use them, we are mindful of the greater volatility and drawdowns that typical investments in early-stage digital disruptors often entail. And, with such companies frequently staying private for longer nowadays, accessing such opportunities may indeed require taking illiquidity risk.

Even the largest and most successful disruptors come with substantial risks. Facebook's volatility, for example, between January 2015 and October 2018 has been double that of the S&P 500 index. It has also suffered more than six drawdowns of more than 10% since 2015 - **figure 4**. We seek not only to help you manage such risks, but also to turn them to your advantage. Digital disruption is here to stay - is your portfolio prepared?

FIGURE 4. DISRUPTORS' DRAWDOWNS



Source: Haver, as of 10 Oct 2018. Past performance does not guarantee future results.



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Glossary

ASSET CLASS DEFINITIONS

Cash is represented by US 3-month Government Bond TR, measuring the US dollar-denominated active 3-Month, fixed-rate, nominal debt issues by the US Treasury.

Commodities asset class contains the index composites – GSCI Precious Metals Index, GSCI Energy Index, GSCI Industrial Metals Index, and GSCI Agricultural Index – measuring investment performance in different markets, namely precious metals (e.g., gold, silver), energy commodity (e.g., oil, coal), industrial metals (e.g., copper, iron ore), and agricultural commodity (i.e., soy, coffee) respectively. Reuters/ Jefferies CRB Spot Price Index, the TR/CC CRB Excess Return Index, an arithmetic average of commodity futures prices with monthly rebalancing, is used for supplemental historical data.

Global Developed Market Corporate Fixed Income is composed of Bloomberg Barclays indices capturing investment debt from seven different local currency markets. The composite includes investment grade rated corporate bonds from the developed-market issuers.

Global Developed Market Equity is composed of MSCI indices capturing large-, mid- and small-cap representation across 23 individual developed-market countries, as weighted by the market capitalization of these countries. The composite covers approximately 95% of the free float-adjusted market capitalization in each country.

Global Developed Investment Grade Fixed Income is composed of Barclays indices capturing investment-grade debt from twenty different local currency markets. The composite includes fixed-rate treasury, government-related, and investment grade rated corporate and securitized bonds from the developed-market issuers. Local market indices for US, UK and Japan are used for supplemental historical data.

Global Emerging Market Fixed Income is composed of Barclays indices measuring performance of fixed-rate local currency emerging markets government debt for 19 different markets across Latin America, EMEA and Asia regions. iBoxx ABF China Govt. Bond, the Markit iBoxx ABF Index comprising local currency debt from China, is used for supplemental historical data.

Global High Yield Fixed Income is composed of Barclays indices measuring the non-investment grade, fixed-rate corporate bonds denominated in US dollars, British pounds and Euros. Securities are classified as high yield if the middle rating of Moody's, Fitch, and S&P is Ba1/BB+/BB+ or below, excluding emerging market debt. Ibbotson High Yield Index, a broad high yield index including bonds across the maturity spectrum, within the BB-B rated credit quality spectrum, included in the below-investment-grade universe, is used for supplemental historical data.

Hedge Funds is composed of investment managers employing different investment styles as characterized by different sub categories – HFRI Equity Long/Short: Positions both long and short in primarily equity and equity derivative securities; HFRI Credit: Positions in corporate fixed income securities; HFRI Event Driven: Positions in companies currently or prospectively involved in wide variety of corporate transactions; HFRI Relative Value: Positions based on a valuation discrepancy between multiple securities; HFRI Multi Strategy: Positions based on

realization of a spread between related yield instruments; HFRI Macro: Positions based on movements in underlying economic variables and their impact on different markets; Barclays Trader CTA Index: The composite performance of established programs (Commodity Trading Advisors) with more than four years of performance history.

High Yield Bank Loans are debt financing obligations issued by a bank or other financial institution to a company or individual that holds legal claim to the borrower's assets in the event of a corporate bankruptcy. These loans are usually secured by a company's assets, and often pay a high coupon due to a company's poor (non-investment grade) credit worthiness.

Private Equity characteristics are driven by those for Developed Market Small-Cap Equities, adjusted for illiquidity, sector concentration, and greater leverage.

INDEX DEFINITIONS

The **Bloomberg Barclays Global Aggregate Bond Index** is a flagship measure of global investment grade debt from twenty-four local currency markets. This multi-currency benchmark includes treasury, government-related, corporate and securitized fixed-rate bonds from both developed and emerging markets issuers.

The **Bloomberg-JP Morgan Asia Currency Index** is designed as a spot index of the most actively traded currency pairs in Asia's emerging markets valued against the US dollar.

The **CSI 300** is a capitalization-weighted stock market index designed to replicate the performance of top 300 stocks traded in the Shanghai and Shenzhen stock exchanges. It was considered as a blue chip index for mainland China stock exchanges

Citi US Broad Investment Grade Index (USBIG)–Corporate, is a subsector of the USBIG. The index includes fixed rate US dollar denominated investment grade corporate debt within the finance, industrial and utility sectors. This index includes US and non-US corporate securities (excludes US government-guaranteed and non-US sovereign and provincial securities).

Citi Emerging Markets Sovereign Bond Index includes local currency sovereign bond indices for 14 emerging markets countries. These indices comprise fixed-rate sovereign debt with at least one-year until maturity. They are market capitalization-weighted and rebalanced monthly for Brazil, Chile, Colombia, Hungary, Indonesia, Malaysia, Mexico, Peru, Philippines, Poland, Russia, Thailand, Turkey, and South Africa.

The **Citi Euro Broad Investment Grade Index** is a multi-asset benchmark for investment-grade, Euro-denominated fixed income bonds. It includes government, government-sponsored, collateralized, and corporate debt.

Citi's US High-Yield Market Index is a US dollar-denominated index which measures the performance of high-yield debt issued by corporations domiciled in the US or Canada. Recognized as a broad measure of the North American high-yield market amongst all Citi's fixed income indices, it includes cash-pay and deferred-interest securities. All the bonds are publicly placed, have a fixed coupon, and are non-convertible.

The **Citi World Broad Investment Grade Index** is a multi-asset, multicurrency benchmark which provides a measure of the global fixed income markets.

The **Euro Stoxx 600** represents large-, mid- and small-cap companies across 17 countries across Europe including: Austria, Belgium, Czech Republic, Denmark, Finland, Germany, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

The **MSCI Emerging Markets Index** captures large- and mid- cap representation across twenty-four Emerging Markets (EM) countries. With 837 constituents, the index covers approximately 85% of the free float-adjusted market capitalization in each country.

The **MSCI Emerging Markets (EM) Latin America Index** captures large and mid-cap representation across five Emerging Markets (EM) countries in Latin America. With 113 constituents, the index covers approximately 85% of the free float-adjusted market capitalization in each country.

The **MSCI World Index** represents the performance of more than 1,600 large- and mid-cap stocks across 23 developed markets countries. The index covers approximately 85% of the free float-adjusted market capitalization in each country

The **MSCI World ex-USA Index** represents the performance of large and mid-cap representation across 22 of 23 developed markets countries excluding the United States. With 1,005 constituents, the index covers approximately 85% of the free float-adjusted market capitalization in each country.

The **Standard & Poor's 500 Index** is a capitalization-weighted index that includes a representative sample of 500 leading companies in leading industries of the US economy. Although the S&P 500 focuses on the large-cap segment of the market, with over 80% coverage of US equities, it is also an ideal proxy for the total market.

OTHER TERMINOLOGY

Adaptive Valuations Strategies is Citi Private Bank's own strategic asset allocation methodology. It determines the suitable long-term mix of assets for each client's investment portfolio. Correlation is a statistical measure of how two assets or asset classes move in relation to one another. Correlation is measured on a scale of 1 to -1. A correlation of 1 implies perfect positive correlation, meaning that two assets or asset classes move in the same direction all of the time. A correlation of -1 implies perfect negative correlation, such that two assets or asset classes move in the opposite direction to each other all the time. A correlation of 0 implies zero correlation, such that there is no relationship between the movements in the two over time.

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LIBOR - The London interbank offered rate is the rate of interest at which banks offer to lend funds to each other. It is used as a reference rate for large amounts of financial contracts.

Price-to-book ratio (P/B) compares the capitalization of an individual stock or of an index of stocks to the value of that stock or that index's combined shareholder capital. It is calculated by dividing the current closing price of the stock by the most recently reported book value per share. A low P/B can indicate a lowly-valued company or index, while a high P/B can indicate high valuation.

Price-earnings ratio (P/E) measures a company's or an index of companies' current share price relative to its earnings per share. A low P/E can indicate a lowly-valued company or index, while a high P/E can indicate high valuation.

Return on equity (ROE) is the amount of net income earned as a percentage of shareholders equity. It captures a company's profitability - or aggregate profitability among numerous companies - by showing how much profit is achieved with shareholders' capital.

Sharpe ratio is a measure of risk-adjusted return, expressed as excess return per unit of deviation, typically referred to as risk.

Strategic asset allocation is the process of creating a long-term investment plan by assembling an appropriate mix of equities, fixed income, cash and other investments. It can potentially enhance portfolio returns and help manage risk. Strategic Return Estimates are Citi Private Bank's forecast of returns for specific asset classes over a 10-year time horizon. The forecast for each specific asset class is made using a proprietary methodology that is appropriate for that asset class. Equity asset classes are forecast using a proprietary methodology based on the calculation of valuation levels with the assumption these valuation levels revert to their longterm trends over time. Fixed Income asset classes are forecast using a proprietary methodology based on current yield levels. Other asset classes have other specific forecasting methodologies. Please note that hedge funds, private equity, real estate, structured products and managed futures are generally illiquid investments and are subject to restrictions on transferability and resale. Each SRE is gross of actual client fees and expenses. Components of the methodology used to create the SREs include the rate of return for various asset classes based on indices. Termination and replacement of investments may subject investors to new or different charges. Past performance is not indicative of future results. Future rates of return cannot be predicted with certainty. Investments that pay higher rates of return are often subject to higher risk and greater potential loss in an extreme scenario. The actual rate of return on investments can vary widely over time, especially for long-term investments. This includes the potential loss of principal on your investment. It is not possible to invest directly in an index.

Tactical asset allocation looks to adjust the strategic asset allocation of a client's investment portfolio to incorporate shorter-term market insights.

Volatility - is a statistical measure of the variation of returns for a given security, market index, or asset class. It is most often measured by way of standard deviation. The higher the volatility, the riskier the underlying asset is considered to be.

Yield-to-Maturity (YTM) is the total return received on a bond or index of bonds when held to maturity. The total return includes both the payment of coupons and the return of the principal at maturity.

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http://www.theocc.com/components/docs/about/publications/november_2012_supplement.pdf and

https://www.theocc.com/components/docs/about/publications/october_2018_supplement.pdf

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(MLP's) - Energy Related MLPs May Exhibit High Volatility. While not historically very volatile, in certain market environments Energy Related MLPs may exhibit high volatility.

Changes in Regulatory or Tax Treatment of Energy Related MLPs. If the IRS changes the current tax treatment of the master limited partnerships included in the Basket of Energy Related MLPs thereby subjecting them to higher rates of taxation, or if other regulatory authorities enact regulations which negatively affect the ability of the master limited partnerships to generate income or distribute dividends to holders of common units, the return on the Notes, if any, could be dramatically reduced. Investment in a basket of Energy Related MLPs may expose the investor to concentration risk due to industry, geographical, political, and regulatory concentration.

Mortgage-backed securities ("MBS"), which include collateralized mortgage obligations ("CMOs"), also referred to as real estate mortgage investment conduits ("REMICs"), may not be suitable for all investors. There is the possibility of early return of principal due to mortgage prepayments, which can reduce expected yield and result in reinvestment risk. Conversely, return of principal may be slower than initial prepayment speed assumptions, extending the average life of the security up to its listed maturity date (also referred to as extension risk).

Additionally, the underlying collateral supporting non-Agency MBS may default on principal and interest payments. In certain cases, this could cause the income stream of the security to decline and result in loss of principal. Further, an insufficient level of credit support may result in a downgrade of a mortgage bond's credit rating and lead to a higher probability of principal loss and increased price volatility. Investments in subordinated MBS involve greater credit risk of default than the senior classes of the same issue. Default risk may be pronounced in cases where the MBS security is secured by, or evidencing an interest in, a relatively small or less diverse pool of underlying mortgage loans.

MBS are also sensitive to interest rate changes which can negatively impact the market value of the security. During times of heightened volatility, MBS can experience greater levels of illiquidity and larger price movements. Price volatility may also occur from other factors including, but not limited to, prepayments, future prepayment expectations, credit concerns, underlying collateral performance and technical changes in the market.

Alternative investments referenced in this report are speculative and entail significant risks that can include losses due to leveraging or other speculative investment practices, lack of liquidity, volatility of returns, restrictions on transferring interests in the fund, potential lack of diversification, absence of information regarding valuations and pricing, complex tax structures and delays in tax reporting, less regulation and higher fees than mutual funds and advisor risk.

Asset allocation does not assure a profit or protect against a loss in declining financial markets.

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Investing in smaller companies involves greater risks not associated with investing in more established companies, such as business risk, significant stock price fluctuations and illiquidity.

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