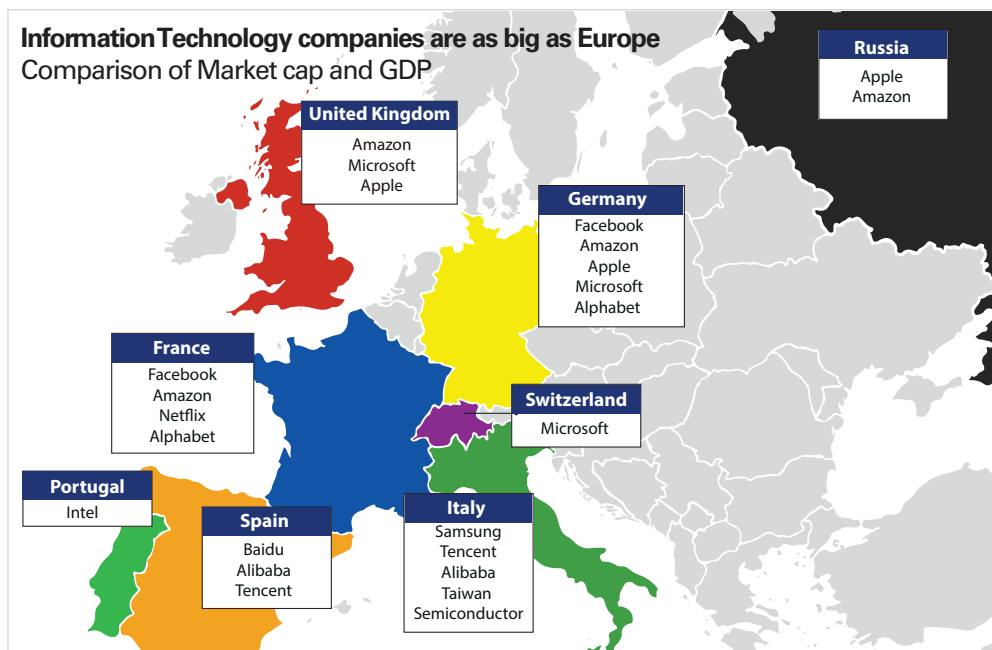


GLOBAL STRATEGY PAPER NO. 29

# Why Technology is not a bubble

Lessons from history



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## WHAT'S INSIDE

A focus on the drivers of technology performance and valuation

Comparisons with previous bubbles (tech 1990s, 'Nifty Fifty' 1960s/70s)

A look at historical 'technology revolutions' and comparison with today

A history of sector and stock dominance in the equity market

- Amazon, Apple and Microsoft have a combined market capitalisation greater than the annual GDP of Africa (54 countries).
- But technology returns have been justified by fundamental growth and valuations are much lower compared with previous market bubbles.
- The biggest individual stocks historically have reached a higher share of the S&P 500 than today. Apple is 4% of the S&P compared with 7% for IBM in 1978, 6% for AT&T in 1981, and 5% for Exxon in 2008.
- Sectors and stocks can dominate equity markets for long periods. Transport remained the largest sector in the S&P for over 60 years (1852 and 1914). While selected 'value' may recover, technology is likely to continue to dominate.

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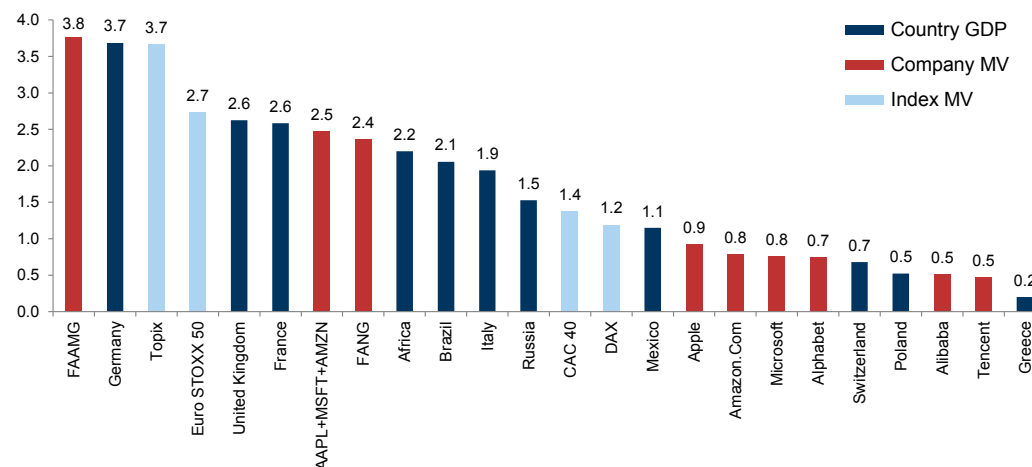
## Technology in numbers

Technology is dominating economies and stock markets alike. Since the start of the financial crisis we have seen a dramatic rise in the dominance of technology in stock markets as well as the influence of technology on sectors in traditional industries. Quite how successful and dominant it has become is difficult to overestimate. But such dominance of sectors and stocks is not without precedents and, as we will show, can be very long lasting.

The current size of the largest most powerful technology companies globally is put into some perspective in the 'map' above which compares some of the tech giants to the current annual size of GDP of some of the major European economies. Of course this is not a like for like comparison (a company value is the net present value of future expected cash flows whereas the size of GDP is an annual snapshot of an economy) but it nonetheless is fairly striking even when you compare the top technology stocks in size to other major markets.

**But as Exhibit 1 shows that widens the comparisons to include stock market indices, the top 5 US technology stocks have a combined market capitalisation of more than the EuroStoxx 50 companies together. The top 20 global technology companies are bigger than the value of the STOXX 600 index of Europe.**

**Exhibit 1: Comparison of GDP and Market Value of various countries, indices and Technology companies**  
2017 GDP, Market prices as of May 30, 2018; USD tn

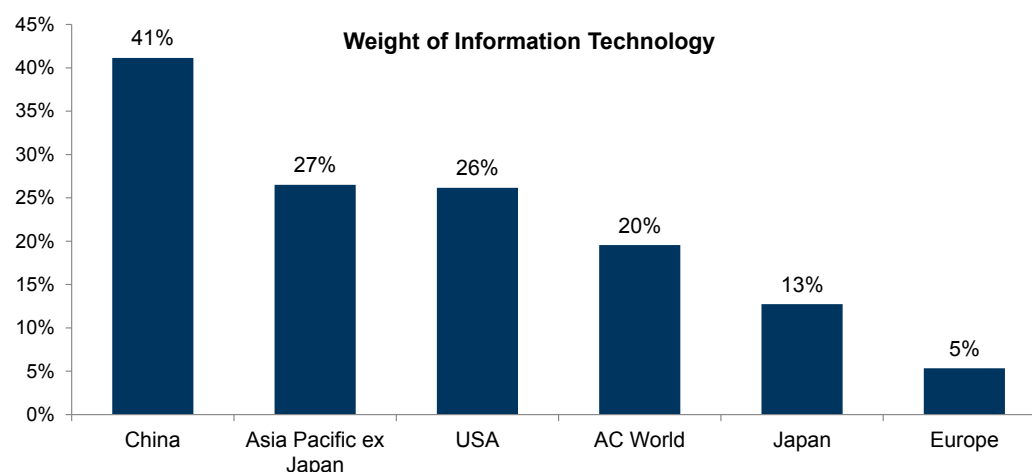


Source: IMF, FactSet, Datastream, Goldman Sachs Global Investment Research

## Technology is dominated by the US and China

While technology companies have become very dominant this is not true in every market. The growth of Technology as a sector has not been evenly spread across the World. Some countries have become much more successful in generating (or attracting) large technology companies than others. **The S&P for example has 25% in Technology, China is now over 40%. Europe, on the other end of the extreme, has just 5% of its market capitalisation in the Technology sector (almost 50% of which is comprised of just two companies, SAP and ASML).**

**Exhibit 2: Weight of Technology in world equity indices**  
MSCI indices



Source: MSCI, FactSet, Goldman Sachs Global Investment Research

It is worth also noting that these aggregates themselves mask even bigger differences across markets since some large 'technology' companies are not defined as such in the indices. **If we add Amazon, and other companies in the Internet retail sub sector, the 'technology' total in the US rises to roughly 30%; if we included biotech the total would be roughly one third of the US stock market.**

This is true for other market too of course. In the case of Japan, the MSCI classification of "info tech" doesn't include many obvious tech-related firms like Sony, Panasonic, Nidec, so the 13% also understates the Tech exposure.

## Changing definitions

The question of definition will become more prominent in September this year when Standard & Poors will re-classify components of the global equity markets (for details, see [\*The once & future tech sector: Regulation and re-classification represent risks for growth investors, US weekly kickstart, 13th April 2018\*](#)). Using the S&P 500 index as an example, five current constituents (GOOGL, FB, EA, ATVI, TTWO) comprising nearly 20% of the existing Information Technology sector will be re-classified into Communication Services. Following the reclassification, the Information Technology sector weight in the S&P 500 will decline to 20% from 25% which will prevent it from overtaking the highest composition that we have seen in the past. Communication Services will also include the current Telecom sector and select media and

entertainment stocks from the Consumer Discretionary sector. The new sector will carry a weight of 10% in the S&P 500 and contain most of the stocks currently facing regulatory scrutiny regarding consumer data and market concentration. **The new “legacy” Tech sector will carry a 20% index weight and exhibit slower earnings growth but also lower valuations, a higher shareholder yield, and significantly less regulatory risk than the current Tech sector.** Our US strategists argue that these qualities will make it attractive for growth-oriented investors who wish to avoid exposure to regulatory risk in their portfolios. Also the new sector will provide the possibility of new higher growing companies as **new technologies and companies evolve in areas such as robotics and cloud computing. This evolutionary effect of innovation has been a characteristic of major technology cycles in the past.**

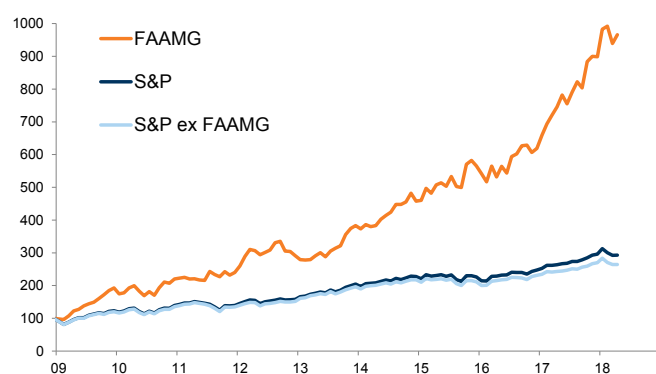
### The winner takes all

**The concentration of the largest stocks globally is also very striking. The biggest 20 technology stocks globally have a combined market cap of over \$6trn, but the top 5 companies comprise 60% of this total. These super - large companies are concentrated in two geographies:**

**1) US - FAAMG:** Facebook, Amazon, Apple, Microsoft, and Alphabet’s Google.

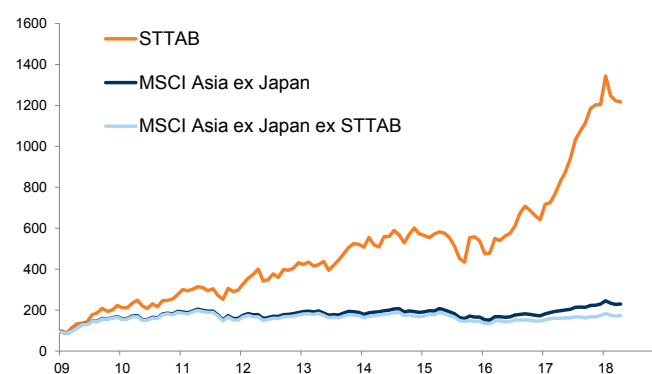
**2) Asia - STTAB:** Samsung, Tencent, Taiwan Semiconductor, Alibaba, Baidu.

**Exhibit 3:**  
Performance of FAAMG and S&P since 2009



Source: Datastream, Goldman Sachs Global Investment Research

**Exhibit 4:**  
Performance of STTAB and MSCI Asia ex Japan since 2009

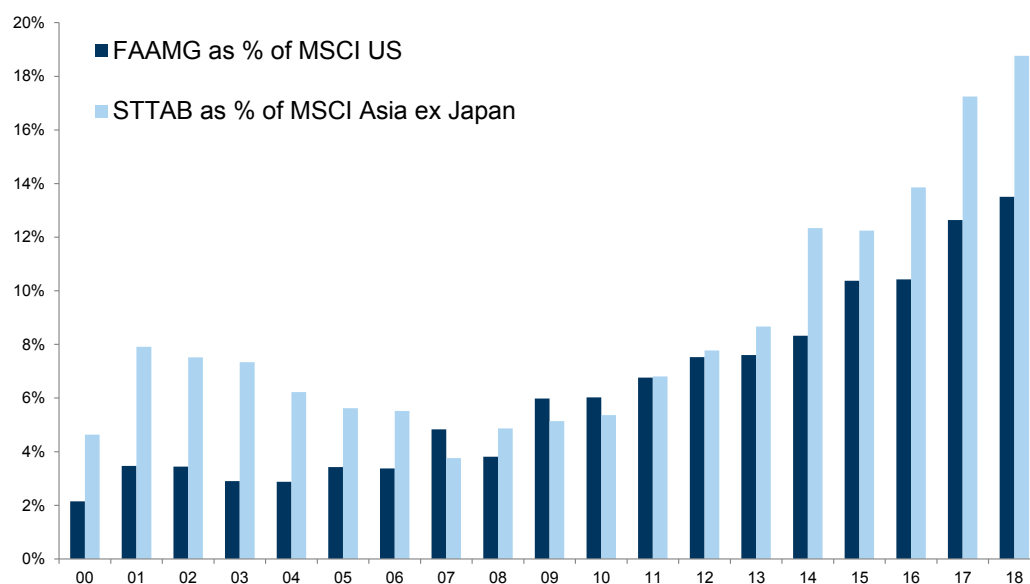


Source: Datastream, Goldman Sachs Global Investment Research

As Exhibit 5 shows the weight of technology in the US and Asia has increased particularly rapidly since the financial crisis. These 5 US companies alone make up about 15% of the S&P 500 and the 5 Asian companies make up about 20% of the MSCI Asia ex Japan. In China alone, however, the large 3 companies Tencent, Alibaba and Baidu make up around 35% of the broader index (MSCI China).

**Exhibit 5: Technology stocks in China have a bigger weight recently**

Current biggest technology companies



Source: FactSet, Goldman Sachs Global Investment Research

In time China is likely to become more influential in technology. According to our economists (see *China's upgrade in manufacturing gives big boost to 'quality of growth', 24th April 2018*), **China's production of higher-tech manufacturers has matched the US's (\$1trn) and now outspends the US in capex in the sector by 80% (\$450bn compared with \$250bn). This is a remarkable growth given that in 2005 China produced and invested one third of what the US did in high tech.**

**Extraordinary Success - justified by fundamentals**

There is no doubt that many larger technology companies have achieved spectacular returns since the financial crisis started but, **unlike the technology mania of the 1990s, most of this success can be explained by strong fundamentals revenues and earnings rather than speculation about the future.**

**Technology stock prices have been driven by margins and earnings.**

**In the late 1990s** the technology sector was driven by significant valuation expansion as investors were seduced into believing that 'technology' or even telecom and media companies could generate huge potential returns. In the current cycle the success of the technology sector largely reflected stronger fundamental revenue growth and margins.

As our colleagues in the US have shown, in the current environment some of the **biggest technology stocks are generating sales growth at 5x that of the rest of the market and margins that are twice as high** (Exhibit 6).

**Exhibit 6: Facebook, Apple, Amazon, Microsoft and Google (FAAMG) vs. the rest of the S&P 500**

YoY sales growth						Net margin					
	Realised			GS forecasts			Realised			GS forecasts	
	2015	2016	2017	2018	2019		2015	2016	2017	2018	2019
FAAMG	14%	8%	19%	20%	15%	FAAMG	18%	18%	17%	19%	18%
S&P 500 ex FAAMG	-6%	0%	5%	4%	4%	S&P 500 ex FAAMG	9%	9%	9%	10%	10%

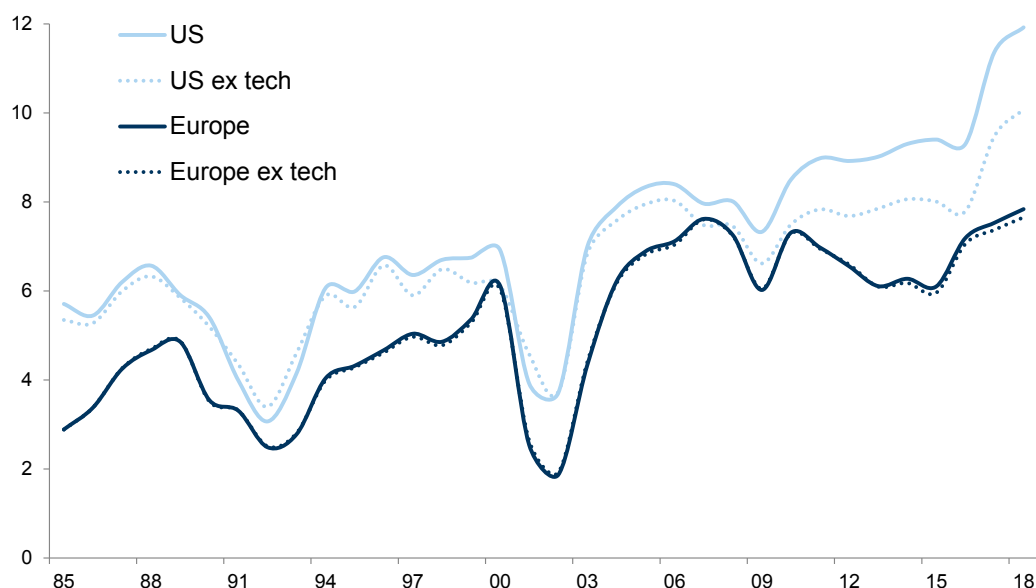
Source: Factset, Goldman Sachs Global Investment Research

The rise in margins of many of the largest technology companies explains much of the success of the increase in overall stock market margins since the financial crisis - at least in the US equity market.

Exhibit 7 shows the picture for the US and Europe. The light blue line shows that for the market as a whole US margins are at a significant all time high - roughly 50% higher than their previous peak just prior to the financial crisis. Europe, by contrast is just now back to the margin levels last seen in 2007. But Technology has driven around 70% of the increase in US margins in this cycle.

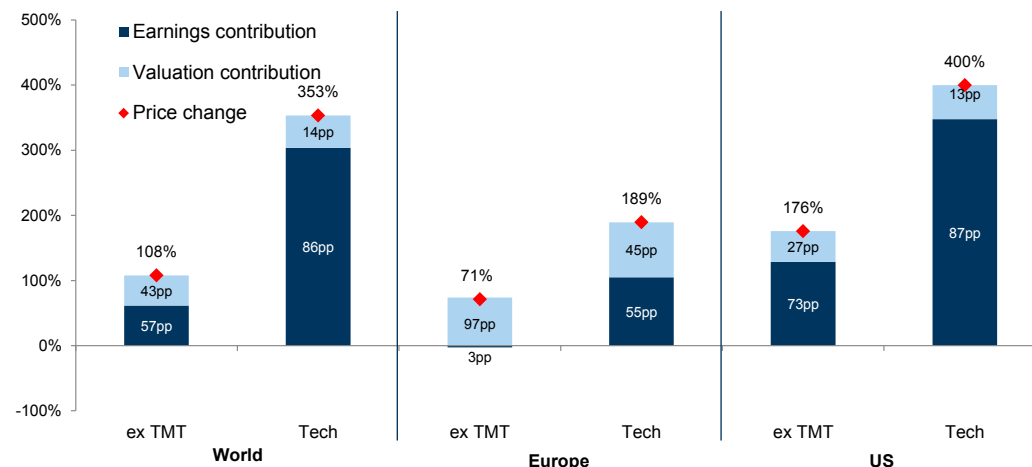
**Exhibit 7: The gap between US and European margins halves if we exclude technology**

Net income margins, in all cases ex financials (%)



Source: Datastream, Worldscope, Goldman Sachs Global Investment Research

**Margin expansion and stronger earnings have explained most of the returns in the technology sector in recent years. Indeed, as Exhibit 8 shows, the bulk of the returns in the technology sector have been driven by earnings (86% of the total since 2008 in the global technology sector). The market ex technology has actually seen a larger proportion of its returns driven by valuation expansion than has been the case in the technology sector.**

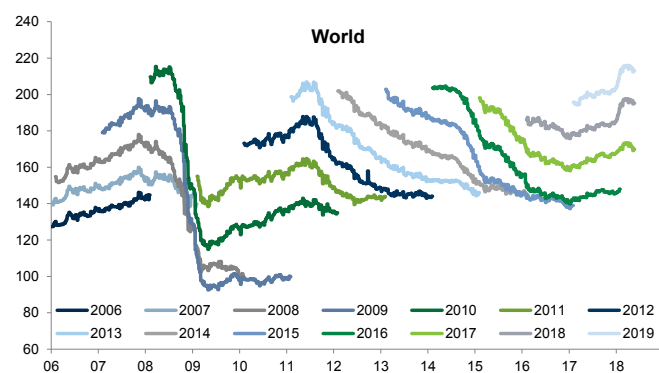
**Exhibit 8: Changes in prices based on valuation and earnings changes since December 2008**

Source: Worldscope, Datastream, Goldman Sachs Global Investment Research

Furthermore, while earnings revisions for the entire stock market experienced years of significant downgrades since the start of the financial crisis (Exhibit 9), technology sector revisions were far more stable (Exhibit 10). **In an uncertain World with significant downside economic tail risks, technology has been seen to be correctly relatively stable.**

**Exhibit 9: The global stock market experienced years of negative earnings revisions**

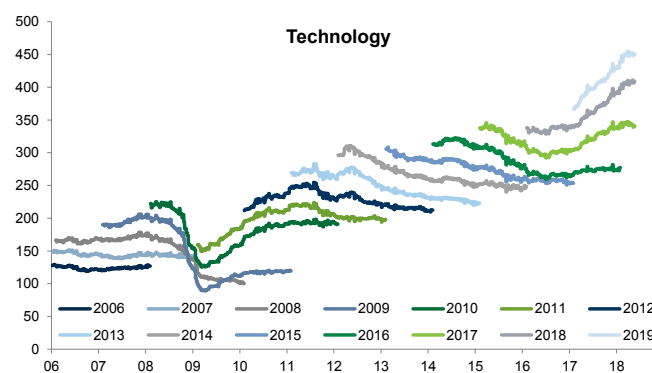
MSCI AC World EPS revisions overtime (2008 EPS = 100)



Source: Datastream, IBES, Goldman Sachs Global Investment Research

**Exhibit 10: Technology was relatively stable**

MSCI AC World Technology EPS revisions overtime (2008 EPS = 100)

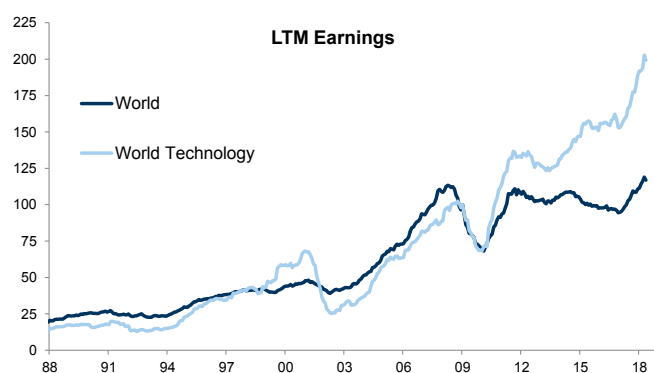


Source: Datastream, IBES, Goldman Sachs Global Investment Research

Consequently the earnings of the technology sector globally have far outstripped those of the global market over the past decade.

**Exhibit 11: Tech earnings outstripped those of the global market...**

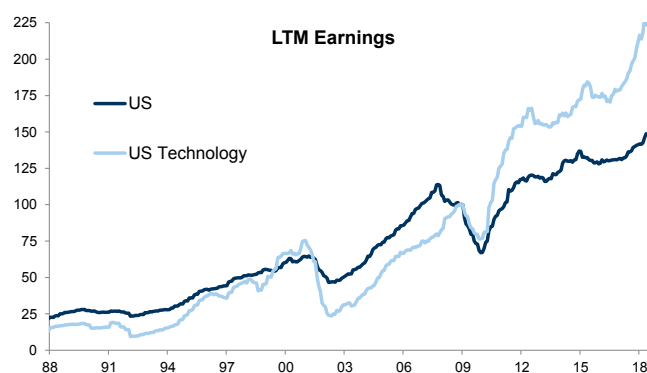
World LTM earnings (01/01/2009 = 100)



Source: Datastream, Worldscope, Goldman Sachs Global Investment Research

**Exhibit 12: ...everywhere**

US LTM earnings (01/01/2009 = 100)



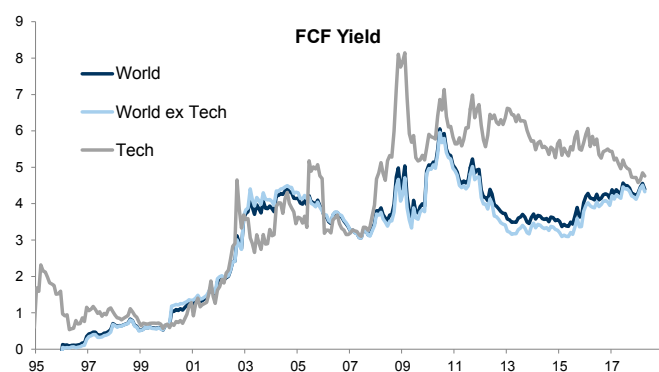
Source: Datastream, Worldscope, Goldman Sachs Global Investment Research

**Technology Stocks today are highly cash generative**

Technology stocks have also been significantly cash generative and globally reached a very high FCF yield in the aftermath of the financial crisis. This relative premium of cash flow yield has eroded over time but despite the higher margins and earnings growth of this sector (and significant re investment in many cases) the sector still manages to generate a FCF yield in line with the broader global index. According to the Economist, the cash cushion is far larger than it needs to be. Developing a 'stress test' they argue that assuming all staff are paid in cash (not shares), and companies pay all their contingent liabilities as well as regulatory and litigation claims the top 5 companies would still have \$390bn of net cash by 2020 (see The Economist, [Tech firms hoard huge cash piles](#), Schumpeter, 3 June 2017). This again is in stark contrast to the past when, at the peak of the 'dot-com bubble', technology stocks were not generating much cash.

**Exhibit 13: Tech manages to generate a FCF yield in line with the broader global index**

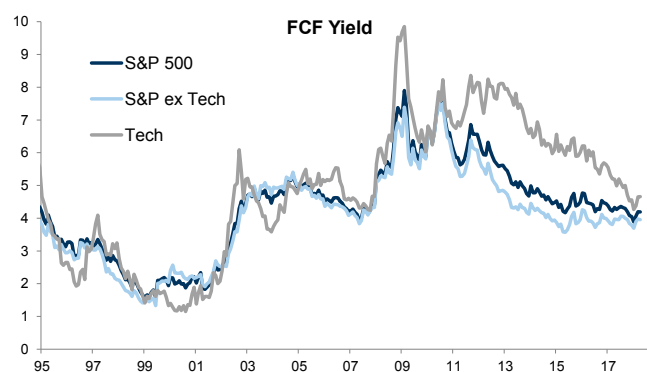
FCF yield of World and Tech since 1995



Source: Datastream, Worldscope, Goldman Sachs Global Investment Research

**Exhibit 14: US Tech FCF Yield is in line with S&P 500**

FCF yield of S&amp;P and Tech since 1990



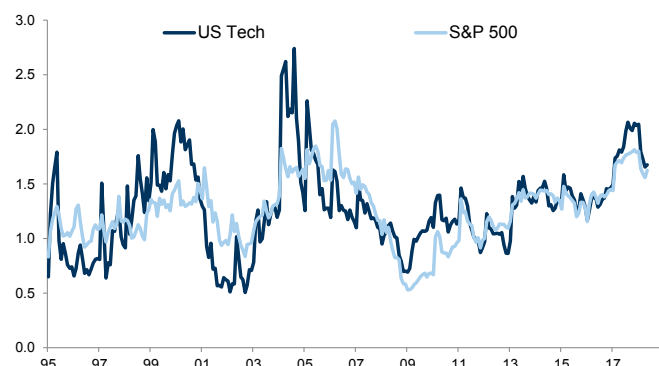
Source: Datastream, Goldman Sachs Global Investment Research

The higher growth rates of the technology sector have meant that the higher valuations have been justified. On a PEG ratio (on a forward FY3 basis) the technology sector exploded relative to the rest of the market in the late 1990s, while today it is very close to the market as a whole (this again is very different from the late 1990's when



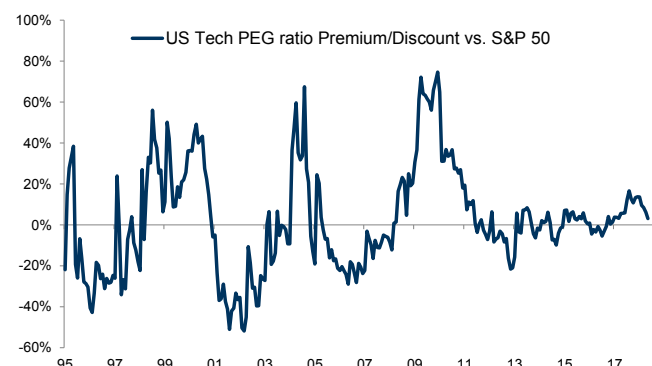
technology PEG ratios rose dramatically relative to the rest of the market). Nevertheless, this still assumes that technology earnings - which have been very strong - will continue to be as strong in the future. The biggest risk to this assumption is probably around regulatory constraints that could, over time, reduce growth rates and squeeze margins.

**Exhibit 15: Higher valuations are justified by higher growth rates**  
PEG ratio (NTM PE / FY3 EPS growth)



Source: Datastream, IBES, Goldman Sachs Global Investment Research

**Exhibit 16: In the late 1990's, Technology PEG ratios rose dramatically relative to the rest of the market**  
US Tech PEG ratio Premium/Discount vs. S&P 50



Source: Datastream, IBES, Goldman Sachs Global Investment Research

### Regulatory Risks

The risk of regulation for the technology sector is a topic that was discussed in detail in *Top Of Mind, Regulating Big Tech, Issue 67, April 26, 2018*. Some of the fears about regulation have started to materialise, particularly through actions within Europe. GDPR is one important aspect of this which has now come into force across the EU and deals with data privacy and represents the biggest shake-up to privacy regulation in 20 years. GDPR, which replaces the Data Protection Directive from 1995, is focused on harmonizing data privacy rules across Europe and adapt those rules to the digital age. GDPR's main objective is to enhance EU consumer rights and control over their personal data, which includes the right to access, erase and object to the use of their personal data by organizations. In general, however, as detailed in the *Top of Mind* our analysts argue that the global tech giants are well positioned to obtain consent given direct and trusted relationships with users. Alphabet, Facebook and Amazon have all been updating their privacy policies to ensure compliance. Facebook CEO Mark Zuckerberg has recently publicly stated that the controls and settings implemented in Europe for GDPR would also be made available globally, albeit in a different format. Where third-party data is involved, our analysts believe they have a strong enough bargaining power to renegotiate contract terms to ensure third-party publishers secure consent on their behalf in order to continue to use their ad technology (e.g., Google).

Alongside GDPR, the European Commission is looking to implement a new ePrivacy Regulation that replaces the existing ePrivacy Directive and brings stricter rules around collecting cookies (i.e., companies need to obtain explicit opt-ins from consumers). This would apply to any company providing electronic communication services including new "over-the-top" players such as WhatsApp, Facebook Messenger and Skype. Although timing is uncertain, this is a risk to watch. In addition, the EU tech regulation has recently included demands that Apple pay €13bn in back taxes to the Irish government;

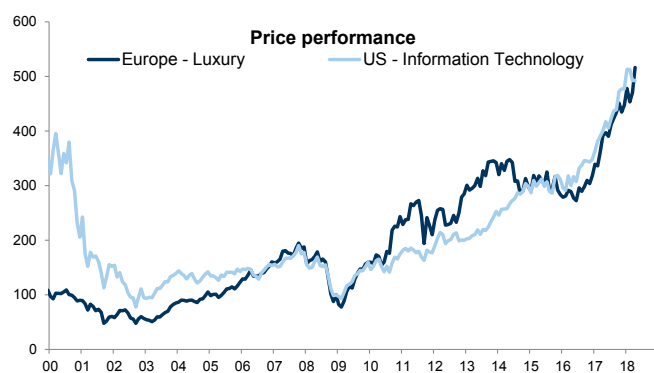
a \$2.7bn fine levied against Google for search practices that favored its own shopping platform; and a string of investigations into Facebook's data privacy policies. While there have been fewer developments in the US, there has nevertheless been more focus on these issues. President Trump focused on Amazon recently when he tweeted about its postal rates and tax practices. **One important point to make is that the new classification of the communications sector discussed earlier will contain most of the stocks currently facing regulatory scrutiny regarding consumer data and market concentration. The new legacy tech sector will be much less at risk from these issues and, on that basis, should attract considerable interest.**

**Also history has shown that dominant companies in the past that have faced regulation can still remain very successful for long periods of time.** Standard Oil, for example, controlled over 90% of oil production in the US by 1900 and 85% of sales. Its dominant position finally resulted in the Sherman Antitrust Act managing to break it up in to 34 separate companies in 1911 (some of these became Exxon, Mobil, Chevron and Amoco). **But by 1917, despite the breakup of Standard Oil, one of its parts - Standard Oil of N.J. - was still the third biggest company.**

### A Comparison with Europe's Luxury Sector

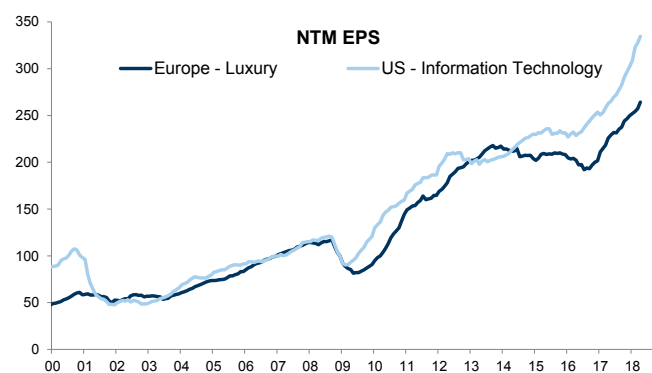
There are other examples of sectors that have achieved very strong growth which, like technology, has been driven by strong fundamentals. One interesting example is the European luxury sector. The similarities are not immediately apparent but, like technology, luxury goods are a global sector with long duration and so benefit from relatively weak growth. Also this is one of the few sectors where Europe 'dominates' an industry and are often seen as having few substitutes. It is also the case that, like the technology sector, much of the success of recent years has been driven by genuine earnings growth. Unlike the technology sector, however, the luxury goods sector has a limited global market and the stocks are much smaller in terms of their impact on the broader market. It is also worth noting from Exhibit 18 that while luxury has been successful in generating earnings growth it has underperformed the earnings of the technology sector over the last 10 years despite similar price appreciation.

**Exhibit 17: Luxury is Europe's success story**  
100 = 31/12/2008, USD



Source: Factset, Goldman Sachs Global Investment Research

**Exhibit 18: Its performance has been driven by earnings**  
100 = 31/12/2008, Local CCY



Source: Factset, Goldman Sachs Global Investment Research

### A comparison with previous Bubbles - The Nifty Fifty (1960s/70s) and technology late 1990s

Two previous periods when a group of stocks dominated the equity markets were the in 1960s to early 1970s in the so-called 'Nifty Fifty' era and the rise in technology in the late 1990s. The 'Nifty Fifty' period saw the dominance of a group of 50 companies that, unlike the 1990s, were not focused on a particular sector but rather a concept. There was significant optimism that US economic dominance would allow a new breed of US corporations to become truly global market leaders - multinationals. Many of the companies that were favoured did enjoy very high returns (rather different from the tech bubble of the late 1990s when the market was dominated by new companies with no returns) and a belief that these could be maintained into the long term future. For that reason they were often referred to as 'one-decision' stocks. You bought and held them irrespective of the price. There was a popular shift away from value investing towards growth investing. As a result the valuations increased hugely. By 1972 when the S&P 500 had a P/E of 19, the average across the Nifty Fifty was over twice this level. Polaroid traded at a P/E of over 90 and Walt Disney and McDonald's over 80x forward expected earnings. Interesting, despite these very lofty valuations, Professor Jeremy Siegel argued (see Valuing Growth Stocks, Revisiting the Nifty Fifty, American Association of Individual Investors, October 1998) that most of the stocks did actually grow into their valuations and achieved very strong returns.

A similar narrative later drove the focus on the 'New economy' of the late 1990s. Then, as in the 1960s, Value (or 'old economy') stocks became very unloved.

The current rise in technology companies that followed the financial crisis is rather different from the frenzy that drove the bubble in the late 1990s. In the years before the crisis banks dominated the sector weights in many equity markets (benefiting from a cocktail of strong growth, high leverage and product innovation). With the demise of the banks leadership in markets, technology has quickly become the major leader of market returns and a dominant sector once again. Since 2008 technology in the global stock market has increased from 7% to 12% - at the same time it has nearly doubled in the US from 13% to 21% in the S&P. In the late 1990s the technology share of global market capitalisation went from just 10% of the S&P in 1996 to a peak of 33% in 2000.

**Exhibit 19: The Global market share of Technology peaked in 2000**

% market share of Technology



Source: Worldscope, Datastream, Goldman Sachs Global Investment Research

**Exhibit 20: Same in the US**

S&P 500 % market share of Technology



Source: Datastream, Goldman Sachs Global Investment Research

## Valuations of today's tech stocks are much lower than in bubble periods of the past

Most importantly, however, the valuation of the companies in the earlier periods was much higher than for those of most technology companies today. As Exhibit 21 shows the largest tech stocks in the tech bubble traded at an average of over 50x PE (although many stocks were far more expensive than that). **The largest Nifty Fifty stocks traded at an average 35x. Today, the largest tech stocks trade at a little above 20x expected earnings despite the very low level of interest rates today (particularly relative to the early 1970s).**

**Exhibit 21: Largest companies in tech today, tech 1990s and Nifty Fifty**

	Size	Valuation
Market weight	Market Cap (\$ Bn)	P/E (FY2)
<b>FAAMG</b>		
Apple	4.0%	922
Amazon	3.4%	788
Microsoft	3.3%	760
Alphabet	3.0%	748
Facebook	1.9%	543
<b>FAAMG Aggregate</b>	<b>15.6%</b>	<b>3761</b>
<b>Tech Bubble</b>		
Microsoft	4.5%	581
Cisco Systems	4.2%	543
Intel	3.6%	465
Oracle	1.9%	245
Lucent	1.6%	206
<b>Tech Bubble Aggregate</b>	<b>15.8%</b>	<b>2040</b>
<b>Nifty 50</b>		
IBM	8.3%	48
Eastman Kodak	4.2%	24
Sears Roebuck	3.2%	18
General Electric	2.3%	13
Xerox	2.1%	12
<b>Nifty 50 Aggregated</b>	<b>20.0%</b>	<b>116</b>

FAAMG data as of 30/05/2018, Tech Bubble data as of 24/03/2000, Nifty 50 data as of 02/01/1973, except 1972 actual for PE

Source: Datastream, Worldscope, Goldman Sachs Global Investment Research

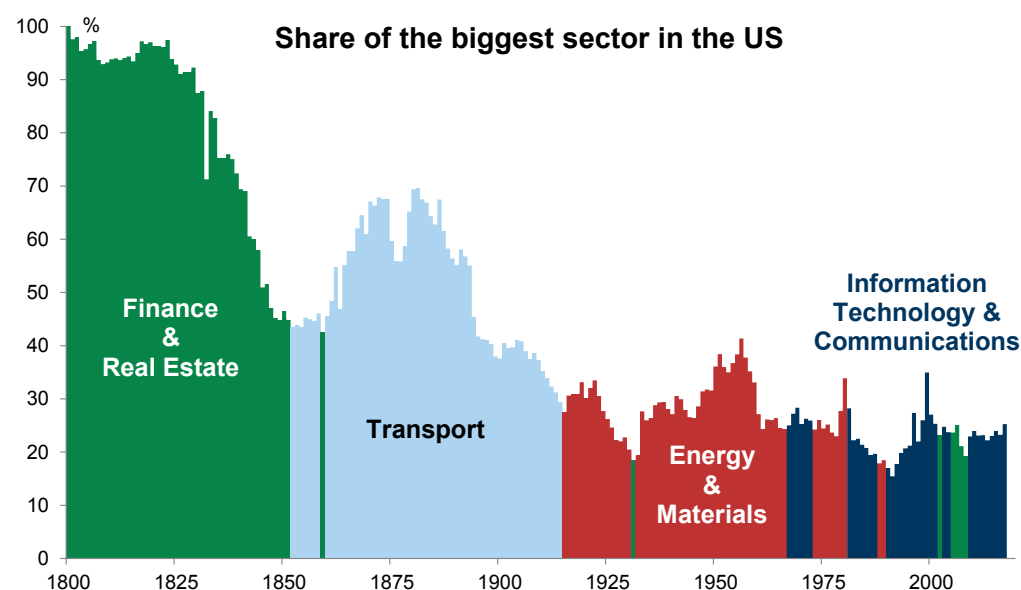
## How long can stocks and sectors dominate?

Despite the stronger fundamentals of the technology sector today relative to the period 20 years earlier, the high weight of the technology sector, particularly in some markets, raises the question of sustainability. What can history tell us about the longevity of sector dominance? How big can a sector or stock get?

### Sector dominance in the market

Looking at the history of the sector composition of the S&P 500 as a benchmark we can see that sector dominance is not new. Over time different waves of technology resulted in different phases of sector dominance; as stocks markets have become more diversified the biggest sector has tended to account for a smaller share of the aggregate market over time.

**Exhibit 22: The biggest sector accounts for a smaller share as stocks markets become more diversified**  
Share of the biggest sector in the US



Source: GFD, Goldman Sachs Global Investment Research

We can split the long sweep of history in the US equity market into 4 main periods of leadership.

### 1) 1800 - 1850s Financials

Over this period banks were the biggest sector. Starting with almost 100% of the equity market, the stock market developed and broadened out. By the 1850s, the sectors weight had more than halved.

### 2) 1850s - 1910s Transport

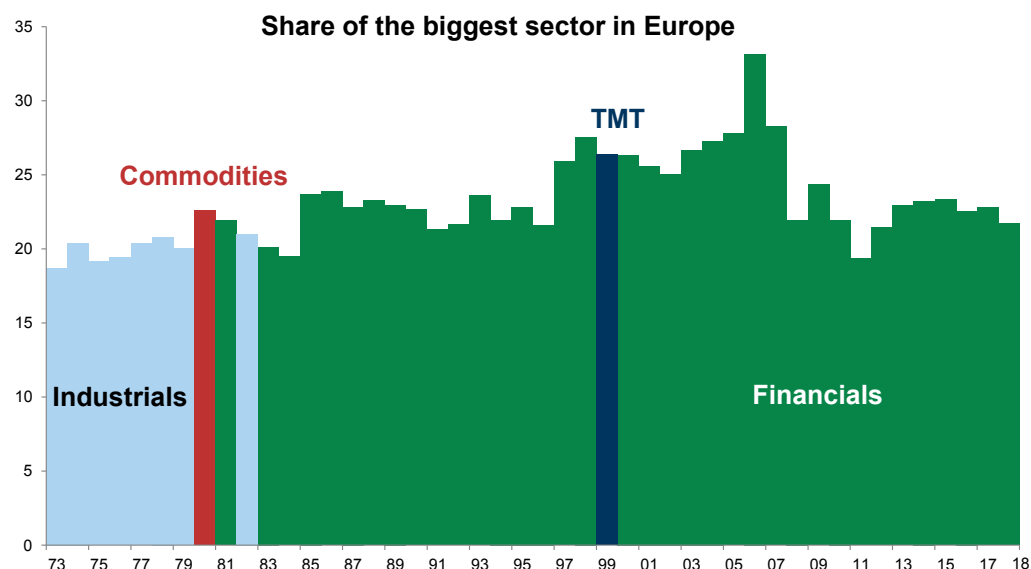
As banks started to finance the exploding railroad system in the US (and elsewhere for that matter), transport stock took over as the largest in the index. In their boom years they reached close to 70% of the index in the US before fading to around one third of the market capitalisation by WW1.

### 3) 1920s - 1970s Energy

With the huge growth of industry, powered by oil rather than steam and coal, energy stocks took over as the biggest sector. This continued as the main sector group until the 1990s, although interspersed with brief periods of leadership from the emerging technology sector (in the first wave it was lead by main frames and subsequently by software).

**Exhibit 23: Not so in Europe where Value sectors are dominating**

Largest sector in Europe in each year, % market share



Source: Worldscope, Datastream, Goldman Sachs Global Investment Research

In the case of Europe, the sector dominance has been slightly different (see Exhibit 23). We do not have the same history to compare with the US but, if we use the same broad 10 classifications we see industrials domination between the early 1970s and 1983 (with a brief period of commodities leading in 1980). Financials then took over as the dominant sector and have remained that way (with the exception of technology in 1999) ever since.

**How big can companies get relative to the market?**

As we showed in our 'technology map', leading tech companies today have become very large in terms of market value, but that reflects the significant growth of technology spending and its ability to displace other more traditional capex spending. Very often the new platforms become virtually the whole market.

But, again, this is not new when we see what happened in past technology waves. Standard Oil, for example, controlled over 90% of oil production in the US by 1900 and 85% of sales. **Meanwhile, another leading company, in a dominant sector, US Steel, managed to avoid a break up and became the first 'billion dollar company'.**

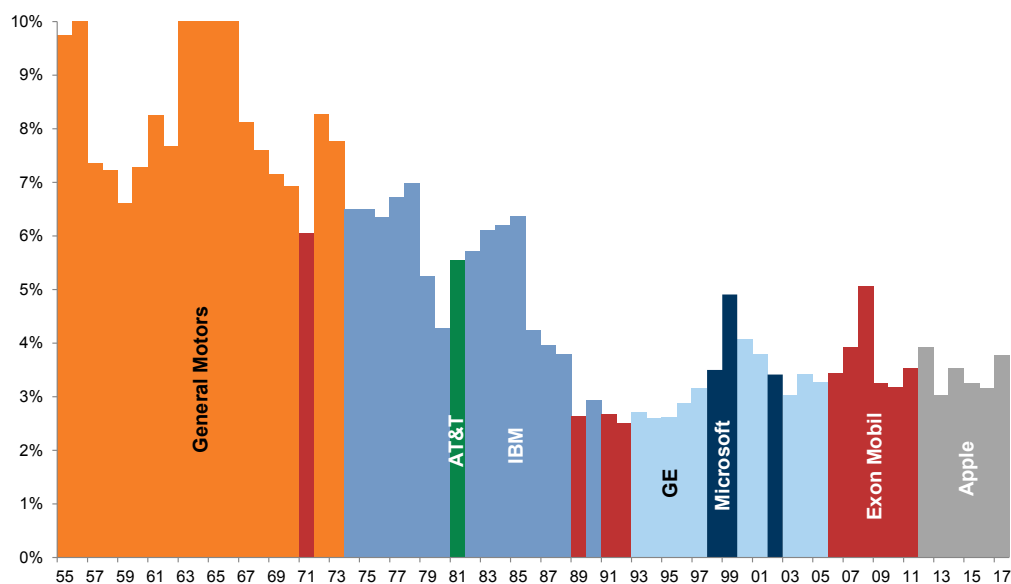
### Yet another wave of technology led to the dominant position of AT&T.

- By 1969 Bell had reached 90% of US households. Just before it relinquished control of the Bell Operating Companies and was split into different companies in 1982 it reached 5.5% of the market.
- As mainframe computers developed in the 1970s there was also a significant concentration of market share in the leading companies. In 1981 IBM had over 60% market share in mainframe computers.
- As software took over as the main driver of technology there was yet another shift in domination. By 2000 Microsoft had a 97% share in operating systems given its domination in the PC and laptop market.
- More recently as mobile computing and Internet applications took over market concentration shifted once again. In Internet searches for example Google has over 90% market share - its next biggest competitor, Bing, has 3.2% (StatCounter, global stats).

So, as with sectors, the dominant companies have remained leaders, often with very dominant market positions, for long phases reflecting the economic conditions. The biggest companies in the S&P were:

1. **1955-1973: General Motors** - the Golden Age of Capitalism, General Motors' earnings were more than 10% of S&P 500
2. **1974-1988: IBM** - the age of mainframes (peaked at 7.6% of market cap)
3. **1989-1992: Exxon** - Exxon was a spin-off from Standard oil which was dominant for such a long period nearly a century earlier - (peaked at 2.7% of market cap)
4. **1993-1997: GE** - (peaked at 3.5% of market cap)
5. **1998-2000: Microsoft** - the age of software (peaked at 4.9% of market cap)
6. **2000-2005: GE** (again) - (peaked 3.5% of market cap)
7. **2006-2011: Exxon** (again) - (peaked at 5.2% of market cap) - although Bank of America and Citigroup were briefly the biggest stocks at points between 2006 and 2007 prior to the financial crisis
8. **2012 to today: Apple** (peaked at 5.0% of market cap)

**Exhibit 24: Largest company in terms of market value in the S&P 500 in each year since 1974**  
 % Market Cap (% Net Income before 1974)



Source: Fortune 500, Datastream, Goldman Sachs Global Investment Research

**So it is clear that dominant companies in previous periods were bigger as a share of the broader market than is the case today.**

But one interesting point is that the biggest companies, particularly long ago, were not as large as today in terms of market capitalisation. For example, before its breakup, AT&T was worth roughly \$47bn which is worth \$120bn today. The reach and earnings power of the dominant companies today is much larger than we have seen in the past. The massive size of the dominant companies of course makes it more difficult for them to grow but this is not likely to limit the dominant contribution of the technology sector more broadly as newer companies evolve.



## The Assent of technology has historical parallels

### Given the success and dominance of the tech sector today's technology revolution seems unprecedented...

After all according to many estimates (see [SINTEF](#), [Science Daily](#), 22 May 2013) 90% of the World's data has been generated over the past two years. Around half the World's population now has access to the Internet - and this has grown from virtually nothing in less than 30 years. The explosion of data and cloud storage is transforming not just the companies that facilitate the technology but also those that use it to disrupt traditional businesses.

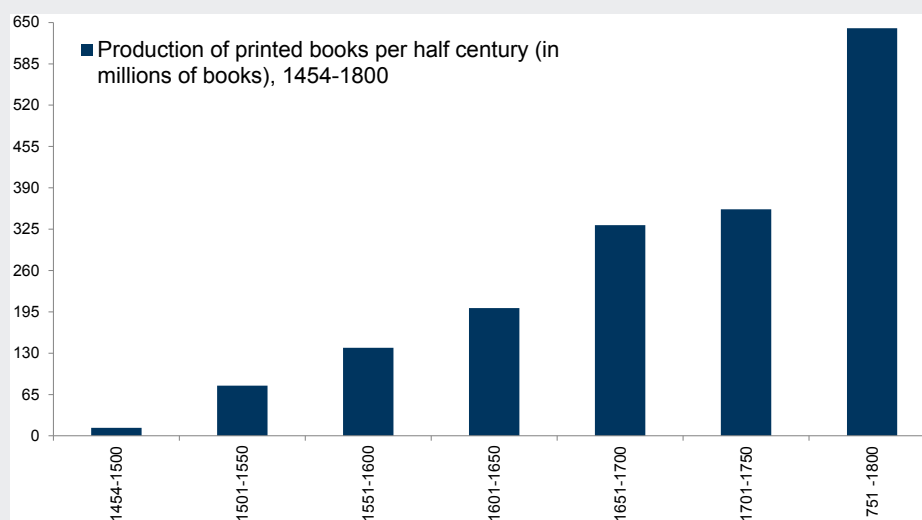
But there are other interesting examples of the astonishing impact of technology 'waves' that can help to contextualise the impact of the digital revolution that we are currently witnessing.

### ...the printing press triggered the first great data revolution

One of the most important waves of technology that revolutionised the way that the World's economies and people worked and communicated was the invention of the printing press in 1454. This technology triggered an explosion of data; it arguably laid the seeds for the Age of Enlightenment with its myriad of other 'life hanging technologies' (or killer applications as they are often referred to in a contemporary setting). Before the printing press information was hand written on manuscripts and the production, as well as access to it, were tightly controlled by the Church. With the onset of the printing press the volume of data that became available grew exponentially and, with it, the cost of information collapsed (sounds familiar). According to research by Buringh and Van Zanden (2009) the number of books published exploded from none to around **3 million per year by 1550 in Europe - more than the total number of manuscripts (pre printed books) produced in the entire fourteenth century**. There were 600 million books published by 1800. Like all technologies the price of books collapsed as the production costs fell. Massive social and societal changes followed.

#### Exhibit 25: The Great data revolution....the explosion of book production

invention of printed books resulted in massive data growth and spawned other technologies



Source: Max Roser (2017) - "Books". Published online at [OurWorldInData.org](#).

We don't know of course how big and powerful the printing companies became within the market but what we do know is that the printing press technology acted as a springboard to generate many other important technologies which, in turn, spurred many new technologies and businesses while at the same time disrupted traditional industries forcing many to change and evolve.

### **...the railway revolution built connected infrastructure**

In the Industrial Revolution technology was again at the heart of growth. Many of these technologies developed from, and relied upon, each other and, importantly the network effect that new infrastructure provided (railway lines like the internet infrastructure today). Part of this was spurred by the extraordinary success and growth of railways. In 1830 England had 98 miles of railway track; by 1840 this had grown to around 1,500 and then by 1849 there was around 6,000 miles linking all of the major cities (George Hudson and the 1840s Railway Mania, Yale School of Management, April 2012). Cheap money and an existing new (revolutionary) technology attracted a surge in investment. In the UK share prices of new railway companies grew exponentially and finally reached a peak in 1845 before crashing spectacularly. By 1850 railway shares were worth less than half their peak values and dividend rates had collapsed from around 7% to less than two percent.

**This first wave of excitement in a ground breaking new technology often leads to an indiscriminate rise in valuations of new entrants because it is, at first, so difficult to anticipate who the relative winners and losers will be. This same process was evident in the late 1990s when new IPOs of companies in the technology sector exploded and share prices rose dramatically across the board.**

At that time of the technology boom of the 1990s the belief that technology would boost data usage resulted in a surge in value across Telecom and Media companies as well as new Technology companies. As it turned out the ultimate winners in the emerging technology spaces were often not the ones that people expected, or even existed, in the first wave. Furthermore, many Telecom and Media companies have been disrupted by the very technological innovations which, 20 years ago, were expected to be so transformative. But the optimism at the time (fuelled by strong growth as a result of globalisation and low interest rates) led to significant price rises in new companies in the technology space across the board.

But despite the over speculation initially in the stock market the development of the rail infrastructure, as with the printing press before it, paved the way for a surge in other complimentary technologies that would not be obvious at the time. **For example the laying of train tracks helped the growth of telegraph infrastructure in the 1840s. Within 10 years (from nothing) sending telegrams had become part of everyday life (a bit like the Internet between the 1990s and 2000s).** By the mid 1860s London was connected to New York and ten years later messages could be sent between London and Bombay within minutes. Telegram and telegraph companies became very powerful; AT&T was born (1885).

### **Electricity and Oil fuelled the 20th Century**

Electricity enjoyed massive growth in the early 20<sup>th</sup> century. In the US in 1900 just 5% of mechanical power was generated by electricity as opposed to steam or water (having risen from just 1% in 1890). By the 1920s electricity had reached half of companies and close to half of households. As with other waves of technology that preceded it, prices collapsed. The real price of electricity fell by around 80% between 1900 and 1920. (Is the Internet Better Than Electricity?, Global Economics Paper no. 49, 20 July 2000). The

growth of electricity use also boosted the value of oil companies.

So while the speed of innovation and the spin offs that these create has never seemed faster, history shows that we have experienced similar patterns in the past. The dominant companies that drove these previous waves of technology also remained dominant for a very long time. But the networking effect of these companies created resulted in the birth of new innovations and companies. There appear to be three relevant observations in terms of technology opportunities. The winners over time tend to either be:

- 1) Companies that invent/ innovate (the printing press, radio, tv, etc)**
- 2) Companies that create the infrastructure to support new inventions (railways/oil/ power generation/ Internet search engines)**
- 3) Companies that utilise new innovations to disrupt/displace incumbents in existing industries (think of technology platforms/market places)**

## Why has technology and 'Growth' performed so well since the financial crisis?

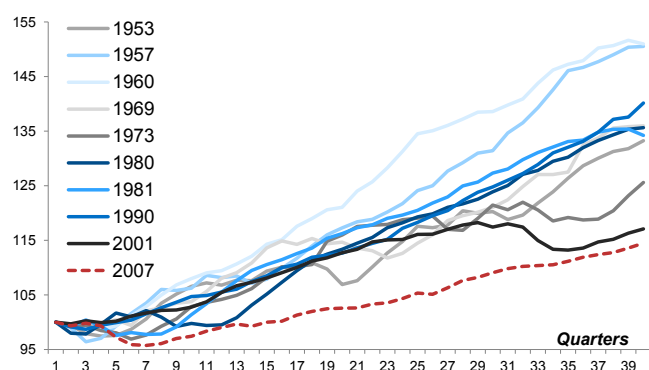
### Factors that have contributed to the success of the technology sector within the global stock market

As discussed earlier, most of the stock market success of technology over the past decade has reflected strong fundamental growth and returns. But there are some additional specific factors that have dominated the post financial crisis landscape that have helped contribute to the performance success of the Technology sector and the general outperformance of 'Growth' relative to 'Value'. This is a topic that we covered in *Global Macroscope, Growth Versus Value; finding the right balance*, April 10, 2018. We see a number of key factors.

#### 1) Growth has been scarce and so valued

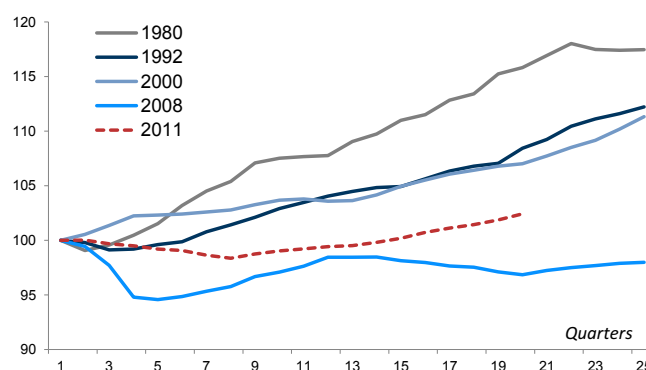
As Exhibits 26 and 27 show, this has been the weakest economic recovery of the past 60 years.

**Exhibit 26: US real GDP following recessions**



Source: Haver Analytics, Goldman Sachs Global Investment Research

**Exhibit 27: Europe real GDP following recessions**



Source: Haver Analytics, Goldman Sachs Global Investment Research

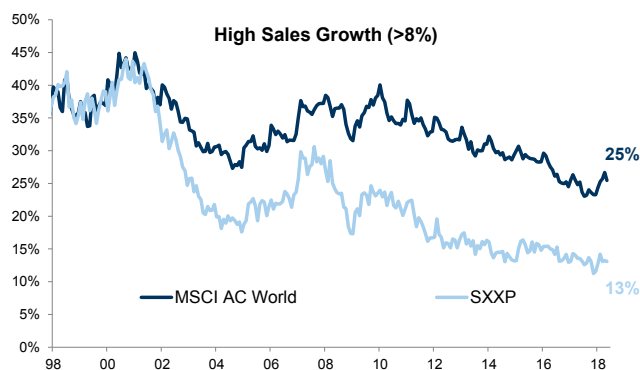
Scarcity of growth has made investors willing to pay a premium for it.

#### 2) Lower inflation and less capital spending has meant fewer companies generating high top-line growth.

Companies have been investing less in traditional capex in recent years making those that do reinvest and grow more valuable. There are many reasons for the broader lack of investment by the corporate sector; economic distress, a preference for spending on technology rather than traditional capex and also the preference to use cash either to strengthen balance sheets or to buy back shares. But whatever the reasons there has been a striking reduction in the proportion of stock markets that are generating high growth. We show this for top line growth in Exhibit 28 which we define as FY3 expected top-line growth of over 8% and in Exhibit 29 for earnings which we define as FY3 earnings growth of more than 15%.

**Exhibit 28: Few companies generate high top-line growth**

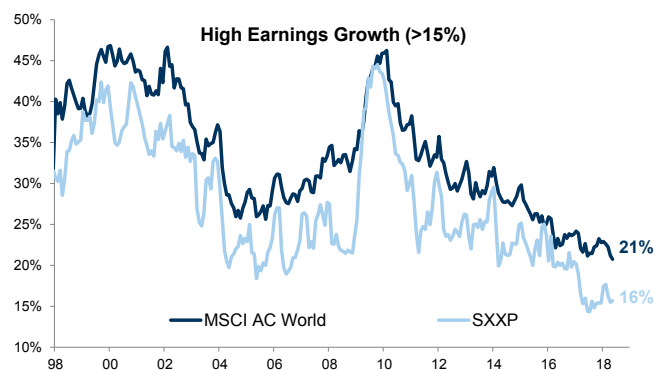
% of companies with high expected Sales growth in FY3



Source: Datastream, IBES, Goldman Sachs Global Investment Research

**Exhibit 29: Few companies generate high bottom-line growth**

% of companies with high expected EPS growth in FY3



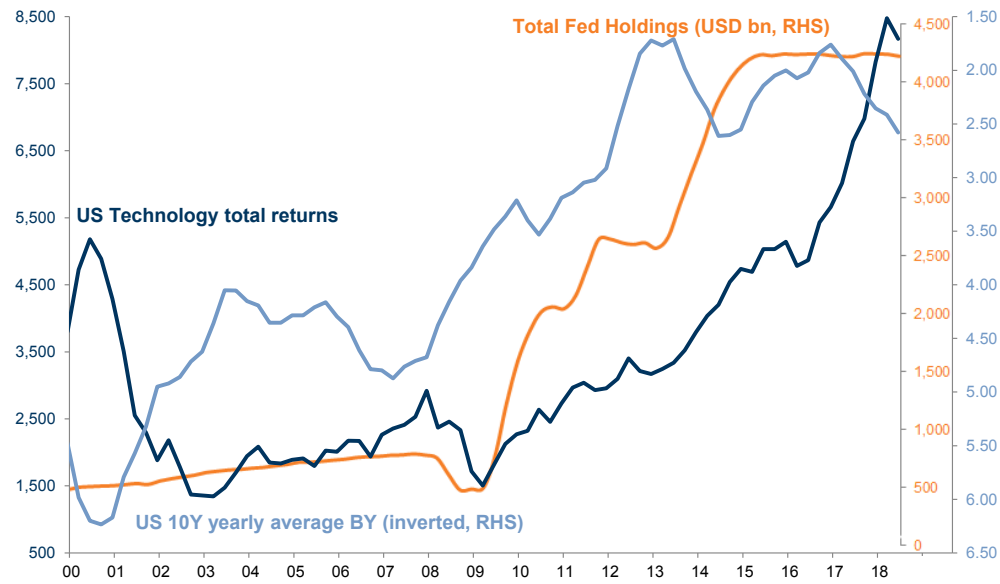
Source: Datastream, IBES, Goldman Sachs Global Investment Research

The scarcity of growth stocks has been highlighted by our US strategists (see *Global Macroscope; Searching for Secular Growth Stocks Around the World*, October 23, 2017). By looking for growth based on a 'Rule of Ten' stocks are classified as a "secular grower" if it has (1) realized sales growth of at least 10% in 2015 and 2016; (2) forecast sales growth of at least 10% in 2017 and 2018 by GS analysts; (3) consensus long-term earnings growth of at least 10%. They exclude companies below \$2 bn in market cap, in the top quintile of its region's EV/Sales, and with average daily trading volume less than \$10 mn. Only 50 of the 2,300 stocks covered by our analysts meet the criteria.

**3) QE has boosted long duration assets**

Technology companies are long duration growth companies and ought to benefit from falling interest rates. As Exhibit 30 shows the stock returns in the technology sector in the US have moved up with the fall in bond yields and the expansion of the Fed's balance sheet.

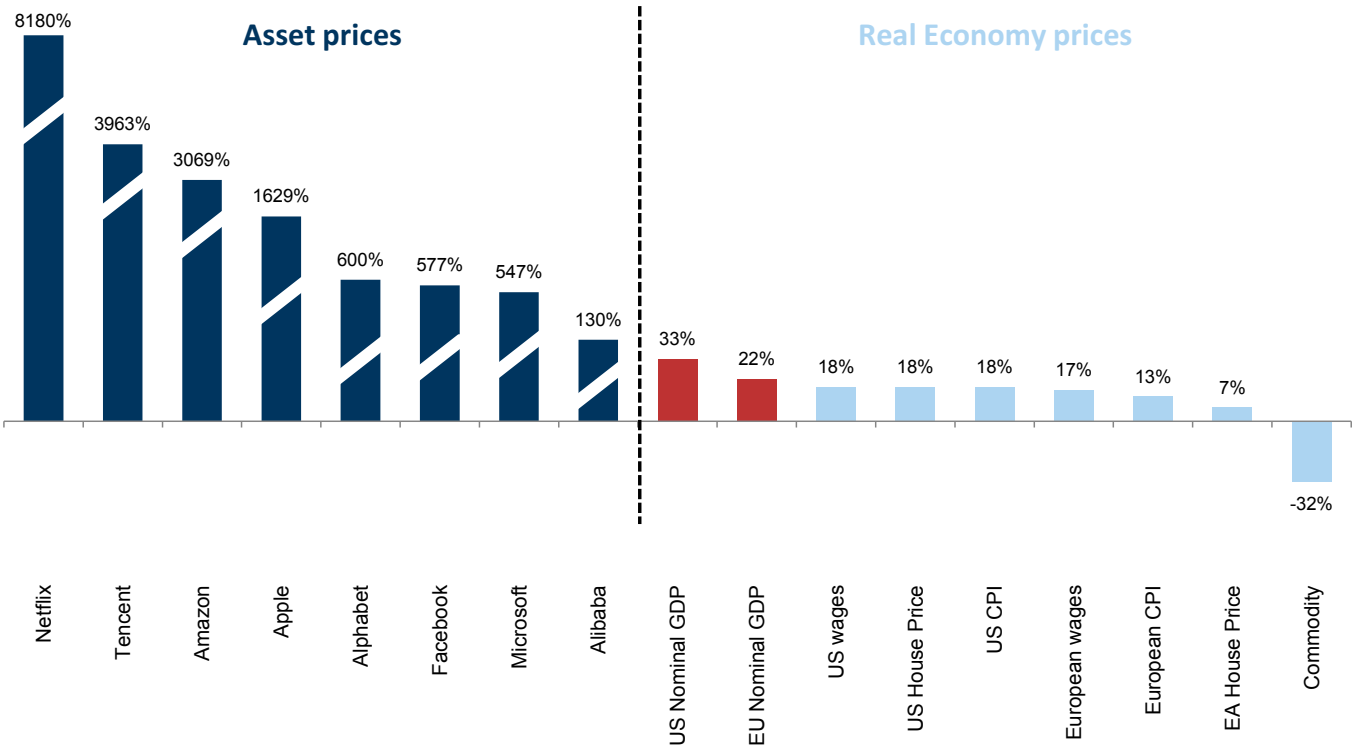
**Exhibit 30: Technology returns and QE**  
Long duration financial assets have benefited from falling bond yields



Source: Worldscope, Haver Analytics, Datastream, Goldman Sachs Global Investment Research

Exhibit 31 shows that since the start of QE (2009) prices measured in the real economy - consumer prices, wages, commodity prices for example (on the right hand side ) have moved only moderately on an accumulative basis since 2009. The largest technology stocks meanwhile have increased between 100 and over 7000% over the same period of time.

**Exhibit 31: Technology companies have enjoyed fantastic returns since the GFC**  
Total return performance in local currency since January 2009



Source: FactSet, Haver Analytics, Datastream, Goldman Sachs Global Investment Research

**4) Technology has benefited from lower bond yields**

A similar point to the one above is how technology (and growth in general) has benefited from lower US bond yields. At first glance this chart looks alarming since growth continues to outperform despite a rise in US bond yields. However part of this is that the sectors that have suffered most from rising bond yields are not the pure growth areas like technology but rather the ‘defensive’ sectors that have acted much like bond proxies through much of the post financial crisis period.

Exhibit 32: Growth is outperforming



Source: Datastream, Goldman Sachs Global Investment Research

**If global bond yields rise from current levels driven by, perhaps, higher term premium, it would make sense for 'growth' and technology not to outperform as much as we have seen in recent years but that does not mean that it should underperform either. The reality is that growth remains fairly scarce globally in terms of revenues and earnings and that valuations dispersion is relatively low. With narrower spreads of valuations in the market it makes sense to seek out the growth areas** (see *US weekly Kickstart: Narrow valuation dispersion suggests recent growth stock outperformance will continue*, March 16, 2016).

### Where to from here?

Our view is that Technology will remain a major driver of growth in terms of market returns. Just as the printing press accelerated the age of enlightenment and then scientific investigation, and the age of steam heralded a wave of technologies that lead to telegram and later telephone, so the fourth revolution that is creating dominance of infrastructure and platform companies will support the growth of many other technologies.

**According to Gartner, Global IT spending is expected to reach \$3.7 tn in 2018, accelerating to 4.5% y/y, from 3.8% last year, driven largely in part by 9.5% growth in Enterprise Software.**

Our technology analysts estimate public cloud revenue will more than quadruple from ~\$30bn in 2016 to ~\$140bn in 2020, with the opportunity to disrupt over half a trillion dollars in IT spend (see *Cloud Platform vol 4, The future of Public Cloud, November 16, 2016*).



Another important point to remember is that technology companies are also benefiting from the growing focus on utilising technology to generate higher returns in other more traditional industries. This 'snow balling' effect is similar to what was experienced during the industrial revolution where one technology led to another and caused traditional industries to spend more on technology to survive (think mechanisation of mills for example).

**Partly for this reason our technology analysts believe that 2018 is shaping up to be one of the strongest IT spending environments in years.** The combination of strong global GDP growth, domestic tax cuts in the US and a board room focus on digitisation and big data. Our technology analysts and GS Data Works team have earnings transcripts for over four hundred S&P 500 companies for a real-time snapshot of conversations in the boardroom which is pointing to a pick up in IT spending including that related to digital transformation and advertising spend (see [\*What are CEO's saying about the outlook for IT spending?, March 2, 2018\*](#)).

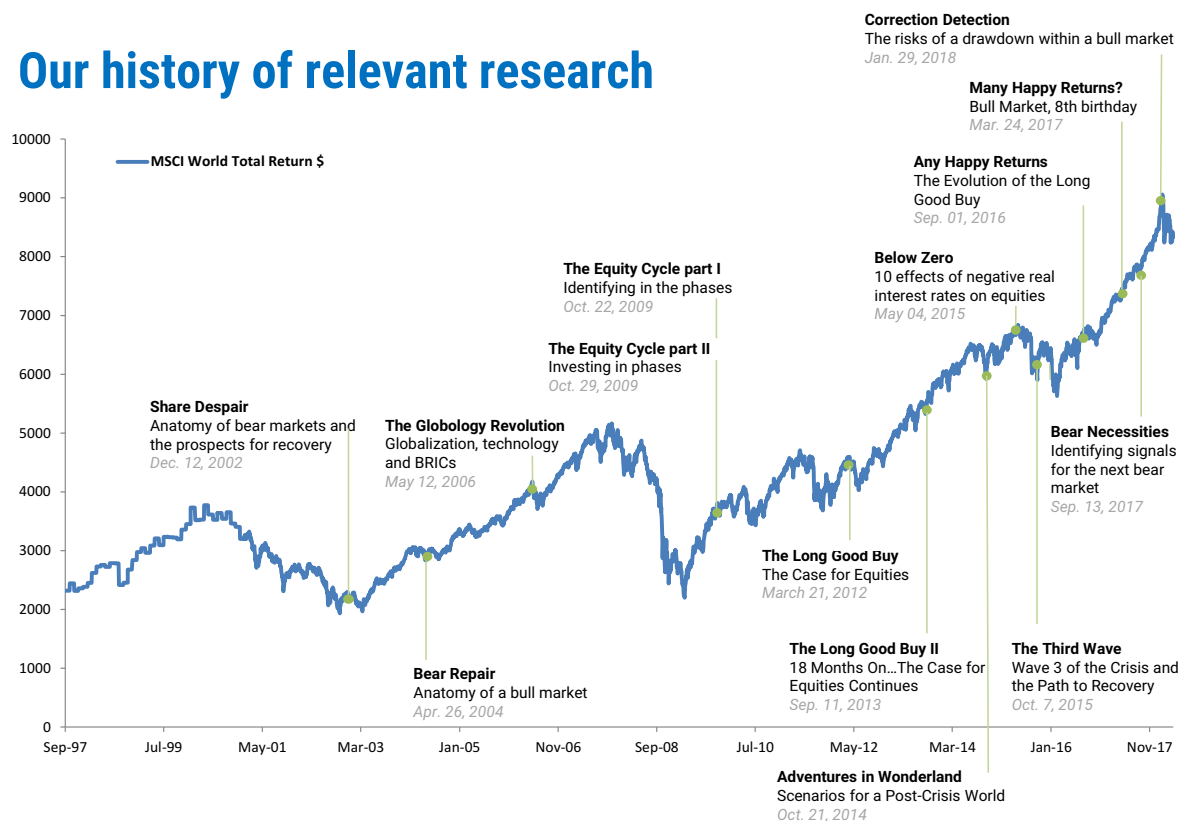
But it is also significant in other more traditional industries as well. We have already seen that new entrants, applying technology, can disrupt very traditional businesses like Retail. It is also having a negative impact on the margins of traditional 'brand' consumer products companies. But, applied in the right way, it can also regenerate businesses in quite mature industries by boosting growth rates. Our luxury goods analysts for example has talked about the growing impact of technology on the sector (see [\*Europe Branded Consumer Goods: Luxury Goods - Turning up the volume\*](#), March 28, 2018).

The impact of technology is also likely to show up in traditional sectors such as utilities. Our analysts estimate that to enable full EV penetration, global utilities would have to invest €2.5tn in infrastructure – equivalent to about ten years of investment in global grids, at the current run-rate. Most of the spending is likely to take place between 2025 and 2050, and to be on: (1) upgrading the grid hardware (to prevent overloads); (2) developing new power connection lines (to electrify parking bays); and (3) digitalizing the grid to enable smart charging (see [\*Global Utilities, Powering up e-mobility\*](#), October 27, 2017).

In line with the history of other waves of technology innovation, newer applications are becoming very significant drivers of capital. Artificial Intelligence, for example, is a significant area of growth. Private venture funding in the category reached nearly \$15bn in 2017, almost 3x 2016 funding numbers, and there is a growing expectation that AI will be a factor in the development of nearly every developing industry and company (see [\*Profiles in innovation: Artificial intelligence\*](#), February 20, 2018).

While the most dominant technology companies today will inevitably find it harder to grow as fast in the future, the broader technology sector is likely to continue to see significant growth in the future. Given that valuations in aggregate are not very stretched, we do not expect the dominant size and contribution of returns in stocks markets to end any time soon.

## Our history of relevant research



Share Despair: Anatomy of bear markets and the prospects for recovery, Dec. 12, 2002

Bear Repair: Anatomy of a bull market, Apr. 26, 2004

The Equity Cycle part I: Identifying the phases, Oct. 22, 2009

The Equity Cycle part II: Investing in phases, Oct. 29, 2009

The Long Good Buy; the Case for Equities, March 21, 2012

The Long Good Buy II; 18 Months On...The Case for Equities Continues, Sep. 11, 2013

Adventures in Wonderland: Through the looking glass: Scenarios for a post-crisis world, Oct. 21, 2014

Below Zero: 10 effects of negative real interest rates on equities, May 4, 2015

The Third Wave: Wave 3 of the Crisis and the Path to Recovery, Oct. 7, 2015

Any Happy Returns: The Evolution of the 'Long Good Buy', Sep. 1, 2016

Bull Market, 8th birthday - Many Happy Returns?, Mar. 24, 2017

Bear Necessities: identifying signals for the next bear market, Sep. 13, 2017

Correction Detection: the risks of a drawdown within a bull market, Jan. 29, 2018

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# Mindcraft: Our Thematic Deep Dives

## Innovation & Disruption

Extended Reality



Drones



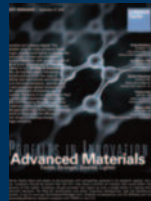
Factory of the Future



Precision Farming



Advanced Materials



AI Hardware



## GS SUSTAIN

The PM's Guide To The ESG Revolution



Blockchain



Space



Rethinking Mobility



The Store of the Future



Digital Divergence



The Genome Revolution



50 Quality Companies



## Macro, Markets & PM Resources

Bear Necessities



A taste of the high (vol) life



Unlocking Value in Europe



The European Conviction List



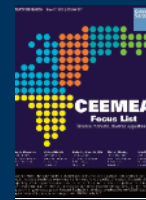
European Passport



Top of Mind



The Ceemea Focus List



## Healthcare

Diabetes



## The Low Carbon Economy

Promising Tech



The IMO 2020: Global Shipping



Power Shift 2.0



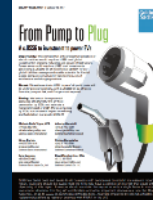
More Lean, More Green



NextGen Power - Solar



From Pump to Plug



Powering up e-Mobility



## Music's Return to Growth



## Commodity Corner

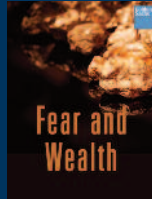
Top Oil & Gas Projects



Copper Top Projects



Gold Primer



Oil: Age of Restraint



## Rising Asia

Rise of China FinTech



China's Rise in AI



Mapping China's Credit Vol2



## Quantamentals



## Consumer Currents

Supermarket Shift: Expect Measured Disruption



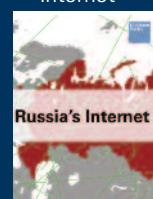
European Business Services



World of Games: Consoles



Russia's Internet



Russian Food Retail



...and more

