DOES VALUE GO TO THE TECHNOLOGY OR THE PLATFORM?

Creating and capturing value in the future of technology **– Bhavtosh Vajpayee and Michael W. Parker**

The winners from the communications and mobility revolutions over the last 20 years have been the Internet sector, Apple, and — at the margin — Samsung and TSMC. The secrets to value accretion over the period have been low capital intensity, low or zero customer acquisition cost, and a "winner take all" market structure. The question of whether these companies were truly creating value, or simply capturing it, has been secondary.

Based on the lessons of the last two decades, in this chapter we consider whether looking at companies that are doing revolutionary things with machine learning is the right approach. Specifically, we consider whether the Internet companies could — again — extract all value from this generation of technology. More fundamentally, we argue that the stakes are too great with this round of technologies for regulators to simply allow a small group of companies globally to once again capture all of the value.

The chapter is set out in two parts:

- How the Internet won the last technology war
- An alternate future

HOW THE INTERNET WON THE LAST TECHNOLOGY WAR

Over the last two decades, the three most-compelling and far-reaching changes in technology globally have been: the increased speed of telecommunications, the falling cost of memory semiconductor, and the improved computing power of processors.

These technologies have put computers (in the form of smartphones) into roughly 3 billion pockets globally, and — in doing so — disrupted and destroyed industries as diverse as landline telephone service, taxis, newspapers, supermarkets, big box retailers, food delivery, music, television, hospitality, and travel. This revolution has also changed how people — to take a few examples — date, watch sport, shop, develop, and express political allegiance, maintain friendships, and — for an increasing proportion of the world's population (call it Generation Selfie) — experience their own lives.

The connected population globally can access a heretofore unimagined amount of not just information but also tools to make them more efficient at work, more connected to

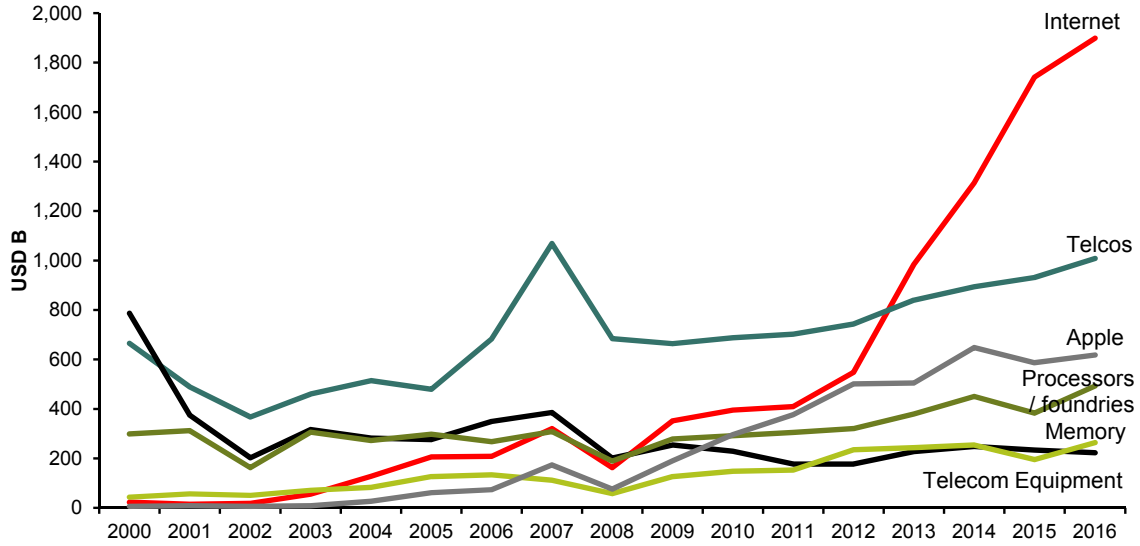
friends and family, and (one might hope) more evolved, more content, more informed, and even happier. And, as ever, we are still early in the innings.

The technology and the infrastructure through which this revolution took place were supplied by a remarkably small number of companies. The telecommunications equipment companies (including Cisco, Alcatel, Lucent, Nortel, ZTE, Qualcomm, and Huawei) increased the speed of telecommunications multiplexing and wireless technology. The large telecommunications companies (AT&T, Verizon, Sprint, British Telecom, Vodafone, Deutsche Telecom, Orange, China Mobile, China Telecom, China Unicom, and others globally) accelerated the roll out of fiber optic infrastructure and third- and fourth-generation wireless technology. Intel and TSMC (among others) increased the speed and power of computer processing, while lowering the cost. Samsung, Hynix, and Micron (among others) reduced the cost of memory storage. Globally, less than three dozen companies did the lion's share of the work.

And, in combination, these three technologies enabled the mobility revolution of the last two decades.

And yet, when the chapter is closed on the key technologies of the first two decades of the 21st century, the headlines will be (roughly in order): iPhone, Facebook, iPod, WeChat, Amazon, BABA, iPad, Instagram, Tinder, and perhaps Uber… plus Samsung's Galaxy Note 7. The technology companies invented the future. The telecommunications industry built it. And the Internet sector (the customer-facing platform) — plus Apple — captured most of the incremental value (see Exhibit 123).

EXHIBIT 123: **Market capitalization across technology and technology-adjacent sectors (2000-16)**



Source: Bloomberg L.P. and Bernstein analysis.

THE COUNTER-FACTUAL... WHERE THE INTERNET STILL WINS

The irony of this allocation of value between the players is that the mobility and communications revolutions would still have occurred without the existence of any of the big names in the Internet sector: Google, Facebook, Tencent, Alibaba, Baidu, Amazon, or even Apple.

The tablet existed before the iPad. Palm rolled out touchscreen technology on its networked Personal Digital Assistants almost a decade before the iPhone. RIMM sold BlackBerries with color screens in 2004. Before Google, there were Ask Jeeves and Yahoo! Before Facebook, there was MySpace. Alibaba's TaoBao and Tmall are an adaptation of the marketplace model pioneered by eBay. Uber and Lyft figured out how to disrupt the limousine business at roughly the same time.

In short, the winners and losers in the Internet sector are completely interchangeable: it is a modern version of Coke versus Pepsi, but with network effects and, therefore, no stable equilibrium other than at the very extremes. Pepsi really does taste better if all of your friends drink it too.

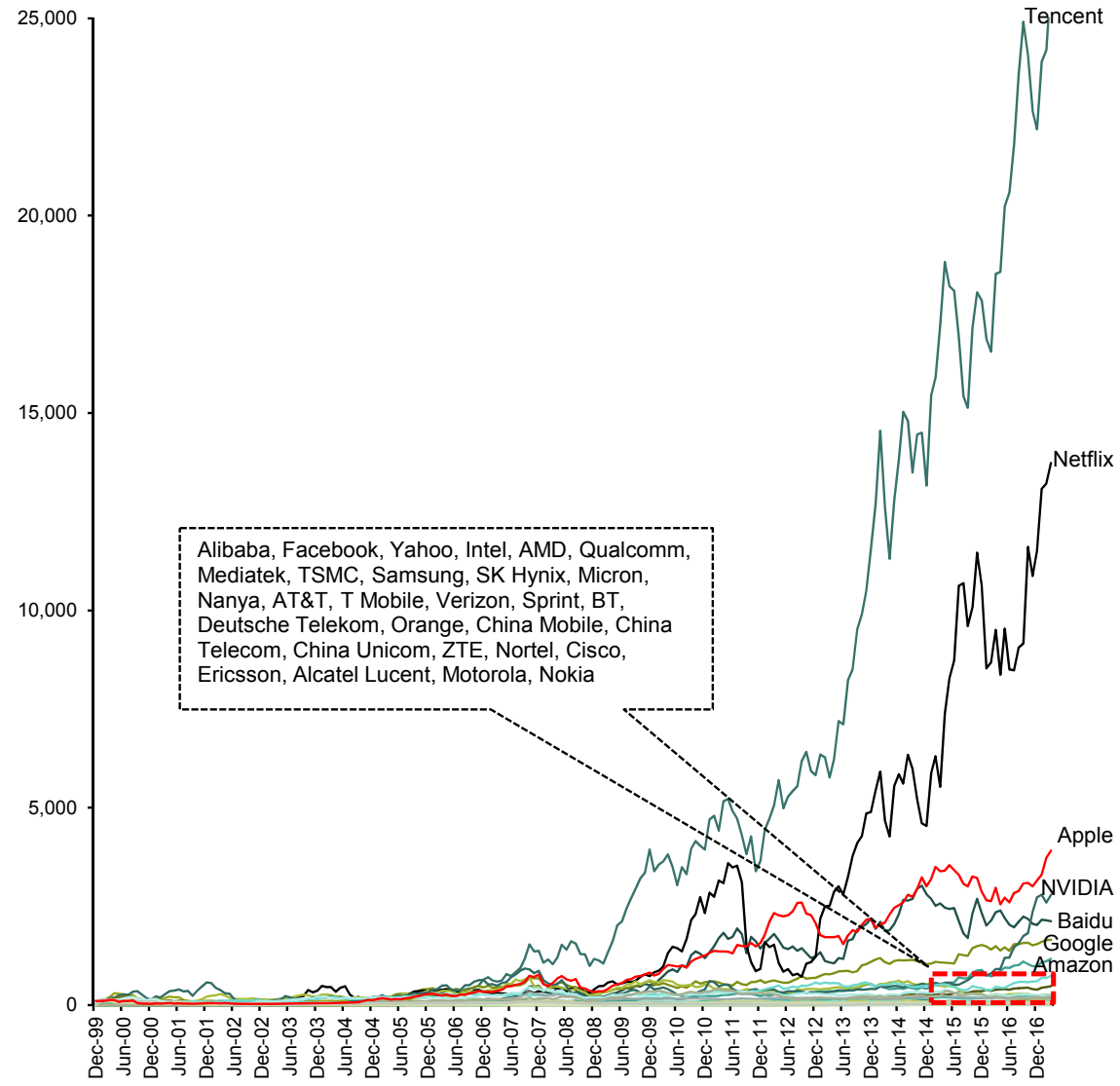
Once the global fiber optic network was built, and with memory cost falling and processors becoming more powerful, someone was going to come up with Instagram. Success in the Internet space comes down to execution. Said differently, there are no new ideas. In a parallel universe where none of the winners in the Internet sector exist, there would still be an Internet and there would still be a mobility revolution.

Yet if, in still another parallel universe, the global telecommunications industry decides — as a group — that it has no interest in funding wireless technologies in the 1990s or data services in the 2000s, then stationery shops, video stores, the daily newspaper, and network television are all still viable businesses. In short, Tinder does not exist in a dial-up world. But in a 4G world without Barry Diller, people would still use new technology to socialize (as humans have done since the invention of the camp fire).

Samsung and TSMC have tripled in value over the last decade, so it is not necessary to feel too bad for all of the "losers" in this arrangement. The telecom equipment manufacturers have had a rougher time. For a brief moment at the end of 1998, Cisco Systems was the most valuable, publicly traded company in the world and Nokia the most valuable company in Europe. Today, they are not (see Exhibit 124).

But if the communications and mobility revolutions of the last two decades were created by a small number of companies, the lion's share of the value went to an even smaller group. And the overlap between the two groups is — at best — haphazard.

EXHIBIT 124: **Indexed price performance of technology stocks (2000/IPO-2017 year-to-date) (December 1999 = 100)**



Note: For stocks that were not listed in December 1999, the base is the IPO month.

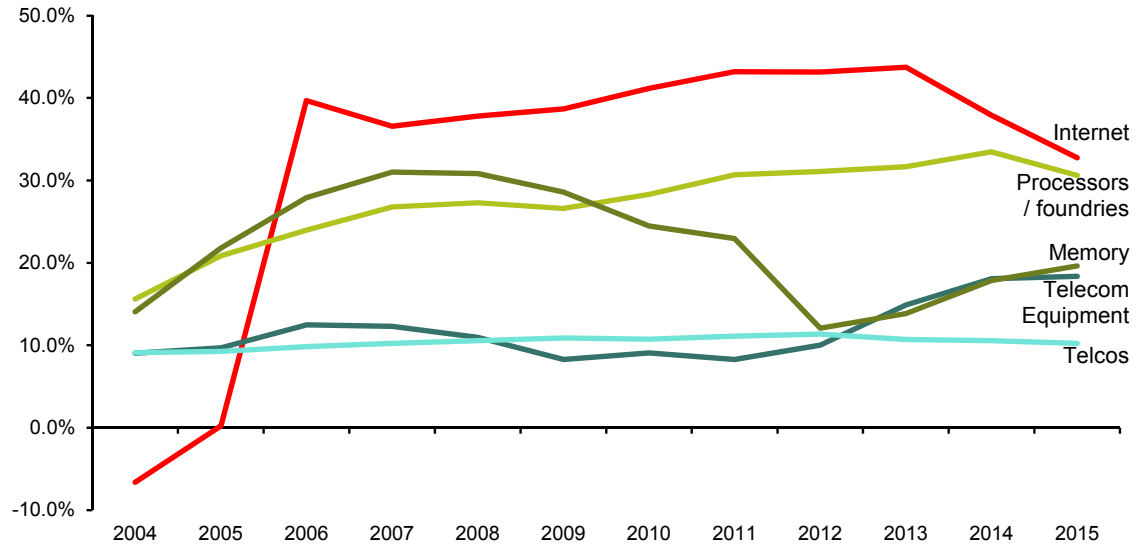
Source: Bloomberg L.P. and Bernstein analysis.

The telecommunications industry started big and — after a decade-and-a-half of converting its customers from landline service to wireless, broadband, and video while spending tens of billions of dollars on fixed assets — the telecommunications industry remains big. Return on invested capital has hardly moved (see Exhibit 125).

Meanwhile, the Internet "winners" have gone from a market capitalization virtually indistinguishable, from zero in 2000 to close to US$2 trillion (see Exhibit 123 and Exhibit

126), even without including Apple. The important question for our purposes is: *could it happen again?*

EXHIBIT 125: **Evolution of ROIC (rolling five-year average, 2004-15)**



Source: Bloomberg L.P. and Bernstein analysis.

We believe this is a particularly appropriate question in the context of this *Blackbook*. As we embark upon discussions of increasingly greater complexity related to the implications of augmented reality, virtual reality, energy storage, machine learning, and artificial intelligence technologies — the future of technology — and the roles of the various technology manufacturers within the supply chain, it is important to ask: *are we looking in the right space if we want to find the companies that will capture the lion's share of value?*

We address three questions in this chapter. First, why did the most critical aspects and technology providers of the communications revolution not capture most of the value? Second, does the future of technology (augmented reality, virtual reality, artificial intelligence, voice recognition, energy storage, and machine learning) face the same challenge? And, if so, from whom is that challenge emanating?

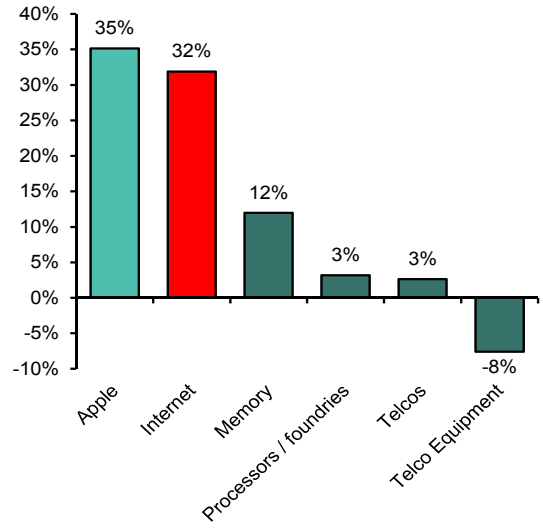
THE ALLOCATION OF VALUE FROM THE COMMUNICATIONS REVOLUTION OF THE LAST 20 YEARS

The communications revolution came down to three things: faster communications, cheaper memory, and better processing power. In our view, once these three technologies and infrastructure capabilities were in place, the rise of the Internet was inevitable (see Exhibit 127 and Exhibit 129).

Faster speed in telecommunications meant two or three "data tsunami" (to borrow a phrase from our telecom analyst Chris Lane) in the last 20 years. The **first** came in the late 1990s and early 2000s as a fiber optic cable backbone was built out globally — through both undersea and terrestrial networks — improving the speed and lowering the cost of

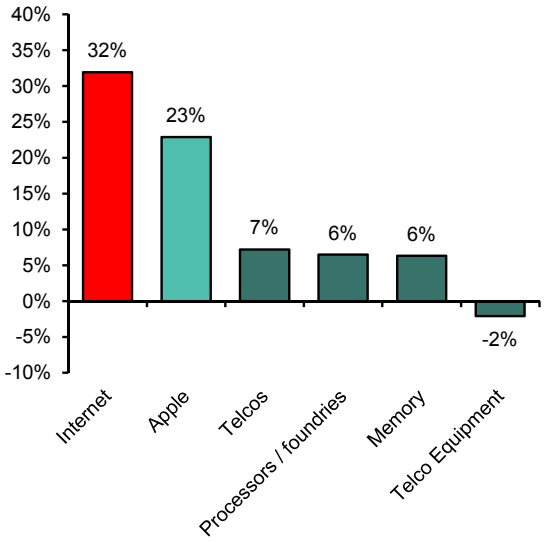
data transmission across the globe. Any volume of content could suddenly move at (something approaching) the speed of light, and for fractions of pennies.

EXHIBIT 126: **Market capitalization CAGR by group (2000-16)**



Source: Bloomberg L.P. and Bernstein analysis.

EXHIBIT 127: **Revenue CAGR by group (2000-16)**

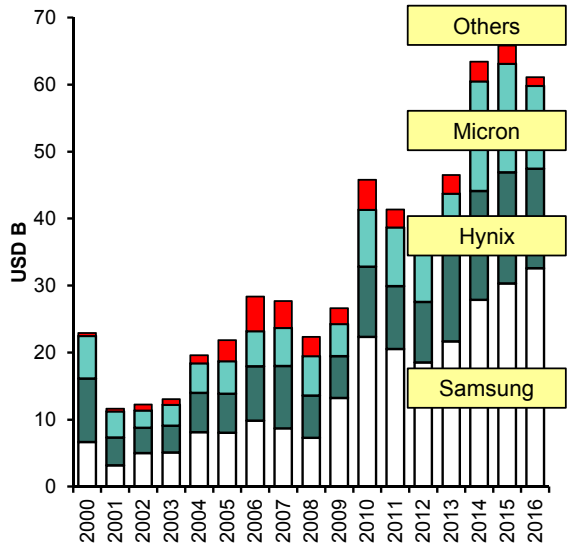


Source: Bloomberg L.P. and Bernstein analysis.

The **second** change in speed came with the resolution of the "last mile" problem between (roughly) 2000 and 2010 — as DSL (transmitting data digitally over a 100-year twisted copper pair infrastructure) and construction of metropolitan fiber-to-the-home and fiber-to-the-neighborhood meant that data did not have to slow down as it approached the end consumer.

Third, the roll-out of 3G and 4G wireless technologies has effectively meant that whatever can be done through the wired infrastructure can now be done wirelessly, almost as fast.

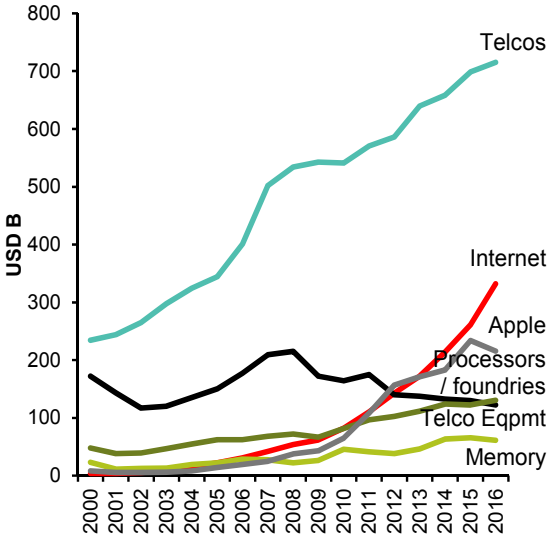
EXHIBIT 128: **Revenue of key companies in the memory sector (2000-16)**



Note: Only memory segment revenues are included for Samsung. Others include Nanya and Powerchip.

Source: Bloomberg L.P. and Bernstein analysis.

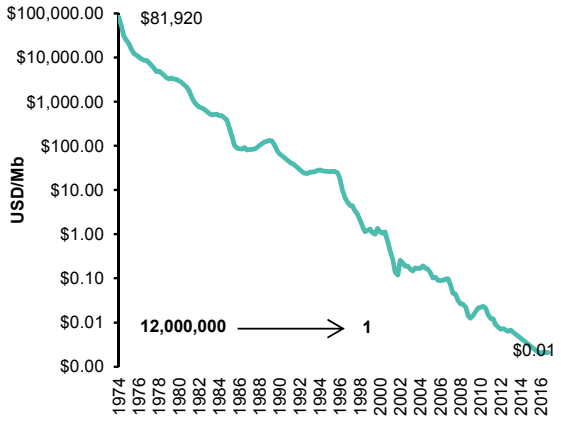
EXHIBIT 129: **Revenue trajectory across the technology sector (2000-16)**



Source: Bloomberg L.P. and Bernstein analysis.

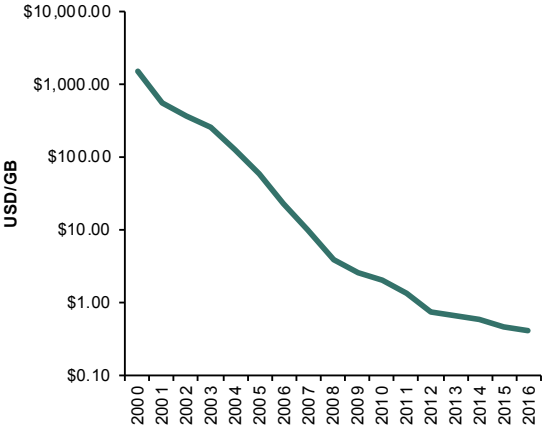
Cheaper memory arose as commodity DRAM and NAND Flash memory prices per bit dropped dramatically (see Exhibit 128). Since the 1970s, commodity DRAM prices have dropped from approximately US$80,000 per Mb to around well under 1 cent per Mb (see Exhibit 130). Similarly, this century, the price per bit for standard MLC NAND has dropped from over US$1,000/GB since introduction to below US$1.00/GB (see Exhibit 131).

EXHIBIT 130: **DRAM pricing has declined exponentially**



Source: DramXchange and Bernstein's Global Memory team.

EXHIBIT 131: **Flash Memory pricing has also declined exponentially**

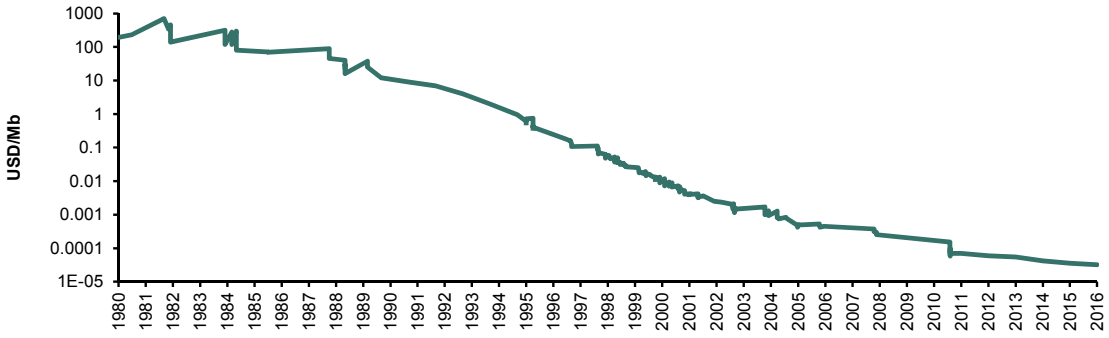


Source: DramXchange and Bernstein's Global Memory team.

The price per Mb of HDD storage has also fallen exponentially since the advent of the first consumer HDD in the early 1980s. In the intervening period, this price has dropped from about US$315/Mb to less than 1/20,000th of a cent per Mb, a six order of magnitude difference (see Exhibit 132).

The average retail price (excluding taxes) of an external HDD for PC applications has declined from about US$3,200 in 1981 to under US$100 in 2016, which is one order of magnitude. Of course, you felt blessed with a 20 Mb HDD in 1983, while contemporary HDDs comfortably reach the 1+ TB (terabyte, or 1 million Mb) capacities.

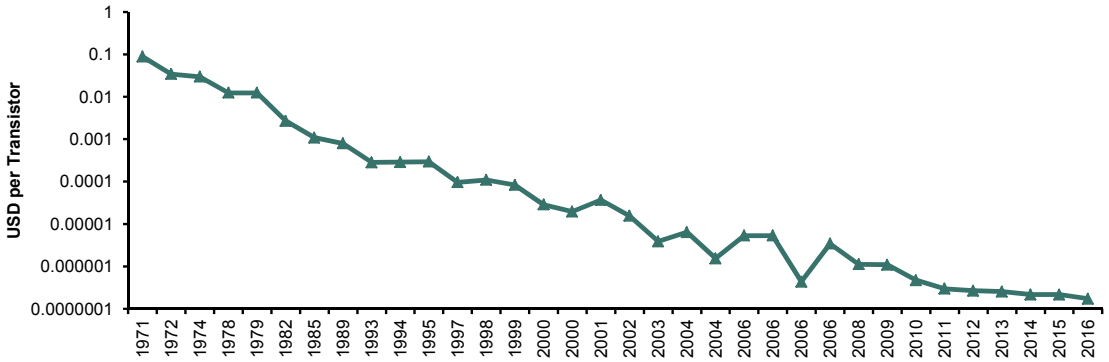
EXHIBIT 132: **HDD storage costs have fallen exponentially**



Source: Ivan Smith (http://ns1758.ca/winch/winchest.html) and Bernstein analysis.

A similar phenomenon is also apparent in CPUs. Although an x86 class CPU had roughly 1.2 million transistors in 1989 (for the then newly introduced i486), compared to a contemporary Intel Xeon processor with over 4 billion transistors (and an equivalent multiple in the processor's performance), their nominal cost on product introduction is roughly about the same, about US$900-US$1,000, implying an exponential decline in the cost per transistor (see Exhibit 133).

EXHIBIT 133: **And, of course, the cost of processing power has also dropped exponentially**



Source: Intel and Bernstein analysis.

THE TRIUMPH OF THE PLATFORM IN THE COMMUNICATIONS REVOLUTION

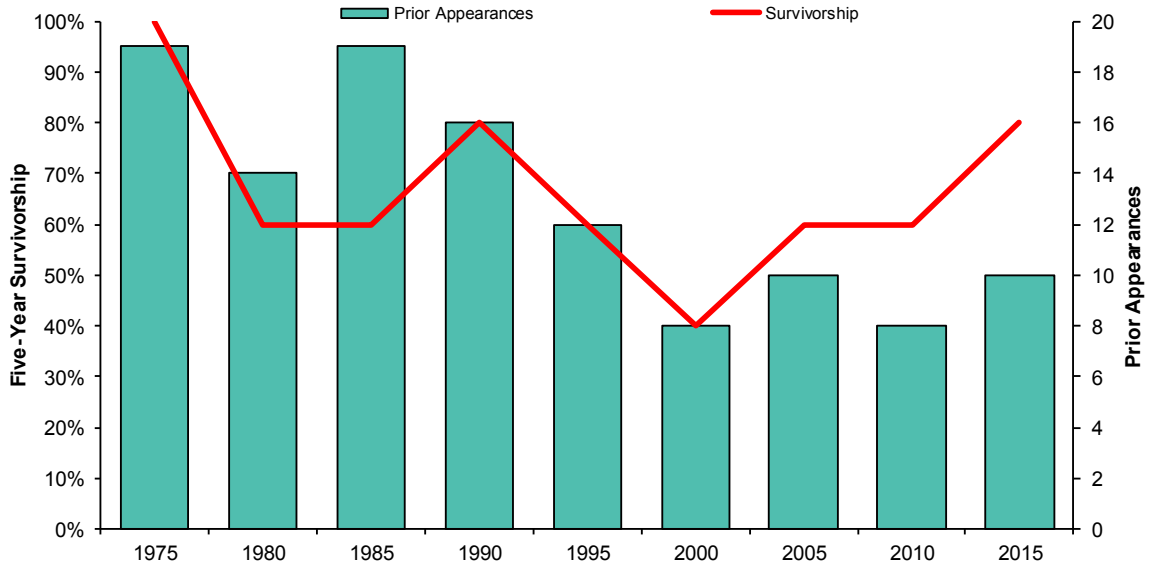
The first lesson from this chapter is the obvious one: life is not always fair, at least over the short term. The entities that created the technologies — and, therefore, the value — when it came to the communications and mobility revolutions were not the entities that captured most of the value.

But the more interesting question is: first, why was this the case, and second, is this a permanent condition that we could see replicated in the machine learning/artificial intelligence version of the future of technology?

Our underlying thesis here is that capitalism is changing. Capitalism did not used to work like this. If you built the railway line, you can charge whatever you wanted (at least to the extent that the charge was cheaper than using the stagecoach) for transport on that railway system. The network won. More broadly, unless heavily regulated, the companies that created the value used to also be the companies that captured the value. The real threat, as we highlight later in this chapter, was regulation limiting returns.

In 1982, the largest company on the NYSE and, therefore, the largest publicly traded company in the world was IBM. IBM made computers. The computer was *Time* magazine's "Machine of the Year" for 1982. There was elegance, or at least predictability to the way that the world worked. IBM, the company that made the best computers in the world, was also the most valuable company in the world.

EXHIBIT 134: **S&P 500 "Top 5" by market cap, 1975-2015**



Source: FactSet and Bernstein analysis.

And that predictability was a near permanent condition. In the 1970s, the largest company in the United States was IBM. In 1990, the largest company in the United States was IBM. The happy cabal of GE, IBM, AT&T, and Exxon were the dominant publicly trading corporations for decades (see Exhibit 135). We rank order the top 10 companies in (what would have been) the S&P 500 beginning in 1951 (the S&P 500 was first

compiled in 1957). From 1951 to 2010, measured in five-year increments, Exxon was in the top 10 every decade. AT&T was in the top 10 in 11 of the 14 five-year measurement periods. IBM featured nine times. In 2000, the survivorship fell to 40% (see Exhibit 134). The number of prior appearances of the top five companies in the list (as compared to the top five companies 25 years ago) in 1990 was 16. The number of prior appearances in the list by the top five in 2015 was 10; and even then, we are using five-year increments.

EXHIBIT 135: **Top 10 S&P 500 constituents by market cap**

Rank	1951	1955	1960	1965	1970	1975	1980
1	AT&T	GM	AT&T	AT&T	IBM	IBM	IBM
2	Exxon	Du Pont	GM	GM	AT&T	AT&T	Exxon
3	GM	Exxon	IBM	Exxon	GM	Exxon	AT&T
4	Du Pont	AT&T	Du Pont	IBM	Exxon	Eastman Kodak	Amoco
5	Union Carbide	GE	Exxon	Du Pont	Eastman Kodak	GM	Schlumberger
6	GE	Texaco	GE	Texaco	Sears Roebuck	Sears Roebuck	Chevron
7	Texaco	Union Carbide	Texaco	Sears Roebuck	Texaco	GE	Shell Oil
8	Chevron	Marathon Oil	Marathon Oil	GE	GE	Dow Chemical	Mobil
9	Sears Roebuck	Chevron	Eastman Kodak	Eastman Kodak	Xerox	Procter & Gamble	Atlantic Richfield
10	Gulf	Sears Roebuck	Ford Motor	Gulf	Gulf	3M	GM

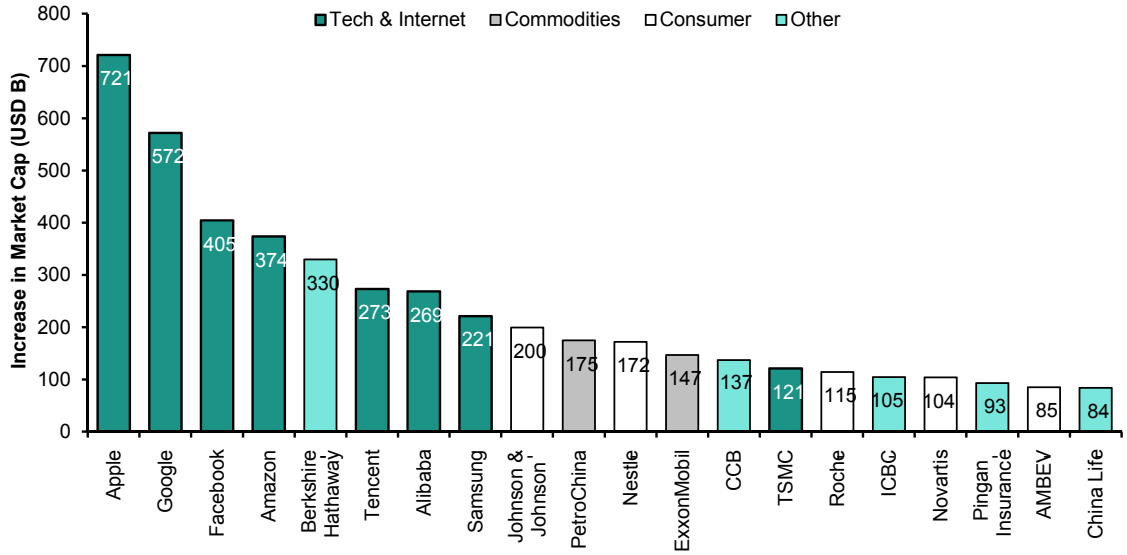
Rank	1985	1990	1995	2000	2005	2010	2015
1	IBM	IBM	GE	GE	Exxon	Exxon	Apple
2	Exxon	Exxon	AT&T	Microsoft	GE	Apple	Alphabet
3	GE	GE	Exxon	Cisco Systems	Microsoft	Microsoft	Microsoft
4	AT&T	Altria Group	Coca-Cola	Intel	Citigroup	Wal Mart Stores	Exxon
5	GM	AT&T	Merck	Exxon	Wal Mart Stores	Berkshire Hathaway	Berkshire Hathawa
6	Shell Oil	Royal Dutch	Royal Dutch	Pfizer	Pfizer	GE	Amazon
7	Amoco	Wal Mart	Altria Group	Citigroup	Johnson & Johnson	Alphabet	GE
8	Royal Dutch	Bristol Myers Squibb	IBM	Wal Mart	Bank Of America	Procter & Gamble	Wells Fargo
9	Du Pont	Merck	Wal Mart	Oracle	American Intrnl Grp	Chevron	Facebook
10	Bellsouth	Coca-Cola	Microsoft	AT&T	Intel	IBM	Johnson & Johnso

Source: FactSet and Bernstein analysis.

Our point is: winners may still be taking all, but they "take all" for a much shorter time in 2016 than in 1966 or even 1996. That is, in our view, the appropriate word of caution when assuming that current technology victors (Apple, Alphabet, and Amazon) are permanent.

In terms of sweeping theories for what has changed in commerce over the last two decades, network effects are — in our view — the strongest. AT&T in 1951 and in 1960 had a network effect…literally. If you wanted to make a phone call in the United States before 1984, you had to use AT&T. After 1984, if you wanted to make a long-distance phone call in the United States, you almost certainly had to use AT&T. The original network effect was underwhelming because it was so obvious, and it required a physical network that was subject to regulation. Vanderbilt owned the railway system. AT&T owned the telecommunications system. Of course, they extracted the value of the network.

EXHIBIT 136: **Top 20 stocks globally by absolute market value increase, 2000-17 year-to-date**



Note: We have assigned all pre-IPO Internet companies a value of US$1 billion in January 2000. This seems generous, given Mark Zuckerberg was 14 at that time. For other sectors, if the company was unlisted on January 1, 2000, we have taken the earliest available value.

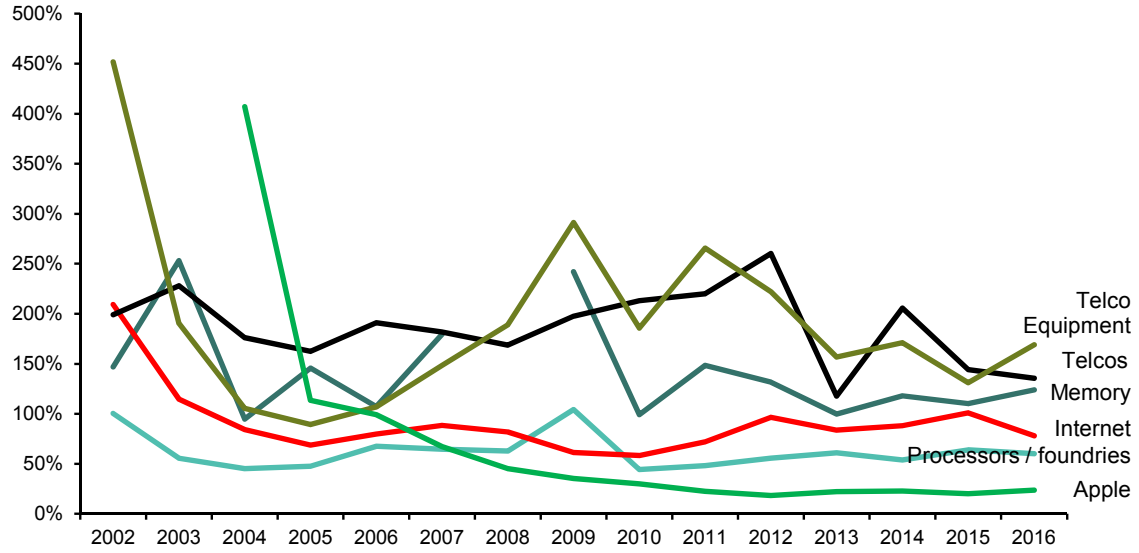
Source: Bloomberg L.P. and Bernstein analysis.

But something changed over the last 20 years. Specifically, two things changed. First, owning assets was no longer necessary when building a network. Second, a business model where there is a cost to acquiring customers is unambiguously inferior to a business model where customers have no choice but to buy from you (AT&T, the regulated monopoly of old) or have no choice but to use your platform today (Instagram today).

Again, in the Internet circa 2017, the decisions between Instagram or Snap may be as arbitrary as the decision between Coke and Pepsi 30 years ago. But Pepsi (Snap in the modern incarnation) really does taste better if all of your friends are drinking it too. Customer acquisition is a prosaic consideration once you achieve scale. The question is customer engagement. Therefore, among other things: why advertise?

Since 2000, globally, the companies that have gained the most in terms of absolute increase in market value conform to one or both of those requirements (see Exhibit 136).

EXHIBIT 137: **SG&A as percentage of operating income (2002-16)**



Source: Bloomberg L.P. and Bernstein analysis.

Apple designs its products in California. They are manufactured by others elsewhere. During the rise of the iPhone a decade ago, AT&T and Verizon — in the United States — were forced to negotiate for the exclusive right to sell the iPhone when it was first released. The currency of that negotiation was the subsidy that the carrier would provide to every new subscriber who purchased the phone. As a consequence, Apple outsourced not just manufacturing but customer acquisition.

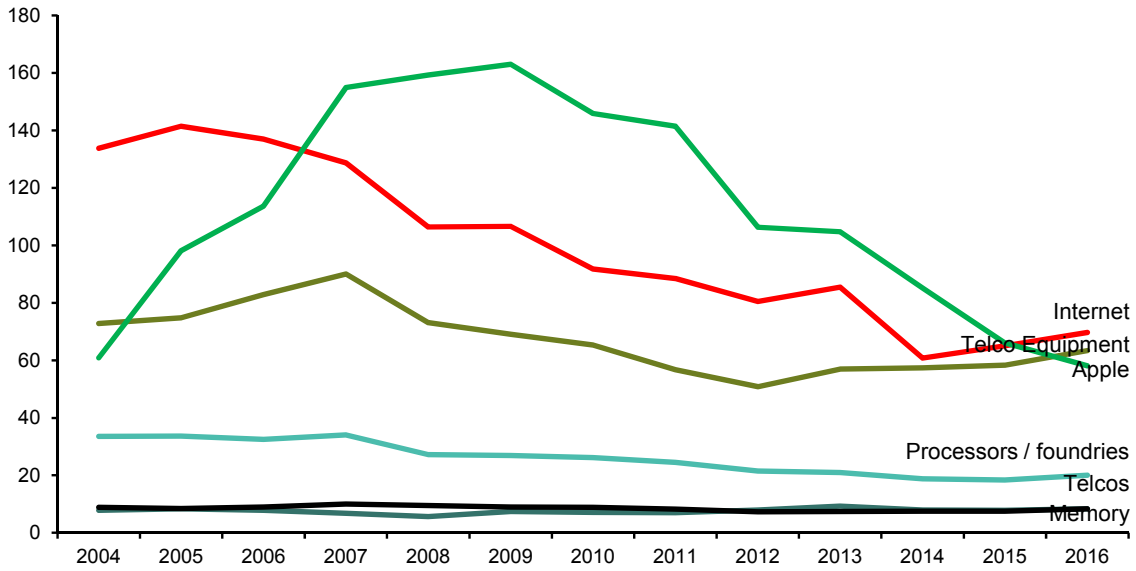
The benefit of network effects — without having to build a physical network — is clearly in the Internet space. Facebook managed the transition from aspirational brand (launching only at Ivy League schools to build cache and the image of exclusivity in 2004) to utility (500 million users by 2010) before it IPO-ed. At that point, Facebook had a network effect.

"Asset-lite network effect beneficiary" is not a perfect formulation of everything Apple, Google, Facebook, Amazon, Tencent, and Alibaba do — and Samsung does not do. But it does align with the quantification. Sales, general, and administrative expense as a percentage of operating income is lowest among the Internet and processor manufacturers/foundries (see Exhibit 137). Market capitalization to capital spending is the highest among the Internet names. In short: do not own assets and do not advertise (see Exhibit 138).

And those decisions drive valuation directly. A warranted price/earnings multiple is a function of earnings growth. Earnings growth is a function of return on equity and investment rate. The investment rate is a function of either enthusiasm (for poorly managed companies) or the delta between return on capital and cost of capital. Accordingly, superior business models maximize net income for every unit of capital

employed. In other words, (i) do not own assets if you do not need to and (ii) try not to waste money on things like acquiring customers.

EXHIBIT 138: **Market capitalization to capex ratio (rolling five-year average) (2004-16)**



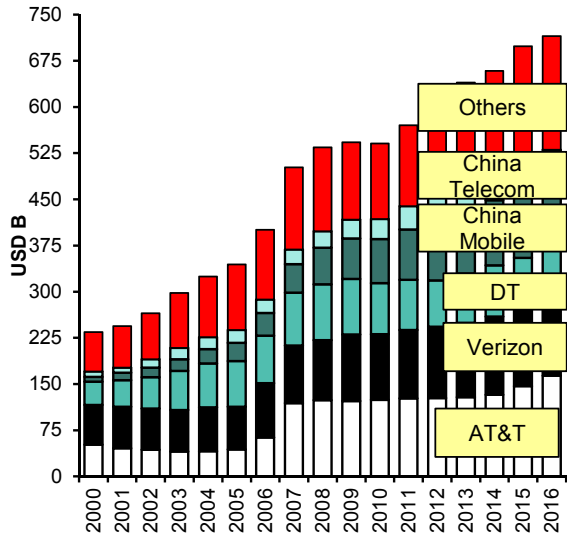
Source: Bloomberg L.P. and Bernstein analysis.

If these are the generic instructions for the kind of businesses that succeed in 2017, the sectors that can most easily comply — outside of Internet — include component makers (especially those with a technology advantage over the competition — TSMC and Samsung) that do not have to "own" retail customers' relationships. Samsung's move into a globally recognized consumer brand (with higher SG&A spending) has hurt it over the last half decade. Telcos appear to be learning, slowly.

The second mandate is a more obvious one: do not build assets if you do not need to. Market capitalization as a ratio of capital spending reflects whether the market is valuing a business based on its physical assets or on its intangible qualities. Not surprisingly, the telecommunications companies and the semiconductor producers struggle on this criterion. The Internet excels.

Of course, top-line growth still helps. However, it does not help as much as one might think. Globally, the telecommunications companies have tripled revenues since 2000 (see Exhibit 139) but are not even also-rans when you consider the winners and losers from the changes in the marketplace over this period (see Exhibit 140).

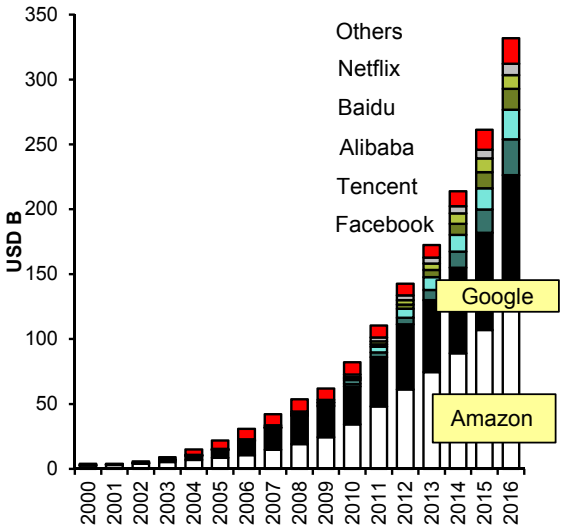
EXHIBIT 139: **Revenue contribution of key companies in the telecom sector (2000-16)**



Note: Others include T Mobile, Sprint, BT, Orange, and China Unicom.

Source: Bloomberg L.P. and Bernstein analysis.

EXHIBIT 140: **Revenue contribution of key companies in the Internet sector (2000-16)**



Note: Others include Yahoo!, YY, Kakao, Netease, 58.com, Naver, SINA, and Weibo Corp.

Source: Bloomberg L.P. and Bernstein analysis.

THE PARALLELS AND DIFFERENCES WITH THE FUTURE OF TECHNOLOGY

There are two contradictory conclusions that can be distilled from all of this.

First, the Internet sector was the extraordinarily fortunate beneficiary over the last two decades of investment by technology and telecommunications companies that did not, for a moment, suspect that the value they were creating could be leached away so rapidly and so efficiently by the platform that sat on top of the true innovation (see Exhibit 141).

Second, the next generation of companies responsible for the future of technology — augmented reality, virtual reality, artificial intelligence, voice recognition, and machine learning — will not be as cavalier in their approach. Business models are going to become more sophisticated (see Exhibit 142).

Further, given that "buying the customer" and "building the asset" are now negative characteristics in any business, the fragility of the right to capture value is changing in a fundamental way. The rise and fall of the companies and sectors that will dominate our thinking and investment controversies over the next decade will be far faster than over the last 60 years. The transition from GE and AT&T to Alphabet and Apple may not be the passing of the baton. We are just seeing the first and the second wave of pretenders to a throne that no longer exists.

EXHIBIT 141: **Financial metrics for sector constituents: Internet, processors/foundries, memory, telecom, and telecom equipment**

	Revenue (USD B)		Revenue	Market Cap (USD B)		Market Cap	ROIC	
	2000	2016	CAGR (%)	2000	2016	CAGR (%)	2000	2016
Internet								
Alibaba	-	15,912	-	-	219	-	-	67%
Baidu	-	10,624	-	-	57	-	-	16%
Tencent	-	22,880	-	-	232	-	-	24%
Google	19	90,272	70%	-	539	-	-	38%
Facebook	-	27,638	-	-	332	-	-	34%
Netflix	36	8,831	41%	-	53	-	-	6%
Amazon	2,762	135,987	28%	6	356	30%	-	19%
Yahoo	1,110	5,169	10%	17	37	5%	11%	-1%
Processors / foundries								
Intel	33,726	59,387	4%	202	172	-1%	37%	17%
AMD	4,644	4,272	-1%	4	11	6%	22%	-8%
Qualcomm	3,197	23,554	13%	62	96	3%	14%	49%
MediaTek Inc	412	8,549	21%	-	11	-	-	14%
TSMC	5,324	29,415	11%	28	145	11%	24%	33%
NVIDIA	375	5,010	18%	2	58	23%	-	97%
Memory								
Samsung	6,645	32,603	10%	19	210	16%	22%	20%
SK Hynix	9,492	14,830	3%	2	27	19%	12%	13%
Micron	6,362	12,399	4%	20	23	1%	31%	2%
Nanya	455	1,292	7%	1	4	7%	6%	8%
Telcos								
AT&T	51,476	163,786	8%	162	261	3%	12%	7%
T Mobile US	-	37,242	-	-	47	-	-	4%
Verizon	64,707	125,980	4%	135	218	3%	7%	14%
Sprint	-	32,180	-	-	34	-	-	4%
British Telecom	30,152	28,712	0%	56	45	-1%	7%	16%
Deutsche Telecom	37,806	80,904	5%	91	81	-1%	3%	7%
Orange	31,097	45,289	2%	100	40	-5%	3%	6%
China Mobile	7,850	106,680	18%	102	217	5%	41%	19%
China Telecom	8,579	53,050	12%	-	37	-	17%	6%
China Unicom	2,862	41,291	18%	19	28	2%	10%	1%
Telecom Equipment								
ZTE Corp	546	15,114	23%	-	9	-	13%	0%
Nortel Networks	27,948	-	-	99	-	-	-	-
CISCO Systems	18,928	49,247	6%	275	152	-4%	13%	38%
Ericsson	29,922	26,043	-1%	89	19	-9%	-	-
Alcatel Lucent	29,005	-	-	69	-	-	-	-
Motorola	37,580	6,038	-11%	44	14	-7%	-	35%
Nokia	28,052	26,137	0%	209	28	-12%	-	10%

Note: Only memory segment revenues included for Samsung. Market capitalization as of end 2000 and 2016.

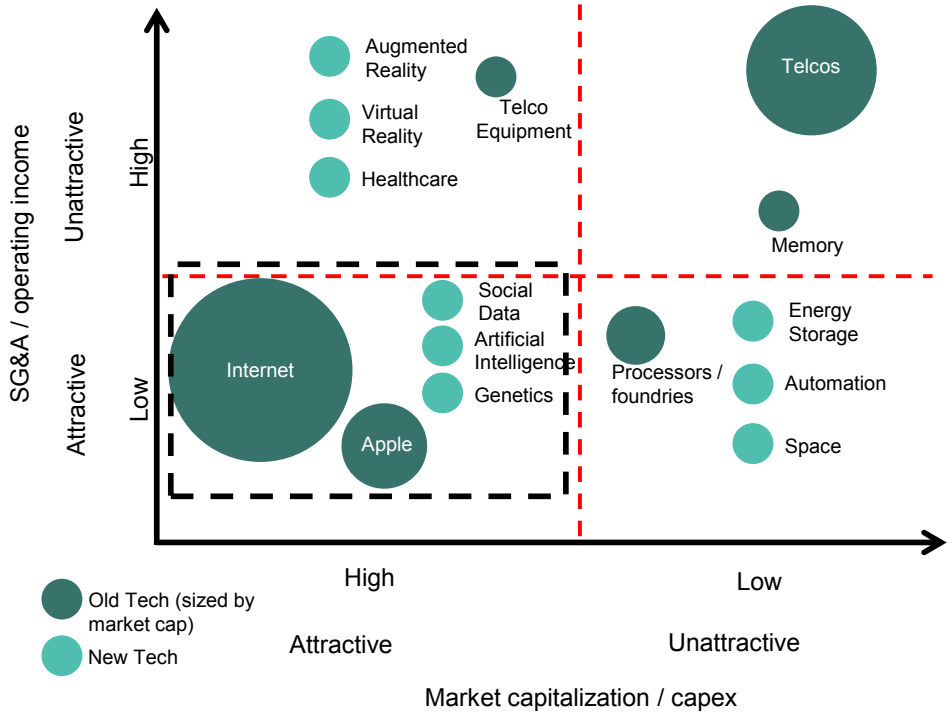
Source: Bloomberg L.P. and Bernstein analysis.

AN ALTERNATE FUTURE

Life is fair — in the long term. And the technology industry may be closer to realizing this than we can currently fathom. There are many strains of thought that lead to this view — a future that contains more disruption, but no free lunches; and a future with relentless change, but also greater friction, higher costs to scale, and lower returns on capital. When this alternate future plays out, our current declarations of supreme victory for today's Internet giants may look amusing in hindsight!

Indeed, the pinnacle of a company or a segment's power has often been looked at, in retrospect, as the moment when the seeds of its downfall were sown. In 1964, *Fortune* magazine feted Sears as an "extraordinary powerhouse of a company." By 1990, headlines told a different tale — "Sears let arrogance blind it to basic changes in the American marketplace." Closer home in tech, Digital Equipment was feted in 1986 thus: "Taking on Digital…these days is like standing in front of a moving train." In 1986, there were under 12 years left in Digital's existence as an independent company. The path to "just desserts" has been shortening through the decades. BlackBerry (founded in 1984) peaked in revenues in 2011 at nearly US$20 billion. Four years later (in 2015), its revenues had collapsed to US$3.3 billion.

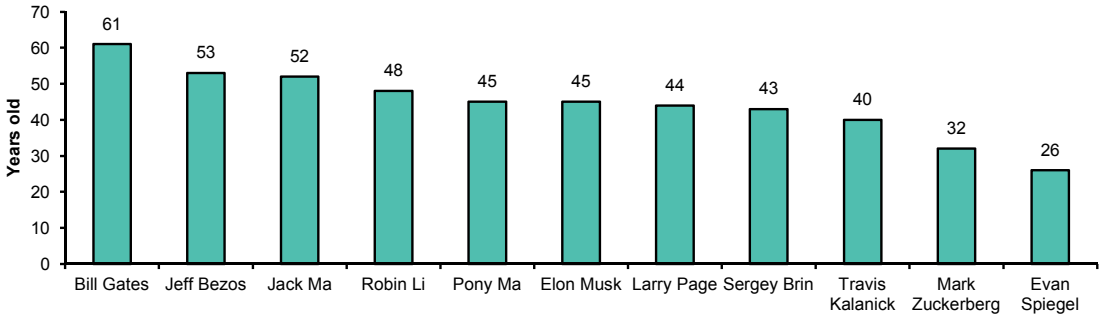
EXHIBIT 142: **Capital Intensity versus marketing expenses matrix for technology opportunities**



Source: Bloomberg L.P. and Bernstein analysis.

Part of the all-pervasive presence of today's Internet giants comes from their youth. As a society, we are enamored by their spectacular rise, by their out-sized influence on our lives, and by the exciting future that may yet lie ahead. This fascination allows us to rationalize the power and valuation of today's tech giants, as well as explain away the less fortunate (telecom OEMs, networking providers, memory, and chip giants). Even at the peak of their value and influence, the leaders of Cisco or Samsung or Intel were not elevated to the rock star status that founders such as Elon Musk (or Steve Jobs before him) enjoy today. Yet, the Internet revolution is under three decades old. The founder of Facebook is in his 30s, the founder of Snap Inc., in his 20s, and the founders of many Chinese Internet giants are still in their 40s (see Exhibit 143). The eventual denouement of this drama lies ahead.

EXHIBIT 143: **Bill Gates has seen it all; Bezos and Ma are merely greying**



Source: Wikipedia and Bernstein analysis.

Blame it on karma. The world of tech is no longer an upstart disruptor to the status quo — the David to many a Goliath. Gone are the days when a few kids in a garage changed the world on a diet of pizza. Technology is the new establishment. It is front and center, the mainstream of societal change and influence, the platform of abuse and angst, the weapon law makers and breakers wish to possess, and the force ordinary humans are increasingly wary of. Vaulting ambition, unrelenting innovation, ease of financing, and the rising sophistication of computing and software have brought technology to a point where the disruption is societal in a way that will be very different from the past.

This is no longer about PCs, smartphones, or tablets — mere toys that enabled us to connect and explore our world differently. This is about how we will live our lives, what kind of jobs we hope to keep and lose, how we will educate and train our children for the new world, how we will fight crime, and how geopolitics will be shaped. This is about how and how long we shall live and how we shall approach old age. How do we grapple with the implications? There are a few methods to frame this debate on future tech.

#1: Ownership — capitalistic appropriation versus the collaborative commons

The question around where value accrues from innovation rests on the premise that ownership of its downstream benefits, powers, and influences remains unchanged. For our generation, which grew through the Reagan-Thatcher privatization era, the end of Communism, and the great globalization experiment of the World Trade Organization, it is hard to believe that the fruits and weapons of innovation have not always been in private hands. Where technology has reached today and where it threatens to go in the future may be leading us to revisit this debate. In part, this now looks inevitable.

In the 1930s, Harold Hotelling, an economist, argued that there are certain kinds of goods that are unique, and that everyone needs to have access to them. Roads and bridges, railroads, and electricity are some of these. This led to the question: who should pay for such goods? Hotelling argued that the government needs to finance (and implicitly own) these public goods and, in turn, provide these to citizens at a marginal cost — in effect, general taxation would finance goods that were needed for society as a whole.

These thoughts, which form the philosophical basis of the Collaborative Commons movement, are being revitalized (for example, by author Jeremy Rifkin in his recent work

"The Zero Marginal Cost Society"). Creative Commons licenses are not uncommon. YouTube boasts a library under it, Wikipedia's entire content was brought under a Creative Commons license in 2009 and hundreds of millions of Flickr photos exist under the same arrangement. Elinor Ostrom became the first woman ever to win the Nobel Prize for Economics in 2009, for her work on the history of the Commons through the last thousand years.

Compare this with where the world of technology has come thus far, and where it is leading us. Today's tech giants own and monetize minute behavioral characteristics that we ourselves may not be fully aware of. By owning our social data, we are "targeted" with ads we are supposed to find relevant, news that is expected to suit our bent, videos that we are likely to watch, and items we are likely to buy. While championing the cause of "net neutrality", tech majors "are walling off information posted by their users from the rest of the web," to quote Tim Berners-Lee, founder of the Internet revolution.

Tomorrow promises to be worse. Healthcare companies will claim intellectual property rights over every little nuance of their work — a new gene decoded, a mutation discovered or synthesized, and a new tissue grown. Ray Kurzweil's "singularity" may be near, but will there be just one? Or are we headed to a future when several strains of "artificial intelligence" fight it out for "market share." Surely, society and governments aren't supposed to sit by and watch as all this plays out in private hands.

This train of thought, therefore, leads us to the following conclusion. Sure, many parts of the tech world benefited disproportionately from the infrastructure created by others — Internet giants stood on the shoulders of semiconductors, telecom equipment, and service providers. This equation, which appears "unfair" to many as of now, could well reverse in the future. The billions of dollars that many technology companies will likely spend in space exploration, healthcare/gene therapy, and artificial intelligence will eventually lead to products that will likely not exclusively belong to them. The companies that appropriated the profits of others in the last two decades will likely have their profits appropriated from them. In this alternate future, much of the current R&D spend in some areas (AI, space, and genetics) is merely a hidden penalty for past appropriations, as the benefits of these R&D outlays are unlikely to be allowed to remain in private hands (see Exhibit 144).

EXHIBIT 144: **Back to the Collaborative Commons**

	Current Model	Risk of reversion to the Commons
Augmented reality	Capitalistic appropriation	Low
Virtual Reality	Capitalistic appropriation	Low
Automation	Capitalistic appropriation	Low
Energy Storage	Mixed	Medium
Social data	Capitalistic appropriation	Medium
Artificial Intelligence	Capitalistic appropriation	High
Healthcare, genetics	Capitalistic appropriation	High
Space	Mixed	High

Source: Bernstein analysis.

#2: Net benefits will determine whether adoption wins over friction: how many are better off versus worse off?

The ideas of extracting out capital expenditure and customer acquisition costs are considered the lynchpins of the victory of Internet-based business models over those that created the infrastructure in the first place. But this need not be Internet's smartest business innovation. Something of far greater consequence has been this — platforms and applications of technology (i.e., Internet) have fundamentally managed to convince us that they exist for the greater good of society, and that the world is a better place as a result.

Alternate thoughts have existed around the propounded benefits for long. Harold Mendelsohn, then Director of the Center of Mass Communications Research and Policy at the University of Denver, proposed a different thought as far back as 1979:

> *The notion that new technologies in communications can be nothing but functional for both individuals and society is the peculiarly naive consequence of the marriage between neo-technocratic ideology and a more traditional unbridled positivism. It simply is not true that every major technological innovation has spawned nothing but benefits to the human race. The prospective dysfunctional consequences of future technologies are far more realistically projected in the motion picture Star Wars, for example, than in pie-in-the-sky, oh-my-gosh, "benefits to humanity" mutterings.*

Technology has proved him wrong in the last three decades. Yet, there is the simmering discontent rising about it, and against it. Countries now accuse each other of cyber attacks. Fake news abounds. Terrorists and other unsavory types run their hiring models on the back of Internet's platforms. New forms of gender discrimination, privacy violations, spying, hacking, theft, and child abuse have emerged — the book *Future Crimes* by Marc Goodman is, thus, a sobering read. Silicon Valley would argue, with some justification, that technology lays bare the wounds of society that were hidden for too long. Yet, the same power creates new ones. The cycle of technology's, and especially Internet's much touted benefits may be about to moderate. And therein lies the rub of how society will react to those who wield such enormous financial power and political/societal influence from San Francisco to Shanghai.

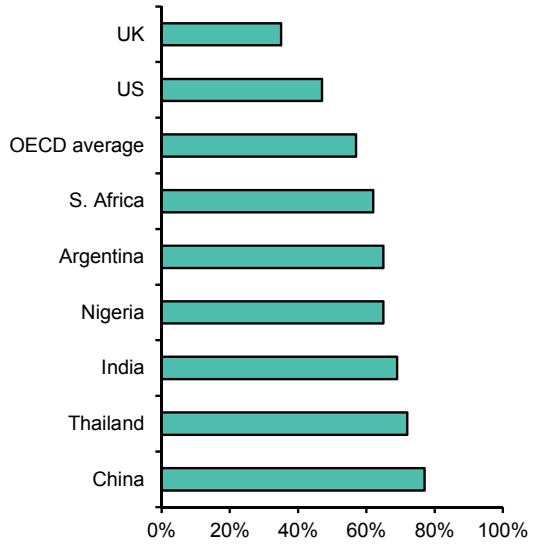
A simple ratio to define the intensity of disruption is this: **number of people better off/number of people worse off or displaced.** We shall call it the net benefit ratio. The higher this ratio, the more likely it is that the disruption will be embraced by society, regulators, and investors. The lower this ratio, the more likely it is that new sources of friction appear. Let us look at some past and emerging technologies in this light.

- **PCs and smartphones**: About 3 billion people own smartphones globally. We can consider they are all better off. Sure, parents may fret about the screen time children enjoy, and studies may moan about the impact of smartphones on attention spans, sleep, and social behaviors. But we are talking cold facts here. Three billion people benefited in some way or the other. Who were worse off? The numbers are small. Factory workers who produced feature phones (or pagers, before phones) were re-deployed to smartphone manufacturing. Postal workers found new work pushing e-commerce packets (although some 200,000 U.S. postal workers did lose their jobs in

2003-13). We could count the employees of Nokia, Palm, BlackBerry, and the likes, perhaps, among the worse off, but even they benefited in their personal lives via the rise of smartphones. Camera manufacturing was worse off. A few other segments were also worse off, but all small. This makes for a very high net benefit ratio.

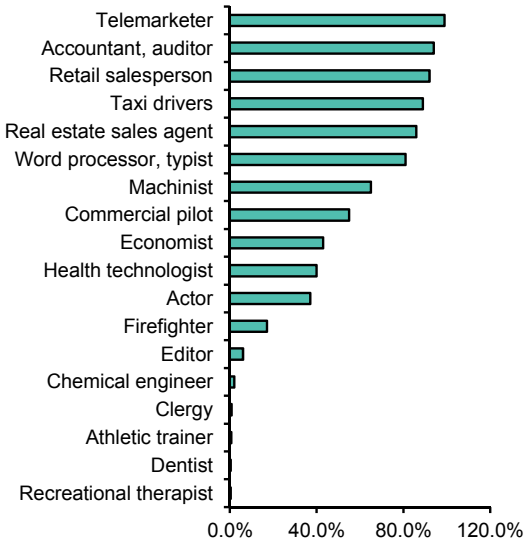
- **Artificial intelligence, driverless cars, and automation:** Now consider AI and automation, at the other end of the spectrum. A World Bank study (see Exhibit 145) contends that between 35% and 77% of all jobs in various countries could be at risk from the rise of AI and automation. Another study by academic researchers (see Exhibit 146) dove deep into the skillsets that have a high likelihood of being computerized. Dentists are safe, as are recreational therapists (which is where we classify ourselves!). Telemarketers and taxi drivers are at the other end of the spectrum. How would our net benefit ratio look in this case? Surely, not anywhere as high as in the case of PCs and smartphones. And it would be more open to societal and political interpretation too.

EXHIBIT 145: **Percentage of jobs at risk from automation**



Source: World Bank Development Report, 2016, and Bernstein analysis.

EXHIBIT 146: **Probability an AI will replace this job**



Source: "The Future of Employment" C. Frey and M Osborne (2013), and Bernstein analysis.

- **Augmented and virtual reality (AR and VR), and healthcare tech:** In contrast to AI-automation-driverless cars, the rise of AR/VR and healthcare tech seems benign. AR/VR technologies are meant to benefit via entertainment, information, and e-commerce applications. Collectively, they could be the next avenue of the "escapism" ethos that rode the wave of radio, movies, television, and social media. Many consumers should be happy, very few (e.g., content creators on old formats) would be worse off. Similarly, healthcare advances that use AI and new technologies would benefit far more people than they harm, presumably. Sure, cancer pathologists will resist robotic reading of MRI scans (studies show that machines are already more accurate than humans) — years of medical study for some may become redundant.

But the health benefits for humanity as a whole are likely to swamp out the naysayers.

An approach that brings the "net benefit ratio" into focus preempts future conflict of ownership, regulation, and influence. When Facebook was a social network, it was benign. When it is the primary mode of news access for billions of people, it is under greater scrutiny. When Google was an algorithmic search engine, it was welcomed. When the same algorithms randomly place ads alongside videos or content deemed inappropriate, it is under fire. These changes are subtle at first, but inevitably build toward an inflexion point.

Take automation for instance. During 1995-2002, 22 million manufacturing jobs were eliminated in the global economy, even as production rose 30%. In the United States, between 1982 and 2002, steel production rose from 75 million tons to 120 million tons, while steel workers declined from 289,000 to 74,000. These forces are far different in impact than the fun factors that have dominated consumer tech in recent years. And the backlash and debate around them may have just begun.

Exhibit 147 aims to present one scenario of net benefits across emerging technologies. In this framework, AR/VR, energy storage and space are likely to face far less debate/friction/challenge from wider society/government/regulators than AI, automation, healthcare/genetics, and even social data gathering platforms such as Facebook.

EXHIBIT 147: **New technologies seen through the prism of the net benefit ratio**

	Beneficiaries	Displaced	Net Benefit Ratio
Augmented reality	Shoppers, gamers, perhaps all connected society		High
Virtual Reality	Shoppers, gamers, perhaps all connected society		High
Energy Storage	All society	Legacy energy infrastructure	High
Space	Perhaps all society		High
Social data	Advertisers, data owners (walled gardens)	Privacy seekers, governments	Medium
Healthcare, genetics	Perhaps all society	Poor patients, those on the wrong side of IP laws	Medium
Automation	Shareholders; all society if workers re-deployed	Workers	Medium
Artificial Intelligence	Perhaps all society	Perhaps all society	Low

Source: Bernstein analysis.

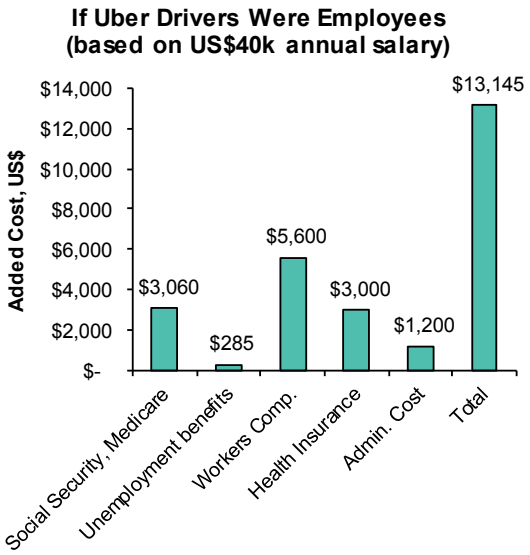
#3: Financial costs: The real costs are yet to arrive

The third line of argument that aims at somewhat re-balancing the "unfair advantage" some technology platforms seem to have enjoyed is around costs. In this debate, the pace of innovation and disruption in some businesses has been fast enough to temporarily mask the real costs of doing business, artificially inflating the profitability of the platform, or reducing its losses. When the final chapter on costs and revenues is written, alongside ownership and adoption, the returns on capital employed will also be determined by the real costs of doing business. Picture this:

- Angst against the on-demand economy has been rising. If Uber were to classify its drivers as full-time workers, its costs could rise by about US$4.1-US$4.3 billion annually (see Exhibit 148 and Exhibit 149). Given that Uber reportedly had losses of some US$2.8bn in 2016, an additional cost of US$4bn could upend its entire business model. Airbnb has been similarly accused of flouting local regulations of the cities it operates in, distorting rental markets by taking 10-15% of vacant properties

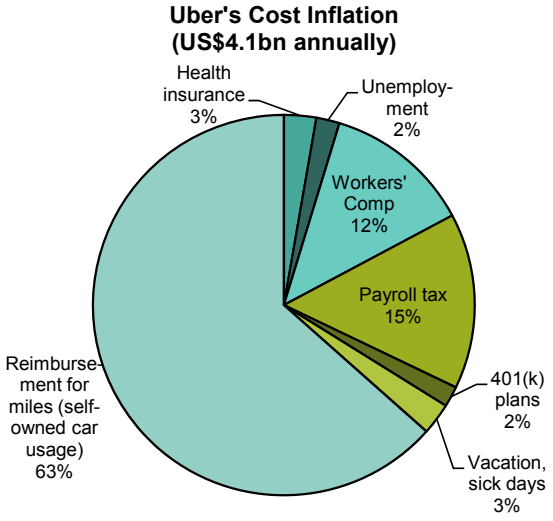
out of circulation and of casting an inflationary impact on real effective rentals. This has let loose a swarm of economic studies, variously sponsored by divergent groups, which aim to prove their respective viewpoints. In some cities, Airbnb has had to backtrack and change its practices. It is now illegal in some US cities, such as New York, to given out accommodation for short term rentals in multi-family buildings unless the host is present as well. After threatening to take the matter to court, Airbnb dropped its lawsuit, reportedly when regulators assured the company that such home owners, and not Airbnb, would be punished for violating the law. The business model lives on, for now.

EXHIBIT 148: **In 2015, there were some 327,000 Uber drivers in United States, who would each cost some US$13,000 more if they were classified as full-time workers**



Source: StaffOne, *Fortune*, and Bernstein analysis.

EXHIBIT 149: **Another calculation yields a similar additional cost to Uber (US$4+ billion) if it was held accountable to all local laws in the United States**



Source: Paychex data, *Fortune*, and Bernstein analysis.

- The cost of doing business could be rising elsewhere as well. Facebook has recently had to put considerable resources to fight fake news, including employing fact checkers as well as spending on educational campaigns. Google has had to increase manpower that scrutinizes videos uploaded on its websites, and change rules so that no ads are rolled out for videos that have not had at least 10,000 views — a reaction against allegations that ads were being placed against inappropriate videos.

- Importantly, none of the areas of investment for major technology platforms seem to promise anywhere close to the profitability and ROCE that their core businesses enjoyed. The margins on search, social media advertising, e-commerce, and video gaming stand truly head and shoulders above what can be expected, in the best case, from cloud computing, online video, electric vehicles, voice recognition, online payments, fintech, and on-demand businesses.

- The evolution of some of the core businesses, over the longer term, also points to lower returns. Consider omni-channel commerce, for instance. Both Amazon and Alibaba seem to be making early investments in brick-and-mortar retail — a trend in contrast to the very revolution they pioneered. How would an equilibrium state look like in coming decades as the way we shop settles into an online-offline blend? Can we picture higher asset intensity, more capex, and lower returns on capital?

In addition to these examples, it is hard to imagine a business as free from friction as social media or search engines — the pinnacle of network effects may be behind us. What lies ahead is a return to the real world, where Moore's Law or the theory of network effects, the soft and encouraging hand of regulation, or the welcoming eagerness of society should no longer be taken for granted. Indeed, history is replete with cases where appropriators have had their assets appropriated. Consider AT&T, for example. For long, a monopoly in communications in the United States, its CEO vented his frustration at the changed circumstances in a media interview thus:

> *"Now what they would like to do is use my pipes for free, but I ain't going to let them do that because we have spent this capital and we have to have a return for it."*

In our alternate future, there will come a time when several of today's most successful platforms will have similar angst.

#4: Ten years of solitude: If tech is not taught humility, perhaps it will at least learn patience!

It might have taken three years for 800 million Chinese users to transition to 4G-enabled smartphones, but not all future dreams suffer from an equivalent absence of friction. It would be foolhardy for anyone to bet against the ability of humans to overcome the odds and achieve things considered impossible at some point or the other. Yet, overcoming the next frontier of tech, and achieving the ambitious dreams of the industry's current leaders, could take longer. Are we heading into 10 years of solitude for tech's innovation juggernaut? Consider this:

- Alphabet's many projects (past and ongoing) have variously included research into longevity (Calico), urban innovation (Side Walk Labs), floating balloons as a way of delivering Internet (Project Loon), high altitude and solar-powered Internet delivering drones (Project Titan), and drone deliveries (Project Wing). Compared to these, others such as self-driving cars, smart home devices, and energy/Internet access (fiber) almost appear tame. Yet, which among these have a path to scale in the next 10 years? Which among these would show network effects as fast as the prior business models did?

- Not everything around us follows Moore's Law. The cost of chip design has risen through the decades due to the gap between the number of transistors on a chip (following Moore's Law) versus the ability of chip experts to design the circuitry around them (not following Moore's Law). Indeed, while logic transistors per chip have grown at 58% annually, productivity of designers has merely improved by 21% annually. Similar effects are now entering other fields of tech.

- Internet of Things, as a concept, has been around for over a decade — some would say longer; a Coke machine installed at the Carnegie Mellon University in 1982 was able to report its inventory and whether drinks were cold enough. At times, the friction comes from areas little seen. Consider 3D printers. Their industrial applications may be well worth some of the hype, but the long anticipated boom in consumer demand (lets print an iPhone case on our home 3D printer, shall we?) has seemingly hit a wall. Consumers need to know proper design tools to get value out of them, and their demands are so specific that 3D printers have simply failed to keep pace. Like in many other parts of tech, we are waiting.

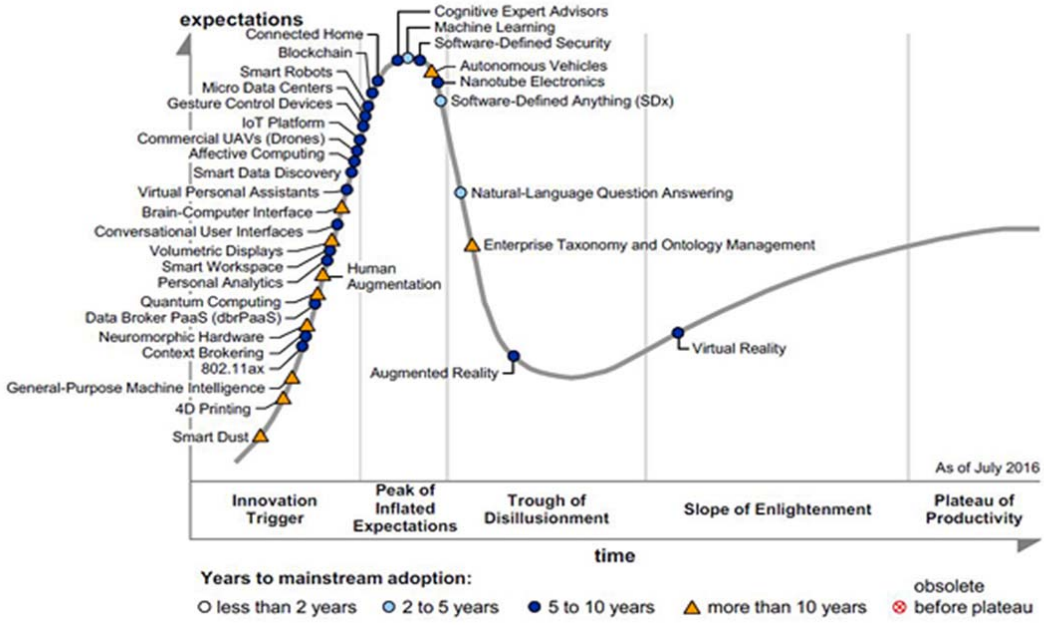
- Various years in the recent past have been declared the "Year of Virtual Reality" — Ernest Cline's VR-based fiction novel, Ready Player One, was published in 2011. Steven Spielberg has been faster on the ball (a movie based on the novel is about to release in 2018) versus tech behemoths themselves, who have had to satisfy themselves with meagre shipments. Tablet shipments made a smaller peak than was expected. Wearables disappointed even sooner. And at the time of this writing, Apple was reportedly having problems incorporating an optical fingerprint sensor in its much awaited next iPhone.

This may sound overly cynical, but technology advancements are not a linear function, but much rather a step function. On the up-step, things change with disproportionate pace — we move from one paradigm to another. We seem to have lived through one such up-step in the last decade and a half. On the flat lines of the step, improvements can be incremental — a painful series of small changes that eventually do lead to magical outcomes (at least sometimes) — but this also explains why the first tablet and the first PDA did not take over the world.

In this alternate future, technology does not learn humility (by failing, or having their profits appropriated away, or by being rejected by society and regulators) but merely patience. It takes longer (and costs more) to achieve the new dreams we are beginning to see. Ideas follow hope, then hype, and time passes as investments go on. Would the returns of tech's supremely profitable platforms look as outlandish once this long trawl ensues?

Via a combination of factors — be it the issue of ownership of a perceived social good, or the scale of adoption versus friction as defined by net benefits (how many gain and how many lose), rising real financial costs, or simply a longer timeline to the next "up-step" in innovation — the balance of value generation and capture within technology could change in fundamental ways. The faster and stronger the current technology efforts succeed, the closer we are to that disruptive change of guard.

EXHIBIT 150: **Ten years of solitude? Perhaps the most benign outcomes among our alternate futures**



Source: Gartner (July 2016) and Bernstein analysis.