

Global Market Insights and Investment Opportunities

— A Silicon Valley Venture Capital Perspective

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Overview

This document describes the current state of global markets and resulting investment opportunities from a Silicon Valley Venture Capital perspective. Venture Capital (VC) in this instance is defined as for-profit investment in early-stage, technology-related companies. Many of these companies are pre-revenue,

* WI Harper Group is global leader in early-stage, cross-border investing between Taiwan and Silicon Valley. Founded by Mr. Peter Liu in 1993, the fund has over 20 years of operating history specializing in Technology/Media/Telecomm (TMT) and Healthcare Technology investments.

and often pre-product, at the time of investment and therefore bear substantial risk for the VC investor. However, successful VC investments can yield atypical returns, often outperforming other asset classes (such as private equity, public markets, real estate, etc.) and major global indices several times over.

Many global VC investment trends originate in the Silicon Valley/San Francisco Bay Area of the United States due to a confluence of factors, including: (i) the region's long-standing history in technological and thought leadership, (ii) a high-concentration of entrepreneurs, academic institutions, and venture capital/private equity funds, and (iii) numerous leading technology companies having headquarters or large operations in the region. Other regions have also become thought leaders in certain technology areas, for example, Taiwan in fabless semiconductors and design manufacturing or Israel in defense-related and security technologies. None-the-less, Silicon Valley remains the nexus of start-up technology and VC investment.

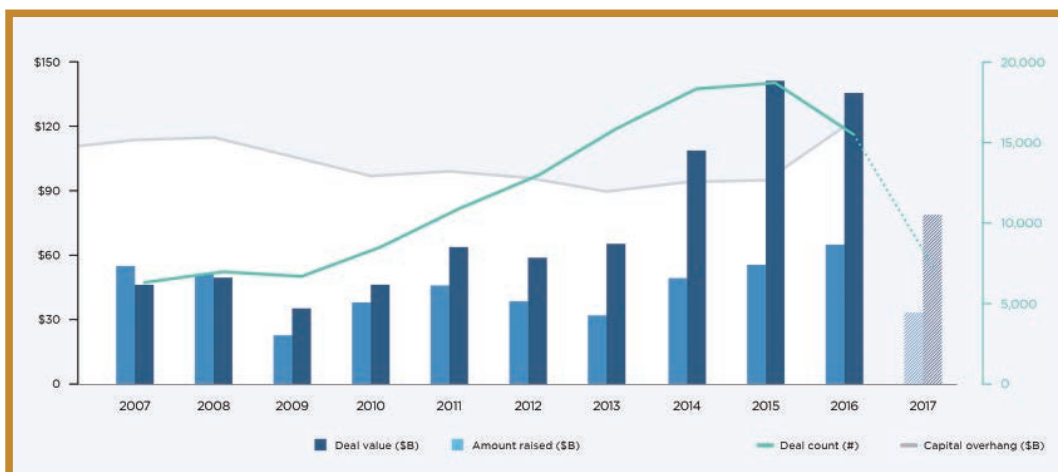
The global VC ecosystem is in the middle of a much-needed correction and normalization period. Key indicators of this correction include a healthy slowdown in investment velocity, increasingly pragmatic valuations for early-stage investment rounds, mergers and acquisitions or public equity buyouts driving more VC liquidity than initial public offerings, and an increased focus in cross-border investing. These combined factors are driving a return to a healthy VC Ecosystem with long-term viability.

Investment Velocity

The most recent decade of VC investment has been heavily impacted by global economic crisis of 2007-2009. VC, like other asset classes, saw a massive slowdown in investment velocity during this time while limited partners, family offices, endowments and sovereign wealth funds withdrew from the market. This led to a substantial build-up of investable capital as cash "sat on the sidelines"

waiting for markets to re-open. As the global economy recovered, investments followed at a reasonable pace – but not at a velocity sufficient to compete with pent up demand and competition for deployment of "sidelined" capital.

Eventually capital flooded the global markets in late 2013, resulting in a spike in both dollars invested and valuations. This movement was further exacerbated by a trend towards "seed investing", in which VC funds invested small amounts of capital into numerous companies at the very earliest stages of development. As a result, deal volume spiked along with valuations and invested capital. These trends can be seen in the chart below:



Note: A spike in key investment indicators as 'sidelined' capital returned to the global VC market in 2013.

Sources: <https://pitchbook.com/news/articles/a-decade-of-venture-capital-an-era-of-excess-datagraphic>.

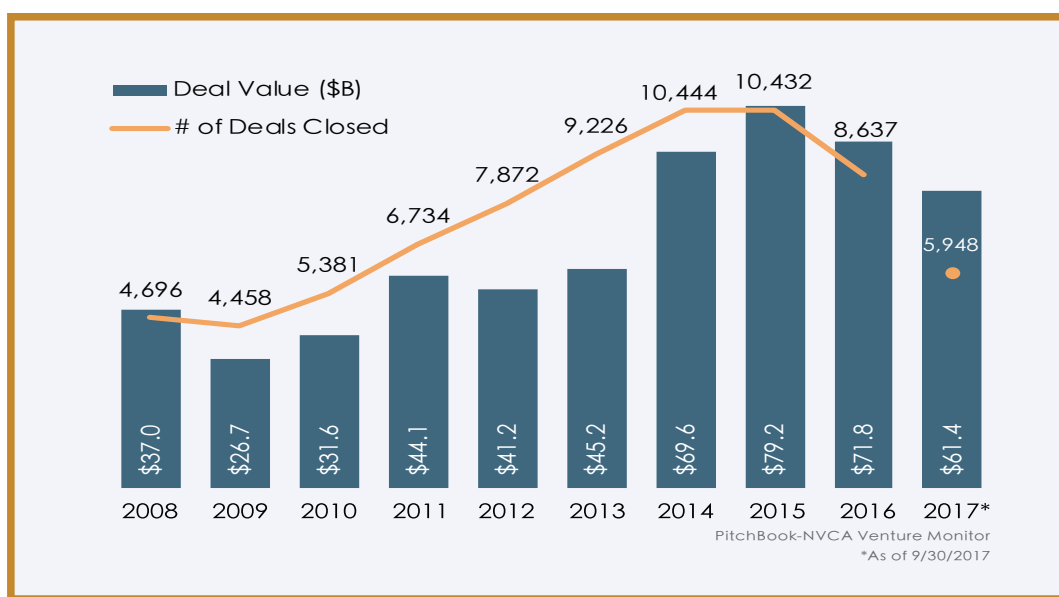
Figure 1 A Decade of Venture Capital Investment

Investment velocity started to readjust to healthy levels in late 2016, with deal activity returning to 2012/2013 levels. Most recently, Q3 2017 (the latest quarter of available data) saw 2,369 VC financings globally.¹ This is a five-year low, marking a 6% decline from the previous quarter and a 13% decrease year-over-year from Q3 2016.

¹ "Venture Pulse Q3 2017." KPMG Enterprise, 11 Oct. 2017, page 6.

Deal Volume is DOWN While Invested Capital is UP

Declining deal volume may at first appear to be cause for concern, however deeper analysis shows that deal volume is entering a subdued plateau while invested capital is on the rise. Both are indicators of a return to a healthier and more rational investment environment. The first three quarters of 2017 saw 7,558 venture-backed companies raise nearly \$90 billion in funding globally. 2017 invested capital is on pace to exceed the total \$134 billion invested in 2016. However, 2017 deal volume is expected to fall short of the 9,717 deals completed in 2016.² These two factors are an indicator that investors are not pulling back from the market – but that they are being more selective on deals in which they invest.



Deal volume continues to decrease back to reasonable levels while invested capital is on the rise.

Note: graph shows US Deals only

Sources: "Venture Monitor 3Q 2017." Pitchbook and National Venture Capital Association, 28 Sept. 2017, page 4.

Figure 2 Deal Volume and Invested Capital Trends

² "Prequin Quarterly Update: Private Equity & Venture Capital Q3 2017." Prequin, Sept. 2017, page 14.

Capital Favors Later Stage Investments

The trend of investing more capital but in fewer deals is further supported by the return of "mega rounds", often exceeding \$100 million, as competition for investing in successful, high-growth companies intensifies. This is particularly noticeable during later stages of investment (i.e. Series C and beyond) where VCs are fighting to maintain ownership while often facing additional pressure from larger and less valuation-sensitive investors, such as private equity, large family offices, sovereign wealth funds and strategic or corporate investors.

Mega-deals are prevalent in all regions, but Asia has seen a particularly sharp increase in related invested capital. Asia's top 10 deals in 2017 accounted for almost one-third of the total VC funding in the region, with half of the deals coming from China alone. The second quarter of 2017 saw two \$1 billion+ mega-rounds, including \$5.5 billion in financing for ride hailing platform Didi Chuxing – the world's largest tech funding round ever – and a \$1 billion funding round to news aggregator Toutiao.³ In the third quarter of 2017, three companies raised \$1 billion+ funding rounds, including US-based property manager WeWorks' \$3 billion round, another \$2 billion for China-based Toutiao, and a \$1.6 billion round from China-owner electric vehicles manufacturer, BAIC BJEV. These significant mega rounds and the continuing decline in deal volume reinforce the disciplined path VC investors are taking by placing fewer bets on angel and seed round opportunities and deploying higher amounts of capital into a more select group of companies.

Recent quarters indicate that the decline in aggregate VC deal flow mirrors a decline in early stage investing, particularly at the Seed and Series A stages. Through Q3 of 2017, early stage investments represented less than 50% of all completed deals for the first time since 2012.⁴ This trend however, may also be

³ "Venture Pulse Q2 2017." KPMG Enterprise, 31 July 2017

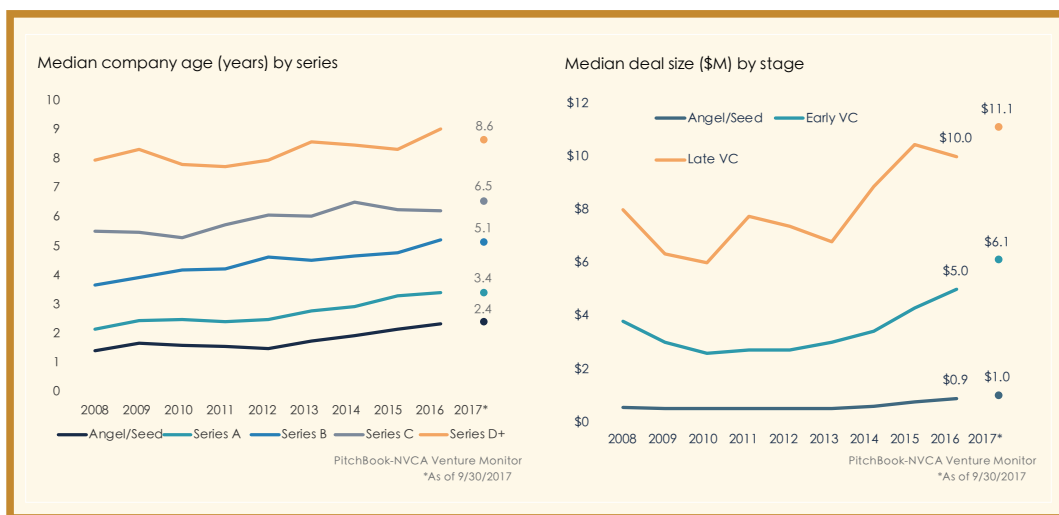
⁴ "Venture Pulse Q3 2017." KPMG Enterprise, 11 Oct. 2017

the result of Seed stage deals moving further into the venture lifecycle, rather than an indicator that invested capital is shying away from funding early stage companies.

On average, companies entering the Angel/Seed stage in 2017 are one full year older than similar companies were 10 years ago (Figure 3). In addition, the median Angel/Seed deal surpassed \$1 million in size for the first time in the past decade (see Figure 4). This trend has been extended by the proliferation of accelerators and incubators, as well as the emergence of angel groups and online platforms for angel investing or equity crowdfunding. The increased investment opportunities prior to formal Angel or Seed funding have prompted many seed-stage VCs to shift toward later and larger deals. This movement has caused a domino effect in which investors at subsequent stages are interacting with more mature businesses and making larger deals than they have historically. "Series A is the new Series B" comments are not only becoming more common, they are becoming more factually sound. In fact, year to date, the median early-stage deal size of \$6.1 million has surpassed the median late-stage deal size of 2010 (\$6 million), marking another VC "first" that has been recorded this year.

It should be noted that deal maturation across all stages explains only part of the transition we continue to see in the VC industry. Another notable trend is that companies are continuing to remain private and delay exits in favor of raising late-stage capital in the private markets, while continuing to capture market share and build sound operational metrics. The last two quarters of 2017 mark just the second time in the past decade that more than \$20 billion was invested in two consecutive terms – and total capital raised during this time is the highest in history for similar timespans.⁵ This is another indicator of investor selectivity and an increase in mega rounds.

⁵ Venture Monitor 3Q 2017." Pitchbook and National Venture Capital Association, 28 Sept. 2017



Seed stage deal volumes are the lowest since 2012. However, this may be the result of companies maturing and moving further into the VC ecosystem rather than an indicator of poor investor confidence.

Sources: "Venture Monitor 3Q 2017." Pitchbook and National Venture Capital Association, 28 Sept. 2017, page 5.

Figure 3 Companies have gotten older

Figure 4 Deals have moved larger



Mega rounds are increasing the aggregate value of deals across the board – another indicator of investor selectivity.

Sources: "Venture Monitor 3Q 2017." Pitchbook and National Venture Capital Association, 28 Sept. 2017, page 6.

Figure 5 Mega-deals propel US VC investment

Mergers and Acquisitions Dominate Liquidity

2016 was the slowest year for US initial public offerings (IPOs) since the 2009 financial crisis. A total of 106 US IPOs raised \$123.7 billion – down approximately 30% from 2015 totals.⁶ This trend is fueled by an increase in mergers and acquisitions of venture-funded companies. In particular, cash-rich and technology hungry strategic/corporate investors are acquiring venture-funded companies. Corporate giants such as Qualcomm, Microsoft, Oracle, Samsung and Tencent are spending significant amounts of capital, often at favorable valuations, to buy up smaller tech companies and gain access to the newest and most disruptive technologies in cloud computing, IoT, smart mobility, social networking, big data analytics and more. 2016 resulted in \$612.9 billion in global tech deals, making it the second-best year of the decade for acquisitions – second in pace only to a record-setting 2015 which saw \$691.4 billion in tech transactions globally.

2017 is already shaping up to be a record-breaking year for exits as investors continue to realize liquidity from pent-up gains that have been accruing, but illiquid for several years. There have been 83 IPOs on US markets year-to-date for 2017, which is up 73% from the same period a last year. Total IPO proceeds for the same period in 2017 is \$21 billion, up 159% year-over-year.⁷ Six 'Unicorns' (venture-funded companies valued at \$1 billion or higher) completed IPOs through Q3 2017: Snap, MuleSoft, Okta, Cloudera, Delivery Hero and Blue Apron. In comparison, there were five "Unicorn" IPOs in all of 2016.

Geographically, China continues to show robust growth in the technology IPO market with 39 companies raising a total of \$5.5 billion so far this year.⁸

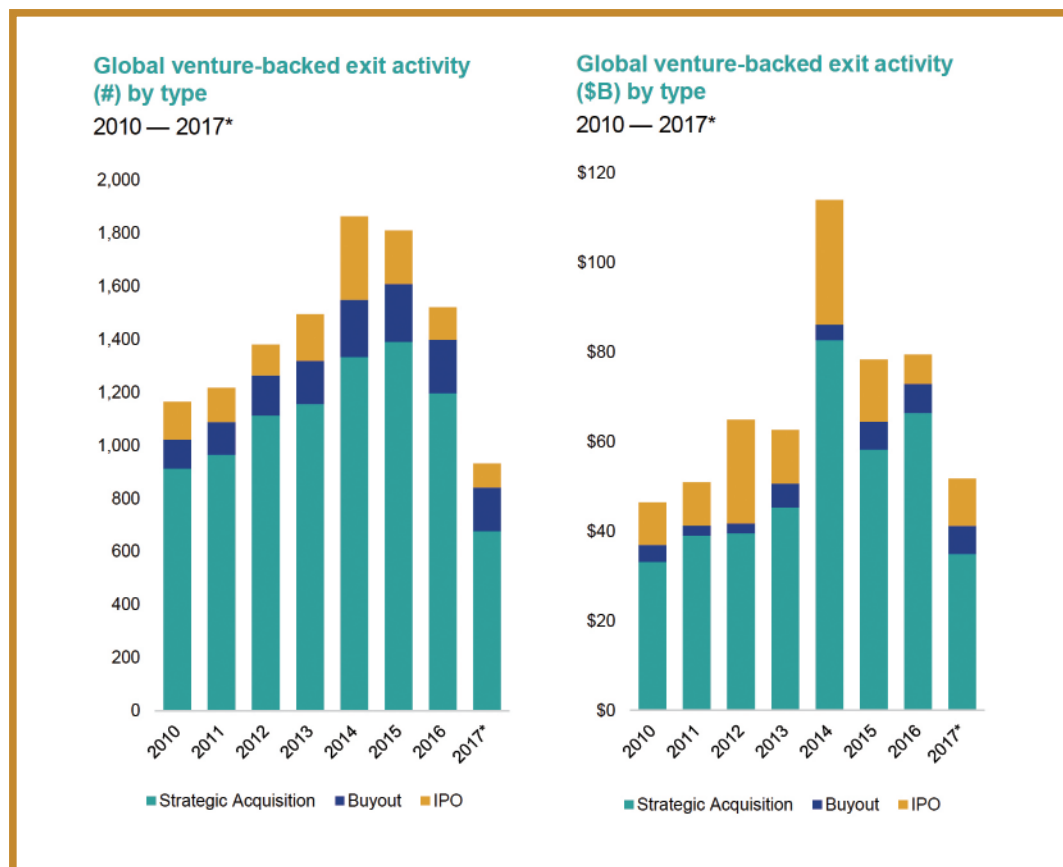
⁶ "Learn more about the 2016 IPOs on Accompany." Accompany, 19 Sept. 2017, <https://www.accompany.com/insights/2016-ipos>.

⁷ Roof, Katie. "The 11 biggest tech acquisitions of 2016." TechCrunch, TechCrunch, 3 Jan. 2017, <https://techcrunch.com/gallery/the-11-biggest-tech-acquisitions-of-2016>

⁸ "Global Technology IPO Review Q3 2017." PWC, October 2017, page 9.

While the Chinese IPO market suffered in 2015/2016, tides have changed and recent IPOs have been favorably impacted by the efforts of the China Securities Regulatory Commission (CSRC) to speed up the approval process as well as support other exit avenues, such as the recently created NEEQ (National Equities Exchange and Quotations) or "the New Third Board."

Despite improvement in the overall IPO landscape this year, M&A still remains the dominate path to liquidity for venture-funded companies, especially with the growing corporate participation in the VC market (see Figure 6). In 2017, corporate acquirers continued to drive the majority of M&A transactions, with



With growing strategic/corporate participation in the VC market, M&A remains the dominant path to liquidity.

Sources: "Venture Pulse Q3 2017." KPMG Enterprise, 11 Oct. 2017, page 24.

Figure 6 Mergers and Acquisitions Continue to Dominate VC Exits

70% ownership of the total M&A market.⁹ Many of these corporate acquisitions are motivated by the opportunity to obtain novel technologies for their own use without the need to invest heavily in R&D. For corporations, this has become the less risky (and quicker) path to addressing innovation.

Corporate acquirers have proven they are willing to pay for innovation, as was demonstrated earlier in 2017 when Cisco acquired AppDynamics for \$3.7 billion the day before the company's planned public offering. The acquisition price represented an 85% premium over the company's \$2 billion market capitalization pricing target.¹⁰ Other billion-dollar deals in 2017 include Intel's acquisition of Mobileye for \$15.3 billion, PetSmart's acquisition of Chewy.com for \$3.3 billion, and Red Ventures' acquisition of Bankrate for \$1.4 billion. Old-guard companies have recognized and embraced the need to innovate to remain competitive as their industries are being affected by a rapidly changing technology landscape.

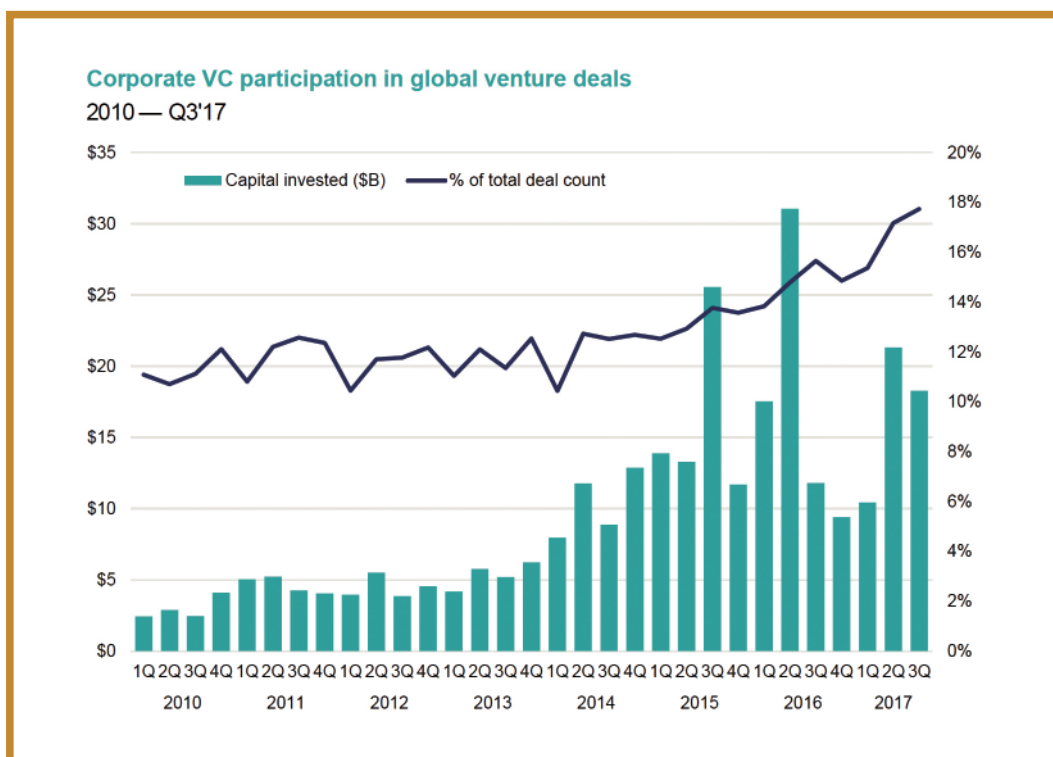
The Resurgence of Corporate Venture Capital

The recent rise in corporate acquisitions has also led to a material increase in Corporate VC with major companies investing in VC-style, early-stage companies. Notable corporate investors, such as Google Ventures, Cisco Investments, Dell Ventures, and Intel Capital, have played a significant role in the VC industry for many years. However there has been a recent influx of new Corporate VCs, ranging from convenience stores (7-Eleven) to financial firms and car manufacturers (GM invested \$500 million in Lyft) that stand out as the new entrants to the market. From 2011 to 2017, the number of global active corporate

⁹ "Venture Pulse Q3 2017." KPMG Enterprise, 11 Oct. 2017, page 24.

¹⁰ Carson, Ed. "Cisco Systems Nabs AppDynamics For \$3.7 Billion, Just Before IPO." Investor's Business Daily, Investor's Business Daily, 24. Jan. 2017, <https://www.investors.com/news/technology/cisco-systems-nabs-appdynamics-for-3-7-billion-just-before-ipo>.

investors has tripled to 965. Today, 75 of the Fortune 100 companies are actively investing in VC-style deals – and over half of these companies (41 at last count) have dedicated Corporate Venture Capital (CVC) teams.¹¹ As a growing source of capital, CVCs are participating in nearly one third of all US venture deals and 40% of all deals in Asia. Q3 2017 alone saw CVC participation surge to 18% of all venture capital deals (see Figure 7).



Corporate investment in VC-style deals may be an indicator of potential acquisitions or strategic partnerships over time.

Sources: "Venture Pulse Q3 2017." KPMG Enterprise, 11 Oct. 2017, page 17.

Figure 7 Corporate VC activity is increasing

¹¹ Carson, Ed. "Cisco Systems Nabs AppDynamics For \$3.7 Billion, Just Before IPO." Investor's Business Daily, Investor's Business Daily, 24. Jan. 2017, <https://www.investors.com/news/technology/cisco-systems-nabs-appdynamics-for-3-7-billion-just-before-ipo>.

The rapid pace of technology innovation – which typically favors smaller, early-stage companies with singular focus – is likely a contributing factor to the increase in corporate investing. Larger, often public, companies must continue to evolve and grow their businesses in order to remain competitive. The pace of disruption has increased exponentially, to the point where an established corporation can seemingly have their core business dramatically changed almost overnight. Well-established companies with strong venture teams and corporate strategy can radically expand their positions in both existing and new markets. For example, Amazon's recent acquisition of Whole Foods and near simultaneous investment in vertical farming company, Plenty, has positioned the company to disrupt the entire grocery industry with an industrial-scale, 'farm-to-retail-to-table' experience. This move comes only a handful of years after Amazon entered an entirely new line of business, web hosting, with Amazon Web Services (AWS). AWS now accounts for more of Amazon's market capitalization than the company's legacy commerce business. Another example is Google's expansion by restructuring the company as Alphabet, launching intelligent transportation company, Waymo, and exploring moonshot opportunities with Google X. By comparison, one-time powerhouse and Google competitor, Yahoo, failed to innovate and was acquired by Verizon for \$4.48 billion – a mere fraction of the company's previous market valuation.

Another factor contributing to Corporate VC activity, particularly for market leading companies, is the mammoth amounts of cash at their disposal. The five biggest tech firms in the US (Apple, Alphabet, Microsoft, Amazon and Facebook) have recently become the five most valuable listed companies in the world with a total market value of over \$2.9 trillion. Together they have \$330 billion in net cash (cash less debt) – a ratio of twice their gross cash flow.¹²

¹² "Tech Firms Hoard Huge Cash Piles." The Economist, The Economist Newspaper, 3 June 2017, <https://www.economist.com/news/business-and-finance/21722809-their-excuses-doing-so-dont-add-up-tech-firms-hoard-huge-cash-piles>.

These companies are pressured to "put this capital to work" in order to generate strategic value and/or accretive returns for the business. While they are active acquirers of companies that are strategic to them, getting involved with companies earlier through investment allows them to gain insights, advantage and early access for acquisition at lower costs than when the companies develop fully on their own. Corporate VCs are merely the vehicle corporations use to get involved with companies earlier than at the acquisition stage.

In closing the discussion on Corporate VC, it should be noted that there are pros and cons to this trend in the VC ecosystem:

Pros: Market Acceleration and Increased Opportunities for Liquidity

Despite some concerns, the general consensus is that the rise of Corporate VC is a positive development in the VC industry – benefitting both traditional VCs through co-investments and startup companies through increased access to capital. Corporate VC participation, especially as a precursor to acquisition activity, can help drive market adoption, accelerate revenue growth and create exit opportunities for early investors. Corporate VCs may also add material value in the process of building successful companies and driving innovation by providing: (i) in-depth industry knowledge, (ii) access to potential customers, distribution channels and lucrative contracts, (iii) solid brand association, (iv) revenue growth, and (v) ongoing capital needed to accelerate growth.

Cons: Different Investment Motives and Return Expectations

Corporate VCs may, and often do, have expectations and desired outcomes that are not always aligned with traditional VC investors. Traditional VCs invest their money for one primary reason – to maximize return on investments for themselves and their limited partners. Corporate VCs, however, make investments based on a wide range of potential outcomes from which they can benefit. Financial returns are a great perk, but more often than not, Corporate

VCS value investments based on strategic relationships, acquisition viability, channel partnerships, product integration, revenue diversity and more. Corporate VCs may even invest to remove a competitor from the market. This can result in serious conflict. For example, traditional VCs invested in a company will seek to maximize return on the investment when that company is acquired. However, a corporate VC invested alongside a traditional VC in the same company is incentivized to minimize acquisition price, especially if the intent is to remove competition from the market.

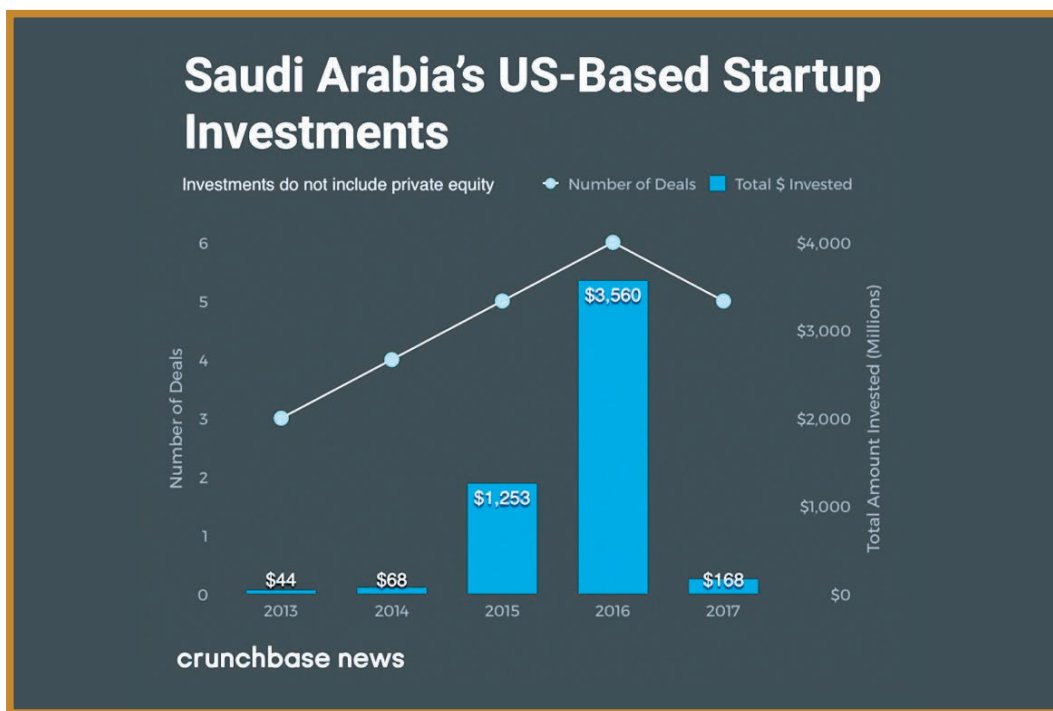
For the most part, the pros outweigh the cons with Corporate VC, but knowledgeable investors proceed cautiously.

Middle East Capital Impacting Global Valuations

Another noticeable global trend to recognize is the massive influx of capital from the Middle East. Middle Eastern sovereign wealth funds have been long-time supporters of Venture Capital, Private Equity and other asset classes – but usually as passive limited partners. This is now changing, particularly with Saudi Arabia. In the past three years alone, Saudi VC firms invested over \$5 billion dollars into US startups, with the pace of investment skyrocketing to all-time highs in 2016 (see Figure 8).

The Saudi investment boom began in 2015 with over \$1.25 billion invested in US startups across a handful of deals, including some of the largest private, and now public, companies in the US.¹³ Lyft walked away with the vast majority of 2015's Saudi funding haul, landing a billion dollars from the Kingdom Holding Company as part of the company's Series F round of financing. Saudi investors also took part in Snap's \$200 million Series E financing. While 2015 showcased

¹³ Adamson, Loch. "Saudi Arabia Signals Pending Power Shift with Mass Arrests." Institutional Investor, 7 Nov. 2017, <https://www.institutionalinvestor.com/article/b15hs9cg5b5n9q/saudi-arabia-signals-pending-power-shift-with-mass-arrests>.



Saudi Arabian direct investment into US startups is at an all-time high, but still follows typical VC trends of investing large sums into proven companies.

Sources: Page, Holden. "Saudi Arabian Startup Investment Into US Startups Slows." Crunchbase News, 30 Nov. 2017, <https://news.crunchbase.com/news/saudi-arabian-startup-investment-us-startups-slows>.

Figure 8 Saudi Arabia VC is at an all-time high

the launch of Saudi capital investing in US deals, 2016 was record breaking on numerous fronts. The vast majority of known 2016 Saudi VC investment went into Uber's \$3.5 billion Series G raise – in which the sole investor was Saudi Arabia's Public Investment Fund (PIF). PIF is a \$224 billion sovereign wealth fund led by the Crown Prince, His Royal Highness Prince Mohammed bin Salman (HRH MBS).

Massive Saudi Arabia investments into US unicorns aren't just notable due to the size of the rounds. More significantly, the Uber, Lyft, and Snap investments illustrate the country's departure from what Saudi Arabia knows best: oil and its respective complements, such as plastics, manufacturing, and chemicals. The country is also going through an ideological shift, with Crown Prince, HRH MBS,

driving large changes in the Kingdom. In the five months he has been in power, the 32-year-old Crown Prince has already determined the non-traditional ways he is going to put the country's virtually unlimited resources to work. At the recent Future Investment Initiative conference, the Crown Prince showcased the Kingdom's ambitious economic plans to move away from its dependence on oil revenue.¹⁴ One of the most notable projects announced was the government's \$500 billion plan to create a sprawling 13,000 square-mile special economic zone, known as NOEM, overlooking the Red Sea.¹⁵ NOEM embodies the Crown Prince's vision for the new Saudi Arabia, or as the website (discovernoem.com) describes it, "a new blueprint for sustainable life on a scale never seen before, where inventiveness shapes a new inspiring era for human civilization" (see Figure 9).



The Crown Prince's vision for the new Saudi Arabia – departure from a dependence on oil revenue and a shift towards innovation.

Sources: NOEM, <http://discoverneom.com>

Figure 9 Saudi Arabia's NOEM

¹⁴ NOEM, <http://discoverneom.com>

¹⁵ "Venture Pulse Q3 2017." KPMG Enterprise, 11 Oct. 2017, page 22.

Investment Sector: Internet of Things (IoT)

Overview

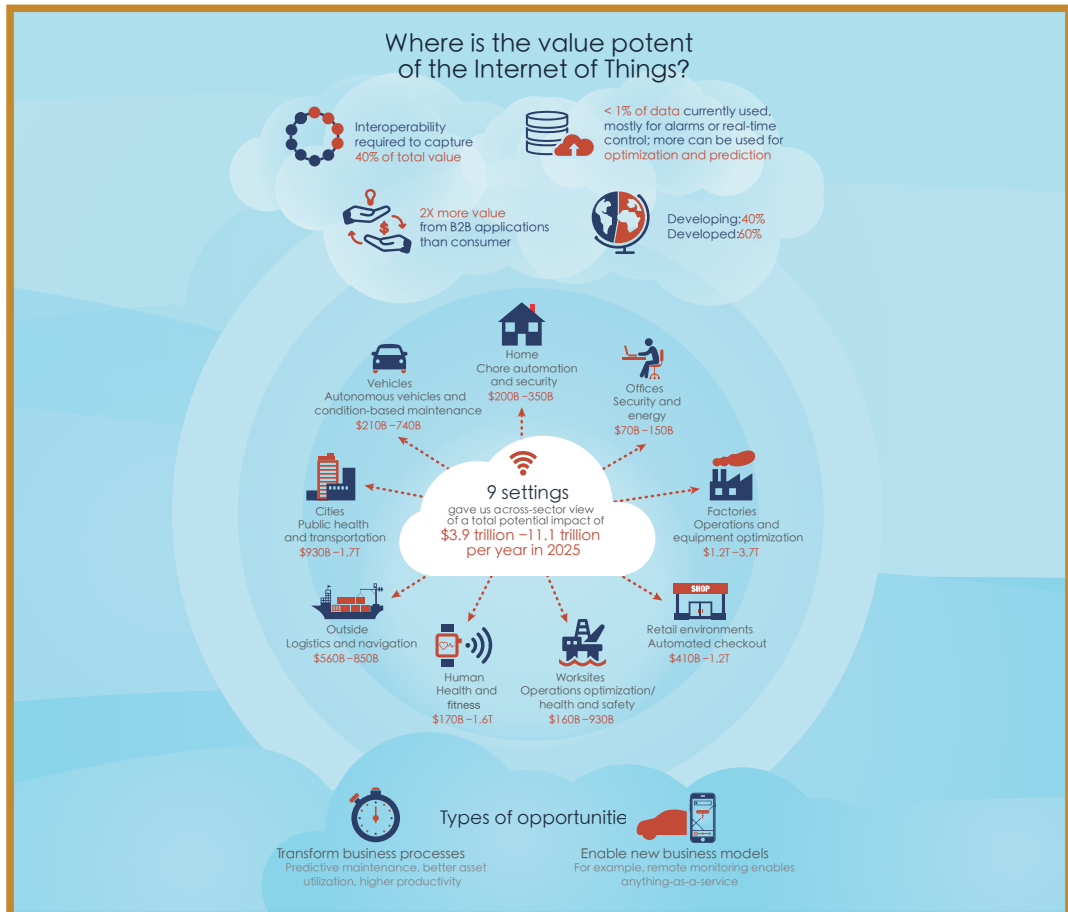
The Internet of Things (IoT), sometimes referred to as the Internet of Everything (IoE), is a broad term used to describe the expansion of the Internet into a broad network of interconnected "things" embedded with electronics, software, sensors, and connectivity. These things can include devices, apps, software, people, virtual machines and more. IoT enables these things to be sensed and controlled remotely, resulting in more direct integration between the physical world and computer-based systems. Clearly identified as the next 'megatrend' in Internet growth and related investing, experts agree that the Internet of Things will extend the reach of the current Internet by at least an order of magnitude (i.e. 10x larger than today) in the next several years.

Market

Market experts, including Cisco, Gartner, and Ericsson, all forecast that IoT enabled touch-points will reach 50 billion units by 2020, which is several times larger than the collective mobile and PC Internet today. Just as the mobile devices dramatically expanded the reach of the previous PC-connected Internet, IoT will again dramatically expand the current Internet and enable a new generation of machine-to-machine communication. This megatrend will impact all aspects of technology and create entirely new fields as well. We are just on the cusp of this wave as we see the first generation of connected thermostats, surveillance cameras, wearables, and connected healthcare devices come to market.

By all accounts, IoT is a multi-trillion-dollar market. Increases in operational efficiency alone will reach into the hundreds of billions. For example, a recent GE IoT study found that a modest 1% increase in operational efficiency in energy, transportation, logistics and healthcare could yield \$276 billion in operational savings by 2030. Moreover, McKinsey, Cisco and HP all estimate the total

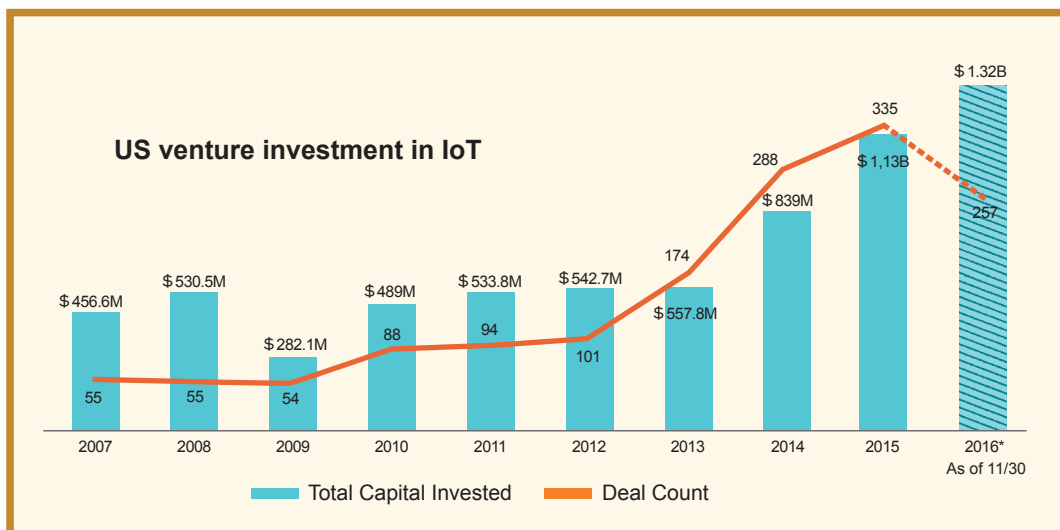
market opportunity of IoT to be between \$10 trillion and \$20 trillion over the next 10 years.



Sources: "The Internet of Things: Mapping the Value Beyond the Hype." McKinsey Global Institute, June 2015.

Figure 10 IoT Opportunity Landscape

Consistent with global trends, investment in the IoT sector has seen a recent shift from primarily VC to corporate/strategic investors, growth funds and private equity. This is being driven in large part by the need for commercial applications in the energy, manufacturing, and transportation industries. Another global trend impacting the IoT sector is more money being invested into fewer deals – and often at later stages with less valuation sensitivity (see Figure 11).



Deal volume decreased in 2016 and 2017, however invested capital continued to increase, supporting the theory that investors are being more selective and investing more money in fewer companies.

Sources: Tom, Mikey. "IoT Breakdown: VCs betting billions on the connected world." Pitchbook News, 7 Dec. 2016, <https://pitchbook.com/news/articles/iot-breakdown-vcs-betting-billions-on-the-connected-world>.

Figure 11 US venture investment in IoT

IoT is the single largest global trend and investment opportunity available today, however VC investors should proceed with caution. Surplus capital from multiple sources flooded this sector early on and it is now facing a substantial correction. In addition, many consumer-facing IoT startups failed to gain market traction and/or meet investor expectations, which has in turn resulted in follow-on rounds of financings being more challenging than anticipated. IoT sector write-offs are increasing rapidly with some VC funds writing off as much as 50% of their IoT portfolios.

The following trends are the most viable investment opportunities within the IoT sector.

- **Trend 1 >> IoT in the Smart Home**

The beginning of the IoT sector investment boom arguably began when Nest captured the imagination of consumers and provided a glimpse into the smart home of the future – and Google's \$3.6 billion-dollar acquisition of the company

ensured that VC investment followed into the sector. Many startups have since been formed to address the growing demand for smart/connected home products. Products include smart locks, lighting, security systems, cameras, A/V equipment and more. These devices learn consumer habits and behaviors and then adjust product functionality to best serve them – all while making homes safer and more comfortable and efficient. In addition, IoT's inherent interconnectivity will enable consumers to access and manage their homes from anywhere in the world.

- **Trend 2 >> IoT Connected Vehicles**

Connected vehicles are one of the most disruptive applications for IoT. Connected vehicles and IoT devices within them offer the ability to capture real time road conditions, relative speed and distance between vehicles, trip information, traffic information, and other sensor-gathered information in order to guide passengers safely to their destination most efficiently – or even autonomously. This will disrupt virtually all forms of transportation, logistics and delivery services. Google is leading in this effort and many auto manufacturers are close behind.

- **Trend 3 >> IoT Optimized Business Processes**

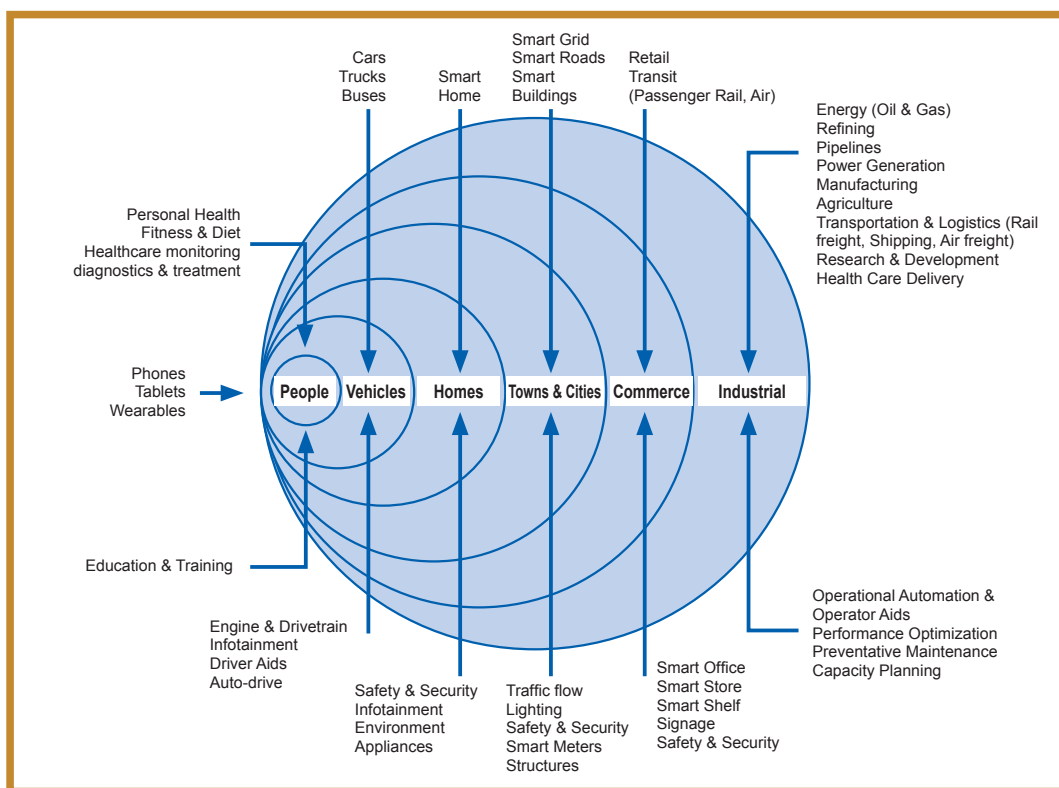
The ability for sensors to monitor processes in real time combined with the ability to store and access information traditionally scattered throughout an organization will enable companies to assemble, visualize, analyze and plan around that information in collaborative workflows or processes that match how the organization works. Companies can also change workflows with previously unseen speed and agility, adapting to changing market conditions and seizing new business opportunities. This IoT segment alone represents a \$10+ trillion opportunity by 2025.

- **Trend 4 >> Industrial IoT**

Consumer IoT currently accounts for the majority of IoT spend and investing. This will change in the near future as industrial IoT begins to deploy at scale

– at which time it is forecasted that up to two-thirds of future demand for IoT products will come from industrial applications. Industrial adoption of IoT has historically been limited due to concerns about stability and security. These issues have now been addressed except for the most rigorous cases. The Manufacturing, Transportation and Utilities sectors are all projected spend over \$50 billion annually and they have already defined applications needed to drive efficiencies critical to their evolution. Additional growth areas, according to IDC, include: healthcare, insurance, and retail verticals.

In summary, the following graphic provides a good representation of IoT investment opportunities by category and timing. VC investors seeking consumer-centric investments should strive to find companies that are capital



This graphic illustrates both the categories and timing of IoT investment opportunities for VC investors.

Source: Based on Goldman Sachs Global Investment Research. Additional analysis by WMG

Figure 12 IoT Investment Opportunities

efficient, have rapid adoptions cycles, superior user experience, social/community involvement, and some model for both upfront and recurring revenue sources. Selective investments may also include enablement platforms that can reduce time to market for vertical applications and ultimately become important elements of the IoT landscape.

Ecosystem

Most elements are already in place to support the growth forecasted in the IoT sector. These elements include: (i) global proliferation of billions of smart and/or feature phones; (ii) emergence of affordable and energy efficient ARM-based processors; (iii) Bluetooth Low Power that allows seamless and energy efficient communications; (iv) miniaturization of sensors, MEMS, and cameras at affordable prices; (v) adoption of IPV6 (opening up to 8×10^{28} addresses for these devices); (vi) big data collection and analytics that provide ubiquitous access to information and enable autonomous operations; and (vii) low-cost wireless and cloud networks.

In addition, several companies like TI, Qualcomm, Broadcom, Mediatek, Arduino, Intel, and others are focusing on two important parts of the value chain to enable IoT rollout on a large scale. The first is sensor technology and chips that will be ubiquitous in all connected devices making up the Internet of Things. The second is the development of IoT Systems on Chip (SoCs) and related platforms that enable startups to accelerate the development and adoption of IoT sub-systems.

Summary

IoT is the largest market opportunity for VC investors today and in the foreseeable future, however VC investors must use caution to find quality investments that have all elements of a successful business in the long-term. There will be few, if any, "quick hits" on the M&A front. Instead acquiring companies, and more so public markets, will seek out and reward only the

most promising companies built on superior technology and with sound operational fundamentals. It should be noted that IoT is a particularly strong fit for a cross-border model between Taiwan and Silicon Valley, as the sector plays to the strengths of both regions. Bay Area startups are leading the way for the development of core IoT software technologies and enabling platforms, while Taiwan is world-renowned for underlying semiconductor and design manufacturing capabilities.

Investment Sector: Augmented Reality and Virtual Reality (AR/VR)

Overview

Augmented Reality and Virtual Reality (AR/VR), sometimes referred to as "Mixed Reality" or "Reality Plus", refers to the set of technologies that seamlessly merge real-world interactions with digital technologies to create an enhanced, and ideally superior, human experience. While both share similar technological underpinnings, the term "Virtual Reality" is often associated with applications that focus on entertainment and social interaction (such as gaming, media consumption, dating, and the like) while the term "Augmented Reality" more often refers to industrial or enterprise applications (such as automotive, healthcare, customer service and so on). AR/VR has been a key trend in VC investing for over half a decade, however recent market developments have made this category one of the fastest growing and well-funded sectors of the VC landscape. Sometimes referred to as the next major computing platform, AR and VR have seen substantial increases in both funding and deal volume (the latter being contrary to most global trends and an indicator of category strength). As is to be expected with a rapidly growing category, mega-rounds and unicorn valuations are abundant.

Market

AR/VR market is estimated to be an \$80 billion to \$100 billion market in the next 5 to 7 years. Therefore, AR/VR is both a sizeable and strategic market for many industries. Much like robotics have altered automotive and logistics companies, AR/VR has the potential to transform industries and provide large companies substantial competitive advantage in short period of time. In fact, AR/VR is already attracting increasingly amounts of capital from both corporate investors as well as traditional VCs. The first three quarters of 2017 saw \$1.65 billion dollars of investment, already surpassing the \$1.56 billion dollars of investment in calendar year 2016 – and 2018 is forecasted to be another record-breaking year.¹⁶

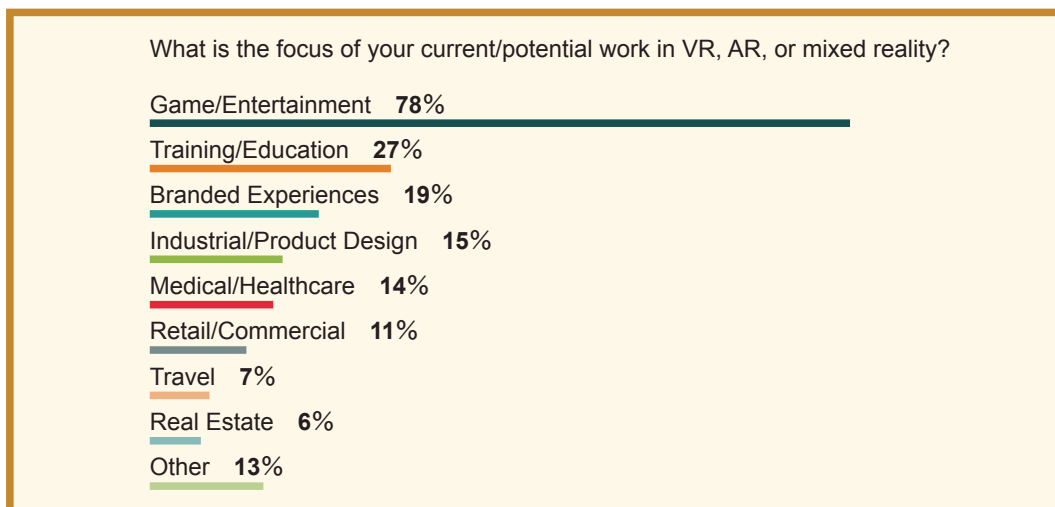
Both mobile and PC computing platforms continue to advance in power and availability, however neither medium has fundamentally changed capabilities in over a decade. AR/VR has the potential to fundamentally alter the use of both platforms and to transform multiple industries, disrupting existing ecosystems and creating new markets in the process. AR/VR is already reshaping multiple industries, including real estate, design, shopping, dating, medicine, sports, entertainment and gaming. Technology is advancing rapidly while competition is increasing availability and decreasing pricing.

The impact of AR/VR technology has been most obvious in gaming. These new technologies enable a new medium, based on different mathematic and algorithmic principles, that provide gamers with a total immersion experience like never before. Users are no longer passive viewers interacting at the periphery of the content, but rather placed at the center of the gaming experience – a virtual world catered specifically to them. Successful market examples include Facebook's Oculus Rift, HTC's Vive, and Sony's PlayStation VR. Particularly noteworthy is the Nintendo/Naintic breakout success, Pokémon Go – a VR

¹⁶ "Healthcare Augmented and Virtual Reality Market Worth \$5.1 Billion By 2025: Grand View Research, Inc." PR Newswire, 19 June 2017, <https://www.prnewswire.com/news-releases/healthcare-augmented-and-virtual-reality-market-worth-51-billion-by-2025-grand-view-research-inc-629349303.html>.

gaming sensation that spanned multiple demographics and generated over \$600 million in revenue during its first 3 months on the market.

Media and entertainment are the second largest emerging category in AR/VR, combining with the gaming category to account for nearly 80% of all AR/VR work (see Figure 13). AR/VR can provide the same immersive, viewer-centric experience for media and entertainment as it does for gaming, which has broad-ranging implications both in front of and behind the camera. AR/VR is particularly impactful for live events that are traditionally limited in reach by venue size and logistics. The new class of AR/VR technologies have the ability to create an improved, immersive experience that can also be accessed by a much larger group of people. While still nascent, sports, live event, and concert organizers are experimenting in the space. One notable example is a recent collaboration between Live Nation Entertainment and Citibank, which partnered with NextVR to produce enhanced experiences for a series of concerts performed throughout 2017.

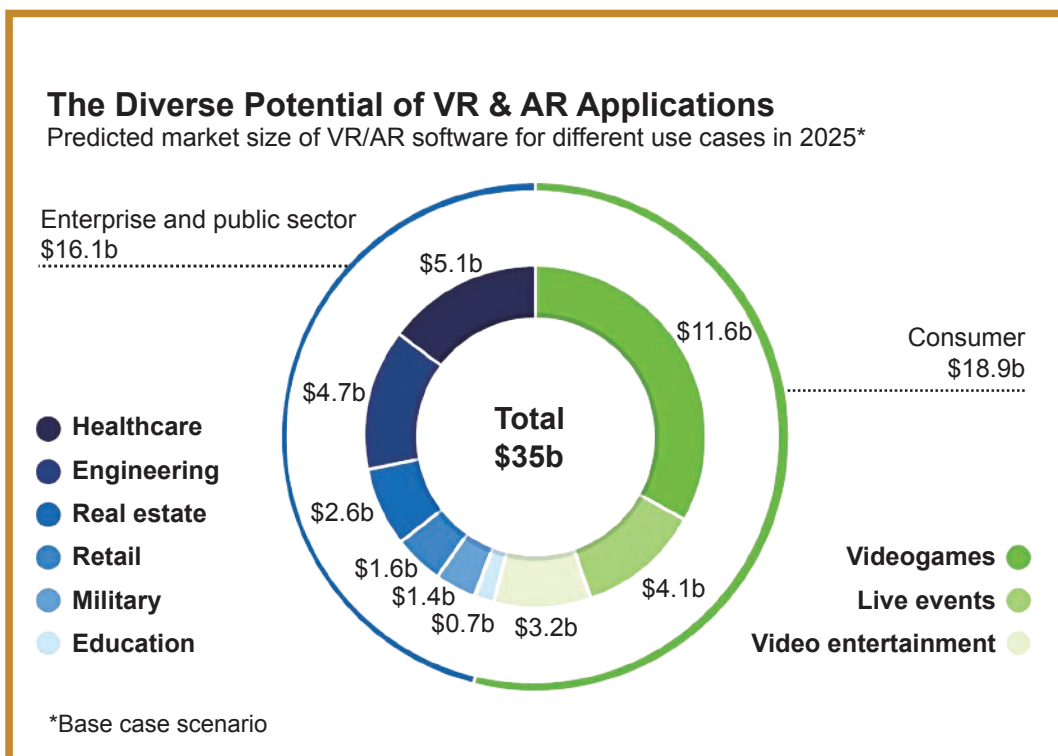


The vast majority of work on AR/VR applications is focused on gaming and entertainment.

Sources: Wiltz, Chris. "AR and Mixed Reality Have More Potential, But VR Has All the Hype." Design News, 11 July 2017, <https://www.designnews.com/electronics-test/ar-and-mixed-reality-have-more-potential-vr-has-all-hype/67311435157095>.

Figure 13 Focus of current and potential work in AR/VR

AR/VR technology continues to scale rapidly. It represents a substantial and fast-growing investment opportunity if global and sector trends are well understood. Industry adoption has historically been driven by Gaming, Media, and Entertainment, however, these categories are now seeing investment saturation. VC-like returns are still possible, but expectations and competition are high. AR/VR is now set to impact numerous new industries (see Figure 14) and the following trends may be better positioned as viable VC investment opportunities.



Sources: Richter, Felix. "Infographic: The Diverse Potential of VR & AR Applications." Statista Infographics, 6 Apr. 2016, <https://www.statista.com/chart/4602/virtual-and-augmented-reality-software-revenue>.

Figure 14 Diverse potential of AR/VR applications

The following trends are the most viable investment opportunities within the AR/VR sector.

- Trend 1 >> Healthcare

AR/VR revenue for the healthcare sector is estimated to hit \$1.2 billion in 2020 and \$5.1 billion in 2025.¹⁷ With healthcare, AR/VR technology can be used (i) as a tool to aid doctors in medical procedures and day-to-day tasks, (ii) for physical therapy and to treat phobias like fear of heights, and (iii) to increase access to doctors through virtual visits. In the US, there are approximately 1.5 million medical professionals which could serve as the addressable user base of VR/AR, with 740,000 specialty physicians, 500,000 primary care physicians and 240,000 EMTs.¹⁸

- Trend 2 >> Real Estate

AR/VR revenue for the real estate sector is estimated to reach \$750 million in 2020 and \$2.6 billion in 2025. Numerous real estate companies, such as Sotheby's, are already experimenting with AR/VR technology to show homes to prospective buyers. The value proposition of a AR/VR home listing ad can significantly outweigh that of an online ad. Additional AR/VR technologies, such as those created by Taiwanese startup, iStaging, enable prospective buyers to "virtually" decorate a home using nothing more than a mobile phone with VR capabilities. With 1.4 million registered real estate agents globally, AR/VR technology will continue to emerge in this highly competitive sector as agents continue to go after commissions in these real estate transactions.

¹⁷ "Healthcare Augmented and Virtual Reality Market Worth \$5.1 Billion By 2025: Grand View Research, Inc." PR Newswire, 19 June 2017, <https://www.prnewswire.com/news-releases/healthcare-augmented-and-virtual-reality-market-worth-51-billion-by-2025-grand-view-research-inc-629349303.html>.

¹⁸ "Profiles in Innovation: Virtual & Augmented Reality – Understanding the race for the next computing platform." The Goldman Sachs Group, Inc., 13 Jan. 2016

- Trend 3 >> Retail

AR/VR revenue for the retail sector is estimated to reach \$500 million by 2020 and \$1.6 billion by 2025. AR/VR is disrupting nearly every retail market in which companies can garner a competitive advantage by using technology for competitive advantage to increase market share. There are notable, near-term opportunities in both the \$180 billion home improvement market and the \$260 billion fashion/apparel market. AR/VR can be used to increase topline revenue and reduce the need for in-store displays (ultimately eroding the value of a physical stores, much like during the Internet boom).

- Trend 4 >> Education

AR/VR revenue for the education sector is estimated to reach \$300 million by 2020 and \$700 million by 2025.¹⁹ AR/VR also has the potential to be a standard tool in education and may revolutionize the way in which students are taught for both the K-12 segment and higher education (college and beyond). Of particular note, is the fact that teachers can use AR/VR to enable students to interact with objects and learn in a 3D environment. For example, students can learn about the solar system, historical events, or sub-atomic structures by interacting with critical structures and events in the virtual world. In fact, Google now offers its low-cost VR tool, Cardboard, to schools for free – and has already developed over 100 "virtual field trips."

Summary

AR/VR is a rapidly growing market opportunity poised to become the next major computing platform. It will also impact numerous vertical industries. The majority of historical VC investment in this sector has been focused on gaming, media, and entertainment, however, these categories have become saturated and

¹⁹ "Profiles in Innovation: Virtual & Augmented Reality – Understanding the race for the next computing platform." The Goldman Sachs Group, Inc., 13 Jan. 2016

VC-like returns are more challenging. Sophisticated investors should consider turning their attention to upcoming categories in which technology advantage and user experience are paramount to maintaining competitive advantage. These industries, described in detail above, include Healthcare, Real Estate, Retail. Education should also be considered as a viable market opportunity given AR/VR technology's ability to improve the learning process.

Investment Sector: Fintech

Overview

Financial technology—FinTech for short—describes the evolving intersection of financial services and technology, and the wave of technological innovations that are disrupting and challenging not only financial services but the business sector in general. Any technological innovation in the financial sector, including innovations in financial literacy and education, retail banking, investment and even crypto-currencies like bitcoin, can be referred to as fintech. Since the internet revolution and the mobile internet revolution, financial technology has grown explosively, from the invention of digital money to double-entry bookkeeping, technology has transformed the way people transact daily businesses. Fintech, which originally referred to computer technology applied to the back office of banks or trading firms, now describes a broad variety of technological interventions into personal and commercial finance. According to EY's Fintech Adoption Index, one-third of consumers utilize at least two or more fintech services and those consumers are also increasingly aware of fintech as a part of their daily lives.

All in all, Fintech provide 1) enablement of transaction and ubiquitous payments system, 2) creating new financial products, 3) new perspective of wealth management, 4) ultimately giving value to new things.

Market

Given the significant interest in fintech globally, and its ongoing evolution in terms of market drivers, technologies and potential use-cases, venture capital funding in fintech has increased exponentially over the last few years with the worldwide investment reaching close to \$25 billion in 2015. In the United States, fintech industry is primed to set to reach new height this year after a lackluster 2016. The increase in invested capital can be attributed to the many mega-rounds, such as SoFi's \$500 million fundraise in February. VC investment in the US fintech space is on track to hit \$7.58 billion in 2017, which would eclipse the previous high set in 2015, when investors spread \$7.46 billion across nearly 600 deals in the industry. Last year, that number dropped off dramatically with roughly \$5.4 billion invested.

Here's a closer look at venture capital invested in the US fintech space since 2010:²⁰

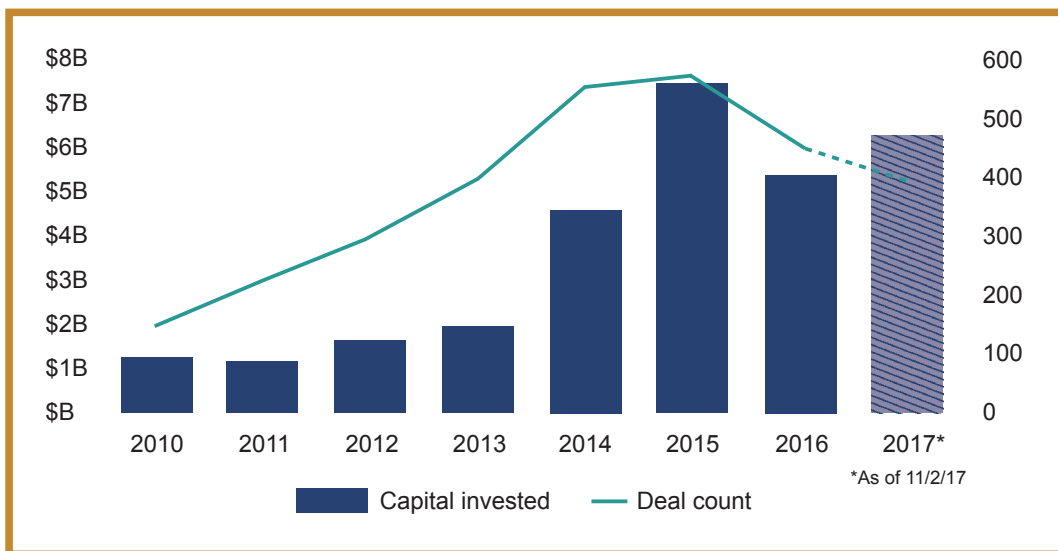


Figure 15 Venture Capital Invested in the US Fintech Space

²⁰ <https://pitchbook.com/news/articles/mega-rounds-drive-renewed-vc-interest-in-us-fintech>

There are currently 26 fintech companies globally that are considered "unicorn" valued at \$83.8 billion. North American produces most of the fintech startups, with Asia following. Much of the money VCs have invested into fintech in 2017 has come in the form of massive fundraisings, with four companies having received over \$1B in disclosed funding to date – Avant (\$1.7B), Kabbage (\$1.5B), Lu.com (\$1.7B) & SoFi (\$1.6B) and 10 US fintech startups having pulled in rounds of \$100 million or more.²¹

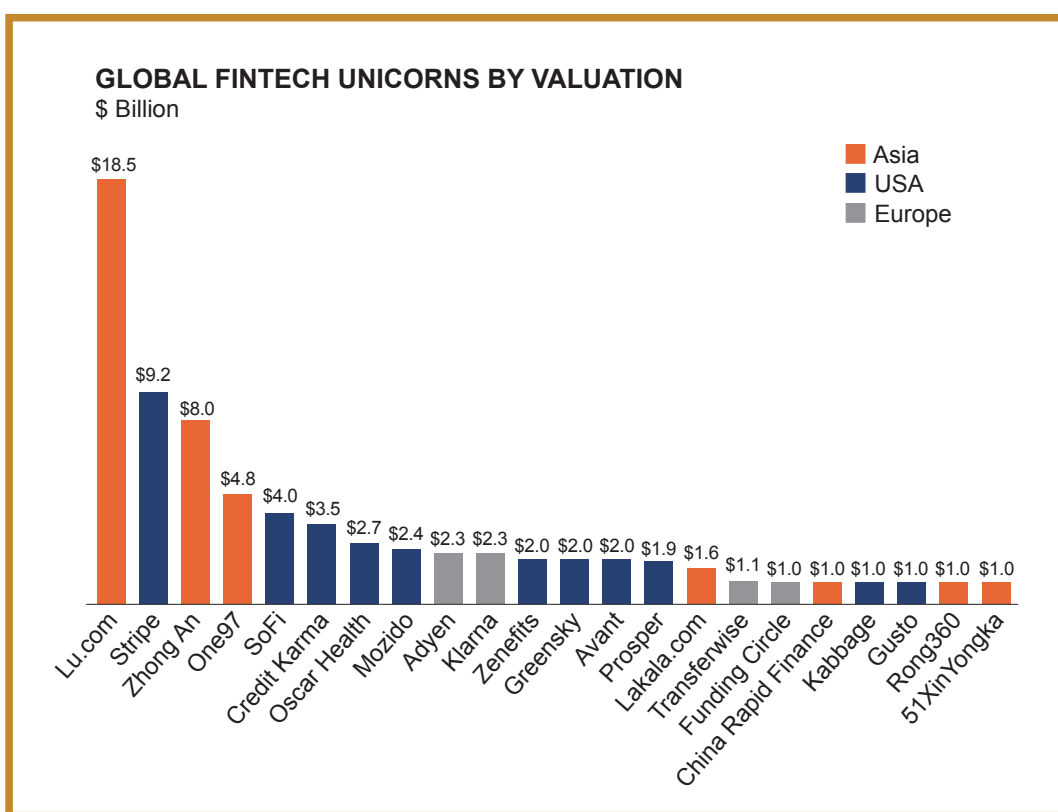


Figure 16 Global Venture-backed Fintech Unicorns by Valuation

²¹ <https://pitchbook.com/news/articles/mega-rounds-drive-renewed-vc-interest-in-us-fintech>

All valuations listed below are at the time of the company's most recent venture financing, ranking by round amount:

	Round month	Round amount	Post-money valuation
SoFi	February	\$500M	\$4.4B
AvidXchange	June	\$300M	\$1.4B*
Bright Health	June	\$160M	\$400M
Addepar	June	\$140M	\$560M
Clover Health	May	\$130M	\$1.2B
Robinhood	April	\$110M	\$1.3B
Coinbase	August	\$108M	\$1.6B
R3	May	\$107M	\$250M
Blend	August	\$100M	\$500M
Bill.com	October	\$100M	\$743M

*estimated

Sources: PitchBook

Below is the valuation-based ranking of the top VC-backed companies in the US, which shows two fintech companies—Stripe and SoFi—ranked in the top 14. In fact, US-based fintech startups have pulled in roughly \$19 billion across more than 1,400 deals with VC participation since the beginning of 2015, according to Pitchbook.

As we enter the year of 2018, the market demand on fintech will remain fierce if not more. FinTech is disrupting the traditional financial services, such as: money transfers, loans, mobile payments, asset management and fundraising, we can expect to see more disruptions as technology continue to advance at a rapid rate. According to Statista, transaction value is expected to show an annual growth rate (CAGR 2017-2021. of 20.5 percent resulting in the total amount of \$6.9 billion in 2021.²²

²² <https://www.statista.com/outlook/295/100/fintech/worldwide#>

	HQ	Founded	Round date	Round amount	Valuation
 stripe	San Francisco	2010	Nov. 2016	\$150M	\$9.2B
 SoFi	San Francisco	2011	Feb. 2017	\$500M	\$4.4B
 credit karma	San Francisco	2007	June 2015	\$175M	\$3.5B
 oscar	New York	2013	Feb. 2016	\$400M	\$2.7B
 A V A N T	Chicago	2012	Sept. 2015	\$325M	\$2B
 APTUS	San Mateo, CA	2006	Sept. 2017	\$55M	\$1.9B
 coinbase	San Francisco	2012	Aug. 2017	\$108M	\$1.6B
 avidxchange	Charlotte	2000	June 2017	\$300M	\$1.4B
 robinhood	Palo Alto	2012	April 2017	\$110M	\$1.3B
 Kabbage	Atlanta	2009	Aug. 2017	\$250M	\$1.3B*
 Clover	San Francisco	2014	June 2017	\$130M	\$1.2B

* estimated

** Two companies have been omitted. Zenefits and Mozido reached \$4.5B and \$2.4B valuations, respectively, with their most recent rounds. But given troubles at each company, it's very unlikely they've retained those valuations.

Sources: PitchBook (As of 10/20/2017)

Trends and investment opportunities to watch out for in the fintech industry:

- Blockchain technology, including Ethereum, a distributed ledger technology (DLT) that maintain records on a network of computers, but has no central ledger. A future of financial industry dominated by blockchain is not hard to imagine, it is only a matter of time leading to wide adoption of blockchain technology by central banks. Various finance industry giants have shown increasing interest in blockchain-related technology (including cryptocurrencies) lately.
- Cryptocurrency and digital cash - a form of digital currency that uses blockchain technology and operates in a decentralized network format.
- Smart contracts, which utilize computer programs (often utilizing the blockchain) to automatically execute contracts between buyers and sellers.

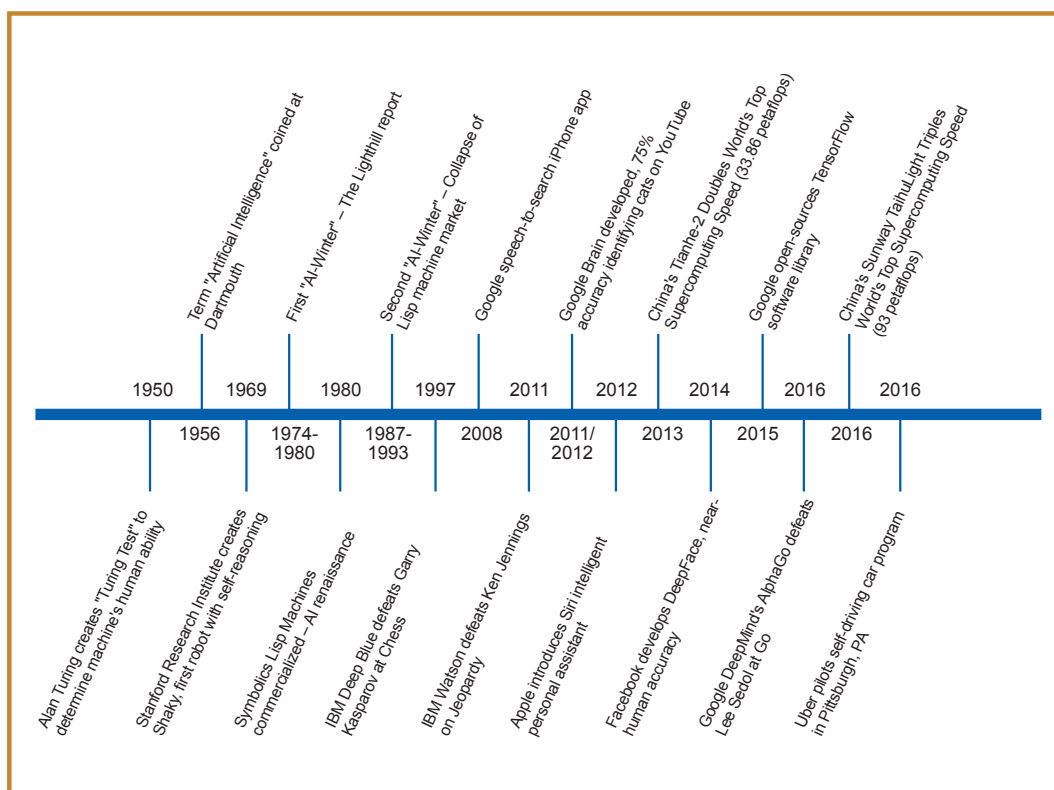
- Open banking, a concept that leans on the blockchain and posits that third-parties should have access to bank data to build applications that create a connected network of financial
- Multi-currency digital wallets - Digital wallets store all of a consumer's payment information securely and compactly, eliminating the need to carry around a physical wallet.
- Institutions and third-party providers. An example is the all-in-one money management tool Mint.
- Insurtech, which seeks to use technology to simplify and streamline the insurance industry.
- Regtech, which seeks to help financial service firms meet industry compliance rules, especially those covering Anti-Money Laundering and Know Your Customer protocols which fight fraud.
- Robo-advisors, such as Betterment, utilize algorithms to automate investment advice to lower its cost and increase accessibility. According to the consulting firm A.T. Kearney, assets under management by robo-advisors will grow by 68 percent annually to a whopping \$2.2 trillion in the next five years.²³
- Unbanked/underbanked, services that seek to serve disadvantaged or low-income individuals who are ignored or underserved by traditional banks or mainstream financial services companies.
- Cybersecurity and payment security using biometrics technology. Given the proliferation of cybercrime and the decentralized storage of data, cybersecurity and fintech will always interlocked.

²³ <https://www.investopedia.com/tech/top-robo-advisors/>

Investment Sector: Artificial Intelligence

Overview

Artificial Intelligence (AI) can be defined as hardware and software systems combined to simulate human intelligence. AI is the apex technology of the information age. The leap from computing built on the foundation of humans telling computers how to act, to computing built on the foundation of computers learning how to act has significant implications for every industry. While some view this moment as the latest boom before the next AI Winter (see Figure 17), we believe that AI is still at an inflection point where improvements in computer processor design and access to larger amounts of data will keep performance advances and breakthroughs coming for the foreseeable future.



Sources: "Profiles in Innovation: Artificial Intelligence – AI, Machine Learning and Data Fuel the Future of Productivity." The Goldman Sachs Group, Inc., 14 Nov. 2016

Figure 17 Evolution of AI, 1950 to Present

One of the most exciting aspects of the AI inflection is the enormous amount of real-world applications. AI has applications and use cases in almost every industry vertical. Where large data sets are combined with powerful enough technology, value is being created and competitive advantage is being gained. For the early-adopting companies, AI is already starting to deliver benefits. For example, retailers on the digital front rely on AI-powered robots to run their warehouses – and even to automatically order stock when inventory runs low. Utility companies use AI to forecast electricity demand. Automakers harness the technology in self-driving cars. On a consumer level, AI is making our smart devices smarter. The most recent example is Apple's facial recognition technology launched with the iPhone X, which turns our faces into a secure, private and fun new way to interact with our devices.

All over, AI technologies are empowering people in their daily lives across work, leisure, and even domestic tasks. Among the many factors driving the adoption of AI are: (i) increased cost savings and productivity, (ii) improved quality of life, and (iii) avoidance of work and tasks deemed dangerous, dull or unpleasant. The long-term prospect for AI is that it will become embedded in many different other technologies and provide autonomous decision making on behalf of humans, both directly, and indirectly through many processes, products, and services.

Market

The overall AI market was valued at \$8 billion in 2016 and is expected to grow at a 55% CAGR (compound annual growth rate), reaching \$47 billion in 2020.²⁴ IDC estimates that half of this amount will go towards software applications. Considerable improvements in commercial prospects of AI

²⁴ "Worldwide Cognitive Systems and Artificial Intelligence Revenues Forecast to Surge Past \$47 Billion in 2020, According to New IDC Spending Guide." IDC, 26 Oct. 2016, <https://www.idc.com/getdoc.jsp?containerId=prUS41878616>.

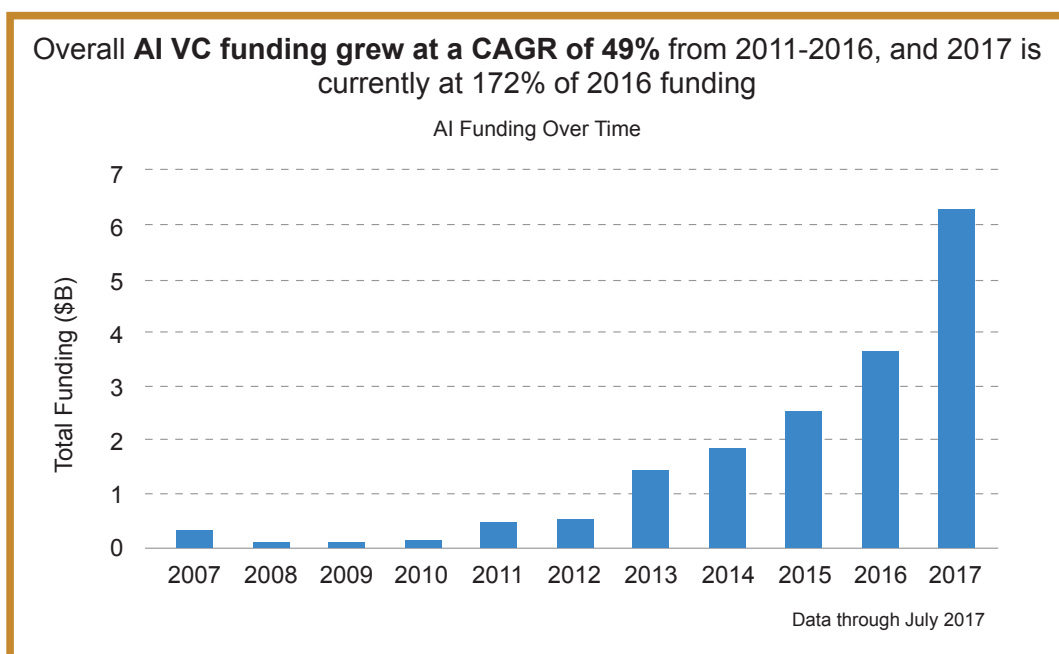
deployment and advancements in dynamic AI solutions are driving the overall industry growth.

We are at the cusp of mass adoption of AI. AI technologies are developing very quickly, and this acceleration is due to a confluence of factors. Computer power is growing, algorithms and AI models are becoming more sophisticated, and, perhaps most important of all, the world is generating once-unimaginable volumes of the fuel that powers AI - data. Billions of gigabytes every day, collected by networked devices ranging from web browsers to turbine sensors. Annual data generation is expected to reach 44 zettabytes (trillions of GB) by 2020, according to IDC's Digital Universe report, a CAGR of 141% over five years, suggesting that we are just beginning to see the use cases to which these technologies will be applied.²⁵

Due to these developments, the AI sector has drawn a massive amount of money from all types of investors – traditional VCs to corporate/strategic investors, growth funds and private equity. Investment in the sector hit new highs in 2017 with an estimated \$6 billion invested into AI and machine learning companies this year, according to Venture Scanner data (see Figure 18). That is almost double what was invested in all of 2016, marking the largest recorded sum ever put into the space in a comparable period. Over 250 companies disclosed funding investments this year with at least 28 AI and machine learning companies closing rounds of \$20 million or more.²⁶ Nearly 40 percent of the funding in 2017 went to two companies: (i) Argo AI, a Pittsburgh-based developer of AI technology for self-driving vehicles, raised \$1 billion from Ford in February, and (ii) Hong Kong-based SenseTime raised \$410 million to develop applications

²⁵ "Profiles in Innovation: Artificial Intelligence – AI, Machine Learning and Data Fuel the Future of Productivity." The Goldman Sachs Group, Inc., 14 Nov. 2016, page 5.

²⁶ Glasner, Joanna. VCs determined to replace your job keep AI's funding surge rolling in Q2. TechCrunch, 15 July 2017, <https://techcrunch.com/2017/07/15/vcs-determined-to-replace-your-job-keep-ais-funding-surge-rolling-in-q2>.



Sources: Pacer, Nathan. Artificial Intelligence (AI) Report Q3 2017. Venture Scanner, 21 July 2017, <https://www.slideshare.net/NathanPacer/venture-scanner-artificial-intelligence-ai-report-q3-2017>.

Figure 18 VC funding into AI has accelerated in recent years

of AI-powered deep learning technology for use cases like facial recognition and image processing.

Large-cap companies have also been pumping large sums into AI through investments, internal R&D and acquisitions. McKinsey Global Research estimated that the large, cash-rich digital-native companies like Amazon, Baidu and Google, spent up to \$39 billion on AI in 2016 alone.²⁷ While most of this investment consisted of internal R&D, a good chunk of it was for developing AI-focused corporate venture funds and acquisitions. In July of this year both Google and Toyota announced new AI-focused corporate venture funds, following on the heels of a similar move by Microsoft. These big tech companies have also been quite acquisitive, snapping up promising AI startups of all stages. According

²⁷ "Artificial Intelligence, The Next Digital Frontier?" McKinsey Global Institute, page 5.

to Crunchbase data, 40 acquisitions of AI and machine learning companies have been completed so far this year, compared to a total of 56 completed in all of 2016.²⁸ The 2017 AI acquirers' list contains some very well-capitalized buyers. That includes Apple, which picked up Lattice Data, a company that applies an AI-enabled inference engine to take unstructured, "dark" data and turn it into structured (and more usable) information. Apple purchased the analysis platform for structured data for a reported \$200 million. The tech giant also snapped up RealFace, a facial recognition technology startup. Cisco made the list too, paying \$125 million for MindMeld, a conversational AI startup. Airbnb also showed an interest in AI with its purchase of Trooly, a developer of background-checking technology.

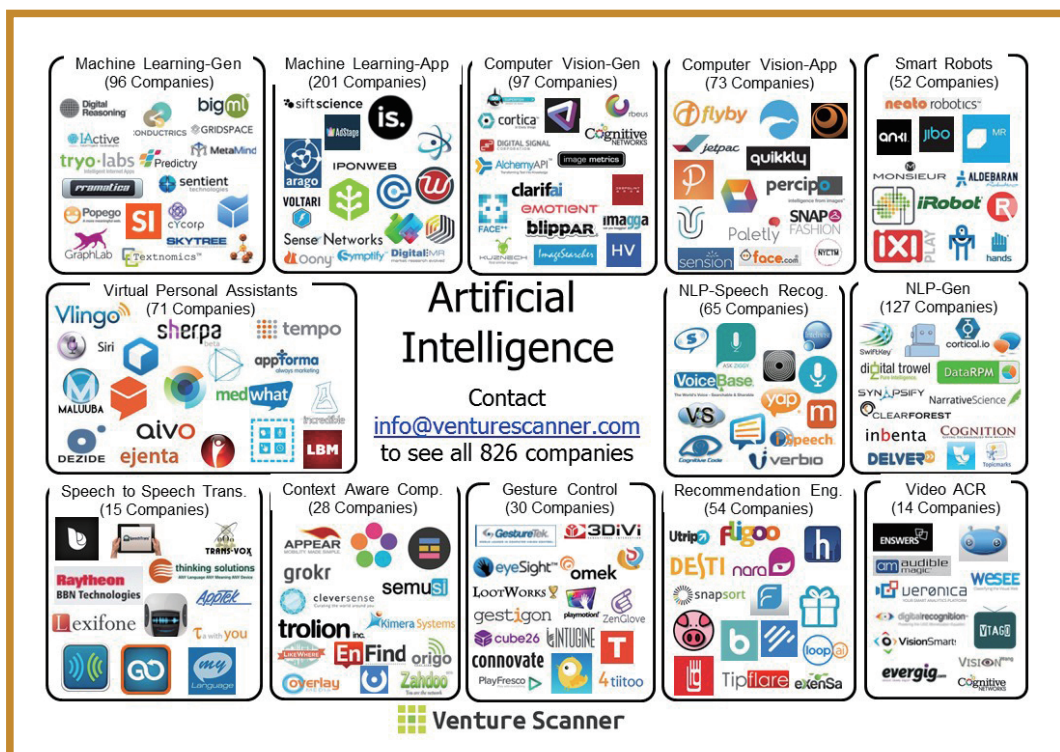
Ecosystem

The AI industry can be segmented into three core technologies: (i) machine/deep learning, (ii) computer vision/ image recognition, and (iii) natural language processing (NLP). These technologies are the foundation to a variety of applications – such as autonomous vehicles, smart robotics, drones, virtual agents – which are position to disrupt all industry verticals (healthcare, retail, energy, agriculture and finance).

The chart (Figure 19) provides a high-level picture of the AI landscape and the sectors within that broad category. The listed companies either build the technology, utilize it as the core offering or a specific function in their products.

- **Machine/Deep Learning:** Machine learning is the technology of computer algorithms that learn from examples and experience (i.e., large data sets) rather than relying on hard-coded and predefined rules. Deep learning is a sub-set of machine learning that focuses on deeply layered neural networks,

²⁸ Page, Holden. "AI Startups Take The Money And Run As Big Tech Comes Acquiring." Crunchbase News, 9 Aug. 2017, <https://news.crunchbase.com/news/ai-startups-take-money-run-big-tech-comes-acquiring>.



Sources: "Making Sense of the Artificial Intelligence Ecosystem." Venture Scanner Insights, 10 Aug. 2015, <https://venturescannerinsights.wordpress.com/2015/08/10/making-sense-of-the-artificial-intelligence-ecosystem>.

Figure 19 AI Sector Map

the closest thing to independent human intelligence. Major advances in deep learning are therefore one of the driving forces behind the current AI inflection point. The machine/ deep learning, which includes technologies that cover neural networks, expert systems, intelligent assistants and embedded systems, is expected to dominate the AI market; both in terms of revenue and CAGR over the forecasted period of 2017 to 2025. The machine/ deep learning market is expected to grow from \$1.4 billion in 2017 to almost \$9 billion in 2022, at a CAGR of 44.1%.²⁹ Technological advancement and proliferation are some of the major driving factors for global machine learning.

²⁹ "Machine Learning Market worth 8.81 Billion USD by 2022." Market Research Firm, <https://www.marketsandmarkets.com/PressReleases/machine-learning.asp>.

Machine learning technology has now reached a stage in its development where these intelligent machines don't necessarily need programming. These systems can understand the nature of the problem it is asked to solve or the task to be performed. To keep their competitive advantage, tech giants like Google, IBM, Facebook are therefore devoting a significant amount of money and resources to this area. For example, the CEO of Google recently announced that AI and machine learning will be the central component in all of their products and have therefore tripled the number of machine learning researchers working for the company over the last few years.³⁰ Google also recently invested \$4.5 million in the Montreal Institute for Learning Algorithms, a machine learning research lab at the University of Montreal, following Intel's investment of \$1.5 million to establish a machine learning research center at Georgia Tech. VC firms are also favoring the machine learning space – 60% of the \$12 billion invested in the AI space last year went towards machine learning start-ups.³¹ This is most likely because machine learning is an enabler for so many other technologies and applications.

- **Computer Vision/Image Recognition:** Computer vision is the method of processing and analyzing images to understand and produce information from them. Image recognition is the process of scanning images to identify objects and faces. These artificial intelligence applications that interpret and act on visual data can be used in a variety of fields. The market is currently being driven by a rapid interest in the commercialization of drones, autonomous cars, and other robotics applications.

³⁰ Regalado, Antonio. How AI is exploding at Google. MIT Technology Review, 27 Mar. 2017, <https://www.technologyreview.com/s/603984/googles-ai-explosion-in-one-chart>.

³¹ "Artificial Intelligence, The Next Digital Frontier?" McKinsey Global Institute, page 12.

- **Natural Language Processing (NLP):** Natural language processing is the method through which computers process human language input and convert into understandable representations to derive meaning from them. NLP leverages machine learning algorithms to learn rules based on large sets of training data that can then be applied to new sets of text. Early applications of NLP have been seen in text mining (e.g., analysis of legal documents, insurance policies, and social media) and automated question answering (like Siri). New advances in neural networks and deep learning models are allowing NLP systems to become increasingly intelligent and can manage the ambiguity of the human language. The most advanced NLP technology is Google's open-source foundation of NLP implemented in TensorFlow, called SyntaxNet, which leverages neural networks to parse sentences in a way that is more understandable to computers.³² The market will continue to be driven by the rise of interest and innovation in machine learning/ neural networks, which is the technology underlying the AI field of NLP.

Industry Application Trends

The following industry application trends are the most viable investment opportunities within the AI sector:

- **Autonomous Driving Vehicles:** This sector has seen major investments from established automakers such as Google, Tesla, and Uber. BCG estimates that the overall market will reach \$42 billion by 2020. There are unique opportunities for investments addressing various technologies that are part of this ecosystem. New entrants are constantly entering into this market that claim to have more advanced features, better functioning algorithms and more creative approaches to serve the ultimate self-driving car (admittedly, most

³² "Google's SyntaxNet and Sentiment Analysis." Brnrd.me, <http://brnrd.me/google-syntaxnet-sentiment-analysis>.

of them are not fundable as stand-alone companies). Autonomous driving vehicles remain imperfect today, with sensors and software that are confused by such conditions as poor weather or certain obstacles or complex driving environments. However, we are seeing novel concepts aimed at increasing the reliability of this means of transport. For example, vehicle-to-vehicle communication, once it gets deployed on a larger scale among the connected cars on the road, will allow each vehicle to broadcast its GPS position, speed, steering-wheel position, brake status, and other data to other vehicles over short distances to ensure safer driving conditions and avoiding accidents.

- **UAV/ Drone Applications:** Unmanned Aerial Vehicles (UAVs) have developed quickly in recent years. According to the Teal Group, the overall commercial market for UAVs is expected to grow to over \$11.5 billion by 2024. Certain companies are already clear leaders in this space, for example, DJI. Smaller drones can be valuable in spying and surveillance; they might also be useful for monitoring disaster areas or delivering supplies to humans. Some start-ups have developed miniature drones, which use artificial eyes and sophisticated sensors that maneuver in tight fitting places to avoid collisions. Artificial Intelligence advancements in "swarm" technology, where connected robots in the air, on land and/or in water can communicate with other another and act in concert, is near ready for commercial and military applications. Many of these technologies and applications are being developed with DOD, DARPA or other government funding. This kind of non-dilutive source of capital, if applicable and available, is attractive and should be considered and pursued for any portfolio company. Securing grants from government and institutions may further enhance future exit valuations.
- **Healthcare/ Medical Applications:** The potential of AI-based applications in the healthcare industry is enormous. They can range from robotics that can assist the visually and physically impaired (e.g., sophisticated prosthetics

with controlled algorithms that allow amputees to walk more naturally and comfortably) to surgical robots that can operate with a magnitude of precision that cannot be replicated by the most skillful surgeon (for use in areas like cardiothoracic, gynecology, urology, orthopedics, neurology, and general surgery). Since the introduction of Intuitive Surgical's da Vinci operating system, the robotic surgery industry revenue has experienced healthy growth; this market alone is projected to be approximately \$6 billion by 2020, growing at a CAGR of 10.2%. The desire to adopt minimally invasive surgery techniques that result in less blood loss and pain should foster greater demand for such robotic equipment. Further out in the future, we hope to witness the practical applications of bio-engineered DNA robots or swimming nanobots that can carry drug payloads to target cancers or other conditions for the ailing patient.

Summary

The linkage with Taiwan and AI is important. There are ongoing AI projects currently at the university level and in government and research labs, such as at ITRI. There are opportunities for investors and start-ups in the US to collaborate with these institutions, and WI Harper can help link researchers in Taiwan with the relevant parties in the US. In addition, Taiwan strategic and venture investors have been and are investing in the field of robotics and AI. Taiwan companies play an integral role in the overall AI/ robotics value chain, especially in the areas of semiconductors, components and sub-systems that are integrated into the final intelligent product.

Although large amounts of investments have already poured into AI recently, investing in this space continues to have tremendous upside. Investors, however, should remain cautious and judicious in their approach evaluating the many investment opportunities. Many of the technologies in this field are still emerging and not ready for prime time. WI Harper is uniquely positioned to take advantage

of the opportunities in this market. The firm has investment professionals who have invested in this space before, and we continue to keep current with the multitude of advancements in AI and robotic technologies by staying in close contact with the world's foremost university researchers (MIT Media Lab and Computer Science and AI Lab [CSAIL], Carnegie Mellon, Stanford, Berkeley, etc.). Successful investing in this field depends in part on establishing these tight relationships with the academic world and with industry, labs, roboticists and entrepreneurs. In addition, WI Harper is well connected to like-minded investors, such as iRobot Ventures. Leveraging these meaningful relationships will allow us to understand quickly the commercial viability of emerging technologies, to appreciate the market needs of breakthrough intelligent machines and systems and to identify and secure the most compelling AI/ robotics deal flow. Our strategy also entails working closely with strategic partners, including co-investing with AI/ robotics companies. Such relationships increase our exit alternatives for our portfolio companies.

In sum, WI Harper's extensive background and deep experience in this area allow us to identify the most emerging technologies in the AI/ robotics field, invest in the most promising companies and guide the most talented teams to successful exits. 🤖