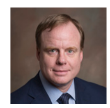
Technological Innovation and Disruption

Perspectives from our annual trip to Silicon Valley.

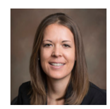
February 2019

KEY INSIGHTS

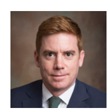
- Innovation is unleashing powerful *secular* forces that are generating new business models and creating significant disruption.
- In our visits to Silicon Valley, we focus on differentiating between companies benefiting from long-term growth drivers and those exposed to *cyclical* swings in demand.
- With disruption occurring across nearly every industry, being on the right side of change is paramount for investors.



David Eiswert
Portfolio Manager, Global Focused Growth Equity Strategy



Emily Scudder
Investment Analyst, Hardware



Joel Grant
Investment Analyst, Industrials

The spectacular pace of innovation in the technology sector in recent years has drawn both investors' and the public's interest. But painting technology with a broad brush is a mistake. Not all technology companies are benefiting from innovation, and some prominent firms are in fact suffering from the disruption that results. Moreover, many of the companies that are benefiting the most from innovation are in industries that seemingly have little to do with the tech sector.

Distinguishing the Cyclical From the Secular

For nearly 15 years, a large group of T. Rowe Price managers and analysts has traveled once each year to Silicon Valley, where they meet with top executives of leading tech-oriented firms. The joint trip supplements many other individual visits over the year, and part of the goal is to share insights on the broader impact of recent advances.

A chief objective of our investment professionals is always to identify the long-term, secular forces at work in the markets. These need to be distinguished from the short-term, cyclical swings that may lead to profits or losses in a given quarter but tell us little about a company's potential to create long-term wealth for shareholders.

A Cyclical Turn?

That distinction may be especially important in early 2019, as the previous few years have seen a powerful cyclical upswing in the tech industry. Business spending on software, hardware, and services has grown rapidly, thanks to faster global growth, investment incentives in the December 2017 tax bill, and other factors.

In recent months, signs have emerged that the cycle might be turning. The deceleration in the Chinese economy in the latter half of 2018 took a toll on the semiconductor firms that supply its

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electronics factories, and companies supplying parts for smartphones produced in China especially felt the pinch. Meanwhile, growth is also slowing in Europe, while businesses are growing more cautious about spending on technology and other investments.

A primary purpose of T. Rowe Price's research visits and other fundamental analysis is to determine how much of a company's recent performance has been tied to such cyclical factors. For example, software giant Microsoft has remained partially exposed to cyclicality in the PC market, where it earns money on every new computer sold with Windows and the Office suite preinstalled. But Microsoft has also diversified into other businesses that are less sensitive to fluctuations in demand.

Three Secular Forces Driving Disruption

While industry cycles are important to understand, T. Rowe Price's growth managers and team of tech managers and analysts are generally focused on the powerful secular market forces unleashed by innovation. Finding the companies that stand to benefit from them is crucial—and so is avoiding the firms whose businesses are being disrupted.

Dave Eiswert, a manager of global growth portfolios, says the recent trip fortified his view that three powerful secular forces are creating widespread disruption:

The growth of media platforms

Alphabet (Google) and Facebook have become two of the most highly valued companies in the world and two of the world's largest media firms by harnessing the power of the internet and mobile telephony, among other technologies. The two companies provide platforms that link content creators, advertisers, and customers. As a result, these and other "platform companies," as they have become known, benefit from significant network effects—the more users on the platform, the more value it provides each of them.

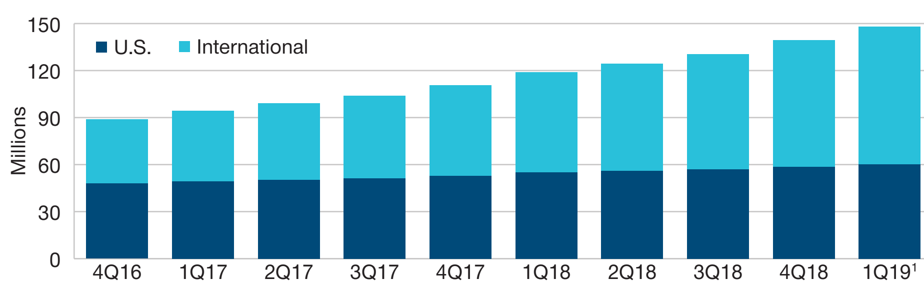
Indeed, one effect of recent innovation has been to vastly increase the scale and scope of leading companies, allowing firms to expand across industries and national borders. Eiswert points out that Netflix—also a platform company in that it links content creators with viewers—has become the largest video company in history because it is not constrained by infrastructure. This provides it a key advantage over firms that need to lay cable or set up broadcast towers to reach customers. International expansion has allowed Netflix to spread the cost of high-quality programming among a global subscriber base.

Netflix has benefited from the growth of the internet, but it is also extending its dominance by using algorithms designed to offer customers targeted viewing

(Fig. 1) Platform Companies Move Easily Across Borders

Netflix Paid Memberships

Fourth Quarter 2016 Through First Quarter 2019



Source: Netflix.

[1] Estimate.

> Analyzing customer preferences is an important example of another innovation reshaping the economy—the spread of AI into various industries.

recommendations. Drawing on its trove of user data, Netflix has a unique perspective on viewing habits across the globe, helping it develop new programming and maintain the loyalty of its customers. Netflix's streaming services are also easily delivered over mobile devices, making it a constant companion for many users.

The rise of machine learning and artificial intelligence (AI)

Analyzing customer preferences is an important example of another innovation reshaping the economy, the spread of AI into various industries. AI relies on powerful computing resources, which are now available to many firms through cloud computing services such as Amazon Web Services and Microsoft's Azure.

But providing computers with the information needed to make decisions and perform tasks without human intervention—the branch of AI known as machine learning—also requires vast amounts of data. Computers calculate much faster than humans, of course, but they require exponentially more data to make the same inferences. The need for massive data is one reason that the biggest tech companies and internet platforms with the most customers are taking the lead in developing machine learning-based AI.

Some of the uses of AI may be surprising. Workday is a cloud-based provider of human resources software. Unlike the static software its competitors install on a company's servers, Workday's product is constantly learning, and its experience with millions of employee records means that it can now predict, for example, which workers are in danger of growing dissatisfied with their jobs.

Eiswert notes that there are many ways to play AI for investors. The companies that provide the hardware are a key one, and chipmaker NVIDIA seems exceptionally well positioned. Roughly a decade ago, computer engineers realized that the company's graphic processing units, originally designed for video gaming, also performed exceptionally well in machine learning. The company has since begun tailoring chips specifically for use in AI and now is a leader in "deep learning" software.

The digitization of the enterprise

Computers have been used in the workplace for over half a century, but recent years have seen a transformation in the way businesses collect and deploy information. Key to recent changes have been constantly updated cloud-based software systems, which allow companies to integrate information in new ways. While the impact of this change is perhaps most visible to consumers in the rise of online retailing, it has been pervasive.

Salesforce.com is at the leading edge of this transformation. Salesforce's customer relationship management system, offered by subscription over the internet, allows companies to not only maintain records on current customers but also to identify new prospects—data that then flow into revenue forecasts, inventory management, and other parts of the enterprise.

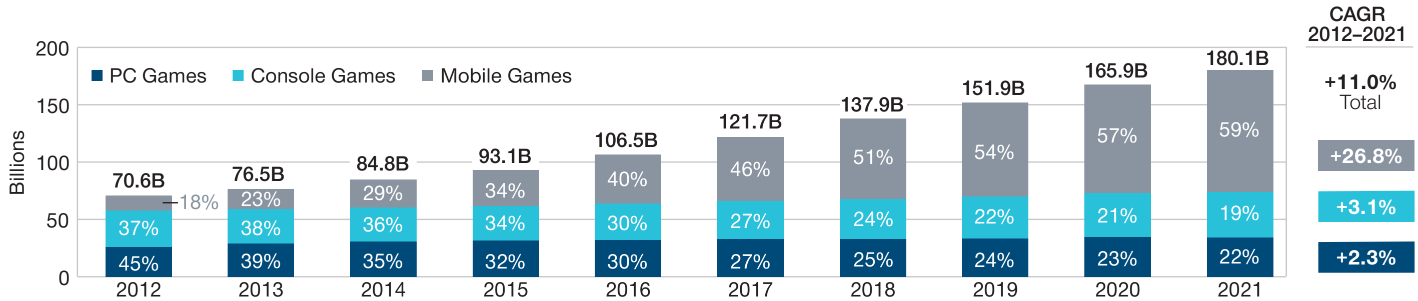
Not All Tech Companies Are on the Right Side of Change

While scale is an advantage in many new technologies, not all large firms are on the "right side of change," as Eiswert puts it. Indeed, several of the largest tech players are at risk of falling behind as new advances threaten their businesses.

Apple may be the primary example of a firm that is at risk of losing its dominance in the coming years. Emily Scudder, a hardware analyst at T. Rowe Price, has been following Apple for years and believes the company faces significant challenges in its reliance on the smartphone market. Replacement cycles for the iPhone are elongating, Scudder notes, as cellphones grow more durable and enhancements—such as the iPhone X's face recognition—fail to entice buyers. Particularly in Apple's important China market, smartphones are becoming more of a commodity, making way for low-cost competitors.

(Fig. 2) Mobile is Disrupting the Video Gaming Market

Growth in Global Games Market by Segment, 2012–2031



Source: Newzoo Global Games Market Report, April 2018 Quarterly Update. ©2018 Newzoo. Used with permission.

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Video Games Become Social Networks

Anyone with a teenager might be surprised that Scudder also sees EA, Activision, and other leading video game companies at risk of being on the wrong side of change. To be sure, the growing popularity of gaming as a leisure activity is a secular tailwind for the industry, as is its aging and wealthier user base. But the industry is also experiencing disruption from newcomers such as Epic Games' wildly popular Fortnite. It and similar games are free to play, are delivered online rather than on a disk, and work across platforms, including mobile devices. Most importantly, perhaps, they foster increased player interaction, making them a social media platform and a type of virtual world.

Eiswert notes that the real center of game innovation is in China. China's Tencent (a partial owner of Epic) has the largest gaming franchise in the world, thanks to the popularity of its mobile games. The company also operates the massive and lucrative social networks WeChat and QQ, and over half a billion people use its payments gateway, TenPay. China's gaming leadership is one reason T. Rowe Price's tech team makes regular journeys across the Pacific and maintains a base in Hong Kong.

Too Soon to Write Off Old Tech

Of course, established tech players are not doomed to irrelevance, especially with the right leadership. Microsoft is an example of a company that has turned itself around in recent years, thanks in large part to its Azure service and its move into other areas with secular growth drivers—a turnaround that Eiswert credits to Microsoft's new CEO, Satya Nadella. Similarly, Cisco Systems has pivoted from a focus on the aging market for physical routers to software-based routers. Scudder thinks the company is early in a new product cycle based around cloud- and subscription-based services.

Other companies may be headed in that direction, and the tech team thinks it is far too early to write off any firm's prospects. Eiswert notes that Intel is scheduled to get a new CEO, and it is possible that a shrewd leader could redirect the company into secular growth markets, such as mobile chips. Scudder sees some promise for Apple in the coming rollout of 5G broadband, which may allow the company to build on its early leadership in using mobile phones as artificial reality platforms.

Disruption Is Everywhere

All sectors and industries are being impacted by secular change, Eiswert notes, and "the companies that harness technology in whatever sector are winning." For example, Exact Sciences has harnessed recent advances in DNA analysis to develop a popular and noninvasive screening tool for colon cancer, and it is developing assays for other cancers, as well. Florida utility NextEra Energy is the largest renewable energy company and has been at the vanguard of renewable energy development. T. Rowe Price analysts believe that technological advances and supportive policy will help renewable energy production double or even triple in size over the next decade.

The auto sector may be among the most visible areas of disruption in the coming years, if industrials analyst Joel Grant is correct. Grant says two major secular changes at work in the industry should eventually come together and further magnify their impact.

Electric vehicles (EVs) are steadily gaining market share, and Grant would not be surprised to see a dramatic shift in consumer preferences toward EVs around 2025—not only because of their smaller environmental impact, but because they will be cheaper, especially given lower maintenance costs. While EVs currently cost roughly $10,000 more to make than combustion vehicles, Grant expects them to cost $5,000 less to produce in a decade.

Will traditional automakers be able to adjust? Grant is doubtful. Unlike its competitors, EV pioneer Tesla is building up scale and lowering costs in the production of EV powertrains and batteries. In addition, traditional automakers focus design efforts and production costs on maintaining a brand. Future customers hailing EVs will be concerned with getting there at minimal cost with maximum comfort, safety, and convenience—not with what they are seen in pulling up to their garage. “I think you’ll see a lot of new interesting vehicle architectures,” Grant observes. EV motors can be moved into the wheels, creating more space inside and making the vehicle more aerodynamic.

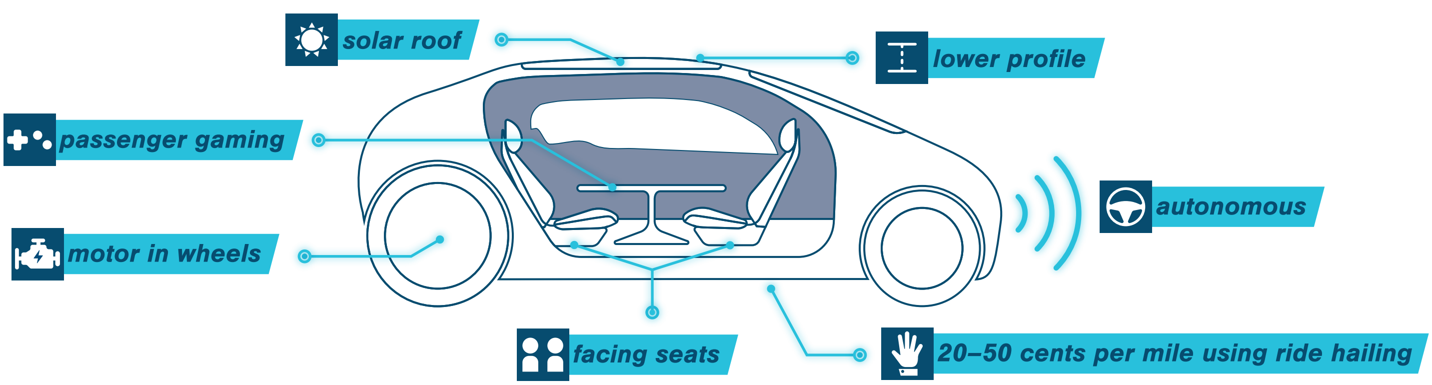
Hailing a Ride for 50 (and Maybe Even 20) Cents per Mile

Autonomous driving is also moving ahead, although at a slower pace than some have suggested. Grant does not downplay the challenges in adopting AI to driving a car. “There are many cases as a driver where you encounter things you’ve never encountered before,” he notes. “It’s difficult to estimate when the technology will be ready to encounter all of those and handle them safely.”

Nevertheless, Grant believes it is possible that fully autonomous electric vehicles will be available as early as 2030. The cost per mile of transporting a passenger in such a car should be under 50 cents per mile and perhaps as low as 20 cents. This would make ride hailing a much more attractive option relative to car ownership, which currently costs around one dollar per mile.

Auto Disruption Could Be Highly Visible

What a “Mobility Pod” Could Look Like in 2030



Source: T. Rowe Price as of February 2019.

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