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Martin Kenney and John Zysman

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Martin Kenney

(mfkenney@ucdavis.edu)

John Zysman

(zysman@berkeley.edu)

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Classical political economists beginning with Adam Smith and Charles Babbage, and then even more so with Karl Marx understood that work, and, in particular the future of work was intimately related to the development of science and technology. While the debate about the ability of technology to shape the factory and work processes continues, most scholars agree that technology opens a range of possible directions or trajectories (Dosi 1982), but the actual evolution is an outcome of an interplay between actors with varying degrees of power to shape such trajectories. It is our contention that certain technological advances provide firms and entrepreneurs with a "lever" which almost always is combined or makes possible new business models that allow a shifting on the grounds of competition. Over the last six decades, the advance of computation and communication technologies has repeatedly created new digital tools that provide entrepreneurs with openings to reorganize or, to put it in the current vernacular "disrupt" existing businesses (Christensen 1997) and create entirely new businesses.[1]

The technological changes underway today will have powerful impacts on firms, workers and communities. Today, we are making technological choices that are shaping the outcomes.[1] This paper first explores the impacts of the new technologies on work. The second section acknowledges the difficulty of deciding how to frame the context of the changes that are occurring and suggests that entrepreneurial finance has an independent influence on the emerging outcomes for work and labor markets. We then extend our previous work on the emerging platform economy and the impacts of computation-intensive automation by examining the impact of entrepreneurial finance on the development and deployment of digital tools (Kenney and Zysman 2016; Zysman and

[1] Following Schumpeter, we do not claim that it is the technologies that make the changes, but managers in existing firms and new entrepreneurs that create the business models that actually change the economy.

Kenney 2018). In the penultimate section, we consider a number of the implications of these changes for labor and labor markets.

1. Technology and the Future of Work

The era of intelligent tools and computation-intensive automation of manufacturing and services is upon us. Or, more prosaically, human society is entering an era in which platforms, intelligent tools, and computation-intensive automation of manufacturing and services are becoming ubiquitous.[2] The rapid development and adoption of robotics and intelligent systems with self-learning algorithms will not only automate job tasks associated with blue-collar work but also automate less-routine job tasks that have been considered knowledge work (Brynjolfsson and McAfee 2012, 2014; Ford 2015). This digitization process seems to be inexorably diffusing into more sectors of economic and social life. Much of this work will be organized on digital platforms.

Digital technologies are evolving very rapidly, as enormous capital investments are being made in computation-intensive automation. Despite this seemingly inexorable march of technology, the future is not predetermined but, rather, will be shaped by social, political, and economic actions taken. In this sense, the future is ours to create. A dystopian future in which jobs are simply lost and workers are only displaced is not inevitable. These tools can be deployed in ways that generate new employment, organize work to augment skills, and support a more just and equal society.

The necessary first task is understanding what the real challenge is. Some recent studies, and much of the resulting press coverage, have suggested an impending dystopia. Other studies undertaken to analyze the current status and likely future impact of intelligent

systems and advanced robotics arrive at different conclusions. The conclusions and implications of these studies are so diverse that it is vital to examine carefully the underlying assumptions each study makes about the future, including those about technology, data sources, and analysis (Manyika et al. 2017). If large swathes of jobs are swept away in the next decade, a crisis might erupt; a steady transformation over several decades, however, produces a more ordinary process of industrial growth and change. Frey and Osborne (2017) imply that 47% of employment will be eliminated. However, rather than entire jobs being eliminated by computation-intensive automation, it seems far more likely, then, that activities and particular tasks that are a portion of particular jobs will be automated. In other words, work processes will become increasingly defined by software, as many of the tasks will be discharged by algorithms, while other, less-automatable ones are performed by humans. Perhaps, the proper analogy is that of manufacturing workers on the assembly line embedded in machinery that, in part, determines many of their movements and activities.[3] For example, on YouTube, video-screening pattern-recognition algorithms identify possible pornography or other violations and then those that are less easy to evaluate are routed to human beings for final determination. In this case, much of the "watching" has been automated and replaced, but final judgments are largely made by people. Technical advances constantly shift the boundary between activities that require humans and those that can be performed by machines (algorithmic).[4]

Importantly the diversity of conclusions reinforces the view that the future is ours to shape. Again, a dystopian future in which jobs are simply lost and workers are just displaced is not inevitable or, in fact, likely. These algorithmic tools and digital platforms

can generate new employment, organize work to augment skills, and support a more just and equal society.

What choices are there to influence the directions and consequences of intelligent technologies? The issues and debates are becoming clear.

1. *Intelligent Machines as Tools.* Stated simply, the first ineluctable fact in the contemporary evolution of machinery (both physical and virtual) is that the tools are increasingly capable of sensing, storing, and processing data. How can people be most effectively engaged and fulfilled in a work world where they are in constant interaction with these intelligent tools? How are and will intelligent systems and machines be used as tools to complement human labor and substitute for and amplify/augment human intelligence even as work is reorganized and reconceived? Is it possible to develop trajectories that not only accelerate productivity and innovation but also reveal new approaches for developing and sustaining human capabilities—skills, training, and education—and for achieving inclusive prosperity?

2. *Policies for Technology, Work, and Labor.* What should policies and policy processes, technology development, and work organization practices look like if we are to shape a future in which intelligent machines do not simply replace human labor but, instead, are used to augment human intelligence?

    - Critical among these are how we develop our education and training systems. Education and training systems dedicated to lifelong learning will likely need to be created to accommodate the continuous reorganization of

work and employment, for example, the shifts from job to job, that are likely. The very character of work, and consequently the skills required, are likely to evolve ever more rapidly, as the frontier between human and machine work changes. In the earlier phases of industrial development, extending the number of years of education—first to primary, then to high school, and on to higher education—was sufficient. We must now reconsider what we do with the years of education: what needs to be learned and how.

- The debates extend well beyond education, to market rules, regulations, competition, and social policy. Consider the debates around Uber. Competition and antitrust policies, which may, at first glance, appear to be distant from the workplace, will inevitably affect labor. For example, if transportation network firms, such as Uber, are allowed to use regulatory arbitrage to offer lower prices for transportation than taxis that have a public-service function (which, of course, is a cost), then this competition decision affects the labor and compensation structure faced by taxi drivers. In some sense, human intelligence will be augmented, but the question, by definition, is who will be replaced and what will be created.

3. *Rethinking Business Strategies*: The difficulty with trying to affect technological trajectories is that socially beneficial evolutionary paths must also be able to survive market competition. Socially beneficial directions that are not economically viable are unlikely to survive in competitive markets. This requires the promotion and development of human-centric business strategies that succeed

> in the market through the effective mobilization of the workforce as an indispensable resource not just as a cost to be reduced or rationalized. Business strategies that promote skill development and the effective and innovative use of the new intelligent tools will be needed. Structures and incentives must be created that shift the calculus such that firms will find their workforce to be resources to be promoted and developed, not just as headcount to be cut or rationalized. This will necessitate creating strategies that promote skill development and the effective and innovative use of the new intelligent tools. Rethinking business strategies, of course, raises the issues of how firms and their profitability are valuated, how they are financed, and the strategies supported by their financing.

All this, particularly the issues relating to business strategies, can be presented more formally and draw directly from the classical literature. Adam Smith and Charles Babbage, and even more so Karl Marx, understood that work, in particular the future of work, is intimately related to the development of science and technology. As the debate over the ability of technology to shape the factory and work processes continues, most scholars agree that technology opens a range of possible directions or trajectories (Dosi 1982), but the actual evolution is the outcome of interplay among actors with varying degrees of power to shape such trajectories. Certain technological advances, this line of reasoning argues, can provide firms and entrepreneurs with a “lever” that is almost always combined with or makes possible new business models that shift the grounds of competition. Over the past six decades, the advances in computation and communication technologies have repeatedly created new digital tools that provide entrepreneurs with openings to reorganize

or, to put it in the current vernacular, “disrupt” existing businesses (Christensen 1997) and create entirely new businesses.[5]

Although this conference largely focuses on labor, the deployment of capital is of vital importance because it funds investment in the tools used to create value. Indeed, capitalism is a system within which differing recipes of capital and heterogeneous labor are combined to create value for consumers and profit for investors. If the availability of capital is unequally distributed or if investors perceive investment opportunities differentially, then the firms that have a greater ability to raise capital will have unique competitive advantages.

Entrepreneurial finance differs from traditional bank lending, as its practice is based on acquiring equity in a young firm in the hope of securing future capital gains. Such investments are high risk by nature, and most often the firms receiving the financing initially lose money. The fastest-growing firms may operate at a deficit for long periods prior to becoming profitable and, in the greatest successes, fabulously profitable. During the initial period, the goal is growth, not profit. The ultimate goal, of course, is to surpass any incumbents (usually from the previous technology regime) and establish a dominant position, if not a monopoly or near-monopoly position (e.g., Intel in microprocessors, Microsoft in operating system and productivity software, Cisco in routers and switches, Google in search, maps, etc., Amazon in online shopping, Facebook in social media, and, of course, Standard Oil in an earlier era).[6] The drive to disrupt and the need to establish a powerful market position affect both the industrial structure and the labor market.

2. Where to Start? Labels and Code Words

Computation is advancing, and it will alter labor and the labor process across a wide variety of industries. This recognition only reinforces the need for a discussion, yet little discussion has taken place on what shapes technologies and how differing technology trajectories will in turn influence social and economic outcomes. Certainly, we have a seemingly endless number of starting points from which to approach these questions, diverse concerns expressed as memes, code words, and half-phrases—labels, each of which reflects one aspect of the story and a new flashpoint. The diversity of views suggests both uncertainty about the outcome and limited understanding of the choices. Consider some of the starting points.

Are the Robots Coming?

Fears that the robots are coming are widespread, including concerns that artificial intelligence (AI)/machine learning and the abundant data on which they are based will simply displace work and workers. The diverse studies, as noted, of the technology and its implications reach widely differing conclusions about the breadth of the impact and the timing, which are based on rather distinct assumptions and presumptions about technology and work. If the AI-powered robots (more generally and more accurately called AI-powered algorithms) arrive tomorrow—that is, if they arrive in the short term (the next five years)—and rapidly displace workers throughout the economy, then Americans will experience a major employment crisis (beyond the one that already exists). If they arrive over thirty years, slowly spreading through society, a more classic structural shift will occur in the economy, with difficult but less dramatic political impacts (see, e.g., Manyika et al. 2017).[7] Indeed, most general economic studies of the links among productivity,

technological innovation, and employment suggest that the aggregate changes may not be very great.[8]

The general conclusion is that technological change has influenced employment levels only marginally over the past few years. Whether that will continue is the question. However, those studies contend that the composition of the workforce has, arguably, been bifurcated, with high-wage/high-skilled jobs, on the one hand, and low-wage/low-skilled jobs, on the other (Autor and Salomons 2017), These results are consistent with the now widely accepted belief that the middle class is hollowing out, with all the attendant implications for politics and the economy.

The Services Transformation and the Bifurcation of Work

Is this bifurcation an inherent feature of the technologies? Some suggest that it is a feature of the Baumol dilemma, which rests on the observation that it takes as many people to play a Beethoven string quartet today as it did when it was written, but in the meantime the wages of these musicians increased significantly (Baumol and Bowen 1966). The issue is the contention that it is more difficult to apply technology and make capital investments in services than in manufacturing and agriculture. Consequently, as the basis of the economy changes from manufacturing to services, productivity will decrease—unless, of course, these jobs in services are amenable to automation.[9] Services have been transformed by digital tools (Zysman et al. 2013).[10] The resulting reorganization of services is much more nuanced than much of the literature suggests. Indeed, this reorganization divides services into at least two groups. The first set of services consists of sectors that have been radically transformed by information technology, such as telecommunications. Add products, such

as jet engines, for which sales of products have been converted into sales of services, as an airline may decide that it will no longer buy a jet engine but, rather, purchase a "lift package" for its airplanes (Guajardo et al. 2012). Many of these transformed sectors have experienced productivity gains and have become, in part, tradable services (Spence and Tyson 2017).

By contrast, the second set of sectors, such as health and education, at the core of the Baumol and Bowen dilemma, appears to be less tradable and slower to reorganize with digital tools. Software and databases are becoming more central to enterprises in these sectors. For example, in the education sector, interest in and adoption of massive open online courses (MOOCs) and course management software have increased, as they have become ever more capable and sophisticated. In health care, expert systems are evolving to become more capable overall and, specifically, capable of learning. Even if we discount the significant hype, it seems inevitable that they will be capable of analyzing images and test results and of recommending diagnoses and treatments. In each of these cases, the software and underlying databases will augment the knowledge and abilities of medical professionals and enable them to care for more patients in a given time period than they can now (see, e.g., Esteva et al. 2017; Simonite 2016).

The Rise of the Platform Economy

Rather than focusing on robots and AI, let us consider the role of digital platforms in reorganizing sectors of the global economy (Kenney and Zysman 2016). Platforms are the fundamental organizing principle for a wide variety of digital businesses that are transforming the current political economy across a broad range of businesses, including

search, mobile (Android), advertising (Google), retail sales, and, more recently, distribution (Amazon, Etsy), social media (Facebook), transportation (Lyft, Uber, Blablacar), lodging (Airbnb), and gig work sites, such as Amazon Mechanical Turk, TaskRabbit, Topcoder, and Upwork. Digital platforms are composed of algorithms and software that run in the cloud and operate on data. Business ecosystems form upon these platforms. The concept of a platform economy refers to the thesis that digital platforms are gradually organizing an increasing share of economic activity (Kenney and Zysman 2016; Lobel 2016).

Labeling the current growth in cloud computing–organized economic activity correctly is important. Initially, many observers termed the new organizational principle a "sharing economy," which referred to their interpretation of the organization of the business models and strategy as a form of sharing. Other more critical observers claimed that these developments were the rise or, more properly, an extension of a "gig economy," largely because they concentrated upon the labor market and organization of work. Finally, yet others termed the new organization an "on-demand" economy. Each of these formulations captures certain features of the evolving reorganization of significant parts of the economy. However, we submit that each of these labels is limiting and ultimately does not capture the profound shift that is occurring as digital platforms are organizing ever greater sections of the economy.

The conceptual basis of the "sharing economy" concept was best captured by Yochai Benkler in his *Wealth of Networks* (2006). He observed that internet-enabled networks facilitated the open-source software movement and community-created websites such as Wikipedia that operated on a sharing movement.[11] However, the label was rapidly appropriated by entrepreneurs and venture capitalists who began to fund firms that allowed

individuals to offer their labor services (TaskRabbit) or labor services with a capital asset (Uber/Lyft and Airbnb) on a firm's platform. In these cases, money is exchanged in return for a good or service. For example, Uber, to the extent that it involves sharing, is really about converting a private asset, a personal consumption good, into a capital asset for a commercial transaction. Indeed, Uber often involves individuals who offer a service without the regulations normally faced by a taxi driver. As J.B. Schor and W. Attwood-Charles show in their article on the sharing economy (2017), Lyft, Uber, TaskRabbit, and others are not "sharing" in the usual sense of the word. Further, the extension of the word "sharing" to the activities of Google, Facebook, and Snapchat stretches it even further, as these are unapologetically capitalist enterprises that offer services in exchange for information about the user or the ability to place content—all of which is sold to advertisers. Sharing, as Wikipedia and open-source software has shown, was a possible evolutionary path that many of these digital platforms could have taken. However, it is clear that the venture capitalists would never have funded growth in that direction, as they could not have secured capital gains from that growth.

The "gig economy" moniker that many use to refer to the current nature of increasing portions of the labor market is a useful metaphor for certain parts of the labor market, but misses the fact that a gig economy can exist without digitization and platforms as the organizing principle. In fact, in developing countries, large portions of the labor force participate in a gig economy with no digitalization. Thus, the notion of gigs does not capture the emerging organization of work, whose organizing principle is, in fact, platforms.

The idea that we are entering an on-demand economy stems from the observation that an increasing number of services are available nearly instantaneously, whether Amazon same-day delivery, entertainment delivered to devices nearly anywhere immediately, or various types of services available by smartphone. Here again, this captures an important aspect of what moving activities to a digital platform can accomplish. However, it focuses on the delivery of the services, not on how the economic activity is organized on and by platforms.

What is certain is that a radical reorganization of segments of the economy, including retail, is underway. Amazon's acquisition of the bricks-and-mortar retailer Whole Foods is an example and further extends its challenge to conventional retailing. The notion of an Internet of Things and Industrie 4.0 presage the reorganization of production itself, including the organization of supply chains.

The conference, though, is concerned with the impact of digital technology–enabled platforms on labor markets, workers, and the organization of work. To this, we add the importance of thinking about changes in the labor process itself, as work becomes even more embedded in platforms in which algorithms are interacting with people. The influence of digital technologies that facilitate online arrangements is intertwined with macroeconomic drivers that influence the absolute level of employment. So, consider the notion that platforms have facilitated the reorganization of work, the partial decomposition of the firm with the emergence of a "gig economy."

The reality is likely to be more nuanced, and less apocalyptic, than conventional discussions imply. The emergence of cloud-based services—such as the in-person service providers Airbnb, Lyft, TaskRabbit, and Uber—and remote service providers—such as

Amazon Mechanical Turk, Innocentives, and Upwork—is seen as an extension of the gig economy (Friedman 2014), which was already expanding as a form of labor organization.[12] An obvious question is whether gig work has actually increased in the digital era. Is it greater than when we found our babysitters or gardeners from cards posted at the local supermarket? Perhaps—because it is easier to find temporary labor for errands or domestic tasks that we might have done ourselves, and, for some more sophisticated tasks, firms such as Upwork, certainly make temporary contract employment easier.

In a recent study using its customers' bank accounts, JPMorgan Chase concluded that 1% of its customers engaged in work through digital platforms in any given month, while 3% had participated in the three-year period of analysis (Farrell and Greig 2016).[13] If its analysis is correct, is this a sufficiently large percentage of the workforce to justify reframing labor law? However, it is possible that labor law can be improved by examining the needs of platform-mediated workers. If we use a broader definition, self-employed contract work, the proportion jumps to a hefty 20-30% of employment (Manyika et al. 2017). However, the conundrum is in how to count who is a gig worker and who is not. Independent physicians and lawyers in a small town may be self-employed, but are they gig workers? In contrast, lawyers at large law firms are partners, while doctors at Kaiser Permanente are employees.

The visible impact of the cloud-based platform gig work, including Uber, has forced a discussion, really a debate, about labor organization and community values. Consider that traditional taxi drivers and companies own medallions; in this case, property rights are devalued by the entrance of Uber drivers. But for many other Uber drivers, driving may be an entry point into the employment in the formal economy. For consumers, securing

transportation is massively eased. The use of the digital platforms to organize the provision of services by what the platform owners claim are "contractors" has attracted enormous attention and various efforts to organize such workers (Dubal 2017).[14] Although this paper does not investigate whether these populations of workers can be organized, the obstacles to organizing workers in work processes with neither a physical meeting place nor common bonds of ethnicity or other "social glue" are daunting.[15]

Ultimately, software is a machine, and, as such, it can be either a consumption good (the software embodied in an artifact such as a talking doll) or a capital good (e.g., the software embedded in an autonomous farm tractor or software and data center operating Google's website).[16] As has been observed by many scholars, machines embody the values and goals of their makers in their design (Latour 1990). This is also the case for digital platforms, which create a virtual "built environment" within which users operate—the environment is composed of the software algorithms and data on which they operate. The fate of labor is thus conditioned by the operation of this software.

Technological change is, of course, constant and thus normally routine. Certainly, "work" has been transformed many times in the past, whether by the assembly line or the earlier introduction of the steam engine, only to be replaced by electric motors—each time facilitating yet another reorganization of the factory and labor process. Although these technologies affected the factory directly, we believe that computation-intensive automation could have equally dramatic impacts, but, as "tools for thought," they are likely to affect a far larger swath of economic activity than that of the factory alone.[17] If the factory was the organizing center for manufacturing and the office building had a similar role for many services, in the virtual world, while offices and factories remain important,

we argue that, more and more, not only transactions but also much of the value creation occurs on and through virtual digital platforms. Digital platforms and platform firms are increasingly integrating the factory and office into their ambit. In the same way as the factory owner had enormous power to organize the work process, platform owners have enormous power to organize and channel the activities undertaken in their platform ecosystem.[18] The result of this power is seen in growth of Amazon, Facebook, Google, and Microsoft and the narrower sectoral platform firms.[19]

3. Finance, the Trajectory of Tech Firms, and Consequences for Work

The future of work is being created as decisions about business models and production shape how work will be organized and the character of work and jobs. The focus of discussion has been heavily on policy and largely about how to limit new business models or to moderate their consequences. For example, enormous attention has been paid to whether Uber, a "tech" company or a "transportation" company, is obliged to follow taxi rules or limousine rules. Because Uber is a platform that controls much of the drivers' work process, much discussion and litigation have taken place as to whether they are employees or independent contractors. Such conundrums abound as platforms organize larger groups of workers.

But what influences those decisions and shapes those choices? What shapes the business models in the first place? Even within similar applications, variations in business models and strategies have deep consequences for the demand for labor and its deployment? In this conference, with its labor focus, we note that elsewhere we have argued that one essential element is whether labor is viewed as an asset that can be

augmented to contribute to the success of the firm or is a simply a cost that must be contained, minimized, in a price-based competition.

We believe that discussion of the dynamics of these digital platform firms could be enriched by considering the role of finance in both supporting start-ups and existing firms, such as finance, and thus contributing to shaping the ways in which technology is deployed and used. Finance, not surprisingly, has a significant impact on the digital transformation on work and employment. Considering the role of finance in the growth of digital platforms is not meant to engage the larger question of the role of finance in the US economy or to enter into the more general debate over the financialization of the US economy (Davis and Kim 2015; Lazonick 2010). It is simply to consider how the increasing financial resources of venture capitalists (and other private equity pools of funds) underwrite the funding of firms intent upon restructuring business sectors.

Investment euphoria is not unique to the current era. As Carlota Perez, in her *Technological Revolutions and Financial Capital* (2003), and William Janeway, in his *Doing Capitalism in the Innovation Economy* (2012), have argued, after such investment euphoria, the political economy is permanently altered. Our discussion draws upon the studies of investment euphoria and current studies of financialization and the separate discussions about how differences in national financial systems influence the relations between business and state structure (Soskice and Hall 2001; Zysman 1983).

"Disruption" has become a code word for an era of platform-based experiments in the creation and delivery of services. Oversimplified, start-up finance, in its abundance and its logic, facilitates the disruptors; the disruptors in turn are attempting to disrupt businesses and sectors.

An important part of this is that the cost of building digital "tools," including platforms, has dropped dramatically, with cloud computing providing low-cost infrastructure for "users" (Murray and Zysman 2011). One consequence is widespread experimentation within businesses and in the form of new start-ups. The winner-take-all features of the platform economy firms, driven by the economics of digital networks, pushes them to focus on a strategy of scale and dominant market presence prior to establishing profitability. The very nature of the start-up process is predicated upon a firm's initially being cash-flow negative, that is, "bleeding" money. The wager that investors make is that the losses are necessary to capture the market. However, with success, the firm is expected to establish a powerful market position—dare we call it proto-monopoly. These firms are not expected to win via early, sustained operating profit but absorb operating losses financed by venture investment of some sort with the aim of driving incumbents and other new entrants out of the market. Investors may be willing to absorb the exceptional losses with the goal of achieving to proto-monopolistic profits. Current antitrust/competition policy is completely unprepared to address business strategies, such as those of small entrepreneurial firms.

What is the real economic value of these disruptions? Disruption has tended to suggest that the modern is displacing the bypassed and old-fashioned. The automobile disrupted the horse-and-carriage business; digital search engines and digitization of content displaced or altered library operations. In this narrative, disruption is a positive; it forces the rest to adapt or vanish. If consumers gain, and the disruptors make money, who should complain? Certainly, Uber makes finding a ride in London easier for a visitor from San

Francisco. Google changes our attitude and approach to information. Facebook and LinkedIn transformed how personal and professional connections are maintained.

Consider the music business, which is experiencing fundamental change. The music business has been and continues to be in turmoil as downloads have given way to streaming, and the direct compensation to the studios and artists is changing dramatically (Sellin and Seppälä 2017). Even as Spotify and Pandora compete with app store downloads, YouTube is entering the competitive space and threatening all these services by offering even lower costs. Not surprisingly, these changes have driven not only the transformation in industrial structure but also compensation schemes and the labor process for musicians. In this case, the music industry has repeatedly had to respond to threats from outside the industry.

The role of Amazon in the book business has been equally profound. Initially, the focus was entirely upon whether the Amazon online bookstore would grow and drive local bookstores out of business—and many of them did succumb. However, the bookstore chains such as Barnes & Noble, Borders, and others were deeply affected as well—and, of course, so were their labor forces. However, Amazon's effect was not confined to bookstores. Trade book publishers are also being affected, as approximately 25% of book sales are now through Amazon's self-publishing function. Yet again, another link in the entire value chain is threatened by an extension of the Amazon platform. The impact on authors and their ability to earn income is as yet uncertain. The Amazon platform allows authors to circumvent the intermediary, the publisher, and have a far more direct relationship with readers. Yet if Amazon self-publishing captures greater portions of the market, authors will increasingly be at its mercy.

Of course, the ultimate question is: why should we care? This logic that progressive "disruption" advances society certainly comes with negative consequences. Let us note at least a few. As the newspaper business struggles, investigative and international journalism declines, and, some argue, with it comes a decline in our democracy. Perhaps we subsidize journalism, which risks making it dependent on government, rather than private interests. Uber drivers lack protections, so perhaps we rejigger employment law. All this, though, assumes that the disruptors in their profit-making pursuits are generating social gain in the form of new services and products that we value or greater efficiency in the provision of existing ones.

But there is another story. Because many of the firms sustain operating losses over long periods, it is possible to question the economic, as much as the social, benefit. Are the disruptions, if they are driven by extended losses, really justified? As we said, many are not, at the moment, structured to eventually attain sustained operating profit. Rather, they pursue growth at all costs, with the aim of achieving market domination—something that can be achieved only by accepting operating losses financed by venture investment of some sort. The envisioned capital gains would come with domination or establishing the distinct value of particular elements of intellectual property. Apart from the notion that monopoly is thought to be contrary to the longer-term social interest, that drive to domination has its own social consequences. Operating losses with the goal of market dominance may also encourage business strategies of transgressing established rules. But financing losses as a way of overcoming existing systems via social disruption and long-term operating losses forms a treacherous environment for profit-making incumbents.

Let us consider some of the elements and cases we have mentioned. The point is not to dismiss the enormous value that digital technologies and platform-based business have created. Rather, it is to interrogate the enormous enthusiasm for generating entrepreneurial start-ups, losses or not, and for seeking to turbocharge their growth to the point that they become so-called unicorns (see below). Two conditions need to be noted and understood: the decline in the cost of experimentation and the abundance in several forms of funding.

Decline in the Cost of Technological and Business Experimentation

Over the past twenty years, the cost of establishing a start-up or experimenting internally has decreased dramatically. As important as the cost decline, incidentally, is how the abundance of software tools and cloud-based operations speeds the time from initiation to implementation (Murray 2014). The reasons for this cost decline are numerous, of which a technical one is the secular decline in the cost of computation—a long-standing tendency encapsulated in the shorthand of Moore's law but far deeper than just the dynamics of semiconductors. The economics of information technology (IT) start-ups, it is evident, have fundamentally changed. Previously, a start-up had to purchase and build an entire IT infrastructure, which was a capital cost. However, the emergence of merchant cloud-computing offerings allow a new firm to rent server capacity from a vendor, such as Amazon Web Services. What previously was a capital investment is now a variable cost, and capacity can be scaled up or down without any capital investment (Murray and Zysman 2011). Cost and time to market were further reduced by the availability of downloadable open-source software modules from sources such as GitHub. This open-source software eliminates the need to write code from scratch, thereby reducing cost, providing

opportunities to customize, and avoiding vendor lock-in (Northbridge and BlackDuck 2016). The availability of low-cost infrastructure and open-source software dramatically decreases the cost of establishing a new digital business. Thus the technical changes permit the entry of far more new firms than ever before and encourage internal experimentation in existing firms.

Abundant Capital and the Toleration of Operating Losses

Extremely low interest rates ipso facto mean that returns to capital are very low; the corollary is that capital is far less expensive, and to increase returns, it is necessary to increase risk. The easy availability of finance and the belief that many industries are poised for disruption because of developments in information and communications technology (ICT), such as big data, machine learning, and the Internet of Things (which, with smartphones, are new classes of computers), and the development of new business models have convinced investors that start-ups offer the opportunity for great potential capital gains. This has resulted in an enormous flow of money into private equity, of which venture capital is one genre.

Not only is the scale of capital available remarkable, but there has also been a proliferation of funding mechanisms for start-ups (Arrington 2010). Let us begin with conventional venture capital firms. Before the internet bubble that began in the mid-1990s, traditional venture capital (VC) firms were the predominant funders of successful technology firms (Kenney 2011). However, as the elite VC firms became more successful, many of the largest VC-raised and managed megafunds held $1 billion or more in assets.

These firms could no longer invest in early-stage firms, where an appropriate investment is $1 million or less <for what reason, to keep money flowing to their investors? >.

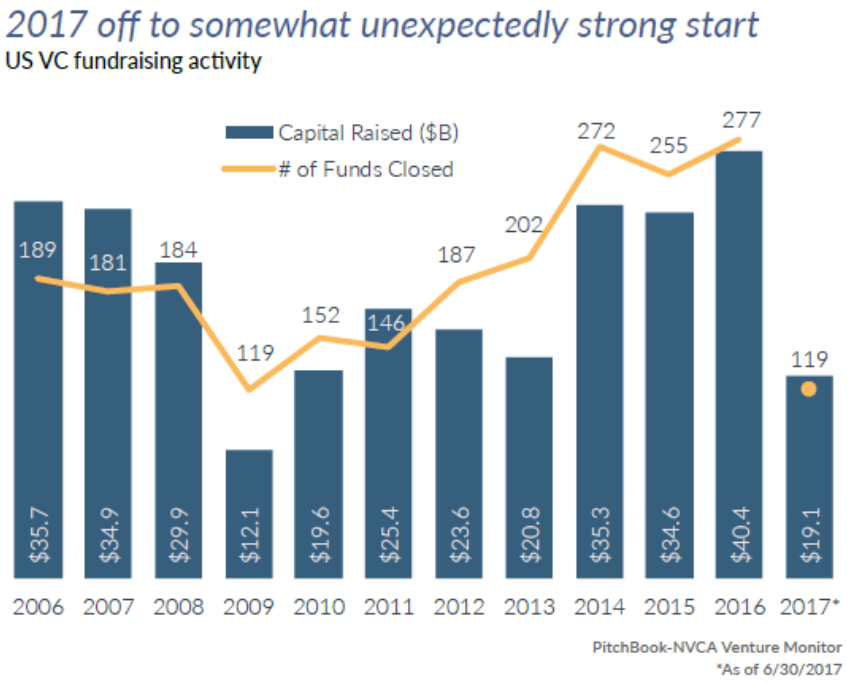
The market gap created by the emergence of gargantuan funds evoked four institutional responses. First, a group of angels or "super-angels" that could easily invest up to a few million dollars in a firm's early stages emerged, particularly in Silicon Valley (Manjoo 2011). Second, accelerators, which vet and then accept aspiring entrepreneurs, and then provide small amounts of capital and coaching in return for a small tranche of equity, emerged. Their goal was to assist in the growth of the entrepreneurs' idea to the point that they could "graduate" and form a proto-firm, able to raise money from super-angels or venture capitalists (Radojevich-Kelley & Hoffman 2012). Third, a wide variety of digital platforms for crowdfunding emerged, ranging from Indiegogo and Kickstarter—where funds are contributed to a project, but the funders receive no equity—to other platforms, such as Angelslist—where only certified investors can invest, and they do receive equity (Belleflamme et al. 2014).[20] Fourth is the emergence and proliferation of smaller, seed-stage VC firms, a functional segmentation of the VC market. In this sense, an ecosystem of organizations and networks has emerged that provide funding for entrepreneurial experiments made possible by the technological changes that reduce the cost of starting an ICT firm.

Because of this reduction in the cost of starting a business, more firms than ever can enter any potentially attractive segment. Thus there are likely to be many new entrants competing for the same market segment. Finance now becomes particularly important because, as we note, these digital markets have winner-take-all (most) characteristics due to network effects. This makes it imperative to grow as quickly as possible to occupy the

space before other start-up competitors or before an established firm can introduce a competitive product.[21] During this phase, profitability is not as important as growth. Initial success often demands even more capital as the start-up grows. In the course of this growth, angels and incubators can no longer provide the capital necessary for such growth, and thus the expanding start-up must secure capital from the big VC firms, and investments must be far larger. The entrepreneurial environment is particularly munificent today as venture capitalists have been raising huge sums for investment. As Figure 1 shows, fundraising in 2014, 2015, and 2016 was the largest since 2006, with a total of $40 billion raised by 277 funds.

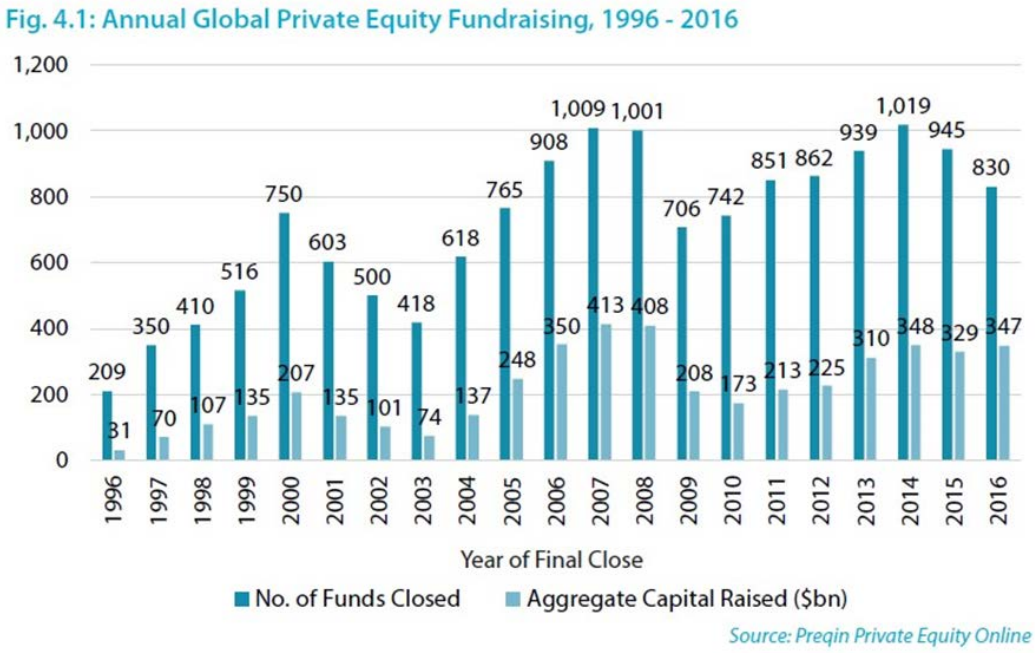
This means that there is an enormous amount of capital searching for investment opportunities.

Figure 1.: Venture Capital Fund-Raising by Year, 2006-2017



Although VC is important for early or midterm growth of the firm, as firms remain private for longer periods, they need to raise even more capital. The enormous growth in the private equity industry in terms of available capital provides a source of funds for private firms to tap in their growth phase. As Figure 2, Private Equity Under Management, indicates, the capital under management by private equity firms has increased to over $2 trillion. This considerable inflow into private equity and VC funds creates a need for fund managers to find opportunities with the promise of significant returns. The returns to investors in earlier platform firms tells investors that they can expect to earn similar returns going forward precisely because platforms have network effects and can result in winner-take-all markets, with their concomitant monopoly dynamics. In the next section, we explore the proliferation of privately held start-ups whose value is over $1 billion—the so-called unicorns.

Figure 2. Private Equity Raised per Year, 1996-2016



Unicorns

The availability and low cost of capital, the low cost of entry, technical changes, and the belief in the possibility of disruption have resulted in a large number of start-ups that are not publicly traded but whose valuation at the last private funding was $1 billion or more. The Silicon Valley venture capitalist Aileen Lee, in her article on the phenomenon (Lee 2013: 2), named such firms “unicorns,” and this appellation has now passed into common parlance. In 2013, Lee identified 39 US public and private firms founded between 2003 and 2013 that had achieved a valuation of $1 billion in 2013. The number of unicorns grew quickly. In February 2017, Verena Schwartz, in her article on characteristics of unicorns (2017), combined a number of these lists and found 267 unicorns globally. Although the number of unicorns fluctuates, as do valuations, in mid-2017 the number of unicorns was declining, yet remained astounding.[22] Some observers have suggested that this is a sign of a valuation bubble.

The point of this discussion is not to debate whether a financial bubble has formed but to examine a related phenomenon: the willingness of investors to invest in firms that are either losing money or not making profits. Of course, the assumption is that the firms will generate sufficient profits in the future to compensate for the current lack of profits. There are both public and private firms that have only minimal profit or even none at all. Although Apple, Facebook, Google, and Microsoft have large profit margins, Amazon barely breaks even. Other important public platform firms, such as Pandora, Blue Apron, and Snapchat, have never made a profit and have no discernable path to profitability. More significantly, nearly all the unicorns appear to be losing money.

The amount of private equity available, much of it raised from pension funds, has also made it possible for firms to stay private longer and lose money longer. Airbnb is interesting from this perspective because it was founded in 2009 and became profitable only in 2016, a long period of unprofitability that was funded by private equity. Given its growth and crossover into profitability, it appears to be ideally suited for an initial public offering (IPO). However, in 2017, rather than going public, it raised $1 billion in capital at a $31 billion valuation. This new influx of capital allowed it to acquire a smaller competitor and expand further.

The number of private unicorns differs in an important respect from the dot-com boom from 1997 to early 2000, in that during the dot-com bubble newly funded firms rushed to make an IPO. Today, firms can remain private for much longer because they are able to raise private equity capital at increasingly high valuations. This ability to continue to fund losses is made possible by the enormous pool of available private equity described earlier.

Private unicorns are largely predicated upon raising capital to fund expansion until either a positive exit event, (either an IPO or a merger,) or becoming cash -flow positive. Of course, some unicorns are able to undertake an IPO even while losing money. The ability to raise capital is vitally important, because a company capable of raising capital to fund operations can offer its product or service without being profitable. This provides such firms a tremendous advantage against over their competitors that are unable to raise capital. Below, we briefly consider the economics of two classic cases: Uber and Amazon.

Uber and Lyft

Uber and Lyft are interesting cases of how investment capital allows new entrants to lose vast amounts of money as they try to conquer a market. Venture capitalists offer their capital in the hope of attaining outsize returns through a future liquidity event. The capital is meant to allow the firm to grow along with the market opportunity. According to some economists, the Uber/Lyft business model does not have any inherent unit-cost economies (Horan 2017); however, it does have two-sided network effects, meaning that having more customers attracts drivers and vice versa—this is an important barrier to entry.[23] This is important, because, given Uber's relatively simple technology, no powerful technical barriers to entry exist, as customers and drivers can and do multihome—in this case using both Lyft and Uber.[24] In this respect, Uber cannot be considered a high-technology firm. Uber is able to compete by decreasing the income of its drivers through offering low fares. In effect, drivers are offering a cross-platform subsidy that undercuts taxis, rental cars, and competitors, such as Lyft.[25] However, as Hubert Horan (2017) points out in his article on the growth of Uber, this does not increase efficiency, because the cost of transporting the

customer does not decrease over time, an inevitable fact. Therefore, Uber can grow in only three ways: first, entice more people to take rides; second, shift riders out of taxis, rental cars, personal cars, or other transportation modalities, such as mass transit; or, third, transport things other than people. Some evidence indicates that Uber has managed to accomplish the first and second and has launched services to offer the third. However, its growth does not address the fundamentals of driver-side economics. Uber's success in persuading riders to switch affects workers in the taxi and rental car businesses.[26]

Most remarkable is Uber's capacity for absorbing losses because of the nearly $13 billion in capital that it has raised since its inception—a feat it has accomplished by offering equity at ever higher valuations. As Appendix Table A1 indicates, Uber was able to expand rapidly geographically and in terms of business areas, while suffering severe losses and, later, geographic setbacks. The ability to raise capital, invest in growth, and depress the price of services has challenged its competitors, whether pushing taxi drivers to extinction or pressuring rental car firms. The assumption is that Uber and its VC-financed twin, Lyft, may be able to form an oligopoly, increase prices, and achieve profitability. Such an oligopolized system, with more drivers who are immediately on call, could operationally be superior for customers for several reasons. However, at the macro-level not many significant operational efficiencies appear to be generated. The certain result is that the industrial structure of the transportation industry will be transformed, and the role and power of labor (and small business, which is, after all, what the owner of the medallion is) will change. The capital advanced to Uber by private equity investors allows the firm undercut the prices offered by taxicab and rental car firms and thereby appropriate their

customers. The investors are betting that when Uber captures the market, the capital gains will materialize.

Amazon

Amazon differs from Uber in that it is a publicly held firm. However, since its inception in 1994, it has grown in sales and in stock valuation. (Amazon was the fourth-most-valuable firm in the world despite having minimal profits in contrast to Apple, Facebook, Google, and Microsoft). The availability of capital and the lack of a need to be profitable has given Amazon a powerful advantage in being able to funnel its earnings into growth—particularly through competitive pricing, expanding into new product markets,[27] integrating the supply chain further, and extending its distribution network into the business-to-business trade.[28] With each expansion, it leverages the infrastructure in terms of data centers, inventory and logistics management software, and logistics facilities that it built for its existing businesses.

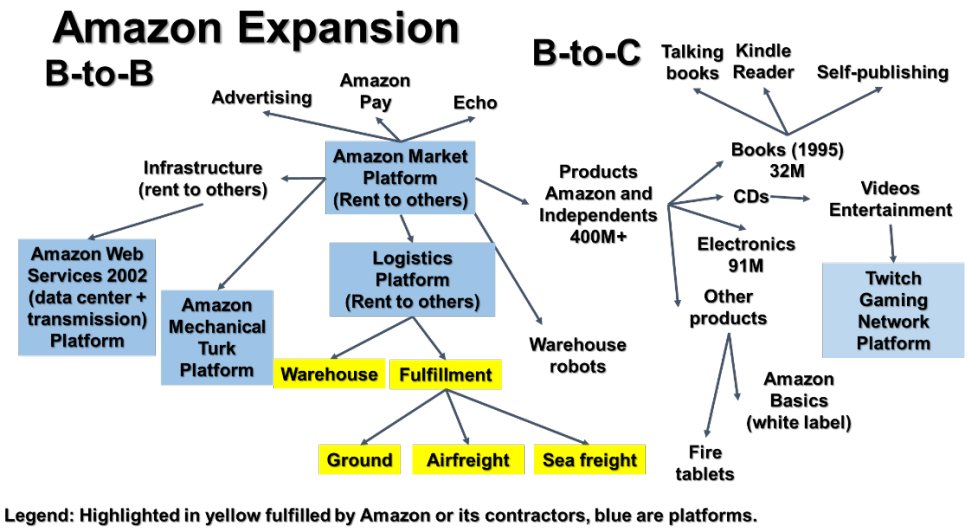
The primary competitors for Amazon have been other retailers, with which it has a co-opetition relationship, and it allows these retailers to offer their products and services in direct competition with Amazon, in the Amazon Marketplace (Khan 2017). Moreover, it provides these competitors with access to Amazon's entire logistics operation—of course, for a price. The key feature in this relationship is that Amazon collects all the data of retailers using its site. It has total visibility of their businesses, but they have no visibility into Amazon's sales. If Amazon detects that a particular product sold by one of its firms is proving to be very profitable, it can and does introduce competitive product using one of its

many brands, and then it can place the product directly next to the competitors' product in the search results. This is a powerful asymmetry.

Amazon's growth now brings the firm into direct competition with the largest US retailer, Walmart. Although Walmart is valued by its current earnings,[29] Amazon is priced like a technology firm, which allows it to have minimal profits and pay no dividends (Amazon's August 2017 price–earnings [P/E] ratio was 244, while Walmart had a P/E ratio of 18). Amazon would respond that its AWS business justifies its categorization as a technology company and that it is certainly more efficient than Walmart. In any case Walmart is required to have regular and consistent profits, while Amazon is not. Regardless of whether Amazon is more efficient than Walmart, it can offer lower prices, as it is not under pressure to have the same profit margins. This price advantage allows Amazon to drive its competitors out of the market.

Amazon is expanding in multiple directions simultaneously, integrating an ever-wider variety of activities (see Figure 3). As it expands in the logistics chain, it confronts incumbents, including third-party logistics providers such as UPS and FedEx, warehousing firms such as Grainger, and, of course, retailers. Amazon's volume enables the firm to negotiate discounts with vendors, while simultaneously optimizing its own logistics offerings.[30] As it integrates more of the logistics chain, it gains a powerful advantage from the data it collects on the significant percentage of all deliveries taking place and thus can optimize the use of its own resources and outsource demand for goods and services it cannot handle directly to third-party vendors. This thorough knowledge of the entire supply chain gives Amazon a heavy advantage over its "partners," whether they are shop owners, transporters, or warehousers, who have only limited visibility of that supply chain.

Figure 3. Amazon Expansion Paths



Source: Authors

4. Financial Weapons in Digital Markets: Implications for Labor

We try to wend our way through this complexity by focusing on investment and business strategies that rest on enduring operating losses. The ability to access enormous sums of capital and an elevated stock valuation provides the focal firm with a powerful tool for outcompeting its rivals, as it can lower prices or even purchase its competitors, as Facebook has done with Instagram and WhatsApp. The structure of competition is important not only for investors but also for labor. *How* firms compete can determine how much of what kind of labor is needed, who will deploy that labor, and where.

Establishing and contributing to the growth of start-ups and internal firm experimentation by investors willing to incur long-term operating losses pose many questions. Rapid growth strategies by platform economy firms have, by implication, raised questions for government regulators in a

wide variety of sectors, in practice an aggressive assault on regulatory boundaries, even as the labor platforms place significant and often effective wage pressure on parts of the workforce. Current strategies seem to suggest less attention on developing the talents and ability of workforces to form structures that support workers. Certainly Uber, Google Maps, and smartphones, for example, transform ordinary drivers with limited knowledge of a locale into "contracted" transportation providers. At the same time, the new Uber drivers put downward pressure on prices for all. There is no single story here; rather, the implications are contingent and continue to evolve. The consequences for labor will vary dramatically depending upon applications, and that varies across applications and market segments, and, indeed, among firms.

By way of conclusion, rather than offering a sweeping discussion of the impact on work generally of intelligent tools, a category that encompasses platforms, robots, AI, and big data, we highlight two issues: first, a wide variety of work arrangements is being generated by digital platforms; second, matters that seem distant from labor markets may determine the possibilities for labor.

Work and Digital Platforms

The complexity of the larger labor story is demonstrated by the character of work emerging on and through the platforms. Digital platforms and platform firms have a variegated impact, and much of the discussion to date focuses simply on one aspect of that complexity, such as gig workers, on which it then concentrates research. Doing so misses other important aspects, such as how workers generate income from work they obtain via platforms. The fissuring described by David Weil (2014) adds to complexity in the composition of the workforce.

We can divide the business and the character of the platform workforce in different ways. A list of workforce categories includes venture labor (Neff 2012), those who develop the firms and are often royally compensated; contractors on platform firms, notably, the "data janitors," who are content monitors and their equivalent, maintaining and cleaning up the software; the many folks who are uncompensated or not directly compensated, including those who generate attractive content uploaded to YouTube (Terranova 2000); and, of course, platform-organized gig workers, who are the focus of so much attention. To this list must be added those who generate consignment businesses, a category that includes not only Etsy but Airbnb. That subdivision is just the beginning, because others are needed, such as in-person service provision, which includes Task Rabbit as well as Uber, and remote service provision, which includes Upwork and is in a real sense an extension of service offshoring, a category with a long history (Dossani and Kenney 2007).

Policy and Work in the Platform Economy

Potential policy implications for labor and labor markets are as complex and diverse as the platforms and are perhaps even less evident than the restructuring of work. Debate, political choices, and legal decisions about what precisely constitutes platform firms will become critical. Uber claims to be a tech company when, in fact, it is firmly in the business of organizing and orchestrating transportation. In this case, the question is whether rules about issues such as public conveyance should apply. Meanwhile, the winner-take-all attributes of most digital platforms that underpin the willingness of investors to accept large operating losses for fairly long periods open a debate over competition/antitrust policies as important responses not only to investors and consumers but to workers (Coyle 2017; Khan 2017).

The concentration of power into a few digital platform giants, combined with the increased use of computation in almost every sphere of work and value creation, will continue to change the nature and process of work. One particularly important facilitator and accelerator of these changes is the enormous amount of capital available to firms experiencing with deep losses in the near and midterm that have the goal of developing a monopoly or monopoly-like position in the longer term when their target industries or markets are transformed. Those interested in the future of work ignore at their peril the role of capital in that transformation.

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APPENDIX

Table A1. Major Uber Expansionary and Fundraising Events

Date	Expansion	Financial Performance *	Expansion Details	Funding Round	Capital raised ($)	Valuation ($000)	Lead Investor
Mar. 2009	Company		Founded as UberCab	-	-	-	-
Aug. 2009	Finance		-	Seed	$200,000	-	Founders
July 2010	Company		Enters San Francisco	-	-	-	-
Oct. 2010	Finance		-	Angel	$1,250,000	-	Individual
Feb. 2011	Finance		-	Series A	$11 million	$60,000	Benchmark Capital
May 2011	National		Enters New York	-	-	-	-
Dec. 2011	International		Enters France	-	-	-	-
Dec. 2011	Finance		-	Series B	$37 million	-	Menlo Ventures
July 2012	International		Enters UK				
July 2012	Product		Announces UberX	-	-	-	-
July 2013	International		Enters Taiwan	-	-	-	-

Aug. 2013	Finance		-	Series C	$363 million	$3,500,000	GV
Aug. 2013	International		Enters South Africa	-	-	-	-
Aug. 2013	International		Enters India	-	-	-	-
Sept. 2013	Financials	Losses $56M, Rev. $104					
Nov. 2013	International		Enters Russia	-	-	-	-
Apr. 2014	Product		Uber Rush bicycle courier service	-	-	-	-
June 2014	Finance		-	Series D	$1.4 billion	$18.2 million	Fidelity Investments
July 2014	International		Enters China	-	-	-	-
July 2014	International		Enters Nigeria	-	-	-	-
Aug. 2014	Product		Uber Pool ride share	-	-	-	-
Sept. 2014	Financials	Losses $470 million, Rev. $415 million					
Sept. 2014	International		Banned in Germany	-	-	-	-

Dec. 2014	Product		UberFRESH in Los Angeles	-	-	-	-
Dec. 2014	International		Banned in India	-	-	-	-
Dec. 2014	Finance		-	Series E	$1.2 billion	$40 million	Glade Brook Capital
Jan. 2015	Finance		-	Debt Financing	$1.6 billion	-	Goldman Sachs
Jan. 2015	International		UberCARGO in Hong Kong	-	-	-	-
Jan. 2015	International		Enters Kenya	-	-	-	-
Feb. 2015	R&D		Autonomous vehicle program hires 50 from CMU	-	-	-	-
Feb. 2015	Finance		-	Series E	$1 billion	-	Glade Brook Capital
Apr. 2015	Product		UberFRESH rebrands as UberEATS	-	-	-	-
June 2015	Setback		Execs. arrested in France for illegal operations	-	-	-	-
July 2015	Finance		-	Series F	$1 billion	-	-

Aug. 2015	Finance		-	Private Equity	$100 million	-	Tata Capital
Sept. 2015	Financials	Loses $2 billion, Rev. $1.4 billion 2015					
Dec. 2015	Product		UberEATS spun off as standalone app	-	-	-	-
Feb. 2016	Finance		-	Private Equity	$200 million	-	Letterone Holdings
Apr. 2016	International		Enters Argentina	-	-	-	-
May 2016	Finance		-	Series G	Undisclosed Amount	-	-
May 2016	National		Leaves Austin, Texas	-	-	-	-
June 2016	Product		Uber RUSH API for merchant delivery system	-	-	-	-
June 2016	International		Enters Ukraine	-	-	-	-
June 2016	Finance		-	Series G	$3.5 billion	$62,500,000	Saudi Arabia Public Investment Fund

July 2016	Finance		-	Debt Financing	$1.15 billion	-	Morgan Stanley
July 2016	Setback		Leaves Budapest, Hungary	-	-	-	-
Aug. 2016	Setback		Leaves China; bought out by Didi	-	-	-	-
Sept. 2016	Product		Maps UK streets	-	-	-	-
Apr. 2017	Financial	Loses $2.7 billion, rev. $6.5 billion in 2016					
Apr. 2017	Finance		-	Undisclosed	Undisclosed	Undisclosed	Undisclosed
Apr. 2017	Setback		Banned in Italy	-	-	-	-
May 2017	National		Returns to Austin	-	-	-	-
May 2017	Setback		Google sues for autonomous vehicles	-	-	-	-
May 2017	Setback		Greyball use of surveillance	-	-	-	-
June 2017	Financials	Loses $718 million, rev.					

		$3.4 billion Q1					
June 2017	Management		CEO Travis Kalanick resigns	-	-	-	-
July 2017	Setback		Leaves Russia, partnership with Yandex	-	-	-	-
TOTAL		>$5.61 billion			$9,964,050,000		

* Estimates by authors from various leaked sources.

[1] A working group at Berkeley is exploring many of the same concerns as those that motivate this conference. The concerns in our research group, as in this conference, are the transformation of work, the economy, and the character of the society that results. Let us start by acknowledging those issues. Much of the language in this statement is drawn from the jointly authored statement of purpose for our research and discussion group, "Working, Earning, Learning in the Age of Intelligent Tools." Those at Berkeley involved in organizing the work include, in addition to ourselves: Annette Bernhardt, Brad DeLong, Ken Goldberg, Jennifer Granholm, Kenji Kushida, Mark Nitzberg, Shankar Sastry, Costas Spanos, and Laura Tyson.

[2] Labels and definitions matter. It is hard to define precisely a somewhat amorphous problem and, at the same time, capture the attention needed to address it. Hence, for some in our group, "robots" and "intelligent machines" include software operations and not just their physical manifestations. Others see computation-intensive automation, an awkward term if there ever was one, as more broadly capturing the field. By using the term "computation-intensive automation," we point to the abundance of computing power that enables the generation and analysis of data on a scale never before imagined, permitting the reorganization/transformation of both services and manufacturing.

[3] We hasten to add that, even in such environments, human beings have the ability to decide the proper functioning of the machines, etc. (Pfeiffer 2016).

[4] For a prescient exposition of the relationship between workers and machines, as the machines became computerized, see Zuboff (1988). As Zuboff (2015): 76) put it more recently, automation has a long history. However, "when it comes to information technology, automation simultaneously generates information that provides a deeper level of transparency to activities that had been either partially or completely opaque."

[5] Following Schumpeter, we do not claim that the technologies make the changes but that managers in existing firms and new entrepreneurs create the business models that actually change the economy.

[6] We do not deny that such monopolies may also have powerful efficiencies that derive from their massive scale.

[7] Of course, the Great Depression, which was, in part, part of the transformation of the US economy from one based on agriculture to one characterized by mass production and mass consumption after the New Deal, was quite dramatic!

[8] There are really two debates: how technology and its adoption in this era affects productivity and growth and how it influences levels of employment. The two debates are linked but somewhat separate. We note that here, but do not explore it. The remarkable technological changes wrought by digitization has created cognitive dissonance among economists, as productivity growth, which is where these changes would normally be captured, has grown significantly more slowly than in previous eras (Gordon 2016). Galvanized by Gordon's work, economists have given a variety of explanations for this slow productivity growth. One possible explanation is variation in adoption rates, with the top 10% of firms globally being most aggressive in adoption and thus having benefited, while the remaining firms are laggards. Thus presumably if the other 90% adopted the new technologies and practices, they would experience similar productivity gains (McGowan et al. 2015). The productivity growth debates are intertwined with those concerning employment and inequality. Some economists have suggested that labor's shrinking share of national income can be attributed to the increased use of information and communications technology (ICT) (Karabarbounis and Neiman 2014).

[9] Of course, another way to increase productivity is to decrease wages.

[10] For a variation on this observation, see Triplett and Bosworth (2004).

[11] More insight can be gained by thinking about the increasing centrality of digital platforms in economic life through the lens of platforms than from the perspective of an economy organized by "sharing," as has been advanced by observers such as Botsman and Rogers (2011) or Sundararajan (2013).

[12] For a more nuanced perspective and less judgmental perspective on contingent workers in technology fields, see Barley and Kunda (2006).

[13] This number is almost certainly an underestimate, as deposits to a bank account are only one way that platform-mediated workers are compensated. Often, payment is through PayPal or another platform.

[14] Although much of the critical literature assumes that in-person service provider platforms, such as Lyft, Uber, and TaskRabbit, are destined to be successful, some observers question their ability to operate profitably (Horan 2017).

[15] A recent unpublished study finds that Uber drivers might conspire to turn off their apps at the same time to trigger surge pricing (Solman 2017). The study suggests that this is a way that drivers regain power in their relationship with Uber. However, in keeping with Burawoy's work, this gaming actually helps manufacture consent. Moreover, as long as it is not perceived by consumers, it does not hurt Uber because the firm takes a percentage of the fare, thus a higher fare produces more income for Uber.

[16] For a powerful discussion of software as a form of capital, see Baetjer (1997) and, in a different way, Lessig (2009).

[17] The idea of computation as tools for thought is in Rheingold (1985), but was extended by Cohen et al. (2000) to the rise of the internet.

[18] On the dynamics and governance of platform ecosystems, see Gawer and Cusumano (2002).

[19] Apple, while enormous in size, sales, and profits, is different, because it operates in its own walled-garden ecosystem, but even it needs to fear Amazon, Facebook, and Google, with their powerful products and constant threat to erode the walls that protect its garden.

[20] The role of the JOBS Act of 2012 in dramatically increasing angel investors and crowdfunding and the current bubble should not be overlooked. For a laudatory article on the JOBS Act, see Stemler (2013). It is also possible to interpret the JOBS Act as a law that encourages "investor fraud."

[21] It is interesting to consider the implications of the fact that each of the new entrants is likely to have a different business model meant to disrupt the incumbent. Thus the challenge the incumbent faces is not one

entrant with one model, but multiple entrants with different models. If any of these models shows promise of success, then the venture capitalists will provide further funding for its growth. It is these multiple experiments/challenges that contribute to making the environment so treacherous for incumbents.

[22] Recent research by Gornall and Strebulaev (2017) suggests that the clauses in the financing contracts dramatically lower the true valuation of the most recent investment to such an extent that nearly half the unicorns they studied were not, in fact, worth $1 billion or more.

[23] Despite its bad publicity, management turmoil, difficult economics for drivers, and outsize losses, Uber continues to grow in terms of revenue. If it can staunch its losses by cutting expenses—something it is already doing, it is still possible for the firm to become profitable, though it is unlikely it will ever make as much money as its backers hoped.

[24] Of course, another limitation is spatial: the amount of screen space or storage space on smartphones that users are willing to devote to transportation apps is likely to be limited. This is another constraint.

[25] Although most observers focus on Uber's impact on taxis, it is also having an effect on the rental car business (King 2017). Of course, other issues are also pressuring the rental car business, particularly the collapse in the price of a used car.

[26] Ample evidence shows that Uber/Lyft is affecting the taxi industry, as can be seen in the decline in the value of medallions (see, e.g., Mosendz and Nasiripour 2017). In rental cars, it has been estimated that, in 2017, 52% of business transportation spending now goes to Uber and Lyft (Richter 2017).

[27] For example, auto parts, in which Amazon has contracted with large auto parts distributors to sell their parts online (*Business Insider* 2017).

[28] Amazon appears to be entering the electrical supplies industry. This is a highly regionalized industry that supplies electrical parts to contractors and others. The key thing here is that it would be Amazon's first direct penetration of the business-to-business market (McCrea 2017). The Chinese platform giant and possible global competitor for Amazon, Alibaba, began in the B-to-B space, but then entered the consumer side.

[29] In fact, this competition has been so disruptive that Walmart recently announced a joint venture with the other platform giant, Google.

[30] For a sophisticated discussion of the logistics issues, see Khan (2017).